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Electricity transmission line planning: Success factors for transmission system operators to reduce public opposition

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Electricity transmission line planning: Success factors for transmission system operators to reduce public opposition

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Preface

The idea for this thesis topic evolved in early 2010. At that time, I worked as a consultant with a special focus on renewable energies. During one of my projects, I came across the first signs of imminent bottlenecks in the European electricity transmission grid caused by delayed line expansions. The transmission network is the backbone of today's European electricity system and an essential prerequisite for its transformation towards a more sustainable system in the future to preserve our planet earth. Hence, I was keen to identify the underlying reasoning for project delays and identify how transmission system operators (TSOs) could address the respective issues. It soon turned out that the lack of social acceptance was the major blocking point in transmission line planning. This led to the combination of technical and sociological aspects in the work at hand, which especially inspired me.

Throughout the development of this work I was supported by several people, to whom I would like to express my utmost gratitude. First and foremost, I want to thank my supervisor Prof. Dr. Dominik Möst, Chair of Energy Economics at the Technische Universität Dresden, for being a sounding board, for the challenging discussions, inspiring thoughts and for his constructive feedback. Moreover, I would like to thank the co-examiner, Prof. Dr. Edeltraud Günther, Chair of Environmental Management and Accounting at the Technische Universität Dresden. Her critical and constructive advice was of great benefit for this work. Additionally, I would like to extend my thanks to the entire Chair of Energy Economics at the Technische Universität Dresden for their very warm welcome, the nice time they gave me whenever I was in Dresden, their critical thoughts in the numerous PhD seminars and their support throughout my study. Further gratitude goes to Dii GmbH, which not only hosted me for a major time of my research work, but also helped me to get in contact with the relevant stakeholders. In addition to this, members of staff supported me in the interviews through simultaneous interpreting and provided a great sounding board especially for the technical aspects of electricity transmission. I want to thank also the numerous interviewees and TSO employees throughout Europe for their time and patience. This work would not have been possible without their valuable input. Furthermore, I have to point out ENTSO-E in Brussels, which supported me to identify potential candidates within the TSO organizations as respondents for my questionnaire and also helped me to distribute it.

Finally, I would like to express special thanks to my partner. I experienced many ups and downs in preparation of my thesis. She always supported and motivated me, especially during the difficult times. Her encouragement helped me to overcome dire straits and to complete this work successfully.

Munich / Dresden, February 2014

Stefan Perras

Dedicated to my parents and grandparents

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List of abbreviations

AA	Appropriate Assessment
AC	Alternating current
ACER	Agency for the Cooperation of Energy Regulators
AS	Average sun
ATSOI	Association of the Transmission System Operators of Ireland
AVE	Average variance extracted
AW	Average wind
BALTSO	Baltic Transmission System Operators Association
BBEMG	Belgian Bio Electro Magnetic Group
CCS	Carbon capture and storage
CEER	Council of European Energy Regulators
CEF	Connecting Europe Facility
CENELEC	Comité Européen de Normalisation Électrotechnique (European Committee for Electrotechnical Standardization)
CESOC	Central European System Operation Coordinator
CIGRE	Conseil International des Grands Reseaux Électriques (International Council on Large Electric Systems)
CRIIREM	Centre de Recherche et d'Information Indépendantes sur les Rayonnements ElectroMagnétiques (Independent Centre for Research and Information on Electromagnetic Radiation)
CSC	Current source converter
CSF	Critical success factor
DC	Direct current
DENA	Deutsche Energieagentur (German Energy Agency)
DSO	Distribution system operator
ECN	Energy Research Centre of the Netherlands
EEA	European Environment Agency
EERP	European Economic Recovery Programme
EF	Electric field
EHV	Extra high-voltage
EIA	Environmental impact assessment
EIB	European Investment Bank
ELF	Extremely low-frequency
ELI	Ministerie van Economische Zaken, Landbouw en Innovatie (Dutch Ministry of Economic Affairs, Agriculture and Innovation)

EMF	Electromagnetic field
EnLAG	Energieleitungsausbaugesetz (Energy Line Extension Act)
ENTSO-E	European Network of Transmission System Operators for Electricity
EnWG	Energiewirtschaftsgesetz (Energy Industry Act)
EPRI	Electrical Power Research Institute
ERGEG	European Regulators Group for Electricity and Gas
ERRA	Energy Regulators Regional Association
ESTEEM	Engage stakeholders through a systematic toolbox to manage new energy projects
ETSO	European Transmission System Operators
EU	European Union
FACTS	Flexible alternating current transmission system
FAQ	Frequently asked questions
FEB	Swedish Association for the Electrosensitive
FIOH	Finnish Institute of Occupational Health
GAMS	General Algebraic Modeling System
GewStG	Gewerbesteuergesetz (German Trade Tax Law)
GIL	Gas-insulated transmission line
GIS	Geographical Information System
GoF	Goodness-of-fit
HS	High sun
HVAC	High-voltage alternating current
HVDC	High-voltage direct current
HW	High wind
Hz	Hertz
IAP2	International Association for Public Participation
IARC	International Agency for Research on Cancer
ICEMS	International Commission for Electromagnetic Safety
ICER	International Confederation of Energy Regulators
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IIREC	International Institute for Research on Electromagnetic Compatibility
IPC	Infrastructure Planning Commission
ISO	Independent system operator
ITC	Inter-TSO compensation
ITO	Independent transmission operator
KMO	Kaiser-Mayer-Olkin

KSF	Key success factor
kV	Kilovolt
LCC	Line commutated converters
LGTT	Loan Guarantee Instrument for trans-European transport network projects
LISREL	Linear Structural Relationships
LVPLS	Latent Variables Path Analysis for Partial Least Squares
MIMIC	Multiple Indicators Multiple Causes
MIT	Massachusetts Institute of Technology
MW	Megawatt
N_2	Nitrogen
NABEG	Netzausbaubeschleunigungsgesetz Übertragungsnetz (Grid Expansion Acceleration Act)
NACE	Nomenclature statistique des activités économiques dans la Communauté européenne (Statistical Classification of Economic Activities in the European Community)
NEA	Nuclear Energy Agency
NGO	Non-governmental organization
NOVA	Netz optimieren vor verstärken vor ausbauen (Grid optimization before upgrade before extension)
NPS	National Policy Statement
NPV	Net present value
NRA	National Regulatory Authority
NUTS	Nomenclature of Statistical Territorial Units
OHL	Overhead transmission line
OLS	Ordinary least squares
PCI	Projects of common interest
PDF	Portable Document Format
PIMS	Profit Impact of Market Strategies
PIP	Priority Interconnection Plan
PLS	Partial Least Squares
PSP	Pumped-hydro storage power plant
quango	Quasi-autonomous non-governmental organisation
RES	Renewable energy sources
RGI	Renewables Grid Initiative
ROCE	Return on capital employed
ROR	Rate of return
RSFF	Risk Sharing Finance Facility

RTE	Réseau de Transport d'Électricité
SAGE	Stakeholder Advisory Group on ELF EMFs
SCENIHR	Scientific Committee on Emerging and Newly Identified Health Risks
SEA	Strategic environmental assessment
SEI	Sustainable Energy Ireland
SEM	Structural equation modeling
SF_6	Sulfur hexafluoride
SOCROBUST	Social Robustness
SPSS	Statistical Package for the Social Sciences
SRU	Sachverständigenrat für Umweltfragen (German Advisory Council on the Environment)
StromNEV	Stromnetzentgeltverordnung (German Electricity Grid Charges Ordinance)
TSO	Transmission system operator
TYNDP	Ten-year network development plan
UCTE	Union for the Coordination of Transmission of Electricity
UfU	Unabhängiges Institut für Umweltfragen (Independent Institute for Environmental Issues)
UGC	Underground cable
UHV	Ultra high-voltage
UKTSOA	UK Transmission System Operators Association
VDE	Verband der Elektrotechnik Elektronik Informationstechnik (Association for Electrical, Electronic & Information Technologies)
VIF	Variance inflation factor
WCD	World Commission on Dams
WHO	World Health Organization
XLPE	Cross-linked polyethylene

List of symbols

γ	Gamma
δ	Delta
ε	Epsilon
ζ	Zeta
η	Eta
λ	Lamda
ξ	Chi
π	Pi

List of country codes

AE	United Arab Emirates
AT	Austria
AU	Australia
BA	Bosnia and Herzegovina
BE	Belgium
BG	Bulgaria
CA	Canada
CH	Switzerland
CN	China
CO	Columbia
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
EU	European Union
FI	Finland
FR	France
GR	Greece
HR	Croatia
HU	Hungary
IE	Ireland
IS	Iceland
JP	Japan
IT	Italy
KR	South Korea
LA	Laos
LT	Lithuania
LU	Luxembourg
LV	Latvia
ME	Montenegro
MK	Former Yugoslav Republic of Macedonia
MO	Morocco
MX	Mexico
NA	Namibia
NL	Netherlands
NO	Norway
PL	Poland
PT	Portugal
RO	Romania
RS	Serbia
SE	Sweden
SI	Slovenia
SK	Slovakia
TR	Turkey
UK	United Kingdom
US	United States

1 Introduction

1.1 Problem statement

The issues of climate change and global warming have gained a growing interest and discussion in the Western societies over the last decades. More and more people have developed environmental concerns and care deeply about the limited natural resources and the conservation of planet earth (EC DG Climate Action, 2011). Such rising concerns have led to decisions to transform the existing European energy system from a system that largely depends on fossil fuel into a more sustainable one relying predominantly on renewable energy sources (RES) over the next decades. In 2007, the European Council agreed on the Union’s core energy policy objectives of achieving an integrated and liberalized energy market, ensuring security of electricity supply and integrating RES. In particular, the decision was made that by 2020, RES should contribute at least 20% to Europe’s final energy consumption that greenhouse gas emissions must fall by 20% and energy efficiency gains need to result in energy consumption savings of 20%. Three years later, these targets, which are also known as 20-20-20 goals, were incorporated by the European Commission into its Energy 2020 strategy (COM (2010) 639). The Commission stated that “[e]nergy is the life blood of our society. The well-being of our people, industry and economy depends on safe, secure, sustainable and affordable energy”. In late 2011, the European Commission also published its Energy Roadmap 2050 targeting greenhouse gas emission reductions of even 80-95% compared to 1990 and RES representing the biggest share of energy supply technologies in 2050 (COM (2011) 885).
The best renewable resources are not spread equally across Europe but are located in certain sweet spots. As a consequence, there is the idea that large new offshore wind farms in the North and Baltic Sea will have to be integrated over the next decades and their electricity to be transported to the demand centres in Central Europe. Similarly, solar energy generated in Southern European or even in North African countries needs to be transmitted to consumers elsewhere in Europe. The historically grown transmission network cannot cope with the increasing regional discrepancies between generation and demand centres. In the past, power plants were built close to an area with high electricity consumption which only required limited transmission line networks. Furthermore, the inherent intermittent characteristic of wind and solar power needs to be balanced. One of the most cost effective ways to do this is by large energy storage facilities that mainly exist in Scandinavia and Austria which stresses the transmission grid additionally. The installation of new conventional power plants close to demand centres to further balance volatile renewables and to relieve transmission grids has recently become uneconomical in the existing market environment (EURELECTRIC, 2011). The nuclear incident in Fukushima, Japan, in 2011 and the resulting decision of the German government to phase out its nuclear power completely at the latest by 2022, has put large base-load energy generation capacities off-grid which exacerbated the difficult situation even more. The European electricity network has to keep pace with these developments and adapt to the new power generation mix. In

addition to this, the targeted creation of a liberalized internal European energy market requires additional interconnection lines across borders. Transmission system operators (TSO), which in Europe are responsible for the installation and operation of electricity transmission lines, are obliged to provide a stable electricity supply to consumers. Brownouts, i.e. drops in voltage, and blackouts, as complete disruptions of electricity supply have to be avoided. Therefore, to address the above mentioned challenges, new electricity lines have to be installed. In particular, almost 42,000 km[1] of new transmission lines are required on European mainland within the next 10 years, amounting to investments of around EUR 81 billion (ENTSO-E, 2012a, pp. 15; 70). However, TSOs are currently facing lengthy and complicated authorization processes as well as extreme public opposition to their transmission line projects. These obstacles regularly lead to significant project delays of many years. Only a very limited number of transmission lines have been realized in Europe within the last decades. The delays carry significant additional costs for TSOs as well as for the society as a whole. In Germany for instance, about 200 GWh of electricity from wind energy had to be dumped in 2010 as grid congestions hindered their transportation to the demand centres (Zimmermann, 2011). Thus, the current electricity grid infrastructure has become the bottleneck of European energy system and its transformation. Without a significant expansion of the electricity transmission network, it will be difficult to integrate the planned shares of RES in Europe and meet the set targets. TSOs need to identify measures to avoid long delays in the planning phase of their transmission line projects. As they cannot directly, except for lobbying, influence the required authorization and permitting processes, their possible field of action is limited to dealing with people directly who oppose the lines. Hence, TSOs need to identify success factors with which to avoid severe public opposition in their transmission line projects and make the people tolerate them.

1.2 Thematic classification and research gap

The described problem relates to three research streams: first, the theory of transmission line planning from a rather practical perspective; second, the aspects of social acceptance as the frame for public opposition; and third, the attempt to identify implementable success factors for management relating to success factor research. The latter classifies the work at hand as a scientific study in the field of business administration (Haedrich & Jenner, 1996, p. 13).

Available research on **electricity transmission line planning** revolves mainly around siting methodology (EPRI, 2006; Vajjhala & Fischbeck, 2007), technical aspects (Cole et al., 2008; Stantec Consulting, 2009), and project risk management (Leung et al., 1998; McCormack, 1995; Tummala & Burchett, 1999). It investigates transmission network planning methods (Chung et al., 2003) and deals with entrepreneurial aspects such as project finance and investment (Buijs et al., 2010, 2011).

[1] Incl. 8,300 km of line upgrades. Subsea cables are excluded.

Scientists working on research regarding **social acceptance** mainly investigated sociological and psychological aspects, in particular the attitudes and behaviours of people (Lucke, 1995) as well as their risk perceptions (Renn, 2000; Renn et al., 1992; Renn & Zwick, 1997; Slovic et al., 1979). Moreover, researchers tried to understand people's interests and motives (Dear, 1992; Fischel, 2001; Wolsink, 1994) as well as respective influencing factors and drivers (Dütschke, 2011). Due to people's rising social awareness, research on social acceptance has experienced a growing interest over the last decades. Just recently, the Boysen Graduate College was founded at the Technical University Dresden to explicitly do research on the interdependence between technical designs and social acceptance.

Theoretical **success factor research** primarily deals with methodological developments for the identification of applicable sets of success factors (Albers & Hildebrandt, 2006; Bauer & Sauer, 2004; Grünig et al., 1996; Ringle, 2004a; Wold, 1982a). It can be differentiated between explorative work that identifies unknown cause-effect relationships and confirmatory work that tests and validates these hypothetical associations. Success factor identification methodologies have been applied practically in several fields such as marketing (Albers, 2010; Kalka, 1996), customer relationship management (Li Kam Wa, 2001), supply chain management (Röderstein, 2009; Schmidt, 2007), information systems (Rockart, 1982), research and development (Trommsdorff, 1990) or strategy (Ganesh & Mehta, 2010; Göttgens, 1996; Grimm, 1983; Steiner, 1969). In general, identified success factors are distinct across different industry sectors or business fields (Haedrich & Jenner, 1996).

The combination of these three research streams defines the field of investigation that is relevant for the previously stated problem. Searches[2] in databases of major publishers (Elsevier, Emerald, EBSCO, Springer, Wiley), in an academic journal archive (JSTOR), in the world's largest bibliographic catalogue (WorldCat) and even in Google Scholar (as recommended by Tranfield et al. (2003)) revealed that the field of interest lacks comprehensive empirical studies and thus represents a significant research gap. In particular, neither a published nor unpublished scientific research work could be found which empirically identified success factors in order to avoid public opposition in transmission line planning.

1.3 Objective, research questions and scope of work

Objective of this work is to identify and to empirically validate success factors with which TSOs can avoid severe public opposition in their transmission line projects and therefore reduce respective project delays. It aims to close the previously mentioned research gap in the literature. In particular, potential success factors and drivers should be identified and hypotheses on possible cause-effect relations between the measures and reduced public opposition should be developed. This research objective translates into the following research questions:

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[2] Using the search term combination of 'public opposition', 'public resistance' or 'social acceptance' with ‚transmission line' and ‚success factors'.

- What are people's motives and underlying reasons for opposing transmission line installations?
- What potential success factors can be derived from requests of stakeholders who are opposing transmission lines?
- What potential success factors can be derived from analog infrastructure projects?
- To what extent do the identified potential success factors reduce public opposition in transmission line projects?

As management practice often faces the challenge of adapting and translating scientific results into practice, the outcome of this work should also be transformed into a set of implementable measures for TSO management. According to Kosiol (1964, p. 745), business administration has two general objectives: the theoretical scientific goal of identifying new findings and integrating them into theory as well as the pragmatic scientific goal for the identification of new findings to solve problems for practice. Thus, the work at hand strives for both of these objectives.

As already mentioned, permitting processes and regulation for transmission lines cannot be directly influenced by the TSOs and thus are not in the scope of this research work. They are considered as exogenous factors. Instead, the work focuses on the TSO's own field of action in the planning phase of new transmission lines. Commissioning, construction and operation of transmission lines are kept out of scope as public opposition is usually not an issue during these project phases. The regional focus of this study is on Europe. In particular, it comprises all member countries of the European Network of Transmission System Operators for Electricity (ENTSO-E), which is the association of all European TSOs. Furthermore, the focus is on the transmission grid with voltage levels of 220 kV and above. At these voltage levels, public opposition is especially high as lines are predominantly built overhead, visual impact through large steel pylons is significant and electromagnetic fields are considerably higher compared to lower voltage levels. In addition, people often do not see direct benefits from these mere transition lines as they are in most cases not directly connected to them. Public opposition is also not a considerable issue for the installation of subsea cables which are therefore excluded from the scope of this work.

1.4 Methodology and structure of work

To answer the research questions, the work at hand is structured as outlined in figure 1.

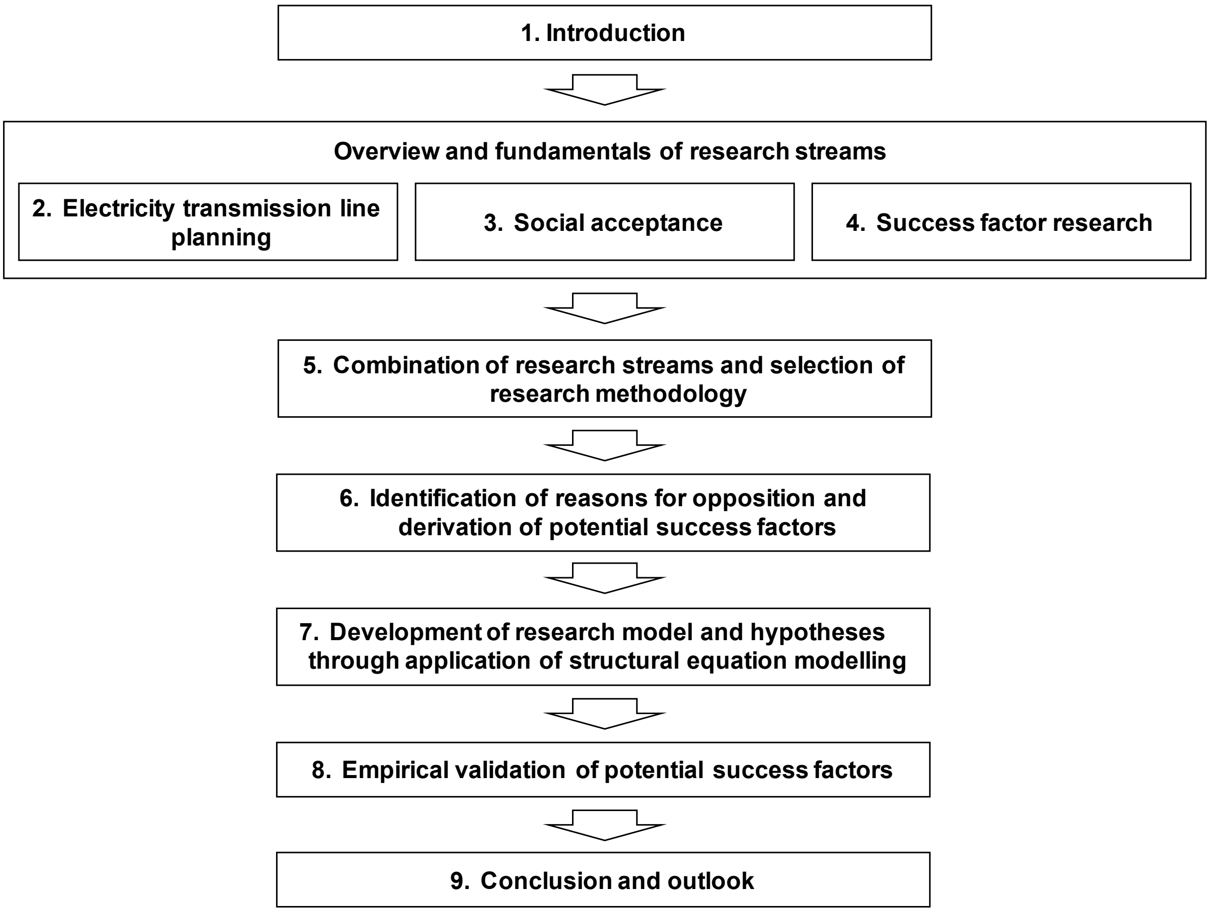

Figure 1: Structure of work.

In the following chapters the fundamentals of the three research streams are outlined and discussed in detail. Chapter 2 starts with an overview of the electricity transmission network, its history and major players, i.e. mainly TSOs, relevant associations and regulators. The different electricity transmission technologies and technical details are explained in a comprehensible way and outlined only to an extent that is required for the purpose and understanding of this work. Furthermore, respective terminologies are defined and explained. A focus is put on the transmission planning process itself, its individual stages and their optimal durations. This is then compared to current transmission line projects in order to illustrate the respective delays and describe underlying reasons. Although not in the primary scope, recent and currently ongoing legislatory and regulatory changes to overcome project delays on national as well as European level are briefly discussed.

In chapter 3 the term social acceptance is defined for the context of this work and an overview of the available literature as well as the status of the scientific research is given. People's motives for opposition are presented in general and contextual factors that influence their attitudes towards transmission lines are identified. Moreover, the history of social movement is explained and different forms of public opposition outlined.

Chapter 4 continues with an introduction of the field of success factor research. Here, success factor terminology is defined and a brief history, recent developments as well as the current state of success factor research is provided. Finally, possible success factor identification approaches are discussed in a systematic way and assessed accordingly.

After the introduction of the fundamentals, the research streams are combined in chapter 5. As the intersection of all three research streams represents a research gap, the streams are combined bilaterally to identify available literature in those joint areas and thereby identify suitable information, which can help to narrow down the research gap. Next to that, the research methodology is selected, i.e. the method with which the success factors are going to be identified empirically.

In chapter 6 the underlying reasons for public opposition against transmission lines are identified. Furthermore, potential success factors and hypotheses about their particular causal relations with public opposition are developed. This is done through interviews with transmission line stakeholders, i.e. action groups and non-governmental organizations (NGO), a comprehensive literature research and the analysis of large scale infrastructure projects, which are in their characteristic similar to transmission line projects.

In chapter 7, the research model is developed through the application of structural equation modeling (SEM). For this purpose, the methodology of SEM is introduced first. Then, the potential success factors and developed hypotheses about causal relations are used to generate a path diagram and to specify the model.

The model is validated in chapter 8 through a questionnaire survey carried out with all European TSOs. For this reason, the research model is operationalized and the questionnaire designed as well as pretested. Possible biases are discussed and respective mitigation measures implemented. To ensure reliable and valid results, the research model is evaluated along common quality criteria. The calculation results are then interpreted, hypotheses verified and respective recommendations for TSO management derived.

The final chapter concludes with a summary of the work’s results and its contribution for research as well as practice. Furthermore, the work’s limitations are discussed and directions for future research are proposed.

2 Fundamentals of electricity transmission line planning

As this work's main focus in on the European electricity network, its history and the different electricity transmission technologies are briefly described. Being familiar with the characteristics of the network as well as the advantages and disadvantages of the different transmission technologies will help to understand the argumentation of certain stakeholders who oppose transmission lines. Furthermore, the major players in transmission line planning and their roles are introduced and the planning process is explained step by step. It will give an understanding in which planning phases and why severe delays occur and will facilitate the identification of success factors for TSOs to them.

2.1 History of the European electricity transmission network

Today's European electricity transmission network design dates back to Nicola Tesla, who invented alternating current (AC) electrical motors and transformers in 1888 in the United States (Tesla, 1888). Electricity transmission was until then only possible via Thomas Edison's direct current (DC) technology across very short distances. This was because electrical engineers failed to step up the voltage levels required for long distance transmission. As a consequence, power stations were built close to demand centres. The American engineer George Westinghouse advocated Tesla's AC transmission technology and ran against Thomas Edison and his preferred type of transmission. This debate about the transmission technology standard is also known as the 'War of Currents' (Europacable, 2011a, p. 5). With transformers invented by Tesla, voltage levels could be changed easily and power transmission was now possible over much longer distances with AC technology. This led to AC power transmission becoming the predominant technology of choice in the subsequent century. European Engineers at the time agreed to a standard frequency of 50 Hz[3]. Since the development of switch thyristors in the 1970's DC electricity transmission has been possible for extra high-voltage (EHV) levels of up to 500 kV (Europacable, 2011a, p. 5) and has been predominantly used for transmitting electricity over long distances. European wide intermeshing of high-voltage alternating current (HVAC) lines started in the late 1930's with the proposed plans from the engineers George Viel, Ernst Schönholzer and Oskar Oliven (Lagendijk, 2008, pp. 80–82). The use of high-voltage transmission lines meant that electricity production was no longer bound to be close to consumers (Lagendijk, 2008, p. 47). In Germany, power transmission lines have been originally engineered with a voltage level of 110 kV. In 1922, the first 220 kV line was installed and after World War II the 380 kV transmission network was established and extended in Germany as well as throughout Europe (VDE, 2010, p. 16). Today's European electricity grid is divided into a transmission and a distribution grid (see figure 2 on the next page). The transmission grid aims to transport electricity across long distances and thereby increases system security. It consists of high-voltage levels of 220 and extra high-voltage (EHV) levels of 380/400 kV. The lower high-voltage

[3] In America the frequency was set to 60 Hz.

level of 110 kV is used for sub-transmission and transmission of bulk quantities of electricity. As such it is also called 'sub-transmission grid'. Furthermore, it connects heavy industry and railways that require high-voltage levels. The distribution grid consists of a medium-voltage level of 1-50 kV to allocate electricity within urban and rural areas, to which industry and city networks are directly connected. The second and lowest level of the distribution grid is called low-voltage level and is transformed below 1 kV. Domestic homes and small commercial customers receive their electricity from it. They get electricity at voltage levels of around 220/230 V (Kießling, 2003, p. 6; Schwab, 2009, pp. 20–21).

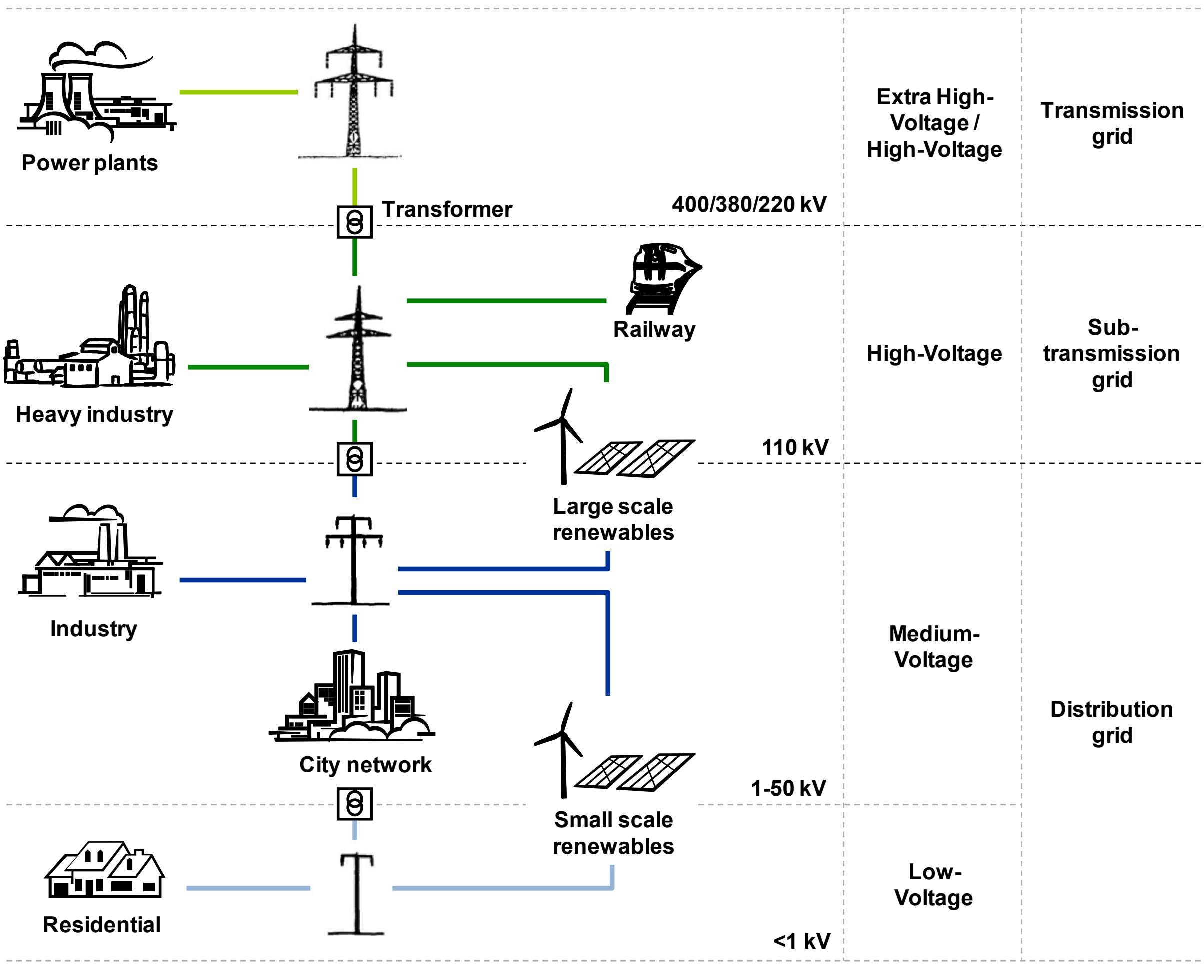

Figure 2: European electricity levels.

Between the different voltage levels, transformers are used to step down the voltage respectively. Large scale renewable energy power plants such as wind or solar parks feed-in their generated electricity either at high-voltage or medium-voltage level depending on their size. The same holds true for small scale renewable energy installations that feed-in either at medium-voltage or low-voltage levels respectively. The current European electricity grid consists of 305,000 km of transmission lines (ENTSO-E, 2011c, p. 2) of which 99.71% have been installed as overhead lines (OHLs) and only 0.29% are installed as underground lines (Leprich et al., 2011, p. 47).

2.2 Transmission technologies

2.2.1 High-voltage alternating current (HVAC)

2.2.1.1 High-voltage alternating current overhead lines (HVAC OHL)

A three-phase high-voltage alternating current overhead line (HVAC OHLs) is the predominant transmission technology installed in today's European electricity transmission network, which is highly meshed with plenty of connection points, so called nodes, to withdraw or feed-in electricity. Transmission flows through HVAC lines depend on the physical laws of Kirchhoff, i.e. "the effect of any change in one part of the network (e.g. changing the load demand at a node, raising the output of a generator, or switching on or off a line or a transformer) will spread instantaneously to other parts of the interconnected network, altering the loading conditions on all transmission lines" (Wu et al., 2006, p. 955). Thus, HVAC line flows cannot be controlled directly as they are subject to line impedances[4]. The limited controllability can also lead to loop flows in an AC grid (Buijs et al., 2011). TSOs need to ensure stability and security of the network system. Transmission lines are usually not operated at their full thermal capacity limit because in case of a failure of a line in the network, other lines need to carry the additional load. In other words this means that an operating system, which has already sustained an outage, must also be able to tolerate another contingency (Alvarado & Oren, 2002). Experts refer to this as the 'N-1 criterion'. An example would be if a line is down for maintenance and another line suffers a technical failure. HVAC network security is not only ensured through its meshed characteristics, but also due to the fact that transmission lines often carry within themselves more than one power circuit (see figure 3 on the next page). In case one circuit fails, the other circuit(s) can carry the complete peak load as a contingency operation (Williams & Gregory, 2010, p. 23). A major disadvantage of HVAC lines is the high transmission losses over long distances that occur due to ohmic resistance. A regular HVAC OHL faces losses of up to 15% over a distance of 1,000 km (Lagendijk, 2008, p. 40). It should be mentioned that the maximum power transmitted through a HVAC OHL that can be used effectively to e.g. drive a motor, is less than the maximum line capacity. This is because reactive power is steadily required to set up the electric and magnetic fields of alternating currents. Reactive power consumes line capacity but cannot be used for electricity consumption. This in turn means that the active power that can be utilized is limited by the maximum physical transmission capacity of the line less the reactive power. Regarding lifetime, HVAC OHL installations can be used for up to 80-120 years where the used aluminium conductors themselves usually need to be replaced after 40 years (VDE, 2010, p. 27).

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[4] It should be noted that HVAC line flows can be controlled to a limited extend through the installation of phase shifting transformers or flexible alternating current transmission system (FACTS) equipment. For details see ENTSO-E (2012a, pp. 173–174).

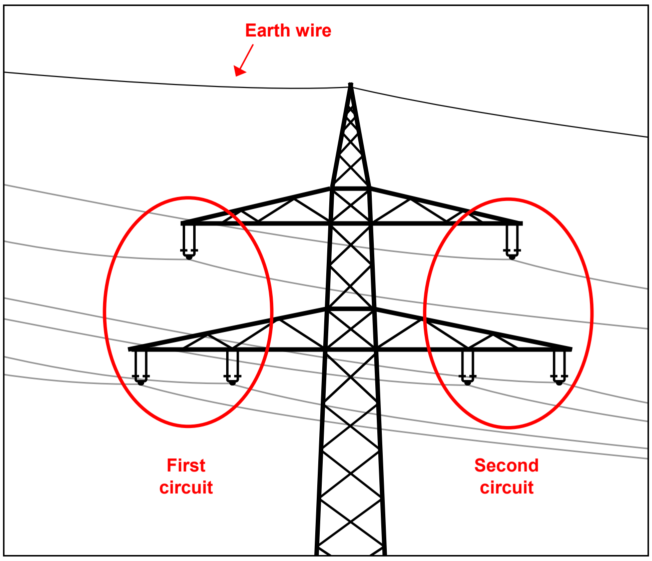

Figure 3: Overhead transmission line system with two parallel AC circuits. The earth wire is to protect against lightning strokes. Own illustration.

2.2.1.2 High-voltage alternating underground cables (HVAC UGC)

Compared to HVAC OHLs, HVAC underground cables (UGC) have a lower ohmic resistance due to their larger conductor cross-section and the usage of copper as a conductor material. The disadvantage of copper is that it is heavy and limits the maximum cable lengths that can be transported due to weight restrictions of roads, bridges etc. However, copper has a higher conductance compared to aluminium alloy conductors that are usually installed for OHLs. This leads up to 50% less transmission losses for HVAC UGC systems compared to HVAC OHLs (Leprich et al., 2011, p. 25) and thus the operation costs of a line are significantly reduced (EC, 2003, p. 25). A downside of HVAC UGCs is that they face higher capacitive currents than HVAC OHLs due to their physical characteristics. Capacitive currents in HVAC UGCs rise proportionally with cable length and represent reactive power that reduces the active transmission capacity of the line. If HVAC UGCs reach a certain length, which is also called the 'critical length', the line needs to compensate these currents in order to keep up the transmission capacity. Without compensation the reactive power would significantly reduce the transmission capacity of the line and would render it economically unviable. Compensation is achieved by installing compensation stations at the ends of a HVAC UGC that are costly and reduce line efficiency[5]. The European Commission states that the maximum length possible between compensation stations is around 20 km (EC, 2003, p. 25). Industry experts claim that without intercompensation the maximum length can even reach 50-100 km for a 380 kV HVAC UGC depending on the resonance of the surrounding grid (Leprich et al., 2011; interview with Heinrich Brakelmann, 01.12.2011). However, this is still about four times less compared to a HVAC OHL

[5] Compensation of 9-10 MVA/km per circuit is required and costs for compensation stations are between EUR 60,000-70,000/km (Brakelmann, 2004, p. 31).

system (EC, 2003, p. 25). Cables installed nowadays are known as cross-linked polyethylene (XLPE)[6]. They can be used for voltage levels of above 380 kV and have been applied at these voltage levels since the early 1990s (Europacable, 2009). However, cables have to be still ordered customized to a certain extent which leads to supply periods being about half a year longer compared to OHL systems (SRU, 2011, pp. 325–326). Total annual EHV cable production capacity is currently around 3,500 km in Europe (Europacable, 2011b, p. 18). In terms of reliability, there are currently two major studies comparing 380 kV UGC and OHL systems with contrasting results. The study by Obergünner et al. (2001) states that the risk of failure is 1.38-6.25 times higher for UGCs compared to OHLs. However, experts regard this study as deficient, as it still includes old oil saturated cable technologies that are not used anymore. Furthermore, its scope is limited to Germany (Leprich et al., 2011, p. 38). A more recent study was conducted by CIGRE in 2009 and includes all European transmission lines. It shows a 0.5 times lower failure rate for UGC systems (CIGRE, 2009). Nevertheless, long-term experience is still lacking (interview with Hermann Guss, 30.11.2011). UGC failures are primarily caused by external factors, e.g. an excavator damaging the cable during ground works. Until today, no failures have been reported that were provoked by defect cable isolation directly. The maximum length of cable pieces for installation is determined by transport weight and cable drum capacity restrictions. The majority of roads limit freight to 40 tonnes. This results in a maximum cable piece length of around 700-900 m and requires the cable pieces to be connected with cable joints that carry an increased risk for failure. The installation of cable joints requires clean room comparable conditions, as accidently included dust particles can disturb the electrical conditions and lead to operation failures (Beers et al., 2011, p. 14). Therefore, engineers regularly erect special huts or containers when installing joints in order to protect from dirt at construction sites (see figure 4). Once installed, joints are usually covered by a mixture of sand and cement as the most cost effective solution. However, as shown in figure 5, TSOs often install concrete joint bays to increase protection and accessibility.

Figure 4: Protection hut for joint installation. Picture: Tennet

Figure 5: Concrete joint bay. Picture: Vattenfall

[6] Also called VPE according to the German description ‘vernetztes Polyethylen’.

If not the full line distance but only a part of it is buried, transition stations are required which connect the OHL part with the UGC system. These installations are costly and technically complex (SRU, 2011, pp. 325–326). The lifetime of HVAC UGC systems is estimated to be between 40-60 years (Arlt et al., 2011, pp. 13–14; EC, 2003, p. 16; Leprich et al., 2011). In a survey conducted in 2006, CIGRE listed around 1,400 installed km of UGCs above 315 kV worldwide. A list of the longest installed HVAC UGCs in the world with XLPE cables can be found in appendix 1.

2.2.2 High-voltage direct current (HVDC)

2.2.2.1 High-voltage direct current overhead lines (HVDC OHL)

In contrast to the three-phase HVAC lines, high-voltage direct current (HVDC) lines are bipolar and do not require reactive power, i.e. only active power is transmitted. HVDC lines have the advantage of 25-35% less ohmic losses compared to equivalent HVAC lines (Kießling, 2003). However, the converter stations that are required at both ends to connect an HVDC line to the HVAC grid induce conversion losses of up to 1.7% per station (Cole et al., 2006, p. 23)[7]. They are also very costly with around EUR 135-250 million each (Cole et al., 2008, p. 51; Meah & Ula, 2007, p. 4). For an OHL, the HVDC technology breaks even compared to HVAC at a distance of around 600 km (see figure 6), when the benefits of low line losses outweigh the downsides of high converter station costs and conversion losses.

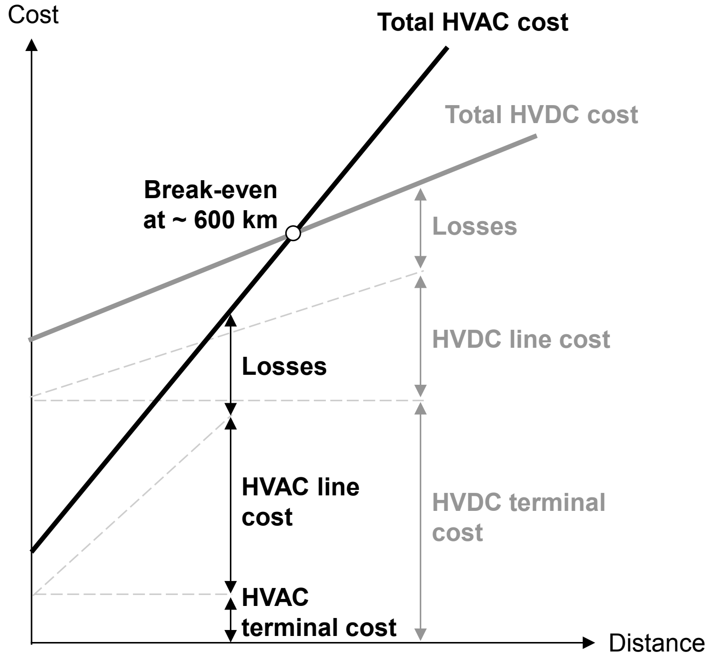

Figure 6: Cost-distance comparison of HVAC OHL and HVDC OHL technology. Own illustration adapted from ABB (2011b).

7 For VSC HVDC. Classic HVDC is only 0.75% per station (interview with Dietmar Retzmann, 01.11.2011).

HVDC OHLs can carry high power of more than 1,000 MW (Europacable, 2011a, p. 3). In contrast to HVAC solutions, HVDC systems allow for full power flow control which leads also to an increase in overall system stability. Thus, HVDC lines are not bound to solidarity and are therefore independent from the remaining network. The technology is often used for interconnecting national or regional grids. This is because in case of a failure in the neighbouring grid, the HVDC line prevents cascading to the domestic one. Moreover, the technology is able to synchronize asynchronous networks. HVDC lines can currently only be used for point to point connections and not operated as a meshed system. This is due to the non-availability of circuit breakers, so called switchgears (ENTSO-E, 2012a, p. 171). However, the development of circuit breaker technology is currently ongoing (Europacable, 2011a, p. 3). Today, there are two main HVDC technology concepts available: Classic HVDC and VSC HVDC. The main difference lies in the design and functionality of the respective converters. The Classic HVDC uses Line Commutated Converters (LCC)[8] which operate at very high voltage levels and need reactive power from the neighbouring AC grid[9]. In the 1990s, a new type of HVDC based on Voltage Source Converters (VSC) was developed and is commonly referred to as VSC HVDC[10]. This new kind of converter allows the independent control of voltage levels and does not need reactive power from the HVAC grid (VDE, 2010, p. 42).

2.2.2.2 High-voltage direct current underground cables (HVDC UGC)

The cost break even for HVDC subsea and land cables compared to HVAC solutions is different to the already mentioned HVDC OHLs. For subsea cables, experts prefer HVDC technology beginning already at a distance of 80-100 km as HVAC compensation measures are impractical at sea. For HVDC land cables the break-even is similar (EC, 2003; interview with Jochen Kreusel, 01.11.2011)[11]. HVDC UGCs can carry medium to high power, i.e. 100 MW-1,000 MW (Europacable, 2011a, p. 3). In terms of references, HVDC UGCs have been commercially applied to a larger extent since the 1950's. Reliability of HVDC UGCs is regarded slightly less than HVAC UGC systems as it does require converter stations, which are additionally prone to failures. TSOs state a minimum life expectancy of 40 years for their HVDC OHLs and according to industry experts, HVDC UGCs do also reach such durations (Europacable, 2011a, p. 9; Stantec Consulting, 2009, p. 79). A list of all worldwide installed HVDC UGC projects can be found in appendix 2.

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8 Also known as Current Source Converters (CSC).

9 Later also Capacity Commutated Converters (CCC) were introduced that altered and improved the behaviour of LCC but they remained overall a niche application with the advent of VSC (Carlsson, 2002).

10 Which is labelled as ‚HVDC Light' by ABB and ‚HVDC PLUS' by Siemens.

11 HVDC could also be the preferred solution for shorter distances if it is to interconnect and synchronize grids.

2.2.3 Gas-insulated lines (GIL)

A special electricity transmission technology is the gas insulated line (GIL), which allows higher transmission voltages and power ratings. The conductor core is placed in an isolating gas within a metal tube. The very first 380 kV GIL system was installed in 1976 in Germany (Koch et al., 2002). At the moment, there are no long distance connections using GIL technology. GIL is more expensive than underground XLPE cables (Buijs et al., 2011) as it requires joints around every 20 m. GIL technology is therefore mainly used to transmit bulk power over a short distance, e.g. from a nearby power plant to a city (Cole et al., 2008, p. 15). GIL systems are easier to integrate in a surrounding AC network than HVDC technology. GILs have an expected lifetime of minimum 50 years (VDE, 2010, p. 535) and can be installed both aboveground as well as underground, with the latter being the preferred solution. When put underground, the lines are in most cases laid in a ventilated tunnel system (see figure 7). GILs are currently offered mainly by Siemens, which has a maximum production capacity of 20 km per year (Niedersächsische Landesregierung, 2011). By the end of 2012, there will be around 85 km of GILs installed worldwide with approximately 30 km being underground (Johnston, 2011). A list of the installed underground projects can be found in appendix 3. Nevertheless, GIL deployment is rather considered for niche applications (ENTSO-E, 2012a, p. 173). Due to the limited available manufacturing capacity and reduced suitability for long-distance electricity transmission, GIL will not be considered further in this work.

Figure 7: GIL installation in tunnel. Source: Siemens.

2.3 Major players

2.3.1 European Transmission System Operators (TSOs) and related associations

2.3.1.1 National Transmission System Operators (TSOs)

National Transmission System Operators (TSOs) are the companies responsible for the transmission of electric power on the main high and EHV electric networks. In contrast to that, the Distribution System Operators (DSOs) manage the distribution grid which is the network at voltage levels below 220 kV. "TSOs provide grid access to the electricity market players (i.e. generating companies, traders, suppliers, distributors and directly connected customers) according to non-discriminatory and transparent rules. In order to ensure the security of supply, they also guarantee the safe operation and maintenance of the system" (Nies, 2009, p. 26). Therefore, TSOs are in charge of the development of the grid infrastructure and need to update and extend their grid regularly. Transmission lines are usually nationally regulated, i.e. TSOs can pass on the investment and operation costs of their lines to the electricity consumers as network tariffs. These fees are subject to approval by the national regulatory authorities (NRA). Next to regulated lines also merchant lines exist. These transmission lines are privately owned by independent transmission companies and do not belong to the regulated transmission asset base. However, as these types of lines are very rare in Europe, they are excluded from the scope of this work.

Historically, TSOs were part of national vertically integrated utilities who also owned the respective national transmission grids. For electricity consumers this carried the risk that companies which operated a transmission grid, and at the same time managed the production and supply, might use their proprietary position to prevent competitors accessing their networks. Therefore in 1997, the European Commission published its Directive 96/92/EC, which contained common rules for creating a European internal electricity market. It declared that "unless the transmission system is already independent from generation and distribution activities, the system operator shall be independent at least in management term from other activities not relating to the transmission system". This was followed by Directive 2003/54/EC stating that transmission systems need to be operated through a legally separate entity in which vertically integrated undertakings may still exist. In vertically integrated companies, the independence of the TSOs regarding generation and supply has to be guaranteed by independent management structures. However, the legally imposed separation did not mean a change of ownership of the transmission assets. In the end, the Directive was not stringent enough to foster effective separation of transmission networks from activities of generation and supply. As a consequence, the European Commission published Directive 2009/72/EC and stated that "without effective separation of networks from activities of generation and supply (effective unbundling), there is an inherent risk of discrimination not only in the operation of the network but also in the incentives for vertically integrated undertakings to invest adequately in their networks". This is often also described as 'strategic underinvestment' (SRU, 2011, p. 297). The Commission regarded "ownership unbundling, which implies the appointment of the network owner as the system operator and its independence from any supply and production interests (…) as the most effective tool by which to promote investments in infrastructure in a non-discriminatory way, fair access to the network for new entrants and transparency in the market”. Member States had three options to choose from for implementing unbundling by latest March 3rd 2012:

1. Implement a fully unbundled ownership structure of vertical undertakings either by divesture or share splitting,
2. set up an independent system operator (ISO) that still owns the transmission assets but outsources the operation and investment decisions to an independent network operator unit, or
3. set up an independent transmission operator (ITO) which is a supplier and at the same time owns and operates the transmission assets. The ITO has to comply with strict regulation and NRA supervision[12].

The only exceptions from unbundling were granted to Cyprus, Luxembourg and Malta[13], as these countries have small isolated systems. It needs to be pointed out that unbundling does not mean that transmission operation must be privatized per se. Unbundled TSOs can still be completely state-owned, as the example of the Dutch/German TSO Tennet demonstrates, which is held by the State of the Netherlands. Today there are 42 TSOs in Europe. For a detailed overview of them and their type of ownership see appendix 4.

2.3.1.2 ENTSO-E

The European Network of Transmission System Operators for Electricity (ENTSO-E) is the European association of TSOs based in Brussels[14]. It was founded in 2008 according to Regulation No 714/2009. European law instructed that “in order to ensure optimal management of the electricity transmission network and to allow trading and supplying electricity across borders in the Community, a European Network of Transmission System Operators for Electricity [ENTSO-E] should be established”. ENTSO-E succeeded the association of European TSOs (ETSO) which was established in 1999 by regional TSO associations. ETSO originally aimed to harmonize compensation between TSOs and to unify actions in order to favour the integration of the European electricity market (Nies, 2009, p. 53). “The mission of ENTSO-E is to promote important aspects of energy policy in the face of significant challenges concerning the operation security of the network, the adequacy of the power system, the market integration and transparency, and the sustainability of development through the integration of renewable energy sources” (ENTSO-E, 2012a, p. 8). Thus, ENTSO-E’s main activities include the drafting of European network codes, the provision of generation adequacy outlooks and

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12 For details on different forms of unbundling see EC (2010).

13 Malta received derogation already by Decision 2006/859/EC.

14 www.entsoe.eu.

the development of a Community-wide 10-year network development plan (TYNDP). The TYNDP is a 10-year investment plan for the European transmission grid that combines a bottom-up approach based on national grid development plans and a top-down assessment with a focus on transnational transmission lines (interconnectors) that are of special interest for an integrated European electricity market. The TYNDP is published biannually and complemented with public consultation. A first pilot plan was revealed by ENTSO-E in March 2010, but it took into account solely the bottom-up approach, i.e. it was a pure compilation of the individual national development plans. The intention of this pilot was to open the debate and start the loop of public consultations and consecutive publications of bi-annual TYNDPs that also include the top-down approach (Buijs et al., 2010). The first comprehensive TYNDP was published in June 2012 focusing on mid-term (i.e. 2012-2016) and long-term (2017-2022) electricity network requirements in Europe (ENTSO-E, 2012a).

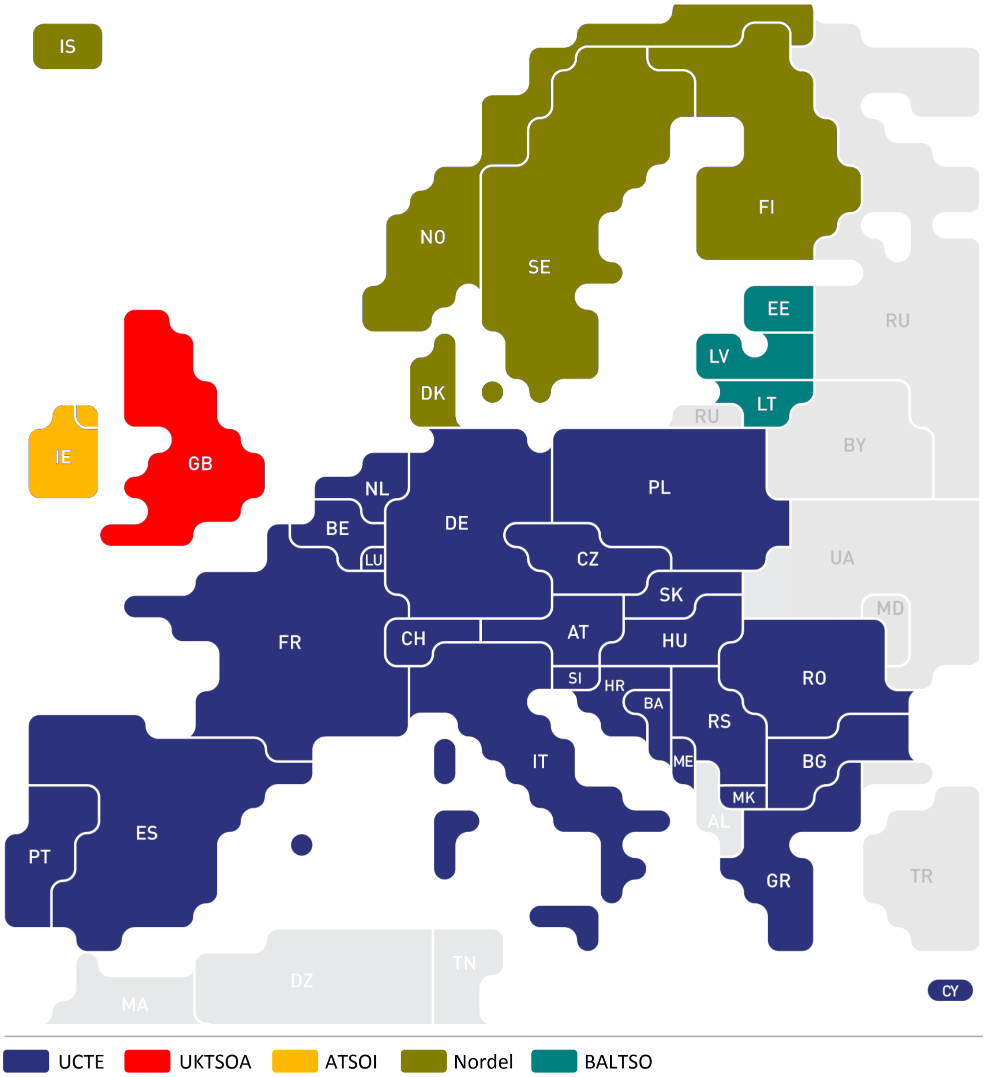

Figure 8: ENTSO-E member countries (ENTSO-E, 2011a).

Today, ENTSO-E comprises all 42 European TSOs[15] from 34 different countries which were formerly organized under ETSO which in turn comprised the transmission associations UCTE[16], UKTSOA[17], ATSOI[18], Nordel and BALTSO[19] (see figure 8 on the previous page). The ENTSO-E network defines the geographic scope of this research work, which comprises the EU-27 Member States without Malta, but including Bosnia Herzegovina, Croatia, Iceland, Macedonia, Montenegro, Norway, Serbia and Switzerland.

2.3.2 Energy regulators and related associations

2.3.2.1 National regulatory authorities (NRA)

Independent national regulatory authorities (NRAs) have been set up in Europe by national governments to protect the interests of all gas and electricity consumers. In some cases, these regulators are also responsible for regulating telecommunications, post and railway (e.g. the German Federal Network Agency) or water markets (e.g. the Bulgarian State Energy & Water Regulatory Commission) of a single country. For electricity, the NRAs promote competition by ensuring non-discriminatory third-party access to the national electricity grids, for instance the approval of merchant transmission investments. Furthermore, they regulate the network tariffs which the national TSOs can pass on to the electricity consumers. According to Directive 2009/72/EC, NRAs "should ensure that transmission […] tariffs are non-discriminatory and cost-reflective". NRAs regularly calculate, review and update these respective fees. The final national network tariffs depend on the total grid size and its characteristics. A significant amount of the network tariff charged to the end consumer is made up by the distribution fees charged by the DSOs for the use of the distribution grid. For instance in Germany, the total network tariff for households was around EURct 5/kWh or approximately 20% of the total electricity bill in 2011 (Bundesnetzagentur, 2012a, pp. 145–146). Thereof only around EURct 0.5/kWh were related to the transmission grid, which represents around 2% of the total bill. The remainder was allocated to the power distribution network (Strom-Prinz.de, 2012). In contrast to the 20% in Germany, the total network tariff made up only 4% of the total electricity bill in the UK (Brunswick Research, 2011). This is because the methodologies used to calculate the network tariffs differ throughout Europe[20]. The traditional approach used is cost-plus, i.e. the reimbursement of

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[15] Please note that during the course of this work, the number of ENTSO-E members was reduced to 41 with the integration of the Austrian TSO TIWAG into the Austrian TSO APG-Austrian Power Grid. Nevertheless, throughout the work at hand all previous 42 TSO will be in scope.

[16] Union for the Coordination of Transmission of Electricity.

[17] UK Transmission System Operators Association.

[18] Association of the Transmission System Operators of Ireland.

[19] Baltic Transmission System Operators Association.

[20] For details see Jamasb & Pollitt (2000), RealiseGrid (2010a) and ENTSO-E (2012b).

occurred costs plus a limited rate of return (ROR)[21]. Usually, NRAs restrict the accepted costs of regulated lines to the most economically viable design option. This is one of the main reasons why today, most of the new transmission lines are installed as OHL systems, as this type is cheaper to install compared to underground solutions. Costs usually include depreciation, operation costs and taxes (RealiseGrid, 2010a, p. 42). Costs can sometimes also include expenses for compensating landowners, environmental costs or R&D expenses. The calculated RORs differ across European countries. For instance, France allows 7.25% (Réseau de Transport d'Électricité, 2011) compared to 9.29%[22] in Germany (Gassmann, 2011) or 8.9%[23] in Italy (RealiseGrid, 2010a, p. 82). A list of all European national regulatory authorities can be found in appendix 5.

2.3.2.2 European associations of energy regulators

In the course of strengthening the market liberalization process, the European Commission published its 'Third Energy Package' in 2009. Part of this package was Regulation 713/2009 that established **the Agency for the Cooperation of Energy Regulators (ACER)**. The Commission identified the improvement of the regulatory framework at Community level as a key measure to achieve the completion of an internal European electricity market. Back in 2003, the independent advisory group called **European Regulators Group for Electricity and Gas (ERGEG)** had been established by the Commission with Decision 2003/796/EC. ERGEG consisted of the national NRAs and its aim was to foster the development of an internal electricity market in Europe by facilitating consultation, coordination and cooperation between NRAs and with the Commission itself. Regulation 713/2009 states that, although ERGEG has made a positive contribution to achieve this European goal, "it is widely recognized by the sector and has been proposed by the ERGEG itself that voluntary cooperation between national regulatory authorities should (…) take place within a Community structure with clear competences and with the power to adopt individual regulatory decisions in a number of specific cases". Hence, ACER was set up to replace ERGEG and fill the regulatory gap at Community level in order to foster the establishment of the internal electricity and gas market. In general, ACER's mission is to assist the NRAs in fulfilling their duties and responsibilities at EU level and to coordinate their actions whenever necessary. Beyond its general advisory role to the EU institutions on trans-European Energy infrastructure issues, it oversees ENTSO-E, notably in regards to the already mentioned TYNDP. According to Kapff & Pelkmans (2010), the agency will particularly check if ENTSO-E's grid development plan is not only a mere compilation of national plans and whether European top-down policy goals such as the 20/20/20 environmental targets have

[21] Also referred to as return on capital employed (ROCE).

[22] Will be reduced to 9.05% in 2014.

[23] For installations from 2008 onwards. After 12 years the ROR is 6.9%. If the investment reduces congestions between and within market zones or increase the cross-border capacity, the ROR is 9.9% for 12 years and then 6.9% thereafter.

been sufficiently considered. In case the TYNDP is verified, ACER and the respective NRAs will review the grid development plans of the national TSOs to assess their consistency with the pan-European plan. In addition to that, ACER develops common network and market rules and coordinates regional activities that facilitate greater market integration. If NRAs fail to reach a final agreement regarding cross-border infrastructure investments within a given period of time, ACER is, according to EU Regulation 713/2009, eligible to decide upon the relevant regulatory issues, which comprises the terms and conditions for access and operational security. This also includes the commissioning of merchant transmission lines across borders (interview with Gabrijel Uros, 11.10.2011). ACER became operational in early 2011 and has its headquarters in Ljubljana, Republic of Slovenia.

2.4 Development of new transmission lines

2.4.1 Planning objectives

As mentioned above, TSOs manage the electricity grids and need to ensure stable operation and a secure supply of electricity. Supply and demand characteristics have changed over recent years. For instance, the amount of volatile RES in the European power generation mix has grown significantly over the last decade from 126 GW in 2000 to 276 GW in 2010 which is more than double. Additionally, electricity consumption has grown in that period of time by approximately 11% (ECN & EEA, 2011; EC DG Energy, 2010). The TSOs need to make sure that the transmission systems keep up with such developments. As a consequence, respective transmission line upgrades and extensions are required. What type and design of transmission technologies the TSOs select, depends on the best balance of three main goals that form a decision triangle as shown in figure 9.

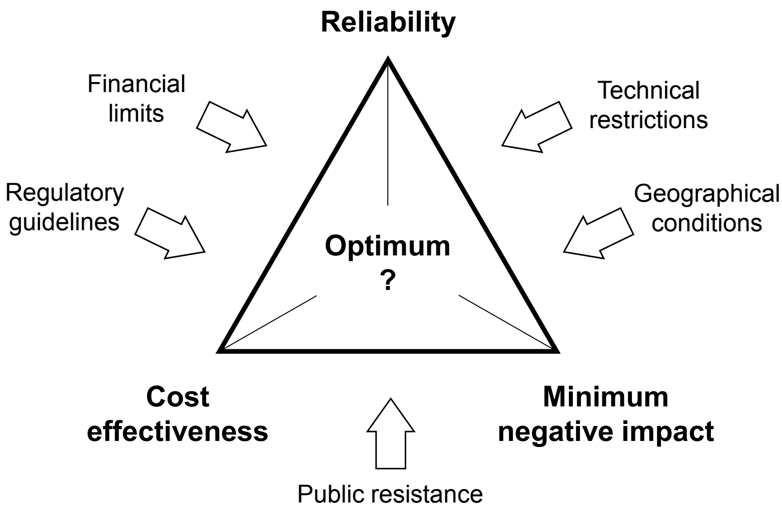

Figure 9: Decision triangle for grid planning.

First, technology and design must ensure secure and stable electricity supply. Second, the installation needs to be cost-effective, i.e. investment and operation costs need to remain reasonable for the consumers while at the same time ensuring that TSOs can still make a sufficient amount of profit in order to sustain and make further investments in the future. Cost-effectiveness also means that planned lines are implemented quickly in order to make them operational as soon as possible. Finally, negative impacts caused by the line should be minimized. This includes impacts on the environment or people's health and safety. As these three goals are often contradicting, TSOs need to find a balance and compromise between them. TSOs seek to maximize social welfare, i.e. they aim to ensure that society receives the maximum benefit through new transmission line installations at lowest possible cost and impact. Next to this dilemma, boundary conditions like financial limits, regulatory guidelines, technical restrictions, geographical conditions or public resistance further influence TSO decisions.

2.4.2 Planning process

In the European Union, Member States apply different approaches for project planning. Nevertheless, one can commonly distinguish transmission line planning between identification and authorization phase. This is succeeded by construction and commissioning as well as operation (see figure 10). Currently, overall planning duration in an ideal case ranges between 5-7 years. TSOs estimate planning costs to be around EUR 140,000/km (interview with Guido Franke, 04.10.2011).

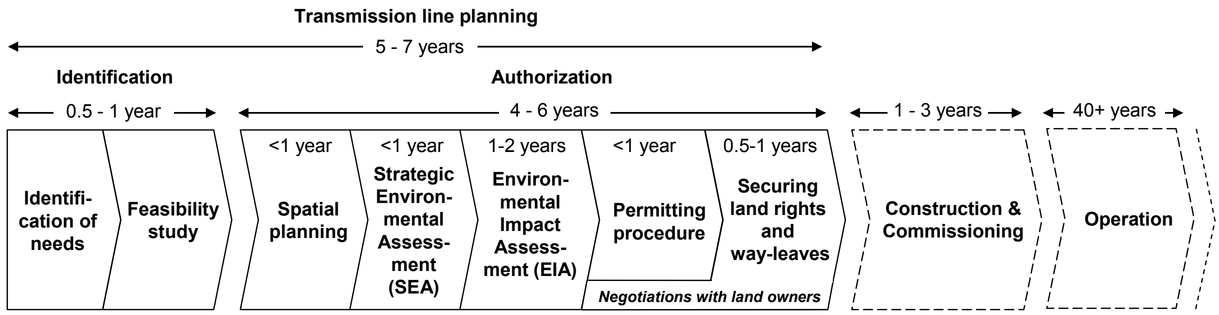

Figure 10: Typical planning process steps for transmission lines.

The following sections outline the individual planning stages with focus on EU legislation. National acts and responsible authorities might slightly differ across Member States and sometimes even within a Member State. Detailing all the national differences would go beyond the scope of this research work[24]. Thus, the following subchapters will outline a general transmission line planning process with respective durations in an optimal case. If public opposition is encountered in a project, planning schedules can be significantly prolonged. This is why "[t]he overall duration of authorization procedures is in many cases unpredictable" (Roland Berger, 2011b, p. 11).

[24] Individual planning procedures for selected European countries can for instance be found in Schneider & Sander (2012).

2.4.2.1 Identification of needs

The initial stage of every new transmission line project is the identification of grid extension requirements. TSOs need to forecast future electricity demand and generation scenarios and assess if the existing transmission network is able to fulfill its objectives over the next years. TSOs usually have a sufficient transparency on existing electricity generating units and respective consumers in the power grid as these directly feed-in or withdraw electricity. Nevertheless, TSOs face a challenge in predicting future electricity generation and demand developments. Especially policy decisions can represent an uncertainty for network planners. For instance, the establishment or cut of feed-in tariffs for RES is often politically motivated and may influence the power mix and its volatility implied to the network. This has been a problem especially in the German electricity network and was further spurred by the government's decision to phase-out nuclear power in Germany after the incident in Fukushima, Japan in March 2011. It meant a massive withdrawal of stable baseload power that was produced close to the demand centres. More electricity imports from neighbouring countries and transport of electricity from RES located far from load centres, e.g. offshore wind, were required and put additional stress on the grid. In case transmission capacities are insufficient to transport electricity from generation sites to load centres or utilize exchange with neighbouring countries sufficiently, security of supply is at risk. For instance, during the cold winter in early 2012 these circumstances led several times almost to a partial blackout in Germany (Bundesnetzagentur, 2012b, p. 51). However, an increasing RES share is important to achieve the 2020 targets set in the Communication of the European Commission (COM (2010) 639). This is accompanied by the European market liberalization that fosters international trade and exchange of electricity across countries. On the one hand consumers benefit from increased competition, but on the other hand increasing electricity exchanges congest the network which needs to be avoided by TSOs. Therefore, if the current grid is expected not to be able to cope with future scenarios, TSOs need to upgrade or build new transmission lines. Generation and demand scenarios combined with grid simulations help TSOs to identify where a new line is needed and what transmission capacity it needs to have.

TSOs document their expansion plans in national network development plans. According to Article 22 of Directive 2009/72/EC, national TSOs need to submit a national 10-year-network development plan (TYNDP) every year to their respective NRAs. The plan includes the electricity transmission infrastructure that is required to be built or upgraded over the next decade.

Figure 11 on the following page outlines the process for the establishment of the national TYNDP. First, the TSO develops generation and consumption scenarios for the next 10 years. In Germany for instance, TSOs have to develop three scenarios for the next 10 years with the most likely one also forecasting the next 20 years according to §12a(1) of the Energy Industry Act (EnWG)[25]. Upon these scenarios, the TSO drafts the national TYNDP and consults the public on it. The NRA then examines,

[25] Amended in 2011.

whether the plan covers all investment needs, considers the objections raised during the consultation process and checks the plan's consistency with the already mentioned non-binding Community wide TYNDP based on Regulation No 714/2009. If doubts regarding consistency arise, ACER gives guidance. The NRA can require the TSO to make amendments to the plan. After examination, the NRA publishes the final draft of the plan and the public again has the opportunity to comment on it. In case of valid concerns, the TSO makes final changes to the plan which is then finally approved by the NRA. The identification of transmission line needs usually takes only a few months. The implementation of the plan is continuously monitored by the NRA.

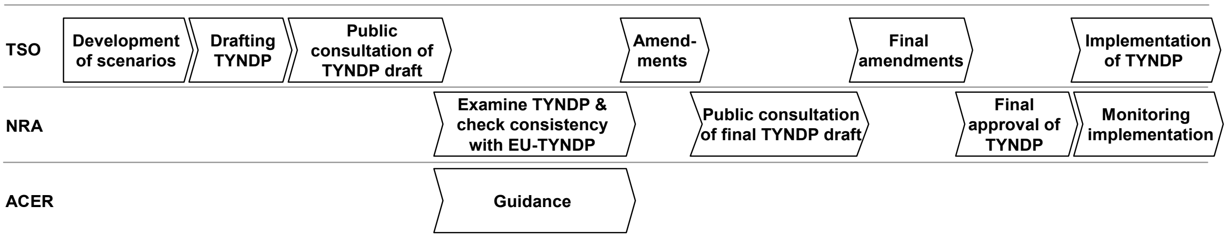

Figure 11: Development process of a national TYNDP.

2.4.2.2 Feasibility study

Once the need for a new transmission line has been identified, the TSO conducts a feasibility study. Its purpose is to justify the technical and economical viability of an investment and define the main parameters of the project. Feasibility studies usually start with electrical assessments. Here, basic design alternatives for a new transmission line are defined according to electrical requirements. These include for instance power flow requirements, system stability and reliability, dynamic performance as well as voltage and reactive power flow control (Kießling, 2003, p. 4). A rough route corridor is drafted (EPRI, 2006, p. 2.2). This is often accompanied by an initial environmental impact assessment to avoid densely populated areas or protected habitats. All preselected alternatives that satisfy the basic electric criteria are then evaluated according their economic viability in a second step. This is similar to a business plan. The economic cost-benefit analysis comprises for instance all related investment costs, operation costs including transmission losses, all maintenance expenses and costs of financing. As an example of considered benefits, the reduced risk of power shortages can be included. Furthermore, the analysis includes sensitivity analyses to account for uncertainties. Finally, the optimal alternative is selected based not solely on technical and economic analyses but often also considering other circumstances and restrictions such as the TSO's experience and competence with a certain technology, local standards, supply of components etc. (Kießling, 2003, p. 4). There is usually no public participation in the development of feasibility studies.

The TSO's cost for conducting a feasibility study can be estimated to range between EUR 0.5 and 2 million (EC DG Energy, 2012) and the development takes approximately six months (ETSO, 2006, p. 24; Tennet & RWE Transportnetz Strom, 2006, pp. 37–38).

2.4.2.3 Spatial planning

According to the official definition by the European regional planning charter, “spatial planning gives geographical expression to the economic, social, cultural and ecological policies of society. It is at the same time a scientific discipline, an administrative technique and a policy developed as an interdisciplinary and comprehensive approach directed towards a balanced regional development and the physical organization of space according to an overall strategy” (European Council, 1983, p. 13). For transmission lines, spatial planning becomes relevant once the preferred reinforcement scheme has been selected by the TSO and the approximate route of the line is determined. This results in a corridor of about ± 200 m (Horstmann, 2000, p. 13). The TSO checks together with authorities what route or route options is / are compatible with official spatial planning, which determines what purpose the land can be used for (Roland Berger, 2011b). In case the plan or project is subject to Article 6(3) of Directive 92/43/EEC, a major part of the evaluation is the so called ‘Appropriate Assessment (AA)’. In other words, “any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives”. The AA checks for compliance with Council Directive 92/43/EEC regarding the conservation of natural habitats, wild fauna and flora and Directive 2009/147/EC regarding the conservation of wild birds[26]. Both Directives form an EU wide network of protected areas called ‘Natura 2000’[27]. It comprises special areas for conservation designated by Member States for habitat protection and special protection areas classified for the conservation of wild birds. Natura 2000 areas encompass about 18% of EU’s terrestrial territory (EC DG Environment, 2011b). Natura 2000 is not a system of strict nature reserves from which all human activities are excluded. The emphasis and purpose of Natura 2000 is to ensure that future management of these areas is sustainable, both ecologically and economically wise (EC DG Environment, 2011a). The AA is conducted by the competent authority, which evaluates the potential environmental impact on the protected areas[28] in order to avoid adverse effects of plans or projects on Natura 2000 sites and thereby maintain the integrity of the network and its features (RGI, 2011e, p. 5). If, according to Article 6(4) of Directive 92/43/EEC, “in spite of a negative assessment of the implications for the site and in the absence of alternative solutions, a plan or project must nevertheless be carried out for imperative reasons of overriding public interest, including those of a social or economic nature, the Member State shall take all compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected”. This means that in most cases new compensatory areas need to be defined for the Natura 2000 territory (interview with Martin Kraus, 02.12.2011). Next to the assessments, the competent

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[26] Codified version of Directive 79/409/EEC as amended.

[27] Natura 2000 areas can be viewed online at http://natura2000.eea.europa.eu.

[28] The European Commission provides respective methodological guidance (EC DG Environment, 2001).

authorities inform relevant stakeholders such as NGOs or the affected public during the spatial planning phase and invite them to comment on the proposal. However, actual stakeholder interest in consultation during this early planning phase is low. This is because stakeholders are often not fully aware that they could be potentially affected by the respective project (Roland Berger, 2011b, p. 30).

In the optimal case, spatial planning takes about one year (Tennet & RWE Transportnetz Strom, 2006, p. 42). The authority's appraisal for the transmission line regarding the spatial planning conformance is usually only valid for a limited amount of time. For instance, in Germany this timeframe is five years (Horstmann, 2000, p. 13). In case the planning is significantly delayed, the appraisals can become void and have to be renewed.

2.4.2.4 Strategic Environmental Assessment (SEA)

In case the planned corridor of the planned transmission line inevitably crosses Natura 2000 territory, it is subject to a Strategic Environmental Assessment (SEA) according to Directive 2001/42/EC. An SEA is also mandatory for projects which are part of an energy sector related plan or programme that sets the framework for future development consent for projects listed in the Annexes of Council Directive 85/337/EEC[29]. Transmission lines that have a voltage level of 220 kV or above, are planned as OHL, have a minimum length of 15 km and are likely to have significant effects on the environment, belong to this set of projects. The goal of a SEA is to fully integrate environmental considerations into the preparation of overregional plans and programmes prior to their final adoption. Thus, the SEA provides for a high level of protection of the environment. Furthermore, it studies several route and technology alternatives including the zero option which means the non-installation of a new line (interviews with Thorben Becker, 29.11.2011 and Martin Kraus, 02.12.2011). The first step of a SEA is called 'screening', during which the TSO and environmental authorities jointly assess whether a SEA is required or not. The second step is termed 'scoping' and determines the scope and level of detail of the environmental assessment to be conducted (Environmental Protection Agency, 2011). After this, an environmental report is developed. TSOs regularly commission these reports to external experts or consultants. According to Article 5 of Directive 2001/42/EC, the TSO must baseline the current state of the related environment and describe significant impacts which the implementation of the plan or programme or reasonable alternatives could cause. Impacts should include issues such as biodiversity, population, human health, fauna, flora, soil, water, air, climatic factors, material assets, cultural heritage including architectural and archaeological heritage, landscape as well as the interrelationship of all factors. Furthermore, the report has to list measures envisaged to prevent, reduce and as much as possible offset any significant adverse effects on the environment. Environmental authorities, NGOs with relevant environmental responsibilities and the affected public

[29] In case the planned line is an upgrade, runs parallel to an existing line or lies within a special corridor that is devoted by the government for certain infrastructure, a SEA is not required.

need to be informed and consulted according to Directive 2003/35/EC. The TSO then evaluates all comments and makes amendments to the environmental report if appropriate. Finally, the competent authority decides if the plan is accepted or not considering the environmental report and the comments made during the consultation and it must publish and explain its decision. In case of acceptance, the authority monitors the realization of the plan or programme (e.g. by measuring noise levels, etc.). The SEA can be regarded as an opportunity and tool for preventive discussion with stakeholders for siting transmission lines. Although the SEA is subject to European law, countries do not always perform such an assessment (RealiseGrid, 2010c, p. 54)[30]. In some cases the SEA is also embedded in a larger Sustainability Appraisal that additionally addresses economic and social impacts, therefore encompassing the three dimensions of sustainable development (Levett-Therivel et al., 2006). The optimal duration of a SEA is around one year but can be prolonged if additional expert evaluations are requested by the authorities (Tennet & RWE Transportnetz Strom, 2006, p. 42).

2.4.2.5 Environmental Impact Assessment (EIA)

Before the TSO can prepare and hand in the application documents, an Environmental Impact Assessment (EIA) needs to be conducted for projects subject to Annex I of Council Directive 85/337/EEC[31], also known as EIA Directive. Similar to the SEA, this applies for OHL systems with 220 kV and above and with a minimum length of 15 km. The EIA is “an integral part of procedures applied by authorities when deciding upon the admissibility of projects. [It] (…) covers the identification, description, and evaluation of the environmental impacts that ensue from the implementation of planning on human beings, animals and plans, soil, water, air, climate, and landscape, including interactions between these protected assets and cultural heritage and other material assets” (Pahl-Weber & Henckel, 2008, p. 184). In contrast to the SEA, the EIA focuses more on detailed and regional specific environmental impacts of concrete projects. Hence, the SEA which concentrates on the high level and overregional scope of plans and programmes can be regarded as an ‘upstream’ assessment compared to the ‘downstream’ EIA. According to the EIA-Directive, “an outline of the main alternatives studied by the developer and an indication of the main reasons for his choice” needs to be included. However, not all Member States have implemented a legal obligation to consider specific alternatives in national law. Therefore, often only one line option is assessed in the

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30 For instance, a SEA has not been performed for the German EnLAG (see Chapter 2.5.3.3)

31 Council Directive 85/337/EEC was amended by Council Directive 97/11/EC, Directive 2003/35/EC and Directive 2009/31/EC. Directive 97/11/EC widened the scope, strengthened the procedural stages and integrated the changes provided by the UN/ECE ESPOO Convention on EIA in a transboundary context. Following the signature of the Aarhus Convention on access to information and public participation in decision-making, the Community law had to be properly aligned with that Convention, leading to an amendment by Directive 2003/35/EC. The EIA Directive was furthermore extended in scope by Directive 2009/31/EC.

EIA. In theory, an overlap between the SEA and EIA should not exist, however, the European Commission states several inefficiencies in its report on the effectiveness of the EIA Directive (COM (2009) 378). The process of the EIA is similar to the SEA. It starts with a screening in which the competent authority identifies whether an EIA is required or not. This is followed by the scoping which determines the content and extent of the matters to be covered in the environmental information and to be submitted to the competent authority. Scoping is crucial for an adequate EIA regime, mainly because it improves the quality of the EIA (COM (2009) 378)[32]. The European EIA Directive does not foresee public consultation during the scoping stage. Only after the scoping and actual assessment have been finalized, there is a legal obligation for public involvement (Kanngießer, 2004). However in rare cases, Member States provide for public consultation at an earlier stage, i.e. at the screening or scoping stage (COM (2009) 378). After the scoping, the TSO conducts the environmental assessment and develops an Environmental Impact Statement according to Annex IV of Council Directive 97/11/EC. This statement needs to include also a non-technical summary that can be used for public consultation. The competent authority then publishes the report and consults with statutory environmental authorities, other interested parties and the public. Timeframes for consultation vary considerably across Member States and range between 10 and 60 days (Roland Berger, 2011b, p. 20). Finally, the authority decides through an Environmental Impact Declaration whether the project can be accepted for further permitting considering the results of the consultation. It publishes its decision including underlying reasoning as well as potential measures to mitigate possible environmental impacts. If authorization is granted, the competent authority monitors the environmental impacts during construction, operation and maintenance of the line. The optimum duration that has been established to conduct an EIA is between 12 and 18 months. However, when amendments to the project plan are requested, this can easily be prolonged to two years. In case new line alternatives need to be studied, the whole process can even last 4-5 years (ETSO, 2006, pp. 20–21). Member States usually limit the validity of their decision to 2-5 years[33]. After that period, additional environmental assessments will be required (EC DG Environment, 2003, p. 61). The European Commission estimates the costs of preparing an EIA between 0.1% of total project costs for large projects and 1.0% for small projects (COM (2009) 378). Ciupuliga (2012, p. 4) even estimates the EIA share being up to 4% of total project costs[34].

[32] To support project developers in conducting an EIA, the European Commission has published guidance on the object of examination, scope and methods (EC, 2001).

[33] Individual validity durations can be found in EC DG Environment (2003).

[34] For the case of Austria.

2.4.2.6 Permitting procedure

Once the spatial planning and the required environmental assessments are completed, the TSO conducts a detailed technical planning of the transmission line. The environmental assessments may hereby influence the line design. After that, the TSO finalizes its application documents which can easily encompass up to 8,000 pages and a number of folders (Roland Berger, 2011b, p. 45). With the TSO's submission of the application documents to the respective authority, the official permitting procedure starts. This licensing step particularly evaluates the project's compliance with respective regulations and planning codes. Therefore, the responsible authority first checks the application's completeness and in case of incomplete or missing documents asks the TSO for resubmission. Once all required files have been handed in, public consultation begins (Roland Berger, 2011b, p. 19). This is done in most cases by a public hearing. A public hearing entails presentations by the TSO or authority in an open forum with citizens. The public can voice opinions and concerns (Guckelberger, 2006; Rowe & Frewer, 2000, p. 8). The competent authority finally makes the decision to issue the permit or not. In doing so, it evaluates all submitted application documents and assessments as well as all concerns that have been raised by the public during consultation. The granted permit can be subject to certain conditions and requirements such as mitigation measures to minimize visual impact, which the TSO needs to consider for project implementation. Then the final decision is published by the authority. After the permitting process, stakeholders have the right to appeal. The right to appeal is restricted to those stakeholders only who have participated in the consultation stage. Generally, an appeal means that the TSO is not allowed to start construction before a relevant court has made a decision. If the appeal is rejected by court, the permit is enforced and the TSO can immediately start with construction work (Roland Berger, 2011b, p. 20). In an ideal case, the whole permitting procedure, including a public hearing, lasts around 9-12 months. However, when legal actions are applied by the public, the timeline can significantly extend beyond this to several years and can even block and abolish a project (ETSO, 2006, p. 22). This is why the permitting stage can become the most time-consuming one.

2.4.2.7 Securing land rights and way-leaves

Once permits have been granted, the TSO needs to secure land rights and way-leaves from affected landowners. In terms of land rights, the TSO purchases land only in rare cases (e.g. for substations, transition and converter stations, etc.). In most cases it negotiates so called 'easements', which are rights in perpetuity that allow the TSO to operate the transmission line across the landowners' property. Thus, the transmission line installation does not alter property rights but only introduces limitations on its use (ETSO, 2006, p. 23). In case the owner of an estate sells the land to someone else, the easement remains valid. The TSO usually offers one-time payments to compensate directly affected landowners for easements, devaluation and limitations of land use. 'Directly affected' means property that is crossed by the planned transmission line corridor which reaches out up to 10 m on each side of the line itself. Landowners who live next to this planned line corridor but whose property is not directly crossed, are usually not eligible for easements and respective compensations, although they might for instance experience visual impact from the line. Next to easements, also way-leaves are required. These are rights granted for a limited duration of 5-10 years, and are compensated by the TSO through an annual rent. In case the property is sold later on to another owner, the way-leave agreement becomes void and needs to be renegotiated (Powerwatch.org, 2011, p. 6). Way-leaves allow the TSO to access the land especially during construction and maintenance. Way-leaves may also be required from landowners whose property will not be directly crossed by the new line but where the TSO needs to use the land to access the line route. In case respective landowners refuse to sell land, grant easements and way-leaves or disagree with the offered compensation, national regulations often allow for expropriation. It takes about 12 months to identify all relevant land owners along a transmission line[35]. The negotiation process itself takes about 6-12 months (ETSO, 2006, p. 12). A TSO usually starts the identification and negotiation process in parallel to the spatial permitting procedure to save time. In case expropriation is necessary, an additional delay of a few months occurs due to required legal cases.

2.4.2.8 Construction, commissioning and operation

Once all permits have been granted, the TSO initiates a detailed design review. Furthermore, it tenders the construction work and negotiates commercial contracts. Contracts are awarded, purchasing orders are placed and the construction of the line starts, which usually lasts between 1-3 years, significantly depending on the line length and characteristics (ENTSO-E, 2011b, p. 4). On average, OHL systems have the shortest installation times as major ground work is not necessary. One kilometre of OHL line can be installed within 1-2 weeks, if the right of way is clear and does not require deforestation. According to ENTSO-E & Europacable (2011, p. 9), the average installation time for a UGC system laid in a trench is around 1.5 months per kilometre. Construction time can be slightly longer for HVDC solutions due the installation of converter stations[36]. When the installation of the transmission line is finalized, the supplier commissions the line, i.e. the line is energized, comprehensive electrical tests (e.g. load testing) are conducted and the TSO staff are trained on how to operate and maintain the line (Stantec Consulting, 2009, p. 84). UGCs in a meshed OHL network increase the operational complexity. To ensure long life-times, regular maintenance needs to be conducted. Although a transmission line might seem to require little service, effective maintenance of a transmission system is as essential as the engineering design itself (Kießling, 2003, p. 702). Transmission line maintenance is less a ‘break-and-fix’ service, i.e. restoring operation immediately after an interruption has occurred,

[35] This can be regarded as an average duration, as the required time strongly depends on the line length and ownership density along the line.

[36] However, construction time highly depends on to what extent work is done in parallel and how many workers are used.

but rather "predicting, detecting, removing and replacing faulty components, therefore actually preventing the development of faults or long-term outages" (Kießling, 2003, p. 702). Due to the criticality of the electricity infrastructure, failures and downtimes have to be avoided whenever possible. The majority of the TSOs' maintenance work comprises monitoring and inspection of transmission lines. For that purpose, TSOs have established maintenance inspection schedules. For OHLs, aerial inspection by helicopters is supplemented with ground and climbing supervision to check line and pylon structure. By nature, once installed in the ground, UGCs are maintenance free. Except for UGC tunnel installations, local route surveillance is not possible. Hence, supervision is done mainly by remote monitoring. A long-term service track record of existing UGC installations has not yet been established, but extensive cable tests and their history to date show that UGC systems can achieve a reliability that is comparable to OHLs (Europacable, 2009). Furthermore, OHLs and UGCs require clearing the right-of-way, which essentially consists of trimming vegetation. Clearing does not harm the environment. Scientific studies state that several successive years of clear-cutting and trimming can even improve the ecological situation (Wahl, 2010). For instance, the German TSO Amprion whose line system exceeds 25,000 km follows such an ecological planning or right-of-way management (Kießling, 2003, p. 717). Time periods for inspection are as follows: corrosion inspection as well as conductors and earth wires every 10 years, earthing system every five years, clearing right-of-way every 5-10 years[37]. Additionally, a general air inspection is carried out by helicopter annually. Most of the required repairs on a transmission line are possible under so called 'life-line' conditions, i.e. that the transmission line remains in operation while repairmen are conducting the work. This is possible for UGCs as well as OHLs[38]. However, particularly with OHLs, this requires special service staff training and safety equipment (Kießling, 2003, p. 716). Mean time to repair includes fault location, repair and testing and takes around two hours for a 380 kV OHL system and around two weeks for an equivalent UGC system (Europacable, 2010, p. 17; Golder Associates & ECOFYS, 2008, p. 83; Oswald, 2007, pp. 25–28).

[37] The cycle highly depends on the climate and vegetation.

[38] Electromagnetic fields (EMF) safety values for UGCs in tunnels have to be considered (interview with Heinrich Brakelmann, 01.12.2011).

2.5 Project delays and obstacles

2.5.1 Project delays

As outlined in the previous chapters, the optimal total duration for a transmission line project, from the identification of needs until the start of operation, ranges between 5-7 years. However, this ideal case is very rare. In reality, the duration is frequently more than 10 years without encountering any major obstacles (Jarass & Obermair, 2005; Schneller, 2007). With significant obstacles and opposition, transmission line projects can take up to 20 years or even more to be completed (ENTSO-E, 2012a, p. 280). Figure 12 lists the top 10 EHV transmission line projects in Europe in terms of delays.

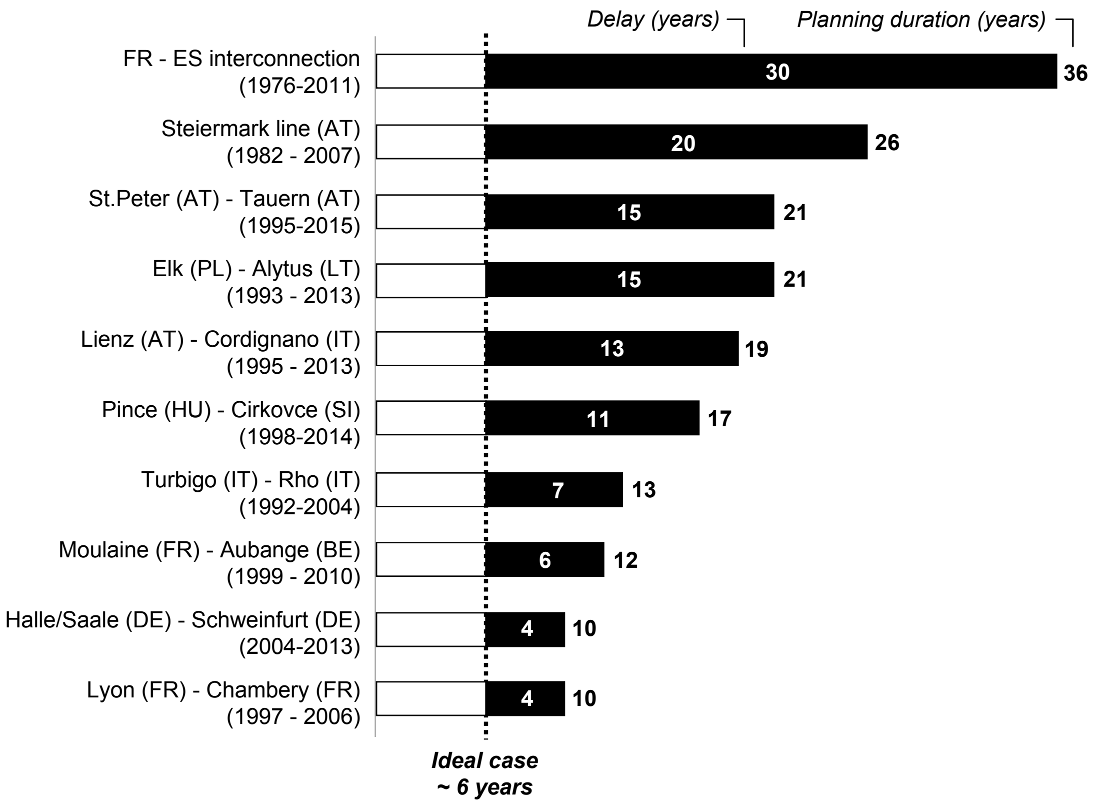

Figure 12: Main European transmission line projects with their respective planning duration and delays (COM (2006) 846; EC DG Energy, 2011a; Mielczarski, 2008; SEC (2010) 505; SEC (2011) 1233).

Although most of the listed projects are interconnectors across the borderline of two different countries, "concerns arise irrespective of whether the developments are domestic or cross-border lines" (ENTSO-E, 2012a, p. 165). Worst case example is the new interconnection line across the French-Spanish border. First discussions and planning activities started back in 1976. The route for the planned OHL was changed several times for political, public and environmental reasons. It was finally approved in 2011 and will be built as a HVDC UGC system. As such, the project experienced an overall delay of 30 years. Moreover, the European Commission stated that 20 out of 32 currently defined European priority transmission line projects face delays. In 12 of them, a delay of one to two years exists, while eight have been already delayed by more than three years (COM (2006) 846).

Similarly in Germany, 10 out of 11 priority projects that were scheduled for finalization in 2010/2011 were reported as being out of schedule (Bundesnetzagentur, 2011; Sander, 2011). TSOs thus face a tremendous challenge in transmission line planning. When planning new transmission line investments, they can never be sure whether the projects will be implemented on time or will face significant delays. The procedures for transmission line assets prove often to be longer and more complex than for any other infrastructure such as roads, railways or gas-pipelines (ENTSO-E, 2012a, p. 165). Buijs et al. (2011, p. 1799) calculated that in case of an exemplary transmission line investment of EUR 75 million, a socio-economic benefit for each year of having the line already in place can be estimated to be EUR 10 million. For delays of 10 years this annual benefit can increase up to EUR 50 million per year. Similarly KEMA, an established grid consulting company, studied in depth the impact of new transmission investments based on the improved economic efficiency of the generation dispatch. For the specific example of a planned transmission link between Poland and Lithuania, KEMA identified annual savings in electricity production costs of almost EUR 50 million (KEMA Consulting, 2005, p. 123). According to Tummala & Burchett (1999, p. 225), delays additionally “cause a loss of income, loss of generation capacity, liabilities with suppliers of energy, cost overruns, and increased potential for accidents due to acceleration of projects“. Next to that, additional costs for expensive congestion management measures occur due to insufficient grid infrastructure which is a result of delayed investments in new lines (ENTSO-E, 2011b, p. 6). In Germany, the TSO Tennet reported that it was forced to actively intervene 990 times on 309 days in 2011 to keep its grid stable (Petersen, 2012). Similarly, the German TSO 50Hertz Transmission reported interventions on 200 days in 2011 that caused additional expenses of EUR 100 million (Flauger & Stratmann, 2012). The German government implemented a law that the German TSOs can cut-off large industry electricity consumers in case of grid instability. The TSOs need to compensate industry players with EUR 60,000 per MW and year[39], which is estimated to amount to around EUR 100 million per year. These additional costs are finally passed on via the grid fees and will result in additional annual cost of EUR 1.75 per average German electricity consumer (Handelsblatt, 2012). Leprich et al. (2011, p. 90) calculated that the additional costs to a TSO caused through a 1-year implementation delay of a 68 km transmission line would amount to EUR 122-124 million which are ultimately passed on to the electricity consumers.

The above mentioned costs that accrue to society by the delay of transmission line projects, can be regarded as severe. Especially with the growing share of volatile renewable energy sources in the European energy mix, the stress on the transmission grid is expected to increase significantly. This means that TSOs will try to counter growing grid instability with additional congestion management measures which will increase cost and burden to the electricity consumer.

[39] If the cut-off exceeds 150 MW per year and industry player.

2.5.2 Rationales for delay

The question remains as to why transmission line projects face such delays. In the case of Germany, the NRA identified in its annual monitoring report, public opposition and the planning regulations as the major reasons for delays (Bundesnetzagentur, 2011). Public opposition is also seen as the core reason for the lengthy processes in Germany by Holznagel & Nagel (2010) and Beers et al. (2011, p. 46). This national insight can be found on European level as well. In its assessment of priority transmission projects in 2007, the European Commission found that complexity and insufficiency of authorization procedures and public opposition are the main obstacles to most of the projects (COM (2006) 846). This was confirmed by a more recent assessment of priority projects in 2010 (SEC (2010) 505). In it, 19 out of 29 transmission line projects[40] faced significant delays. As the overview of the main reasons in figure 13 shows, public opposition is by far the most mentioned obstacle followed by insufficient authorization procedures[41].

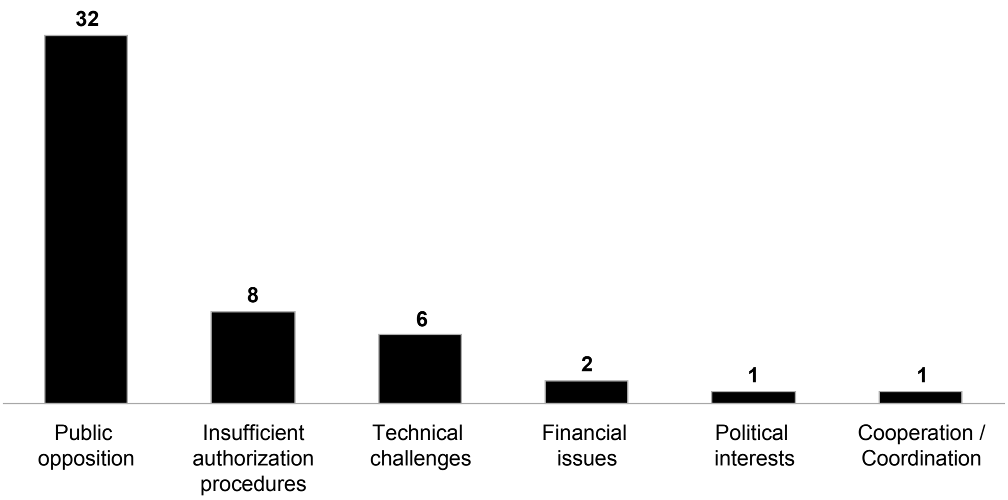

Figure 13: Main reasons for project delays of European priority transmission line projects (SEC (2010) 505).

Also Gerlach (2004, p. 146), Zane et al. (2012) and ENTSO-E (2012a, p. 13) report that opposition as well as regulation and approval processes are the main reasons for delays in the realization of new transmission lines. TSOs interviewed in a study by Roland Berger (2011b, p. 3) confirmed this. ENTSO-E joins with its statement that “the main concern is the lack of social acceptance that severely delays or jeopardizes the realization of transmission projects” (ENTSO-E, 2012a, p. 10). Battaglini et al. (2012, p. 255) state that “[i]n the majority of Member States public opposition is considered to be the main cause preventing the expansion of the high-voltage electricity grid”. Next to this, other minor obstacles are reported. The following subchapters describe all obstacles in more detail.

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[40] Excluding submarine cable projects.

[41] A single project can have more than one reason for delays.

2.5.2.1 Minor obstacles

As illustrated in figure 13 above, other minor obstacles also cause project delays in the planning phase of transmission line projects. One of them are **technical challenges**. In some interconnection projects the identification of suitable cross-border connection points and the technical synchronization were reported as being problematic (COM (2006) 846). Unharmonized network codes are another example. Difficult terrain, the inexperienced application of new technologies and delays in supply of components, especially of UGC systems (Uken, 2012a), were also mentioned (SEC (2010) 505). Moreover, a lack of harmonization of technical procedures and requirements (e.g. line temperature limits) causes delays and increases complexity further (Buijs et al., 2011, p. 1799).

Another reason is **project finance and funding**. Transmission line investments require large amounts of money that the TSOs must raise. This has become even more difficult since most TSOs became unbundled from utilities and do no longer have direct access to large sources of equity (RGI, 2011b, p. 3). Substantial increase in costs can also occur during the authorization phase, when additional environmental assessments are required. Furthermore, compensation measures imposed by the authorities to minimize project impacts also substantially increase project costs. These costs can rise up to 50% or more of the initially planned investment budget for an OHL (ENTSO-E, 2011b, p. 5). In early 2012, the German TSO Tennet announced that it will face massive problems in financing the required transmission lines necessary to integrate new offshore wind parks and therefore has put all future connection projects on hold (Focus Online, 2011; Welt Online, 2012). As mentioned earlier, NRAs restrict to what extent TSOs can pass on their investment costs to electricity consumers. In some Member States other necessary TSO expenses, e.g. costs for research and development, are not compensated by the network tariffs, thus putting additional stress on the financial situation of TSOs. Moreover, it has been stated that the regulated network tariffs calculated by the NRAs occasionally use inappropriate assumptions for the interest on debt or do not consider the time lag between investment and revenues caused by the construction phase of a line (von Burchard, 2008, p. 14).

Political interests sometimes also cause project delays (interview with Nicole-Nabi Siefken, 09.02.2011). Responsible local politicians may try to influence the permitting process and it has been stated that in some cases authorization decisions were delayed to avoid discussions prior to or during local elections (interview with Stephanie von Ahlefeldt, 21.09.2011). Politicians are elected for a limited period of time. As such, close to elections, they will try to win the favour of constituents and their votes. In the literature, such politically motivated opposition is expressed by a variety of acronyms: ‘not in my district’ (NIMD) (University of Miami, 1990), ‘not in my term of office’ (NIMTOO) (Kunreuther et al., 1993; Schively, 2007, p. 255), ‘not in election years’ (NIEY) (University of Miami, 1990) or ‘not in my election year’ (NIMEY) (Dunphy & Lin, 1991). Therefore, they will usually follow a political agenda that supports their goals most. For transnational interconnection projects, different political interests can also block or delay decision making as reported for the transmission line project between France and Spain (interview with Pierre Lopez,

07.10.2011). Lack of political support was also mentioned as one of the obstacles in ENTSO-E's recent TYDNP (ENTSO-E, 2012a, p. 165).
Seldomly, when a transmission line project crosses national or regional borders and therefore involves at least two different TSOs, problems of **cooperation and coordination** can occur (Nies, 2009, p. 69). "The current common focus and cooperation among TSOs is important, but not sufficient" (RGI, 2011b, p. 1). Cooperation also includes best practice sharing. However, with the recent foundation of ENTSO-E this has been significantly improved. The close cooperation between the TSOs Swissgrid and TransnetBW serves as a positive example. Both companies founded a joint venture called 'Central European System Operation Coordinator (CESOC)' for collaborative interconnection development.
As these listed obstacles do not occur on a regular basis and do not cause significant delays during the project planning phase, they are not considered hereinafter. Identifying success factors also for these problems would go beyond the scope of this work.

2.5.2.2 Public opposition

As previously mentioned, public opposition is the main obstacle to transmission line authorization. However, before going into details of public opposition it should briefly be outlined how 'public' is defined. According to Arbter (2008), 'public' comprises on the one hand individual private persons and privately organized action groups and on the other hand institutional representatives of public interest. The latter includes NGOs (e.g. an environmental protection group), associations (e.g. a farmers' association), unions but also public agencies and institutions such as municipalities. Hence, when referring to 'public' and when not stated otherwise during the course of this work it represents the described scope of stakeholders[42]. When talking about 'public opposition' or 'public resistance' in the following, it means that at least one of the mentioned stakeholder groups is opposing the planned transmission line. Public opposition is the main contributor to delays in the planning process. In case of resistance against a project, stakeholders usually submit an extensive amount of objections that need to be screened and commented by the respective authorities. This already results in delays in the permitting process. To give an example: in the consultation phase of the planned 230 km long German line Wahle-Mecklar around 18,000 objections were raised by the public that had to be handled and processed by the competent authority, consuming a significant amount of time (Piegsa, 2010). Similarly, the 225 km long Scottish line between Beauly and Denny faced 17,000 objections (Cotton & Devine-Wright, 2011, p. 117). Both examples led to around 75-80 objections per line km. If stakeholders' views and objections are not sufficiently reviewed and taken into account by the TSO, stakeholders frequently continue their opposition via lawsuits, causing even more project delays (van der Welle et al., 2011, p. 62). Regarding spatial planning, environmental and public concerns make it

[42] Note that Heiskanen et al. (2008, p. 89) define ‚stakeholders' as those individuals or groups influenced by the project, or ones that can influence the project.

difficult for the TSOs to identify suitable transmission line routes and connection points. Moreover in the EIA stage, stakeholders often request additional environmental studies to be conducted. Serious delays until the granting of the final permit can become problematic because approvals endorsed along the authorization process may become void due to their limited validity. In such cases, approvals need to be renewed, which in the worst case means that the EIA has to be conducted again. Once the project permit has been granted, stakeholders often launch legal appeals against it which additionally delay the start of construction. This is also confirmed by Kanngießer (2004), who points out that court appeals usually result from insufficient public participation during the authorization phase. Litigations are fought through several juridical instances in many countries. For example, an interviewed action group resolutely proclaimed that it would go through litigations up to the highest instance in case the permit for the line will be granted (interview with Hans Kutil, 09.11.2011). Opposition can even force modifications in transmission design and route which increases uncertainties, deters investment, and provokes project cancellations (Gerlach, 2004, p. 146). Commonly, construction of a line is not allowed to start before litigations are settled. A recent decision by the European Court of Justice[43] has given environmental associations wider access to justice and therefore increases the likelihood that the number of litigations will grow. Thus, it becomes even more important for TSOs to gain public acceptance for their projects and avoid appeals. Finally, opposing landowners in many cases refuse to sell their property, do not accept the offered compensation payments or disagree on way-leave and easement offers made by the TSOs. This regularly results in additional court proceedings that consume further time (Schneller, 2007).

All in all, public opposition can be regarded as one of the central obstacles for the realization of new transmission lines (interview with Nicole-Nabi Siefken, 09.02.2011). Public opposition against infrastructure projects has been steadily growing over the last decades, leading it to become the most critical factor regarding future transmission line planning. In contrast to insufficient authorization procedures, TSOs can directly address this issue through their own actions and measures. Hence, as the work at hand deals with the TSOs' perspective and aims to identify how they can actively tackle the issue of planning delays, the problem of public opposition is the central focus of analysis.

2.5.2.3 Insufficient authorization procedures

Insufficient authorization procedures have been identified as one of the two major responsibles for lengthy planning durations. Even if legal procedures are generally comparable across most Member States, the overall planning application process is arranged through differently structured procedures and responsibilities (COM (2006) 846). A detailed study commissioned by the European Commission Directorate-General Energy has explicitly identified the following obstacles. The responsibility for the overall permitting procedure is usually not clearly assigned to a single authority or institution.

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[43] Case C-115/09 from 12.05.2011 (‚Trianel'-Decision).

Moreover, the transparency on the progress of the permitting procedures is insufficient. Standardization as well as effective monitoring and reporting instruments are lacking to control and benchmark the progress of permitting. Furthermore, a maximum allowed time for authorities to grant a permit is in most cases absent. When delays occur, clearly defined measures for mitigation are missing. A major underlying reason is often the lack of sufficient resources and expertise in the authorities (Roland Berger, 2011b, p. 4). The legal frameworks in place foresee relevant stakeholder involvement only at a very late stage of the permitting procedure. In some Member States like Germany the public is not an integrated part of the legal approval process (Sander, 2011, p. 28). In its report on the effectiveness of the EIA Directive, the European Commission states that public participation in the decision-making process is still no standard practice across the EU. There is no common reference point for the beginning of the consultation process and timeframes for consultations vary significantly across countries (COM (2009) 378). As already mentioned earlier, an overlap of environmental assessments and therefore unnecessary double work occurs between authorization stages. In the case of transmission line projects across nations or across national regions with different regulations, the heterogeneous planning processes and timelines cause difficulties. This can result in a transmission line on one side of a border already being approved or even installed whereas on the other side the project may still be in the early stages of authorization. This is for instance the case for the interconnections Poland-Lithuania[44] and Belgium-France[45] as well as the national line Halle-Schweinfurt[46] which is across two German Federal States. TSOs also criticize the rapid change of regulations. As already mentioned, transmission line planning usually takes several years. Therefore in some cases, legislation has been changed during the running authorization process of a project and TSOs had to fulfill these additional planning requirements or had to conduct additional assessments (Bundesnetzagentur, 2011, p. 23).

The work at hand focuses on the perspective of the TSO and identifies how delays in transmission line planning can be actively reduced by considering certain success factors. Except through limited lobbyism activities TSOs usually have no influence on the definition and setting of authorization processes, regulations and laws themselves. Thus, this research work excludes this field as sphere of activity for TSOs. Furthermore, the problem of insufficient authorization procedures has already been widely recognized and respective suggestions have been made from several sides. Despite it being not within the primary scope of this work, a brief overview of recent governmental measures and changes and further recommendations should nevertheless be given in the following excursus.

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[44] The project has been approved on the Lithuanian side in August 2011. At this stage the project on the Polish side was still in the preparation of the EIA (LitPol Link Sp. z o.o., 2011).

[45] In 2007, the line was already installed on the Belgium side whereas the French section was still in study phase (COM (2006) 846).

[46] Whereas the line on the Thuringia side has already been in the final stage of permitting, the Bavarian side was still in the phase of spatial planning at the end of 2011.

2.5.3 Excursus: Recent governmental measures to overcome delays

Over the last years the European Commission as well as individual Member States have recently implemented or are currently about to enforce actions and legislative changes to overcome insufficient and lengthy authorization procedures. The following subchapters list all those European Member States in which major legislative efforts have recently been implemented. In the following these measures are outlined and briefly evaluated to what extent they are able to avoid project delays. The analysis will give transparency on the need for further TSO measures in addressing public opposition.

2.5.3.1 Austria

At the end of 2008, the Austrian Federal State of Salzburg amended the Provincial Electricity Act[47] of 1999. The update forced TSOs to install a high-voltage transmission line above 110 kV as UGC system if the line route falls below minimum distances to sensitive areas. The Federal State of Salzburg adapted the minimum distances from the German Underground Cable Law of the Federal State of Lower Saxony at the time. This means that if a line route cannot keep a minimum distance of 200 m to single residential houses or 400 m to settlements, the relevant section needs to be installed underground as long as technically and economically viable. The law is also valid for changes or upgrades of existing transmission lines above 110 kV.

Conclusion:

The Provincial Electricity Act does not improve permitting procedures themselves. However, with the implementation of UGC systems in sensitive areas, public opposition can be expected to lessen. Thus, overall planning duration is likely to be reduced. As a downside, the law is only in force in the Federal State of Salzburg and does not apply for the rest of Austria.

2.5.3.2 Denmark

Facing strong political and local opposition to proposed new OHLs in 2007, the Danish state-owned TSO Energinet realized it would never achieve the necessary reinforcement of the grid if it insisted exclusively on OHL systems. Therefore, Energinet commissioned a high level technical study including representatives of both local and national government departments to investigate possible grid development strategies. Evaluated options ranged from the complete underground installation of all existing and new transmission lines to no new UGC systems at all (Elinfrastrukturudvalget, 2008). Acting upon the report in 2008, the Danish parliament decided to lay all new transmission line projects underground. All existing lines of 132 and 150 kV will be buried successively over the next 20 years in accordance with a coherent action plan, published in March 2009 (interview with Sigrid Bluhme, 04.11.2011). For the time being, all existing 400 kV OHLs are not planned to be replaced by UCC systems. However, respective undergrounding might be carried out gradually in the future as potential

[47] Landeselektrizitätsgesetz.

technical barriers are eliminated and network planners, network operators and equipment suppliers gain experience and confidence with respect to the performance of such systems. The visual appearance of several existing 400 kV lines will be improved by using pylons with new innovative designs (Palenberg, 2012, p. 12). Overall costs are estimated to be around EUR 2.2 billion[48] until 2030 (Lund, 2010). Denmark has the advantage of flat topography and sandy soil that offer ideal conditions for burying the lines and thus reduce installation costs (interview with Jan Hildebrand, 26.09.2011).

Conclusion:

With this recent legislative act, Denmark has become the spearhead of installing transmission lines underground in Europe. However, planning procedures themselves have not been improved. The Danish government has rather tried to speed up authorization by choosing a transmission technology and mitigation measures that are more acceptable to the public. Hence, less public opposition and appeals can be expected which in turn reduces the overall planning duration.

2.5.3.3 Germany

Back in 2007, the German Federal State of Lower Saxony introduced the Underground Cable Law[49] as a result of ongoing public protest against OHLs. The law required that stretches of transmission lines which would be located at a distance below 200 m distance to residential houses or below 400 m to settlements, had to be built as UGC solution (Sander, 2011). However, shortly after the law's implementation, it was substituted by the nationwide Energy Line Extension Act (EnLAG[50]) in 2009. The EnLAG prioritizes 24 urgently needed national transmission line projects of public interest for which TSOs no longer have to provide justification. Comments submitted during the public consultation phase of these projects questioning their need do not have to be considered by authorities anymore (Roland Berger, 2011a, p. 6). Prioritization comes along with a reduced required level of analysis in the authorization processes. Furthermore, legal recourse against authority decisions is limited to one level of jurisdiction (Leprich et al., 2011, p. 4). Four out of the 24 EnLAG projects are declared as pilot lines in which authorities can decide on the implementation of UGC sections in case minimum distances[51] to houses and settlements cannot be ensured (similar to the distances set in the Underground Cable Law of Lower Saxony). According to the Energy Industry Act (EnWG), TSOs need to build transmission lines as economically as possible, which mainly results in OHL solutions being installed. For the four EnLAG pilot lines however, TSOs are eligible to pass on the additional cost of UGC systems to the electricity consumers. In Germany, regional authorities are usually in charge of approving transmission lines. As regulations are different across Federal States, transmission

48 DKK 17 billion.

49 Niedersächsisches Erdkabelgesetz.

50 Energieleitungsausbaugesetz.

51 The EnLAG was amended in 2011. Before that the TSO could voluntarily implement UGC sections in the pilot projects. Undergrounding was made subject to authority decision in the amendment.

line projects that span across two States have faced the problem of unharmonized authorization processes and timelines. Thus, significant delays have occurred regularly during these projects. To address this issue, the German government introduced the Grid Expansion Acceleration Act (NABEG[52]) in 2011 and amended the EnWG. According to this new legislation, German TSOs have to create together with the German NRA a national grid development plan. TSOs can be asked by a competent independent institution to reveal the underlying assumptions and load flow data under a non-disclosure agreement for verification[53]. The plan lists all required national grid expansions across Federal States which are not listed in the EnLAG yet. After approval by the German government, the TSOs detail the rough expansion routes by concrete projects and line corridors in the Federal Grid Plan. The German NRA is in charge of coordinating regional authorities and granting permits for projects included in the Federal Grid Plan. This represents a full one-stop shop for TSOs in terms of authorization, avoids double assessments and speeds up processes. Furthermore, approval procedures have become standardized and streamlined in some cases[54]. However, the German government explicitly stated that this will not constrain or limit public opportunities for participation (Deutscher Bundestag, 2011, p. 2). In terms of obtaining the land rights, §27 of NABEG[55] allows TSOs to start expropriation activities already prior to the final planning decision to save time. Similar to the EnLAG, NABEG defines one pilot project eligible for the reimbursement of additional costs of a UGC system installation. Along with the NABEG, the German Power Grid Remuneration Ordinance (StromNEV[56]) was amended and allows compensating municipalities for the negative impacts of transmission lines with EUR 40,000/km. With regard to communication, the German Federal Ministry of Economics and Technology and the Ministry of Environment also planned a national information campaign to inform the public about the necessity of grid extensions and to trigger public discussion.

Conclusion:

The recent implementation of new German legislation can be regarded as a step towards speeding up authorization procedures for transmission line projects. A governmental decision regarding the need for certain expansion projects will reduce discussion at the local level if lines are required or not. Though, authorization acceleration is often limited to a small privileged number of projects. UGC systems are limited to four pilot projects within the EnLAG and only one pilot project within the framework of NABEG. Moreover, the German NRA so far has no competence with regard to transmission line permitting but is required to hire several hundred new experts within a short period of time to perform the central transmission line authorization of NABEG. In contrast to the EnLAG,

[52] Netzausbaubeschleunigungsgesetz Übertragungsnetz.

[53] According to §12f (2) EnWG.

[54] If a new line is either planned along the route of an existing line (upgrade), in parallel to an existing line or within a transmission corridor that has been defined in the Federal Grid Plan.

[55] In conjunction with §45 EnWG.

[56] Stromnetzentgeltverordnung.

the NABEG does not limit litigations to only one level of jurisdiction and thus does not effectively restrict time-consuming legal recourses. The planned information campaign faced severe internal conflicts of interest regarding organizational responsibilities and was put on hold at the time of this work (Bauchmüller, 2012). Opportunities for early public involvement in terms of consultation have been improved. However, it remains unclear to what extent public concerns and objections will be considered in the decision making process. The new legislation still lacks sufficient participation of the public.

2.5.3.4 Great Britain

Similar to the Office of Energy Projects in the Netherlands, Great Britain implemented a coordinating institution via the Planning Act of 2008 which came into force in March 2010. This 'Infrastructure Planning Commission (IPC)' was designated as the single authority, granting permits for nationally significant infrastructure projects, replacing decision-making by local planning authorities and the Secretary of State. The relevant projects[57] were listed in the National Infrastructure Plan. Under the Planning Act, TSOs had to conduct extensive public consultation before submitting application documents to the IPC. They even had to seek approval for their consultation structure and handling from the IPC, which monitored also its implementation. After an application for a project had been submitted, the IPC held a second public consultation involving all stakeholders (Roland Berger, 2011b). Maximum permitting duration was set to 12 months. In case delays occured, the IPC had to report them directly to parliament (Roland Berger, 2011a, p. 8). However, with the recent change of government, the new leading political party opposed the IPC and regarded it as an affront to democracy. The new Prime Minister David Cameron argued that "[p]eople need a planning system in which they feel they have a say – both on national and local level" (Grice & Russell, 2008). Thus, at the end of 2010, the British government introduced the Localism Bill, which included a series of measures with the potential to achieve a substantial and lasting shift in power away from central government and towards local people (UK Department for Communities and Local Government, 2011, p. 1). The Bill changed the procedures under the Planning Act of 2008 and replaced the IPC with a Major Infrastructure Planning Unit as part of the Planning Inspectorate. Hence, decision-making regarding transmission line projects was returned to the Secretary of State. This was justified by the argument that, in contrast to the Government ministers, the IPC was an unelected quango[58] and therefore not directly accountable to the public (Grice & Russell, 2008; UK Department for Communities and Local Government, 2011, p. 14). The Localism Bill gained royal assent in late 2011 and came into force in April 2012. The Bill was accompanied by the National Policy Statement (NPS)

[57] Only transmission lines with a voltage level of 132 kV and above (Cotton & Devine-Wright, 2011, p. 122).

[58] Quasi-autonomous non-governmental organization.

for Energy[59] in 2011, which defined policies against which proposals for major energy projects have to be assessed against. Furthermore, in 2012, the government introduced the National Planning Policy Framework that streamlined national planning policy into a consolidated set of priorities and thereby reduced bureaucratic red tape.

Conclusion:

The original Planning Act with the installation of the IPC can be regarded as having been an effective measure to speed up permitting transmission line projects. However, this was at the cost of public participation. With the new Localism Bill, public participation is strengthened again which is valued by the British citizens (interview with Elke Bruns, 27.09.2011). In addition, the streamlining of national planning procedures by the National Planning Policy Framework looks promising. However, at the time of this work no experiences have been made yet, if and to what extent new legislation can lead to an acceleration of the overall planning of transmission lines.

2.5.3.5 Netherlands

In 2009, the Dutch Electricity Act[60] was renewed with Article 20a, which stipulates new high-voltage transmission lines being approved according to the National Coordination Regulation[61], which has been effective since 2008 (RealiseGrid, 2010c, p. 16). The Regulation covers two important aspects: first, the decision process to define projects of national interest in a National Fitting-in Plan[62], and second, the granting of the respective licenses.

In terms of the first aspect, the Office of Energy Projects identifies required installations and drafts a National Fitting-in Plan. The draft is distributed to the affected municipalities, where it can be consulted upon. Written objections can be made within a timeframe of three months. If local authorities cannot keep the deadline or if the quality is not as requested, the Ministry acts as ‘authority of last resort’ and makes the decision instead (Roland Berger, 2011a, p. 7).

The second aspect aims to speed up authorization procedures. Therefore in 2010, the Dutch government designated the Ministry of Economic Affairs, Agriculture and Innovation (ELI) as the single authority for handling the permitting procedure. It is responsible for the coordination of the interface between the TSO, competent authorities and stakeholders, the issuing of a high quality permit, and the completion of the procedure within the foreseen time limit. Thus, processes of different authorities can be run in parallel and better aligned. The Office of Energy Projects supports the Ministry and keeps track of the progress of the procedures. The maximum overall permitting duration, from the submission of application documents until the final decision on the permit, is set to 9 to 12 months. All spatial plans, environmental assessment results and permits will then be published,

59 Transmission line relevant NPS is ‘EN-1: Overarching Energy’.

60 Elektriciteitswet.

61 Rijkscoördinatieregeling. Part of the Dutch Spatial Planning Act (Wet ruimtelijke ordening).

62 Rijksinpassingplan.

followed by a six week period for public consultation and the final decision. These measures mean that the overall time until the project is finalized should be reduced from 10-15 years to around six years (Roland Berger, 2011b).

Conclusion:

Centralized permitting seems to be a step to accelerate authorization. However, the recent Dutch TSO's experience has shown that processes have actually not been sped up (van der Welle et al., 2011, p. 63). Based on a report of the respective TSO and competent authorities, significant preparations are necessary on both sides prior to the permitting procedures in order to meet the short authorization timelines. This includes high quality application documents and extensive stakeholder discussions upfront. The parallel processes of the National Fitting-in Plan and permitting are problematic, as changes to the plan cause the licensing process to start again from the beginning (RealiseGrid, 2010b, p. 20). Furthermore, the Ministry's overruling of municipalities, which represent public interests, is unlikely to reduce public opposition. This concern was also shared by an interviewed representative of a Dutch action group (interview with Luc Meijer, 15.11.2011).

2.5.3.6 European Union

As mentioned earlier, lack of project funding is one of the reasons that can hamper project implementation. In 1996, the EU established **Trans-European Energy Networks for Electricity (TEN-E)[63] Guidelines** according to Decision 1254/96/EC by the European Parliament and Decision 96/391/EC by the European Council[64]. The Guidelines provide a framework for increased coordination, monitoring progress in implementation and financial support[65] for three defined categories of transmission line projects in Europe shown in figure 14.

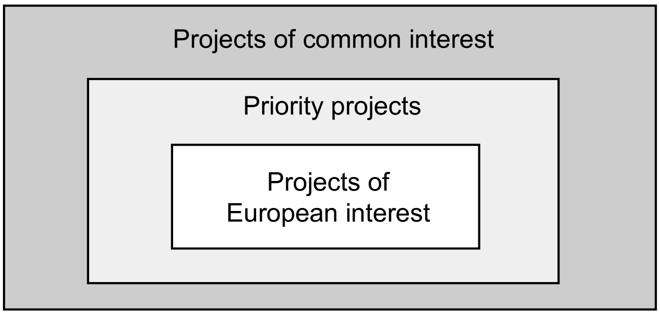

Figure 14: Project categories of TEN-E framework.

[63] The TEN-Guidelines include also gas transmission projects (TEN-G). For clarity these are neglected here.

[64] Both Decisions have been combined in 2003 into Decision 1229/2003/EC and repealed in 2006 by Decision 1364/2006/EC.

[65] A list of financed projects between from 1995-2010 can be found in EC DG Energy (2012).

The first and broadest category comprises transmission line projects that favour the establishment of a trans-European energy network. They are called ‘projects of common interest’ (PCI). Furthermore, the Commission identified priority corridors throughout Europe that especially foster the internal energy market, ensure the security of supply by interconnecting countries or integrate renewable energy. All PCIs along these corridors are categorized as ‘priority projects’. They receive financial assistance mainly through support by the European Investment Bank (EIB). All those priority projects that are interconnection lines or have a significant impact on cross-border transmission capacity are labelled as projects of ‘European interest’ – the third category – and are listed in the **Priority Interconnection Plan (PIP)** (COM (2006) 846). This last category of projects receives priority funding from the TEN-E budget. However, the budget consists of only EUR 155 million for the period 2007-2013 according to Regulation No 680/2007. In addition, Regulation No 2236/95 limits funding to a maximum of 50% for planning activities, such as feasibility studies or environmental assessments and to at most 10% for eligible works’ costs. The funding rate per project has so far rarely reached more than 0.01-1% of the total investment cost (SEC (2010) 1395). It should be mentioned that the EU provided additional finance during the financial crisis through the **European Economic Recovery Programme (EERP)** under Regulation No 663/2009. Nevertheless, it provided only a one-time finance opportunity of EUR 910 million to a very limited number of transmission line projects[66].

Next to finance, Member States agreed that projects of European interest should face only a maximum of five years in planning and approval procedures. This was to be achieved by higher project visibility and prioritization in the authorization procedures against other infrastructure projects. Nevertheless, more than half of the projects have faced delays (EC DG Energy and Transport, 2008). To intervene in case of significant implementation difficulties, the Commission appointed four ‘**European coordinators**’ in 2007. They were meant to act as facilitators and to resolve project conflicts. This worked out very successfully for instance for the interconnection project between Spain and France, which at the time faced a delay of already more than 25 years due to severe public opposition and environmental concerns. The designated coordinator Mario Monti, who later in 2011 became Italian’s Prime Minister, successfully helped to resolve the project conflict.

Back in 2008 in a **Green Paper** (COM (2008) 782), the European Commission stated that the TEN-E framework needs improvement and alignment with the new European 2020 targets[67]. In a more detailed analysis in 2010, the Commission reviewed the implementation of the TEN-E framework between 2007 and 2009. In the final report, it concluded that there was a lack of focus and too much ambiguity in the guidelines about the categorization of projects. The TEN-E policy seemed ineffective,

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66 For the sake of completeness it should be mentioned that in the context of financing the TSOs can receive additional operating revenues through Inter-TSO Compensation (ITC) and the Congestion Revenue Scheme. As not in focus of this work, both instruments are not elaborated further.

67 20% renewable energies, 20% less greenhouse gases and 20% more energy efficiency by the year 2020. Also known as ‘20/20/20 target’.

mostly due to the fact that it was not binding for Member States. Furthermore, the TEN-E budget was regarded as insufficient, as it provided only very limited funds for studies but no direct risk mitigation instruments (COM (2011) 658, COM (2010) 203 and SEC (2011) 755). In the light of this assessment, the Commission issued a Communication on '**Energy Infrastructure Priorities for 2020 and Beyond**', as a blueprint how to overhaul the TEN-E framework and called for a new EU energy infrastructure strategy to coordinate and optimize network development on a continental scale (COM (2010) 677). This blueprint resulted in a **Regulation proposal** at the end of 2011 that came into force on January 1st 2013 (COM (2011) 658). The new Regulation primarily aimed to streamline permit granting procedures and provided financial support to certain projects. It defined 12 strategic trans-European energy infrastructure corridors and areas. All projects necessary to implement these priorities were labelled 'projects of common interest' (PCI). Other categories such as 'priority projects' or 'projects of European interest', as mentioned in the former TEN-E framework, were not used anymore. The number of PCIs was estimated to be around 100 for electricity transmission[68]. 'Priority status' at national level was granted to ensure rapid administrative treatment. Moreover, maximum durations for authorization procedures were set for these projects (see figure 15).

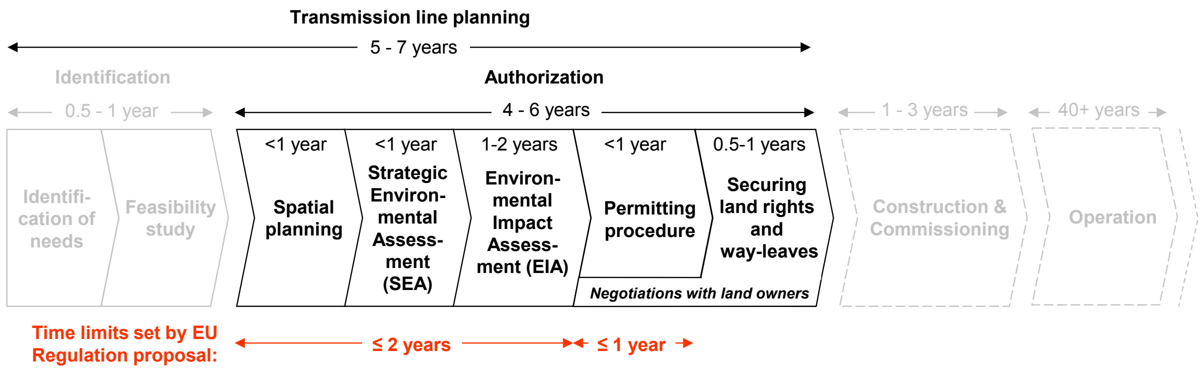

Figure 15: Typical planning process steps for transmission lines with new authorization deadlines (red) set by EU Regulation.

Specifically, this meant that spatial planning and all environmental assessments needed to be completed within two years. To facilitate this, Member States should establish a single competent authority acting as one-stop shop for the TSO and which is responsible for coordinating all other relevant authorities. With this setup, complex, uncoordinated and lengthy authorization processes as well as double environmental assessments should be avoided. Once the environmental assessment is finalized, the TSO should hand in the application documents to the competent authority which has to reach a final decision within a year. In comparison to earlier ideal authorization durations, this means a saving of up to two years[69]. The Commission claims that this will cut administrative costs for a given project by about 30% on the TSO side and about 45% on the authorities' side (EC DG Energy, 2011b).

[68] In total the Regulation proposal covered also additional gas transmission projects.

[69] Please note that securing land rights and way leaves still takes 0.5-1 years.

Despite the acceleration of the authorization procedures, the Commission aimed still to ensure the "highest possible standards of transparency and public participation" with its new legislation. In other words, the time limits should make permitting processes more efficient without compromising the high standards for the protection of the environment and public participation. Explicitly, the TSO should consult the affected public at least once about the planned project prior to the submission of application documents. Furthermore, a minimum of three alternative routes should be considered including an assessment of their expected impacts and a list of possible mitigation measures. In addition, the TSO should invite all affected stakeholders to meetings in written form. In terms of transparency, the TSO should publish relevant project information through a project website and other appropriate information channels[70]. The Regulation proposal also provided a methodology and a process for the elaboration of an energy system-wide cost-benefit analysis for PCIs. According to this methodology, costs and benefits of a cross-border transmission line can be identified and allocated.

TSOs are obliged to submit a status report about their PCIs to ACER on an annual basis. These reports must include current planning progress and, where relevant, the occurred delays compared to the original implementation plan. ACER then evaluates these reports and proposes mitigation measures such as the nomination of European coordinators to overcome delays and difficulties.

In terms of funding, the Regulation proposal intended to replace the existing TEN-E financing regime with the **Connecting Europe Facility (CEF)**. The CEF is part of the next **Multiannual Financial Framework 2014-2020** which represents the EU budget that comprises total funds of EUR 1 trillion (COM (2011) 500). Out of this total budget, EUR 9.1 billion is planned to be allocated to the CEF to accelerate electricity infrastructure development (COM (2011) 500). The CEF should be centrally managed and provide funding to transmission line projects that are of EU interest, i.e. which foster the establishment of an internal electricity market, increase security of supply or support the integration of renewable energy. Finance is planned to be limited to 50% of total costs for studies and works[71], but could be increased in exceptional cases up to 75%. However, grants for works are about to be only granted if the line is not commercially viable (COM (2011) 665). CEF finance aims to act as multiplier and is intented to promote substantial participation by private sector investors and financial institutions. To assist the financing of the CEF, the Commission set up the **Europe 2020 Project Bond Initiative** as one of several risk-sharing instruments[72] upon which the facility may draw in order to attract private finance in projects. The Bond Initiative thus acts as a catalyst to re-open the debt capital market (currently largely unexploited for infrastructure investments following the financial crisis) as a significant source of financing for the infrastructure sector (EC, 2011).

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70 Sensitive information has to be kept confidential. Annex VI No 5 of the Regulation proposal lists what kind of information should be published on the website.

71 This is different to the previous TEN-E financing scheme.

72 Next to Risk Sharing Finance Facility (RSFF) and Loan Guarantee Instrument for Trans-European Transport Network Projects (LGTT) of the European Investment Bank (EIB).

Conclusion:

The new European Regulation is very likely to result in an overall improvement in transmission line planning. However, it has several pitfalls. First, it is only valid for interconnection projects or national projects with significant cross-border impact. All other national projects are completely left out regarding acceleration and funding. Furthermore, although the Regulation came into force on January 1st 2013, the Member States have additional six months to set up national one-stop shop authorities and nine months to streamline the environmental assessment procedures. The first list of PCIs is unlikely to be available before summer 2013 and the CEF funding will come into place at the beginning of 2014 when the TEN-E finance scheme runs out. Thus, still a lot of additional time will have passed before the changes are implemented and new projects benefit. It also cannot be assured that the set planning time limits are achievable given the planned regulatory and legislatory changes as no experiences exist. In contrast to the former TEN-E framework, the new Regulation is more binding. Nevertheless, it lacks clear plans in terms of what will happen, if the set project deadlines are not met. The Regulation does not foresee any penalties. It simply states that "in the event of an expiry of the time limit (sic!) (…) the competent authority shall present (…) measures taken or to be taken to conclude the permit granting process with the least possible delay". There is no option that ACER or any other European institution will intervene or even take over permit granting if the national authorities fail to keep to the deadlines. The only possibility included is that the Commission names alternative operators or investors to implement the project, if commissioning is delayed by more than two years. This however, only applies if the TSO cannot give sufficient justification for the delay, which is very unlikely. In terms of transparency and participation, the new Regulation improves transparency and stakeholder involvement. Nevertheless, involvement is limited to consultations and does not comprise active stakeholder engagement. The Regulation explicitly states that permits can also be granted to PCIs which have an adverse impact on the environment for reasons of 'overriding public interest'[73]. This might on the one hand speed up implementation but on the other hand is unlikely to increase trust and reduce public opposition. During consultation on the new Regulation, NGOs reacted reservedly regarding this rule (SEC (2011) 1233). Without increasing social acceptance in general, opponents will continue to raise several thousands of objections that need to be assessed by the authorities, there will still be complicated and difficult negotiations with landowners about land rights and way-leaves and opponents will pursue litigation and appeals. Thus, the new Regulation is a step in the right direction but the core problem of delays, namely the public opposition, has not been sufficiently addressed.

[73] When the conditions of Directives 92/43/EC and 2000/60/EC are met.

2.5.3.7 Further recommendations

Next to the recently conducted legislative changes in several Member States of the European Union, further measures have been suggested. In their assessment for the European Commission, Roland Berger (2011b) proposes a series of potential measures for regulations on Commission and Member State level listed in figure 16.

	European Commission	EU Member States
1. Improve Transparency and Manageability	> **MEASURE 2**: Implementation and monitoring plan > **MEASURE 4**: European Energy Infrastructure Supervision > **MEASURE 6**: Definition of a reference permitting process	> **MEASURE 1**: Definition of projects of public interest > **MEASURE 2**: Implementation and monitoring plan > **MEASURE 3**: National Energy Infrastructure Supervision > **MEASURE 5**: Legally binding target durations
2. Empower Authorities	> **MEASURE 9**: Award for territorial entities for implementing a smooth permitting procedure	> **MEASURE 7**: One stop shop > **MEASURE 8**: Improving authorities' access to experts
3. Optimise Permitting Procedures		> **MEASURE 10**: Fixing the legal status quo for the duration of the permitting procedure > **MEASURE 11**: Integration of spatial planning into the permitting procedure > **MEASURE 12**: Mandatory Scoping > **MEASURE 13**: Granting access to land / easement together with permit > **MEASURE 14**: Limiting legal recourse to a single level of jurisdiction
4. Increase Project Developers' Engagement	> **MEASURE 15**: Principles for inclusive permitting procedures > **MEASURE 16**: Linking access to EIB, EBRD, EU funds to guidelines	> **MEASURE 17**: Creating incentives for developers to take responsibility for effective stakeholder dialogue within the procedure
5. Improve Communication and Mitigate Public Opposition	> **MEASURE 18**: Communication strategy focusing on the necessity and benefits of extending energy infrastructure in the EU	

Figure 16: Recommended measures identified by Roland Berger (2011b, p. 10) to improve transmission line regulation.

A first area of recommended improvements is the transparency and manageability of permitting procedures. This mainly includes monitoring measures and the setting of legally binding target durations of permitting activities. The second area comprises empowering respective authorities, especially to bundle fragmented competences in order to create one-stop shop authorization for TSOs. Third, the optimization of permitting procedures themselves is suggested. It contains examples such as the integration of spatial planning into the permitting procedure where still separated and limits the legal recourse to a single level of jurisdiction to avoid lengthy litigations. Fourth, effective stakeholder dialogue, especially outside the legally required context, should be incentivized for TSOs. Finally, on EU level, a communication strategy focusing on the necessity and benefits of extending energy infrastructure in the EU should be implemented. In a second report, the authors identify good practice examples of national authorization processes, which they regard as congruent with their recommendations. These concrete examples could be used to inspire other Member States in defining further improvement measures (Roland Berger, 2011a).

Other publications also identify room for improvement. ENTSO-E (2011b, pp. 6–8) put forward that important transmission lines of public interest should be stated in law, i.e. an objectively defined list of priority projects that do not have to be justified by the respective TSOs anymore. Furthermore, accelerated permitting procedures should apply for these priority projects. Similarly, so called ‘infrastructure corridors’ should be reserved in national spatial planning for high priority infrastructure projects including transmission lines. Infrastructure projects in these corridors would have the privilege of authorization shortcuts. Regarding planning procedures, ENTSO-E further proposes a clear definition of what kind of documents should be required during the authorization procedures (e.g. during EIA). This is not always clear and authorities often need to request missing documents which takes additional time for the TSO to prepare and submit. Simplified authorization procedures for upgrading existing transmission lines are also recommended. Moreover, it should be possible to build necessary infrastructure projects in protected areas (e.g. Natura 2000), if the environmental effects of these projects can be mitigated adequately and compensation measures are taken. National authorities need to have sufficient and specialized manpower in place to deal with infrastructure projects in an effective and timely manner. Although identified in the specific context of national regulations, the following recommendations can also be regarded relevant for other Member States. The German Advisory Council on the Environment suggests clearly assigning responsibilities and distinct scopes for environmental assessments to eliminate double work. In addition, it proposes an improved cooperation and coordination between sectoral planning and grid regulation to avoid and handle competing claims of land use (Schneider, 2010, pp. 54–56). Sander (2011) also touches on the shortcomings of the German authorization approach. As an improvement idea she mentions the installation of a citizen’s advocate. The advocate should be officially partial, supporting the public in taking an active role throughout the authorization process. Citizen advocates should be familiar with details of the approval process, rights and proceedings and should also have a broad technical expertise. Furthermore, Sander recommends legally setting minimum distances of housing to transmission lines. Politics should consider the above described suggestions for their next legislative amendments regarding transmission line planning.

2.6 Interim conclusion on the fundamentals of transmission line planning

Chapter 2 provided background knowledge about electricity transmission technologies, the development of new transmission lines, project delays and obstables, major players, etc. required for the understanding of the subsequent parts of this work. It can be summed up that in general there are two major types of electricity transmission technologies: HVAC and HVDC[74]. Both can be implemented as OHL or UGC system. The predominantly applied type in Europe is the HVAC OHL system, as it is most cost effective and suitable for the topography of a meshed grid. National TSOs are responsible for the development and operation of the electricity transmission lines and have to ensure a stable and secure supply of electricity at considerable cost. Originally, these companies have been vertically integrated as utilities covering power generation as well as electricity transmission. With the liberalization of the European energy market, Member States had to enforce the unbundling of these entities to increase competition. TSOs are regulated by NRAs and are associated under respective bodies on European level. TSOs have to strive for security of supply, the integration of RES and an integrated European market. Grid expansion has to be conducted at reasonable costs, which has led to TSOs preferably installing OHL solutions that require lower investment costs than UGC systems. Transmission line planning consists of an identification and authorization phase and ideally lasts around 5-7 years. The public is consulted only to a limited extent in the planning process, rather than being able to actively participate in decision-making. As mentioned earlier, next to inefficient and lengthy authorization processes, public opposition regularly causes significant planning delays. Members States as well as the European Commission have recognized these problems and have recently implemented, are currently about to or will soon introduce new legislations to overcome these shortfalls. The actions are expected to reduce the authorization duration to a certain extent. Several countries implement a so called one-stop shop, i.e. one authority granting all required permits. Fixed timelines and central process monitoring are additionally applied measures. However, only reducing permitting durations or speeding up the decision making processes does not reduce public opposition against infrastructure projects per se. This is because most resistance is caused by the lack of involvement of stakeholders in the project planning process and not meeting their expectations and demands. Member States have increased the opportunities for public consultation but have failed to implement sufficient opportunities for participation in the decision making process. Mere consultation, in which people can comment but not really get involved in planning, is seen as not being sufficient to reduce public opposition. As such, stakeholders will most probably continue to significantly raise objections and ask for additional environmental assessments which will keep authorities busy and thus cause delays. Furthermore, citizens will very likely continue to appeal against permits, refuse to sell land or disagree with offered way-leaves as long as they do not feel properly involved in the authorization process. As long as such resistance exists, planning times will still face significant delays despite improved authorization processes. Hence, it is up to the TSOs to identify how to reduce public opposition in their transmission line projects in order to reduce opposition and avoid long project delays.

[74] As already mentioned, due to its currently limited available production capacity and unsuitability for long electricity transmission, GIL technology is neglected in this work.

3 Fundamentals of social acceptance

3.1 Definition and classification

Acceptance stems from the Latin word 'accipere' and means 'receive'. The Duden defines acceptance as "the willingness to accept / endorse / approve / acquiesce something" (translated from Müller 1982, p. 47). According to the Longman Dictionary of contemporary English, acceptance is determined as "the act of agreeing that an idea, statement, explanation etc. is right or true" (Procter, 1995, p. 7). Kistler et al. (1990, p. 167) define acceptance as an individual positive attitude which is expressed by a certain behaviour that can be described as approving, endorsing or receiving. In contrast to the clear definition of acceptance, the use and understanding of the term 'social acceptance' is rather vague. Wüstenhagen et al. (2007, p. 2684) state that social acceptance as a term is often used in practical policy literature, but clear definitions are rarely given. Among the rare available definitions, Deuten et al. (1997) refer to social acceptance as the degree of acceptance by the public and thereby use public as a synonym for society. This definition will be used hereinafter. To further contribute to the understanding of social acceptance, figure 17 gives an overview of the different dimensions of social acceptance. It is based on the description of Schweizer-Ries et al. (2011, p. 11) who state that people's attitude can either be positive, indifferent or negative.

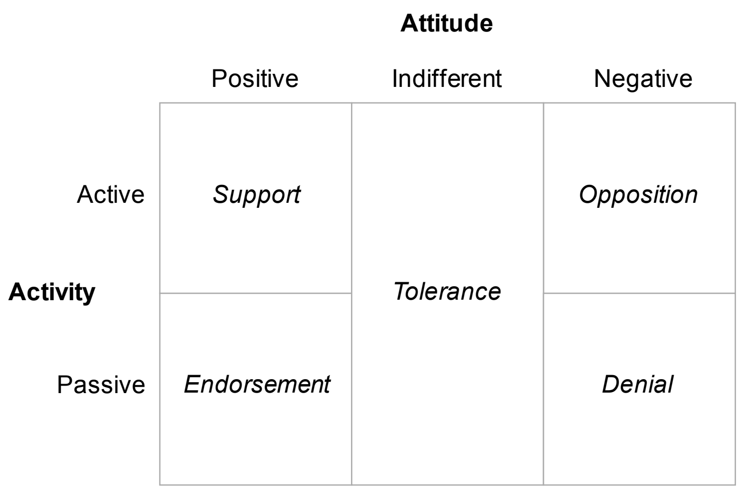

Figure 17: Dimensions of acceptance. Based on Schweizer-Ries et al. (2011, p. 11).

Moreover, people's activity can either be active or passive. In case they are active they engage in support for a project development or opposition respectively. If they are rather passive, they show only endorsement or denial respectively. People, who are indifferent about a planned transmission line tolerate it. If something is regarded as socially accepted, it does not necessarily mean that every single member of the society but the vast majority of it actively supports it or shows endorsement. Nevertheless, striving for full social acceptance of their transmission line projects in society would be literally impossible for TSOs. As long as there is no active opposition, TSOs can successfully proceed with their project plans. Therefore, their minimum objective for project implementation is to reduce severe public opposition which is why this work aims to identify success factors how TSOs can achieve that. Reducing public opposition means in turn to increase social acceptance at least to a level that the majority tolerates the transmission line project. This is why throughout this work the reduction of public opposition goes in hand with the increase in social acceptance.

It is furthermore important to distinguish between the national and local level of social acceptance. People on a national level may agree on the need for transmission lines as they bring general benefits to society as a whole. Nevertheless, a transmission line which is planned directly across local people's properties automatically implies individual negative impacts for them (Koskinen & Laitinen, 2010). If the affected local people are not willing to carry this burden for the sake of society, they will most probably actively oppose the line. Thus successfully avoiding public opposition on a national level is not necessarily a panacea for TSOs to avoid local opposition to transmission lines as well. As illustrated in figure 18, stakeholders can be classified according the local and national level. Several nomenclatures have evolved for these different stakeholder groups.

	Local acceptance	Local opposition
National acceptance	*PIMBY* *YIMBY*	*BIBYTIM* *LULU* *NIMBY* *NIMFOS* *NIMFYE* *NUMBY* *PITBY*
National opposition	-	*CAVE* *BANANA* *NIABY* *NOPE*

Figure 18: Classification matrix regarding acceptance on local and national level. Own illustration.

The most famous stakeholder classification is 'not in my backyard', or NIMBY, which is also referred to as 'Saint Florian principle' and stems from an old prayer to the Holy Saint Florian begging to protect ones own house while burning others. The term NIMBY was formally introduced by O'Hare in 1977 (O'Hare, 1977) and picked up by several authors at the time (e.g. Matheny & Williams (1985), Popper (1981) or Morell & Magorian (1982)). The term NIMBY suggests that people have a positive attitude towards something until they themselves face individual impact from it, at which point they oppose it for selfish reasons (O'Hare, 1977). Welsh (1993) and Heiman (1990) have identified that protests which had explicitly been claimed by opponents not to be based on NIMBY arguments, but rather on more general concerns, had been more successful. Project developers characterize opposing local stakeholders as "worried, irrational, ignorant of scientific and technical facts, and selfishly unwilling to support projects that benefit the broader society" (Cotton & Devine-Wright, 2011, p. 118). Dear (1992) describes NIMBYism as the motivation of residents who want to protect their turf. He refers to it as "the protectionist attitudes of an oppositional tactics adopted by community groups facing an unwelcome development in their neighbourhood". He further argues that "residents usually concede that these 'noxious' facilities are necessary, but not near their homes" (Dear, 1992, p. 288). Wolsink (2000, p. 51) states that the NIMBY concept represents a specific social dilemma. Similar to game theory in economics, the outcome of such a dilemma[75] is not optimal due to individuals' utility maximization. Personal costs and benefits are weighed up against each other.

Further acronyms that are often used with a similar meaning to NIMBY are 'not under my backyard' (NUMBY), 'not in my front yard either' (NIMFYE), 'better in your backyard than in mine' (BIBYTIM) or 'put it in their backyard' (PITBY). In case the planned facility implies significant negative environmental and health impacts, opposition to the project is regularly described as 'locally unwanted land use' (LULU). In the context of visual impact, 'not in my field of sight' (NIMFOS) is often used. Thus, NIMBYism and its similar acronyms imply a positive correlation between spatial proximity and resistance. The positive relationship between distance to a site and opposition to it has been studied and confirmed by several researchers (e.g. Massey (1978), Lindell & Earle (1983), Furuseth (1991) or Furuseth (1990)). Phrases that represent nationally and locally unwanted projects are 'citizens against virtually everything' (CAVE), 'not in anybody's backyard' (NIABY) or 'not on planet earth' (NOPE). 'Build absolutely nothing anywhere near anybody' (BANANA) does not exclude social acceptance per se, but as most areas in Europe are densely populated, large scale infrastructure installations literally cannot avoid being built close to someone. Therefore, BANANA can also be considered as an acronym of complete opposition. Moreover, there is a stakeholder class that nationally as well as locally welcomes a project. This group is often referred to as 'please in my backyard' (PIMBY) or 'yes in my backyard' (YIMBY). Both categories represent supporters of TSOs when it comes to implementing new transmission lines. Although never explicitly coined as a phrase, there are cases in which a project is opposed nationally but wanted locally. To give an example, Kunreuther et al. (1993, p. 314) describe a case where 20 American communities voluntarily applied to host a temporary nuclear waste storage facility, despite the fact that most Americans were against nuclear power at the time. A similar case was the siting of a nuclear waste facility in Korea described by Chung & Kim (2009). However, such cases are rare. 'NIMBY' is often incorrectly used today for all kinds of public opposition to an infrastructure project independent of the respective stakeholder attitudes and motivations. The acronym therefore has negative connotations. Proponents of a facility often apply the term NIMBY as "a succinct way of discrediting project opponents" (Burningham, 2000, p. 55).

[75] Similar to the famous multi-person prisoner's dilemma (O'Hare, 1977).

3.2 Contextual factors that influence stakeholders' attitudes

Stakeholders' attitude towards a transmission line is subject to several contextual factors. Knowing these factors and their deterministic influence on attitudes helps to understand and even predict respective stakeholder motivations at the beginning of the planning phase to a certain extent. Contextual factors especially influence the severity of opposition. In total there are seven main contextual elements that are described in more detail below:

- Proximity of stakeholders to a facility
- Risk perception of individuals
- Individual knowledge base
- Existing and marginal exposure
- Land valuation and heritage
- Trust in project developer
- Energy system development level

3.2.1 Proximity of stakeholders to a facility

In his study about exploring the relevance of project location and the related impact on local resistance, van der Horst (2007) states that proximity has a strong influence on public attitude towards proposed projects. Cotton & Devine-Wright (2011, p. 121) found in a transmission line case study from Scotland that opposition is very much driven by people closest to the line route, whereas people living farther away are extremely pleased that it is not in their vicinity. With diminishing distance to a line, property value is increasingly reduced (Farber, 1998). Furthermore, resistance almost completely fades away once the installation is out of sight. Probably the most extensive study so far has been conducted by Warren et al. (2005). They found that people living within 5 km of a planned wind turbine were six times more opposed to it than people in the area that was 5-10 km away from the site. Other authors such as van der Welle et al. (2011) or Hannon (1994) confirm that a positive correlation between proximity and resistance exists. Interestingly, when asking people about their attitude towards an existing facility, there is no correlation anymore (Devine-Wright, 2005). In their survey on a transmission line, Priestley & Evans (1996) surveyed residents living within a corridor of 275 m to an existing line in San Francisco. The line was planned to be upgraded. The results showed no significant difference in attitude towards the planned upgrade between residents living close to or farther away from the existing line. This means that if there is no line yet, people living closest to the planned project are expected to oppose it most. Once a facility has already been implemented, even those people in the direct vicinity of an installation seem to have 'got used to it'. Also related to the aspect of proximity is the population density of an area. For a project developer more densely populated areas mean less available suitable space for the siting of new infrastructure facilities and as a consequence more opposition per line kilometre can be expected (Vajjhala & Fischbeck, 2007, p. 664).

3.2.2 Risk perception of individuals

Siting decisions usually have to deal with environmental, economic, and social risks (Owens, 2004). Hillson (2009, p. 7) defines risk as “uncertainty that matters”. According to this definition and considering the fact that stakeholders usually do not have perfect information, perceived risk can differ significantly from real scientific risks. Renn (2002, p. 68) illustrates this with the example of why people prefer riding a car compared to flying in an airplane. Most people perceive the risk of a possible aviation accident as being higher compared to an accident in road traffic, although scientific statistics show the opposite. According to the World Health Organization, “[h]ow people perceive risks can depend on their age, sex and cultural background” (WHO, 1998). Older people are generally more averse to risk than younger ones. They furthermore have more negative perceptions of transmission lines (Priestley & Evans, 1996, p. 70). This was also confirmed by the survey of Soini et al. (2011) where people below the age of 29 had the most positive attitude towards transmission lines. Walter (2011) surveyed 2,000 opponents of transmission lines, airports, train stations and wind projects. He found that 70% of the opponents were older than 45 years, while people between 16-25 years represented only 1.1% of all opponents. According to a study by Becké et al. (2011, p. 5), most opponents are usually in their 60’s or even older. They have often already retired and have plenty of spare time. Furthermore, the majority of opponents are well educated, well off and have higher-status occupations (interview with Ivan Stone, 30.11.2011; Priestley & Evans, 1996, p. 70). In a case study of nuclear waste storage siting, Bassett et al. (1996) found that women perceived significantly greater risks compared to men. Regarding cultural differences of risk perception, Renn (2000, p. 213) concludes that this “is a rather complex phenomenon that cannot be described on the basis of a single theory or model”. Available studies aiming to identify cross-national differences, lack representative samples or show inconsistent results. Several studies from the USA and Europe have identified general factors that influence individual risk perception (Renn, 2002). For instance[76], risk perception depends on the

- voluntary nature of the risk,
- familiarization with the risk source,
- reversibility of risk consequences,
- catastrophic potential of the risk source and
- the trust of information sources regarding potential risks.

Put in the context of a planned transmission line, it is possible that people who live near a line perceive high potential health risks due to its electromagnetic fields (EMF), whereas other people in the same surroundings may not at all. As a consequence, the former are likely to oppose the project whereas the latter might not.

[76] A detailed list can be found in Renn (2000, p. 21).

3.2.3 Individual knowledge base

Whenever people do not have sufficient information about something new their first natural reaction is rather cautiousness and suspicion. People are also often driven by prejudices. This is especially the case when they lack detailed information and in contrast have received information e.g. from hearsay. Generally, the level of acceptance rises with the level of information that people receive. In a study of a wind farm in Denmark, Krohn & Damborg (1999, p. 956) state that people with a high degree of knowledge of energy generation and renewables tend to be more positive about wind power than people with minimal knowledge. Similarly, regarding biomass energy plants, Upreti & van der Horst (2004) show that most stakeholders' concerns are due to uncertainty or misinformation. In the context of transmission lines, there is often uncertainty about the risks and impacts they could have. Moreover, there is a clear lack of knowledge on transmission technologies – especially their possibilities and limits, the permitting process as well as participation possibilities. This has been confirmed by a study on a planned German transmission line (Schweizer-Ries et al., 2010). Furthermore, part of the public lacks familiarity with a TSO's role (Cotton & Devine-Wright, 2011). Most people do not know that TSOs in Europe have been unbundled and are not in charge of power generation anymore.

3.2.4 Existing and marginal exposure

In some cases transmission line projects are planned in areas where other infrastructure facilities already exist. Thus, the area has already been 'exposed'. Heiskanen et al. (2008, p. 24) state that past experiences due to the accumulation of applications and projects seem to have an impact on public attitude. People often feel that they already face enough disadvantages and do not want to shoulder additional burdens. In most countries spatial planning tries to foster the bundling of infrastructure facilities to reduce the harm for people and the environment. However, this means that people living close to an existing facility will face even more disadvantages through the increasing concentration of infrastructure installations (Deutsche Umwelthilfe & Forum Netzintegration, 2010, p. 63). As a result, such residents are likely not to welcome new installations. The level of existing exposure, as one of the major influencing factors of opposition, has been confirmed by interviews conducted in the course of this work with people who are against transmission line projects. For instance in Austria, in an area in which a large antenna tower has already been installed, a planned new line in that area would destroy the landscape completely. Along a planned transmission line in Germany, an existing high-speed train line was seen as enough existing impact and burden on the local people (interview with Guido Franke, 04.10.2011). In the Italian region of Veneto, a landslide in 1963 caused a hydro dam to spill over, which killed more than 2,000 people. As such, residents in the area reject any additional major infrastructure project (interview with Enrico G. Orzes, 24.10.2011). More generally, other interviewees stated that exposure to existing infrastructure plays a major role in acceptance of new projects (interviews with Jan Hildebrand, 26.09.2011 and Marcus Mattis, 11.10.2011). The general consensus was that the more time has passed since the last implementation, the less resistance could be expected for a new project. In other words, residents get used to it (Elliott et al., 1997). This is illustrated in figure 19. The level of acceptance is usually higher before the announcement of a concrete project plan. After the announcement, acceptance reaches its lowest level during the planning and construction phase but increases slowly once the facility has been built and is in operation. Acceptance post project completion might in some cases even be higher than before the project was announced (SEI, 2003).

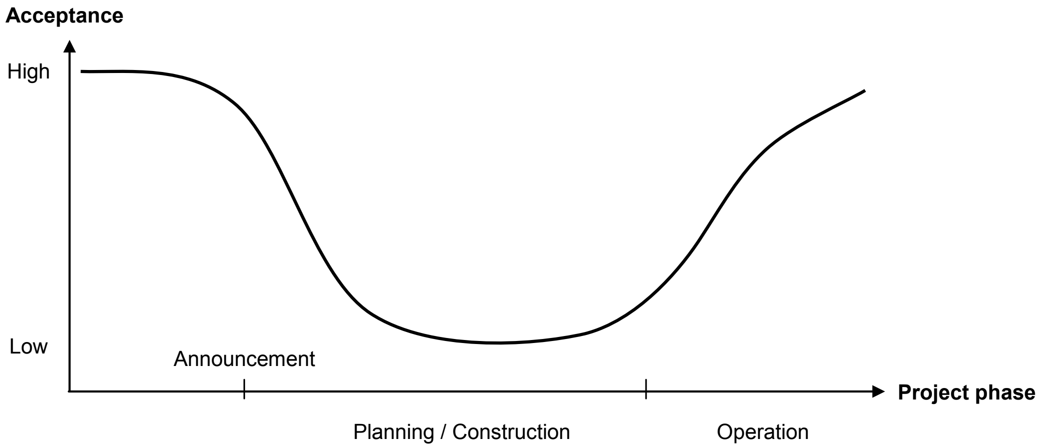

Figure 19: Acceptance level before, during and after an infrastructure project planning / construction. Own illustration based on Krohn & Damborg (1999, p. 958) and Devine-Wright (2005, p. 130).

Not only existing, but also marginal exposure has a strong influence on stakeholder motivation in opposing a project. This means the larger the additional, i.e. marginal, impact is, the more opposition can be expected. In addition, longer lines impact more people living nearby and thus attract a larger number of opponents (SRU, 2011, p. 324).

3.2.5 Land valuation and heritage

If and to what extent residents oppose a new infrastructure project in their neighbourhood strongly depends on how much they value their countryside in an emotional sense (van der Welle et al., 2011, p. 65). People, who have a positive sense of identity with regard to their homeland, are likely to resist new project developments that have negative impacts on it. They will strive for the preservation of the cultural heritage (Pahl-Weber & Henckel, 2008, p. 43). This can be observed mainly in rural areas, where in contrast to urban centres, the landscape is still to a certain extent untouched (van der Horst, 2007). Furthermore, many studies report fundamental preferences for natural and untouched landscapes which are attributed to healthy living and recreation (Kaplan & Kaplan, 1989; Ulrich, 1986). Therefore one can assume that a project planned in an already industrially affected landscape will be perceived as less of interference than a project that is to be constructed in a previously untouched landscape (van der Horst, 2007, p. 2709; Zoellner et al., 2008). This is illustrated by the interview quote from a survey on wind power plant siting done by Butler et al. (2011, p. 308): “In the right location in an industrial area I don't think [wind generators] really create a problem, but then if you visualized the skyline across the Mendip Hills or the Quantock Hills ... I wouldn't accept them because they are not creating sufficient energy to justify losing something that we really all ought to be enjoying and that is the heritage of the landscape”. Only recently the importance of local identity has been recognized in siting controversies (e.g. Wester-Herber (2004)). How many people and to what extent they value their surroundings also depends on how long they have been living there (Priestley & Evans, 1996). Inhabitants, who have grown up in an area and have been living since ever there, value the unspoilt nature of their countryside much more than those who have just moved into the area. Woods (2003, p. 312) sees a wider trend of rural change with people moving into the countryside because of a choice of lifestyle and who are less dependent on the traditional rural economy (e.g. retired ‘townies’, commuters, second home owners, etc.). Although they may have only recently settled in rural areas, they act to protect their financial and emotional investment by opposing developments and activities that threaten the perceived ‘rurality of their new homes’ (van der Horst, 2007, p. 2709). Topography also plays a major role as to what extent locals attribute value to their surroundings. Hilly landscapes are regarded as being more beautiful and attractive than flat areas (Deutsche Umwelthilfe & Forum Netzintegration, 2010, p. 63) which was also confirmed by several interviewees in the course of this work (e.g. interviews with Jan Hildebrand (26.09.2011) or Marcus Mattis (11.10.2011)).

3.2.6 Trust in project developer

According to EPRI (2001, p. 2.5), in the first half of last century people understood and had personal control over the technologies that they used. For instance, the majority of car owners could diagnose and repair most car problems with the help of a good manual and a few tools. Today’s complexity of technology means that one has to rely to a great extent on others to manage technology on his behalf and in a manner that protects his safety. This calls for new levels of trust. Thus, “industry must demonstrate respect for and empathy with the public’s views, compassion for their concerns, responsiveness to their requests, and ordinary courtesy, in addition to technical competence” (EPRI, 2001, p. 2.5). Trust is therefore also a key element in transmission facility siting (Slovic, 1993) and a key factor in the perception of risk (Siegrist et al., 2000). Whether stakeholders trust a respective project developer or investor or not, can significantly influence their attitudes towards the project. Trust is very fragile, which means that it takes years to be built, but only minutes to be destroyed. As already mentioned above, the public usually has little knowledge regarding the proposed project and its potential harmful impacts. In such a case, their decision to support or oppose a development depends highly on whether they trust the project developer. Slovic (1993, p. 677) argues that “if you trust [the project developer] (…), communication is relatively easy. If trust is lacking, no form or process of communication will be satisfactory”. Trust strongly depends on the perceived competence of someone or confidence in its ability, on credibility, image and/or reputation (Beierle, 1998, p. 8;

Lucke, 1995, p. 368; Wüstenhagen et al., 2007, p. 2687). Trust is damaged if stakeholders perceive degrees of opportunism, dishonesty and mistakes. People usually trust governments and NGOs more than private companies (Huijts et al., 2007; Sander, 2011). Industry in general faced an erosion of public trust in the recent past (Peters et al., 1997). In particular, private companies are often accused of selfish profit maximization and not caring about social welfare. For instance, Meister et al. (2010) report that in Germany only every third citizen trusts big companies, which has been confirmed by a European wide survey (EC DG Communication, 2006, p. 23). Trust can exist on two levels: first on an individual basis between the developer's personnel and the stakeholders, and second between the developer organization as a whole and the stakeholders (Baxter et al., 1999, p. 510). Lost trust is very hard to regain but it is not impossible to do so. A good example of successfully rebuilding trust is the bribery scandal involving the German industrial company Siemens in 2008. At the time, Siemens' image and reputation suffered immensely. However, through extensive anti-bribery measures Siemens regained trust and rebuild its reputation again. Today, Siemens is even recognized as a role model for compliance.

3.2.7 Energy system development level

Assefa & Frostell (2007, p. 67) state that depending on a society's level of development, its individual members aspire to different levels of needs, as articulated in Maslow's (1970) 'hierarchy of needs'. Thus, economic status, standard of living and social aspirations shape people's attitudes towards technological risks (interview with Gabrijel Uros, 11.10.2011; Renn, 2000, p. 218). A core element of economic development is the national energy system. People usually strive for a secure and stable supply of electricity as a base for economic development and personal convenience. At a comparably low level of development and an insufficient energy system, citizens are very likely to welcome new facilities that improve the security of electricity supply. They might not oppose new electricity projects to the same extent as citizens of countries would do, in which stable electricity supply is already prevalent. In contrast, acceptance for new infrastructure installations in developed, high-tech societies is not a given anymore (Wuppertal Institut et al., 2008). Energy systems are much more advanced and developed in old EU Members States, and although they are catching up, new EU Member States in Eastern Europe still have problems with security of supply (interview with Karina Veum, 11.11.2011). This has been confirmed by CEER's 5th benchmarking report on the quality of electricity supply. It reveals that the majority of listed Eastern European countries face significantly higher unplanned electricity interruptions per year than the average Western European country (CEER, 2012, p. 117). For instance in 2010[77], Poland (386 min/year), Lithuania (260 min/year) and Estonia (196 min/year) faced significantly more lost minutes per year than Denmark (17 min/year), Germany

[77] The latest benchmark figures are only available until the year 2010.

(19 min/year) or Austria (32 min/year). Hence, public resistance to new electricity lines can be expected to be lower in Eastern Europe compared to the other European countries.

3.3 The history of social movement against infrastructure facilities

In the past, the extent of public opposition to infrastructure projects was not as extensive as today. Thirty to forty years ago much less controversy surrounded the siting of such facilities. During the last decades, the public has gained substantial interest and power in its ability to avert facilities that it does not want (Kunreuther et al., 1993, p. 302). In other words, a social movement against such facilities has emerged. This movement took root primarily in the Western world with a growing appetite for civil engagement and community empowerment (MacKinnon et al., 2007), i.e. to actively participate in the decision-making process (Visgilio & Whitelaw, 2003). Gerlach (2004, p. 151) defines such a movement "as a group of people who are organized for, ideologically motivated by, and committed to a purpose that implements some form of personal and/or social and cultural change, who are actively engaged in the recruitment of others, and whose influence is growing in opposition to the established order". In the 60's and 70's more and more people started to care about the environment and critically assessed any planned changes to it. For instance, Germany at the time faced a large anti-nuclear movement. People demonstrated against the siting of new nuclear power plants. The famous protests in the area of Wyhl were successful and led to the abandonment of a planned power plant (interview with Marcel Keiffenheim, 30.09.2011). This success stimulated the movement and was further spurred on by the nuclear disaster of Chernobyl in 1986. In France, the social movement against major infrastructure plans also started with anti-nuclear protests, and in 1971 French citizens demonstrated against the planned reactor in Fessenheim. In the UK, test drilling plans for a high level nuclear waste repository at Mullwharchar Hill in 1978 led to intense public resistance. Although protests have initially been directed towards nuclear facilities, they later spread across other project types such as airports, fossil power plants, bridges, high-speed train lines, open-cast mining, pumped-hydro storage facilities, motorways and even planned facilities for the Olympic Games[78]. Major protests against transmission lines have been rarely reported until 1990. TSOs confirm that in the past, major infrastructure projects could easily receive full approval without the need of any public involvement. One of the reasons was that TSOs were part of state-owned utilities and people did not seem sceptical of the proposed projects, the need for them and the applied technology (Sander, 2011, p. 25). Since the early 90's, opposition has grown rapidly throughout Europe. In particular, more and more citizen action groups have been formed to organize opposition. In 2011, 44 citizen action groups opposing transmission lines could be found in Germany alone[79], 16 of them opposed the line between Wahle

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[78] In 2011, major local protests occurred in Garmisch-Patenkirchen (Germany) which was planned to host the Olympic Winter Games 2018.

[79] For a complete list of German citizen action groups against transmission lines see appendix 6.

and Mecklar. Probably the largest, as well as oldest European transmission line opposition group that still exists, can be found in the UK, called REVOLT. It was founded back in 1991 to oppose an 80 km 400 kV OHL and claims to have worked with more than 1,000 households and 100 landowners (Gerlach, 2004, p. 151). In particular during the last decade, new forms of communication such as the internet have made it much easier to mobilize and organize protest. Nowadays, citizens require a much higher level of information and participation compared to 20-30 years ago (interviews with Pierre Lopez, 07.10.2011 and Karsten Bourwieg, 14.10.2011). People seek more facts and figures that prove the need for a new facility, its advantages, disadvantages, costs, etc. They want clear evidence. A TSO employee, who was interviewed during a survey by Cotton & Devine-Wright (2011, p. 122), said "[y]ou need to get over the information so that people can go on fact, rather than hearsay and whatever". If information is not sufficient, stakeholders tend to oppose a project. The tendency of stakeholders to require hard facts is often described in the literature as 'there are real reasons' (TARR) (e.g. Gerlach (2004, p. 152)).

3.4 Forms of public opposition

As already mentioned, the predominant form of opposition is channelled through the formation of citizen action groups. These groups usually exist for a limited period of time until legal cases are lost and the infrastructure project is built or until the project has been successfully abandoned (interview with Karl Zotter, 10.11.2011). After this, members will lose motivation for further activities. Some action group members will continue only in rare cases to inform about or lobby against transmission lines, such as the group 'REVOLT' in the UK. During the course of this work, one action group in Germany planned to continue with a campaign against local wind power installations after they had successfully prevented the nearby siting of a transmission line. Interestingly, the group claimed not to be against renewable energy in general. Action groups often name themselves after their region (e.g. 'Interessensgemeinschaft Uckermark'), their main request (e.g. 'Pro-Erdkabel') or other attention attracting phrases (e.g. 'Achtung Hochspannung!'). Most associations are well organized with a clear division of labour according to the capabilities and experience of their members. Action groups usually have a president, vice-president, treasurer, secretary, webmaster and also a spokesman. They hold regular formal meetings and decide about future actions and positions democratically. In general, action groups are founded by a small core group of neighbours, who then try to persuade others to join. The internet is a useful tool in swift mobilization of people. The majority of groups have their own website, which nowadays can be set up at virtually no cost and without special IT know-how. 31 of the 44 identified action groups in Germany had their own online representation. In addition to this, emails, blogs or other social media such as twitter or facebook are regularly used by these action groups for communication and coordination. However, in interviews conducted in the course of this work, action group leaders have reported problems with regard to 'recruiting' people who are not directly affected by the respective planned transmission line and live further away from the project.

Thus, group participants can be divided into core activists that dedicate a significant amount of time to the group's work and some other peripheral members who show their solidarity and sympathy but are less active (Gerlach, 2004, p. 150). Solidarity of peripheral members in this sense means that these stakeholders join opposing ones, follow them in their protest activities, share the same opinions on the planned development or even provide financial aid for campaigns and expert assessments (interview with Sigrid Bluhme, 04.11.2011). Walker & Cass (2011, p. 50) gave this solidarity phenomenon the term 'community mode' that sees people very much as collectives rather than individuals. Action groups are formed in locations/districts primarily along the planned line corridor. If route corridors are changed, "those who escape impact often drop out and those who are newly impacted launch their defense (sic!)" (Gerlach, 2004, p. 150). Depending on their common interests and views, the initially scattered action groups often merge into one large group in order to have more leverage against the project developer and the authorities. Otherwise, they may at least ally and exchange information on a regular basis in a network of groups. Occasionally, they will be joined by other associations that e.g. strive to advocate claims such as environmental protection on a broader and not solely project specific basis (Gerlach, 2004, p. 150). Opponents also try to register action groups officially as legal entities in order to be able to file a suit against the project developer. Actions and activities of the action groups are plentiful. Classically, such associations organize demonstrations, blockages and pickets to show their opposition (see figure 20).

Figure 20: German action group members demonstrating against a planned line.
Photo: Ortwin Siebold (citizen action group 'Werra-Meißner-Kreis').

Moreover, members usually sign petitions, send letters, organize information events, attract media attention, conduct political lobbying, go for legal confrontation and purposely slow down authorization processes (Baxter et al., 1999, p. 518; Wolsink, 2000, p. 54). They are not only active on local level. Groups' representatives and core activists participate on supra-regional or national panels, public hearings, conferences, national initiatives and give TV or newspaper interviews. In some European Member States even cases of sabotage have been reported. In Spain activists removed bolts from transmission pylons. In France construction equipment was set on fire and in another case an air gun was fired at construction workers (without injuries). However, it needs to be said that such radical measures take place only rarely and that the majority of protest activities are peaceful. As most members of action groups are people without electro-technical know-how, such groups do a lot own research to learn about transmission line technologies, their costs, disadvantages and risks. During this research process they approach industrial experts, manufacturers of transmission line equipment as well as scientific experts from universities and institutes. They summarize their research information on their websites or organize local meetings to inform, warn and educate the public. Sometimes, groups even conduct electromagnetic measurements by themselves or organize site visits for the public to other existing transmission lines to make the future impact of a planned transmission line more tangible. Finally, action groups regularly meet with politicians and authorities to convey their requests, lobby them and try to gain political support.

3.5 Interim conclusion on the fundamentals of social acceptance

Public opposition against large infrastructure projects originated primarily from anti-nuclear protests in the 60's and 70's. Since then, people have become more and more concerned about the environment and increasingly interested in actively participating in decision making. Opponents usually organize in action groups and use new media such as the internet for communication and coordination. They try to acquire knowledge about transmission technologies and inform people about what they have learned. In light of this, achieving full social acceptance for transmission lines in society is nearly impossible for the respective TSOs. They need to focus on reducing public opposition against their installations to the largest possible extent in order to complete required projects in time. In general, stakeholders can be classified into different types according their attitude (positive, indifferent, negative) and level of activity (active versus passive). This can differ between the local and the national level. To successfully avoid or address public resistance, TSOs need to know what contextual factors can influence stakeholders' attitudes. Proximity to a planned line, individual risk perception and knowledge play an important role. Furthermore, the more the local area has previously been affected by infrastructure projects, the less willing are people to accept further installations. This can be different for nations or regions that face a below average developmental level with regard to energy systems. Every increase in electricity security of supply is then most likely welcome rather than opposed. Trust in a TSO is also crucial. Unbundled private TSOs are accused of purely striving for profit maximization and thus face a lack of trust by the people. TSOs' awareness of the above mentioned aspects will contribute to their understanding of who the relevant stakeholders are, how they are organized and work as well as what influences their attitudes.

4 Fundamentals and methodology of success factor research

4.1 The goal of success factor research

The underlying goal of success factor research is to identify determinants that positively influence the success of a company including factors that avoid failure. Thus, the basic assumption is that a limited number of decisive variables exist regarding the respective success or failure of a company (Haenecke, 2002, p. 166; Klotz & Strauch, 1990)[80]. Success factor research tries to identify factors that are common among successful organizations. Such research helps managers and practitioners in determining those factors on which they should focus their attention on in order to be successful. Thus, success factor research can be seen as a cornerstone in strategic planning and strategy development processes (Leidecker & Bruno, 1984, p. 23) and gives regular impulses for researchers to continue their work in this academic field (Daschmann, 1994, p. 1).

4.2 Defining success factor terminology

4.2.1 Success

Success can be defined as the achievement of a positive result (Hagen, 1996, p. 32). Most success factor studies have focused on an organization and its positive financial results as a mode of success. To what extent a result can be regarded as positive depends on the respective viewpoint of the stakeholders involved. A TSO might be interested in completing a project within the planned timeline without delay. In contrast, a citizen action group might regard a project as successful if the route alternative they are living closest to is abandoned. Furthermore, success for an environmental action group would be, if the transmission line is rerouted in order to avoid intersecting protected environmental areas. As already mentioned in the introduction, this work focuses on the TSO perspective, and thus, its viewpoint will be the relevant one for determining success.

There are three general approaches in social science how to rate success (Böing, 2001, p. 41). The first is the ‘target orientated approach’, which measures the success of an organization according to the predefined organizational goals (Raffée & Fritz, 1990, p. 8). As a result of comparing several success factor studies, Kalka (1996, p. 27) and Winkelmann (2004, p. 64) state that hard monetary targets have been predominantly used to measure success in success factor studies. However, it does not have to be solely hard financial figures (e.g. profit, return on capital employed, etc.) that determine success, but can include soft facts such as the motivation of employees as well. Success is not measured according to single factors but rather according to a complex bundle of them (Göttgens, 1996, p. 118; Raffée & Fritz, 1991, pp. 1211–1212). The focus of the target orientated approach is inner-organizational.

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80 Röderstein (2009) explicitly distinguishes success factors in positive and negative ones. However, to simplify matters in the course of this work, only the term success factor should be used, spanning both attributes.

If the focus is extended to external relationships, it becomes the second major success measurement called 'systematic approach'. In this case, success is measured depending on the degree to which the organization has interacted with its environment, i.e. the system as a whole (Fritz, 1995, p. 219). An example of this would be the company's social responsibility and the sustainability of its operations (Klug, 2009, p. 176).

The third and final major concept is the 'pluralist interest approach', and measures the success of an organization in terms of satisfaction of the organization's own interests as well as that of all involved external stakeholders such as customers, governments, etc. (Böing, 2001, p. 43; Klug, 2009, p. 175). This approach is the broadest of all three. In their research, Greif et al. (1998) state that almost all of their interviewed managers regarded the satisfaction and acceptance of their stakeholders as an abstract criterion of success. Osterhold (1996, pp. 6–8) also mentions customer satisfaction as one of the main soft success measures. The target orientated approach has been predominantly applied in success factor research due to the fact that the focus has been mainly on organizations and how they could outperform in the market (Kalka, 1996, p. 25). However, for the work at hand, the most relevant approach is the pluralist interest approach. This means that it is not the financial results of the TSOs, but the interaction with and reaction of the affected stakeholders in a TSO's transmission line project. A project is usually regarded as successful if it is completed in time, in budget and in quality (Dey, 2001, p. 634), which is also known as the golden triangle of project success (Westerveld, 2003, p. 414). As outlined above, public opposition is the dominant obstacle in transmission line projects leading to significant delays. Hence, from the perspective of a TSO and in the course of this research, the success of a transmission line project entails the reduction of public opposition, which causes project delays. In the context of the 'pluralist interest approach' this translates to satisfying stakeholders, who are mainly affected citizens, action groups and environmental associations. Public opposition does not necessarily have to be, and in most cases cannot be, completely avoided for a project to be still regarded as successful. This is congruent with Riekeberg (2003, p. 8), who states that any exploitation of success potential can already be called a success.

Thus overall, any achieved reduction of project implementation delay that would have been caused by people's resistance is already a success for the TSO and will be used as definition in the course of this work.

4.2.2 Success factors

Factors that influence and determine success are called success factors[81]. Adhering to the above outlined context specific definition of success, this includes all factors that reduce or even totally avoid project delays caused by public opposition in a transmission line project. Steiner (1969) is reported to have been the first to use the terminology of success factors, particularly focusing on strategy. Other researchers followed, with some of them using equivalent terms such as strategic success factors,

[81] For an overview of several success factor definitions see Kalka (1996, p. 23).

excellence factors, pulse points, strategic variables, success determinants or key result factors (Grimm, 1983, p. 26; Kalka, 1996, p. 23; Rybnikova, 2011, p. 22; Steiner, 1969). They all define these factors similarly as a limited number of characteristics, conditions, or variables that have a direct and serious impact upon the effectiveness, efficiency, and viability of an organization, programme, or project (Boynton & Zmud, 1984; Bullen & Rockart, 1981; Rockart, 1979; Steiner, 1969). Success factors exist not only inner-organizationally, but also externally to a company (Seibert, 1987, p. 11). As Little (1991) and Williams & Ramaprasad (1996) point out, it is rarely true that a single success factor is sufficient for the occurrence of success, but a combined set of success factors is likely to be. Einhorn & Hogarth (1986) confirm that sufficiency always requires a causal field which is a set of factors and not a single factor. “What is or is not a (…) success factor for any particular manager (…) [has been] a subjective judgment arrived at only after some thought” (Bullen & Rockart, 1981, p. 11). Subjectivity depends highly on an individual’s cultural, economic, professional, social and personal attributes (Greif et al., 1998, p. 9). To avoid subjectivity, Williams & Ramaprasad (1996) therefore propose the extent of statistical causality between a factor and success. Causality represents an ordinal measure of the strength of the success factors' relationship to success and thus is also helpful when a prioritization on a limited amount of success factors is required, e.g. due to resource contraints. Factors that are most ‘critical’ to success are often also called ‘critical success factors’ (CSF)[82]. The identification of success factors requires an analysis of cause-effect relations between potential success factors and success itself. Success factors can have several dimensions. First, there is a distinction between direct and indirect factors. The former directly influence success whereas the latter affect success through their affect on a direct factor or on the relationship between a direct factor and success, or on both (Williams & Ramaprasad, 1996, p. 254). Another dimension differentiates between implicit and explicit factors. Explicit factors can be directly discovered, e.g. through measurement or documentation. They are therefore manifest and comprise concrete implementable measures for managers. In contrast, implicit factors are latent and cannot directly be observed. According to Bullen & Rockart (1981, p. 5), successful managers apply implicit success factors often intuitively or subconsciously. They are often unable to clearly and concisely articulate these success factors or appreciate their importance (Caralli, 2004, p. 12). Success factor research tries to make these implicit factors explicit. A third dimension of success factors is their scope (e.g. Riekeberg (2003, p. 6) or Grabner-Kräuter (1993 p. 286)). There are internal and external success factors. Internal success factors are those that are within the control of a manager. In contrast, the manager has limited or no control at all with regard to external factors (Caralli, 2004, p. 22). For instance, considering the success of a car manufacturer, an internal success factor would be the production of a fuel efficient engine. An external example would be fuel price. Both have a positive cause-effect relation on the manufacturer’s car sales and thus on its success.

82 Sometimes also referred to as ‘key success factors’ (KSF) (Lehner, 1993, p. 58).

4.3 Success factor research history and current state

The concept of success factors dates back to ideas by Daniel (1961). At the time, organizations found themselves in the midst of an information revolution, as the growth of information systems in companies – spurred by the advent of the first personal computers – resulted in the production of significant amounts of data and information to be used for decision making (Caralli, 2004, p. 9). Daniel suggested that in order to avoid information overload, an organization's information system needs to focus on certain factors which determine the company's success. Later, Rockart (1979) picked up Daniel's ideas, developed a concrete success factor methodology and applied it to an information system. The methodology consisted of a structured interview procedure through which an analyst or consultant could support a CEO in identifying success factors. Additionally, performance measures were identified to represent the success factors. Bullen & Rockart (1981) enhanced this methodology further and created a comprehensive planning tool for organizations. Leidecker & Bruno (1984) transferred this methodology to strategic planning in 1984, and since then, success factor research has primarily targeted the success of a certain department or the organization as a whole. Success factors represented the few key areas of activity in which favourable results are absolutely necessary for a manager to reach his goals (Boynton & Zmud, 1984, p. 17; Bullen & Rockart, 1981, p. 3). Probably the most famous work published with this focus was 'In search of excellence' by Peters & Waterman (1982)[83]. As such, success factors have become an inherent part of strategic management. This has been highlighted by Ghemawat (1991, p. 2), who states that "[t]he search for success factors is what the enterprise of strategy has largely been about ever since". Over time, success factors have not only been applied to organizations as such, but also to specific initiatives, programmes or projects (Caralli, 2004, p. 11; Dobbins & Donnelly, 1998).

4.4 Classification of success factor studies

As outlined in the previous chapter, a multitude of success factor studies have been done over the last decades. In the literature, two main criteria are used to distinguish and classify success factor studies: specificity and causality (Kube, 1991, p. 4; Trommsdorff, 1990, p. 15)[84]. Specificity defines the degree of generalizability of success factors study results. In other words, specificity indicates to what extent the results of a specific study can be adopted and applied in other fields or to other cases. Hence, it determines the success factors' reach. Success factors are regarded in science as the cause of an effect, i.e. success. Hence, researchers strive to verify cause-effect relations, i.e. they want to identify the causality of factors on success. Both classification criteria are described in more detail below.

[83] Who developed the well known „McKinsey-7S" model.

[84] Other factors also sometimes used for classification are precision, intention, reliability and validity (see e.g. Riekeberg (2003, pp. 90–99)). However, they are neglected here as they are not decisive for the methodology selection in this work.

4.4.1 Specificity

Fortune & White (2006) conducted a meta study during which they reviewed 63 publications dealing with success factors in projects. They conclude that there is no consensus among researchers and authors on factors that positively influence project success. The main reasons for this is that scientists in the past have usually tried to identify and publish generalizable factors that can be applied across all project types and industries – so called 'general laws of the marketplace'. This however, turned out to be a tough challenge for science.

One of the rare successful examples of discovering several general success factors for organizations is the PIMS[85] programme (Buzzell et al., 1989). It started in the 1950s as a large long-term database project with information on 2,600 strategic business segments of mostly American, but also European companies. Each of the business segments contained around 200 additional details (Grünig et al., 1996, p. 9). With this database, analyses could be conducted in order to identify cross-industry success factors. The research programme however was discontinued in 1999 in the USA (Feldo, 2011, p. 18). Studies that investigate large heterogeneous samples of companies across several industries face the challenge that the factors have to be as abstract as possible (Kube, 1991, p. 4). This in turn implies on the downside that the more abstract and intangible a success factor gets, the harder it is for a manager to adopt and implement it in his business. Hence, the identification of general factors primarily helps to broaden basic knowledge and develop theories in a field of science, rather than giving detailed recommendations to managers (Trommsdorff, 1990, p. 17). Fritz (1989) argues that most success factors strongly depend on the industry and are therefore not open to generalization. This opinion is shared by several other authors (e.g. Aaker (1989, p. 93), Adamer et al. (1993), Feldo (2011) or Haenecke (2002)). Furthermore, many studies empirically show that success factors are industry dependent (Bass, 1974; Cattin & Wittink, 1976; Hatten & Schendel, 1977; Porter, 1974).

Thus, in recent years, success factor research has increasingly focused on the identification of industry specific success factors (Feldo, 2011, p. 1; Haenecke, 2002, p. 166). In 1984, Leidecker & Bruno were the first who defined levels of specificity. They distinguished between macro-, industry and organizational levels. A few years later, Seibert (1987, p. 10) extended this to the following five general levels of specificity, starting with the least specific one:

1. Cross-industry specific
2. Industry specific
3. Strategic group specific within an industry
4. Company specific
5. Business segment specific

[85] Profit Impact of Market Strategies.

What level of specificity to chose depends on the goal of the individual success factor study. Cross-industry analyses have a low specificity. They contribute to the general theory of success factor research and need to be taken into account by management practice. In contrast, studies focusing on a single company or even on a business segment are very specific. They are of high value for management practice but are in turn limited in scope and transferability. Managers from other companies cannot easily adapt or transfer such success factors to their own business.

4.4.2 Causality

The concept of causality has been extensively discussed by researchers in different fields of science. For example, discussions can be found in the areas of psychology (Harvey & Weary, 1984; Kelley, 1973; Sedlak & Kurtz, 1981), sociology (Blalock, 1971), economics (Zellner, 1984), law (Fincham & Jaspars, 1980), statistics (Cohen, 1977b), medicine (Susser, 1973) and social sciences (Little, 1991). Causality itself can only be wholely discerned and proven in a controlled experiment (Homburg & Hildebrandt, 1998, p. 17). This means that an independent variable is continuously changed and the effect on a dependent success variable is observed while keeping all other factors constant (Trommsdorff, 1990, p. 16). However, this is not applicable in practice in social sciences as experiments are unlikely to encompass the full complexity of success in the context of a whole organization or project (Schulz, 1970). Furthermore, experiments are very time consuming and therefore not suitable for the investigation of success factors in a business environment (Kube, 1991, p. 47). Therefore, Cook & Campbell (1979, p. 31) and Hildebrandt (1983) propose the following requirements so that causality can be subsumed without conducting an experiment:

1. Changes to an independent variable, i.e. success factor, leads to changes to a dependent variable, i.e. success, and
2. the change of an independent variable occurs before the change of a dependent one, and
3. the independent variable represents the only plausible explanation for the change of the dependent variable. That means, variation is not caused by any other common variable, and
4. all cause-effect hypotheses are theoretically justified.

The third requirement is especially hard to meet in reality, as the influence of all possible factors cannot be controlled. Thus, Blalock (1982, p. 24) loosened the requirement in the sense that causality can already be assumed, if variations in the independent variable cause variations in the dependent. According to Weiber & Mühlhaus (2010, p. 9), causality can only be assumed if a necessary and sufficient condition is given. They regard Cook's & Campbell's first three requirements, i.e. the statistical dependency, as the necessary condition. For sufficiency, the relationship between the two variables must be based on an intensive theoretical and logical foundation.

Hence, social science tries to approximate causality by proposing cause-effect hypotheses and then confirming or rejecting them through analyses. Such analyses can range from simply validating the parallel existence of two phenomena, to extensive statistical tests. In general, qualitative (analysis of successful companies and analysis of contrast groups) and quantitative approaches (uni-/bivariate and multivariate methods and controlled experiments) are possible. Due to the inherent use of statistics, quantitative approaches are more appropriate to reveal potential causal relations (Haenecke, 2002, p. 173). In contrast to uni-/bivariate statistics, multivariate statistical methods can examine the influence of several variables.

4.5 Success factor identification approaches

4.5.1 Systematization of success factor identification approaches

Success factor research has enjoyed great popularity over the previous decades. However, for a long time success factor research had been criticized for lacking a standard research approach. Researchers had used different and inconsistent methods. Grünig et al. (1996, p. 4) even state that some of them were insufficient. The applied concepts differed significantly in sample size, survey and analytical processes or with regard to the selection of influence factors (Fritz, 1989, p. 103). Over time, several authors have tried to systematize heterogeneous success factor approaches. Grünig et al. (1996) were the first who developed a comprehensive standardized systematization of success factor approaches, which was later picked up by Haenecke (2002) and Schmalen et al. (2005) and is regarded today as the predominant one. As illustrated in figure 21, this systematization distinguishes four different identification approaches along the dimensions identification procedure, data acquisition and investigation method.

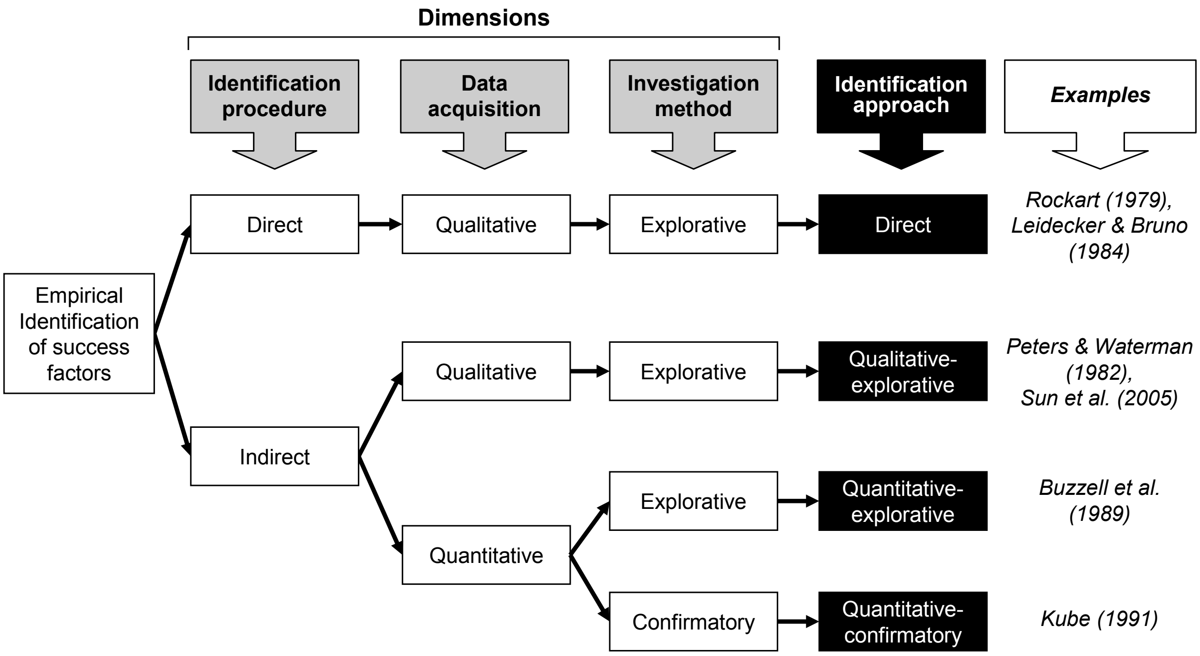

Figure 21: Systematization of success factor identification approaches. Own illustration based on Feldo (2011, p. 10), Haenecke (2002, p. 168) and Schmalen et al. (2005, p. 4).

A direct, as well as an indirect identification procedure is possible. In the former, the researcher interviews industry experts, employees of the companies under examination, customers, suppliers, etc. and directly enquires about potential success factors. An example of this is the previously mentioned early success factor study by Rockart (1979). In contrast, the indirect procedure attempts to uncover causal linkages between potential success factors as independent variables and success as the dependent one. Thus, its focus is on discovering relations instead of the success factors themselves. The decision, which identification procedure to use depends on the availability of success factor variables in the literature (Schmalen et al., 2005, p. 5). If no empirical results are available on specific success factors, then the direct procedure is the appropriate choice. It serves as a basis to identify potential success factors and to form hypotheses (Heckner, 1998, p. 70).

This leads to the second dimension of systematization: the type of data acquisition. An approach that uses the direct identification procedure, acquires its data in a qualitative manner, i.e. through interviews and/or literature research. This data acquisition can be methodically accompanied by creativity techniques (e.g. Kepper (1994)) and heuristic concepts such as the Delphi technique (e.g. Turoff & Linstone (1975)). It can be also materially supported by checklists that are based on grey literature or first hand experience. Such checklists improve the identification process but the interviewee must still be able to raise additional factors that are not yet on the list. In recent years, success factor studies have often made use of the PIMS database to avoid time extensive and costly data acquisition. Notwithstanding, this carries the disadvantage that data will often not fit the original goal and causal requirements of the respective study (Trommsdorff, 1990). If data is explicitly collected for a specific research work, the identification of proper success factors is more likely.

The indirect identification procedure allows for both, qualitative as well as quantitative data acquisition. The former usually does not apply statistical methods to analyze and identify cause-effect relationships, but rather looks for commonalities across successful companies (Schmalen et al., 2005, p. 5). The latter uses methods that are based on figures and statistics to identify causal relations (Grünig et al., 1996, p. 8). As already described above, quantitative success factor identification approaches are superior to qualitative one as they can reveal a higher level of causality.

The third systematization dimension is the respective investigation method. Every approach that collects data in a qualitative manner has automatically an explorative character. The goal is to identify potential success factors as no empirical data is available and to develop respective cause-effect hypotheses. All quantitative data acquisitions can either be of explorative or confirmatory character. The quantitative-explorative approach is used to discover structures and relations of variables by filtering those which have a significant impact on success. The approach is used if no explicit causal relationships exist (Buzzell et al., 1989, p. 6). If an empirical model has been established and needs to be confirmed or rejected for another specific case or sample, then the quantitative-confirmatory approach has to be chosen. A representative example is Kube's (1991) study on branch networks.

The vast majority of success factor studies have used the direct (e.g. Leidecker & Bruno (1984) or Rockart (1979)) or qualitative-explorative approach (e.g. Peters & Waterman (1982) or Sun et al. (2005)). This is because they are the least complex and time consuming approaches. Furthermore, they are applied if no empirical results on potential success factors or their relations exist, which is often the case in success factor research.

4.5.2 Approach assessment

Success factor approaches can be assessed according to their performance potential and utility. Current research proposes the following assessment criteria: objectivity, reliability, theory consideration, multi-perspectivity, value for strategy formulation, time effort and financial effort (Grünig et al., 1996, p. 10; Little, 1970, p. 467). **Objectivity** is given if the results of a study are not influenced by the researcher (Berekoven et al., 2006, p. 86). In other words, different researchers using the same input data and the same success factor identification approach must reach comparable results (Bortz & Döring, 2009, p. 326). Approaches that use qualitative data acquisition are especially prone to subjectivity. Three conditions must be fulfilled in order to ensure objectivity. First, the researcher must not influence interviewees or other informants. Second, the researcher has to ensure an accurate and unbiased analysis of data. This includes also the upfront design and articulation of the respective questions. Third, the scientist must not interpret data in an opportunistic manner (Heckner, 1998, p. 83). **Reliability** measures to what extent results can be reproduced. Reliability can be increased through repeated (test-retest method) or parallel measurement (split-half method) of the results (Atteslander, 2006, p. 214; Berekoven et al., 2006, p. 84). It is more difficult to assure reliability in qualitative approaches. However, through accurate documentation the probability of reproducing similar results can be increased (Yin, 2009, p. 45).

An approach has a high **theory consideration,** if it builds on recent empirical results. It avoids a situational bias by considering results that have been identified in previous studies and situations (Kube, 1991, p. 55). As already mentioned in the previous chapter on the systematization, different approaches require empirically validated cause-effect relations or indicators. Hence, they have a high theory consideration.

Multi-perspectivity exists if all relevant aspects and dimensions are covered in a study. What is relevant and what not is pre-defined by the set goal of the respective study (Grünig et al., 1996, p. 10). Kube (1991, p. 56) gives an example of a success factor study that relied on the perspective of the managers only and neglected the perspective of the customers. Such reliance can lead to biased results.

The **value for strategy formulation** is strongly influenced by the four aforementioned criteria. It evaluates to what extent the results generated through the respective approach can be applied in practice and are beneficial to strategic management (Grünig et al., 1996, p. 10).

The last criteria, **time and financial effort,** simply evaluate how fast an approach can generate results and at what cost. This is of special interest in practice when resource restrictions are in place and when fast results are required. In addition to this, financial funds are limited in research (Heckner, 1998, p. 87). Table 1 shows the evaluation of the success factor identification approaches according to the outlined criteria. As a standard weighting of the criteria cannot be determined, there is no overall score. Though it can be said that the more '+' the evaluation indicates for each approach, the higher is its utility and overall performance.

Table 1: Assessment of success factor identification approaches adapted from Grünig et al. (1996) and Heckner (1998).

Criteria / Approach	**Objectivity**	**Reliability**	**Theory consideration**	**Multi-perspectivity**	**Value for strategy formulation**	**Time effort**	**Financial effort**
Direct[86]	++	+	+	+++[87]	++	+++	+++
Qualitative-explorative	++	++	++	+++	++	++	++
Quantitative-explorative	++++	+++	+++	++++	+++	++	+
Quantitative-confirmative	++++	+++	++++	++	++++	+	+

Thus, the quantitative-explorative and the quantitative-confirmative success factor identification approaches especially show strong assessment results. However, the disadvantage is that success factor research studies using these approaches usually imply significant temporal and financial effort on the part of the scientist. According to Haenecke (2002, p. 171), the quantitative-confirmatory approach has advantages over the quantitative-explorative one as it is able to better avoid effects from confounding variables. It furthermore provides a higher explanatory power.

The selection of the right identification approach depends on the documented state of knowledge in the literature on potential success factors as well as their causal relationships on success. It will be conducted in chapter 5.3 later in this work.

4.6 Criticism to success factor research

As any other research approach, also success factor research has faced criticism over time. Two aspects have already been mentioned in the course of this work. One is that causality itself cannot be directly determined but rather approximated. The other is that success factor scientists have often aimed to derive success factors that are as generalizable as possible. However, the more general the identified factors are, the less easy it is for managers to adapt or apply them. If success factors are identified in the context of a specific industry for instance, the results cannot be just transferred or

86 In their assessments, Haenecke (2002) and Grünig et al. (1996) distinguish the direct success factor identification approach in methodical and material support. However, this split is neglected here, as not relevant in the course of this work.

87 If not only the managers', but also the customers', suppliers', etc. perspective are considered.

adapted to other industries. This is often overlooked. Another, and probably one of the major points raised by sceptical authors, goes in the same direction and is the lack of practicality. Success factor research is deemed to be an exemplary approach in realigning rigor and relevance (Walton, 1985). Hodgkinson et al. (2001) argue that researchers prefer to pursue and solve problems that have been defined by themselves or other scientists rather than problems that are raised by practitioners. This is due to the lack of inherent and regular communication on the part of scientists with practitioners. Researchers tend to improve the relevance of their research to practice with higher rigor in their academic work. However according to Kieser & Nicolai (2005, p. 276), this implication does not hold true. They argue that "[i]ncreasing the relevance of management research is only possible at the expense of scientific rigor". Otherwise success factor research leads to managers being unable to follow and evaluate the results and discussions, researchers have published in scientific journals. Thus, success factor research must strike a balance between scientific rigor and relevance. Although challenging Kieser & Nicolai's critical publication on other aspects, Bauer & Sauer (2004) also confirm that there is still a lack of implementation or transfer research. A further deficit authors attribute to success factor studies is the lack of theoretical foundation. In other words, scientists are criticized for not deriving their hypotheses sufficiently from empirical work or theoretical background (Kube, 1991, p. 55; Meffert, 1988, p. 19; Wahle, 1991, p. 10; Wohlgemuth, 1989, p. 91). Critique of data acquisition goes in a similar direction. Until today, success factor research has been lacking standards for identification approaches with regard to the required sample size (Haenecke, 2001, p. 54). Furthermore, researchers often do not compile their own data, but use existing ones from the literature. This may be due to problems with acquiring confidential internal data from companies or simply the large time efforts and costs in collecting a large set of new data. This means that data from the literature often does not and cannot comply with the specific research situation to a full extent (Trommsdorff, 1990, pp. 16–17; Winkelmann, 2004, p. 42). When researchers conduct their own data collection, they do so in most cases by interviewing industry experts or managers. Critics argue that the interview process is laden with bias on the part of the interviewer and its interviewees (Boynton & Zmud, 1984, p. 18; Kube, 1991, p. 58). For a manager for instance, "factors which are direct, instigating or enhancing may appear to provide a better basis for action than factors which are indirect, standing, or inhibiting. Thus, the perception of action potential of a type of factor may bias its choice as a CSF" (Williams & Ramaprasad, 1996, p. 258). Furthermore, managers are often routine-blinded and might not be able to identify or recognize all success factors. Though, Munro (1983) compares in his study two different success factor analyses and indicates that the potential bias is comparably low. In addition, Hildebrandt (1989) argues that bias can be further minimized by careful selection of interviewees. Success factor studies usually investigate only a short period of time. Several industries face industrial cycles or even seasonal fluctuations. Hence, the changing context and the participants' understanding of the respective context can cause success factors to change dynamically over time (Bullen & Rockart, 1981, p. 14). However, Patt (1988, p. 10) argues that the attitudes and decisions of customers, which can be compared to transmission line stakeholders in this work, do not change over night but only long-term. Nonetheless, practitioners should regularly review and critically evaluate identified success factors. Besides the above outlined critique, many authors also testified to the inherent benefits and advantages, the success factor research has (Bauer & Sauer, 2004; Boynton & Zmud, 1984; Caralli, 2004, p. 30; Dickinson et al., 1984; Grabner-Kräuter, 1993; Hoffmann, 1986; Kreilkamp, 1987; Magal et al., 1988; Munro & Wheeler, 1980; Rockart, 1979; Segler, 1986; Shank et al., 1985). Gälweiler & Schwaninger (1986, p. 247) even emphasize that problem orientated strategic management can only be achieved by knowing the respective success factors. As a summary, it can be argued that success factors

- reduce ambiguity by developing and communicating a set of explicit drivers,
- help to clearly define and articulate goals and therefore facilitate the mobilization of all areas of an organization, programme or project towards the same goal,
- provide a key risk management perspective for managers,
- can be valuable for strategic course correction,
- provide measures to gain competitive advantage.

The listed advantages have been one of the major drivers in the growing interest and application of success factor research over the last decades. Despite its benefits, researchers need to take the above mentioned critique into account when conducting success factor studies.

4.7 Interim conclusion on the fundamentals of success factor research

Altogether, success factor research attempts to identify the determinants of an organization's success. The respective success factors make up an inherent part of an organization's strategic management. How success is defined depends on the individual angle. For this study, project success is defined as avoiding or significantly reducing public opposition to transmission line projects. Over the last decades, success factor research has primarily focused on the strategic management of an organization and more recently on the implementation of projects and programmes as well. On the one hand, success factor studies can differ in their specificity, i.e. the outreach of their results. Specificity depends on the study's individual scope, which can range from cross-industry, industry, strategic group within industry, company to business segment within a company, with the last being of highest specificity. The higher a study's specificity is, the higher is its validity but the less is its transferability to other fields of business, companies or industries. As the scope of this work includes all European TSOs, the minimum specificity should be at industry level. On the other hand, success factor studies differ on their level of causality. Causality itself cannot be identified by social science but approximated. Especially quantitative studies face a high causality which means that their results have a high ability to determine and explain the effect that a factor has on success. In general, there are four different success factor identification approaches: direct, qualitative-explorative, quantitative-explorative and quantitative-confirmatory. The latter provides the highest explanatory power and will be targeted in this research work. However, it requires existing empirically identified hypotheses. If these do not exist, the other approaches will have to be taken into consideration. Although authors have pointed out the advantages, benefits and importance that success factor research has for practice, there is also criticism which is considered in the work at hand.

5 Success factor research on social acceptance in transmission line planning – a combination of research streams

5.1 State of research

As outlined in the introduction, a research gap exists in the combination of the research streams electricity transmission line planning, social acceptance and success factor research. Nevertheless, when combining the research streams bilaterally, appropriate scientific information can be identified as shown in the Venn diagram in figure 22. In the following subchapters these overlaps will be analyzed in more detail in order to approach the research gap, gain a better understanding of it and derive potential ideas as how to close it. In particular, the following subchapters will elaborate on social acceptance in electricity transmission line planning (section A in figure 22), success factor research on social acceptance (section B in figure 22) and success factor research in electricity transmission line planning (section C in figure 22). The listed findings will be discussed in depth in the course of this work.

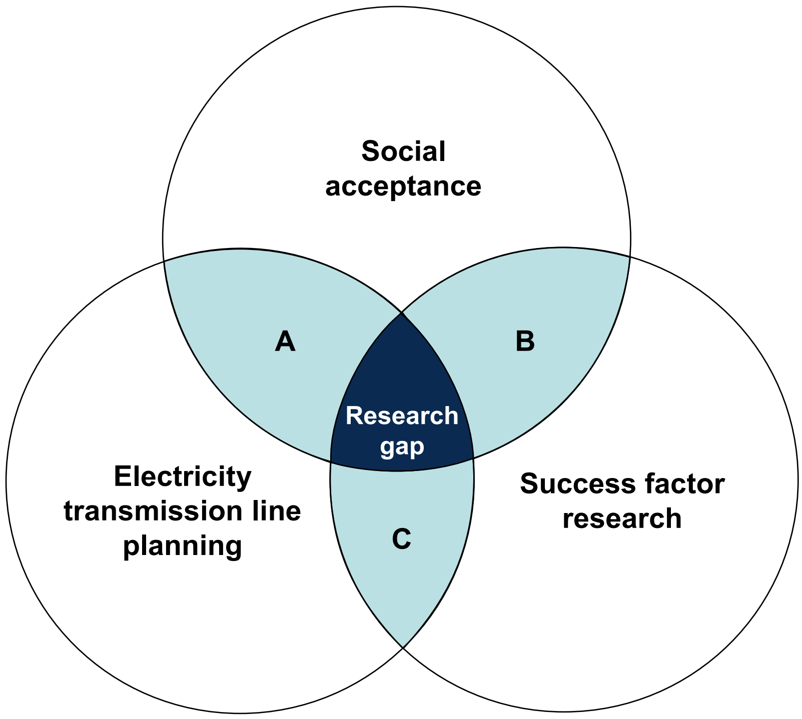

Figure 22: Venn diagram of research streams and research gap.

5.1.1 Social acceptance in electricity transmission line planning (A)

The first research stream overlap to be analyzed is that between electricity transmission line planning and social acceptance. Available research on this intersection research area is listed in table 2 on the following pages.

Table 2: Literature on social acceptance in electricity transmission line planning.

Study	Type	Scope	Methodology	Main findings
Battaglini et al. (2012)	Journal paper (2,629/3,035)[a]	EU	Survey (n = 108) / Content analysis / Focus group	TSOs should ▪ use underground cables nearby human settlements ▪ foster infrastructure bundling ▪ involve stakeholders in the planning process ▪ improve project information and transparency ▪ utilize independent institutions and experts to verify and disseminate information ▪ foster stakeholder education through information campaigns
Cotton & Devine-Wright (2012)	Journal paper (1,838/2,435)[a]	UK	Interviews (n = 22)	▪ TSOs mainly apply a 'top-down' approach excluding local involvement at the strategic level of transmission line planning ▪ They regard early involvement at macro-level as problematic and involve stakeholders only at local level later in the planning process
Furby et al. (1988b)	Journal paper (1,449/2,649)[a]	-	-	Citizens' attitudes towards transmission lines depend on ▪ property alterations ▪ aesthetics ▪ human health and safety issues ▪ environmental impact ▪ economic benefits & equity effects ▪ process characteristics ▪ information and knowledge ▪ symbolic meaning
Priestley & Evans (1996)	Journal paper (1,449/2,649)[a]	US	Survey (n = 236)	▪ A transmission line is perceived to have negative impacts on health & safety, property values and aesthetics ▪ Older people have more negative perceptions than younger ones

[a] Journal impact factor / 5-year impact factor (Thomson Reuters, 2011).

Table 2 (continued): Literature on social acceptance in electricity transmission line planning.

Study	Type	Scope	Methodology	Main findings
Soini et al. (2011)	Journal paper (2,070/2,360)[a]	FI	Survey (n = 630) / Latent class method	▪ The majority regards transmission lines, both existing as well as new ones, as negative landscape element ▪ Around one third of people has a positive or indifferent attitude towards transmission lines with people below 29 years being the most positive age group
Vajjhala & Fischbeck (2007)	Journal paper (2,629/3,035)[a]	US	Survey (n = 56)	▪ The likelihood of opposition is higher in densely populated areas ▪ The higher the potential loss of property value the higher is landowners' opposition ▪ People with a pronounced environmental concern are more likely to oppose
Deutsche Umwelthilfe & Forum Netzintegration (2010)	Study report	DE	-	TSOs need to ensure ▪ transparent decision making and disclosure of planning data ▪ evaluation of technical alternatives (especially UGCs) ▪ piloting of new transmission technologies ▪ installation of lower and new designs of pylons to minimize visual impact ▪ sufficient justification of line needs ▪ avoidance of grid extensions through optimization and upgrade measures ▪ bundling of infrastructure
EPRI (2001)	Study report	US	Survey (n = 37)	TSOs should ▪ use exhibits at schools, shopping malls or county fairs for communication ▪ give tours at existing transmission lines ▪ have a speakers bureau and offer to give talks to local groups ▪ foster meaningful public participation and share control wherever they can ▪ create several reasonable technical options ▪ consider financial or other forms of compensation ▪ empower stakeholders with EMF measurements ▪ use third-party experts to explain risks ▪ be honest and acknowledge past mistakes ▪ communicate early and directly with people ▪ respond to public concerns quickly

[a] Journal impact factor / 5-year impact factor (Thomson Reuters, 2011).

Table 2 (continued): Literature on social acceptance in electricity transmission line planning.

Study	Type	Scope	Methodology	Main findings
Gerlach (2004)	Book section	CA, UK, US	-	▪ Citizens question the need of new transmission lines ▪ People fear electromagnetic fields (EMF) caused by lines ▪ New installations harm the environment, cause visual impact and impact agriculture negatively ▪ People are worried about loosing 'control' ▪ Opponents organize professionally in action groups
Gouhier et al. (2009)	Survey report	FR	Survey (n = 2,000)	▪ The majority (74%) of households consider transmission line as visual nuisance ▪ Nearly three quarters of all workers are disturbed by the presence of pylons ▪ Almost 40% of households consider the noise of the line to be 'disturbing'
Hübner & Pohl (2010)	Unpublished work	DE	Survey (n = 937)	▪ The majority of people are not against transmission lines per se ▪ They favour UGCs over OHLs and are willing to bare the extra costs ▪ The need of transmission lines needs to be justified ▪ New lines should mainly support the integration of renewable energy ▪ Lines should not be built in sensitive areas
Lantz & Flowers (2010)	Study report	US	-	TSOs should ▪ engage all stakeholders early and often ▪ present broad and balanced information that is regarded as factual by all ▪ identify and nurture 'champions' among stakeholders ▪ deploy champions with messages resonant to their particular community
RGI (2011d)	Declaration	EU	-	TSOs should ▪ create more transparency in transmission line planning and needs ▪ evaluate reasonable alternatives and pilot new technical solutions ▪ involve stakeholders earlier and promote dialogues ▪ protect nature by minimizing adverse effects ▪ foster infrastructure bundling ▪ increase best practice sharing

Table 2 (continued): Literature on social acceptance in electricity transmission line planning.

Study	Type	Scope	Methodology	Main findings
RGI (2012)	Workshop document	EU	Workshop	Citizens oppose transmission lines due to ▪ unclear need of new line ▪ lack of knowledge on planning procedures ▪ questioning credibility of TSOs' information sources ▪ late stakeholder involvement TSOs should ▪ involve stakeholders early ▪ ensure transparent processes and decisions ▪ provide credible and understandable information ▪ seek compromise ▪ foster ongoing dialogue and consistency
SRU (2011)	Special report	DE	-	TSOs should ▪ prefer the optimization and upgrade of existing transmission lines to new installations ▪ ensure that stakeholders are informed and involved early on ▪ evaluate technical alternatives (OHL versus UGC) ▪ evaluate different route alternatives in a transparent way ▪ consider impacts of existing infrastructure installations for transmission siting
Sander (2011)	Master thesis	DE	Interviews (n = 40)	TSOs should ▪ actively meet information needs of stakeholders ▪ pilot new transmission technologies (especially UGC) ▪ use neutral moderators/mediators to foster dialogue
Schweizer-Ries et al. (2010)	Study report	DE	Survey (n = 462)	▪ The need for new transmission lines is generally accepted ▪ UGCs are preferred over OHLs ▪ Infrastructure bundling is supported ▪ People require more information about transmission technology and the planning procedures ▪ Monetary compensation does not automatically increase acceptance

Table 2 (continued): Literature on social acceptance in electricity transmission line planning.

Study	Type	Scope	Methodology	Main findings
Van der Welle et al. (2011)	Study report	EU	Nine case studies	TSOs should ▪ be aware of project specific contextual factors that influence public acceptance ▪ involve stakeholders and consider their expectations ▪ link the need of new transmission lines to renewable energies ▪ use transmission technologies that properly integrate in natural context
Zane et al. (2012)	Study report	EU	Interviews (n = 214)	Citizens oppose transmission lines due to ▪ insufficient stakeholder involvement ▪ lack of transparency and communication ▪ insufficient line justification (grid development plans) TSOs should ▪ enhance communication with stakeholders ▪ cooperate with stakeholders ▪ involve stakeholders early ▪ conduct best practice exchange

Nearly two thirds of the listed studies are grey literature and one third are peer-reviewed journal papers with impact factors ranging from 1,449 to 2,629[88]. Most of the studies investigate the public's perception of transmission line and try to identify the reasons why people oppose transmission lines and what respective contextual factors influence their attitudes. Some studies give first ideas and suggestions what TSOs should do better in the future to increase social acceptance and thus reduce opposition. However, none of the available sources explicitly applies a success factor research approach to empirically identify success factors and test their effectiveness in reducing public resistance. Furthermore, the majority of the listed studies have a project specific focus on a certain country, mainly Germany and the USA, and do not try to provide generalizable solutions. A possible reason for this is elucidated by Gerlach (2004), who reports that he had extreme difficulties in obtaining detailed information and insights from TSOs and action groups. Thus, it seems obvious that scientists face problems in accessing and obtaining sufficient data on a broader international basis.

The most advanced work that can be mentioned in this respect is the practitioner's guide by EPRI (2001). Although focusing on the US, the report lists useful recommendations for TSO on how to communicate with the public properly in transmission line planning. Another valuable work, although being grey literature, is the workshop protocol of the NGO Renewables Grid Initiative (RGI). Together with eight European TSOs and several other NGOs it collected a set of potential best practices (RGI, 2012). Nonetheless, these identified recommendations have neither been empirically confirmed with regard to their effectiveness nor been discussed with any local stakeholders. Moreover, Battaglini et al. (2012) conducted a stakeholder survey and identified individuals' perceptions of barriers for electricity grid expansion in Europe. They also collected first suggestions for overcoming the obstacles although the gathered ideas are rather policy recommendations than concrete improvement measures for TSOs.

As conclusion it can be said that there is a need for success factor studies that focus on the identification of measures as well as their empirical validation of effectiveness and causality. Moreover, success factors must be generally applicable and should not be limited to a specific project or country. Nonetheless, the available literature will help in the course of this work in understanding people's perceptions, identifying the underlying reasons for their resistance against new transmission lines and deriving potential success factors for TSOs to reduce public opposition.

5.1.2 Success factor research on social acceptance (B)

The second overlap of research streams to be analyzed is between success factor research and social acceptance (section B in figure 22 on page 77). There are several success factor studies about social acceptance in large infrastructure projects that are similar in their characteristics to transmission lines. Transmission line projects are large scale in character due to their sheer length. They furthermore

[88] According to Thomson Reuters (2011).

cause impacts on the environment (e.g. through deforestation of corridors) as well as on health and safety (e.g. through EMF). Moreover, OHL carry visual impact through their tall pylons. Table 3 on the next pages lists several studies on analog infrastructure projects that share the four mentioned characteristics to a large extent with transmission lines. Relevant research results can be found especially for biomass plants, carbon capture and storage (CCS) facilities, geothermal plants, hydro dams, landfills, mobile networks, nuclear power plants and waste repositories as well as wind projects. In addition, studies are available on large scale renewable energy projects in general. In contrast to transmission line projects, scientific research regarding social acceptance is quite advanced for these project types. The majority are peer-reviewed journal papers with impact factors ranging from 945 to 4,081[89]. In almost all listed studies, comprehensive scientific methodologies have been applied. The scope is mainly restricted to countries like the USA, Canada and Germany. The studies have identified certain success factors for implementation which project developers need to consider. The wind studies by Jobert et al. (2007), canWEA (2008) and Huber & Horbaty (2010) as well as the work by WCD (2000) about hydro dams revealed the most relevant points. The best practices and success factors listed in the existing literature on analog infrastructure projects will help in the course of this work to develop a set of potential success factors for TSOs in transmission line projects as hypotheses for further validation.

[89] According to Thomson Reuters (2011).

Table 3: Analog infrastructure projects and identified success factors for implementation.

Project type	Study	Type	Scope	Methodology	Identified success factors
Biomass power plant	Upreti & van der Horst (2004)	Journal paper (3,840/4,671)[a]	UK	Interviews / Content analysis / Survey (n = 43) / Participatory appraisal	▪ Early involvement of stakeholders ▪ Trust, openness and respect ▪ Interactive communication (dialogue) ▪ Local support
CCS	Brunsting et al. (2011)	Journal paper (n.a./n.a.)[a]	EU	Eight case studies[b]	▪ Understanding local contingencies and early engagement of stakeholders ▪ Open, two-way dialogue ▪ High-quality communication material ▪ Trust in project developer
	Dütschke (2011)	Journal paper (n.a./n.a.)[a]	DE	Two case studies	▪ Early involvement of stakeholders ▪ Transparent decision making ▪ Professional information material ▪ Trust in project developer
	Terwel et al. (2011)	Journal paper (4,081/4,787)[a]	-	Three experiments (n = 73, 75, 83) / Survey (n = 264)	▪ Trust in project developer
	van Alphen et al. (2007)	Journal paper (2,629/3,035)[a]	NL	Interviews (n = 11) / Workshop	▪ Open communication to the public
	Wuppertal Institut et al. (2008)	Study report	DE	Interviews (n = 21) / Surveys (n = 15, 171, 61)	▪ Trust ▪ Information/Education of stakeholders ▪ Dialogue and face-to-face meetings ▪ Early involvement

[a] Journal impact factor / 5-year impact factor (Thomson Reuters, 2011). [b] Not all case studies were CCS project but also analog project types (e.g. wind, biomass, gas pipeline).

Table 3 (continued): Analog infrastructure projects and identified success factors for implementation.

Project type	Study	Type	Scope	Methodology	Identified success factors
Geothermal power plant	Dowd et al. (2011)	Journal paper (2,629/3,035)[a]	AU	Facilitated group workshops (n = 29, 47, 60, 62, 131)	▪ Stakeholder participation ▪ Risk communication via dialogues ▪ Education and information
	Heiskanen et al. (2008)	Study report	EU	27 case studies	▪ Trust in project developer
Hydro dam	Mirumachi & Torriti (2012)	Journal paper (2,629/3,035)[a]	LA	Case study	▪ Stakeholder participation ▪ Cost-benefit analysis
	WCD (2000)	Study report	World (52 countries)	Eight case studies / Survey (n = 127) / Thematic reviews (n = 17)	▪ Stakeholder analysis ▪ Stakeholder participation ▪ Transparent decision-making ▪ Sufficient information provision ▪ Sufficient project justification ▪ Alternatives and options evaluation ▪ Benefit sharing
Large scale renewable energy projects in general	Heiskanen et al. (2008)	Study report	EU	27 case studies	▪ Local embeddedness ▪ Local benefits and fair distribution of gains ▪ Interaction with right people in the right way ▪ Proper communication and participation procedures ▪ Respect
	Raven et al. (2009b)	Journal paper (3,597/3,681)[a]	EU	27 case studies	▪ Systematic stakeholder involvement (ESTEEM tool)
	Zoellner et al. (2008)	Journal paper (2,629/3,035)[a]	DE	Interviews / Survey (n = 349)	▪ Economic benefits ▪ Stakeholder participation ▪ Sufficient communication (incl. post-communication) ▪ Local support (multiplicators)

[a] Journal impact factor / 5-year impact factor (Thomson Reuters, 2011).

Table 3 (continued): Analog infrastructure projects and identified success factors for implementation.

Project type	Study	Type	Scope	Methodology	Identified success factors
Large scale renewable energy projects in general	Schweizer-Ries et al. (2011)	Study report	DE	Survey (n = 859) / Interviews (n = 21) / Workshop / Three focus groups	▪ Sufficient internal resources and know-how ▪ Utilization of local support ▪ Transparency ▪ Stakeholder participation
Landfill	Baxter et al. (1999)	Journal paper (1,111/n.a.)[a]	CA	Case study / Interviews (n = 44)	▪ Trust ▪ Fairness ▪ Public participation
Mobile network	Deutscher Städte- und Gemeindebund (2005)	Study report	DE	Interviews (n = 34)	▪ Regular communication with and continuous information of municipalities and citizens ▪ Clear communication processes and times ▪ Early involvement of stakeholders ▪ Developer-internal communication rules ▪ Qualification of developer's employees
Nuclear power plant and nuclear waste repository	Armour (1991)	Journal paper (1,062/1,100)[a]	CA	Case study	▪ Collaboration with and involvement of stakeholders ▪ Joint problem solving and decision making
	Bassett et al. (1996)	Journal paper (2,096/2,344)[a]	US	Survey (n = 606)	▪ Trust
	Chung & Kim (2009)	Journal paper (2,004/2,789)[a]	KR	Interviews (n = 564) / Structural equation modeling	▪ Perceived economic benefits ▪ Risk perception ▪ Trust
	Ibitayo & Pijawka (1999)	Journal paper (1,126/1,330)[a]	US	Survey (n = 50)	▪ Trust ▪ Stakeholder participation
	Kunreuther et al. (1990)	Journal paper (2,096/2,344)[a]	US	Interviews (n = 1001) / Survey (n = 1201)	▪ Trust ▪ Perceived fairness

[a] Journal impact factor / 5-year impact factor (Thomson Reuters, 2011).

Table 3 (continued): Analog infrastructure projects and identified success factors for implementation.

Project type	Study	Type	Scope	Methodology	Identified success factors
Nuclear power plant and waste repository	Sjöberg (2004)	Journal paper (2,096/2,344)[a]	SE	Survey (2,548)	▪ Trust
	Sjöberg & Drottz-Sjöberg (2001)	Journal paper (946/1,124)[a]	SE	Surveys (n = 828, 667, 532)	▪ Compensation of municipality ▪ Trust
Wind park	Dimitropoulos & Kontoleon (2009)	Journal paper (2,629/3,035)[a]	GR	Choice experiment / Survey (n = 212)	▪ Involvement of stakeholders ▪ Cooperation with local representatives
	canWEA (2008)	Study report	CA	-	▪ Establishment of community support ▪ Stakeholder involvement ▪ Sufficient communication ▪ Soft skills ▪ Effective and respectful addressing of opposition
	Huber & Horbaty (2010)	Study report	AU, CA, CN, EU, JP, MX, US, ZA	-	▪ Distributional and procedural justice ▪ Local support ▪ Sufficient communication via different media ▪ Education of stakeholders ▪ Flexibility and openness
	Jobert et al. (2007)	Journal paper (2,629/3,035)[a]	FR, DE	Five case studies	▪ Minimization of visual impact ▪ Community/Private ownership ▪ Combination with local tourism concept ▪ Utilization/Empowerment of local contacts and supporters ▪ Trust in developer ▪ Transparency ▪ Sufficient and early information ▪ Stakeholder participation

[a] Journal impact factor / 5-year impact factor (Thomson Reuters, 2011).

5.1.3 Success factor research in transmission line planning (C)

The third and last overlap of research streams is between success factor research and transmission line planning (section C in figure 22 on page 77). Here, available literature is very rare. The only study that can be indentified is the work of Tummala & Burchett (1999). Their study deals with the risk management of an EHV transmission line project in Hong Kong. The researchers apply a risk management methodology to identify potential project risks. Identified risks related to social acceptance are lengthy public consultation, requested design changes and denied access by landowners. All other identified risks are related to operational project management and construction. Tummala & Burchett (1999) argue that TSOs are guided through their developed risk database to achieve project success. However, their risk database significantly lacks the risks associated with public opposition, which is the preeminent cause of project delays in transmission line planning. Thus, their results might be useful and applicable for operational project management of transmission lines but not for dealing with public opposition.

5.2 Value add and classification of this work

As outlined above, there is a research gap regarding success factors to reduce or even avoid public opposition to transmission line projects, which the work at hand aims to close. The bilateral combinations of the three research streams provide initial ideas and help to identify suitable hypotheses. Having outlined the two classification criteria 'specificity' and 'causality' earlier, the work at hand is categorized accordingly in figure 23 on the next page together with other exemplary success factor studies. Relevant controlled experiments in success factor research could not be found in literature[90]. Regarding specificity, this study deals with the European TSOs and thus with the industry of electricity transmission[91]. It aims to identify generalizable success factors for European TSOs which represent an industry and not a strategic group. Porter (1999, pp. 181–184) defined strategic groups according to 13 dimensions (e.g. pricing, market power, product quality, vertical integration etc.). Geographic location is not part of these dimensions. Hence, the specificity of this work is more advanced than that of most available studies, which have only a limited focus on specific projects and countries and lack generalizability across the industry in their findings. Their results are therefore difficult or even impossible to apply to other cases or regions. In contrast, the set of success factors identified in this work can be applied to almost any transmission line project in Europe. They even might be applicable to other regions outside Europe. According to the second classification criteria 'causality', the work at hand belongs to the quantitative analyses and in particular to the

[90] This is because experiments are unlikely to encompass the full complexity of success in the context of a whole organization or project (Schulz, 1970).

[91] NACE industry code D35.1.2.

multivariate methods as structural equation modeling (SEM) is applied. Details on this methodology will be elucidated in detail later on.

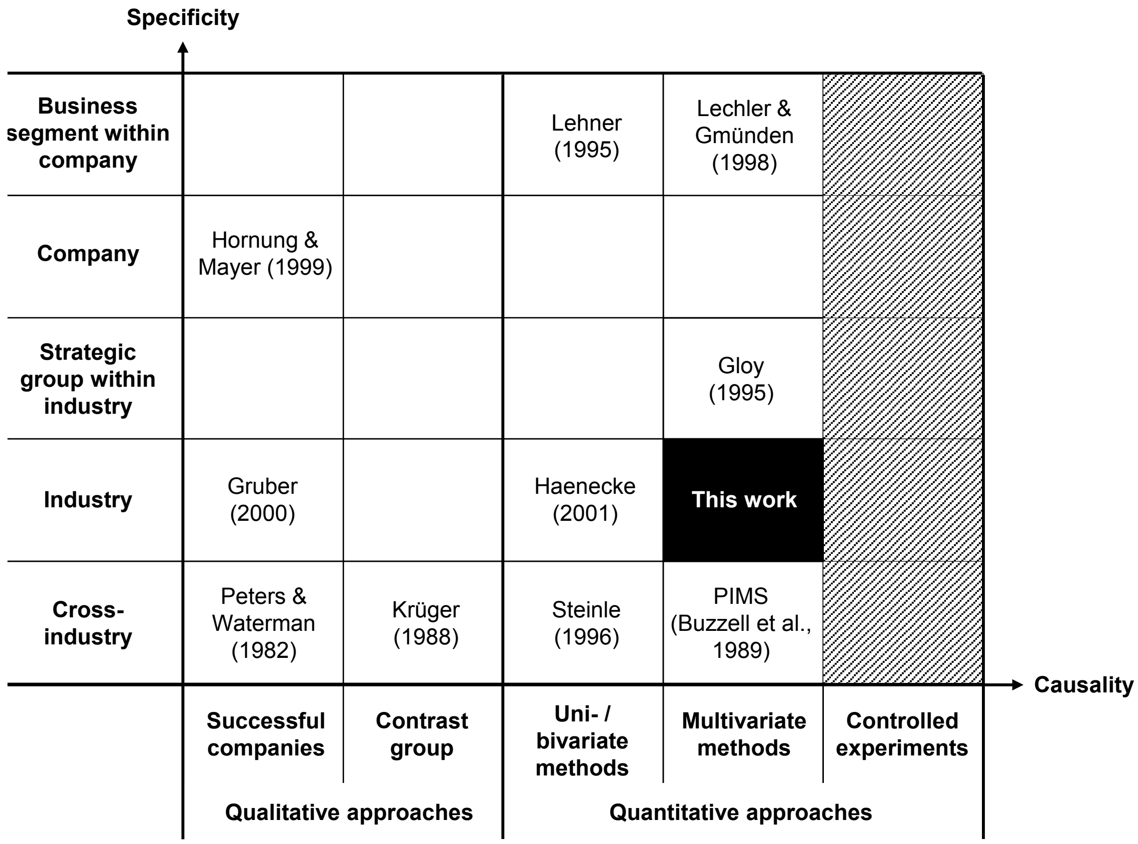

Figure 23: Classification of current work. Own illustration based on Winkelmann (2004, p. 37).

5.3 Research design

The available success factor identification approaches have been already described and assessed in chapter 4.5. The selection of an appropriate approach and herewith the definition of the research design depends on the status of available research results in the field of study (Wohlgemuth, 1989, p. 94). The work at hand follows a two-step approach that is common in success factor research (Riekeberg, 2003, p. 95). As outlined in the previous chapters, no empirical validated success factors for TSOs to overcome or avoid public opposition are available. Thus as outlined in figure 24 on the next page, a direct, qualitative-explorative approach is chosen to identify potential success factors. It will entail interviews with affected citizen action groups, NGOs, regulators and other energy experts in Europe. The interviews will help to identify stakeholders' underlying reasons for opposing transmission line projects. Furthermore, interviewees' proposals and demands are complemented with recommendations from existing literature and best practice examples from analog project types as outlined above in order to develop a set of potential success factors.

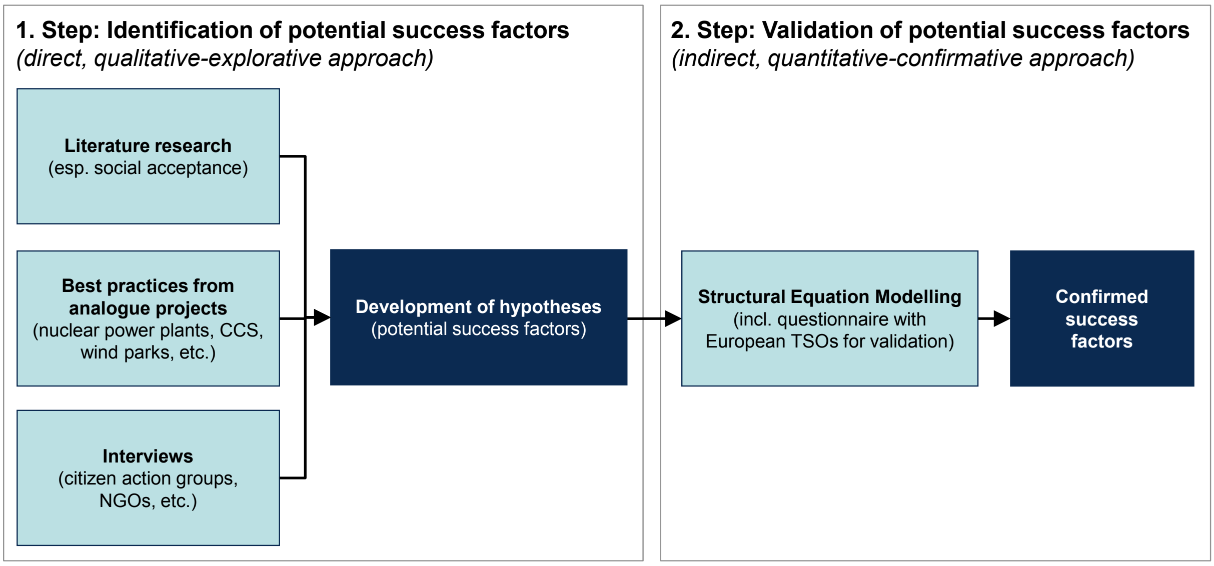

Figure 24: Overview of research design.

In a second step, these hypotheses will then be validated by an indirect quantitative-confirmative approach. More specifically, the hypotheses will be used to form a structural equation model, which is then tested and validated. This assessment will determine the feasibility and more importantly the causality each potential success factor has on project success in terms of mitigating or avoiding public opposition. As outlined earlier, the quantitative-confirmative approach is regarded as best approach to approximate causality in order to identify success factors (Haenecke, 2002, p. 173; Trommsdorff, 1990, p. 17). Also Schmalen et al. (2005, pp. 8–9) propose a confirmatory approach for success factor identification that validates the previously derived hypotheses. In other words, success factors identified with this approach have high objectivity, reliability and theory consideration. Furthermore, they are of high value for strategy formulation. The quantitative approach is only possible if empirical results already exist (Haenecke, 2002, p. 175). This requirement is fulfilled by the antecedent direct explorative approach. Such a two-step approach is not problematic as long as the identification of hypotheses and the respective validation are not conducted with the same set of information carriers. Otherwise, results would be subject to self-fulfilling prophecy (Riekeberg, 2003, p. 95). Therefore in this work, the confirmation of potential success factors, which have been identified through interviews with citizen action groups, NGOs, etc. and literature research, is carried out through a questionnaire with the European TSOs. The validation is not done on a specific project but rather hypothetically and generally for the TSOs' future projects as there is a scarcity of recent or actual transmission line projects in Europe to base a project specific survey on. Later on in this work, chapter 8.1.3.3 will discuss the topic of potential biases that can arise using this approach in more detail. Most quantitative-confirmative success factor studies use hypotheses from existing research studies instead of collecting their own data and apply them to a specific case. This is mainly because the qualitative identification of potential factors is time consuming. Thus, these studies can at most confirm or reject potential success factors but cannot identify better or new ones. The advantage of the work at hand is that it explicitely identifies potential success factors and does not rely on external data. The following subchapters will explain why interviews as well as structural equation modeling were chosen as methodologies to identify and to validate potential success factors.

5.3.1 Identification of potential success factors through a direct, qualitative-explorative approach

5.3.1.1 Overview of methodologies

A direct qualitative-explorative approach will be used to identify underlying reasons for public opposition and derive relevant potential success factors. Regarding qualitative research methodologies, one can basically distinguish between desk and field research (see figure 25). The former consists of secondary analyzes of existing findings in the literature, whereas the latter originally collects new information – so called primary data. Content analysis, as main methodology of desk research, is defined as a systematic analysis and objective identification of generalizable elements and conclusions across several available documents (Kromrey, 2006, p. 319). It has been pointed out earlier in chapter 5.1 that empirical information is rare. Information gained from infrastructure projects, which are analog to transmission line projects, is useful in deriving potential success factors for TSOs. However, this information is not sufficient enough and therefore further field research needs to be conducted.

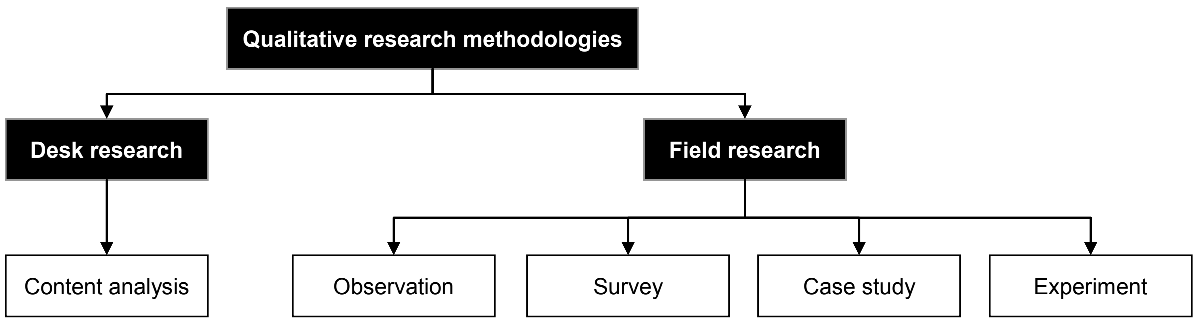

Figure 25: Overview of main qualitative research methodologies for exploration of hypotheses. Own illustration based on Töpfer (2009).

There are four general qualitative field research methodologies: observation, survey, case study and experiment. Observation aims at studying the actions and behaviour of research objects in particular (Kromrey, 2006, p. 346). A researcher can conduct an observation either passively by analyzing research objects (i.e. participants) from outside or actively via participation and being in direct connection with the research objects (Mayring, 2002, pp. 80–81). In both cases the researcher can act either in a manner in which he is hidden and unrecognized or open and recognized by the research objects (Kromrey, 2006, p. 349).

Experiments are in principal similar to observations. The significant difference is that experiments are conducted in a completely controlled environment. This means that any external factors that could negatively influence the empirical results are to be eliminated or at least measured and controlled for.

As mentioned earlier in this work, an experiment is the only methodology with which to identify real cause-effect relations. This is often done by comparing an experimental with a control group. However, in reality it is often difficult and impractical to set up an experimental environment in which all external factors are known and controlled.

In contrast to observations or experiments, the survey allows the researcher to directly address his points of interest to the research object. In social science the survey is the most applied and developed research methodology (Kromrey, 2006, p. 358). It basically consists of posing questions either personally via direct conversations, phone calls or in written form through mail or internet.

Case studies deal with specific research conditions which means that the researcher focuses his investigation on a certain situation and research object. This could be a specific project, company, region or all of them together. The goal is to identify certain patterns from the specific case that most likely hold true also in other cases (Töpfer, 2009, p. 207). Other methodologies such as a survey or an observation can be applied also in a case study itself.

Transmission line projects are not unique. It is difficult to identify a complete and comprehensive set of potential success factors from a single or a handful transmission line cases only. Thus, the two methodologies case study and observation are not suitable for the work at hand. Kube (1991, p. 6) argues that in reality controlled experiments are impossible to set up in practice for success factor research. This leaves the survey as the remaining option of a qualitative research methodology.

5.3.1.2 Survey

A survey can be conducted in several ways. As illustrated in figure 26, options vary according to the mode of communication (i.e. either verbal, written or a combination of both) and the degree of structure (i.e. unstructured, semi-structured or structured).

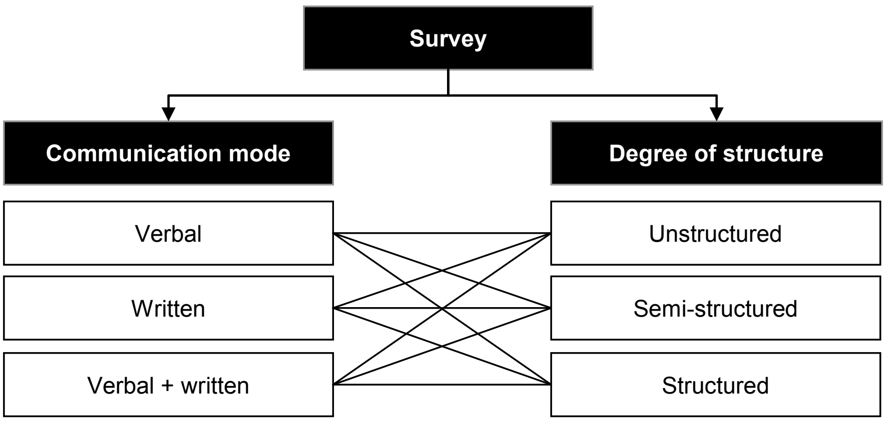

Figure 26: Survey types.

Regarding the communication mode, the researcher can conduct verbal interviews either via telephone (e.g. see Marsden & Wright (2010), Schnell et al. (2005, p. 363) or Frey et al. (1990)) or face-to-face (e.g. Deppermann (2008) or Nohl (2009)). The verbal type has the advantage of allowing the researcher to collect additional information next to the answers themselves. This means that the moods, emphasizes or mimics and gestures (only in personal interview) of the interviewee can be observed. This is not possible through the written form. Furthermore, one must not underestimate that the response rate is usually higher for interviews. In other words, the chance of getting an interview appointment is on average higher than the return rate of distributed email requests and questionnaires. In interviews the researcher can react to questions or ambiguities on the part of the interviewee. This is not possible in written surveys where there is no such direct interaction. Moreover, interviews avoid the risk of item non-response. In questionnaires respondents often skip questions on which they are uncertain or sometimes they simply forget to answer some questions (Porst, 2011, p. 54). Interviewing people directly also makes sure that the interviewee is suitable in terms of position, responsibility, knowledge and expertise. However, interviews come with the disadvantage of higher costs in terms of time effort, travel expenses or telephone charges (Porst, 1998, p. 17). Furthermore, interaction with the interviewer can carry bias, or, in other words, the interviewer may influence the interviewee (e.g. by the way the questions are asked) or interpret the answers subjectively. A written request allows the respondent to take more time to think about the questions rather than answering them spontaneously. A combination of a verbal and written communication methods is outlined by Atteslander (2006, p. 123): the researcher announces the questionnaire via phone, sends the written request and finally calls again to clarify any open or unclear issues. Surveys can be distinguished also by their degree of structure. In a structured survey (see e.g. Raab-Steiner & Benesch (2010), Bradburn et al. (2004), Oosterveld (1996) or Kirchhoff (2010)) the researcher must have an a priori sufficient knowledge on the topic itself and a list of detailed and standardized questions at hand when conducting the interview or developing the questionnaire. However, the structured design allows for almost no flexibility during the survey. In contrast, the unstructured survey (e.g. see Scholl (2009) or Konrad (2007)) is a 'free-floating' discussion or unstructured informal written request. It allows for most flexibility. However, it carries the risk that information collection becomes aimless and will not lead to the intended results. The semi-structured survey is a mix of both types (e.g. see Bogner (2009), Dexter (1970), Ney et al. (2007) or Meuser & Nagel (1991)). It uses a rough guideline to lead the interviewer through the interview while still allowing for sufficient flexibility (Meuser & Nagel, 1991, p. 448). The guideline also ensures that the results from several interviews can be compared with each other to some extent (Bortz & Döring, 2009; Lamnek, 2005, p. 202). For the work at hand, the verbal semi-structured survey type will be used as it is regarded as superior in terms of structure, flexibility and return rate. Furthermore, it is recommended in research contexts to focus on a limited number of questions (Przyborski & Wohlrab-Sahr, 2009, p. 140). For the work at hand this means the identification of underlying reasons for public opposition and respective success factors.

5.3.2 Quantitative-confirmatory approach to validate potential success factors

5.3.2.1 Overview of statistical methodologies

Success factor research aims to identify and validate cause-effect relations between variables. Once a hypothetical model of potential success factors and hypothetical relations is set up, there are several quantitative-confirmatory methodologies available for its validation. In general, there are univariate and multivariate statistical methodologies. In contrast to the former, multivariate methodologies consider the simultaneous variation of more than one variable (Kromrey, 2006, p. 421). As such, multivariate methodologies are predominantly used in success factor research because multiple success factors have to be identified. As illustrated in figure 27, there are confirmatory and exploratory multivariate methodologies in statistics.

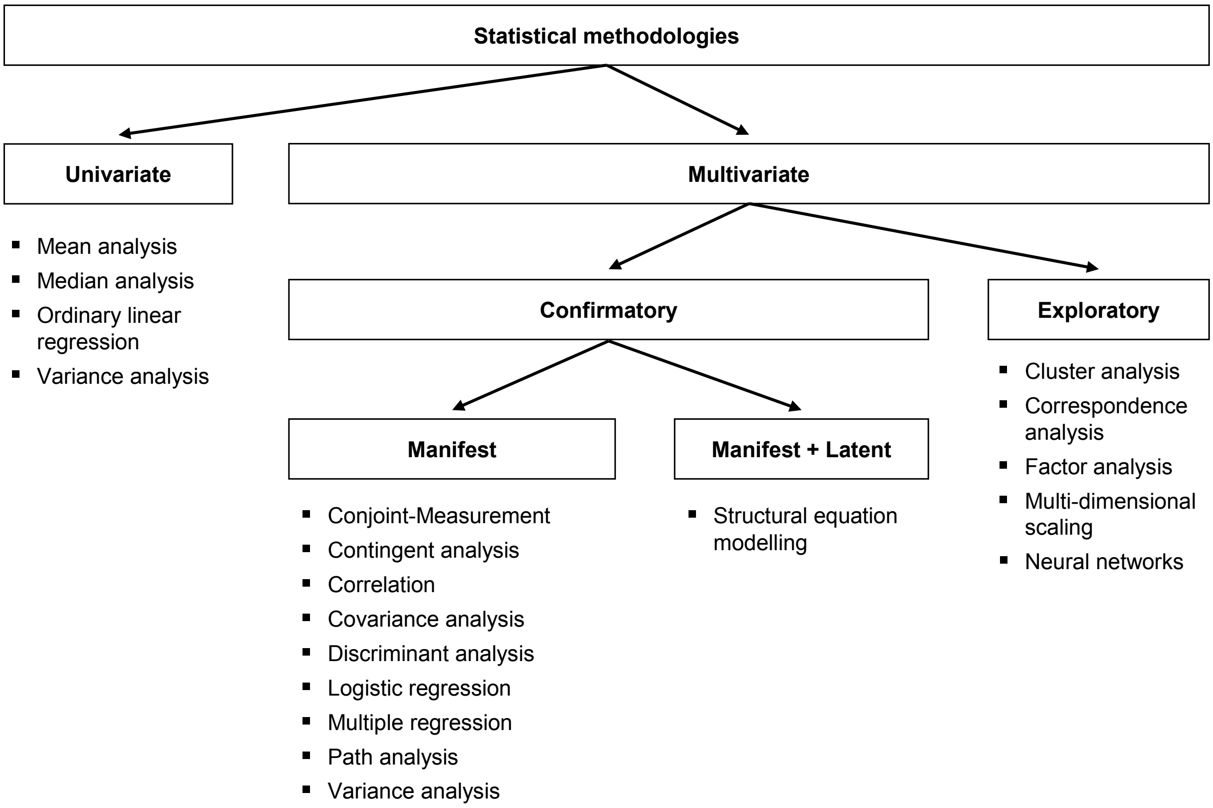

Figure 27: General statistical methodologies. Own illustration based on Schmalen et al. (2005, p. 8).

Confirmatory methodologies are primarily applied to validate hypothetical cause-effect relations, i.e. to find out, if and how strong potential success factors influence respective success (Backhaus et al., 2006, p. 6). In general, there a two major types of variables: manifest and latent. Manifest variables can be directly measured or observed. In contrast, latent variables are theoretical constructs that cannot be directly observed or measured, i.e. they are not tangible (Fuchs, 2011, p. 3; Weiber & Mühlhaus, 2010, p. 19). They are often refered to as 'latent constructs' or just 'constructs'. However, theoretical constructs are abstract attributes that are responsible for certain effects and therefore also need to be considered in research in order to achieve accurate results (Hildebrandt, 1989, p. 101; Trommsdorff, 1990, p. 17). Latent variables are especially important for the identification of complex cause-effect relations. For example, success itself is a latent variable that cannot be directly measured. Company culture, customer satisfaction or employee motivation that are often regarded as general success factors in the literature, are further examples of latent variables. Thus, considering latent variables is essential for a sufficient identification of success factors (Hildebrandt, 1983, p. 25; Winkelmann, 2004, p. 34). Confirmatory statistical methodologies such as multiple linear regressions, discrimination analysis, contingent analysis, etc. can only measure manifest variables. A multivariate confirmatory methodology that can validate cause-effect hypotheses with latent variables as well as manifest ones, is structural equation modeling (SEM) (Backhaus et al., 2006, p. 11). SEM is often subsumed in the literature as 'causal modeling', although being only one type of it (Hildebrandt, 1998, p. 17; Opp, 1973, p. 83). It can also analyze complex cause-effect relations and has therefore become one of the most popular methodologies in social sciences (Homburg et al., 2008). According to Backhaus et al. (2006, p. 415), the confirmation of cause-effect relations via causal modeling is falling short if a profound empirical theory foundation does not already exist or has not been developed by the researcher in advance to the validation. The work at hand fulfills this requirement by developing sound hypotheses through explorative interviews and literature research beforehand. Hence, SEM will be used in this work for the validation of potential success factors.

5.3.2.2 Structural equation modeling (SEM)

SEM basically tests theoretically established hypotheses that are put together in a model. It provides researchers with the ability to show „that the relationships you have hypothesized among the latent variables and between the latent variables and the manifest indicators are indeed consistent with the empirical data at hand" (Diamantopoulos & Siguaw, 2000, p. 4). In other words, SEM is a methodology that allows the drawing of conclusions on cause-effect relations through parameter estimation based on a priori empirically measured variances and co-variances of indicator variables (Homburg, 1989, p. 2). SEM uses regressions, but is superior to classical regression analysis as it has more application possibilities and gives a higher quality of results (Ringle, 2004b, p. 282). SEM had first been applied in marketing to identify suitable marketing instruments and understand causal relations between marketing measures and customer behaviour (Bagozzi, 1980). During the last decade, SEM has been widely used to identify success factors in several fields of research (e.g. Riekeberg (2003), Kube (1991), Croteau & Li (2003), Hwang & Xu (2008), Chung & Kim (2009) or Hemminger (2010)). In the following subchapters, the path analysis as an underlying principle of SEM is introduced, the basic structure of a SEM is outlined, available methods to estimate a SEM are compared and the mathematical specification of a SEM is provided.

5.3.2.2.1 Path analysis

SEM is based on path analysis, which consists of multiple regression analyses (Schreck, 1998, p. 105). Path and regression analysis are methodologies on their own. In a model containing only manifest variables that are not interdependent, the regression analysis is the methodology of choice with which to identify causal relations. However in the complex reality, variables are likely to be interdependent. ‘Complex’ in this sense means that variables can be independent as well as dependent at the same time (Weiber & Mühlhaus, 2010, p. 18). Moreover, a variable cannot only be influenced directly by another variable, but also indirectly through a third variable. In contrast to classical regression analysis in which variables can only either be independent or dependent, but not both, path analysis uses path coefficients instead of partial regression coefficients as a measure of influence (Weiber & Mühlhaus, 2010, p. 19). Regression coefficients are only able to measure the direct effect of a variable on another (Reinecke, 2005, p. 8). Path analyses have first been applied by Wright (1921, 1923, 1934). A path analysis uses a path diagram to visualize the hypothetical cause-effect relations derived from theory. This helps the researcher to display a complex structure of relations. If a theory model cannot be validated and needs to be rejected, a path diagram is also useful for ‘theory trimming’, i.e. a respective modification of the model (Opp & Schmidt, 1976, p. 31). As path analysis is an essential part of SEM, a brief and simple example is provided subsequently. Figure 28 illustrates a simple path diagram with the three variables x_1, x_2 and x_3.

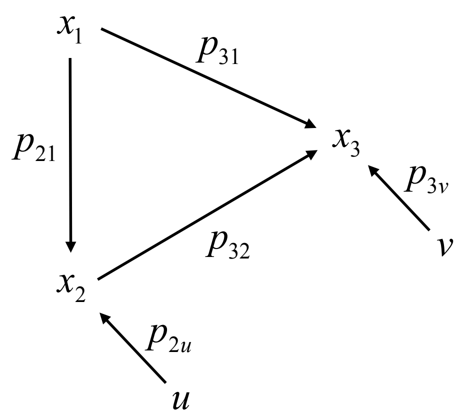

Figure 28: Path diagram with three variables (Bortz & Schuster, 2010, p. 436).

The individual paths represent relations between variables. The path coefficients p_{21}, p_{31} and p_{32} represent the individual weights of the exogenous variables on the endogenous ones. In other words, they describe the relevant effect size (Bortz & Schuster, 2010, pp. 435, 441). Their value can range from -1 to +1. A value of 1 signalizes a perfect positive correlation. This means that the variation of an independent variable leads to an identical variation on the dependent one. Thus, it can be assumed that both variables are identical. Values higher than 0.4 are regarded as strong correlations. -1 is the respective perfect negative correlation, with values below -0.4 being regarded as strong. Path coefficients between -0.1 and 0.1 can be considered as insignificant while a path coefficient of 0 means that there is no influence at all between the two variables (Jahn, 2007, p. 10; Lehner & Haas, 2010, p. 82). The variables x_2 and x_3 are 'explained', i.e. influenced causally, by other variables and respective residua u and v weighted with their related path coefficients p_{2u} and p_{3v} [92]. For each endogenous variable a structural equation can be defined:

$$x_2 = p_{21}x_1 + p_{2u}u \quad (5.1)$$

$$x_3 = p_{31}x_1 + p_{32}x_2 + p_{3v}v \quad (5.2)$$

Via mathematical transformation[93] the respective correlations r_{13}, r_{23} and r_{12} between x_1, x_2 and x_3 can be modelled by the path coefficients:

$$r_{13} = p_{31} + r_{12}p_{32} \quad (5.3)$$

$$r_{23} = p_{32} + r_{12}p_{31} \quad (5.4)$$

$$r_{12} = p_{21} \quad (5.5)$$

Solving these equations for the individual path coefficients leads to the final equations:

$$p_{31} = \frac{r_{13} - r_{23}r_{12}}{1 - r_{12}^2} \quad (5.6)$$

$$p_{32} = \frac{r_{23} - r_{13}r_{12}}{1 - r_{12}^2} \quad (5.7)$$

$$p_{21} = r_{12} \quad (5.8)$$

The path coefficients p_{2u} and p_{3v} can be calculated as variances of the respective endogenous variables x_2 and x_3. Assuming a recursive model and standardized variables which have a variance of 1, the residua do not exist. Finally, the total effect can be calculated per variable, which comprises all direct as well as all indirect effects. For instance, the total effect of x_1 on x_3 is $p_{31} + p_{21}p_{32}$.

The example above shows, how path analysis works and how it can be used to calculate cause-effect relations. However, path analysis is limited to manifest variables only. As the inclusion of latent variables in success factor research is crucial, path analysis as the standalone methodology would not

[92] This is based on the assumption of linear relations and a recursive model. Recursive means that all relations in the model have the same direction. In other words, the effect of an exogenous variable on others does not directly or indirectly have an affect on itself.

[93] For details see Bortz & Schuster (2010, pp. 441–442) or Reinecke (2005, pp. 47–50).

be sufficient anymore. The SEM complements the path analysis by including also latent variables (Wenninger, 2002) and is thus the methodology of choice in this work.

5.3.2.2.2 Structure of SEM

As latent variables cannot be directly observed, SEM operationalizes them via measurement models (Weiber & Mühlhaus, 2010, p. 31). In other words, SEM measures manifest variables that operationalize the respective latent variables. This is why SEM generally consists of two separate types of models. As illustrated in figure 29, these are measurement and structural models. The structural model analyzes the causal relations γ_{kj} between exogenous latent variables ξ_j and endogenous latent variables η_k[94]. It is often called the 'inner model' (e.g. Hoyle (1999, p. 321)) and needs to be based on empirical theory.

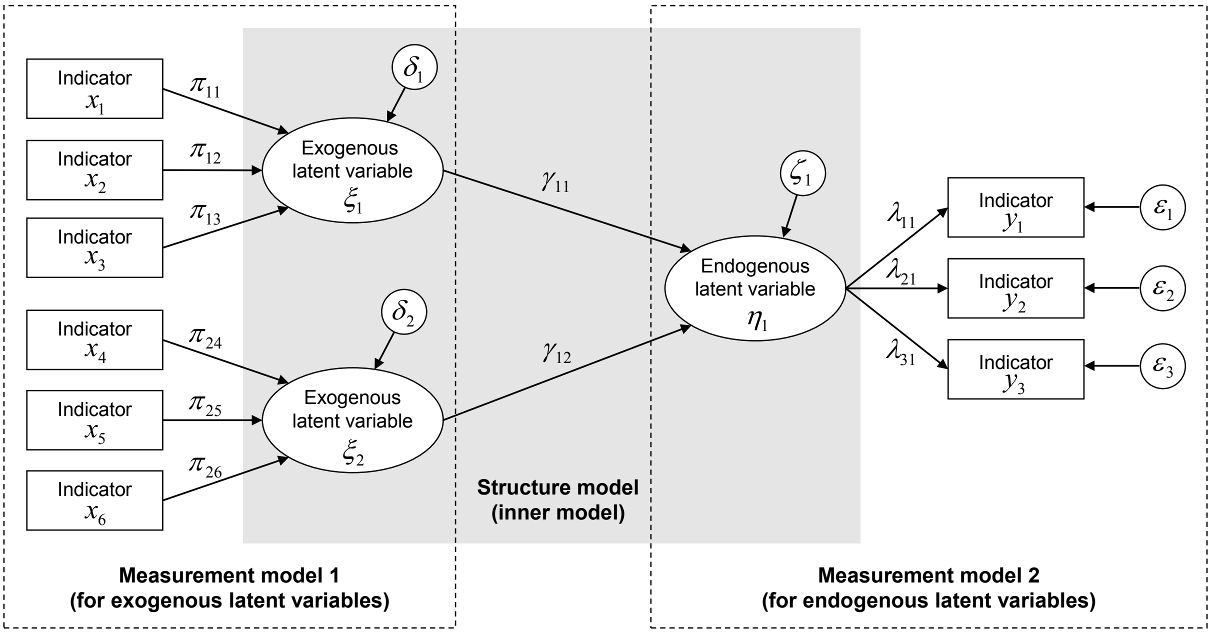

Figure 29: Structural equation model.

The advantage of SEM is that it can control the deviation from the real construct through the integration of a respective residuum ζ_k (Jöreskog & Sörbom, 1996, p. 2). This residuum is not caused by the model itself, but can be regarded rather as measurement error or unexplained variance (Huber et al., 2007, p. 5). The relations between the exogenous ξ_j and endogenous η_k latent variables in the structural model are formalized as

$$\eta_k = \sum_j \xi_j \gamma_{kj} + \zeta_k \qquad (5.9)$$

with j = index of exogenous latent variable and
k = index of endogenous latent variable.

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[94] A full list of used variables and their pronunciation can be found in the list of symbols.

The structural model is surrounded by usually two outer measurement models that investigate the relations between manifest variables, called indicators (Wohlgemuth, 1989, p. 99), and latent variables. Conventions in the literature (e.g. Backhaus et al. (2006, p. 361)) suggest depicting latent variables as an oval, causal relations with a directed arrow, where the start of the arrow represents the cause and the end represents the effect, and manifest variables as squared boxes. A measurement model can have two different characteristics. In other words, there are two different ways of operationalizing latent variables: formative and reflective. Measurement model 2 in figure 29, for instance, is of a reflective type. Indicators are determined by the latent construct which means that the direction of causality is from the latent variable η_k to the manifest variables y_l. The indicators are selected in a way that each of them can reflect the construct as a whole to a large extent. The indicators are causal effects of the latent construct (Bollen & Lennox, 1991, p. 305; Eberl, 2004, p. 3). Thus, any change of the latent value will cause changes to the indicators as well. In turn, the elimination of an indicator is not problematic as it will not change the construct significantly as the remaining indicators still reflect the latent construct to a large extent. The indicators therefore have a high intercorrelation and are internally consistent (Jahn, 2007, p. 9). The path coefficients λ_{lk} in a reflective measurement model are called loadings and represent the correlation between the manifest variables y_l and the latent construct η_k (Fuchs, 2011, p. 8; Lee et al., 2011, p. 313). Respective residuals ε_l have to be included for the indicators and can be interpreted as measurement errors or 'noise' (Hoyle, 1999, p. 323). The absence of a measurement error (i.e. $\varepsilon_l = 0$) implies a perfect correlation between the indicators. The reflective indicators can be expressed as a function of their associated latent variables:

$$y_l = \lambda_{lk}\eta_k + \varepsilon_l \qquad (5.10)$$

for k = index of endogenous latent variable and
l = index of reflective indicator.

Measurement model 1 in figure 29 is of a formative type. The path coefficients π_{ji} in formative measurement models are called weights and correspond to the beta coefficient weights calculated as part of a multiple regression analysis. They represent the relative individual importance of the manifest indicators x_i in the formation of the exogenous latent variables ξ_j (Lee et al., 2011, p. 313). Formative indicators were first introduced by Blalock (1964). They are not influenced by a latent variable, but rather influence or 'cause' blockwise a respective latent variable.

For a latent variable that is operationalized by formative indicators this translates into the respective equation

$$\xi_j = \sum_i \pi_{ji} x_i + \delta_j \qquad (5.11)$$

with i = index of formative indicator and
j = index of exogenous latent variable.

In contrast to reflective models, indicators do not have residua in a formative measurement model as they are inherent elements of the latent construct. Any residuum is therefore 'caught' by the latent variable with an individual error term δ_j (Eberl, 2004, pp. 7–8). Although often referred to as 'error', it is not a measurement error but rather represents a gap caused by indicators that have not been considered in the model (Diamantopoulos, 2006, p. 15)[95]. This is why it is not correlated with the indicators in the model (Diamantopoulos, 2006, p. 12)[96]. The higher δ_j is, the more inaccurate is the formative measurement model, or in other words the more it lacks important indicators. $\delta_j = 0$ implies that the latent construct is specified by all relevant indicators. However, in reality this is virtually impossible to achieve (Diamantopoulos, 2006, p. 12). A typical example for such a formative model is socio-economic status, which as a latent variable is caused by indicators such as education, income, residence, etc. If any of these manifest variables change, socio-economic status does as well (Hauser, 1971, 1973). Figure 30 illustrates the basic difference of both measurement model types. The reflective approach aims to maximize the overlapping of indicators, which results in a high intercorrelation. In contrast, the formative approach tries to minimize the overlaps. All indicators together form the construct. The elimination of one would significantly change also the construct.

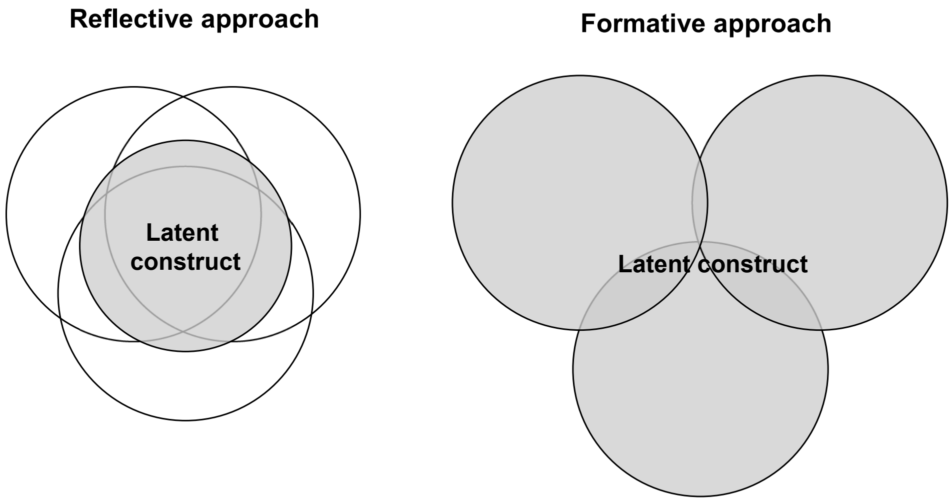

Figure 30: Different approaches to operationalize a latent construct.
Own illustration according to Nitzl (2010, p. 10).

The decision what type of measurement model to choose for the operationalization of a latent construct is essential and depends highly on the research goal, empirical theory and the latent construct itself. Several scientists have tried to provide rules that determine whether a construct needs to be operationalized in a formative or reflective way (Bollen & Ting, 2000; Chin, 1998a, p. 9; Eberl, 2004, p. 18; Huber et al., 2007, p. 19; Jarvis et al., 2003, p. 203). Others have made expert judgements on

95 Lohmöller (1989, p. 15) regards it also as 'lack of validity'.

96 I.e. $\text{cov}(x_i, \delta_j) = 0$.

both approaches (Diamantopoulos & Winklhofer, 2001, p. 271; Fornell & Bookstein, 1982, p. 292; Rossiter, 2002, p. 306). However, as Götz et al. (2010, p. 697) state, "the boundaries between formative and reflective specifications are rather fuzzy". Reflective specification has been the conventional wisdom in the literature (Bollen & Lennox, 1991). This is because most researchers in social sciences assume that indicators are an effect rather than a cause (Bollen, 1989, p. 65). This assumption is based on the classical test theory (Lord & Novick, 1968) and the domain-sampling model (Nunnally & Bernstein, 2006). Diamantopoulos & Winklhofer (2001) criticise that many scientists have used reflective measurement models without examining, if it is the appropriate type or not. They list several studies in which models have obviously been misspecified by the authors with reflective approaches although formative approaches would have been more appropriate. Fassott & Eggert (2005, p. 44) analyzed 25 studies which used reflective measurement models for latent variables and found out that in more than 80% of the papers a formative operationalization should have been selected instead. A similar assessment was conducted by Jarvis et al. (2003), who report that 29 percent of all studies published during a period of 24 years in four journals misspecified the measurement models. Thus, the selection whether to use the formative or reflective approach needs to be made carefully and is described for the work at hand in the following.

5.3.2.2.3 Methods for SEM estimation

There is a covariance and a variance based method to solve or in other words to estimate a SEM. The former is predominantly used in economic and social sciences as the meta analysis by Homburg & Baumgartner (1995) shows. This is mainly because of the early availability of suitable software packages for covariance based SEMs. Both methods for SEM estimation are often seen as rivals. However, Wold (2002, p. 52) argues that both methods are complementary as they do not constitute substitutes. What method to select depends on the model itself and the goal of the individual researcher. There are several contributions in the literature that compare both methods (e.g. Chin (1995), Dijkstra (1983), Fornell & Bookstein (1982), Lohmöller (1989), McDonald (1996) or Scholderer & Balderjahn (2005)). Similarly, in the following the two methods will be outlined and evaluated regarding their appropriateness for this work.

To start with, the covariance based method is often also referred to as Linear Structural Relationships (LISREL) approach. Its development can be dated back to works by Jöreskog (1970, 1973, 1977). He combined Wright's (1921) path analysis with multi-equation systems in econometrics (Schultz, 1938; Wold & Juréen, 1953). The name is derived from the computer programme called 'LISREL V'[97], which was developed by Jöreskog & Sörbom (1981) to handle the complex SEM estimations. Over the last decades, the LISREL software has been continuously improved (Jöreskog & Sörbom, 1982, 1984;

[97] Today's available software programmes like EQS (Bentler, 1985) or AMOS (Arbuckle, 2009) are based on LISREL.

Jöreskog et al., 1989) and is today available in its latest version 'LISREL 9'. In earlier times before the development and wider application of the variance based method, LISREL was synonymously used for SEM (e.g. Breckler (1990)). The goal of a covariance analysis – hereinafter referred to as LISREL – is to draw conclusions from the reflective measured manifest variables on the relations with respective latent constructs. For this purpose, LISREL uses the individual variance-covariance matrices (correlation matrices[98]) of the empirically measured variables. In other words, the more the individual manifest variables correlate with each other, the higher is their estimated relation with the respective latent construct. More specifically, LISREL estimates the parameters (i.e. all path coefficients) in the SEM in such a way that the produced covariance-matrix represents the empirical covariance matrix of the sample as exactly as possible. Thus, it minimizes the difference between both matrices. There are several statistical algorithms available for this estimation: Maximum-Likelihood, Generalized Least Squares, Weighted Least Squares and Unweighted Least Squares with the first one being used predominantly (Chin & Newsted, 1999, p. 309; Herrmann et al., 2006, p. 37).

As mentioned in the previous chapter, many past studies have misspecified the measurement models in a reflective instead of formative manner. This has led in science to the development of a variance based SEM method that is able to analyze formative measurement structures. The new approach originates from Wold's (1966, 1975, 1982a) work and is refered to as Partial Least Squares (PLS). In contrast to LISREL, the method is applied if no explicit empirical model of causal-relationships exists already (Buzzell et al., 1989, p. 6). Therefore, the goal of the PLS method is to identify optimal values for the latent variables and the respective factor weights of the manifest variables that specify them. In other words, it tries to reproduce the indicator values and the weights as close to the empirical data as possible. This is done by least squares, which minimize the variance of the error terms in the measurement models as well as the structural model (Herrmann et al., 2006, p. 37). The detailed working procedure of the PLS algorithm is described in the next chapter.

The first available software to estimate a variance based SEM – hereinafter PLS – was the statistical package 'LVPLS' (Latent Variables Path Analysis for Partial Least Squares) developed by Lohmöller (1984; 1989). It served as the basis for today's available enhanced programmes like PLS-Graph or SmartPLS[99]. A comprehensive overview of the origin and evolution of the PLS method can be found in Mateos-Aparicio (2011). The main advantage of PLS over LISREL is the easy integration of formative measurement models. Theoretically, LISREL is also capable of processing formative measurements. However, this is only possible under certain conditions[100]. For maximum-likelihood

98 Please note that covariance is a measure for the strength of a relation between two variables. In case the observed variables get standardized, covariances and correlations become identical (Backhaus et al., 2006, p. 341).

99 For a detailed comparison of available software packages see chapter 8.2.1.

100 This is partially possible for the specific case of a Multiple Indicators Multiple Causes (MIMIC) model where latent constructs are measured in a formative as well as reflective way at the same time. For details

estimations, LISREL needs to assume a multivariate normal distribution of the underlying input data, which make traditional parametric-based techniques applicable to test significance (Hoyle, 1999, p. 328). Nevertheless in reality, normally distributed data is often rare (Jahn, 2007, pp. 12–13). PLS does not presume such a distribution of data (Scholderer & Balderjahn, 2005, p. 91). LISREL estimates model parameters simultaneously in order to approximate the empirical covariance matrix in the best possible way. It can therefore also be called ‘full information approach’ (Herrmann et al., 2006, p. 38). In contrast, PLS optimizes locally, i.e. it estimates parameters blockwise in an iterative manner through a series of ordinary least squares regressions. It can thus be regarded as a ‘partial’ estimation method (Eberl, 2004, p. 12). This is why the method is called Partial Least Squares (PLS). It tries to maximize the explained variance of endogenous latent variables in the structural model and the indicators in the respective measurement models (Fuchs, 2011, p. 19; Scholderer & Balderjahn, 2005, p. 92). LISREL requires at least three indicators per reflective operationalized latent variable to avoid identification problems. In contrast, for PLS the identification is not a problem for recursive models as only the individual regressions need to be identified (Chin & Newsted, 1999, p. 313)[101].

A quasi downside of PLS is the fact that the latent constructs are estimated through linear combinations of the respective indicators and therefore include their measurement errors. This causes the latent constructs to become inconsistent and means that exact parameter estimation can only be ensured for a high number of indicators per latent variable which reduces the weight of the errors (Huber et al., 2007, p. 12; Jahn, 2007, p. 14). This limiting case is called ‘consistency at large’ (Wold, 1982a, p. 25). A small number of indicators lead to an overestimation of the relations between the formative indicators and the exogenous latent constructs (Herrmann et al., 2006, p. 41). At the same time, the relations between the latent constructs themselves are underestimated. However, this does not influence the prediction quality. Areskoug (1982) managed to show that both effects offset each other[102]. Thus, PLS has perfect prediction ability (Huber et al., 2007, p. 11). Due to the computational efficiency of the PLS algorithm, large complex models with hundreds of latent variables and thousands of indicators can be processed (Chin & Newsted, 1999, p. 313). The LISREL algorithm comes to its limits already at around 100 indicators. Moreover, PLS has the advantage that it can produce consistent results with a minimum sample size of 20 (Chin & Newsted, 1999, p. 328). Chin & Newsted (1999, p. 326) state that “[d]ue to the partial nature of the estimation procedure, where only a portion of the model is involved at any one time, only that part that requires the largest multiple regression need be found”. LISREL in contrast requires about 5-10 times the number of all indicators

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please refer to Fornell & Bookstein (1982, p. 441), Jöreskog & Goldberger (1975, p. 331) or Winklhofer & Diamantopoulos (2002, p. 152).

[101] Note that a formative model alone would not be statistically identifiable. Only its embedding in a larger complex model makes that possible (Ringle, 2004a, p. 33).

[102] This was confirmed also by Chin & Newsted (1999, p. 329), Fornell & Cha (1994, p. 67) and Dijkstra (1983).

(Homburg & Baumgartner, 1995, p. 1103), i.e. the researcher should at least aim at an overall sample size of 200 (MacCallum et al., 1996; Marsh et al., 1998). This is why LISREL can be regarded as statistically more accurate. However, LISREL requires an assured theory regarding the causal relations of the variables, which is unlikely to exist in most cases (Ringle, 2004c, p. 26)[103]. In particular, LISREL is parameter orientated, i.e. its "goal is to obtain population parameter estimates for explaining covariances with the assumption that the underlying model is correct" (Chin & Newsted, 1999, p. 311). Thus, LISREL is applied when the underlying model already exists and has proven to be right. In contrast, the PLS method cannot rely on an already validated model and is thus prediction orientated. As already mentioned, it aims to reach an as exact prediction of the empirical observations as possible (Fuchs, 2011, p. 19), i.e. it tries to 'find' the correct model. This makes PLS especially interesting for the identification of certain measures that facilitate success and have not been previously tested in the literature. In the context of this work, PLS helps to 'predict' concrete measures that support a TSO reducing public opposition in its transmission line projects. In addition to this, Albers & Hildebrandt (2006, p. 3) argue that if the researcher aims to identify concrete and implementable recommendations for management, a formative measurement model and therefore the PLS method should be used (see also Albers 2010, p. 419). Table 4 summarizes the above explained characteristics of both methods.

Table 4: Comparison of PLS and LISREL method to estimate a SEM according to Chin & Newsted (1999, p. 314) and Eberl (2004, p. 12)

Characteristic	PLS	LISREL
Objective	Optimal prediction of variables (i.e. prediction orientated)	Optimal accuracy of model structure (i.e. parameter orientated)
Approach	Variance based	Covariance based
Possible latent-manifest variable relations	Formative and reflective	Typically[104] only reflective
Assumptions	Predictor specification; no normal distribution required (non-parametric)	Typically multivariate normal distribution (parametric)
Estimation principle	Iterative (partial least squares)	Simultaneous (maximum-likelihood)
Parameter estimates	Consistent as indicators and sample size increase (i.e. consistency at large)	Consistent
Model complexity	Large complexities (> 100 constructs and 1,000 indicators possible)	Small to moderate complexity possible (< 100 indicators)
Sample size	Minimum 20	Minimum 200

[103] For details please refer to Bollen (1989, p. 78) and Riekeberg (2002, p. 942).

[104] Except the specific case of a MIMIC model.

The LISREL method has been predominantly used in the literature. As already mentioned, among these studies several authors have identified a remarkable number of incorrect specifications regarding the measurement models. In other words, researchers have wrongly used reflective measurement models instead of correctly applying formative ones. Only recently a growing number of success factor studies have been published which apply the PLS method (e.g. Esteves et al. (2003), Guan & Ma (2009), Hwang & Xu (2008), Lehner & Haas (2010) or Ringle (2005)). In marketing, which has been at the forefront of success factor research, PLS is today even the method of choice (Albers, 2010). As a summary and according to the guideline of Chin & Newsted (1999), PLS has to be used, if

- predictions need to be made (see also Fornell & Bookstein (1982, p. 443)),
- the cause of the investigation is new, and approved measures are not at hand,
- the model is rather complex and has many indicators,
- a multivariate normal distribution is not given,
- the sample is relatively small.

All these points hold true especially in the context of this research work. In particular, predictions regarding potential success factors should be made. Moreover, a proven theory and approved measures do not exist and a normal distribution is not necessarily given. The total of 41 European TSOs constitutes a comparably small total population, which makes large sample sizes impossible. Therefore, the PLS method will be used in the course of this work to analyse the SEM model.

5.3.2.2.4 PLS algorithm

To estimate a SEM that includes also formative measurement models, Wold (1966) developed the basic PLS algorithm. The algorithm estimates values for the latent variables in an iterative way through respective blocks of empirical indicators, i.e. linear combinations of indicators. The estimation is carried out in three major stages:

I. Iterative estimation of latent variables scores
II. Estimation of path coefficients in the structural model and weights/loadings in the measurement models
III. Estimation of location parameters (i.e. regression constants)

Stage I estimates the individual scores of latent variables. In particular, the stage consists of an initial step followed by four recurring steps as illustrated in figure 31 on the next page.

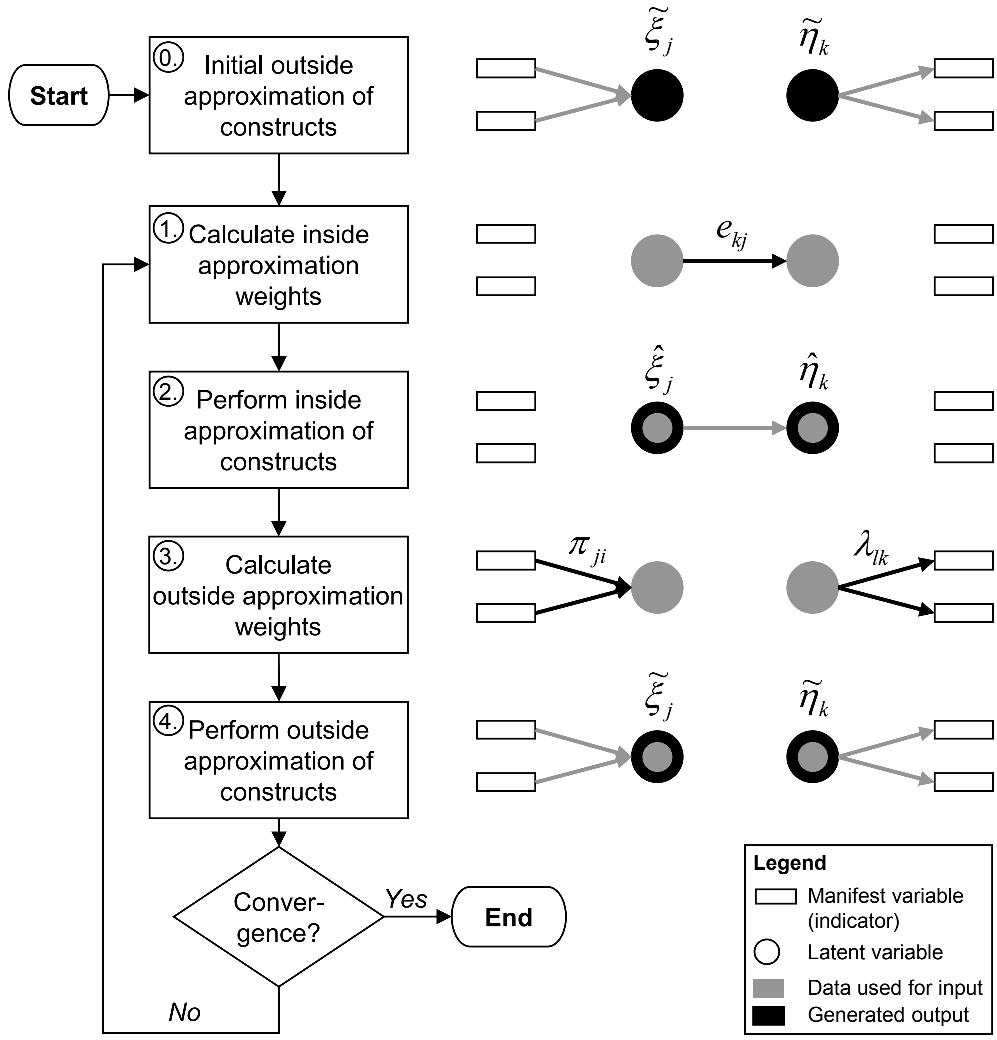

Figure 31: Main steps of stage I of the PLS algorithm. Own illustration according to Ringle et al. (2006, p. 84) and Chin & Newsted (1999, p. 320).

The algorithm starts with an initial outside approximation of the latent constructs. In particular, each latent variable is calculated with auxiliary weights w_{ji} for the formative or w_{lk} for the reflective measurement model:

$$\tilde{\xi}_j = \sum_i w_{ji} x_i \tag{5.12}$$

$$\tilde{\eta}_k = \sum_l w_{lk} y_l \tag{5.13}$$

with ~ indicating estimation from outside.

Usually, the first indicator's weight is set to 1 whereas the other weights remain 0 (Chatelin et al., 2002, p. 9; Tenenhaus et al., 2005, p. 169). Furthermore, the weights are standardized in order to obtain latent variables with unitary variance (Henseler, 2010, p. 111; Tenenhaus et al., 2005, p. 169).

This eliminates the error terms. Thus, the latent constructs are represented in the initial approximation by one indicator each:

$$\tilde{\xi}_j = x_i \quad (5.14)$$

$$\tilde{\eta}_k = y_l \quad (5.15)$$

with i and l as the lowest indicator indices of the respective measurement models.

In the next step (1.), the algorithm calculates the inside approximation weights between the latent variables. In other words, it determines the weights between the latent constructs with the provisionally obtained latent variables scores. There are three different calculation approaches:

- **Centroid Weighting Scheme**
  This is the simplest weighting scheme and preferred by Wold (1982b). It considers neither the directness nor strength of the relationship between latent constructs (Lohmöller, 1989, p. 42). The construct relation is defined as +1 or -1 according to their covariance (Ringle et al., 2006, p. 84).
- **Factor Weighting Scheme**
  This scheme sets the relation between constructs equal to their correlation coefficient (Chatelin et al., 2002, p. 9; Ringle et al., 2006, p. 84).
- **Path Weighting Scheme**
  The path weighting scheme is the only weighting scheme that takes directed relations into account. All precedent and therefore explanatory constructs of a latent variable are weighted with their regression coefficients, which are yielded from a regression of the focal latent variable on its latent repressor variables. All subsequent latent variables are weighted with their respective correlation coefficient similar to the factor weighting scheme (Henseler, 2010, p. 111).

The practical use of PLS has shown that the choice of a specific weighting scheme has only a minor influence on the results (Johansson & Yip, 1994, p. 587; Ringle et al., 2006, p. 85). This work will use the path weighting scheme as it is the only scheme that takes the causal order into account within the structural model. It is currently also widely recommended by other scientists (e.g. by Henseler (2010, p. 114) or Hair et al. (2011, p. 142)). The inner weights are determined with the path weighting scheme for each latent variable in order to reflect how strong the other connecting constructs are related to it (Henseler, 2010, p. 111):

$$e_{kj} = \begin{cases} cor(\tilde{\xi}_j;\tilde{\eta}_k) & \text{if } \tilde{\xi}_j \text{ and } \tilde{\eta}_k \text{ are directly connected and } \tilde{\eta}_k \text{ is a successor of } \tilde{\xi}_j \\ d_{kj} & \text{if } \tilde{\xi}_j \text{ and } \tilde{\eta}_k \text{ are directly connected and } \tilde{\xi}_j \text{ is a predecessor of } \tilde{\eta}_k;\ d_{kj} \text{ as regression coefficient of } \tilde{\eta}_k \text{ on } \tilde{\xi}_j \\ 0 & \text{else.} \end{cases} \quad (5.16)$$

These inner weights and the provisional latent scores are then used in the following step (2.) to perform the inside approximation. Its aim is to estimate instrument variables that are the 'most suitable neighbours' to their predecessors or successors (Fornell & Cha, 1994, p. 65).

$$\hat{\eta}_k = \frac{1}{C_k}\sum d_{kj}\tilde{\xi}_j \quad (5.17)$$

$$\hat{\xi}_j = \frac{1}{C_j}\sum e_{kj}\tilde{\eta}_k \quad (5.18)$$

with

$\hat{\eta}_k$ = instrument variable of latent construct η_k

$\hat{\xi}_j$ = instrument variable of latent construct ξ_j

$\hat{}$ = indicating estimation from inside

C = number of constructs linked to $\hat{\eta}_k$ and $\hat{\xi}_j$ respectively. $\frac{1}{C}$ is included to scale the latent variable[105].

The next step (3.) aims to identify outside weights in the measurement models which represent the instrument variables best (Magnus, 2007, p. 150). The algorithm solves the individual regressions of the measurement models with the respective instrument variables:

$$\hat{\xi}_j = \sum_i \pi_{ji} x_i + \hat{\delta}_j \quad \text{(formative measurement model)} \quad (5.19)$$

$$y_l = \lambda_{lk}\hat{\eta}_k + \varepsilon_l \quad \text{(reflective measurement model).} \quad (5.20)$$

The extracted regression coefficients λ_{lk} [106] and π_{ji} can then be used as new outer weights for the last iteration step (4.) to estimate the latent scores from the outside again. This is similar to the initial step

[105] This is to avoid consolidated matrix algebra in the following. The scaling is offset again in the fourth step. For details see Betzin & Henseler (2005, p. 62).

that calculated the latent variables as linear combinations. Instead of the previously used auxiliary weights, the new determined weights from the previous step are now applied:

$$\tilde{\xi}_j = c_j \sum_i \pi_{ji} x_i + \delta_j \tag{5.21}$$

$$\tilde{n}_k = c_k \sum_l \lambda_{lk} y_l + \varepsilon_l \tag{5.22}$$

with c as re-scaling factor.

After each iteration, the algorithm conducts a test for convergence by comparing the outside and inside estimations of the latent constructs:

$$\sum_j \left\|\tilde{\xi}_j - \hat{\xi}_j\right\|^2 \wedge \sum_k \left\|\tilde{\eta}_k - \hat{\eta}_k\right\|^2 < z \tag{5.23}$$

with z = convergence criterion.

If the squared difference of the outside and inside estimation for all latent variables is below the convergence criterion, the algorithm stops the iteration. Otherwise the algorithm continues with step 1 again. For the convergence criterion z a value of 10^{-5} is used.

After the latent scores have been successfully estimated, the path coefficients in the structure and the weights/loadings in the measurement models are estimated in **stage II** of the PLS algorithm. This is done via multiple least squares regressions (Ringle et al., 2006, p. 86). Each dependent variable in the model, i.e. either an endogenous latent variable or reflective indicator, is regressed on its respective independent variables, i.e. either exogenous latent variables or formative indicators (Chin & Newsted, 1999, p. 319).

In the first two stages, indicators and latent variables are considered as deviations from their means. In case the researcher wants to obtain estimates that are based on the empirical data metrics, the PLS algorithm determines the respective means as well as location parameters of the latent and manifest variables in the **III. and final stage**. This is done by calculating the empirical means of the indicators first. With the use of the estimated weights from stage I, the means for the latent constructs are then derived. Given the means and the path coefficients from stage II, the location parameter (i.e. any regression constant) for each dependent construct is calculated as difference between the obtained mean and the systematic part, accounted for by the independent constructs that influence it. Similarly, the location parameters for the reflective indicators are calculated by the difference between their mean and the estimate based on the underlying latent constructs as well as the path loadings (Chin & Newsted, 1999, p. 319).

[106] As the instrument variables $\tilde{\xi}_j$ and $\tilde{\eta}_k$ are standardized, the regression coefficient λ_{lk} is equal to the respective covariance $\mathrm{cov}(y_l, \tilde{\eta}_k)$.

Overall, the PLS algorithm can be summarized in the following statement by Chin et al. (2003, p. 199):

“The PLS procedure is (…) used to estimate the latent variables as an exact linear combination of its indicators with the goal of maximizing the explained variance for the indicators and latent variables. Following a series of ordinary least squares analyses, PLS optimally weights the indicators such that a resulting latent variable estimate can be obtained. The weights provide an exact linear combination of the indicators for forming the latent variable score that is not only maximally correlated with its own set of indicators (...), but also correlated with other latent variables according to the structural (...) model.”

6 Identification of reasons for public opposition and derivation of potential success factors

6.1 Conducted interviews

In the literature, one of the most important criteria indicating the scientific quality of an explorative study is the transparency of the research process (Wohlgemuth, 1989, p. 97). To account for that the following chapters will outline what and how interviewees were selected for the identification of potential success factors. Furthermore, the preparation, conduction and documentation of the interviews are briefly explained.

6.1.1 Selection of interviewees

The best target group for interviews in order to understand the underlying problems of public opposition and to obtain ideas for potential success factors in transmission line planning are the affected stakeholders themselves. They comprise affected citizens and relevant NGOs. The former regularly organize into action groups to oppose the respective projects. Action groups usually have a president or a spokesperson who represents the general opinion of their members and is therefore a good candidate for interviews. As already mentioned earlier, most action groups have their own websites. Conveniently, some action groups include weblinks on their pages to further action groups. Therefore, relevant groups opposing high-voltage transmission lines could be identified via internet searches across Europe in the course of this work. Interestingly, action groups were found almost predominantly in Western and Central Europe. The search did not bring any results for Eastern European countries like Czech Republic, Poland, Hungary, etc (see figure 32 on the next page). There might be two main reasons for this: either action groups in these countries are less organized and do not have websites or there is less public opposition in these countries. The most action groups were found in Germany[107]. To avoid an imbalance with the limited number of action groups in other European countries, only five German action groups were selected from the two major currently planned transmission line projects Wahle-Mecklar and Halle-Schweinfurt[108]. This resulted in a total of 24 interviews with representatives from 23 action groups[109] in twelve European countries. As such, action groups accounted for 36% of all conducted interviews.

[107] See a full list of identified action groups in appendix 6.

[108] Also known as Thuringia power bridge (Thüringer Strombrücke).

[109] From one large action group two respresentatives were interviewed.

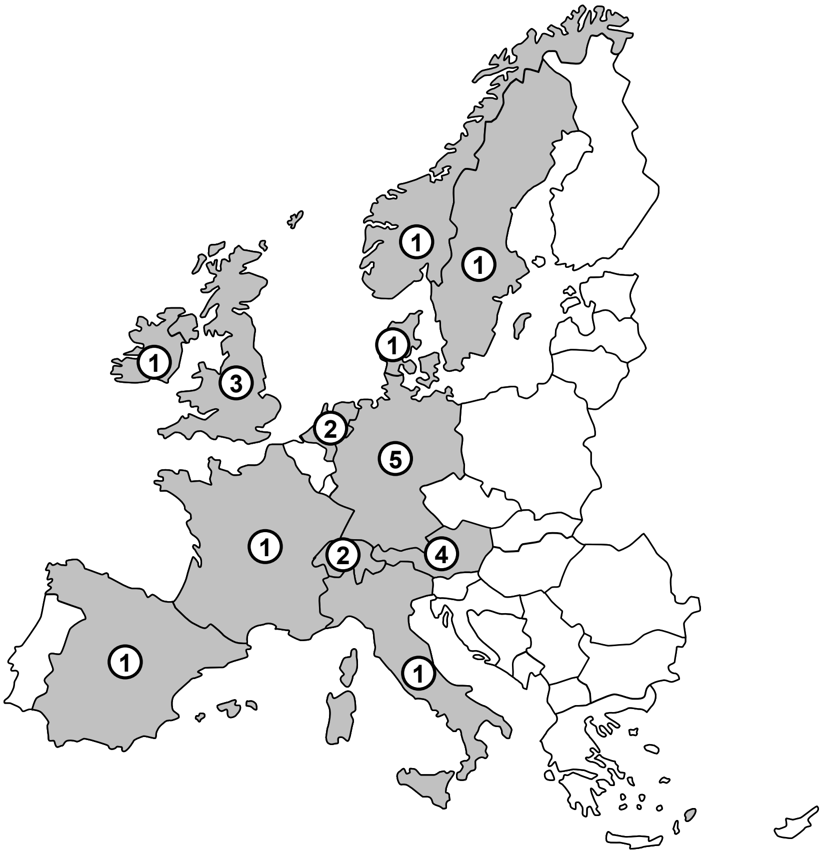

Figure 32: Number of action groups per country that were interviewed.

One further interviewee group were NGOs, which comprised mainly environmental organizations as environmental issues are often discussed extensively in transmission line projects. Overall, 10 interviews were conducted with nine NGOs[110] which accounted for 15% of all interviews. Further talks were carried out with representatives from academia and research institutes who deal with public opposition or transmission systems. To understand the regulatory boundaries and legislations in detail conversations were arranged with contact persons from governmental institutions and regulators. In order to also identify potential success factors from a technical perspective, industry experts such as transmission equipment manufacturers and suppliers were interviewed. Due to the fact that communication is one of the key aspects for a TSO when dealing with affected stakeholders, seven communication experts were interviewed with regard to measures and best practices.

Not all of the 101 identified potential candidates responded or agreed to an interview. The response and refusal rate was calculated according to Frey (1983, pp. 38–40). In total, 66 interviews were conducted. Thus, the response rate was 65% and slightly below the typical range of telephone surveys[111] of 70-85% (Dillman, 1978; Groves & Kahn, 1979; Siemiatycki, 1979). 19 candidates actively declined an interview, which led to a refusal rate of 19% that was below the median of 28%,

[110] Two representatives from one large NGO were interviewed.

[111] As most interviews were conducted via telephone (see chapter 6.1.2).

determined by Wiseman & McDonald (1979) out of 182 studies. The main reason for refusal in the context of this work was the lack of time. The remaining 16 candidates did not answer the interview request and the respective reminders. Table 5 details the different stakeholder groups represented in the 66 conducted interviews. A detailed list of the interviewees can be found in appendix 7.

Table 5: Overview of conducted interviews.

Type	Number of organizations	Number of interviews	Percentage
Action groups	23	24	36%
Research institutes / Universities	10	11	17%
NGO	9	10	15%
Industry experts	7	8	12%
Communication experts	7	7	11%
Governments/Regulators	6	6	9%
	62	66	100%

The reason for selecting different interviewee groups was to get a broad picture of possible success factors. Schmalen et al. (2005, p. 8) also state that a trade-off between the homogeneity of interviewees and broad reach needs to be found. Furthermore, the different interviewee groups serve the purpose of triangulation, which is defined as viewing something from different perspectives (Schirmer & Blinkert, 2009, p. 100). In addition, Wohlgemuth (1989, p. 99) argues that the identification of potential success factors from more than one source improves the quality of the research hypotheses. As already mentioned earlier in this work, TSOs are not part of the interview process as this would create the risk of 'self-fulfilling prophecy' later on in the validation of the hypotheses by the TSOs. The majority of interviewees were identified via internet search and recommendations from other interviewees. Next to the goal of gaining a better understanding of the research topic, visiting the following conferences helped to identify further candidates for interviews:

- ENTSO-E: Conference 'Towards electricity infrastructure for a carbon neutral Europe' (10.-11.02.2011, Brussels, Belgium)
- German Environmental Aid: 'Forum for Integration of Renewable Energy – Participation and conflict resolution during planning of new transmission lines' (07.09.2011, Berlin, Germany)
- German Environmental Aid: 'Expert conference for grid extension' (15.03.2012, Berlin, Germany)

6.1.2 Preparation, conduction and documentation of interviews

Mayring (2002, p. 71) proposes five steps in carrying out a successful semi-structured interview[112]. As illustrated in figure 33, the first step is the initial **problem analysis and the determination of the interview target**. In the context of this work, this has already been outlined above. The goal is to identify potential success factors for TSOs in the planning phase of transmission line projects to reduce public opposition. The second step is the **development of an interview guideline**. The guideline is meant to lead the researcher through the interview while still allowing the interviewee enough flexibility in his answers (Meuser & Nagel, 1991, p. 448).

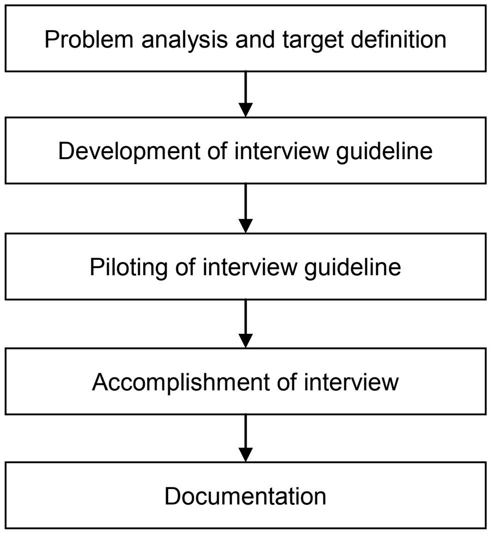

Figure 33: Process steps of a semi-structured interview. Own illustration based on Mayring (2002, p. 71).

The development of questions was based on the theory introduced above on social acceptance and transmission line planning. The questions were furthermore designed in an open manner to allow for most flexibility in the answers (as suggested by Atteslander (2006, pp. 136–139)). Moreover, according to Przyborski & Wohlrab-Sahr (2009, p. 140), the first question was formulated as general as possible as an introduction to allow the interviewee to describe his role and the context. The final question asked for suitable contact persons for further interviews. The interview guideline comprised in total 17 questions and can be found in appendix 8. The third step in the process of a semi-structured interview is the **piloting of the interview guideline**. Thus, after the guideline has been drafted, it needs to be pretested (Ney et al., 2007). This was done with two randomly picked members of a citizen action group during a conference on acceptance of grid infrastructure. The feedback received from the test persons was considered for the fine-tuning of the final guideline. The fourth step comprises the **accomplishment of interviews**. With the enhanced guideline a total of 66 interviews were conducted[113] from August to December 2011. This was carried out mainly via telephone in order

[112] A similar proposal can also be found in Bortz & Döring (2009, pp. 310–313).

[113] All interviews have been conducted by the author himself.

to save travel expenses and to have results available faster (Frey, 1983, pp. 29–35; Porst, 1998, p. 16). Following Schnell et al.'s (2005, p. 369) recommendation, interviewees were initially approached in written form via email. In the email the context and goal of the study was introduced and anonymity was offered if requested. To further incentivize the potential candidates to agree to an interview, the text also emphasized that the interview would be a good opportunity for them to raise their concerns and help to improve transmission line planning in the future. Furthermore, they were offered to receive the study results once finalized. If candidates agreed, interviews were scheduled either via an ex ante phone call or via email. Some interviews were also held face-to-face during the visited conferences. The majority of interviews were conducted in German or English. In case interviewees were not able to speak one of these two languages, respective native speakers were used during the interviews as translators[114]. Interviews lasted on average between 40 and 60 minutes which is similar to the range in other reported telephone surveys (Frey, 1983, p. 48). In order to create trust, it was again emphasized at the beginning of each interview, as recommended by Ney et al. (2007) that all answers would be treated anonymously if requested. A neutral position was taken during the whole interview, i.e. no comments were made that would have supported or opposed the statements of the interviewees. This was to avoid any bias and ensure objectivity. All statements cited in the following throughout the work at hand have been double-checked with the interviewees through a follow-up email to ensure accuracy. When interviewees asked for anonymity, cited statements were also double-checked for accuracy but marked without dedicated reference. The final step in the interview process is the **documentation of results**. Therefore, according to Schnell et al., p. 388 (2005), respective notes were made during the interviews[115]. Regarding the behaviour and mood of the interviewees during the talks, it should be mentioned that most of the action group representatives became swiftly disappointed, upset or even angry about the respective TSOs in the course of an interview. This was characterized through a rise of voice and vigorous answers and in personal interviews also through facial expression and gestures. Most interviewees were unexpectedly open and intensely criticized TSOs for several reasons. Overall, great dissatisfaction with TSOs and their behaviour in the past could be recognized among action group members and NGOs. Detailed interview results and results from literature research, in particular underlying reasons for public opposition and potential success factors for TSOs to reduce it, will be directly incorporated in the following chapters.

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[114] This was the case for three interviews that had to be held in French, Spanish and Italian.

[115] In contrast to narrative interviews, the literature does not regard detailed transcriptions with the interpretation of pauses, etc. as necessary for semi-structured interviews (e.g. see Meuser & Nagel (1991, p. 455)). Furthermore, interviews in this work had the goal to identify hypotheses in an explorative way which will later on be validated. Thus, in contrast to content analysis, notes were regarded as being sufficient for this purpose.

6.2 Reasons for public opposition

In order to identify possible success factors to reduce public resistance in transmission line planning, the people's reasons why they are opposing transmission line projects have to be understood first. Knowing the reasons of opposition will also help to derive respective actions and measures to address these concerns. Often motivation is vague or not significantly clear from the beginning. Van der Horst (2007, p. 2711) notes that many stakeholders seek an acceptable post-justification for having gone along with their initial 'gut feeling'. Interestingly, the line of argument used by opponents can also be totally different compared to their actual underlying reasoning. For instance, Wolsink (2000, p. 56) describes the case of a wind farm, which an active local group was opposed to because of visual impacts. Nevertheless, noise became the formal argument used in the judicial discussion. This was the only chance to stop the project legally, as there is an official noise limit but no regulation on visual impact. In the context of power transmission lines, several interviewees confirmed that action groups often have little chance of successfully blocking a project legally. Thus, 'pseudo-arguments' that are legally enforceable are used instead (interviews with Guido Axmann, 27.09.2011 and Markus Durrer, 14.10.2011). An argument that is often used as a false pretence is to claim that the facility is not needed or that its siting is insufficient (Popper & Mihori, 1985). Timewise, it is said that opponents also keep their best arguments until the end of the planning process, with the intention of increasing chances of success (interview with Elke Bruns, 27.09.2011). This can be very dangerous for a TSO, which might feel 'secure' at the beginning of the planning phase when less resistance is occuring.

The reasons for public resistance against transmission lines which were brought up throughout the interviews can be categorized as illustrated in figure 34 on the next page. The lack of trust of people in TSOs can be regarded as the central argument. Furthermore, it can be stated that health and safety issues as well as reduced quality of living were mentioned most frequently by the interviewees. Similar categories of reasoning are mentioned in Cotton & Devine-Wright (2012, pp. 2–3) or SEC (2011) 1233. The following subchapters describe the identified reasons for public resistance in more detail.

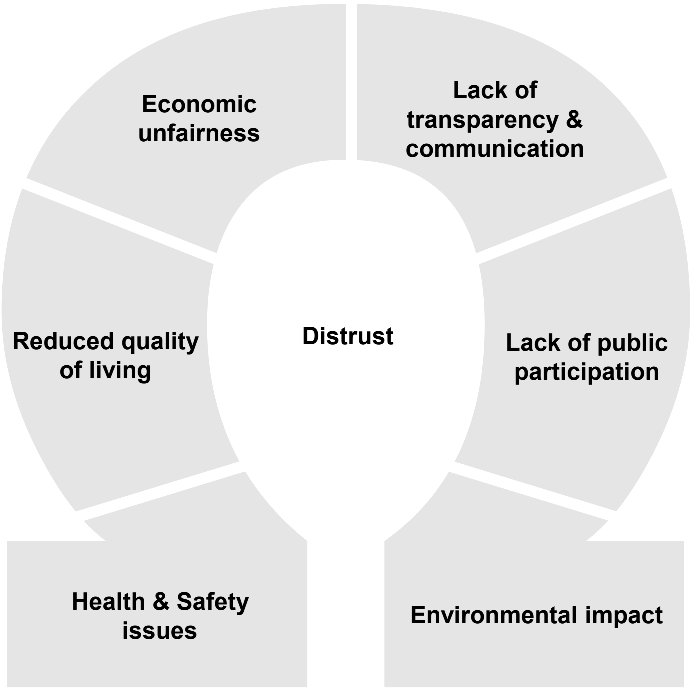

Figure 34: Main reasons for public resistance in transmission line planning.

6.2.1 Health and safety issues

6.2.1.1 Electric and magnetic fields (EMF)

A frequently mentioned reasoning in the conducted interviews for opposing transmission lines were health concerns due to extremely low frequency[116] electric and magnetic fields (EMF) (e.g. interviews with Pierre Lopez (07.10.2011), Hans U. Jakob (24.10.2011) or Mike O'Carroll (20.09.2011)). In addition, Gerlach (2004, p. 161) argues that exposure to EMF has become the most cited reason of opponents. Electric fields are created by the charge, i.e. the voltage of a line, and are measured in volts per meter (V/m). It means that the higher a line's voltage level is, the larger is its electric field. In contrast, magnetic fields are generated by currents flowing through a transmission line and are measured in micro-tesla (µT[117]). In other words, the more amperes a power line transmits the higher are its magnetic fields. Since the 70's, people have become increasingly concerned about EMF in transmission line siting as research revealed first indications that EMF might be associated with an increased risk of cancer (Gerlach, 2004, p. 162). Electrical and magnetic fields induce circular currents in the human body that acts as an inductor (Bundesamt für Strahlenschutz, 2008, p. 33). Concerns have centred on magnetic fields rather than electric ones. This is due to the fact that electric fields can be easily shielded by objects and therefore rarely enter buildings. In contrast, shielding of magnetic fields is possible but rather complex (Neitzke et al., 2006). Scientists from different disciplines, mainly epidemiology, cellular biology, biostatistics, and risk assessment have conducted studies to identify a

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[116] In case of European transmission lines this is 50 Hz.

[117] Equals 10^{-6} T.

relationship between EMF and potential negative impacts on health (Gerlach, 2004, p. 164). Today, there is an almost unlimited number of publications on EMF and its potential impact on human health. Furthermore, many NGOs, councils, panels or national agencies have been founded to analyze and interpret scientific findings and also publish own reports. Appendix 9 provides an exemplary overview of these organizations. Giving a detailed overview on the available literature would go beyond the scope of this work. However, a selection of studies that show a positive correlation between EMF and negative health effects will be provided in the following.

The most researched potential harm caused by EMF is cancer. In their meta-studies Ahlbom et al. (2000) and Greenland et al. (2000) pooled the available scientific information on the relationship between EMF and childhood leukaemia. They come up with a low statistical relationship between an increased risk for cancer and children living in areas with magnetic fields above 0.3 µT and 0.4 µT respectively. Similarly in 2006, Kabuto et al. found statistical relations for magnetic fields above 0.4 µT. More recently in 2008, Yang et al. identified a 4.3 times increased risk for leukaemia of children living within 100 meters of a transmission line. Besides child leukaemia, an increased risk of breast cancer (Loomis et al., 1994; Matanoski et al., 1991) as well as brain cancer (Guénel et al., 1996) is mentioned also. In addition to cancer, studies are also available that claim EMF causing Alzheimer's (Andel et al., 2010; Davanipour et al., 2007; Feychting et al., 2003; García et al., 2008; Huss et al., 2009), asthma (Li et al., 2011), amyotrophic lateral sclerosis[118] (Huss et al., 2009; Kheifets et al., 2009; Röösli et al., 2007), miscarriage (Li & Neutra, 2002), poor sperm quality (Li et al., 2010), malaise (Ratzel et al., 2010, p. 117), dermatological symptoms as well as fatigue, headache, heart palpitation, nausea or concentration problems (SCENIHR, 2009, p. 40). People with a cardiac pacemaker are also in jeopardy when approaching a transmission line as the EMF can negatively influence the operation of the device (Ratzel et al., 2010, p. 118). Interviewees reported also a continuously feeling of threat that made them uncomfortable and negatively affected their daily lives (interviews with Elke Bruns, 27.09.2011 and Sigrid Bluhme, 04.11.2011).

Next to studies which reveal a slight positive statistical correlation between EMF and negative health effects there are at least the same number of studies that cannot confirm an association. Thus, overall the research on EMF of transmission lines and related negative health effects is inconclusive and contradictory. Epidemiological studies are mainly criticized for their poor methodology, their small sample size, selection of target and control group or insufficient elimination of external factors. In recent years, the methodologies applied in studies have improved according to that. The recently identified associations between EMF and negative health effects have become smaller. Kheifets et al. (2009, p. 78) put it thus "[a]lthough the epidemiological evidence suggests excess risk with occupational EMF exposure for some health outcomes, there is no outcome for which the combined

[118] Also referred to as Lou Gehrig's disease. It is a form of motor neurone disease that mainly causes rapidly progressive weakness and muscle atrophy.

evidence is strong or consistent enough to support the conclusion that a health hazard exists”. Buijs et al. (2009) argue that until today, health risks of oscillating low frequency magnetic fields have not been proven scientifically. Conversely, they have never been disproven. Statistical relations between living close to transmission lines and negative impacts on human health, such as child leukaemia, have been stated in several epidemiological research studies. However, scientific cause-effect correlation or interaction mechanisms between magnetic fields and biological effect in vivo or in vitro have not been confirmed yet in order to attest the statistical observations (interviews with Christiane Pölzl-Viol, 28.09.2011 and Markus Durrer, 14.10.2011). This implies that theoretically other effects could exist that are responsible for causing cancer. Hence, a sufficient uncertainty remains as to the potential of EMF involvement in cancer aetiology (Kheifets, 2002). Nevertheless, following results from epidemiological studies, the International Agency of Research on Cancer (IARC) classified extremely low-frequency (ELF) magnetic fields in 2002 into group ‘2B – possibly carcinogenic to humans’, i.e. potentially cancer-causing. This is on the same level with coffee, chloroform, lead or gasoline engine exhausts. ELF electric fields were grouped into the lower risk category ‘3 – not classifiable as to carcinogenicity in humans’ and thus are on the same level as tea, kerosene or hair colouring products (IARC, 2012). In 1998, the International Commission for Non-Ionizing Radiation Protection (ICNIRP) published guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (ICNIRP, 1998). General public thresholds of 5 kV/m for electric and 100 µT for magnetic fields and occupational thresholds of 10 kV/m and 200 µT respectively were defined for a frequency of 50 Hz. A few years later, the guidelines’ limit values were implemented into EU legislation including the Council Recommendation of 12 July 1999 for the general public and Directive 2004/40/EC for the working environment. Since then, almost all European countries have implemented the recommended thresholds for the general public into national law. The World Health Organization (WHO) also recommends the thresholds set by ICNIRP (WHO, 2007).

EMFs in general depend on factors such as number and arrangement of line systems and phases, voltage level, power rating, etc. Specifically for OHLs, the height of the pylons and the sag of the lines play an important role. For UGC systems, the laying depth and the cable cross-section dimension are also important[119]. Figure 35 on the next page shows the magnetic fields of a HVAC OHL and comparable HVAC UGC system under normal operation. Both do not exceed the set threshold of 100 µT by far.

[119] For a comprehensive list of influence factors please see Neitzke et al. (2010, pp. 11–13) or Ratzel et al. (2010, pp. 62–64).

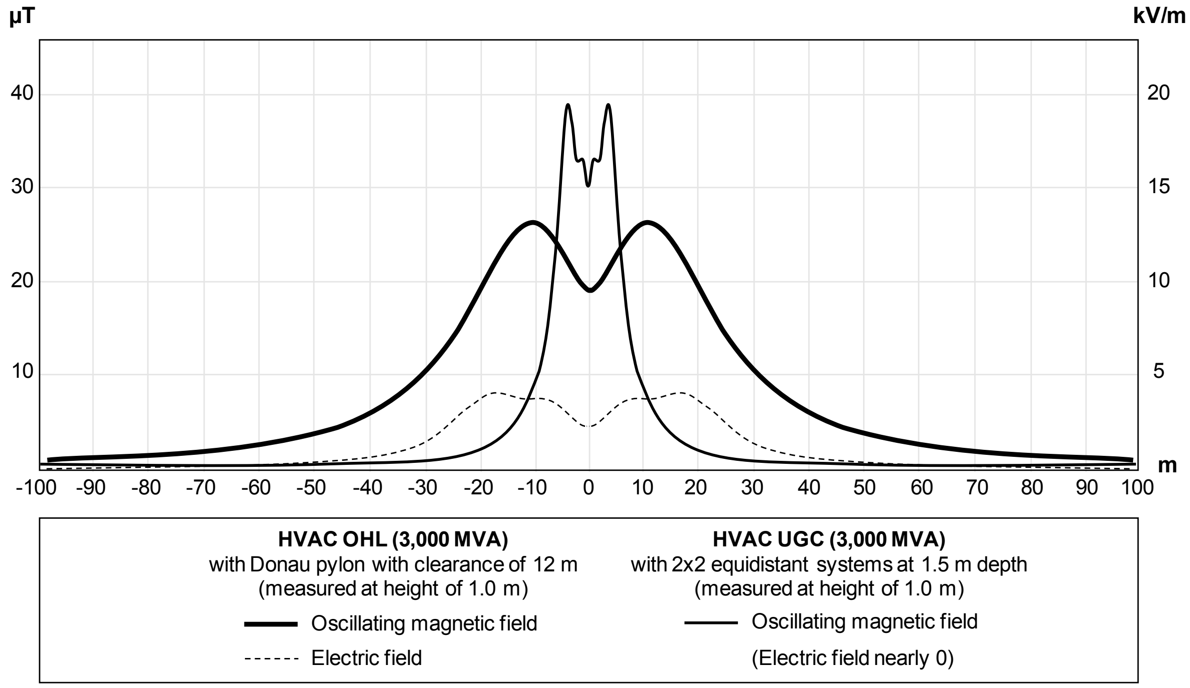

Figure 35: Electric (kV/m) and magnetic fields (µT) of different transmission line alternatives under normal operation. Own illustration based on Rathke & Hofmann (2011).

The magnetic field depends on the actual current on the line (SCENIHR, 2009, p. 37). However, even under exceptional N-1 operation the threshold would not be transcended (Rathke & Hofmann, 2011). The electric field is only illustrated for the OHL, as the burial of UGC systems shields almost all emissions. The threshold of 5 kV/m is also not exceeded. At a distance of 100 m from the transmission line the magnetic as well as the electric field are almost zero for both alternatives and operation modes. Some interviewees complained that EMF levels are not measured directly on the line but rather are calculated theoretically by the TSOs (interview with Markus Durrer, 14.10.2011). In homes that are not close to power transmission lines, residential wiring and appliances such as hair dryer, microwave oven, television, vacuum cleaner, iron, etc.[120] usually cause a total background field between 0.05 µT and 0.15 µT (Ratzel et al., 2010, p. 66). "EMF burden even increases with the use of cordless phones, mobile phones and wireless LAN. Nevertheless, citizens accept these burdens as they have a direct use from the devices" (interview with Elke Bruns, 27.09.2011). In homes close to power transmission lines the typical background values are higher. Public concern is especially high for HVAC OHLs whereas EMF from HVAC UGC systems is regarded as less dangerous. However, as figure 35 shows, the magnetic field from the HVAC UGC above the cable trench is even higher than directly under a comparable OHL system. This is because of the more compact arrangement and larger cross-sections of the cables. On the other side, the more compact arrangement in the ground makes the

[120] For detailed emissions per appliance please refer to Neitzke et al. (2006, pp. 4–16), Ratzel, et al. (2010, p. 67) or Rathke & Hofmann (2011, p. 256).

magnetic field drop more rapidly with increasing distance from the line compared to an OHL system (Neitzke et al., 2010, p. 195). Exposure decreases with the square of distance to the lines (SCENIHR, 2009, p. 37). In contrast to the oscillating magnetic field of HVAC systems, the field of HVDC systems is static and has the same characteristics as the earth magnetic field. The magnitude of the field is less than the earth magnetic field's magnitude of 48 µT for example in South Germany and therefore represents no significant health risks (Buijs et al., 2009). This is why no HVDC alternative is included in figure 35. Due to increasing public concerns and the continuous uncertainty in science regarding the potential negative health effects of EMF, several Member States have implemented precautionary thresholds that are significantly, i.e. up to 500-1,000 times lower than the EU values (see table 6 on the next page). These new thresholds have been mainly based on, or triggered by, continuous uncertainties regarding EMF, findings of recent epidemiologic studies or calls from independent research institutes and NGOs. Many of the thresholds however are recommendations to be implemented on a voluntarily basis and need to be interpreted carefully. At these thresholds, precautionary measures should in most cases only be considered if possible at reasonable or "very low cost" (ENTSO-E, 2012c, p. 2).

Regarding the proposed occupational thresholds, the European medical community raised its concerns in 2005 due to the potential negative impact on the use and development of certain magnetic resonance imaging activities. Furthermore, wider concerns existed across a number of industries regarding the Directive's requirement for complicated and costly risk assessments. Thus, in 2008 the European Commission delayed the mandatory implementation date of its originally in 2004 proposed and in 2008 amended Directive 2008/46/EC for occupational thresholds to April 2012, in order to be able to revise it again. An initial proposal for a revision was published by the Commission in 2011 (COM (2011) 348), which is currently being discussed and will delay the final implementation of the Directive further until April 2014. The Commission suggested a significant increase in the occupational thresholds to 1,000 µT and 20 kV/m regarding effects on the head and 13,320 µT respectively for effects on the whole body. Meanwhile in 2010, ICNIRP published a revision of its 1998 guidelines and increased the general public reference level for magnetic fields and 50 Hz from 100 µT to 200 µT (ICNIRP, 2010; interview with Rüdiger Matthes, 09.12.2011). Hence, despite rising public concerns regarding the potential negative impacts of EMF, respective reference level increases of more than 100% have recently been proposed. In particular, interviewed action group members could not understand the proposed increases and as such were very angry (e.g. interviews with Caroline Paterson (07.12.2011) or Hans U. Jakob (24.10.2011)). However, in its position paper, ENTSO-E considers the present threshold of 100 µT still as "adequate and suitable" (ENTSO-E, 2012c, p. 1).

Table 6: Deviating national general public thresholds for electric and magnetic fields of 50 Hz electricity transmission lines. Based on Swanson (2011).

Country	Electric field [kV/m]	Magnetic field [µT]	Comment
EU	**5**	**100**	
BE		0.2 / 10	Flemish regulation regarding the indoor pollution of buildings (quality target/intervention value)
CH		1	Per installation in sensitive use locations (rooms regularly occupied for significant period of time and children playgrounds). Exemptions possible, if all technically and operationally feasible and financially viable measures have been already taken
DE		0.3 / 10	Precautionary value in the Federal State of Bremen / Precautionary value of the building planning in the Federal State of North Rhine-Westphalia
DK		0.4	Indication value for investigation of possible ways to reduce magnetic field near dwellings, childcare institutions and schools
FI		0.4	Indication value for voluntary non-costly mitigation actions
HR	2	40	For new facilities
IE		16	For schools and dwellings
IT		0.2 / 3 / 10	Valid only in the regions Veneto, Emilia-Romagna and Tuscany and an exposure for more than four hours per day / Quality target for new lines and new homes / Attention value for exposure for more than four hours per day
NL		0.4	Sensitive objects such as dwellings, schools and crèches in which children are present for at least 14-18 hours a day
NO		0.4	Threshold that requires mandatory investigation of possible ways to reduce magnetic field for new lines and homes, kindergartens and schools. Mitigation measures must only be adopted if reasonable in terms of cost-benefit, safety, etc.
PL	1	48	For residential areas
SE		2 / 4	Precautionary value in Stockholm / Precautionary value for old lines
SL	0.5	10	For new facilities in protected areas, i.e. close to hospitals, health resorts, residential areas, tourism buildings, nurseries, schools, playgrounds, public parks, recreational areas and public centres which include services and restaurants

As a summary it can be stated that as long as research falls short of providing clear empirical results, people, who are living or are about to live close to a transmission line, will remain highly concerned (interview with Ralf Eggert, 13.10.2011). Currently, people are unable to cope with the sheer endless and in many cases contradicting available amount of information on EMF. Therefore, it is likely that opponents will pick those studies that confirm their concerns regardless of the respective scientific reach, as most people cannot evaluate the empirical significance and validity of certain studies. They often cite non peer-reviewed research (ENTSO-E, 2012c, p. 2). Inconsistent research results and controversy among scientists increase people's uncertainty even more and under uncertainty most people tend to be rather sceptical and concerned (Schweizer-Ries et al., 2010, pp. 16–17). The mere fact that many countries, even though mostly on a non-mandatory basis, have set own EMF thresholds that are far below the proposed ones by ICNIRP may have contributed to people's fears (interview with Christiane Pölzl-Viol, 28.09.2011). Furthermore, the ICNIRP thresholds apply only for new lines. Existing transmission systems that were installed decades ago in populated areas often exceed the set exposure limits (interview with Markus Durrer, 14.10.2011). It can be concluded that EMF is the most prominent reason for opposition to transmission lines as negative health impacts carry more weight than any other reason.

6.2.1.2 Falling ice

Another health and safety issue is falling ice. During winter, cold weather can cause ice to cover the conductors of a transmission line. The ice is either created through freezing rain, snow accretion or through freezing moist air (Kießling, 2003, p. 165). After a while, wind and rising temperatures cause pieces of ice to fall down to earth. Figure 36 illustrates such an example of fallen ice. Falling pieces can reach weights of several kilograms that can cause severe injuries to people walking close to or under a line. Damage of property like broken windshields of cars have also been reported.

Figure 36: Piece of fallen ice from a transmission line.

6.2.1.3 Toppled pylons and ruptured conductors

High winds and significant loads of ice or snow on the conductors or falling trees can cause transmission pylons to topple over and conductors to rupture. Especially transmission lines close to houses can carry a significant risk for residents. Next to the risk of high voltages for human beings, ruptured lines also can spark fires (see figure 37). In dry areas of Southern Europe this can cause forest fires (interview with Xavier Llorente, 05.12.2011). Many old transmission pylons have been manufactured with a certain type of steel[121] that can become fragile over time (Focus Online, 2005). In addition to this, new pylons cannot always withstand significant loads of ice, snow and wind. Toppling pylons are not unusual as the following examples show. In December 1999, hurricane 'Lothar' damaged approximately 600 pylons in Switzerland (Rösler, 2007, p. 26). In 2003, five pylons of a HVAC line toppled over due to strong winds (interview with Hans Kutil, 09.11.2011). Two years later in 2005, more than 80 pylons were damaged during a storm in Western Germany (N-tv online, 2005). More recently in 2007, hurricane 'Kyrill' caused several hundred pylons to fall over throughout Europe. In France, even a motorist was killed after a falling pylon hit her car (Spiegel Online, 2007).

Figure 37: Fallen pylon and house damage (left) as well as toppled pylon with ruptured line causing a fire (right).

6.2.1.4 Flashover

Farmers are also in jeopardy when working with their machinery on fields crossed by a transmission line (interview with Wolfgang Krüger, 21.09.2011). Specifically during summer, the conductors have their maximum sag. A typical 380 kV transmission line has a minimum clearance of 7.8 meters between conductors and the ground (Oswald, 2005, p. 30). With their heavy machinery and respective mountings farmers can easily reach heights of four meters and therefore come close to the conductors. While they concentrate on the work at ground level, there is the risk that they fail to recognize the line

[121] Thomas steel.

above them. In the worst case, a disruptive discharge and flashover can occur that can significantly harm the farmer's health. In order to prevent flashovers, Schrenk (2006) proposes keeping a safety distance of five meters between machinery and the conductor. Similar risks exist, if the field is covered with large protective sheets (e.g. plastic foil), which in windy situations can accidently be lifted up towards the conductors or if the field is being irrigated and wind blows the water up against the line (EPRI, 2001, p. 4.8; Schrenk, 2006).

6.2.2 Reduced quality of living

6.2.2.1 Visual impact

Visual impact of OHLs was the second most cited reason for public opposition during the interviews (e.g. interviews with Peer Schulze (06.10.2011), Pierre Lopez (07.10.2011) or Mike O'Carroll (20.09.2011)). In the previously mentioned French survey by Gouhier et al. (2009), 74% of the participating households considered the line as a visual nuisance. Similarly, in a Finnish survey, 64% of the respondents considered transmission lines to be negative landscape elements (Soini et al., 2011, p. 299). In Schweizer-Ries et al.'s (2010, p. 14) study of a German transmission line, affected residents regarded OHLs as having a significant impact on the landscape. Priestley & Evans (1996) and EPRI (2003a) confirmed the perceived negative impact on landscape aesthetics via a similar survey in the USA. Brush & Palmer (1979) asked 30 landscape architects and planners to evaluate photographs of different landscape view classes. Multiple regression analyses show that the number of electricity pylons has the greatest negative effect on the ratings. In his research on public perception of transmission lines, Gerlach (2004, p. 161) quotes an interviewee saying "[y]ou see, these wide open spaces are why we're here. If you have these big old monsters, you suddenly have an encroachment on your space. And it would destroy our peace of mind. It would destroy the quality of our life". It should be noted that vague public fears about health and safety aspects of a transmission line often get attached to visual appearance issues, making them highly laden with emotion (Priestley, 1984). Therefore, the size and design of an installation matter. For transmission lines this entails the width and height of pylons, the length of the line, the voltage carried, and the complexity of the system (Gerlach, 2004). Thus, opposition to a small low-voltage OHL distribution line is expected to be less than to a large 380 kV EHV OHL. In addition, people are likely to be less resistant to an UGC compared to an OHL system due to the non-existance of visual impact. There is no standard measurement scheme for visual impact (Brakelmann, 2004, p. 43). However, GFN et al. (2009, p. 119) provide four main categories of visual impact level: dominant, sub-dominant, marginal and insignificant, depending on the distance of a line to an observer and the portion of the observer's field of view the line takes up (figure 38 on the next page). Legislative mandatory compensation for visual impact of transmission lines does not exist as there is no individual right to an unspoilt view (interview with Klaus Rohmund, 07.09.2011).

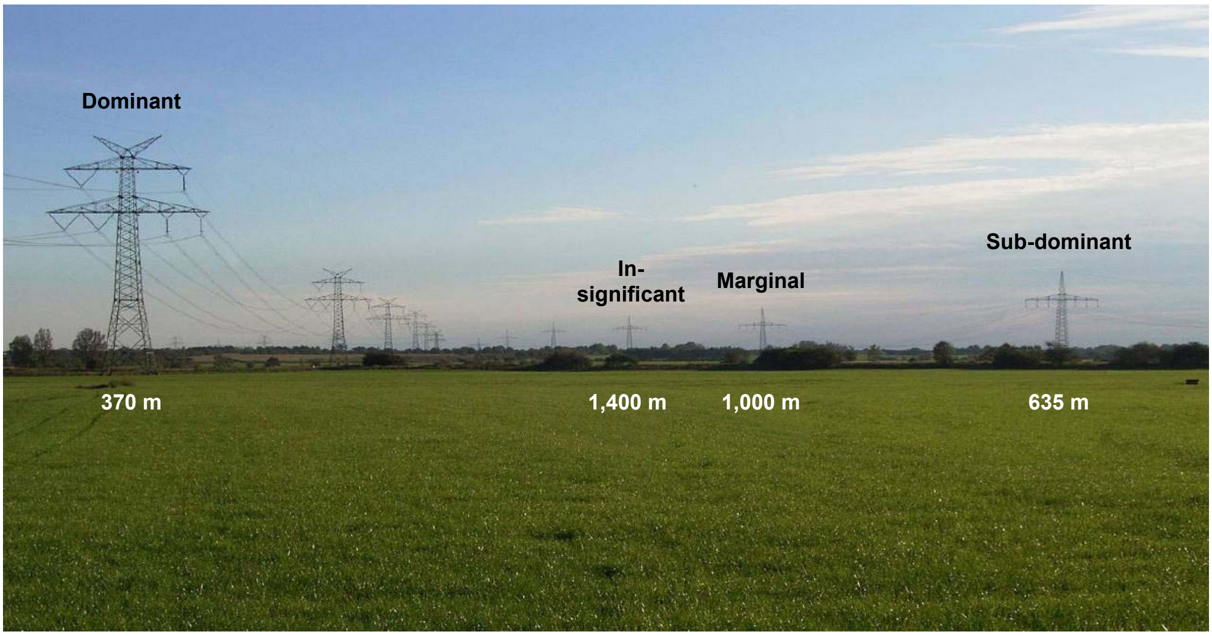

Figure 38: Exemplary categorization of visual impact at certain distances (GFN et al., 2009, p. 120).

Typical 380 kV transmission pylons are between 50 and 80 m high and about 45 m broad (Brakelmann, 2004, p. 6; Kießling, 2003, p. 104). Figure 39 compares such a pylon with other reference objects for better illustration.

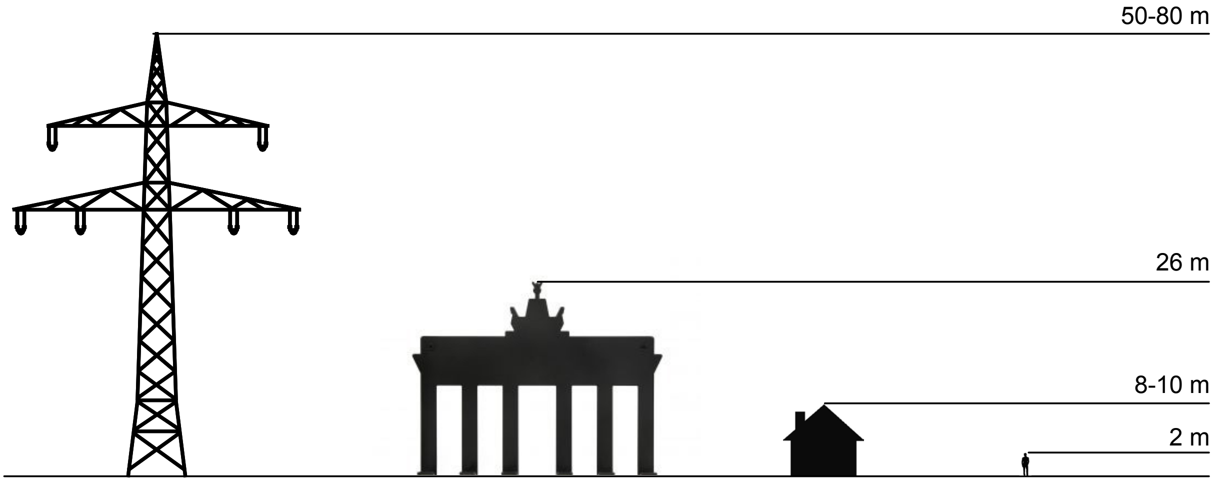

Figure 39: Height comparison of a typical 380 kV transmission pylon with certain reference objects.

Van Veelen (2011) argues that the construction of new power lines disrupts and destroys the relationship between a particular location and its habitants. In particular, he states that "the relationships between the functions, forms and meanings of the various landscape elements underpin the distinct identity of a particular location, the perception of its aesthetic beauty, and the sense of belonging it can generate". People regard OHLs as a visual intrusion, especially in rural and suburban landscapes (Priestley & Evans, 1996). This is because people in these areas identify more with the area in which they reside than others, who live in urban areas. Moreover, the topographical and morphological characteristics of a landscape influence the extent of OHL's visual impact (Brakelmann, 2004, p. 44). In contrast to flat areas, hilly landscapes are generally regarded as a more beautiful type of landscape. Furthermore, a transmission pylon on an elevation is especially exposed and has an extraordinary long range effect (Nohl, 1993, p. 27). Thus, an OHL in such scenery is seen as more negative than in a flat surrounding. As population density increases, the desire for uncluttered open space grows apace (Lantz & Flowers, 2010). However, untouched landscapes are becoming increasingly rare. Landscape is experienced individually with varying connotations to identity, history, etc. (Huber & Horbaty, 2010, p. 10). As already outlined in chapter 3.2.5, land valuation and heritage are major contextual factors influencing social acceptance of power transmission lines. Not only those who have ever since lived in an area but also people who have recently moved there specifically for the landscape, peace, and absence of industrial development, oppose new project developments in their area more frequently (Koskinen & Laitinen, 2010; Schmid & Schuppli, 2009). Today, many people feel disturbed by the existence of OHLs (interviews with Markus Troja, 27.09.2011 and Peer Schulze, 06.10.2011; Schweizer-Ries et al., 2010, p. 6). However, as Tikalsky & Willyard (2007) point out in their historical research on visual impact perception, this has not always been the case. Additionally, during the interviews for this work, some stakeholders fairly mentioned that it is almost impossible not to live close to any infrastructure installation such as a highway, railway, waste disposal, etc. these days (interviews with Guido Axmann, 27.09.2011 and Marcel Keiffenheim, 30.09.2011).

It can be summarized that OHLs reduce residents' quality of living. Similar to wind turbines, people may become opponents of an installation due to its perceived negative visual impact although they might not be in general against it (Wolsink, 2000, p. 51). Interestingly, in the course of this research work, a private group of people were identified in the United Kingdom, who even appreciate and welcome electricity pylons as they are fascinated about their design and appearance[122]. However, this remains an exception in Europe.

6.2.2.2 Noise

Noise caused by power transmission lines has been a growing concern in recent years (interviews with Pierre Lopez, 07.10.2011 and Markus Durrer, 14.10.2011; Kießling, 2003, p. 8). In a survey with 1,920 residents along French transmission lines, 79% of households considered the noise of the line to be a nuisance, 39% even stated that the noise is disturbing or insupportable and therefore reduces the quality of living (Gouhier et al., 2009, p. 10). In another survey, Fidell et al. (1978) asked 270 residents living close to a transmission line to evaluate the line's noise. 42% reported regularly hearing an acoustic sound from the line. The sound is caused by the so called corona phenomenon on OHL systems (Meah & Ula, 2007, p. 4) which is generated by discharges, i.e. the disruption of air

[122] Visit the website www.pylons.org of the Pylon Appreciation Society for more details.

dielectrics around the conductor when the electrical field reaches a critical surface gradient (Kießling, 2003, p. 36). The occurring sound is often described as ‘zooming’ (e.g. Klüser (2009)). While during dry and fair weather only little acoustic impact is present, audible noise occurs primarily during foul weather (Kießling, 2003, p. 40). Figure 40 illustrates the maximum noise levels that can be expected in the surroundings of a 380 kV HVAC OHL. The maximum acoustic impact directly below the line is about 38 dB(A). In certain but rare weather conditions levels of up to 60 dB(A) can be reached (GFN et al., 2009, p. 137) which is comparable to the noise level of a normal personal conversation in a range of 1 m.

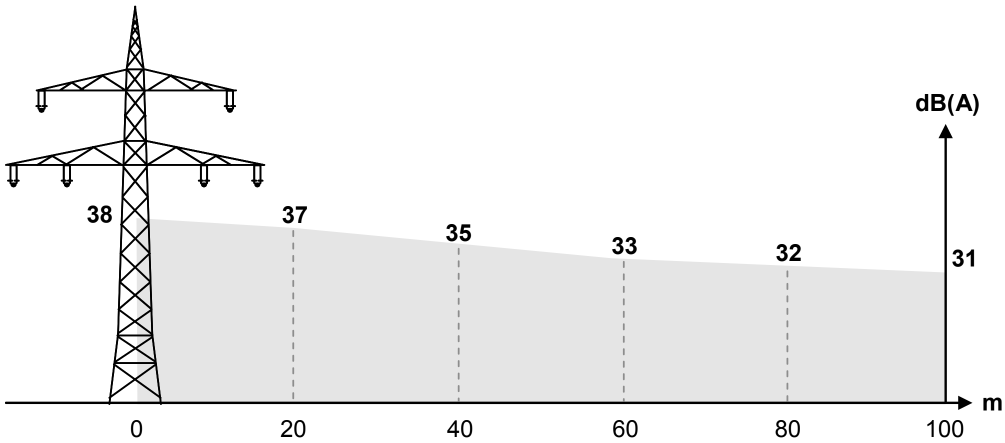

Figure 40: Expected maximum noise levels at a 380 kV transmission line due to corona effects. Own illustration based on Amprion (2011, p. 56).

The WHO recommends maximum noise levels of 30 dB(A) in bedrooms at night and 50 dB(A) in outdoor living areas during day-time (WHO, 1999, p. 47). During construction, sound levels of 55 dB(A) can be expected (May, 2005). Corona effects along HVDC OHLs do not exist due to the absence of alternating currents. However, HVDC converter stations produce noise levels of about 10 dB(A) at a distance of 350 m (Maruvada et al., 1982; Schmidt et al., 1996). The corona effect not only causes noise but also creates ozone. However, the emissions at a 380 kV transmission line lie at a yearly average of 0.1 µg/m³. In unfavourable weather conditions, values of up to 5.4 µg/m³ can be reached. Beyond approximately four meters from the line, no significant amount of ozone can be measured anymore (Runge et al., 2011, p. 59). Thus, the potential negative impacts of ozone on people’s health can be neglected (Ingenieurbüro Schöneiche, 2007, p. 255). The survey by EPRI (2001, p. 4.7) also revealed that the fear from ozone was the least reported issue in transmission line siting.

As a summary, the noise caused by OHLs does not present a significant negative impact on health as maximum thresholds are met. However, people feel disturbed and distracted by the acoustic sound and the fear of ozone which negatively influences their quality of living.

6.2.3 Economic unfairness

6.2.3.1 Devaluation of property and insufficient compensation

A major economic concern of transmission line opponents is the devaluation of their property caused by new line installations (e.g. interviews with Peer Schulze (06.10.2011), Jan Hildebrand (26.09.2011) or Marcel Keiffenheim (30.09.2011)). According to Fischel (2001, p. 144), the majority of opposing stakeholders are homeowners who are striving to "insure their major (and often only) asset against devaluation" caused by a nearby transmission line. Interviewees stated devaluations of 30-40% (interview with Hans Kutil, 09.11.2011) or 50-80% (interview with Ralf Messerschmidt, 07.09.2011). Kinnard (1967) was one of the first who undertook a comprehensive study regarding the effects of electric transmission lines on the value of residential property. Several of his analyzed studies provide indications of negative impacts on value. Colwell's (1990) work, which is not included in Kinnard's bibliography, also finds negative impacts on residential properties in close proximity to power lines. Many more research studies followed and revealed more concrete results. The main reasons for property devaluation are the fear of EMF, negative visual impact, disturbing sound and other safety issues (Delaney & Timmons, 1992, p. 320). Study results show decreased values of 1-6% at around 60 meters and 6-9% at a distance of 15 meters from the line (Des Rosiers, 2002; EPRI, 2003b; Sims & Dent, 2005, p. 667). Transmission pylons cause reductions of up to 20% at 15 m, which diminish to a loss of around 3% at 100 m (Bond & Hopkins, 2000, p. 57). Des Rosiers (2002) also states that devaluation of property fades away in the range between 100-150 m from the line. However, there are also scientific studies that do not support the finding that power lines and pylons have a significant negative impact on residential property values (e.g. Bond & Hopkins (2000) or Blinder (1979)). In their meta analysis, Kroll & Priestley (1992) find that around half of their reviewed studies do not show negative value effects. However, they regard these studies as being unreliable due to their perceptional concept methodology rather than being valuation based. Already back in 1988, Furby et al. (1988a, p. 81) recognized a clear discrepancy between expert and lay judgements regarding the effects of transmission lines on property value. The latter estimated a significantly high negative impact while the former often maintained that there is no effect at all. Residents feel bound to their property and selling would imply a significant loss of money up to a complete non-salability of the property (interview with Ralf Messerschmidt, 07.09.2011). This means although they might want to move away to 'escape' a new transmission line installation, they cannot do so without a financial burden. In other words, they are somehow trapped and cannot insure their asset against devaluation (Fischel, 2001, p. 144). Furthermore, people plan the sale of their homes as a sort of retirement provision which is put at risk if devaluation through a transmission line occurs (Schweizer-Ries et al., 2010, p. 15). In general, Vajjhala & Fischbeck (2007, p. 665) state that the higher the potential loss of property value is, the higher is a landowner's opposition.

Chapter 2.4.2.7 outlined the process on how TSOs secure land via permanent easements and temporary way-leaves. Affected residents regard the financial compensation offers made by the TSOs as by far not sufficient (Deutsche Umwelthilfe & Forum Netzintegration, 2010, p. 64). In most European countries, the compensation amounts are not defined by law. This is contrary to other linear infrastructure projects where compensation payments are defined by law along certain criteria like noise levels, etc. The difficulty with regard to transmission lines is that there is no standard measurement for visual impact (interview with Ivan Stone, 30.11.2011). As such, payments are mainly subject to the wills of the TSOs. In case TSOs grant compensation, they usually do so only to those people living directly next to the line corridor or where the pylons are located even directly on their property (interviews with Richard Hubmann, 02.11.2011 and Xavier Llorente, 05.12.2011). TSOs limit the amount of monetary compensation as they fear an inflationary trend of compensation claims from residents (Krumrey, 2011). It was mentioned that landowners whose land is 50-60 m next to an electricity line, but which is not crossed overhead, will regularly not receive such payments although their property might also face a reduction in value (interviews with Luc Meijer, 15.11.2011 and John Woods, 21.11.2011). Interviewees reported very different monetary offers. For instance, in Scotland an annual way-leave per pylon of approximatey 40 EUR was reported (interview with Caroline Paterson, 07.12.2011). A one-time payment between 15,000-17,000 EUR per pylon was offered in Ireland (interview with John Woods, 21.11.2011). This is comparably low to the annual compensation payments for a single wind turbine of 20,000 – 40,000 EUR (Uken, 2012b). Roland Berger (2011b, p. 197) cite a one-time compensation in Austria of 69,000 EUR per kilometre of line. Further interviewees mentioned a non-recurring compensation of 17,000 EUR in Austria (interview with Karl Zotter, 10.11.2011) and even a one-time payment of 135,000 EUR in Denmark (interview with Sigrid Bluhme, 04.11.2011). However, these figures should be interpreted carefully and should not be directly compared to each other as further details about proximity to the individual line and size of property are unknown. Interviewees reported that the compensation payments were in most cases negotiated on an individual basis between the TSO and the respective landowner (e.g. interview with Caroline Paterson (07.12.2011)). This intransparency and heterogeneity caused suspicion and distrust among local residents. Interestingly, individually offered and negotiated compensation is often perceived as a kind of bribery (Frey & Oberholzer-Gee, 1996; Kunreuther et al., 1990, p. 480; interview with Mats Weinesson, 05.12.2011).

6.2.3.2 Expropriation

Due to property devaluation and insufficient compensation offers, landowners often refuse to grant way-leaves or negotiate easements with the respective TSO. Usually, national legislation, e.g. the Energy Industry Act (EnWG) §45 in Germany, gives a TSO the right for expropriation after it has obtained the necessary permits. Any appeal against the right to expropriate can only be based on the grounds of insufficient compensation (ENTSO-E, 2011b, pp. 8–9). Often the legal payments that landowners receive in expropriation lawsuits are less than the voluntary monetary compensation offered by the TSO beforehand. An interviewee mentioned a case in Austria, where landowners refused to accept the TSO's one-time offer of 17,000 EUR. Later in the expropriation process the residents received only 7,000 EUR (interview with Karl Zotter, 10.11.2011). Landowners also reported hard bargaining by TSOs, citing "either you take what we offer, otherwise you'll get nothing" (interview with Mike O'Carroll, 20.09.2011). As such, local residents feel trapped and put under pressure, which makes them to fight the planned transmission line even more. The fear of expropriation causes a feeling of lack of control among the stakeholders and contributes to negative public perception of the line (EPRI, 2001, p. 4.6).

6.2.3.3 Negative impact on tourism

Another reason for transmission line opposition mentioned by interviewees was the potential negative impact on local tourism (e.g. interviews with Peer Schulze (06.10.2011), Pierre Lopez (07.10.2011) or John Woods (21.11.2011)). Especially regions, which lack infrastructure or are comparably underdeveloped, are often highly dependent on local tourism as one of the only economic perspectives (Schweizer-Ries et al., 2010, p. 15). They attract tourists with their unique and recreational landscape and scenery. Residents who profit from tourism fear that a planned power transmission line would destroy the beauty of the environment which is often their only tourist attraction. As such, people fear that the image of their community will suffer with the installation of a new line (Chung & Kim, 2009, p. 9). In rangy areas, high infrastructure installations like transmission lines also interfere with aerial sports such as paragliding and hang-gliding (Nakazawa, 2009). However, there is currently no scientific research available that investigates and quantifies the potential negative impact of power transmission line on the local tourism business. Research only exists for wind turbines (e.g. Aitchison, 2004; Kuehn, 2005; Lantz & Flowers, 2010). However, the available study results are inconclusive. Some scientists do not find negative impacts on tourism through wind turbines while others show more mixed results.

6.2.3.4 Lack of direct benefits and distributional unfairness

Next to mainly socio-economic benefits, projects also involve risks, costs and disadvantages to stakeholders and their surrounding environment (Vajjhala & Fischbeck, 2007). These costs and benefits are usually not balanced but distributed asymmetrically among stakeholders. This applies especially for transmission lines. In contrast to electricity distribution lines which supply residents with electricity locally, passing-by transmission lines are used for the mere transit of electricity to other regions. People oppose transmission lines as they on the one hand have to carry the burden and on the other hand cannot directly benefit from it. The benefit of increased security of supply is rather dispersed across broader society (Quah & Tan, 1998). Especially rural populations do not want their landscapes affected for the transport of electricity that serves urban demand (Furby et al., 1988b, p. 32;

Krumdieck, 2009). An illustrative example is the statement of a rural resident cited in a study by Casper & Wellstone (1981, p. 71): "Why do you have to avoid towns? Why not put it [the transmission line] right over all the towns. They're the ones that are getting the benefits". Resistance especially can be observed, if the new line is mainly utilized for transporting and selling electricity abroad to other countries (Schweizer-Ries et al., 2010). Residents are unwilling to accept that TSOs make profits with transmitting electricity at their cost. In other words, people argue that new transmission lines do not serve the interests of those affected by the transmission project, but rather generate profit for the organization which owns and operates the transmission system (Gerlach, 2004, p. 160; Heiskanen et al., 2008, p. 25; Schweizer-Ries et al., 2010, p. 20). As previously stated, new transmission lines are urgently required to ensure a secure supply of electricity, foster market liberalization and to integrate renewable energies. It has been scientifically confirmed that new power transmission lines increase overall social welfare (see e.g. Hobbs & Rijkers (2005), de Nooij (2011), Malaguzzi Valeri (2009) or Sauma & Oren (2005)). However, local affected people are often not aware of these overall positive effects for society. In contrast to other large infrastructure projects such as power plants, transmission lines generally do not imply a sustainable creation of new local jobs (Schweizer-Ries et al., 2010, p. 12). Furthermore, TSOs usually do not have to pay excise tax to the host municipality that is crossed by the transmission line. This is different for wind turbines where operators have to pay a certain tax share to the local community[123]. If the disadvantages dominate, stakeholders will perceive this imbalance as unfair and in case these stakeholders are not willing to carry this burden for the sake of society, they will oppose the project. They care about their direct individual benefits rather than about any socio-economic or macro-benefits. This is also confirmed by the fact that action groups often face problems to attract members from regions that are not directly located at the new planned transmission line route and therefore do not directly face the negative impact of the new installation. An overall trend can be observed that society has more and more desocialized over recent decades (interview with Klaus Rohmund, 07.09.2011).

6.2.3.5 Agricultural disadvantages

Next to residential landowners, also farmers often oppose planned power transmission lines (interviews with Enrico G. Orzes, 24.10.2011 and John Woods, 21.11.2011). The take of arable land through the installation of pylons and installation of access routes is not the only negative impact for agriculture. Construction during crop growth and harvesting season can have a detrimental effect on harvest yield. If the construction is conducted during lambing or calving season, this may have also a negative impact on livestock as it has only restricted access to large tracts of land. Land use might not only be restricted during construction but also during maintenance (Golder Associates & ECOFYS,

[123] For instance in Germany, the trade tax of the wind turbine operator is distributed as follows: 70% for the municipality where the turbine is located and 30% for the municipality that hosts the headquarters of the company (§ 29 GewStG).

2008, pp. 91–92). As mentioned earlier in the chapter on health and safety, OHLs also carry a significant risk for farmers working beneath them with heavy machinery. In terms of UGC systems, deep rooting plants and trees cannot be planted anymore within the exclusion zone. UGC trenches may be partially backfilled with material different to the original soil and cause a disruption to drainage on agricultural land (Deutsche Umwelthilfe & Forum Netzintegration, 2010, p. 72; Golder Associates & ECOFYS, 2008, p. 91). An increase of soil temperature by up to 10°C is possible at a depth of 0.5 m which influences plant growth negatively (Golder Associates & ECOFYS, 2008, p. 102). Reduced crop yields can also occur due to soil compaction (Gerlach, 2004, p. 154). Soja et al. (2003) found out that winter wheat yields were on average 7% less under OHLs than elsewhere. UGC systems are accused of drying-out the surrounding soil and slowing down the germination and growth of plants (Deutsche Umwelthilfe & Forum Netzintegration, 2010, p. 72; Gaul, 2010, p. 24). This is why farmers are often more favourable towards an OHL system solution, which clashes with the requests of other residents, who want the line to be put underground (interview with Karsten Bourwieg, 14.10.2011). However, Europacable[124] (2011b) claims that under normal load operations, UGC temperature would not lead to a drying of the surrounding soil. It is only under long-term full load conditions that the soil may heat up by approximately 2°C. As a further negative impact, Gerlach (2004, p. 154) mentions the impossibility or increased danger of using airplanes or helicopters in agriculture e.g. for spraying, etc. The use of irrigators is also limited for safety reasons (EPRI, 2001, p. 4.9). Moreover, in their study on a French transmission line, Gouhier et al. (2009) investigated the impact of a transmission line on the animals of farms. The interviewed farmers whose land was located close to the line reported significantly higher level of nervousness and more hesitation on the part of dairy cattle to enter the milking parlour. Furthermore, they claimed more inconsistent yields of milk from each cow. For other animals, a reduction in drinking, a higher loss of weight, a reduced rate of growth and increased aggression have been reported. The authors stated that their findings are consistent with a study by Blatin D. & Benetière (1998). In the current German discussion, farmers regard the monetary compensation they receive due to transmission lines crossing their farmland as insufficient (interview with Karsten Bourwieg, 14.10.2011). In Germany, the German Farmers' Association estimates non-recurring payments that range between 0.4 and 1.8 EUR per m² of crossing line corridor (Krumrey, 2011). Delhaes & Stratmann (2012) calculated a maximum one time compensation of 75,000 EUR per kilometre, which is around 1.1 EUR per m². For Switzerland, a one-time compensation payment of 830 EUR was offered by a TSO for the next 25 years per 100 m of line across farmland (interview with Hans U. Jakob, 24.10.2011). Compensation values are accused of being outdated and calculated at values of 50 years ago. As such, critics claim that much higher payments are needed (interview with Wolfgang Krüger, 21.09.2011). The taken land is often compensated through land elsewhere. However, the enclaves offered to farmers are sometimes located further away, which causes

[124] European Confederation of Associations of Manufacturers of Insulated Wires and Cables.

inconveniences and operational inefficiencies. If a transmission line is planned and permitted in an environmentally protected area, new environmental compensation areas have to be created. These areas are often 3-4 times larger than the area impacted by the transmission line. In most cases, arable land is typically used as compensation area, which steadily reduces the overall available farmland. Although farmers receive compensation, they lose their basis for agricultural business in the future (interview with Wolfgang Krüger, 21.09.2011).

6.2.4 Lack of transparency and communication

6.2.4.1 Insufficient justification of line need

When TSOs communicate their plans of building a new transmission line to local citizens, they first of all lay out the need for the line (interview with Xavier Llorente, 05.12.2011). According to Gerlach (2004, p. 154), "[o]pponents of transmission lines quickly learn that the first defence against the line project is to declare that is [sic!] not needed". TSOs internally determine the requirement for new transmission lines through comprehensive load flow analyses. This process is often very intransparent and detailed data and results are usually not published (Zane et al., 2012, p. 197). TSOs are accused of having an information monopoly (von Hirschhausen, 2011). TSOs argue that this non-publication is due to data protection for their industrial customers (Krumrey, 2011, p. 24). Even the stakeholder request to reveal the data to an independent third party under a non-disclosure agreement for assessment was rejected by a TSO (interview with Peer Schulze, 06.10.2011). Concealment causes the public to become suspicious about the TSO plans (interview with Gundula Hübner, 21.11.2011). For instance in Germany, the German Energy Agency DENA[125], together with the German TSOs, published line requirements in two joint grid studies. People especially criticize the lack of transparency in how the needs were identified and believe that the amount of identified lines is exaggerated (e.g. interviews with Marian Klobasa (12.10.2011), Marcel Keiffenheim (30.09.2011) or Peer Schulze (06.10.2011)). People have to believe the results as they do not know the details or cannot understand the calculations and models used to derive the needs (interview with Thorben Becker, 29.11.2011). However, NGOs have come to the TSOs' defence by stating that line justification and respective communication cannot be the sole responsibility of the TSOs (interview with Peer Schulze, 06.10.2011). Governments that commit TSOs to ensure security of electricity supply need to participate and support the TSOs as well (interview with Thomas Duveau, 30.09.2011; RGI, 2011c, p. 6; Sander, 2011, p. 25). One argument for the need of new lines is security of supply. Opponents do not always accept this reasoning. They state that power lines are only utilized by 40% on average (interview with John Woods, 21.11.2011). Nonetheless, this annual average neglects transmission peaks as well as N-1 security requirements. Citizens also argue that new lines can be avoided by modernizing, optimizing and upgrading of existing transmission lines with new

[125] Deutsche Energie Agentur.

technologies such as high temperature conductors. This is also referred to as NOVA[126] principle. TSOs sometimes justify new lines with the integration of RES. The public supports RES (Schweizer-Ries et al., 2010, p. 8) and thus is more likely to accept a line that serves the integration of RES (interview with Gundula Hübner, 21.11.2011). Especially since Fukushima, TSOs have obviously been more successful by using this argument (interview with Ortwin Renn, 14.10.2011). However, in the eyes of action groups, TSOs' argumentation for RES is not always the right argument. In several cases, action groups found out that also a bulk of conventional and especially unpopular nuclear power was planned to be transmitted[127] and blamed the TSO of not being honest (interview with Ralf Messerschmidt, 07.09.2011). This is because people are especially reluctant to support lines that are primarily intended to carry nuclear or other conventionally generated power. In other cases, transmission lines were planned for the export or mere transition of electricity through the country by connecting two neighbouring states (interviews with Hans U. Jakob, 24.10.2011, Enrico G. Orzes, 24.10.2011, Richard Hubmann, 02.11.2011 and Karl Zotter, 10.11.2011). In the eyes of opponents, such reasoning solely serves the business interests of the TSO and not the public's (Gerlach, 2004, p. 154; interview with Sigrid Bluhme, 04.11.2011; Sander, 2011, p. 22). Interestingly, during the interviews many cases were reported in which TSOs switched their argumentation during the planning process as they recognized that the argument used initially had not been accepted by the public (interviews with Richard Hubmann, 02.11.2011, Hans Kutil, 09.11.2011, Synnøve Kvamme, 17.11.2011 and John Woods, 21.11.2011). The integration of RES was then mainly used as new argument. The change in arguments created distrust. Critics of new transmission lines also regularly urge TSOs to apply more decentralized energy generation (interview with Martin Knoch, 06.10.2011), smart grids, storage, etc. in order to avoid new line installations. Opponents argue that with decentralized energy generation, transmission losses can be avoided, security of supply can be increased and the dependency on a few large utilities can be broken (interview with Xavier Llorente, 05.12.2011). However, stakeholders are often not informed about the recent unbundling of utilities and TSOs as previously described in chapter 2.3.1.1. Today, TSOs do not have the possibility anymore to foster e.g. more decentralized energy generation. They have to take generation and consumption as externalities and have to ensure security of supply. Finally, it should be mentioned that there are many action groups that accept the general need for new transmission lines (interview with Klaus Rohmund, 07.09.2011; Schweizer-Ries et al., 2010). To emphasize this, they actively declare that they are not against a line per se, but want a more transparent and justified solution than that proposed by the respective TSO (interviews with Thomas Duveau, 20.09.2011 and Caroline Paterson, 07.12.2011).

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[126] Originates from the German ‚**N**etz **o**ptimieren vor **v**erstärken vor **a**usbauen' (grid optimization before upgrade before extension).

[127] A 100% guarantee to solely transmit renewable energy through a line can anyhow not be guaranteed in an AC network (interviews with Thomas Duveau, 20.09.2011 and Jan Hildebrandt, 26.09.2011).

6.2.4.2 Insufficient, inaccurate and late information

Literature review and interviewee reports show that TSOs provided wrong or inaccurate information during transmission line planning (Zane et al., 2012, pp. 191–192). For instance, misleading pylon heights were given in the planning documents (interview with Hans U. Jakob, 24.10.2011) as well as imprecise planning maps (interview with Peer Schulze, 06.10.2011). Moreover, the provided details about planned line routes deviated between the internet and information given in personal meetings (interview with Padraig O'Reilly, 02.12.2011). In several cases the understatement of visual impact in the TSOs' photomontages was reported (interviews with Hans Kutil, 09.11.2011, John Woods, 21.11.2011 and Padraig O'Reilly, 02.12.2011). Landowners felt betrayed when they first gained knowledge of a nearby planned transmission line via a newspaper report or through the grapevine rather than having been informed by the TSO itself directly and early on (interview with Pierre Lopez, 07.10.2011). It was also reported that TSOs sent out invitations to consultation meetings too late or not to all relevant affected residents (interview with Hans Kutil, 09.11.2011). In their study, Schweizer-Ries et al. (2010) found that the affected stakeholders in general require more information on transmission technologies and the planning process itself. In addition, they want to learn more about participation possibilities and litigation options. Information and data provided by the TSOs is often too technical and detailed so that the public cannot understand it. Opponents accuse TSOs of complicating information on purpose to keep critics away. Interview partners in Sander's (2011, p. 47) research study described how TSOs actively held back information or showed a certain 'you won't be able to understand this, anyway' attitude, brushing-off questions and alternative suggestions from the public. People quickly become frustrated with the technical and patronizing language (Baxter et al., 1999, p. 512). A statement of objection from a German action group illustrates this problem with the words "we have to tell you that we cannot comment your proposed figures as we do not understand them" (Action group 'Pro Erdkabel Bad Gandersheim/Kreiensen', 2011). Another criticizes that "unfortunately the information is not provided in a manner that interested people are able to understand them" (Action group 'Delligsen in der Hilsmulde e.V.', 2011). Planning documents regularly comprise several folders and thousands of pages with detailed technical information. For concerned people the provision of information in such a way is not appropriate for consultation. Documents are often laid out only for a very limited number of days at the local municipality or authority that itself has limited opening hours during a working week. Action groups often help themselves and split the task of screening the documents among their members (interview with Guido Franke, 04.10.2011). Interviewees have complained that members of staff in municipalities failed to provide guidance through the documents as well as failed to help concerned citizens to find the right information and understand it (interview with Peer Schulze, 06.10.2011). Even if documents are published on the internet, a detailed screening of thousands of pages in order to find the relevant and appropriate information requires extraordinary efforts and time.

6.2.4.3 Intransparent decision making

Citizens regularly feel confronted with accomplished facts when TSOs present a planned transmission line with its technical design and the proposed routing for the first time. Opponents criticize that there is no transparency on how a proposal was derived and to what extent alternatives have been assessed as well (interviews with Synnøve Kvamme, 17.11.2011 and Philipp Godron, 24.11.2011). They are told that the outlined design and route is the best or most economically viable option without being able to check or challenge it. Most transmission lines are still planned as OHL solutions. Information provided by the TSOs regarding the costs of alternative UGC solutions varies significantly, often remains unproven and in some cases has turned out to be even wrong (Sander, 2011, p. 23). Furthermore, in many cases it remains unclear to what extent a TSO has considered people's objections, concerns and proposals in the final planning and decision making phase (Creighton, 2004, p. 391).

6.2.4.4 Inappropriate appearance

The appearance and behaviour of TSO staff during interactions with concerned people in consultations, hearings or conversations has been rated as inappropriate by many interviewees and increased opposition even more. Arrogant appearance by TSO staff was mentioned in the majority of conducted interviews with action group representatives (e.g. interviews with Padraig O'Reilly (02.12.2011), Synnøve Kvamme (17.11.2011), John Woods (21.11.2011) or Xavier Llorente (05.12.2011)). Interviewees further mentioned a "dictatorial approach" (interview with Padraig O'Reilly, 02.12.2011), "treating people as totally stupid" (interview with Hans U. Jakob, 24.10.2011), "laughing" (interview with Hans U. Jakob, 24.10.2011) or even "shouting at opponents" (interview with Mats Weinesson, 05.12.2011) during consultation meetings. In Krumrey's (2011) work, TSOs were even described as arriving as with Russian tanks. Furthermore, concerned landowners were put in front of accomplished facts with statements like "it cannot be changed anymore" (interview with Peer Schulze, 06.10.2011) and the general attitude of TSO members in meetings was described by an interviewee as being "confrontational" (interview with Mike O'Carroll, 20.09.2011). TSO staff were said to be very competent technically but lacked competence in conflict management, empathy or general communication skills (interview with Heinz-Jürgen Siegel, 05.10.2011). An interviewee put it as "they are engineers and no diplomats" (interview with Peer Schulze, 06.10.2011).

However, it should be mentioned that interviewees also emphasized that the above outlined accusations do not apply for every member of staff they had come into contact with (e.g. interviews with Caroline Paterson (07.12.2011) or Karl Zotter (10.11.2011)).

6.2.4.5 Expert dilemma

In many cases, action groups doubt the reasoning or information provided by TSOs. This is why they regularly conduct their own research on power transmission technologies and the potential negative effects. They try to educate themselves by visiting transmission system suppliers and manufacturers, conduct site visits, visit conferences, talk to transmission experts or just simply search the internet. This self-education can carry the risk that opponents will selectively search for information that supports their position. This can become problematic as „[n]aturally, what people know about a particular issue affects their attitudes" (McGuire, 1969). If action groups rely only on selective information they will be biased[128]. As mentioned earlier in the chapter on potential negative health effects of EMF, there is at least an equal amount of research studies that could and could not find a statistically significant association between EMF and cancer. Interviews revealed that action groups sometimes raise money and receive donations to commission their own experts and fund independent assessments for the planned transmission line, as they do not trust the ones undertaken by the TSOs (interview with Karl Zotter, 10.11.2011). They collect their own data in order to buttress their position and satisfy their objectives (Kunreuther et al., 1993, p. 303). A specific case in Ireland was reported in which even five different assessments and reports were conducted (interview with Padraig O'Reilly, 02.12.2011). There are a few consultants, private and academic institutions – mainly in Germany – that offer such independent assessments (interviews with Richard Hubmann, 02.11.2011 and Karl Zotter, 10.11.2011). For instance, additional analyses were drawn up for lines in Austria by Prof. Noack (Noack, 2010), in Switzerland by Prof. Brakelmann (Brakelmann, 2009), in Ireland by ASKON Consulting (ASKON Consulting Group, 2008) and in Germany by Prof. Oswald (Oswald, 2005, 2007) and Prof. Jarass (Jarass, 2010). They analyzed the general need for the line, the most appropriate transmission line design and route, potential negative impacts and costs. However, with respect to uncertainties, risks and insecurities associated with the subject as well as limited data, there are often discrepancies in the assessment results leading to an expert dilemma between the TSO's and the action group's analysis (interviews with Frank Ulmer, 27.09.2011 and Peer Schulze, 06.10.2011). Study results often deviate as detailed technical data is limited and independent institutions have to make certain assumptions and estimates in their calculations which are then challenged by the TSOs again (Kunreuther et al., 1993, p. 303). Expert dilemmas occur especially in discussions on transmission line design – in particular if the line should be built as an OHL or UGC system. Action groups usually want to have the line buried as this avoids visual and other potential negative impacts. TSOs are restricted to implement their projects at economically reasonable cost and thus mainly argue for the cheaper OHL design. Discussions arise between the parties on the cost of the different options and especially on the underlying assumptions and calculation methods. Every party claims that its own report is correct and condemns the other's work. Even if the TSO uses an independent institution to

[128] TSOs will be biased accordingly if they also rely on selective information only.

conduct an assessment, opponents mistrust it. Action groups accuse these institutions of creating results in favour of the TSOs as they are hoping for follow up business. Furthermore, independent institutions are often blamed of not being independent because they regularly receive payments or donations by TSOs or because former TSO employees are now working for them (interviews with Mike O'Carroll, 20.09.2011, Guido Franke, 04.10.2011 and Hans U. Jakob, 24.10.2011). The development of assessments and counter assessments as well as the lengthy and sometimes even judicial discussions on them regularly cause significant delays in the planning phase of transmission line projects.

6.2.5 Lack of public participation

6.2.5.1 Lack of involvement

Opponents claim that they were not sufficiently, too lately or not sustainably enough involved in the planning process of transmission line projects (e.g. interviews with Heinz-Jürgen Siegel (05.10.2011) or Andreas Fusser (21.09.2011)). In case an infrastructure project is to be implemented nearby, which carries significant risks that people cannot control, they feel helpless (Gerlach, 2004). Especially when local concerns are ignored, it creates the feeling that such projects are enforced top-down (Heiskanen et al., 2008, p. 61). In an analysis of a US transmission line project, Priestley (1983) states that "[w]hat the protesters seemed to be most concerned about was not the powerline's tangible effects, but its symbolic effects as an intrusion into their turf". They strongly identified themselves with the land. In their eyes the transmission line project constitutes both, a real and a symbolic violation of it (Furby et al., 1988b, p. 33). In a similar assessment by Casper & Wellstone (1981, pp. 303–304), a farmer is cited as saying "[w]e have been feeling this control over our lives coming". Another opponent put it as "we've been invaded!" (Wasserman, 1979). People interpret this loss of control as a threat to their freedom (Gerlach, 2004, p. 161). Thus, people want to be involved early, participate in the decision making process and have their say (Zane et al., 2012, p. 197). Slovic (1993, p. 675) describes such wishful thinking as 'participatory democracy'. Gross (2007) points out that "perceptions of fairness do influence how people perceive the legitimacy of the outcome, and that a fairer process will increase acceptance". Several consultations are required by law but they are mainly limited to the authorization stage of a transmission line project after the TSO has submitted its project application. This has been criticized by opponents who want to be involved already prior to the application in order to be able to influence the route or transmission line design for instance (interview with Peer Schulze, 06.10.2011). An interviewee put it as "once the application is handed in, we can only change the line route for a few hundred meters… that's all" (interview with Karl Zotter, 10.11.2011). Affected stakeholders call for participation and not just consultation. Furthermore, authorities in charge sometimes have trouble to successfully inform the public of consultation possibilities. In some cases, TSOs offered further opportunities for involvement on a voluntarily basis. Although this is highly appreciated by the public, opponents criticize that often not all relevant stakeholders are invited or the opportunities are scheduled during holidays when the majority of the people are away on vacation (interviews with Peer Schulze, 06.10.2011 and Karl Zotter, 10.11.2011). Moreover, time provided for consultation and participation is often very limited. Opponents feel that they are not given enough time to sufficiently gather information on the topic in order to be able to comment accordingly within the given timeframe (interview with Synnøve Kvamme, 17.11.2011).

6.2.5.2 One-way communication

In the interviews, transmission line opponents criticized that interaction with TSOs resembled one-way communication. People perceived the meetings with TSO staff as information events rather than constructive dialogues (e.g. interviews with Mats Weinesson (05.12.2011) or Peer Schulze (06.10.2011)). TSO staff was reported as having continuously been in 'broadcasting mode' (interview with Padraig O'Reilly, 02.12.2011). According to van der Welle et al. (2011, p. 62), stakeholders and the general public are simply informed by the project developer. Stakeholders are perceived as receivers of information and neither as senders of information on an equal level with the project developer, nor as co-owners of decisions. Thus, action group representatives request a more cooperative discourse in meetings with TSO employees (interview with Markus Troja, 27.09.2011). Some critics also mentioned a lack of availability of TSO contact persons as well as poor responsiveness. In particular, concerned people could not reach TSO members by phone or did not get a reply to their written requests at all or not within a reasonable time frame (interviews with Sigrid Bluhme, 04.11.2011 and Padraig O'Reilly, 02.12.2011).

6.2.5.3 Lack of bindingness

When TSOs do involve affected people and ask them for their opinions, concerns and requests, opponents claim sometimes that none of this is binding (Baxter et al., 1999, p. 517; UfU, 2010). One of the surest ways to destroy trust is to make stakeholders believe that they can participate in the decision making, and then ignore them (Trudell & Tikalsky, 1997). An interviewee who wants to remain anonymous put it with the words "they hear us, but they do not listen" and another mentioned that the TSO "never took into account the suggestions" (interview with Xavier Llorente, 05.12.2011). TSOs are accused of pretending stakeholder involvement, but in reality do not consider the submitted objections[129]. People claim that there is no transparency regarding what comments and concerns have been taken into account. Moreover, clear argumentation and reasoning is not often given as to why certain objections have not been considered. Selle (2007, p. 66) describes this as "participation without effect".

[129] It should be noted that ‚objection' in this sense are concerns that have arisen in meetings organized by the TSO itself and should not be mixed with the ‚objections' submitted to authorities in the course of official regulatory consultations and hearings.

6.2.5.4 Inflexibility

Opponents also mentioned that TSOs often presented them a fait accompli (e.g. interviews with Karl Zotter (10.11.2011), Markus Troja (27.09.2011) or Hans U. Jakob (24.10.2011)). They accused the TSOs of following a 'Decide-Announce-Defend' strategy and persisting with their initial plans (Sander, 2011). Under a 'Decide-Announce-Defend' approach the developer proposes a project plan and generally defends it against any opposition (Cotton & Devine-Wright, 2012). According to Kunreuther et al. (1993, p. 302), such an approach in siting of large infrastructure projects was common for project developers through the 1970s and more or less widely accepted by the public. However, as already outlined earlier in this work, people's attitudes have changed. In the case of transmission line planning, TSOs have in some cases shown no flexibility and willingness to change anything to the proposed plans, e.g. the used transmission technology, line design or line route. Alternatives are often not evaluated (ENTSO-E, 2012a, p. 166). Critics proposed that TSOs should not decide too much upfront without having involved the affected residents (interviews with Markus Troja, 27.09.2011 and Hans U. Jakob, 24.10.2011).

6.2.6 Environmental impact

Large infrastructure projects usually carry a certain negative impact on the environment – either on the flora, the fauna or both. Concerns over and opposition to developments can therefore also be motivated by people who have a strong environmental awareness (Tsoutsos, 2002; Vajjhala & Fischbeck, 2007, p. 664). Environmental concern is often described as environmental justice. It refers to the "cultural norms and values, rules, regulations, behaviours, policies, and decisions that support sustainable communities where people can interact with confidence that their environment is safe, nurturing, and productive" (Visgilio & Whitelaw, 2003, p. 4). Environmental concern can exist on a national, as well as on a local level. An example of the former is concern about climate change and an example of the latter is worrying about the protection of a local habitat. Opposing stakeholders in this sense are environmentally aware individuals or environmental action groups. They argue for ecosystem preservation and the conservation of nature and natural resources (Pol et al., 2006, p. 48). Reports in recent years about rapidly melting glaciers and extreme weather conditions have increasingly sensitized people in regards to climate change. This was confirmed by a European survey in 2007 showing that 57% of European citizens were concerned about climate change compared to 45% back in 2004 (EC DG Environment, 2008, p. 8). Furthermore, being 'green' has become en vogue in society, attracting more and more people who care about their environment and oppose developments that might harm it. Citizens of Western European Member States in particular have become more sensitive to environmental impacts. However, as stated in SEC (2011) 1233, this has been increasingly the case in new Member States over the last years as well. In the following subchapters the identified details on the concerns regarding flora and fauna are outlined.

6.2.6.1 Flora

The installation of transmission lines usually comes with an inevitable impact on the environment and especially on the flora. The land take of transmission lines depends on the transmission technology itself, the transmission capacity and the individual design. Furthermore, land consumption is higher during construction than operation later on. The following example compares a typical two circuit 380 kV HVAC OHL carrying around 3,000 MVA with an equivalent HVAC UGC solution. To reach the equivalent transmission capacity of the two OHL circuits, four cable systems which consist of a total of 12 cables are usually installed. During the construction phase, the OHL requires a corridor of about 100 m compared to 45 m of the HVAC UGC alternative, including roads required for the construction equipment such as cranes or diggers (see figure 41). Moreover, access roads to the transmission line routes have to be built to allow heavy machinery to reach the construction site. This leads to soil compression and in some cases to additional deforestation (Rathke & Hofmann, 2011, pp. 36–37).

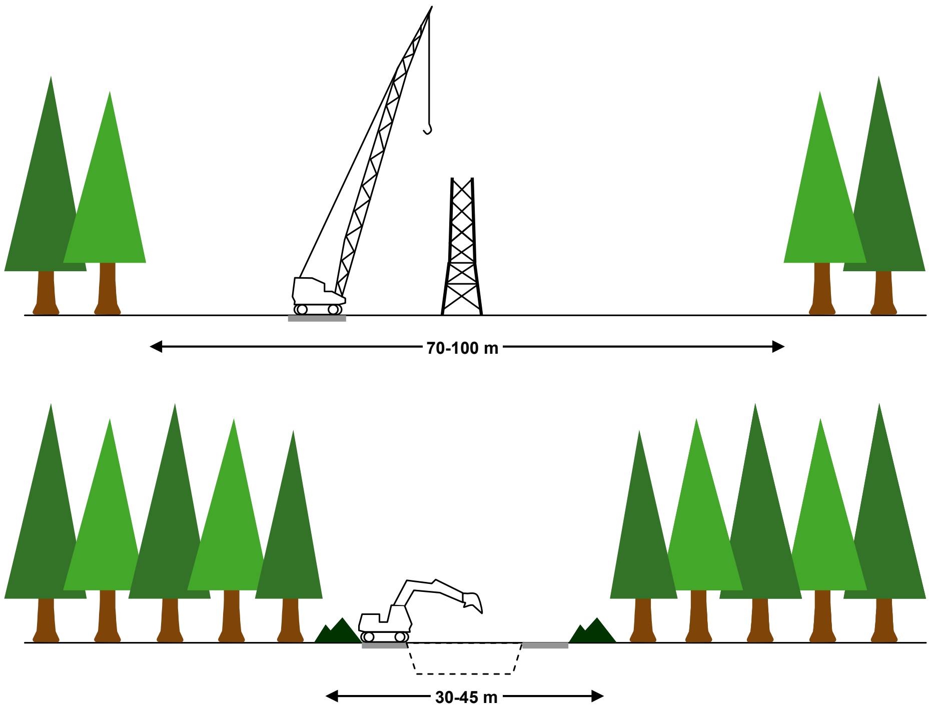

Figure 41: Typical land take of a HVAC OHL (top) and UGC system (bottom) during construction phase.

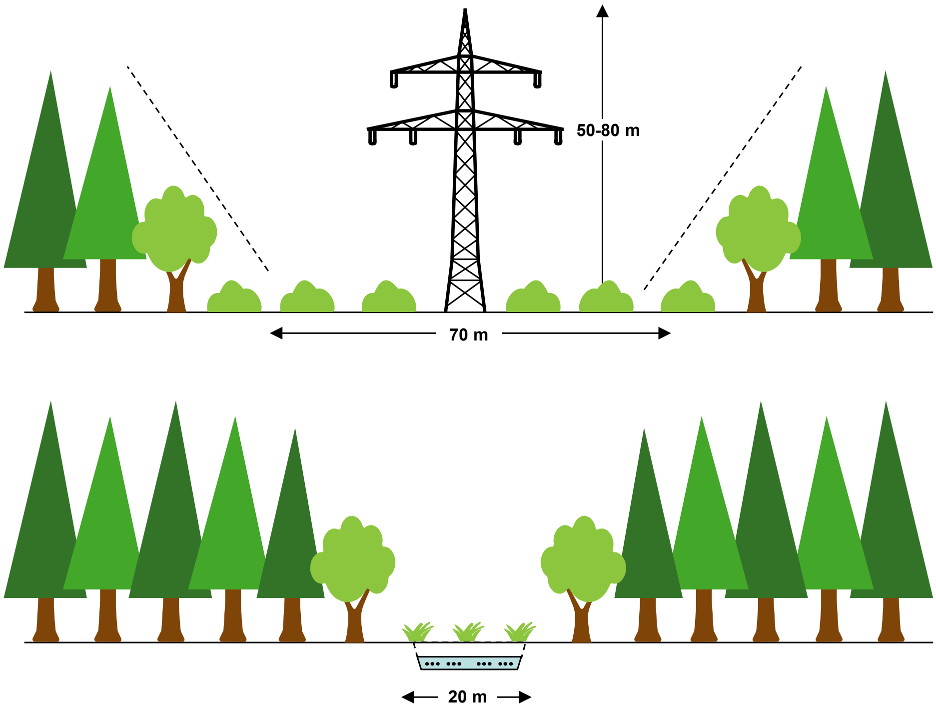

Figure 42: Right-of-way of a HVAC OHL (top) and UGC system (bottom) during operation phase.

As illustrated in figure 42 above, during the operation phase the corridors narrow down to about 70 m for HVAC OHLs and around 20 m for HVAC UGCs as part of the corridors can be vegetated (Europacable, 2009). For OHLs the top of the trees under and at the edge of the corridor must keep a certain minimal distance to the lines for safety reasons. Continuous rights-of-way management is therefore needed (Röderstein, 2009, p. 100). Instead of manual trimming, TSOs sometimes favour the use of selective herbicides to limit and suppress the growth of vegetation (DeCicco et al., 1992, p. 32; Geier et al., 1992, p. 209). However, environmentalists are concerned that the use of herbicides might provoke potential damages to the ecosystem (EPRI, 2001, p. 4.11). With a cable solution, no deeply rooted plants or trees are allowed directly over the cable course and about five meters on each side in order to avoid any damages to the system (ENTSO-E & Europacable, 2011, p. 15). If HVDC lines are installed instead of HVAC lines, the corridor width narrows, both for the OHL and UGC system. This is because HVDC is bipolar compared to the three phase HVAC transmission technology leading to a lesser number of needed cables and lines. Next to the impact of the line route itself, UGC systems require transition stations at both ends of the line to connect to the surrounding OHL system (see figure 43 on the next page). The size of these stations is approximately half the size of a soccer field (swissgrid ag, 2011). Furthermore, HVDC transmission technologies require large converter stations at the ends of the line with each taking up about 70 m²/MW[130] of land (Golder Associates & ECOFYS, 2008, p. 76) as illustrated in figure 44 on the next page. Such land take sometimes results in deforestation and other negative impacts on the environment.

[130] In case of compact VSC HVDC technology.

Figure 43: Transition station to connect an OHL with an UGC system.

Figure 44: HVDC converter station. Picture: Siemens.

In earlier years, leaded paint was used to protect transmission pylons from rust. During maintenance, repainting spoiled the ground around pylons (Stolz, 1994). The exact impact on the soil and as a consequence on agriculture has not been determined yet. Since the 70’s only lead free anti-corrosive protection is allowed (Rögener, 2011). As already mentioned in the chapter on negative impacts on agriculture, UGC systems are accused of drying out the surrounding soil. Overall, it can be said that impact on flora is considerably less for OHL than for UGC systems. UGCs present a more significant threat to flora in the sense that the full length of the cable trench impacts the environment (Golder Associates & ECOFYS, 2008, p. 102). Most flora generally recovers within two years on lowland pasture. However, flora is often much more sensitive in other areas such as wetlands and heathland and thus may even fail to recover fully (Jacobs Babtie, 2005).

Interestingly, interviewees cared less for possible negative environmental impacts than for issues that impacted them directly such as EMF or noise. Many complained that national and European legislation in general protects the environment better than human beings (interviews with Klaus Rohmund, 07.09.2011 and Karl Zotter, 10.11.2011). More precisely this means that transmission line routes often have to be built close to residents in order to avoid the crossing of environmentally protected areas.

6.2.6.2 Fauna

Environmentalists show a special aversion to projects being built in wildlife conservation areas or other sites of special environmental interest regarding animals. Transmission line corridors cause habitat fragmentation especially in previously undisturbed areas (EPRI, 2001, p. 4.11). Animals are especially endangered during the construction of transmission lines. Deforestation often entails the dissection of their habitats (Beers et al., 2011, p. 37; Deutsche Umwelthilfe & Forum Netzintegration, 2010, p. 60). Next to the risk of accidental killing of animals when way-leaves are cleared, the noise of construction may disturb them, especially during the breeding and paring season (Golder Associates & ECOFYS, 2008, p. 102). Rathke & Hofmann (2011, p. 61) list those protected animals that are especially endangered by the installation of an UGC and OHL system. Whereas UGCs provoke only risks to animals during the construction, OHL systems have also potential negative effects on animals during operation. The main risk is birds striking the lines (Kießling, 2003, p. 101)[131]. In particular, they collide with the comparable thin earth wire at the top (Haas, 2008; interview with Dieter Haas, 20.09.2011). This is because birds usually recognize the conductor wires and ascent to fly over them and then hit the earth wire. Collisions with the pylons themselves occur rarely and mainly in foggy weather or at dawn (Rathke & Hofmann, 2011, p. 65). In his study on the Netherlands, Koops (1987) estimates 160-220 mortalities per line km and year. Taking the mean and given the 305,000 km of transmission lines in Europe (ENTSO-E, 2011c, p. 2) that would add up to a total of around 58 million dead birds per year. Next to strikes, population reductions of protected bird species are reported to be caused by habitat changes induced by transmission line installations (Silva et al., 2010). Insects also face potential risks from transmission lines. Negative impacts through the electrical fields are mentioned especially on honeybees[132] (see e.g. studies by Greenberg et al. (1981), Bindokas & Greenberg (1984) or Bindokas et al. (1988)). Moreover, Begall et al. (2008) and Burda et al. (2009) demonstrate that the magnetic alignment[133] of grazing and resting cattle and deer is disturbed by the magnetic field of power transmission lines. Fernie & Reynolds (2005) reviewed studies that have investigated the effects of EMF on birds. According to them, most studies indicate that EMF exposure of birds generally changes their behaviour, reproductive success, growth and development, physiology and endocrinology, and oxidative stress under EMF conditions. The negative impacts of EMF on milk cattle have already been described above in chapter 6.2.3.5 regarding agricultural disadvantages.

6.2.7 Distrust

Through the course of the conducted interviews a great amount of distrust on the part of opponents towards TSOs was recognized (e.g. interviews with Harry van der Weij (5.12.2011) or Caroline Paterson (07.12.2011)). In the eyes of most people TSOs have earned a bad reputation through their behaviour in the course of current or recent transmission line projects. An interviewee framed it as "it takes ages to build up a good reputation, but it takes only a few minutes to destroy it" (interview with Andreas Fusser, 21.09.2011). Once with a bad image, TSOs face the problem of a negative preceding

[131] In contrast to medium and low-voltage transmission lines, electric shocks are not a risk for high-voltage transmission lines due to its technical design and especially the large span between the conductors and the type of isolators used (NABU, 2002, p. 8). HVDC lines to not carry this risk at all (Deutsche Umwelthilfe & Forum Netzintegration, 2010, p. 73; interview with Dieter Haas, 20.09.2011; NABU, 2002, p. 8).

[132] For example increased motor activity with a transient increase in hive temperature, abnormal propolization, impaired hive weight gain, queen loss and abnormal production of queen cells, decreased sealed brood or poor winter survival.

[133] Resting and grazing cattle and deer usually tend to align their body axes in the geomagnetic North-South direction.

reputation in the next project (interview with Markus Troja, 27.09.2011). Local residents then start with an adverse attitude against the TSO from the very beginning – often without any concrete reasoning. Thus, citizens become suspicious and doubt the TSO's comments or information. Any cooperation or involvement of citizens in the planning process is then often not possible anymore without major conflict and therefore becomes nearly ineffective.

Moreover, to several people the mere fact that a TSO has recently been privatized evokes the image of being an organization that just seeks profit at the expense of society. Opponents accused TSOs of being too narrowly focused on the most efficient and economic way of making business rather than also taking citizens' concerns into account (interview with Harry van der Weij, 05.12.2011). In particular, "the monetary motives of power companies may be viewed as being in conflict of interest with health and environmental objectives, and these monetary motives are becoming more visible with deregulation and the opening up of the energy market" (EPRI, 2001). In a recent German survey on the image of certain industries, utilities achieved one of the lowest ranks (Sigmund & Stratmann, 2012). Although unbundled, uninformed citizens still associate TSOs with their former utilities and thus allocate a similar image to them.

6.3 Potential success factors to reduce public opposition

In order to identify success factors for TSOs to reduce public opposition in their transmission line projects, hypotheses need to be derived in an explorative manner first. Thus, ideas were generated based on the conducted interviews, available literature, mainly about analog large infrastructure projects, and the derived reasons for public opposition against transmission lines. Each idea was considered, independently from how often it was mentioned in the literature or interviews.

As already mentioned in the introduction, the focus of this work is on the TSO perspective. Therefore, the potential success factors in the following do not include any legislatory recommendations. Rather, legislation is regarded as 'external' factor in this work which cannot be influenced by the TSO except through limited lobbying. The ideas identified below describe to what extent a TSO can tackle such problems by itself. The identified potential success factors were grouped into the following six categories which represent the potential latent success factors:

- Communication (Chapter 6.3.1)
- Participation (Chapter 6.3.2)
- Economic benefits (Chapter 6.3.3)
- Organizational readiness (Chapter 6.3.4)
- Stakeholder liaison (Chapter 6.3.5)
- Technical planning (Chapter 6.3.6)

To ensure a proper grouping, Anderson & Gerbing (1991, p. 734) suggest to conduct a pretest and evaluate two proposed indices. The first is an indicator's proportion of substantive agreement

$$p_{sa} = \frac{n_c}{N} \qquad (6.1)$$

with n_c representing the number of experts in the pretest who have assigned the factor to the right group and N as the total number of involved experts. It measures the proportion of respondents who assign an item to its intended group correctly. p_{sa} can have a value between 0 and 1 with high values indicating a high agreement. The second index is an indicator's substantive-validity coefficient

$$c_{sv} = \frac{n_c - n_0}{N} \qquad (6.2)$$

with n_0 as the number of experts who have assigned a factor to a wrong category. N and n_c have the same meaning as in the equation outlined above. The index reflects the extent to which respondents assign a factor to a group more than to any other (Anderson & Gerbing, 1991, p. 732). c_{sv} can range between -1 and +1 with positive values indicating a high validity. For this study seven transmission experts were approached in advance and asked to assign the randomized list of indicators to several proposed groups. After they have made their assignment of each factor, they were asked to go back, check again and make respective changes if necessary. Anderson & Gerbing (1991, p. 734) mention that a test of statistical significance can be conducted for the indices. However, as the total population of this study is only 41 TSOs, a pretest with at least 30[134] respondents to ensure statistically significant pretest results would not be adequate[135]. Therefore, the indices are not tested for significance but rather used as an indication. The pretest revealed positive high p_{sa} and c_{sv} values for all factors except 'foster joint fact finding' and 'use neutral moderation/mediation'[136]. As the majority of experts assigned these two factors to the category 'participation', they were regrouped accordingly. For all other factors a sufficient existing group assignment was indicated.

The potential latent success factors, i.e. groups, and their respective manifest success factors are described in detail in the following. Each subchapter concludes with a box that states the potential manifest success factor in an implementable manner for TSO management. The respective variable name for the structural equation model is included in brackets. The potential success factors will then be validated by a TSO survey in the subsequent chapters 7 and 8.

[134] Bortz & Schuster (2010, p. 87) propose a minimum sample size of 30 to ensure statistically significant results.

[135] As all candidates used for the pretest could not be used for the real test anymore.

[136] The detailed values can be found in appendix 10.

6.3.1 Communication

6.3.1.1 Communication strategy

A fundamental requirement for successful communication is the development of a communication strategy upfront. At a minimum, such a strategy has to comprise the identification of relevant stakeholders, their attitudes and concerns, the conflict potential of the project, the definition of messages, a communication schedule, next steps and processes, a selection of appropriate media[137], a choice of professional as well as trusted internal or even external resources and the required budget (EPRI, 2001). Messages should provide information as to why the line is needed, on possible negative impacts for the affected citizens and planned mitigation measures, potential social benefits (Roland Berger, 2011b, p. 118), general aspects surrounding the planning procedure as well as participation possibilities for stakeholders. Moreover, the role of the transmission grids in the development of renewable energy sources and in the transition to a decarbonised power sector in general should be emphasized (RGI, 2011b, p. 3). A successful communication strategy has to distinguish between national and local level as stakeholders, media and messages are likely to differ at each level. Due to the fact that projects, stakeholders and the local context are always unique, communication itself should be as well (interview with Frank Ulmer, 27.09.2011). Therefore, a communication strategy needs to be thoroughly defined at the very beginning of every transmission line project and strategies should not be generic and blindly repeated from project to project (Walker G. et al., 2010). In particular, the communication of potential risks associated with the line requires intense preparation and planning. In the special case of communicating possible EMF risks, the WHO (2002) as well as del Pozo et al. (2010) published useful communication guidelines for project developers. The information helps to understand how concerned people perceive the potential risk of EMF and provides guidance when, with whom, what and how to communicate. Risk communication should not only include a scientific presentation and calculation of the risk associated with the project, but also provide a forum for discussion on broader issues of ethical and moral concern (Dowd et al., 2011, p. 6306). A more general but comprehensive guideline about how to communicate with the public in transmission line planning was published by EPRI (2001). It is also recommended to develop and align the communication strategy together with the respective planning authorities in order to improve coordinated stakeholder communication. During the course of the project, the communication strategy has to be continuously revised and modified on an ad hoc basis if necessary and when new information is available (WHO, 2002, p. 28). This allows TSOs to adapt to stakeholder concerns and project characteristics in a timely manner.

► Develop a communication strategy (1a_STRAT)

[137] This includes an a priori identification of media in the local area.

6.3.1.2 Early communication

An early communication by TSOs about the planned transmission line was strongly requested by the majority of interviewees (e.g. interviews with Enrico G. Orzes (24.10.2011), Roger Spautz (22.09.2011) or Elke Bruns (27.09.2011)). Especially the interaction with potentially affected citizens before the application process was seen as key (e.g. interview with Guido Franke (04.10.2011)). It is noted also in the study by EPRI (2001, p. 1.4) that "[a] plan for public communication should be developed and partially implemented well before regulatory proceedings begin". Jobert et al. (2007, p. 2759) state that a major lesson from wind energy projects is that the lack of information about the project from the beginning will result in significant resistance and a slow-down of the project later on. TSOs need to ensure that citizens hear about the project from them first and before reading about it in the local newspaper or hearing it through the grapevine (canWEA, 2008, p. 7). TSOs should proactively approach citizens and should not wait until they are contacted with questions and concerns by them (interview with Ralf Eggert, 13.10.2011). Early and proactive communication needs to include information on the intended project and a rough timeline, its location and size, reasons why the project is necessary, potential benefits for society, next steps and possibilities for public participation as well as information about the TSO itself including respective contact details (NABU, 2008, pp. 10–11). Moreover, the TSO needs to make sure while providing the above outlined information that stakeholders do not get the feeling of being confronted with a fait accompli. In other words, they should not get the impression that the project design and route have already been finalized and that there is no chance anymore to change things. Flexibility as a potential success factor on its own is described in detail in chapter 6.3.2.8 below.

► Communicate proactively and at earliest possible stage (1b_EARLY)

6.3.1.3 Line justification

Kunreuther et al. (1993, p. 305) state that "[a] siting process must begin with agreement that a facility is needed". For a TSO the justification that its planned transmission line is needed is absolutely crucial (interviews with Marcel Keiffenheim, 30.09.2011, Peer Schulze, 06.10.2011 and Gundula Hübner, 21.11.2011). The basis for reducing the opposition against transmission grid expansion is that the public understands why an additional line is needed (RGI, 2011a, 2012, p. 1). This is of special importance in countries that have a comparably high security of supply, i.e. where people are used to a stable supply of electricity and do not face regular blackouts. People have to understand the consequences if the planned transmission line is not installed at all or too late. Thus, TSOs need to lay out possible consequences in a faithful manner without exaggeration. Basically, transmission lines are required for a release of bottlenecks in the network, the integration of conventional and renewable energies, the more efficient utilization and allocation of energy resources and the promotion of a liberalized European energy market through imports and exports of electricity. Line justification needs to be consistent and honest (interview with Heinz-Jürgen Siegel, 05.10.2011). TSOs should not argue that a line will serve the integration and transport of renewable energy simply because people are generally in favour of RES (interview with Marcel Keiffenheim, 30.09.2011). A guarantee that only 'green' electrons will be transmitted can anyhow not be given technically in a meshed AC network (Krumrey, 2011). TSOs should lay bare which purpose the transmission line will predominantly serve. They should make clear that the primary purpose is not an exclusive one. Even if the main goal is the integration of a conventional power plant, TSOs should be honest as people will at some point find out anyhow the real reason behind the project (interview with Roger Spautz, 22.09.2011). Furthermore, a change of argumentation during the planning process will create distrust and thus more severe opposition. The only exemption that allows for an adjustment of arguments is the case when external circumstances change significantly during the planning phase, such as the nuclear phase out decision in Germany. A TSO needs to clearly state the purpose and relationship of the local line within the energy system as a whole (interview with Andreas Fusser, 21.09.2011). Grid expansion alternatives such as decentralized energy generation are no longer in the scope and control of unbundled TSOs. This needs to be communicated proactively to people in order to avoid misunderstandings and unjustified accusations, especially in cases in which TSOs are still owned by utilities but are already unbundled organizations. Moreover, it needs to be made clear that transmission lines usually do not operate at their maximum capacity in order to ensure N-1 security. People often doubt a TSO's argument regarding the existence of a grid bottleneck if the line capacity is not utilized to 100%. Therefore, TSOs need to dispel such misunderstandings when justifying a new transmission line.

A successful line justification requires a transparent determination or calculation of the need (interview with Thorben Becker, 29.11.2011). Transmission system modeling is very complex and most of the people do not understand it. Thus, the examination of modeling results should be conducted by a competent and independent institution[138]. If load flow data is subject to confidentiality, a non-disclosure agreement should be signed with the independent assessor.

► **Justify need of line clearly and honestly (1c_JNEED)**

6.3.1.4 Direct personal conversation

TSOs should proactively seek direct and open personal conversations with affected citizens (EPRI, 2001, p. 2.6; Wuppertal Institut et al., 2008, p. 175). In the past, communication between a TSO and its stakeholders has often occurred at an arm's length and impersonally (interview with Markus Troja, 27.09.2011). Interviewees mentioned that they would highly welcome it, if a TSO dedicates and

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[138] In Germany, this is already required by law according to §12f of the Energy Industry Act (EnWG).

assigns at least one of its employees as a personal contact for them. Just to provide an entity like the 'Communication Department' as such as a general contact is not sufficient (IAP2, 2006, p. 1). A personal contact reduces anonymity and creates a more personal relationship providing a specific 'face behind the TSO' (interview with Heinz-Jürgen Siegel, 05.10.2011). Thus, TSOs need to include personal contact information on every communication (canWEA, 2008, p. 11). In some cases, TSOs have provided a contact person in their communication leaflets or on their website, but concerned people have often never met the listed employee personally. This means that the TSO organization is often seen as an impersonal and anonymous institution. Opposition to something at a distance is often more significant than when a much closer and personal connection exists. Thus, the dedicated TSO contact persons need to show significant local presence and foster direct personal conversations with the stakeholders during transmission line planning. To start with, TSOs should consider an introductory advertisement in the local newspaper including a profile and photo of the contact person. Next to personal letters, emails and phone calls, personal face-to-face meetings via 'kitchen table' discussions in a person's home or conversations with small groups in round table meetings in local pubs, restaurants, etc. should be conducted and respective feedback[139] collected (canWEA, 2008, p. 12; interviews with Klaus Rohmund, 07.09.2011 and Andreas Fusser, 21.09.2011). It is important that these meetings take place in a safe and familiar setting. A cooperative discourse and spirit should be nurtured in such meetings (interview with Ortwin Renn, 14.10.2011). This helps to create trust (interviews with Frank Ulmer, 27.09.2011 and Ralf Eggert, 13.10.2011) and a more personal environment for discussion to take place, which is essential for consensus, especially in the context of potential risks that can occur (Kasperson et al., 1992). TSOs must be aware that every interaction with stakeholders is a 'moment of truth' for their reputation and the degree to which they are welcomed by the public (canWEA, 2008, p. 5). Direct conversation fosters a mutual understanding of respective individual interests and necessities. Some interviewees suggested that a TSO and its stakeholders should try switching roles during such direct discussions and try to argue and defend their new standpoint (interviews with Mike O'Carroll, 20.09.2011 and Ortwin Renn, 14.10.2011). This would facilitate the understanding of each other's position. Furthermore, opponents are more likely to open up and reveal their true reasons for resistance in such personal conversations. In large town-hall meetings, individual stakeholders often 'hide' in the audience and behind claims of action groups although these might not be consistent with their own opinions. As pointed out earlier in this work, opponents' arguments often differ to their real underlying concerns. They rather use arguments that are legally more enforceable. For example, as TSOs regularly comply with defined international EMF standards, concerned people have very little chance of successfully using EMF as an enforceable reason for objection and litigation (interview with Markus Durrer, 14.10.2011). Thus, people tend to put forward other reasons like property devaluations or questioning the general need of a new line

[139] A suitable feedback form is provided for instance in EPRI (2001, p. F.2).

during the planning phase. They might be less concerned of these reasons but they are more likely to prove successful in litigation. Direct personal communication can uncover such underlying reasoning and address it. The earlier direct communication with affected stakeholders is initialized by TSOs, the higher is the chance to avoid conflicts, misunderstandings, resistance and escalation. Direct personal communication is also an access mechanism to knowledge that the public holds. The inclusion of stakeholder and local community preferences and values can elicit important information that may otherwise be overlooked in a purely technical analysis (Fiorino, 1990). Hence, TSOs should see the public as a source of knowledge that can help to point out possible mistakes in certain assumptions or to generate alternative solutions (Beierle & Cayford, 2001; interview with Guido Axmann, 27.09.2011).

► Seek personal direct conversation (1d_DIREC)

6.3.1.5 Appropriate communication mix

TSOs can inform their stakeholders in transmission line planning through a broad variety of different media. The selection of media should be based on a preceding stakeholder analysis as stakeholders differ in their access to and use of certain media and communication channels. Elder people tend to feel more comfortable with conventional media such as newspapers, letters, television or radio spots. In contrast to this, younger generations prefer to use new media on the internet like emails, blogs, wikis, podcasts or even social media such as facebook, youtube or twitter. Thus, a TSO should not rely on a single media but an appropriate mix of communication instruments. Project information needs to be available to and accessible by everyone, independent of the individually preferred communication channel (Arbter, 2008; Lindner & Vatter, 1996; WCD, 2000, p. 215). In terms of contact, stakeholders must be able to phone, email, write or personally visit the TSO (canWEA, 2008, p. 11; EPRI, 2001, p. 2.6). A good hint for identifying the appropriate media in the interaction with action groups is to examine what sort of communication they use to organize themselves and interact amongst each other. Action groups usually have their own websites, communicate and organize via blogs, email, personal letters or even facebook and regularly hold meetings and assemblies in local pubs or restaurants. TSOs should utilize these communication channels to ensure that they reach action groups (Huber & Horbaty, 2010, p. 58). Table 7 on the following page provides an overview of conventional and new media for informing stakeholders, which have been collected from the literature (EPRI, 2001) and conducted interviews.

Table 7: Possible communication media for stakeholder information.

Conventional media	New media
▪ Aerial route photographs / Photomontages	▪ 3D model / Computer animation
▪ Billboard / Poster	▪ App
▪ Booth (e.g. in pedestrian zone, shopping mall, etc.)	▪ Blog
	▪ Computer game
▪ Exhibition / Fair / Special event	▪ DVD
▪ Flyers, brochures, leaflets, factsheets	▪ Email
▪ Formal presentation	▪ GIS[140] map
▪ Informal assembly (e.g. in restaurant)	▪ Newsletter / News feed
▪ Local information office	▪ Online multimedia (e.g. flickr, youtube)
▪ Municipality black board	▪ Podcast
▪ Newspaper / Magazine	▪ Project website
▪ Personal conversations (face to face or in small groups)	▪ SMS
	▪ Social media (e.g. facebook, twitter)
▪ Personal letter	▪ Wiki
▪ Press talk	
▪ Radio report / spot	
▪ Road show / Info bus	
▪ School kit / Board game	
▪ School visit	
▪ Site visit / tours	
▪ Television report / spot	
▪ Town-hall meeting	

It needs to be pointed out that careful press coordination and management is essential as well (Lantz & Flowers, 2010, p. 28). TSOs need to continuously monitor media coverage. Maintaining open and frequent contact with local media and asking them to be part of any story on the project is crucial – no matter if the report is positive or negative. As such, TSOs will be able to make their side of the story clear (canWEA, 2008, p. 8). Closely working with external media can help TSOs to make their points and enhance their reputation and credibility. Thus, TSOs have to proactively seek contact with media and establish good relations. CanWEA (2008, pp. 17–20) provides a guideline on how to establish a successful media relationship. Newspapers, magazines and leaflets are not the only available conventional media. Other possibilities are a TSO information office in the affected area that increases local presence (interview with Ralf Eggert, 13.10.2011), a booth in the local pedestrian zone or

[140] Geographical Information System.

shopping mall, town-hall meetings or the participation in local exhibitions, county fairs or other special events like local festivals (EPRI, 2001, p. 2.6). An illustrative example for the latter is shown in figure 45 in which two TSOs joined forces and provided information and guidance on a planned interconnection line with a booth during a local medieval festival. This action received very positive feedback from the public (Mielczarski, 2010).

Figure 45: TSO tent at medieval festival (Mielczarski, 2010).

Examples of new media are online multimedia like youtube (Deutsche Umwelthilfe & DENA, 2011), GIS maps (Rodman & Meentemeyer, 2006), photomontages (Lantz & Flowers, 2010, p. 27), computer animations or 3D models for visual impact assessment (interview with Heinz-Jürgen Siegel, 05.10.2011) or even apps for smartphones (Deutsche Umwelthilfe & DENA, 2011, p. 44). The use of frequently asked questions (FAQs), either in written form or online, will reduce the communication effort for a TSO to some extent. When people find their questions already answered in the FAQs, they will not put them to the TSO again which reduces communication workload for the TSOs. Communication should not be limited to the local level but should also be conducted on a more regional if not national level. The amount and detail of information has to decrease from the local to the regional or national level. Communication on national level must not be project specific only, but should also include information about electricity transmission in general. An example of that are distributable school kits, board games and computer games[141] to increase the youngsters' general understanding of power transmission lines and why they are needed. School visits can complement

[141] Demonstrative examples are the online computer games ‚Transmission Control' from the German utility Vattenfall or 'Energy in everyday life' from the German utility RWE.

this (EPRI, 2001, p. 3.4). If required, TSOs can also use professional communication consultants and agencies. Action groups often try to compensate the lack of communication on the part of authorities and TSOs. They gather information by themselves and communicate the findings to their members. Therefore, TSOs can utilize the representatives of action groups as messengers. Especially action group representatives can be personally invited to talks by the TSOs on a regular basis and receive first hand information, which they can pass then on to their members.

► Use appropriate communication mix (1e_COMIX)

6.3.1.6 Comprehensibility

Electricity transmission line engineering is a very technical subject that requires a certain amount of expert knowledge to be understood properly. While TSO engineers are very familiar with technical vocabulary, most of the people are utterly incapable of understanding such ‘technical and patronizing language’ and usually become quickly frustrated (Baxter et al., 1999, p. 512). Thus, the challenge for the TSO is to translate and summarize complex technical information and make it available in a manner and format that an ordinary citizen can understand (EPRI, 2001, p. 3.3; interview with Wolfgang Schulze, 07.09.2011; Siegel, 2011a). Additionally, the authorization process is complex and uses legal terminology, which discourages concerned citizens (Banthien & Eggert, 2011; Meister et al., 2010). Authorities often fail to provide information to the public in a comprehensible way. TSOs should consider this in their communication activities and provide easy-to-understand information on the authorization process as well. For TSOs, the provision of information in the authorization process is a balancing act. On the one hand they need to submit comprehensive and detailed information to the permitting authorities, on the other hand they need to provide manageable and comprehensible information to citizens. Therefore, TSOs should provide an additional ‘citizen summary’ next to the detailed planning documents that is written in a simple and straightforward language. Moreover, when planning documents are laid out for consultation in the respective municipalities, TSO employees should make themselves available for a certain amount of time in order to provide guidance through the vast number of documents, as municipal staff is usually not able to do so (interview with Peer Schulze, 06.10.2011; Schweizer-Ries et al., 2010, p. 26). Such a moderated approach would help concerned citizens to find relevant detailed information faster and immediately have an answer to questions such as ‘will the proposed line cross my property?’ or ‘what amount of compensation can I expect?’. If the planning documents are published also on the internet, the TSO should implement an online chat, moderated online forum or telephone hotline to provide guidance.

► Provide comprehensible information (1f_COMPR)

6.3.1.7 Sufficient and honest information

In order to identify what information is requested by concerned stakeholders, TSOs have to approach them proactively and early on and ask them for their information needs. TSOs should also double-check data and information for accuracy before communicating it to the public. They must avoid exaggerations or promises which they cannot keep (Interview with Ivan Stone, 30.11.2011; Kunreuther et al., 1993). TSOs must be correct and accurate in all dealings with the public (EPRI, 2001, p. 2.6). Communication should be done in an open way (van Alphen et al., 2007, p. 4371). Otherwise, people will accuse TSOs of dishonesty. Especially the communication of potential negative impacts and risks should be carried out carefully. Although TSOs might be tempted to play certain risks down, they should rather take the bull by the horns and proactively communicate negative impacts in a faithful and balanced way (Lantz & Flowers, 2010). This would increase a TSO's credibility and avoid the development of mistrust among citizens. The more people are informed about a transmission line project the less uncertainty and doubt exists (Schweizer-Ries et al., 2010). The previously mentioned publications by WHO (2002) and del Pozo et al. (2010) provide useful recommendations for TSOs on proper risk communication. Furthermore, proper risk communication should always comprise a description of the risk, its likelihood, its potential negative impacts and finally, and most importantly, a provision of possible mitigation measures (Wiedemann & Clauberg, 2005). It has to be ensured that everyone has the information he or she needs to make informed decisions (canWEA, 2008, p. 5). As outlined earlier, communication is done via several media. TSOs need to ensure that the data and information provided is always up to date and consistent across all used media and channels. When TSOs argue with facts, independent and acknowledged third party information should be used wherever possible (e.g. in the case of potential negative impacts through EMF) as people will most probably trust and accept those sources more. A usual request made by opponents is the publication of load flow data as they often doubt the need of the line. Where not yet legally obliged anyhow, TSOs should voluntarily select an independent institution such as a university chair or external consultancy to evaluate and confirm its network modeling results. This should be done under a non-disclosure agreement to ensure data privacy. Furthermore, TSOs have to continuously evaluate people's concerns and requests for information during the planning process and provide relevant data accordingly (Sander, 2011). Opponents claim that planning information is laid out by authorities for a too short amount of time and during inconvenient office hours (Schweizer-Ries et al., 2010, p. 26). TSOs should provide additional opportunities for concerned citizens to access the information. This could be done either via online publications or the setup of a local TSO office with office hours that do not clash with the main working hours of citizens. TSOs have to make themselves available for discussions with and possible questions from citizens (EPRI, 2001, p. 2.6). This needs to be realized in a way that is convenient for citizens. A toll-free hotline and extended office hours would be appropriate examples. In Great Britain, an interviewee reported that TSOs occasionally also offer a 24/7 contact centre (interview with Ivan Stone, 30.11.2011). TSOs need to staff such call centres and hotlines with competent employees who are updated with recent project developments and thus are able to answer upcoming questions. People get easily frustrated if the person they call always puts them off and says someone will get back to them. Attention should also be paid to responsiveness. Queries by citizens should be answered within a reasonable amount of time[142], otherwise people will become frustrated (canWEA, 2008, p. 8; EPRI, 2001, p. 2.6). Moreover, replies should not be standard pre-written emails or letter, but should specifically address the individual stakeholder's request.

► Provide sufficient and honest information (1g_SUFFI)

6.3.1.8 Stakeholder education

As already mentioned, transmission line systematics and the respective legal authorization processes are rather complex and hard to understand for people. Affected citizens often try to compensate their lack of knowledge about the topic by searching the internet (interview with Richard Hubmann, 02.11.2011), which increases the chance that they will use information that is outdated or inaccurate. Furthermore, self-education carries the risk that concerned people might selectively choose information and thus establish biased viewpoints already at a very early stage (Würtenberger, 2000). Hence, concerned people might draw together information and evidence, which often contradicts that of the experts (Baxter et al., 1999, p. 507; Burningham, 2000). People in most cases cannot judge the relevance and appropriateness of certain technical information. Often facts published on the internet have to be seen and interpreted in a certain context. During the interviews, several opponents mentioned certain cost factors by which an UGC system was claimed to be more expensive than an OHL system. They had found the factors on the internet. However, such a cost factor always has to be calculated project specifically and in a certain context. In many cases, stakeholders also rely on certain myths which they know from hearsay or they argue on a gut level (interview with Marcus Mattis, 11.10.2011). A proactive stakeholder education by the TSO would clear up such misunderstandings. By anticipating the most common misconceptions, TSOs can take the wind out of the stakeholders' sails. TSOs should proactively distribute information leaflets, publish information and videos on the internet, offer site visits or open house events and organize information meetings where the basics of transmission line technology are outlined, explained and discussed (EPRI, 2001, p. 2.6; Lantz & Flowers, 2010, pp. 26–29; interview with Mats Weinesson, 05.12.2011). A study on social acceptance of CCS also proposes to invite critics in order to ensure a balanced discussion (Wuppertal Institut et al., 2008, p. 23). Not only general stakeholder communication as outlined in the chapter 6.3.1.4 above, but also education should be carried out with a vocabulary and format that can be understood by the ordinary citizen. Where possible, independently published information as well as

[142] Within 24-48 hours as proposed by canWEA (2008, p. 11).

independent external experts and speakers (e.g. from academia) should be involved as citizens are likely to trust them more than the TSO itself (Battaglini et al., 2012; EPRI, 2001, p. 2.6; interview with Christiane Pölzl-Viol, 28.09.2011). Furthermore, education must be conducted before stakeholder consultation begins (interview with Ivan Stone, 30.11.2011). In their study, Schweizer-Ries et al. (2010, p. 18) point out that most of the citizens, who they had surveyed along a planned transmission line project, requested more information about UGC systems. A positive example of comprehensible education is a recently published brochure by Europacable (2011b) that tries to dispel existing myths about UGC transmission technology in an illustrative and easy understandable manner.

In addition, TSOs should not only conduct stakeholder education in a project specific context and limited to the area of the respective line corridor, but also in general and on a broader scope. Possible measures could be nationwide information campaigns, road shows and lectures. Education should also not be limited to adults. As already outlined in chapter 6.3.1.5 above regarding possible communication media, information kits and board games can be distributed in schools to improve children's' understanding on power transmission lines and why they are required. Such initiatives can also be undertaken in cooperation with the government. Similar educational projects have already been successfully implemented for wind power or renewable energy in general in Germany (Huber & Horbaty, 2010, p. 58). Overall, stakeholder education will allay misinformed, irrational objections and encourage affected stakeholders to adopt a more positive attitude towards technical proposals (Cotton & Devine-Wright, 2011, p. 122). Furthermore, stakeholders who are educated regarding the basics of electricity transmission will feel more comfortable when participating in discussions with the TSO.

► Educate stakeholders regarding technical and legal aspects (1h_EDUCA)

6.3.1.9 Post-communication

TSO information dissemination should not be limited to the project planning phase and stopped once permission for the line has been received. Rather, communication needs to be continued during construction and even during the operation phase (interview with Frank Ulmer, 27.09.2011). In a study by Zoellner et al. (2008, p. 4140), post-communication has revealed to be an important aspect of social acceptance. Construction site visits (NABU, 2008, p. 28) or regulars' tables during the operation period in order to present the status of construction or operation details like real line flow data can be appropriate instruments with which to continue informing local stakeholders (interview with Andreas Fusser, 21.09.2011). TSOs can invite stakeholders to their control centres to give them a feeling of the challenges of transmission line operation. Through continuous information about operation details, locals are likely to increasingly understand the need of the respective transmission line, which in turn reduces their opposition. In addition, regular conversations after project completion help to identify and address people's concerns. For instance, inhabitants can be informed early on about planned line maintenance activities, refurbishment or the trimming of the right-of-way of a line corridor. Planned activities can thus be coordinated with local citizens to minimize impact and disturbance. This will surely be appreciated by the landowners and create trust. Last but not least, an ongoing post-communication after a project with a special emphasis on positive aspects and moments can effectively reduce the resistance to further line extensions or upgrades later on (interview with Ivan Stone, 30.11.2011).

► Continue communication after project finalization (1i_POSTC)

6.3.2 Participation

6.3.2.1 Pre-polls

In their survey along a planned German transmission line, Schweizer-Ries et al. (2010) found that 86% of the interviewed citizens would have welcomed an opinion poll prior to transmission line planning. Experts and scientists state that there is a general acceptance for renewable energies and related grid extensions (Gerlach, 2004; Heiskanen et al., 2008, p. 43; Hübner & Pohl, 2011, p. 33; Raven et al., 2009b, p. 564). This is mainly due to increasing environmental concerns and the fact that transmission lines are urgently needed to integrate renewable energies (interview with Stephanie von Ahlefeldt, 21.09.2011; Zoellner et al., 2008). However, despite the general high-level acceptance, problems can arise on the local level (Aitken, 2010; Brenner, 2011). This discrepancy between the general and local viewpoints has already been outlined and described above with regard to the NIMBY phenomenon. Thus, TSOs need to identify the general attitude of the local population for every project, as the local situation is likely to be different. A pre-poll or 'pulse-check' helps to attain an initial feeling of the conflict potential and might reveal important stakeholder groups (EC, 2006; Upham et al., 2009). The poll has to be conducted by an independent institution or company as people will become suspicious if the survey is done by the TSO itself (interview with Klaus Rohmund, 07.09.2011). Furthermore, the survey needs to be carried out as early as possible in the planning process. This will also give the affected citizens the feeling that the TSO, as the project developer, cares about local opinion at an early stage at which things can still be influenced.

► Conduct pre-polls to determine stakeholders' attitudes upfront (2a_PPOLL)

6.3.2.2 Participation possibilities

When dealing with stakeholders, TSOs should avoid mere one-way communication (interview with Peer Schulze, 06.10.2011). Providing information can be an important first step, but by limiting communication to a one-way information flow, people have little influence and opportunities to express themselves (Haggett, 2011, p. 17). In the past, efforts for public involvement have focused on keeping the public informed of the siting progress rather than involving them directly in decision making (Baxter et al., 1999, p. 505). However, concerned citizens want to have their say (Cotton & Devine-Wright, 2011, p. 125). Compulsory legal consultations and hearings during the authorization procedures are rare and do not allow for interactive discussions. Figure 46 illustrates the difference between information, consultation and participation of stakeholders.

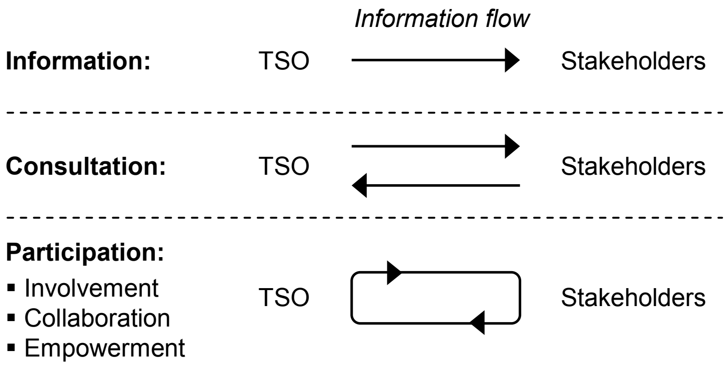

Figure 46: General types of TSO – stakeholder interaction. Own illustration based on Rowe & Frewer (2005, p. 255).

Only the participation approach offers sufficient interaction with a continuous bidirectional information flow. It can be further differentiated into involvement, collaboration and empowerment, with the latter representing the utmost level of participation (canWEA, 2008, p. 36). According to Schweizer-Ries et al. (2011, p. 16) and Baxter et al. (1999, p. 506), an increasing level of stakeholder engagement goes always along with an increasing reduction of TSO decision making power. Stakeholders should thus be regarded by TSOs as partner in problem solving and decision making (Armour, 1991, p. 56). In contrast to participation, stakeholder consultation is basically limited to two information flows: TSO proposal and stakeholder response. In other words, stakeholder engagement is limited to the public display of documents and the possibility of submitting an objection (Sander, 2011, p. 28). An extensive discussion is not possible. Stakeholders do not regard consultation as sufficient engagement. Thus, TSOs need to go one step further and offer additional, extended participation opportunities. TSOs might be tempted to avoid additional participation opportunities as they fear giving opponents a stage for their resistance. However, as Guckelberger (2006) emphasises, this does not hold true. People are more likely to tolerate a final decision, even if it does not reflect what they wanted, if such a decision is taken in an open process based on discourse in which citizens are given an opportunity to present their point of view. Also Mirumachi & Torriti (2012, p. 126) state that "[p]ublic participation, or the inclusion of stakeholders is highly important". Therefore, additional possibilities would give stakeholders the opportunity to bring up their concerns. Moreover, additional participation would allow the TSOs themselves to identify what type of information stakeholders require (Deutscher Städte- und Gemeindebund, 2005, p. 7). A TSO can identify individuals' goals and expectations regarding the project, common grounds to build on as well as disparities and conflicts which need to be discussed and solved (MacKinnon, 2007; interview with Hans-Uwe Neuenhahn, 07.11.2011). The identification of expectations in local project development and implementation is crucial as it reduces uncertainty (Raven et al., 2009b, p. 566). Understanding residents' definition of threats and risk perception in order to anticipate their potential reactions is of utmost importance (Takahashi, 1997). Moreover, possibilities for compromises can be explored (interview with Markus Troja, 27.09.2011). Stakeholders often have good ideas which a TSO can make use of (Schweizer-Ries et al., 2011, p. 141). When people's expectations are not met nor sufficiently taken into account, their resistance will increase (van der Meijden, 2010, p. 64). TSOs can make use of the about 100 different participation methodologies that can be found with detailed descriptions in Austrian Ministry of Agriculture and Forestry, the Environment and Water Supply (2012) or Rowe & Frewer (2005, p. 257). There is also the International Association for Public Participation (IAP2) that provides guidance and a toolbox for project developers on how to engage the public (IAP2, 2006)[143]. Moreover, the EU funded a project in 2008 called 'CreateAcceptance'[144], which developed ESTEEM[145] – a six step process as illustrated in figure 47 on the next page to successfully engage stakeholders in energy projects[146] (Jolivet et al., 2008; Raven et al., 2009a; Raven et al., 2009b). The whole process is performed by an external consultant together with the project manager and starts with understanding the past and present situation of the project. The next step involves the project manager on the one hand and a core group of stakeholders (e.g. action group and NGO representatives) on the other, who identify and express their expectations and visions. Conflicting interests are then compared in a third step. Topics of conflicts are identified and ranked according to their importance and urgency. In the fourth step, the consultant and project manager identify possible solutions which are used as input for a stakeholder workshop in the next process step. The workshop could be substituted by any other of the participation methodologies. During the workshop all parties can again bring up their expectations, discuss the proposed options and try to reach a compromise. Afterwards, the results and agreements

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[143] For further information please visit www.iap2.org.

[144] Project details are available under http://www.createacceptance.net.

[145] ESTEEM (Engage stakeholders through a systematic toolbox to manage new energy projects) succeeded the earlier approach SOCROBUST (Social Robustness). Since recently, ESTEEM is also available as modified version MECHanisms for small local projects and the target group of municipalities (http://mechanisms.energychange.info) (interview with Mia Paukovic, 16.11.2011).

[146] Also available as user-friendly Microsoft Excel tool incl. manual under http://www.esteem-tool.eu.

are communicated and implemented in an action plan (van der Meijden, 2010, p. 69). In case no agreement can be reached, the process needs to be started again.

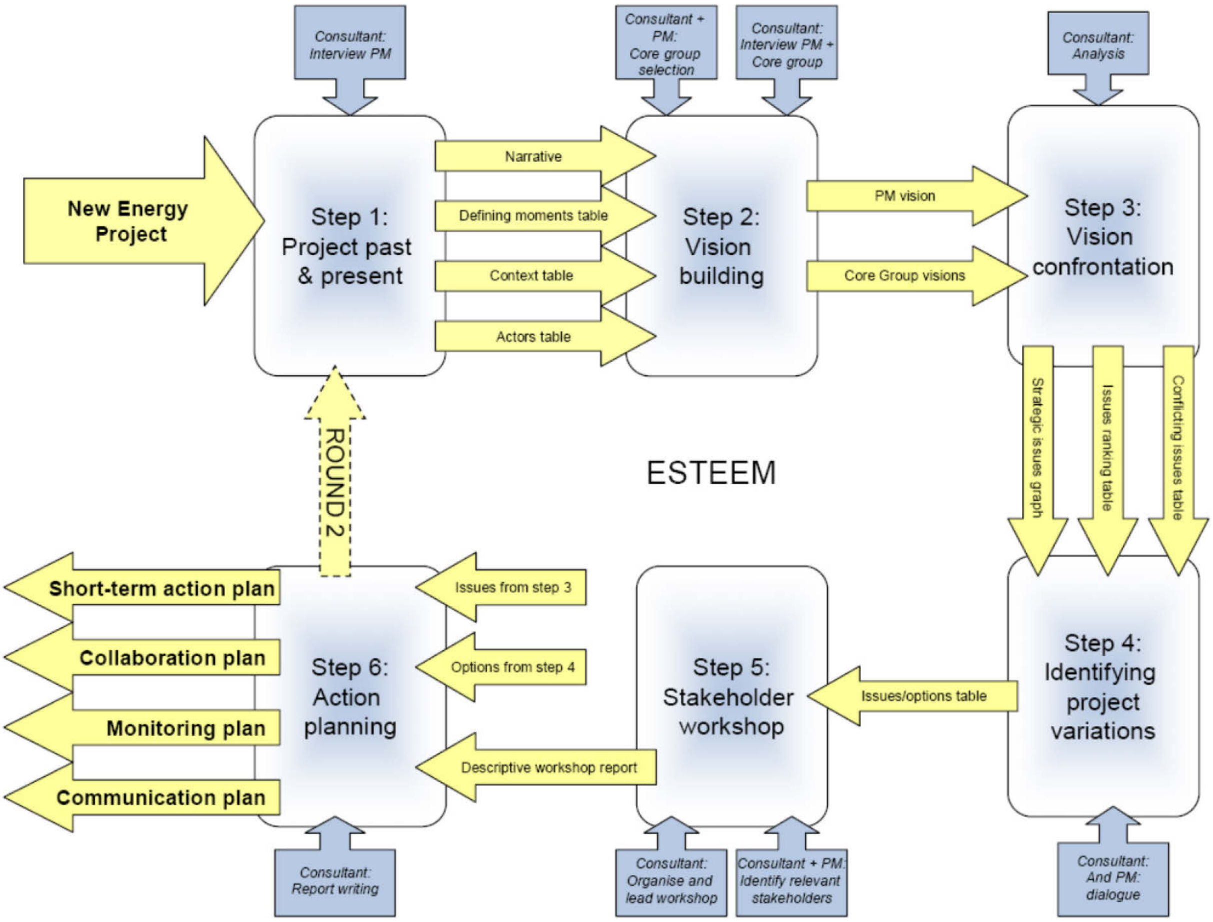

Figure 47: General ESTEEM process flow chart (Jolivet et al., 2008, p. 12).

The first major advantage of ESTEEM is that it uses “a processual and formalized structure for project managers to create a reflective space and anticipate and systematically think about societal acceptance issues in new energy projects” (Raven et al., 2009a, p. 975). A second substantial gain is opening the negotiation process with concerned stakeholders early in the project. In the ideal case, the TSO develops the participation process and opportunities jointly with the stakeholders upfront (NABU, 2008, p. 7). This would increase the chances of successfully avoiding resistance and achieving a joint compromise. The participation process must be fair, efficient, legitimate and in a format that allows people to participate although they do not have technical expert knowledge (Papadopoulos & Warin, 2007; Webler, 1995). When offering a participation possibility such as a workshop, TSOs should ask people what time and location suits best while considering local stakeholders’ daily, seasonal or cultural routines (canWEA, 2008, p. 11). This will be highly appreciated (interview with Hans-Uwe Neuenhahn, 07.11.2011). Interviewees also complained that the time provided to submit inputs to TSO proposals was too short (interviews with Peer Schulze, 06.10.2011, Karl Zotter, 10.11.2011 and Synnøve Kvamme, 17.11.2011). Kunreuther et al. (1993, p. 305) state that “[i]t may be necessary to 'go slowly in order to go fast'". Baxter et al. (1999, p. 517) complement with „[a]ny urgency built into the process may threaten (…) trust if residents view the siting managers as pushing things forward without paying due attention to community needs". Thus, TSOs should allow for realistic and adequate participation durations and timelines. This is a vital investment for the long-term success of a planned project (canWEA, 2008, p. 5). Furthermore, participants should be able to influence the agenda of meetings (Beierle & Konisky, 2000; Branch & Bradbury, 2006). Front stage presentations and monologues have to be avoided as much as possible during the participation meetings (interview with John Woods, 21.11.2011). Citizens must always be given sufficient time and stage at the very beginning to bring up their concerns and requests (NABU, 2008, p. 29). The Austrian Ministry of Agriculture and Forestry, the Environment and Water Supply (2011) also published a useful guide for standards in the preparation, implementation, monitoring and evaluation of the participation process. It includes recommendations for good practice. Stakeholder participation must not be regarded as being an optional add-on but should rather be a normal and integral part of the planning process (Cotton & Devine-Wright, 2012, p. 3).

► Provide additional participation possibilities (2b_PPOSS)

6.3.2.3 Participation information

At the beginning of the project planning process, the TSO must define and communicate possible participation opportunities to the relevant stakeholders. This needs to be done by providing sufficient advance notice to allow stakeholders adjust their schedules accordingly (canWEA, 2008, p. 11). Such communication should not only comprise the additional participation possibilities provided by TSOs on a voluntary basis, but also the consultations and hearings regulated by law. Authorities often fail to sufficiently inform and educate citizens about their participation rights, possibilities and respective time limits (NABU, 2008, p. 15; Roland Berger, 2011b, p. 4). Several citizen action groups in the study by Sander (2011, p. 28) reported that they had learned of approval procedures more or less coincidentally. Thus, stakeholders need to get more transparency on planning and permitting procedures (EPRI, 2001, p. 3.4; RGI, 2011b, p. 3). There are several guidelines published by NGOs or communication consultants for stakeholders on how they can sufficiently engage in project planning (e.g. Schütte (2006) or DIALOGIK (2012)). TSOs can use these publications as a starting point and as input for informing their individual stakeholders. It may sound paranoid that a TSO should proactively inform stakeholders about participation possibilities as it can expect comments, change requests and objections by people once involved. However, people will appreciate this and therefore will be more likely to agree on a compromise and give up resistance. Hence, TSOs have to encourage people to participate (canWEA, 2008, p. 8). For its additionally offered participation opportunities, the TSO must define clear procedural rules and set time limits to smoothen public participation and avoid lengthy and unstructured discussions that will fail to reduce or avoid planning delays at all (Abelson & Gauvin, 2006; Deutscher Städte- und Gemeindebund, 2005, p. 7; interview with Philipp Godron, 24.11.2011). It needs to be emphasized which aspects are already set and not up for debate as well as which aspects still can be influenced by the public (Arbter, 2008). For instance, if the need for a line has been already determined and approved by a national transmission expansion plan, the line must not be questioned in the public participation process anymore. This should be made clear to the participating stakeholders upfront. Communicating a clear process with its limits avoids stakeholders establishing wrong expectations regarding their possible involvement, which if such expectations are not met, will lead to frustration and resistance. This comprises a detailed schedule including individual process steps and deadlines until the final decision is taken. Stakeholders must agree on the process at the beginning. Furthermore, the roles and tasks of the TSO and the public as well as rules of the game need to be defined upfront and made transparent (Heiskanen et al., 2008, p. 110).

► Proactively inform stakeholders about participation possibilities (2c_PINFO)

6.3.2.4 Macro-planning involvement

As mentioned earlier, stakeholders often doubt the need for a new transmission line. The public is usually completely left out of long-term transmission line planning and identification processes on macro-level (Cotton & Devine-Wright, 2012). Nevertheless as interviews revealed, people want to get involved at this early stage as well (interviews with Mike O'Carroll, 20.09.2011, Markus Troja, 27.09.2011 and Philipp Godron, 24.11.2011). TSOs often think that stakeholder involvement at macro-level is not necessary, as resistance is merely subject to local concerns, and think that people therefore do not care. However, 1,500 objections were submitted during the recent consultation of the national grid expansion plan in Germany (Factory, 2012). This example shows that people very well care already at macro-level. There is a concerted movement of scientists and policy-makers to bring public involvement upstream in the development process of projects in order to improve general acceptance for a technology and the project (Wilsdon & Willis, 2004, p. 18). The more a project moves down the development process, the less influence stakeholders will have to change or abolish it (Cotton & Devine-Wright, 2012, p. 3). Stakeholder involvement during the identification stage is regulated by law only in a few countries such as Germany[147]. In countries where such legal enforcement does not exist, TSOs should conduct a high-level consultation during the macro-planning of their transmission network (Cotton & Devine-Wright, 2011, p. 120). TSOs need to at least provide the opportunity to comment on the assumed generation and demand scenarios that represent the

[147] In Germany according to §12a (2) EnWG, the public needs to be consulted on the developed generation and demand scenarios, on which the TSOs base their decisions on future grid expansions needs.

underlying basis for transmission line modeling. The majority of people will not react and protest until they know they are directly affected by a concrete local transmission line project (interview with Ralf Eggert, 13.10.2011). However, local politicians, NGOs, or other action groups are interested in such consultations on macro-level. They act as a kind of representatives for the public. Once concrete transmission line corridors are identified through macro-planning, local citizens are less likely to question the need for a line as they know that other affiliated stakeholders have already been sufficiently involved in the high-level planning process. TSOs should inform the broad public in general and local politicians, NGOs and other action groups in particular about possible high-level consultation opportunities. A one time announcement in a national newspaper is regarded as not sufficient (UfU, 2010).

► Involve stakeholders already in macro-planning (2d_MACRO)

6.3.2.5 Pre-application involvement

Pre-application involvement as a potential success factor is different to the aforementioned macro-planning involvement. Whereas the latter consults the general public on a national level, the former invites only local stakeholders to participate in the planning process for a specific transmission line. Involvement at local level needs to start as early as possible and at a reasonable point prior to the submission of the application documents (Arbter, 2008; Rowe & Frewer, 2000). Many interviewees claimed that once the application had been filed by the TSO to the permitting authorities, they had almost no chance anymore to influence the route and design of the transmission line as alternatives had been ruled out already (interviews with Klaus Rohmund, 07.09.2011, Marcus Mattis, 11.10.2011 and Mia Paukovic, 16.11.2011). Sumper et al. (2010) provide a methodology how the public can be involved in the assessment of possible impacts through the installation of a new line. In this sense, people can influence how individual impacts are weighted. TSOs need to move on from a ‘Decide-Announce-Defend’ towards an ‘Announce-Discuss-Decide’ approach (Haggett, 2011, p. 17; Sander, 2011). Only if the main disputes have been settled and a major agreement on the transmission line route and design has been reached, the TSO should submit the application for authorization.

► Involve stakeholders prior to application process (2e_PRIOR)

6.3.2.6 Neutral moderation/mediation

Concerned people often do not trust TSOs per see. Discussions between a TSO and stakeholders often reveal contradicting opinions and arguments. If a TSO’s member of staff is moderating such a discussion session, people often feel that he is biased and favours his colleagues. This is seen as manipulation (interview with Richard Hubmann, 02.11.2011). Therefore, a neutral moderator should be used, who is accepted by both parties and who must not influence the talks with his personal opinion (DIALOGIK, 2011, p. 40; interview with Philipp Godron, 24.11.2011; Sumper et al., 2010). The purpose of moderation is to visualize and document all interests, concerns and proposals and to guide the parties through the discussion process in order to reach a common understanding, shared vision and consensus (NABU, 2008, pp. 13–14). In case a severe dispute arises, this neutral person should also be in charge of mediation. A mediator acts as intermediary between the conflicting parties. He needs to be in close contact with the parties and people involved and try to help both sides in finding a sustainable compromise (Sander, 2011, p. 50). This is why mediation will only successfully eliminate a dispute, if both parties are willing to find a compromise, but do not know how to find it. Only a compromise that is better than the best alternative, i.e. the exit option, will be accepted (interview with Hans-Uwe Neuenhahn, 07.11.2011)[148].

The target of mediation is to identify possible solutions, jointly evaluate them and together agree on one of them (NABU, 2008, pp. 19–20). A person with high standing in society like current or former politicians, academics or other recognized members of the public can be chosen for such a task (Wuppertal Institut et al., 2008, pp. 23–24), as it was done in the conflict about the German rail station project ’Stuttgart 21’[149]. Alternatively, NGOs or professional communication consultants can be hired (interviews with Rotraud Hänlein, 26.09.2011 and Richard Hubmann, 02.11.2011). The discussion parties need to jointly agree on a candidate. Factual conflicts are less likely to be resolved until interpersonal conflicts are settled. The moderator/mediator needs to be independent with a good reputation, must have an adequate qualification and has to be knowledgeable of communication as well as participation tools and methodologies (Meister et al., 2010; interviews with Andreas Fusser, 21.09.2011 and Ivan Stone, 30.11.2011). For instance, a useful moderator’s guide and checklist is provided by the Centre for Public Dialogue (2000). Special guidance for mediation in the permitting process is given by Kanngießer (2004). Finally, the moderator/mediator has to be familiar with the subject of electricity transmission technology terminology and the related authorization process (Sander, 2011, p. 50).

The cost of the moderator/mediator is usually borne by the TSO. However, several interviewees brought up concerns that in case the TSO pays the facilitator, he is likely to be biased with a view to receiving follow-up orders from the TSO in the future. As such, the best solution is cost coverage by the NRA (interviews with Klaus Rohmund, 07.09.2011 and Guido Franke, 04.10.2011). In case this is not possible, a fair split of the expenses between the TSO and the opponents should happen. Action groups usually do not have the money to equally share such costs. So in order to still facilitate an

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[148] This is also refered to as ‘best alternative to a negotiated agreement’ (BATNA) principle within the Harvard concept of successful negotiation developed by Fisher et al. (2011).

[149] The former politician Heiner Geissler was successfully utilized as mediator.

acceptable solution, although the TSO is baring the cost, a pre-selection of candidates should take place by the TSO and stakeholders should be able to make the final choice (interviews with Andreas Fusser, 21.09.2011 and Heinz-Jürgen Siegel, 05.10.2011). Alternatively, involved parties can jointly define a list of required criteria and a profile upfront (interview with Hans-Uwe Neuenhahn, 07.11.2011). Both sides can then identify and propose possible candidates, evaluate them together along the predefined criteria and the profile and then jointly make a choice. In order to avoid bias, the TSO needs to contract the facilitation service as such and not any outcome or content (interview with Markus Troja, 27.09.2011).

In all, the moderation/mediation process needs to be open-ended (interview with Hans-Uwe Neuenhahn, 07.11.2011). Furthermore, the selected facilitator must proactively make his background transparent to all parties (interview with Hans-Uwe Neuenhahn, 07.11.2011). Selection and involvement must take place at the very beginning of the planning process so as to avoid any severe conflict and thus resistance. Unfortunately in the past, facilitators have – if at all – mostly been used as 'fire fighters' once conflict had already come about (interviews with Markus Troja, 27.09.2011, Ralf Eggert, 13.10.2011, Hans-Uwe Neuenhahn, 07.11.2011 and Ivan Stone, 30.11.2011). This is too late and makes a joint agreement on conflicting points difficult as battle lines have already been drawn. When a suitable person is found, all parties need to jointly define and agree on the moderation/mediation process (interview with Markus Troja, 27.09.2011). This process has to be as transparent as possible, i.e. people should know the process steps, their roles in this process and respective rules of the game (interview with Hans-Uwe Neuenhahn, 07.11.2011).

Mediation must start with a baselining of individual interests, concerns and requests (NABU, 2008, p. 15). It must be clearly and transparently communicated that moderation or mediation can be stopped at anytime in the planning process, when one or both parties feel uncomfortable with the process or doubt the neutrality of the facilitator. This will give the facilitator an incentive to remain neutral in order to stay in employment during the process (interview with Hans-Uwe Neuenhahn, 07.11.2011).

The use of an independent facilitator will help to build trust in the process and facilitate the consensus building process (Heiskanen et al., 2008, p. 26; RGI, 2011a). Experience has shown that decisions that have been made via a moderated or mediated process are more sustainable than without external support (NABU, 2008, p. 22). The involved parties should jointly communicate the results of the moderation or mediation process, e.g. in a joint press conference (NABU, 2008, p. 24).

► Use neutral moderation/mediation (2f_MODER)

6.3.2.7 Joint fact finding

As outlined earlier, expert dilemma is one of the obstacles in the transmission line planning process. Action groups often doubt the TSO's feasibility study or project proposal and raise money to commission their own independent counter-assessment. Permitting authorities or NRAs regularly commission such assessments as well, which takes additional time and further delays the planning process (Meister et al., 2010). Each side argues using its own study results and experts which leads to an expert dilemma (interview with Frank Ulmer, 27.09.2011). Disagreements among experts magnifies people's confusion and uncertainty and consequently results in even more opposition (Covello & Mumpower, 1985). TSOs need to trigger a joint fact finding process in order to collect and analyze risks, costs, and benefits of the different siting proposals (Kunreuther et al., 1993, p. 304). Joint fact finding needs to begin at the earliest possible stage in the planning process. Double assessments have to be avoided wherever possible. To foster joint fact finding, TSOs need to invite representatives from the scientific community and academia as well as other independent experts from industry to panels and round tables in order to discuss and clarify facts and figures (Lantz & Flowers, 2010, p. 25; interviews with Klaus Rohmund, 07.09.2011 and Christiane Pölzl-Viol, 28.09.2011). Lengthy independent studies need to be avoided as they take additional time and cause planning delays. However, if opponents still insist on an independent line assessment, both parties need to jointly agree on an independent assessor upfront (interview with Gabrijel Uros, 11.10.2011). Otherwise, in case the TSO were to solely select and pay the assessor, his financial dependence on the TSOs would immediately result in the stigma of biased information (interview with Richard Hubmann, 02.11.2011; Sander, 2011, p. 48). Interviewees reported that costs for independent evaluations range from 80,000 EUR to several hundred thousands of euros (interviews with Hans U. Jakob, 24.10.2011 and Karl Zotter, 10.11.2011). Opponents are in most cases not able to raise such amounts of money. If the authority or NRA neglects financing such an independent assessment, the TSO will have to bare the cost. Thus, to avoid any potential bias due to financing, a joint selection that avoids mistrust is required (interview with Andreas Fusser, 21.09.2011). The identification of experts can be conducted in several ways that were brought up during the interviews:

1) The TSO proposes a short list of independent experts and consultants and then lets the opponents make the final decision (interview with Frank Ulmer, 27.09.2011).
2) Both sides propose a short list of experts. Assessors with obviously extreme or biased positions are then to be deleted from the list. TSO and stakeholders finally jointly agree on one of the remaining experts (interview with Ralf Eggert, 13.10.2011).
3) Each side proposes an independent expert. Both experts then have to conduct a joint assessment and solve discrepancies bilaterally (interview with Andreas Fusser, 21.09.2011).
4) Similarly as in 3), but the experts do not conduct a joint assessment. In fact, one conducts an analysis and the other acts as quality gate, similar to a peer review (Meister et al., 2010).

Once the TSO and the relevant stakeholders have jointly selected an assessor, they should also come to an agreement on the main assumptions and the calculation methods (interview with Markus Troja, 27.09.2011). Moreover, it is essential that both parties agree upfront to accept the study results. Otherwise, the party whose position the study outcomes do not support, will dissociate from it (interview with Hans Kutil, 09.11.2011). However, such an agreement will not avoid that parties might interpret the results differently (Meister et al., 2010). Therefore, an interviewed communication expert proposed the use of the value-tree logic. In particular, TSO and stakeholders have to define what, and to what extent, is important to them (i.e. the respective weighting). The tree logic can then be applied as a guideline for evaluating the assessment results in a structured and objective way (interview with Frank Ulmer, 27.09.2011). If disputes cannot be resolved between the TSO and its stakeholders through a joint and independent assessment, the TSO has to refer to the authorization process itself, which will solve all open issues in legal procedures (NABU, 2008, p. 14). All agreements reached in the joint fact finding process should be documented.

► Foster joint fact finding (2g_JFACT)

6.3.2.8 Flexibility, openness and respect

TSOs need to demonstrate flexibility during the participation process and should not rigorously insist on their initial standpoint (interview with Klaus Rohmund, 07.09.2011). They need to be willing to change proposed plans and allow also for stakeholder influence (BBC Research & Consulting). Otherwise, people will not feel sufficiently involved. TSOs should talk about options and discuss them with stakeholders before anything is finalized (interview with Ivan Stone, 30.11.2011). It must be possible to revise plans, add alternatives or consider the zero-option, i.e. not implementing a project at all (Sander, 2011, p. 14). Interviewees mentioned that TSOs often vehemently insist on their initial proposal and allow at maximum for minor modification to their plans, such as a route change by a few hundred meters (interviews with Karl Zotter, 10.11.2011 and Synnøve Kvamme, 17.11.2011). TSOs need to provide more degrees of freedom. Nonetheless, flexibility should be limited to the extent that it does not lead to significant development risks or cost overruns making the project financially not viable anymore. Flexibility is not only crucial regarding the outcome but also for the participation process. TSOs should point out mandatory elements of the engagement process (e.g. the above described ESTEEM method), but at the same time allow enough flexibility regarding which tools and methods to use during the process (van der Welle et al., 2011, p. 71). TSOs have to continuously assess the 'pulse' of stakeholders and adapt the process adequately (BBC Research & Consulting). TSOs need to anticipate potential issues and develop strategies to address them (canWEA, 2008, p. 5). Moreover, TSOs have to be open-minded toward stakeholder input and show willingness to change things upon request (interview with Klaus Rohmund, 07.09.2011). Staff must be aware that local residents have a right to ask questions, be sceptical, concerned and to oppose TSO plans (canWEA, 2008, p. 5). People should not be confronted with established facts. The participation process needs an rather open outcome. In particular, TSOs have to listen to stakeholder arguments, discuss their opinions and then jointly decide on the next steps. They should strive to develop an atmosphere for cooperation (Renn, 1995, pp. 364–366). Due to their limited technical knowledge, opponents often raise concerns or propose ideas that turn out to be wrong, sound ridiculous or are technically not feasible. TSO staff must not humiliate people because of this, but should rather appreciate any input and point out the correct facts in a comprehensible and polite manner. TSOs should also write thank-you letters to any written objection (canWEA, 2008, p. 8). As such, TSOs should at all times strive to maintain a respectful, fact-based dialogue with stakeholders (canWEA, 2008, p. 7, 12; Upreti & van der Horst, 2004, p. 68). Mutual respect is of utmost importance in the discussion process in order to reach an agreement (Austrian Ministry of Agriculture and Forestry, the Environment and Water Supply, 2011, p. 9).

► Show flexibility, openness and respect (2h_FLEXI)

6.3.2.9 Commitment and bindingness

Stakeholder involvement is ineffective if concerns and objections are not considered at least to some degree by the TSO. In other words, without sufficient TSO commitment and bindingness the process is rather a 'pseudo participation'. Opponents often accuse TSOs of only pretending to be interested in dialogue (Sander, 2011, p. 25). In a study by Becké et al. (2011, p. 4) about stakeholder involvement during an airport project, 98% of the opponents had the impression that their input was not considered adequately in the planning process. Public participation, which is limited to mere commenting on a project proposal, is perceived as a tool to legitimate decisions or as a pretence that the public is being involved (Beierle & Konisky, 2000; Rowe & Frewer, 2000). Instead, an open discourse is required that tolerates stakeholders' standpoints and considers these in the final decision to certain extents. Verbal commitments by the TSO and joint agreements need to be followed by concrete actions and promises must not be reneged upon (Armour, 1991). True commitment and bindingness exists when the decision making power of the TSO is reduced at least to some extent (Schweizer-Ries et al., 2011, p. 16). Stakeholders will recognize when a TSO is just 'hearing' but not 'listening' and therefore pretending stakeholder involvement. TSOs need to give stakeholders the impression that their opinion matters and their input is valuable. Therefore, concerns and requests must be taken seriously which in turn will create trust (canWEA, 2008, p. 5). In contrast, discrediting stakeholder input will enhance opposition even more. People need to see the TSO as being fully committed to the participation process and not just involving stakeholders because it is required to do so by law. Objections must not only be received but need to be also sufficiently discussed. TSOs cannot simply block any risen stakeholder objection. They also need to accommodate people with offering compromises (RGI, 2012, p. 1) such as the implementation of mitigation measures, a rerouting of the line or additional compensation payments. To ensure accountability, participants need to be able to follow-up on performance and have avenues of recourse in case they see that agreements and promises are being ignored (Branch & Bradbury, 2006; Sander, 2011, p. 14).

► Show commitment and bindingness (2i_BINDI)

6.3.2.10 Transparent decision making

Stakeholders have an inherent interest that all decisions throughout the planning process are made in a transparent way (interviews with Synnøve Kvamme, 17.11.2011 and Philipp Godron, 24.11.2011; WCD, 2000, p. 215). TSOs often internally select a certain route and transmission line design and then file a respective application to the authority. Opponents have no transparency on how the TSO's proposal was drawn up and why other options have been ruled out a priori. Van der Welle et al. (2011, p. 64) point out that it is essential to distinguish between the project itself, i.e. the physical transmission line and the project process, which is the series of decisions. Opponents may not necessarily be satisfied only when the transmission line is abandoned, but rather when all affected stakeholders agree that the decision process is transparent. If this is done to their satisfaction, they are more likely to accept the outcome of it, although it might not be in line with their individual preferences. Thus, TSOs must avoid the impression of making decisions behind the scenes (RGI, 2012, p. 1). Stakeholders often request the decision making process as such to be as clear, fair and transparent as possible (Sander, 2011, p. 13). They require procedural justice (Dore & Lebel, 2010; Huber & Horbaty, 2010, p. 15). For the public it should be discernible during the whole process which decisions are being made by the TSO and how the decision making is taking place (Branch & Bradbury, 2006; Dütschke, 2011, p. 6240; Rowe & Frewer, 2000). TSOs have to sufficiently present the details of how different line alternatives have been evaluated upfront and why a certain option was selected. Furthermore, during the planning process, a TSO needs to make transparent to what extent it has considered people's concerns and objections in the final decision and provide a clear reasoning in case it has not taken their input into account. To ensure transparency, TSOs should document all relevant decisions and proactively communicate them to the affected stakeholders promptly.

► Ensure transparent decision making (2j_DECMA)

6.3.3 Economic benefits

6.3.3.1 Local benefits

As already outlined in chapter 6.2.3.4 above, the lack of direct benefits and the distributional unfairness regularly cause people to oppose a transmission line. If people are to carry a burden, they want to either be compensated or participate in the benefits and receive a share of the profits in turn. In contrast to other infrastructure installations like streets or electricity distribution lines, residents usually do not gain any advantage from a passing-by transmission line but must bare the burden of visual impact and other negative effects (EPRI, 2001, p. 3.3; SRU, 2011, p. 324). Moreover, transmission lines usually neither create tax incomes for the local municipality nor do they create local jobs. Many new wind turbine installations have recently come with a financial model by which locals can invest in the project and receive regular returns (Huber & Horbaty, 2010, p. 45, 51; Jobert et al., 2007, p. 2759; Krohn & Damborg, 1999, p. 956; Renewable Energy Focus, 2011; Toke et al., 2008). Such benefit sharing models have turned out to reduce public opposition significantly. Pioneer in introducing such civil models was Denmark. The Danish language even has its own word 'Vindmøllelaug' for this type of participation, which basically means wind turbine cooperative (Köpke, 2012). In contrast to wind turbines, this does virtually not exist for power transmission lines. An only pilot example can be found in Germany, where the TSO Tennet has recently offered the affected residents a 'citizen bond' for its planned transmission line between Niebuell and Brunsbuettel. The amount of financial participation was limited to 15% of the total line investment. People could buy the hybrid bond with an interest rate of 3% per year that increases to 5% once line construction starts (Tennet, 2013). Although private investment will only bare a small part of the overall project cost, it is still likely to reduce people's opposition against the line. People might feel to be part of it somehow (interview with Guido Axmann, 27.09.2011). However, according to Kunreuther et al. (1993, p. 302), there is a general agreement that benefit-sharing should be introduced as a part of the process only after the affected public is convinced that appropriate mitigation and control measures will be in place so that the risk associated with the facility is considered to be acceptable. TSOs need to offer such local financial participation models proactively and must not wait until concerned residents ask for it (interviews with Karl Zotter, 10.11.2011 and Mia Paukovic, 16.11.2011). Local residents and directly affected stakeholders should be granted priority investment rights. The closer people live to the transmission line and the more negative impacts from the installation they have to suffer, the more investment rights they should receive as compensation.

► Ensure local benefits (3a_LOCAL)

6.3.3.2 Individual compensations

As already described, compensation paid by the TSOs to landowners and farmers is not regarded as being sufficient. TSOs need to propose direct compensation for unavoidable impacts proactively and only after all other mitigation efforts have been evaluated (RGI, 2011c, p. 6). Otherwise, people would see this as an attempt to bribe and to buy support (Haggett, 2011, p. 23; Schively, 2007). This is also emphasized by Schweizer-Ries et al. (2010) who argue that monetary compensation is only desired by people if the line cannot be avoided anymore. TSOs must offer compensation in an open and transparent way and set certain standards (interview with Mike O'Carroll, 20.09.2011). Private individual negotiations and agreements will create distrust among the citizens (interview with Caroline Paterson, 07.12.2011). TSOs have to negotiate compensation with affected people by themselves. Interviewees condemned TSOs for outsourcing this task and sending land agencies or lawyers instead (interview with Caroline Paterson, 07.12.2011). TSOs need also pay attention to professional consultants[150] who advice citizens on how much compensation they should request from TSOs and support them in litigations and legal cases. In contrast to the additional costs of UGC systems, NRAs usually accept the compensation payments of TSOs. TSOs have to make this clear to the affected landowners, otherwise it will appear questionable to people why compensation payments are possible but additional expenses for undergrounding are not (SRU, 2011, p. 327). Compensation payments regularly account for around 4% of the total project cost (Deutscher Bundestag, 2011). TSOs need to announce clear rules upfront who is eligible to receive individual compensation and who is not. For instance, a line corridor needs to be defined and it must be stipulated that all landowners living within this zone will receive compensation (interview with Marian Klobasa, 12.10.2011). Farmers require recurring payments in addition to one-time compensations for areas crossed by a transmission line (interview with Wolfgang Krüger, 21.09.2011). TSOs have to carefully define the amount of payment. It must be sufficiently high in order to satisfy people’s requests but should be also limited to some extent in order to avoid inflationary demand (interview with Heinz-Jürgen Siegel, 05.10.2011). According to Schively (2007, p. 260), monetary compensation only works if the amount of compensation is large enough to offset the negative externalities of the proposed facility. Furby et al. (1988b, p. 33) report that in case land has to be taken, TSOs will be tempted to limit compensation amounts to the market value of the affected property. However, this will in most cases leave landowners feeling discriminated against the rest of society, as they do not plan to sell their property. A higher monetary compensation might reduce people’s perceptions that they have suffered a net loss and thus made an unfair sacrifice, while at the same time society, i.e. the remaining electricity consumers, reaps the benefits (Furby et al., 1988b, p. 33). In other words, every Euro spent above market value will reduce opposition to a line. Also O'Hare et al. (1983) strongly argue for the value of monetary compensation in reducing public opposition. TSOs can also offer a home value insurance as

[150] For instance Cambridge Land Consultants Ltd. (www.cambridgelandconsultants.com).

an alternative compensation measure which reimburses homeowners if their property values will not increase in accordance with the neighbourhood or regional price index (Fischel, 2001). Instead of money, in-kind payment is also possible. This can entail for instance the planting of trees in front of a house in order to protect from electrical fields (Leitgeb, 2008, p. 5). Moreover, the installation of noise protection windows or room isolation against EMF as illustrated in figure 48 can be applied (interviews with Andreas Fusser, 21.09.2011 and Karl Zotter, 10.11.2011).

Figure 48: Room isolation against EMF (Jakob, 2011).

Next to the aforementioned positive effects of sufficient individual compensation, it has to be emphasized that there is also a certain level of scepticism. Specifically, direct compensation is not desired by all opponents. There are also people who do not want to receive any compensation payment but simply want the transmission line to be put underground with the newest transmission technology (interview with Ralf Messerschmidt, 07.09.2011; Schweizer-Ries et al., 2010, p. 28). "In particular, for siting facilities that have potential environmental or health impacts, an emphasis on risk compensation rather than risk reduction may result in severe distrust rather than acceptance by residents" (Chung et al., 2008, p. 1023). In the context of siting nuclear waste facilities, Kunreuther et al. (1990, p. 478) state that "compensation will not increase the utility of the repository as long as the risks are perceived to be serious". Offering monetary compensation may be viewed as a signal that the installation imposes a risk where before concerned people thought it was non-existent (Kunreuther et al., 1990, p. 480). Similar findings were made by Sjöberg & Drottz-Sjöberg (2001). In their study about a planned transmission line, Schweizer-Ries et al. (2010, p. 28) conclude that financial compensation is regarded not as a sufficient factor to reduce public opposition. Nevertheless, as there are at least some sources that state a possible positive effect of individual compensation on reducing resistance, it should be included as a potential success factor in the work at hand.

► Provide sufficient individual compensations (3b_INDIV)

6.3.3.3 Municipality compensations

Next to compensating individual landowners, TSOs should also provide financial payments to municipalities. This ensures that also those residents will receive a kind of benefit who are not living directly under or next to the line but still face visual impact for instance. In several countries, NRAs even explicitly allow for the reimbursement of compensation payments to municipalities. For instance, in Germany this is limited to EUR 40,000/km for OHLs[151]. In Austria, a municipality received up to EUR 69,000/km. Further such cases are reported from France (interview with Rotraud Hänlein, 26.09.2011) and Italy (Roland Berger, 2011b, p. 197). To determine the adequate amount of money, TSO could consult aesthetics experts including artists who make judgements about the impact on the scenic beauty (Gussow, 1977). To avoid the one-time character of a compensation payment, TSOs could for instance donate an annual fixed rate or rate per transmitted GWh to the municipality (interview with Ortwin Renn, 14.10.2011). The latter would also give the residents transparency as to what extent the line is utilized. Next to direct monetary payments, TSOs could also apply in-kind transfers (EPRI, 2001, p. 2.6). Such measures in general improve the recreational value of the municipality and its surroundings (Roland Berger, 2011b, p. 197). Examples are the installation or funding of parks, schools, swimming pools, play grounds or fountains. Next to that, also afforestation and the creation of environmental protected areas represent possible measures (interviews with Marcel Keiffenheim, 30.09.2011 and Marian Klobasa, 12.10.2011). Another possibility is organizational or financial support of community driven projects or local environmental organizations (interview with Andreas Fusser, 21.09.2011; Rogers et al., 2008). It needs to be emphasized that TSOs should not rely on compensation to municipalities only. It must be combined with compensations to those individuals who are most affected by the new transmission line. Several interviewees mentioned that landowners facing significant devaluation through the transmission line installation would not sufficiently benefit from the general municipality compensation alone and thus public opposition would not be reduced significantly (interviews with Heinz-Jürgen Siegel, 05.10.2011, Peer Schulze, 06.10.2011 and Marian Klobasa, 12.10.2011). In other words this means that municipality payments have to be seen complementary to individual compensation. If there are too many residents along the line, individual negotiations would require a significant amount of time and put the project timeline at risk. In such a case the TSO should pay a total compensation sum directly to the municipality and ensure that it distributes the money to the directly affected landowners.

► Provide sufficient compensations to municipalities (3c_MUNIC)

[151] According to §5(4) German Electricity Grid Charges Ordinance (Stromnetzentgeltverordnung - StromNEV).

6.3.3.4 Socio-economic benefits

As stated earlier, people oppose transmission lines as they do not see direct benefits but only the burden for them. In today's developed world, it has become almost impossible not to live close to an infrastructure installation. TSOs need to make this clear to people. Someone always has to take the burden for others. Everyone receives electricity from the socket, but does not necessarily live close to a power plant. People drive cars on the motorway and ride trains but often do not live directly next to a motorway or train line. Furthermore, they produce waste on a daily basis, but most do not live next to a waste facility. This is similar to the installation of a transmission line. If people do not recognize the benefits for society as a whole from the line, they will not accept it (interview with Ortwin Renn, 14.10.2011). TSOs have failed in the past to communicate potential socio-economic benefits in a transparent way to concerned people (interview with Marian Klobasa, 12.10.2011). Thus, they have to proactively explain the relationship between the local transmission line and the whole energy system on national or even European level. They have to make clear, how important the line is for society and to what extent it positively contributes to social welfare (ENTSO-E, 2012a, p. 161; interview with Andreas Fusser, 21.09.2011). A major benefit is the potential reduction of system operation costs by allowing the dispatch of more efficient generators in one area (e.g. areas with higher sun irradiation or wind resources) and transporting electricity to the demand centres instead of using less efficient units directly at the consumption site. Moreover, transmission expansion leads to an increased security of supply and may increase market competition (Altmann & Brenninkmeijer, 2012; ENTSO-E, 2012a, pp. 15–16). Societal benefits of a transmission line can be calculated in monetary terms through transmission system modeling and a related cost-benefit analysis. Mirumachi & Torriti (2012) outline the use of a cost-benefit analysis in a hydropower case study. The excursus below will briefly outline how such an analysis can be applied for a transmission line.

6.3.3.5 Excursus: Social cost-benefit analysis of a new HVDC line between France and Spain

This section exemplarily shows how to conduct a social cost-benefit analysis of an electricity transmission line and builds on a separate work of Perras et al. (2014). The fundamental economic impact of a transmission line expansion is that it makes the system more efficient and thus leads to a more economicial dispatch (CAISO, 2004). The outlined approach helps a TSO to model and calculate the overall socio-economic contribution of its planned transmission investment. The results can be used to give opponents an understanding of the related societal benefits and by that reduce public opposition against a TSO's expansion project.The line evaluated in this example is the planned HVDC VSC UGC interconnection between France and Spain with a capacity of 2,000 MW and a length of 65 kilometres. It is currently being installed and is expected to be operational in early 2015. It should alleviate the severe grid bottlenecks in the Eastern border region between the two countries.

In a social cost-benefit analysis, all project related costs are compared with the indirect benefits from it for society. The latter is mainly determined by the socio-economic welfare effects arising through the project installation. According to ENTSO-E (2012a, pp. 16–17), new transmission line investments should positively address socio-economic welfare. It is calculated using classical economic surplus measures and comprises consumer rent, congestion rent as well as producer rent (see figure 49[152]).

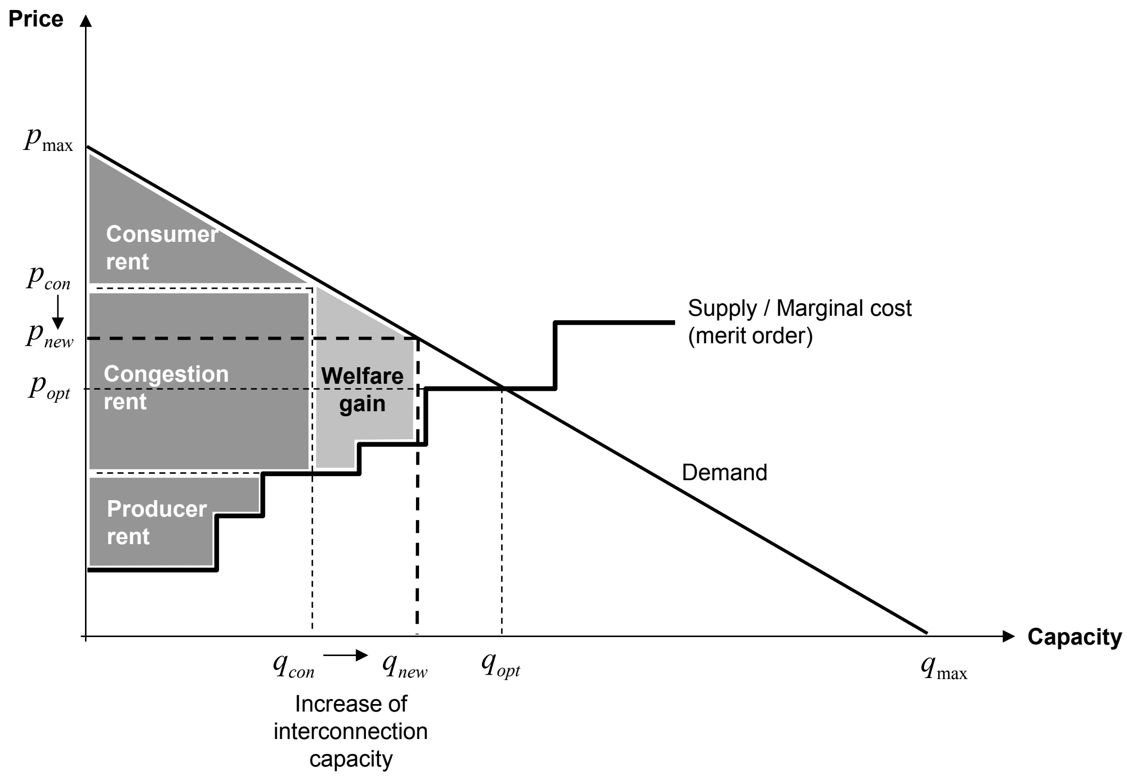

Figure 49: Socio-economic welfare gain through an increase of interconnection capacity.

The existing transmission line capacity q_{con} between two regions is congested. It is increased to q_{new} through the installation of the new interconnection line. At the optimal line capacity q_{opt} the welfare is maximized. The consumer rent is the benefit of electricity consumers having to pay less than they would be willing to. Similarly, producer rent is the additional revenue electricity producers generate when they are able to sell at higher prices than their generation costs. Congestion rent is a TSO's additional revenue from power flows between regions by utilizing price discrepancies. According to ENTSO-E (2012a, p. 156), the modeling assumes perfect competition, which means that all producers sell at their production costs. Socio-economic welfare is calculated prior to and after the installation of a new line. The resulting difference represents the welfare gain caused by the line expansion. To determine the welfare effects, the example at hand uses ELMOD, which today is one of the larger engineering-economic models (Leuthold et al., 2005). It approximates AC line flows via the DC load flow approach and uses nodal pricing. ELMOD maximizes total welfare W across all grid nodes n which is determined by a node specific linear inverse demand function and the respective

152 A detailed description of the socio-economic assessment methodology can be found in CAISO (2004).

merit order, i.e. supply function (Eq. (6.3)). To calculate the demand functions, a price elasticity of -0.25 (Green, 2007) and a reference price of EUR 60/MWh as the average of current annual spot prices of the respective European electricity exchanges are used[153].

$$\max_{g,q} W = \sum_{n} \left(\int_{0}^{q(n)} np(q(n))\, dq(n) - \sum_{p} \left(c(p,n)\, g(p,n) \right) \right) \tag{6.3}$$

with	p	power plant type
	$q(n)$	electricity demand at node n
	$np(q(n))$	linear inverse demand function
	$c(p,n)$	marginal generation cost of power plant p at node n
	$g(p,n)$	generated electricity of power plant p at node n

Furthermore, at each grid node demand and supply need to be equal to the best possible dispatch (Eq. (6.4)). The variable $netinput(n)$ accounts for any residua, i.e. electricity injection or withdrawal at grid nodes. Due to their technical characteristics, HVDC lines cannot be modeled with the DC load flow approach. Thus, the HVDC lines are considered in the model as point-to-point connections by including their directed positive flows $P_{HVDC}\ (n,nn)$ in the energy balance for both the import and export direction. To approximate N-1 security in the AC network, a transmission reliability margin of 20% for all AC lines is included as proposed by Leuthold et al. (2012). Equations (6.5), (6.6) and (6.7) ensure that line flows and electricity generation stay within maximum capacities.

$$\begin{aligned} 0 = {} & q(n) + q_{psp}(n) - g_{wind}(n) - g_{pv}(n) \\ & - \sum_{p} g\ (p,n) + netinput\ (n) \qquad \text{nodal energy balance} \\ & + \sum_{nn} P_{HVDC}\ (n,nn) - \sum_{nn} P_{HVDC}\ (nn,n) \end{aligned} \tag{6.4}$$

with	$q_{psp}(n)$	electricity consumption of pumped hydro storage plants (PSP) at node n
	$q(n)$	electricity demand at node n
	$g_{wind}(n)$	wind generation at node n
	$g_{pv}(n)$	solar PV generation at node n
	$g(p,n)$	generation of all other power plants p which could be localized exactly and assigned to a node n
	$netinput\ (n)$	injection or withdrawal of electricity at node n

[153] For details how to derive the demand function see Leuthold et al. (2012).

$$|P(l)| \leq P_{\max}(l) \quad \text{capacity constraint of AC lines}^{154} \qquad (6.5)$$

$$P_{HVDC}(n,nn) \leq P_{HVDC\max}(n,nn) \quad \text{capacity constraint of DC lines}^{155} \qquad (6.6)$$

$$g(p,n) \leq g_{\max}(p,n) \quad \text{maximum generation constraint} \qquad (6.7)$$

Electricity generation data is taken mainly from EC DG Energy (2010) and ECN & EEA (2011). Detailed figures are listed in appendix 11. Marginal generation costs are calculated based on Müller (2001) and IEA & NEA (2010) and are outlined in appendix 12. Country specific capacity factors are determined respectively and can be found in appendix 13. The reference year is 2015 as this is the first full year the new HVDC line will be under operation. Due to the fact that location specific information on solar and wind generation is rare, national capacity is distributed via GIS software to the respective grid nodes according to wind resource and solar irradiation data. Yearly electricity consumption and hourly variations are derived from ECN & EEA (2011) and ENTSO-E (2011d).

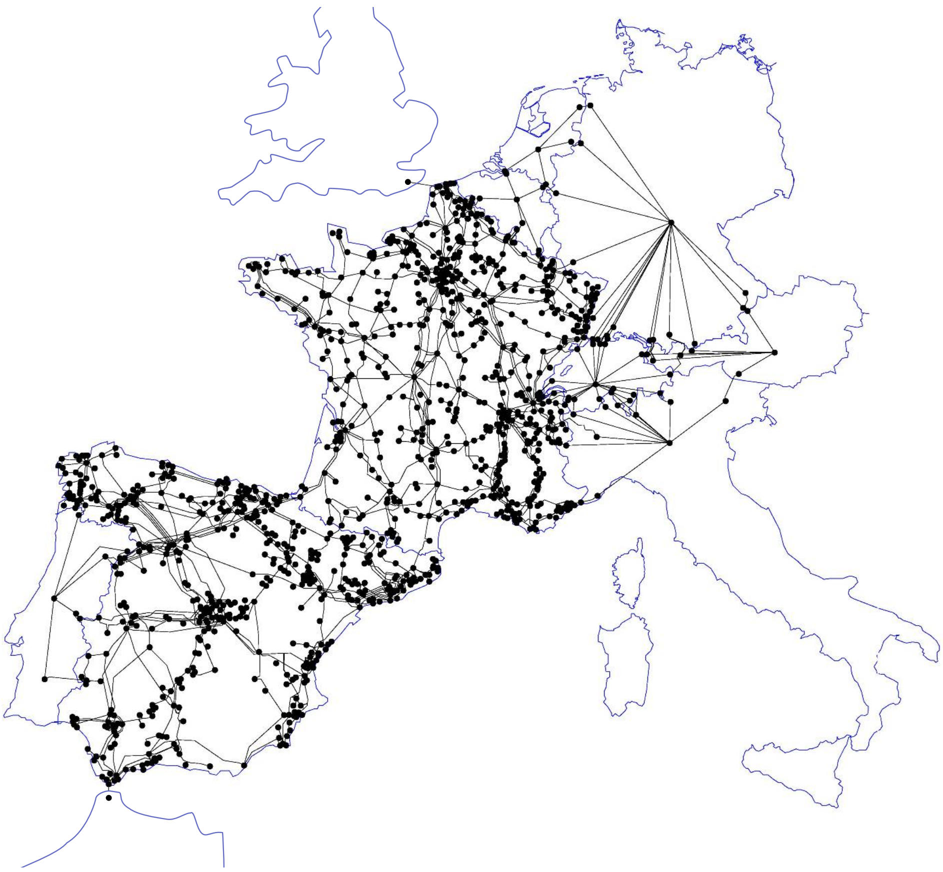

Figure 50: Transmission grid scope for modeling.

[154] Line losses for AC lines are included via respective resistances and reactances.

[155] HVDC converter losses are included with 1.7% per station (Cole et al, 2006, p. 23). HVDC line losses are neglected due to the short line length of 65 km.

Grid node allocation is done through the correlation with available economic income per NUTS-3[156] level. To account for loop flows, the detailed transmission grids of 220 kV and above in France and Spain are included. All neighbouring countries are integrated by consolidated nodes (see figure 50 on previous page).

Welfare gains are modelled for a representative year via several representative hours and then scaled up to the total of 8,760 hours. The complete model is coded[157] and solved as a non-linear problem in the General Algebraic Modeling System (GAMS)[158] with a CPLEX solver. The calculation results in table 8 show in total a positive annual welfare gain of EUR 0.5 million. Consumers benefit as they can source more electricity at a lower price from other regions through the increased transmission capacity. TSO's congestion rent also increases as more electricity is transmitted to utilize the price differences between regions. Producers in turn lose rent as the overall price deteriorates through increased competition.

Table 8: Annual socio-economic welfare effects through installation of new HVDC line.

Annual gain in million EUR	
Consumer rent	5.5
Producer rent	-9.9
Congestion rent	4.9
Welfare	0.5

Next to socio-economic welfare gains, there is another benefit through a new transmission line that has to be included in the social cost-benefit analysis: the release of grid bottlenecks by the new installation leads to an increased security of supply. One possible way to calculate this effect is to determine the potential savings of avoided peaking power plant capacity that does not have to be kept available anymore in order to avoid blackouts (de Nooij, 2011, p. 3101). According to the Commission for Energy Regulation (2011), the standby costs of an open cycle gas fired power plant are around EUR 75/kW per annum. The nominal backup capacity avoided can be assumed to be 30% of the interconnector capacity increase of 2,000 MW. With a transmission line life-time of 40 years (Golder Associates & ECOFYS, 2008, p. 178) and a discount rate of 8% (DENA, 2010, p. 189) this benefit leads to a net present value (NPV) of EUR 737.6 million. To finalize the cost-benefit analysis, all project related costs have to be considered and compared to the benefits described above. A proposed transmission line expansion is considered as beneficial when the socio-economic welfare change and

[156] The Nomenclature of Statistical Territorial Units (NUTS) is a standard hierarchical system for dividing up economic territories of the EU.

[157] The detailed code can be found in appendix 14.

[158] For details see www.gams.com.

the benefits from security of supply are greater than the corresponding costs. Investment costs of the planned HVDC line are EUR 700 million. Annual operation expenses sum up to around EUR 3.5 million which leads to a net present value of EUR 30 million. Table 9 summarizes all discounted benefits and costs. There is an overall positive net present value of EUR 42.4 million which means that society benefits from the installation of the new transmission line.

Table 9: Discounted[a] benefits and costs of new HVDC line.

In million EUR	**Benefits**	**Costs**
NPV welfare	8.9	
NPV security of supply	737.6	
CAPEX		-700.0
NPV OPEX		-30.0
NPV total	**42.4**	

[a] Life-time 40 years, discount rate 8%

TSO should use such cost-benefit calculations to show concerned citizens that new power transmission lines are beneficial to society as a whole. It gives the people the confidence that the TSOs have evaluated the required need for a line also from a socio-economic perspective. Moreover, it would address people's requests for more fact based information as outlined earlier in this work.

► Clearly argue and communicate socio-economic benefits (3d_SOCIO)

6.3.4 Organizational readiness

6.3.4.1 Stakeholder analysis and management

As previously outlined in chapter 3 on the fundamentals of social acceptance, stakeholders differ in demographics, risk perception as well as attitudes towards and motives against transmission lines. Therefore, TSOs have to conduct a comprehensive stakeholder analysis at the very beginning of the transmission line planning process to gain transparency about them. TSOs need to have an overview of the local community itself, its environment and stakeholder structure. Information about the economic conditions, political landscape, demographic structure, opinion leaders and the community's history can be gathered through available statistical and socio-economic data, surveys, site visits, interviews, or the aforementioned pre-polls (canWEA, 2008, p. 6). In addition, a geographical profile should be developed which analyses the environment, evaluates the scenery and lists already existing large infrastructure installations (interview with Ivan Stone, 30.11.2011). Stakeholders themselves can be identified through internet searches, continuous local press monitoring, prior informal talks and interviews in which people are also asked to name further possible stakeholders and contact persons (canWEA, 2008, p. 8). To identify potentially affected landowners, TSOs should contact the local registration office or land registry. Once a TSO has identified the stakeholders, it needs to ascertain their opinions, concerns, and interests as well as to estimate their potential reaction to the announcement of the line expansion plan (ENTSO-E, 2012a, p. 158; interview with Ivan Stone, 30.11.2011). All results should be summarized in a community profile and stakeholder map. Table 10 lists the general stakeholder groups and their main interest with regard to a transmission line project. It should be noted that motives can sometimes also be contradictory across stakeholder groups leading to a conflict of interest between them. An example are residents who want to put the transmission line underground. In contrast, local farmers will ask for an OHL solution as it does not limit their land use to the same extent as an UGC system would do. Toke (2005) points out that opponents often do not represent the opinion of the majority of affected stakeholders. However, they can still fight a successful campaign and delay or even completely block a project. For a TSO, this means that all relevant stakeholders or stakeholder groups need to be identified and evaluated according to their attitudes and have to be carefully managed.

Table 10: General stakeholder groups and their main interests (partly based on EPRI (2001, p. 5.3)).

Stakeholder group	Main interests
Citizen action groups/ Community associations/ Landowners	Avoid health and safety issues; reduce/avoid visual impact; maintain property value; gain transparency and achieve stakeholder involvement; be present in the media to keep momentum and motivation of group members
Environmentalists/ Wildlife activists/NGOs	Prevent harm to flora and fauna; avoid negative social impacts
Farmers	Maintain crop and dairy yield; avoid limited land use
Local businesses	Avert loss of profits (e.g. tourism)
Media/Press	Create transparency about transmission project and inform people on possible negative impacts; publish stories that 'grab' the audience
Municipality/ Local authority	Avoid negative impact on attractiveness of community and reduced quality of living
Politicians/Officials	Win election or keep mandate by supporting concerned people; avoid being caught unaware by the media or the public
Silent majority	Being kept informed in a comprehensible manner; 'wait and see'

Furthermore, attention needs to be paid to the silent majority. These people usually do not actively oppose a transmission line. However, they can become opponents at any time throughout the planning process. TSOs must not neglect this group just because they are not constantly putting themselves in the limelight as NGOs or action groups use to do (interviews with Ivan Stone, 30.11.2011 and Padraig O'Reilly, 02.12.2011). Attitudes of people can change throughout the project, which means that TSOs have to conduct continuous monitoring and evaluation of the respective stakeholders (Heiskanen et al., 2008, p. 89). Healey (1998) also describes this problem in an example of spatial planning in the UK. In her case, developers made the mistake and viewed stakeholders' attitude as fixed. This led to a too late recognition of changing stakeholder attitudes and the development of severe opposition. Thus, stakeholder analysis needs to be an ongoing process.

The degree to which stakeholders have an influence on a project can also differ (Heiskanen et al., 2008, p. 89). This can be in terms of their power to influence, their basis of legitimacy or the urgency of their claim (Mitchell et al., 1997). Chapter 3 above described the fundamentals of social acceptance. In particular, stakeholder differences regarding attitude and activity were detailed in chapter 3.1 and distinguished on local versus national level. Chapter 6.2 elaborated on the different motives people have in opposing a transmission line and chapter 3.2 discussed the different contextual factors that can influence individuals' motivations. TSOs need to be familiar with these fundamentals in order to conduct a successful stakeholder analysis. The stakeholder analysis in turn is the basis for ongoing stakeholder management, i.e. the TSO needs to determine a strategy and process for each individual stakeholder or stakeholder group and continuously review it. In particular, the TSO has to decide how and when to provide information to people, educate them, invite them for participation, listen to them, address their concerns, etc. The work by EPRI (2001) represents a suitable guideline for this and even provides several useful templates. As a TSO interacts with many different stakeholders throughout the planning process, it is essential that it develops a database of names, contact information, recent interactions as well as the people's main concerns and requests. This will help the TSO to ensure an efficient management process. When communicating with stakeholders repeatingly, the TSO can refer to previous interactions with them and thus give them the feeling that they matter and that it has taken their concerns into consideration. The TSO can furthermore ensure that identified stakeholders are not forgotten or left out in following participation and communication activities. There are several software programmes available that support TSOs in tracking stakeholder interactions (canWEA, 2008, p. 7)[159].

► **Conduct stakeholder analysis and management (4a_ANALY)**

6.3.4.2 Qualification and development

As already outlined, interviewees claimed that the attitude and behaviour of TSO staff in the interaction with stakeholders was not always adequate. According to EPRI (2001, p. 6.10), "choosing the person who will act as the company's spokesperson to a particular audience is one of the most important decisions a company can make (…). A person who does not 'connect' with the audience will not get their attention and may in fact arouse hostility." The majority of TSO employees are electrical engineers. Many of them do not have a professional education in communication,

[159] One example is the programme SCORPIO from the British communication consultancy 3G Communications (http://www.3gc.co.uk/communication.php?content_id=21040).

presentation and conflict management skills. “[T]hey are often unable to convey technical issues in lay language” (EPRI, 2001, p. 6.10). In addition to this, employees have usually a high level of commitment to their projects and are often very good at warding off criticism towards it (Berglund, 2005). According to a study by Deutscher Städte- und Gemeindebund (2005, p. 2), proper qualification of the developer’s personnel is key for stakeholder communication. Zane et al. (2012, p. 192) found the lack of competence of some TSO staff being a barrier in grid development. Hance et al. (1990) warn to use company lawyers, as they may create the impression of a TSO organization which is more concerned about the letter of the law than people’s welfare. Instead, TSO staff needs to have sufficient interpersonal skills in order to be able to successfully deal with opponents. More specifically, employees must be polite and demonstrate a high level of empathy towards people (Deutscher Städte- und Gemeindebund, 2005, p. 9). They have to be capable of dealing with emotional situations, should withstand pressure, must not take accusations personally, need continuity and have to remain calm as well as objective in conflict situations (interview with Klaus Rohmund, 07.09.2011). Media training is also helpful when dealing with the press. TSO employees who are present locally and are discussing with the stakeholders also should have some authority to make decisions or recommendations within the TSO organization (EPRI, 2001, p. 6.11). Otherwise, they always have to put the stakeholders off and come back to them later which is quite frustrating for the people. TSO staff should be comfortable with talking to concerned people (interview with Ivan Stone, 30.11.2011) and gaining their trust, which is essential when conveying messages (Lantz & Flowers, 2010, p. 25). In conversations, employees need to listen, be patient, adopt a gentle tone of voice and reflect people’s concerns (canWEA, 2008, p. 26). Every major interaction with stakeholders should be thoroughly prepared and rehearsed (interview with Hans-Uwe Neuenhahn, 07.11.2011). Moreover, role plays among TSO employees beforehand can help to create an understanding of opponent’s viewpoints and prepare for possible objections and difficult upcoming questions. The book by Fisher et al. (2011) on the Harvard concept of successful negotiation provides useful guidance for the preparation of TSO staff for future discussions.

TSO personnel, who have contact to stakeholders, must be sufficiently briefed with information about the current status and details of the project in order to be able to answer any question (interview with Padraig O'Reilly, 02.12.2011). If they treat opponents with respect, are empathetic, show understanding and develop a constructive relationship with them, people will increasingly view the TSO employees separately from the project itself (Heiskanen et al., 2008, p. 111; interview with Ivan Stone, 30.11.2011). This is essential to solve conflicts and find compromises on an objective base. Arrogance and ‘know-it-all’ attitude must be avoided at all times.

Technical knowledge needs to be taught continuously as well, i.e. TSO personnel need to be familiar with recent technical innovations and new transmission technologies. Interviewees claimed that TSO employees often lacked detailed knowledge of UGC systems or HVDC (interview with Heinz-Jürgen

Siegel, 05.10.2011). Regular training with the help of manufacturers or suppliers of transmission technology as well as research institutes can help a TSO to develop its staff's skills.

TSOs need to pay attention to the above mentioned qualifications when hiring employees for stakeholder management. They have to carefully select the employees who are going to interact with concerned people. Simply hiring a communications expert will not solve the problem as he will most probably lack the technical know-how (interview with Ralf Eggert, 13.10.2011). Finally, to develop their employees, TSOs need to setup comprehensive and continuous internal training programmes which impart interpersonal and soft skills as well as recent technical innovations (interview with Markus Troja, 27.09.2011).

► Ensure proper qualification and development of staff (4b_QUALI)

6.3.4.3 Sufficient resources

Roland Berger (2011b) mentioned in their report that TSOs sometimes create authorization delays themselves by not allocating sufficient internal resources to handle the permitting procedure. As a result, application documents are handed in incomplete or not in the required quality and responses to authorities' requests are made too late (Roland Berger, 2011b, p. 4; SRU, 2011, p. 298). A prerequisite for successful stakeholder management throughout the planning process is that TSOs dedicate sufficient resources in terms of money, personnel and time to it (Schweizer-Ries et al., 2011, p. 91). A significant and non-negotiable amount of money has to be reserved for stakeholder management activities and included in the overall project budget from the very beginning (canWEA, 2008, p. 10). Costs for communication, moderation and mediation activities have been totally underestimated by TSOs in the past (interview with Ralf Eggert, 13.10.2011). TSOs must not cut communication budgets if project cost overruns are likely in the course of the planning process. This would be counterproductive, would not reduce project delays and spur the risk of even higher overall costs in the end (interview with Ralf Eggert, 13.10.2011).

In terms of personnel, TSOs have to pay attention that an adequate number of employees are deployed with the right qualifications (see chapter above). Nominating only one or two persons to manage all stakeholders in a transmission line project is insufficient.

Finally, spending enough time on stakeholder management is essential. It must not be a part time job. In fact, selected TSO staff need to be fully dedicated to the tasks and activities. Continuous monitoring and evaluation of people's opinions, local presence, preparation of communication activities in dealing with affected stakeholders, etc. require a significant amount of time if conducted properly (de Meyer et al., 2002, p. 65).

► Deploy sufficient resources for stakeholder management (4c_RESOU)

6.3.4.4 Internal coordination

Within the TSO organization, clear roles and tasks need to be defined when dealing with stakeholders. The best way to organize for successful stakeholder management is to set up an internal stakeholder team for each project. Next to core team members who are dedicated full-time to project stakeholder management, the team should be complemented by a technical project manager, an asset manager and members of the communications as well as the public affairs department. Further support staff is also helpful. Roles, responsibilities, ownership, tasks and rules need to be clearly defined and assigned to the team members (canWEA, 2008, p. 10; Deutscher Städte- und Gemeindebund, 2005, p. 2). All activities have to be sufficiently coordinated internally (Deutscher Städte- und Gemeindebund, 2005). Thus, one team member should be appointed as team leader and overall coordinator. Adequate authority must be granted to him as he has to interact across the TSO organization. All involved employees need to meet on a regular basis and update each other on the latest project status and stakeholder activities, concerns, etc. Overall coordination is especially important if external parties like communication consultants, local authorities or even stakeholders are involved in the activities.

► Ensure proper internal coordination (4d_COORD)

6.3.4.5 Cultural change

Interviewees mentioned that TSO organizations need a cultural change. According to them, TSO employees engage still in traditional thinking in terms of 'Decide-Announce-Defend'. The mindset is rather confrontational (interview with Mike O'Carroll, 20.09.2011). In particular, formerly state-owned TSOs that have recently been unbundled and privatized are accused of still having a rather forceful culture. Members of staff who have been working for a TSO organization for more than a decade must not continue to insist on OHL systems being the one and only solution for transmission line expansion. They need to change their old habits. In other words, they have to be open for alternative solutions like UGC systems and acquire relevant competencies in those fields (interviews with Heinz-Jürgen Siegel, 05.10.2011 and Padraig O'Reilly, 02.12.2011). A TSO has to implement a company culture that welcomes and values stakeholder involvement and understands that successful transmission line expansion is not possible without it. Concerned people should not be seen as 'enemies' but rather as customers. A change of mentality is necessary and stakeholder involvement needs to become a cultural imperative within the TSO's organization. Cultural change takes time and needs to be planned and driven thoroughly within an organization in order to be successful. Cameron & Green (2009, pp. 255–280) provide a guideline for such a cultural change.

► Foster development of social acceptance orientated culture (4e_CULTU)

6.3.4.6 Top-management support

Top-management support is a widely accepted general success factor in the literature that has been identified in many organizational and project studies (e.g. Li Kam Wa (2001) or Pinto & Slevin (1988)). In the context of transmission line planning, top-management support is essential to support and foster the above mentioned necessary cultural change within a TSO organization. High-level management support and 'tone from the top' is vital for the resolution of change management issues (Butler & Fitzgerald, 1999, p. 366). Moreover, it will also diminish resistance to change (Li Kam Wa, 2001, p. 35) and create followership. On a project specific level, TSO management needs to show long-term commitment to provide sufficient resources, i.e. personnel, budget and time to stakeholder management and support all related activities. Obtaining the sponsorship of and backing by the chief executive officer or chief financial officer should be a priority of the internal coordinator who is in charge of stakeholder management (Lenckus, 2005). The coordinator should directly report to the TSO's top-management. Dealing with opponents and the risk of project delays also requires top-management's acknowledgment that such risks are realities and a respective commitment to address them sufficiently (Galorath, 2006). Furthermore, managers have to show up on the project site from time to time to give the local stakeholders the feeling that the TSO organization takes their concerns seriously.

► Ensure top-management support (4f_TMGMT)

6.3.4.7 Best practice exchange

TSOs across Europe frequently make their own experiences and learnings when dealing with opponents in transmission line planning. Some have already identified a couple of best practices. The exchange of these learnings among TSOs today is very limited and occurs only to some extent via ENTSO-E or with the help of NGOs like the Renewables Grid Initiative (RGI). Whereas the former mainly focuses on technical issues, the latter deals mostly with regulatory aspects (interview with Antonella Battaglini, 07.09.2011). Thus, the topic of social acceptance is neglected to a large extent. TSOs must interact and cooperate more closely and exchange their experiences and ideas on a regular basis in order to improve more quickly with regard to dealing with concerned stakeholders (Zane et al., 2012, p. 89). Learning from each other would help TSOs to reduce or even avoid making painful experiences, suffering project delays and bearing additional costs. Using best practices in project planning would help to manage uncertainty and risks in an effective and efficient manner (Chapman, 2004, p. 619; Hampton, 2006). To professionalize best practice exchange, TSOs should dedicate a sufficient amount of time at the end of each transmission line project to discuss and document what worked well and what still needs improvement (Hillson, 2009, pp. 25–26). This is similar to a win/loss analysis in other industries. Finally, all learnings need to be proactively shared with other TSOs (RGI, 2011d, p. 7).

► **Drive best practice exchange with other TSOs (4g_EXCHA)**

6.3.5 Stakeholder liaison

6.3.5.1 Stakeholder cooperation

TSOs should foster a close cooperation with stakeholders during transmission line planning. This has to be done on a national or even international level as well as on a project specific local level. A positive example for the former is the Renewables Grid Initiative (RGI). It brings together several European TSOs and respective NGOs to discuss certain topics regarding transmission line planning and agree on different approaches in a multi-stakeholder consensus building process. Just recently, a joint declaration was signed (RGI, 2011d). RGI further spurs knowledge exchange by organizing joint conferences (RGI, 2011a). Agreements reached with NGOs on (inter-)national level, although not legally binding, are likely to be cascaded down to the local stakeholder level. In particular, this means that if an environmental NGO has agreed with a TSO on certain aspects on the national level, the NGO's local representation is likely to follow the agreement. Moreover, TSOs should support the provision of information from neutral parties like NGOs to reduce opposition (RGI, 2012, p. 1). Another positive example is the Forum Netzintegration[160] that has been established by the German Environmental Aid. It provides a platform for TSOs, NGOs and concerned citizens to discuss main barriers in transmission grid development on a regular basis and identify possible solutions. A major outcome of these regular discussions was the report 'Plan N' (Deutsche Umwelthilfe & Forum Netzintegration, 2010). It lists several recommendations – mainly addressed to the government – on how to overcome certain barriers. Something similar exists in Great Britain and is called 'Electricity Network Strategy Group'[161] (Zane et al., 2012, p. 41). Stakeholder cooperation and partnerships should be fostered by the TSO also on a local project specific level. It is important to develop a meaningful partnership with potential host communities early in the process and maintain that commitment even after a facility is constructed (Dimitropoulos & Kontoleon, 2009; Kuhn & Ballard, 1998, p. 543). Thus, TSOs should first of all contact mayors, local councillors as well as other provincially and federally elected officials to identify their concerns and needs and increase the level of trust (canWEA, 2008, p. 7; interview with Ivan Stone, 30.11.2011). In addition, collaboration with action groups should not be precluded. Joint communication activities or the organization of expert

160 www.forum-netzintegration.de.

161 www.decc.gov.uk/en/content/cms/meeting_energy/network/ensg/ensg.aspx.

discussions should be considered. Action groups can be furthermore invited to open door events (e.g. TSO control centre) or site visits (e.g. other transmission lines of the TSO).

► Cooperate with stakeholders on national / international level (5a_COOPE)

6.3.5.2 Supporters / Multiplicators

Identifying and winning supporters as multiplicators on national as well as on local project specific level is essential for TSOs (Heiskanen et al., 2008, p. 25; Krumrey, 2011). Individuals and institutions that favour the planned project can exert influence on others' perceptions and opinions (Huber & Horbaty, 2010, p. 28). Thus, establishing and earning community support and creating a network of supportive actors around the project is key (canWEA, 2008, p. 7; Jobert et al., 2007, p. 2758). TSOs should deploy multiplicators with messages resonant to their particular community (Lantz & Flowers, 2010, p. 28). Examples of potential multiplicators on national level are NGOs, celebrities, politicians, energy experts or academics. Several interviewed NGOs mentioned that they do not necessarily agree with the arguments used by concerned citizens and emphasized the role of knowledge transfer and open communication when it comes to understanding the issues at hand (e.g. interview with Thomas Duveau (20.09.2011)). Hence, these NGOs should be utilized as supporters by the TSOs. Examples of local opinion leaders are local politicians, especially the mayor, journalists, pastors, doctors, etc. Sports clubs, local environmental action groups or other local associations can also be approached. If residents recognize that local opinion makers support the infrastructure project, they are more likely to accept it, too (Zoellner et al., 2008, p. 4140). Nonetheless it should be noted that winning someone against an infrastructure project is by far easier than winning someone for it (interview with Markus Troja, 27.09.2011). When identifying potential multiplicators, TSOs should carefully check if the persons live within or close to the line corridor. These people will have a better effect on others as they are affected themselves. They are thus more credible. TSOs should meet with potential multiplicators, describe the planned project, educate them on technical information, sufficiently answer their respective questions and as a consequence gain their support. As outlined in chapter 3.1 about the different types of stakeholders, multiplicators can activate especially latent supporters and persuade latent opponents. Convincing active opponents will most likely not be successful as their attitude is too strong and distinct. TSOs should utilize multiplicators especially for communication as local people trust them more than TSO staff (interview with Andreas Fusser, 21.09.2011). Multiplicators can thus act as 'messengers' for the TSO (Lantz & Flowers, 2010, p. 25) spreading the word and activating their network (Toke, 2005). However, TSOs must not pay multiplicators for their support or provide other benefits as this would destroy multiplicators' credibility.

► Win supporters / multiplicators (5b_MULTI)

6.3.5.3 Local empowerment

Another potential measure to reduce public opposition against transmission lines is empowering local people and involving them in the project planning process (Kuhn & Ballard, 1998, p. 543). As illustrated in chapter 6.3.2.2, empowerment is the utmost level of participation. In particular, TSOs should look for residents who have relevant skills, assign suitable tasks to them and also place decision-making in their hands to some extent (Armour, 1991, p. 19; canWEA, 2008, p. 36). Skilled citizens can be electrical engineers, physicists, environmentalists, etc. (interview with Ivan Stone, 30.11.2011). Possible tasks for such empowered citizens can be EMF measurements on other transmission lines to show that EMF levels are considerably low (EPRI, 2001, p. 2.6). Moreover, stakeholders can conduct EMF measurements afterwards on the finished transmission line to show that there is no considerable harm. They can be also assigned to monitor TSO activities, e.g. communication activities or the assessment of alternative routes, technical options, traffic and noise levels. Local environmentalists can support the TSO in conducting the EIA. TSOs could also trigger the establishment of a community advisory board which supervises the TSO in the planning process (Dear, 1992; Dütschke, 2011, p. 6240; EPRI, 2001, p. 6.8). Empowering affected people to exercise greater control over the facility and its potential impacts is essential for reducing opposition against the proposed facility (Kasperson et al., 1992). Also EPRI (2001, p. 2.6) proposed that TSOs should share control wherever they can.

► Empower local stakeholders (5c_EMPOW)

6.3.6 Technical planning

6.3.6.1 Line avoidance options

Transmission line opposition can be decreased if the TSO has evaluated all possible options to avoid the transmission line (SRU, 2011, p. 327; Schweizer-Ries et al., 2010, p. 10). However, the TSO must make clear that certain options are out of its scope of responsibility (interview with Martin Kraus, 02.12.2011). For instance, opponents often ask TSOs to apply a more decentralized electricity generation system and electricity storage although they are no longer in charge of energy generation since they have been unbundled (EPRI, 2001, p. 4.8; Streitfragen, 2011; interview with Marcus Mattis, 11.10.2011). Requests for smart grids (interview with Enrico G. Orzes, 24.10.2011) or demand side management (ENTSO-E, 2011b, p. 5) are also misleading as such topics fall into the responsibility field of DSOs. Nevertheless, TSOs should evaluate all NOVA[162] measures, i.e. all measures that optimize and upgrade existing transmission lines in order to avoid the installation of new ones

[162] Grid optimization before upgrade before extension (German: **N**etz **o**ptimieren **v**or verstärken vor **a**usbauen).

(Deutsche Umwelthilfe & Forum Netzintegration, 2010, p. 11; interview with Ralf Eggert, 13.10.2011). Examples of optimization are the use of high temperature conductors or the application of temperature monitoring[163], which both allow a short-term overloading of up to 150% of the existing line capacity (Deutsche Umwelthilfe & Forum Netzintegration, 2010, p. 48). TSOs must also point out the potential negative impacts of these measures to the stakeholders. For instance, the use of high temperature conductors causes higher transmission losses, and therefore higher costs, as well as an increased risk for birds as the cable temperature can reach up to 230°C (Deutsche Umwelthilfe & Forum Netzintegration, 2010, p. 44; ENTSO-E, 2012a, p. 170). The line sag becomes also more severe. Furthermore, high temperature conductor costs are generally higher than conventional aluminium conductors (ENTSO-E, 2012a, p. 170). Next to line optimization, there is also the possibility of respective line uprates or upgrades (interview with Jochen Kreusel, 10.12.2011). Opponents often request that existing 110 or 220 kV lines should be upgraded to 380 kV. TSOs have to thoroughly evaluate such options. Nevertheless, they also have to make clear to people that upgrades are not always possible as new impact assessments would be required (ENTSO-E, 2012a, p. 170). In such an assessment, the upgrade of an existing 220 kV line to 380 kV could violate the new EMF limits, as in the past transmission lines have often been built in the vicinity of homes. EMF limits have not existed when most of the transmission lines have been built but will apply if a line is now upgraded. A very recent innovation is the Ultranet concept, developed by the German TSO Amprion, which operates an AC and a DC system in parallel on the same transmission pylon. Usually, interferences through remaining ripple of direct current, ion clouds, etc. may influence the transformers and measurement devices. A parallel operation of a DC system and an AC system on the same line is only possible as long as necessary precautions are considered (interview with Frank Jenau, 12.07.2012). Amprion solved the technical problems by installing additional switching elements and using a third neutral DC conductor, which is located closest to the nearby AC system as illustrated in figure 51 on the next page (Schöne, 2012; Schramm, 2012). This makes the hybrid operation of a DC system on an existing AC line possible, increases transmission capacity significantly and avoids the installation of new pylons. Amprion is currently testing its Ultranet innovation on a short test line and wants to apply the concept on a 430 km long transmission line in Germany by 2019. The capacity increase with the DC system has the advantage that it will not raise but rather decrease the EMF levels as the magnetic field generated by direct current is static and has the same characteristics as the earth magnetic field.

[163] Also known as real-time thermal rating or dynamic line rating (ENTSO-E, 2012a, p. 172). Temperature monitoring allows in cold and windy weather situations to overload the line as the increased line temperature is cooled by the environmental effects.

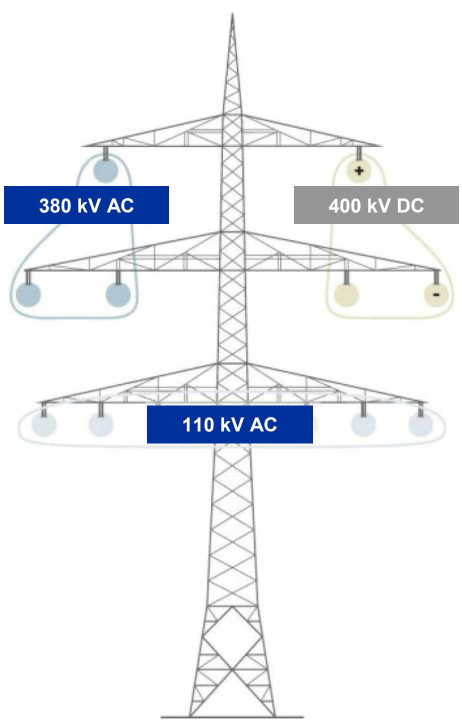

Figure 51: Ultranet concept for hybrid AC and DC operation. Picture: Infrografik DWO.

In the case of Germany, action group members also asked TSOs to make use of the existing railway grid (e.g. interview with Ralf Eggert (13.10.2011)). However, the existing 110 kV rail electricity network is too weak and offers almost no remaining capacity for large additional electricity flows. It can only carry large additional loads if it is combined with new transmission lines along the existing routes and corridors. A recent study commissioned by the German NRA, concludes that only a combination of the existing rail electricity network with HVDC lines is technically reasonable. However, in case the rail grid is combined with HVDC OHLs, higher pylons are required, which leads to around 1.4 times higher costs compared to an equivalent HVAC OHL system. A HVDC UGC system is even about three times more expensive than a completely new HVAC OHL system (Hofmann et al., 2012, pp. 5–6). Thus, the combination with the existing rail electricity network is regarded as not advantageous. TSOs need to make their upfront evaluations transparent and document that they have taken all major alternatives into consideration (interview with Klaus Rohmund, 07.09.2011). Brief arguments that all line avoidance options are not feasible or too expensive is not sufficient (interview with Synnøve Kvamme, 17.11.2011). The evaluation has to be done prior to filing the installation application for the new line (interview with Peer Schulze, 06.10.2011). Only if the TSO can transparently show that there is no better solution than the installation of a new line, stakeholders are likely to believe that the proposed facility is needed (RGI, 2011c, p. 6; Schively, 2007, p. 262).

► Evaluate and discuss technical alternatives that can avoid new line (6a_AVOID)

6.3.6.2 Route alternatives

Interviewees claimed that TSOs often have not evaluated several route alternatives prior the submission of the application documents (e.g. interview with Thorben Becker, 29.11.2011). To reduce opposition, TSOs have to identify several possible route options[164] in an open and transparent way and discuss them with the affected stakeholders (interview with Marcel Keiffenheim, 30.09.2011; SRU, 2011, p. 327). This would give concerned people the feeling that there is still some flexibility with regard to the final decision. In contrast, if stakeholders are confronted with only one single solution which they can only comment on, resistance is likely to develop (NABU, 2008, p. 8). Discussions with stakeholders also help the TSO to learn about areas that are of special value to the local residents and which could turn out to be 'no go' areas for a transmission line (interview with Gundula Hübner, 21.11.2011). All proposed alternatives have to be feasible (interview with Peer Schulze, 06.10.2011). After discussing with the relevant stakeholders, TSOs need to choose one of the route alternatives and clearly and transparently justify their decision. Different route alternatives will automatically lead to opponents arguing against each other as no one wants to have the line in his area. This can be beneficial for a TSO when choosing one of the alternatives, as the selection will most probably be supported by the opponents of those areas which are not going to be affected anymore.

► Evaluate and discuss route alternatives prior to application process (6b_ROUTE)

6.3.6.3 Transmission technology options

Different transmission technologies have already been introduced in chapter 2.2. Probably the most widespread request of opponents is that transmission lines should be put underground, i.e. UGC systems should be applied (Sander, 2011, p. 17). In addition to HVAC, many stakeholders often ask for HVDC UGC transmission technology due to lower EMF levels (interview with Hermann Guss, 30.11.2011). Opponents are usually aware of the additional costs of UGC systems, but are in general willing to bare those (Hübner & Pohl, 2010). Today, only 0.29% of the European EHV network consists of land cables (Leprich et al., 2011, p. 47). In the past, UGCs have been primarily installed in areas where it was not possible to use OHLs. Reasons for this have been space constraints in densely populated areas or technical restrictions (e.g. wide river crossing). Nevertheless, there has been a clear preference on the part of TSOs for HVAC OHL systems as this is the most cost effective and proven electricity transmission design (CIGRE, 2007, p. 45). TSOs are in most cases obliged by the NRAs to install transmission lines at the lowest possible cost in order to keep the burden for society, i.e. the grid fees to a minimum. Opponents accuse TSOs of not having evaluated alternative transmission technologies before submitting the project application to the authorities (e.g. interviews with Caroline

[164] EPRI (2006) provides practical guidance for the development of corridor and route alternatives.

Paterson (07.12.2011), Padraig O'Reilly (02.12.2011) or Luc Meijer (15.11.2011)). The respective authorities can only check and evaluate the submitted technical alternatives. Interviewees wanted TSOs to get out of their ‘comfort zone’ and consider also UGC systems upfront (interviews with Synnøve Kvamme, 17.11.2011 and John Woods, 21.11.2011). Thus, TSOs should conduct an alternative assessment prior to application submission in a transparent manner (interview with Luc Meijer, 15.11.2011). If it can show in a clear and traceable way that certain technology options are not feasible, too costly or less advantageous, stakeholders are more likely to accept the TSO’s choice. When carrying out the evaluation, TSOs should try to already involve stakeholders (EPRI, 2001, p. 2.6). Especially the joint fact finding process as outlined above is crucial. Otherwise, stakeholders will not accept the assessment of alternatives. The main arguments concerned people use for the implementation of UGC systems are the absence of visual impact as well as lower EMFs (Leprich et al., 2011, p. 4). Table 11 compares the different transmission technology options[165] along certain criteria.

Table 11: High-level comparison of different transmission line technologies.
Indications based on Cole et al. (2008, p. 22) and Rathke & Hofmann (2011, p. 312).

	Criteria	**HVAC OHL**	**HVAC UGC**	**HVDC OHL**	**HVDC UGC**
Socio-political	Health & safety impact	− −	+	− −	+
	Visual impact	− −	+ +	− −	+
	Property devaluation	− −	+ +	− −	+
	Impact on tourism	− −	+ +	− −	+
	Environmental impact (flora)	− −	− −	− −	−
	Environmental impact (fauna)	− −	+ +	− −	+ +
	Permitting time	− −	+ +	− −	+ +
Technical	Thermal capacity	+	−	+ +	+
	Temporary overload capability	+	+ +	−	+
	Power flow control	− −	− −	+ +	+ +
	Network operation	−	− −	+ +	+
	Stability	+	+	+ +	+ +
	Reliability	+ +	− −	+ +	− −
	Logistic restrictions	+ +	− −	+ +	− −
	Lifetime	+ +	+	+ +	+
	Construction time	+ +	−	+	− −
	Availability of components	+ +	+	+ +	+
Economical	Investment cost	+ +	+	−	− −
	Operation cost (incl. losses)	+	+ +	− −	−

+ + very positive; + positive; − negative; − − very negative

[165] GIL technology is not considered here due to its limited production capacity. Futhermore, it is rather suitable for transmission of bulk power over short distances and is therefore less applicable for electricity transmission over longer distances.

It should be emphasized that the work at hand does not intend to conduct a detailed technical comparison. The overview should rather provide an indication, which can be used as a starting point for detailed assessments. As every project is unique and is embedded in a specific environment, the choice of whether an OHL or UGC system or of whether HVDC or HVAC technology should be implemented, has to be made individually for every case. The indications in table 11 have then to be replaced with concrete values and facts. Details regarding the socio-political and technical criteria have already been elucidated during the course of this work. The economic aspect will be elaborated on in more detail in the following, as costs are the subject opponents and TSOs argue most about in transmission line planning.

Investment costs are in general significantly higher for UGC systems compared to OHL alternatives. This is mainly due to the increased cable costs and the need for significant ground work to bury the line. According to a recent meta study by Arlt et al. (2011, p. 14) and a paper by ENTSO-E & Europacable (2011), investment costs for HVAC UGCs are 5-13 times higher compared to HVAC OHL systems. If 10% partial undergrounding is applied the cost factor is reduced to 1.5. HVDC cable costs are around half of HVAC cable costs (Cole et al., 2008, p. 51). However, converter stations which cost approximately EUR 135-250 million each increase installation costs significantly at short distances compared to HVAC alternatives.

Operation costs include all expenses for the operation and maintenance of the line as well as all related losses. Once in operation, HVDC and HVAC UGC systems are nearly maintenance free (ENTSO-E & Europacable, 2011; Europacable, 2011a). Transmission losses of the HVAC OHL option are higher than for an equivalent UGC system. This is mainly because copper is used as material for the cables that has a lower resistance than aluminium, which is used for OHL conductors (ENTSO-E & Europacable, 2011, p. 10). Nonetheless, UGC systems need additional compensation measures. As already stated earlier in this work, HVDC OHL and UGC systems carry very low line losses but significant conversion losses occur in the converter stations of around 1.7% (Cole et al., 2006, p. 23). HVDC line loss benefits outweigh the converter disadvantages at a length above 80-100 km for UGC systems (EC, 2003) and at a length of above 600 km for OHL systems.

There are plenty of studies and assessments that compare the overall costs of the different technology alternatives. Arlt et al. (2011) analyzed 176 cost evaluation studies between 2000 and 2011. Results for overall UGC system costs[166] range between 1.29 and up to 23 times higher than OHL system costs (Arlt et al., 2011, p. 58). The great discrepancy of cost values published in these studies is mainly due to the fact that overall costs significantly depend on line capacity, design and length. Furthermore, the respective authors applied different standard line evaluation methods. In particular, they used different assumptions, e.g. regarding the lifetime of a line, and often did not include all relevant aspects in their calculations. Arlt et al. (2011) revealed that only 2% of their analyzed studies covered 90% of criteria

[166] All investment and operation expenses.

which they regard as required for a sufficient line evaluation. Until today, there is no standard method, as how to evaluate and compare the different transmission technology alternatives without considering the details of the particular project (interviews with Hermann Guss, 30.11.2011 and Jochen Kreusel, 01.12.2011). It is still unclear what factors and criteria to include in the comparison, how to weigh them and to what extent benefits can offset certain disadvantages. TSO need to always consider total costs. Solely arguing that investment costs are higher for UGC systems is not sufficient and will not be accepted by stakeholders. Moreover, using general cost factors is unreliable as each and every project is different and faces unique circumstances and conditions. In order to identify the overall cost differences of technology alternatives, they have to be evaluated in detail by the TSO in a transparent manner and prior to filing any final application to authorities. TSOs should not only compare the preferred OHL solution with a complete UGC option but also with the option of partial undergrounding, i.e. complementing OHLs with UGC systems in sensitive areas as this reduces the additional costs significantly (interview with Volker Wendt, 18.11.2011). Furthermore, TSOs must not evaluate alternatives merely along technical and economical criteria. They also have to take socio-political aspects into account and quantify them (SRU, 2011, p. 326). However, to avoid an endless inclusion and analysis of factors, a clear distinction has to be found, as to what socio-political effects to take into the consideration and what not (interview with Heinrich Brakelmann, 01.12.2011). This can be supported by a standard rating matrix as presented in Merker (2010) or Arlt et al. (2011, pp. 8–9) which is similar to table 11 above. Criteria can be broken down to a more detailed level if required. In general, NGOs, other national interest groups and TSOs should jointly agree once and not in any project-related context on such a standard scheme and allocate respective weightings to the different criteria. In case certain aspects are hard to quantify in monetary terms like visual impact[167], a maximum number of points should be dedicated to these criteria. When applying the standard scheme in a specific project case, the points can be distributed in a joint discussion with the stakeholders across the different line alternatives. This allows for sufficient flexibility and gives stakeholders the feeling of being involved. The point advantage of a certain alternative to others can be compared to and balanced with the related additional costs (CIGRE, 2007, p. 53; Merker, 2010, p. 61). This should be done together with relevant stakeholders and leads to a weighing of interests. When discussing and comparing the different technology alternatives, TSOs have to be aware that, although a certain option might create additional costs which are not recovered by the NRA, the option can still be more economical in the overall context for the company. As UGCs face significantly less public resistance (Noack, 2010, p. 4), projects with this technology can be realized much quicker leading to less opportunity costs or costs for redispatch measures due to grid bottlenecks for the TSO. Furthermore, TSOs need to consider potential mitigation measures or costly reroutings that might be requested by

[167] Please note that there some attempts in literature to quanity the external costs of visual impacts. For instance see Navrud et al. (2008). However, a well accepted standard does not yet exist.

the authorities throughout the authorization process due to public objections, if the OHL solution is chosen.

To summarize, TSOs should transparently evaluate different technology options. Next to the assessment of a complete UGC solution the TSO has to also evaluate the cheaper partial undergrounding option with UGC systems in sensitive areas. Stakeholders need to be involved in these assessments and a standard rating scheme has to be developed and agreed on. The alternative evaluation has to be conducted prior to submitting the application to authorities.

► Evaluate transmission technology alternatives (6c_TECOP)

6.3.6.4 Piloting of innovations

There are several technical innovations available that can reduce social resistance in transmission line planning. TSOs should proactively test and pilot such new developments in their projects (RGI, 2011d, p. 7). Not all innovations increase installation costs. Some of them can even significantly decrease expenses. Even though certain technical measures might be more expensive in terms of installation costs, they have the potential to reduce public resistance and lead to an earlier implementation of the project. For instance, if new types of pylons are more expensive than the standard ones, but reduce public opposition and in turn lead to the project being accepted as an OHL system, the overall project costs will be still cheaper than for putting the line underground. Some examples of innovations which have been identified during the course of this work through interviews and literature review and which can help to reduce public opposition are briefly introduced below in an excursus.

6.3.6.5 Excursus: Exemplary transmission line innovations

As outlined above, UGC investment costs are still higher than for OHL alternatives. This is mainly due to the expensive ground works necessary to lay the cables underground. Installation innovations that reduce the costs of ground work will help to narrow the cost gap between UGC and OHL systems making the former increasingly attractive. The Austrian company IFK[168] developed a **cable plough** that can plough ductworks for 380 kV cables[169] (see figure 52 on the following page). The cables themselves are then floated into the ducts using high pressure water[170]. With this technique, cables can be laid at a depth of up to 2.5 m and installation is around 20 times faster than using excavators. Installation costs can be reduced by as much as 60%. The technique can be applied in soft rock and

[168] www.verlegepflug.at.

[169] Cables with voltage levels of up to 110 kV can be even ploughed directly into the ground without the use of ductworks (interview with Konrad Lehner, 06.12.2011).

[170] For details see www.watucab.com.

areas with a slope of up to 40 degrees. A first pilot project[171] was implemented in Vienna, Austria (interview with Eduard Knapp, 07.12.2011).

Figure 52: Cable plough. Picture: IFK GmbH.

Another technical innovation reduces the installation cost of UGC systems which require walkable tunnels (e.g. for maintenance reasons). The German company Dupré[172] has developed slow moving machines that create a **concrete tunnel in a continuous[173] and cost effective process** onsite (see figure 53 on the next page). Total costs are around EUR 950 per metre including cable support structures and ventilation inside, which are less than 50% of conventional tunnel expenses (Brakelmann, 2009, p. 14).

[171] For a 110 kV system.

[172] www.cdupre.de/infrastrukturkanal.html.

[173] 15 metres per day (Brakelmann, 2009, p. 15).

Figure 53: Onsite tunnel fabrication. Picture: Dupré Bau GmbH & Co KG.

A similar cost effective tunnelling method is **pipe jacking** as illustrated in figure 54 . The installation speed can be around 15-20 metres per day and a maximum tunnel length of 1,400 – 2,000 m can usually be reached (interview with Robert Stein, 07.12.2011). This technology is especially suitable for installing UGC systems in densely populated and built-up areas where trenching is not possible or too costly. Furthermore, it is environmentally friendly as it does not require deforestation or a drawdown of the water level. Hydraulic joints even allow for tunnel bends and long distance tunnelling is also possible. The technique has already been successfully applied in the construction of deep gravity sewer systems. Where applicable, it is in general cheaper than conventional tunnel installation techniques (interview with Robert Stein, 07.12.2011).

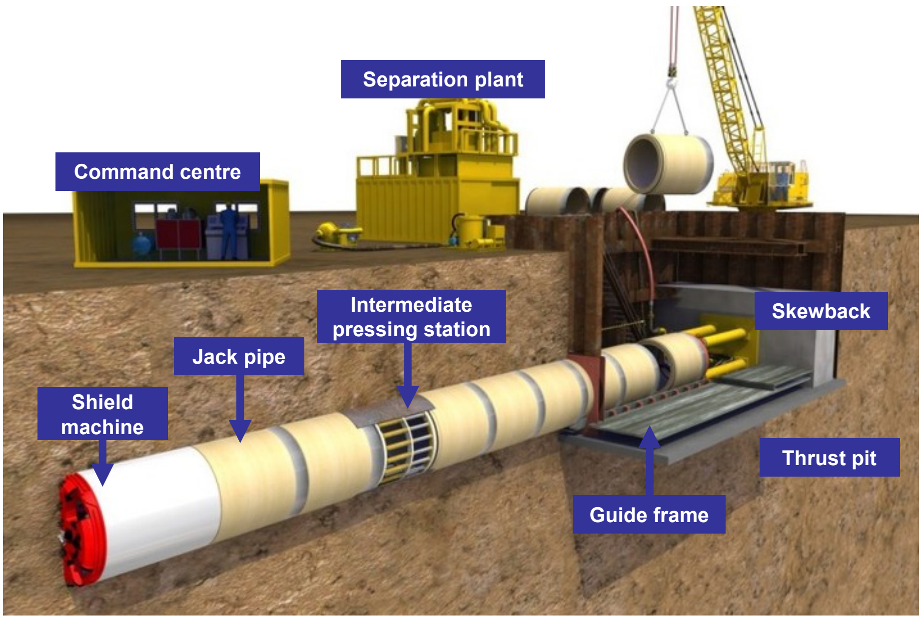

Figure 54: Pipe jacking method. Picture: S&P Consult GmbH.

Another innovation is a new **cable drum transport concept** developed by the Danish company nkt cables[174] (see figure 55). Due to the use of copper, XLPE underground cables weigh about 40 kg per metre. Most road transport is limited to loads of 40 tons, which is approximately the weight of a cable drum with a 900 m[175] long cable (Golder Associates & ECOFYS, 2008, p. 63; Rathke & Hofmann, 2011, pp. 29–30). Furthermore, the cable drum height is limited due to bridges. Hence, although in many cases cable insertion points can be accessed via roads that allow for more weight, the height restrictions limit the maximum cable length.

Figure 55: Flat-bed trailer concept with longer cable drum length wise. Picture: nkt cables.

Typical transporters carry the drums with the axle cross wise. A new fled-bed trailer concept with a very low load height and the possibility to carry heavy weight can transport a longer cable drum that is arranged length wise. This allows the transport of cable lengths of up to 2,000 m and in turn reduces the number of required joints which increases UGC system reliability.

PowerTubes is an innovative cable system with two installation variants. It uses a special shielding of the cables for a more compact installation. The first variant allows the installation of multiple cables in one casing (see figure 56 on the next page). By using special filling material (Cable-Cem), a cooling pipe and shielding conductors, two cables can be included in one steel tube without causing significant interference. If laid in open construction, the narrow design significantly reduces the required cable trench width for a four circuit system from 15-20 m to 5-8 m (Brakelmann et al., 2011, p. 75). The second variant is the installation in a walkable tunnel system (see figure 57 on the next page). This uses aluminium pipes for the encapsulation of the cables, which are also connected with each other and grounded. The shielding significantly reduces short-circuit forces. As a consequence, the usual safety distance of about 0.5 m between the cables can be reduced significantly which leads to a much more compact installation in a tunnel. Additional circuits or reserve cables can thus be implemented, which increases the reliability of the UGC system. The mounting systems do not have to withstand potentially extreme short-circuit forces anymore, which further reduces costs. In addition, the usually high magnetic fields in the tunnel reduce to an almost negligible amount which increases safety for maintenance workers (Brakelmann et al., 2011, p. 77).

174 www.nktcables.com.

175 For a cross section of 2,500 mm².

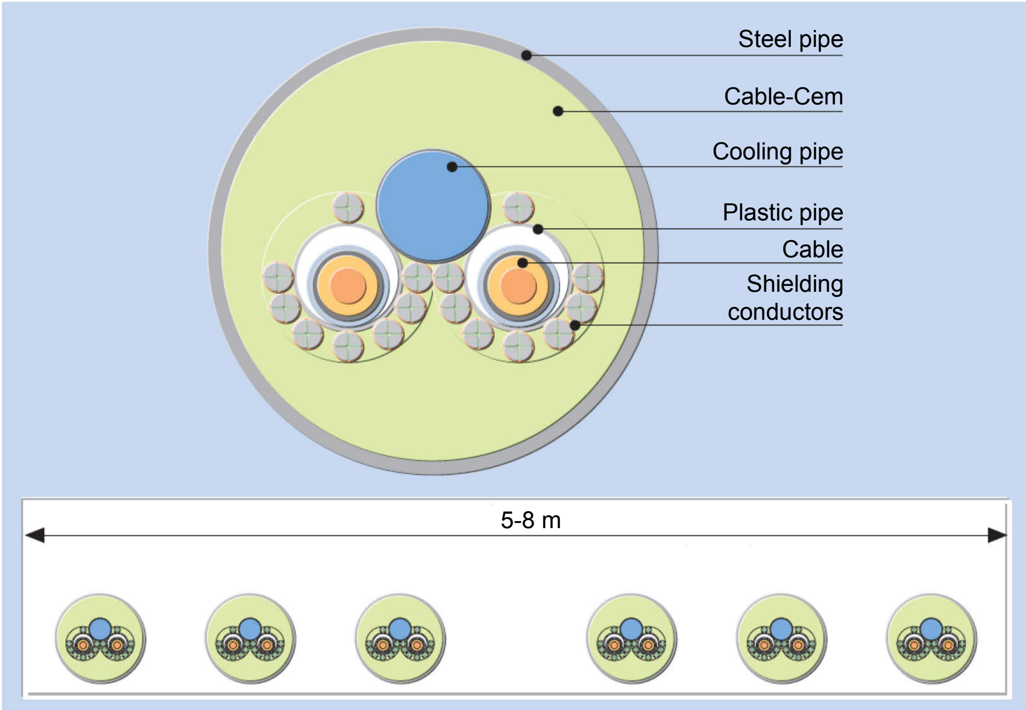

Figure 56: PowerTube installed in a casing. Picture adapted and modified from Brakelmann et al. (2011, p. 75).

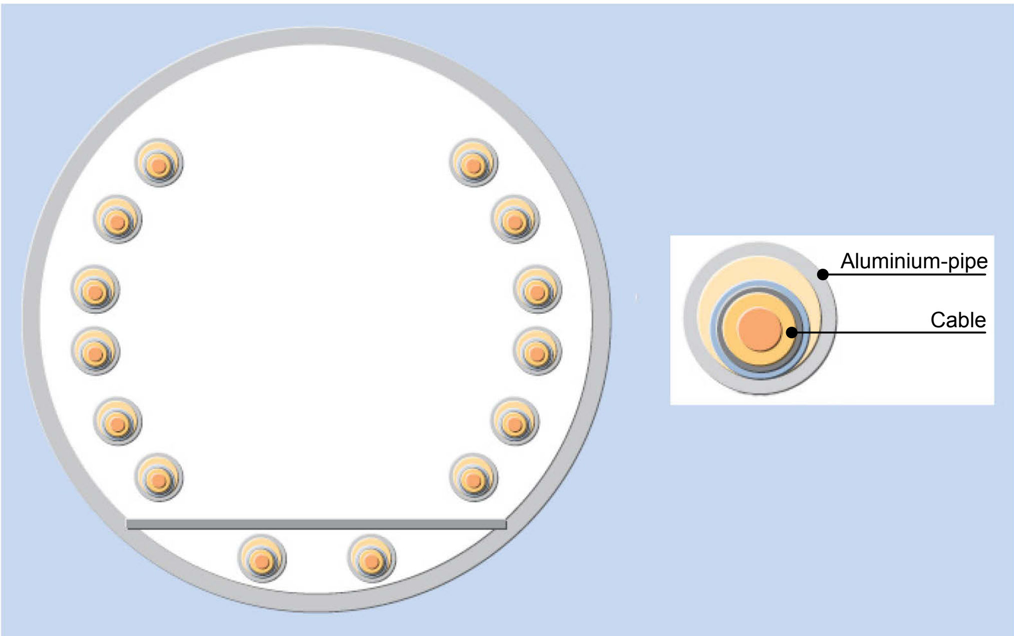

Figure 57: PowerTube installed in walkable tunnel. Picture adapted and modified from Brakelmann et al. (2011, p. 75).

As mentioned earlier, transmission pylons have a visual impact on the landscape. Opponents regard the typical pylon look as odd and disturbing. In general, people want to see transmission lines as little as possible (Tikalsky & Willyard, 2007, p. 36). **Special painting** that is similar to the surrounding or **silvering** can be applied to disguise the pylons to some extent (EPRI, 2005; interview with Peer Schulze, 06.10.2011). **Reducing the pylon height** (e.g. by using single-level pylons) is also an option to hide them between trees or other high objects. However, a lower pylon height requires a reduction of the distance between two pylons which leads to a larger number of required pylons overall (Brakelmann, 2004, pp. 43–44). **New pylon designs** can be used which have a reduced visual impact or integrate properly in the natural context (van der Welle et al., 2011, p. 68). Such designs use streamlined and thin structures to make the pylons virtually invisible. Another and completely new concept is to apply creative pylon designs that look not odd but are somehow of an artistic nature (EPRI, 2005). A recent British pylon design competition[176] revealed a number of innovative structures. Similar design competitions have also been held in Austria and Iceland. Moreover, back in the 70's, there were already first ideas and several publications in the United States that proposed aesthetic guidelines and provided examples of appealing transmission pylons. For instance, the designer Henry Dreyfuss worked closely with a structural engineering company and developed more than 100 variations of 24 basic modern designs, which are published in Lummis et al. (1968). Similar publications were made for example by SCE (1972) or Howlett (1979). Architects and designers tried to ensure that their proposals meet also the static requirements of transmission pylons. Thus, new pylon designs either reduce the visual impact or are visible but in an aesthetic and artistic way which makes them more likely to be accepted. They even can become a tourist attraction. Depending on the complexity of the design, the costs for TSOs might be higher compared to the regular pylons[177]. However, these additional costs might pay-off through faster project execution due to reduced public opposition. Figure 58 on the next page shows several of these low visual impact or appealing pylon design examples.

[176] www.ribapylondesign.com.

[177] It should be noted that these new pylon designs are mostly still concept studies only. Thus, detailed static characteristics as well as substantiated cost assessments are not available yet.

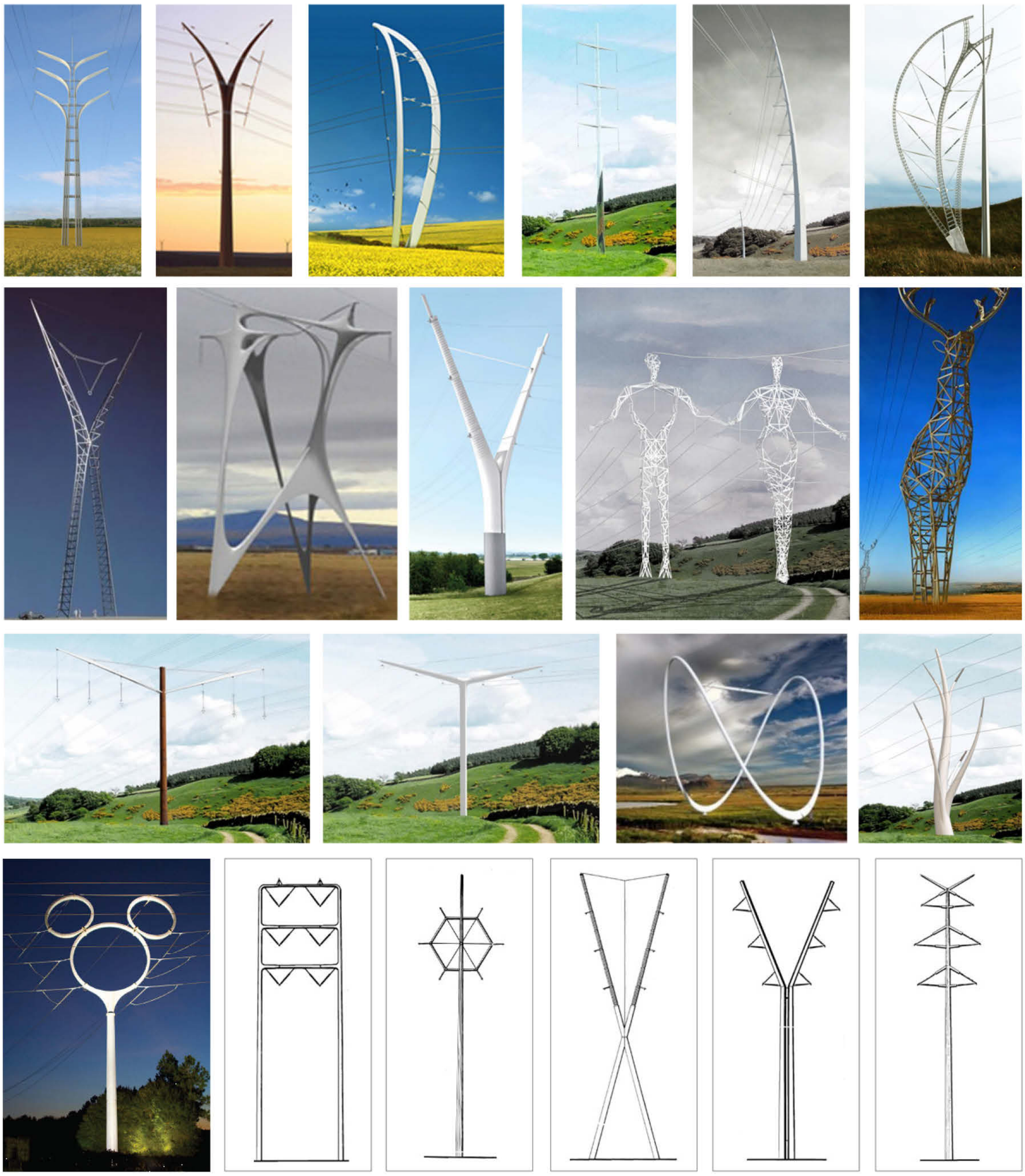

Figure 58: Innovative pylon designs. Pictures: Royal Institute of British Architects, Choi+Shine Architects EUCI and Henry Dreyfuss.

Another type of pylon was developed by the TSO Tennet in the Netherlands. Next to a design with reduced visual impact, the **Wintrack pylon** reduces the EMF zone by 60% compared to a typical Donau pylon through a favourable arrangement of conductors as illustrated in figure 59 on the next page (Runge et al., 2011, p. 60). The magnetic fields of the conducters compensate each other to some extent. This means that the EMF zone reaches out to only about 50 m on each side instead of 150 m (van der Meijden, 2010, p. 13). A disadvantage of the compact conductor arrangement is that life-line services, i.e. repair of one system while the other is still under full operation, cannot be carried out anymore (Rathke & Hofmann, 2011, p. 10).

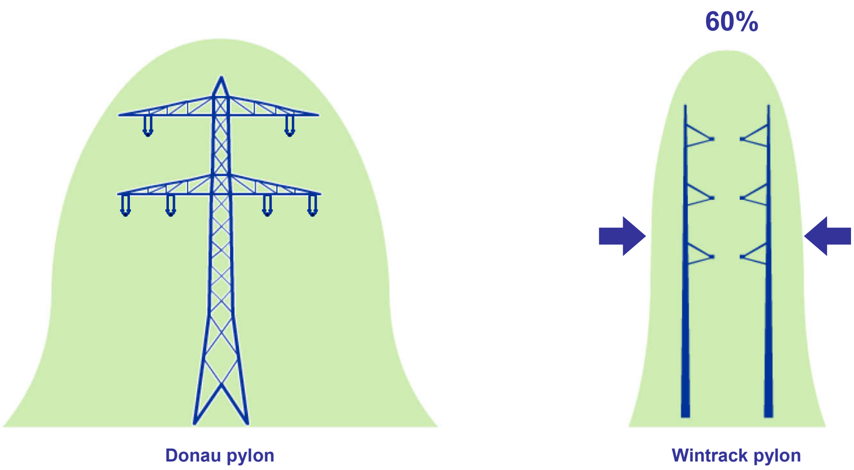

Figure 59: EMF zone comparison of a standard Donau pylon with the new Wintrack pylon concept. Picture: Tennet TSO B.V.

Another new pylon concept has been developed by the German company SAG[178]. It reduces the required pylon height by using steel ropes that can be tightened more firmly than the transmission conductors between the pylons themselves. The conductors are then attached to these steel ropes leading to less line sag as illustrated in figure 60 and thus to a reduced number of required pylons along a transmission line (Pohlmann, 2012, p. 35).

Figure 60: Compact pylon design with reduced height. Picture: SAG GmbH.

The above mentioned examples can only provide a non-exhaustive overview of technical innovations which TSOs could proactively pilot in their projects. It is not important what specific innovations a TSO applies as long as they reduce the negative impacts of a transmission line for the affected people.

► Proactively pilot technical innovations that reduce negative impacts for stakeholders (6d_INNOV)

[178] www.sag.de.

6.3.6.6 Avoidance of sensitive areas

A lot of protests against transmission lines arise because the lines are planned too closely to populated areas or across environmental habitats. TSOs should avoid sensitive areas when planning route corridors wherever they can (Deutsche Umwelthilfe & Forum Netzintegration, 2010, p. 70; Hübner & Pohl, 2010). TSOs are tempted to construct a line with the shortest possible length in order to keep costs low. However, the benefits of a reduced line length might be outweighed by accompanying conflicts and the resistance of stakeholders. Thus, TSOs should strive for minimal distances to houses and avoidance of Natura 2000 areas where possible (interviews with Marian Klobasa, 12.10.2011 and Enrico G. Orzes, 24.10.2011). The placement of towers and guy wires out of flight paths of birds should also be considered (DeCicco et al., 1992, p. 32). Transmission lines are often built close to houses to avoid conflicts with environmental areas, which are general protected to a larger extent by law than populated areas. TSOs should consider populated areas as at least as important as environmentally protected areas in the route identification process (interview with Marcel Keiffenheim, 30.09.2011). In particular, populated areas must be considered as 'avoided areas' in GIS transmission route planning (EPRI, 2006). A comprehensive conflict potential assessment and constraints mapping should be conducted during route planning to anticipate and avoid potential conflicts with environmentalists or landowners (Devine-Wright, 2011, p. 59).

► Avoid sensitive areas in route planning (6e_SENSI)

6.3.6.7 Bundling of infrastructure

As already explained in chapter 3.2.4, resistance to a planned transmission line depends also on the level of the existing impact by other infrastructure installations. TSOs need to carefully evaluate the individual area's existing exposure to large infrastructure installations (Deutsche Umwelthilfe & Forum Netzintegration, 2010, p. 63; SRU, 2011, p. 326). People are only willing to bare burdens to a certain extent (interview with Frank Ulmer, 27.09.2011). Too many installations are perceived as overload and considered as unfair (Deutscher Städte- und Gemeindebund, 2005, p. 7). First, TSOs should check for existing and planned installations such as motorways, trainlines, bridges, pipelines etc. Second, TSOs should talk to local people and assess whether these projects in the area have led to significant local resistance (Krumrey, 2011; Schweizer-Ries et al., 2010, p. 20). If this is the case, TSO should try to bundle existing or planned infrastructure in the area with the new transmission line to limit the impact on residents (Battaglini et al., 2012; GFN et al., 2009, p. 128; interviews with Peer Schulze, 06.10.2011 and Hans Kutil, 09.11.2011). Interviewees reported two cases in which UGC systems could have been implemented in a cost-effective way along a planned motorway (interviews with Guido Franke, 04.10.2011 and Padraig O'Reilly, 02.12.2011). They require TSOs to search more proactively for other planned infrastructure projects in the respective areas. Joint planning approaches with other installations could save planning time and reduce costs such as for an environmental impact study. In certain cases, installation costs could even be shared, e.g. between the TSO and a telecommunications provider for a joint tunnel. Bundling can also include a combination, i.e. the parallel routing, of a new with an existing transmission line (Beers et al., 2011, p. 43). The combination of pylons with integrated or attached small-scale wind turbines[179] can also reduce public opposition (see figure 61) and represents the strongest form of bundling.

Figure 61: Transmission pylon with integrated small-scale wind turbines. Picture: Wind-In.

► Foster bundling of infrastructure (6f_BUNDL)

6.3.6.8 Line deconstruction

When new transmission lines are installed, they sometimes make existing old lines with a low capacity obsolete. People request that TSOs should proactively deconstruct these lines (Schweizer-Ries et al., 2010, p. 28). Old transmission lines have often been built close to or even across populated areas. As a courtesy, TSO could offer to deconstruct such a line if people accept a new line nearby that at least does not directly cross houses. Such a case happened for instance in Austria where a 220 kV line had been deconstructed for the sake of a new close-by 380 kV line. Thus, when planning a new transmission line, TSOs should always proactively assess if any existing transmission line in the affected area can be removed (Deutsche Umwelthilfe & Forum Netzintegration, 2010, p. 63).

► Proactively deconstruct old lines (6g_DECON)

[179] This represents a first idea that needs to be assessed further for technical feasibility and cost effectiveness.

6.3.6.9 Regulatory overachievement

In order to reduce public opposition, TSOs should show a certain amount of commitment by overachieving regulatory requirements (Floricel & Miller, 2001, p. 451). The study by EPRI (2001, p. 7.2) also states that "being in compliance with regulations is simply not enough to ensure project acceptance. Companies should be prepared to go beyond compliance". One example is keeping minimum distances, e.g. more than 200 m to houses (interview with Marian Klobasa, 12.10.2011). Moreover, TSOs can proactively implement mitigation measures to reduce EMF. For UGC systems, this can entail the application of isolating lean concrete or a metallic raceway (Argaut et al., 2007) and for OHL systems the use of compensation wires or new pylon types as introduced above (Neitzke et al., 2006). Environmental overachievements can include the installation of bird protection devices and the erection of nesting aids (as shown in figure 62) as well as voluntary afforestation (Deutsche Umwelthilfe & Forum Netzintegration, 2010, p. 85).

Figure 62: Installation of bird protection devices on a transmission line per helicopter (left, picture: RWE). Nesting aid installation on a transmission pylon (right).

► Overachieve regulatory technical requirements (6h_OVERA)

7 Development of research model

7.1 Procedure

After the potential success factors have been identified above in a qualitative manner, they will be validated quantitatively in the next step. As previously outlined, this will be done through structural equation modeling (SEM) which can identify causal relationships in an empirical way. For the preparation and conduction of a SEM, the literature suggests a certain procedure. The following process steps are derived from Backhaus et al. (2006, p. 357) and Diamantopoulos & Siguaw (2000) and serve as the structure for the subsequent part of the work:

1. Development of hypotheses on causal relationships (Chapter 7.2)
2. Development of path diagram and model specification (Chapter 7.3)
3. Identifiability of model structure (Chapter 7.4)
4. Empirical data acquisition (Chapter 8.1)
5. Parameter estimation[180] (Chapter 8.2)
6. Model evaluation (Chapter 8.3)
7. Verification of hypotheses and discussion of results (Chapter 8.4)

7.2 Development of hypotheses on causal relationships

The first step in SEM is the development of hypotheses on causal relations between latent variables in the inner model. As identified in chapter 4.6, some critics argue that most success factor studies lack sufficient theoretical foundation. To counter this, scientific references will be given in the following. In particular, the previously outlined studies on analog infrastructure projects provide valuable input for hypothetical cause-effect relations.

7.2.1 Stakeholder liaison

The TSO's liaison with stakeholders in terms of cooperation with them, utilization of stakeholders as multiplicators or empowering of stakeholders is regarded as creating trust. Zoellner et al. (2008, p. 4140) found that people's trust increased in the TSO once the local mayor, who had been used as multiplicator by the TSO, was in favour of the project. Similarly, Kuhn & Ballard (1998, p. 543) as well as Dear (1992, p. 294) state that partnerships with stakeholders early in the process are essential to enable trust. Beierle (1998, p. 19) mentions that trust is also created through stakeholder empowerment, e.g. in form of a citizen advisory committee. Thus, the following hypothesis can be derived:

Hypothesis 1: There is a positive relationship between a TSO's stakeholder liaison and the level of stakeholder trust towards a TSO.

[180] Including selection of software (Chapter 8.2.1).

7.2.2 Participation

As outlined in chapter 6.3.2, several interviewees came up with potential success factors for TSOs to improve stakeholder participation. In the literature, researchers identified a profound positive linkage between stakeholder participation and the increase of stakeholders' trust in the respective project developer. In a case study about landfill siting, Baxter et al. (1999, p. 503) state that "public participation is a practice for building trust". Similarly, Healey (1996, p. 213) found that public engagement is a way to restore diminished trust. In their work about CCS, Terwel et al. (2011, p. 185) identified that trust is created through stakeholder involvement and fair decision-making, which especially includes the binding consideration of stakeholders' interests. In RGI's (2012) workshop with several European TSOs, participation of stakeholders was named to be a possible measure to create trust in transmission line projects. Hence, stakeholder participation can be assumed to increase trust in the TSO.

Hypothesis 2: There is a positive relationship between stakeholder participation in transmission line planning and the level of stakeholder trust towards a TSO.

Stakeholder participation is not only seen as creating trust, but also as directly reducing public opposition. Kunreuther et al. (1993, p. 313) argue that "[a] participatory process appears to be an important ingredient for siting success". Similar findings were made by Armour (1992), Ibitayo & Pijawka (1999), Petts (1995) and Rabe (1992). In their case study about the siting of a nuclear waste repository, Baxter et al. (1999, p. 503) found that public participation reduced stakeholder conflict and therefore increased project acceptance. Beierle (1998, p. 19) states that public participation measures such as public hearings or the use of mediators reduce conflict with stakeholders directly. Thus, for the work at hand, a direct positive causal effect of proper stakeholder participation on the reduction of opposition against transmission line projects can be assumed and the following hypothesis derived:

Hypothesis 3: There is a positive relationship between stakeholder participation in transmission line planning and reduced public opposition in the TSO's transmission line projects.

7.2.3 Communication

Several potential manifest success factors have been identified in chapter 6.3.1 through interviews and literature research which help the TSO to ensure a sufficient communication with its stakeholders throughout and even after the transmission line planning process. An indication of a causal linkage between proper stakeholder communication and trust in the project developer can be found in the work of several authors. In his case study about a military base in California, Beierle (1998, p. 19) argues that the provision of sufficient information as well as public education increase trust. Terwel et al. (2011, p. 185) found that the project developers of CCS facilities could instigate trust through sufficient and, even more important, honest communication. In terms of risk communication, Peters et al. (1997) argue that if done effectively, i.e. if information is disclosed sufficiently and communicated in an open and honest way, communication increases public's trust. Also EPRI (2001, p. 2.6) argue that "effective communications (…) engender trust in those who carry the message". Finally, RGI (2012) mentions that dialogue and understandable information have a positive influence on stakeholders' trust in the TSO. These results in the literature therefore provide a strong signal that there is a positive relation between stakeholder communication and trust.

Hypothesis 4: There is a positive relationship between a TSO's stakeholder communication and the level of stakeholder trust towards a TSO.

Next to the causal effect of communication on trust, scientists have also found a direct effect of communication on the reduction of public opposition against project facilities. In eight CCS case studies, Brunsting et al. (2011) evaluated the quality and grade of the developer's communication activities towards the stakeholders and identified a positive effect of proper communication on reduced opposition on the part of the public. Furthermore, interactive communication is mentioned by Upreti & van der Horst (2004) as a prerequisite to convince local residents. Similarly, for geothermal plants, Dowd et al. (2011) argue that sufficient dialogue with affected people increases support for project implementation. Hence, there is empirical evidence which backs the development of the following hypothesis:

Hypothesis 5: There is a positive relationship between a TSO's stakeholder communication and reduced public opposition against its transmission line projects.

7.2.4 Organizational readiness

It was emphasized above that the organizational readiness of a TSO is essential in transmission line planning. Interviewees and findings from the literature emphasized the importance of internal coordination, employment of sufficient resources, adequate training and qualification of staff, top-management support, and an organizational culture that welcomes stakeholder participation. Thus, organizational readiness refers to whether or not a TSO organization has made the necessary preparations for effectively dealing with stakeholders. According to Wüstenhagen et al. (2007, p. 2687), Beierle (1998, p. 8) and Terwel et al. (2011, p. 185), trust depends on someone's perceived competence or the confidence in someone's ability to do something. Similarly, Baxter et al. (1999, p. 512) found that the qualifications and competences of a project developer increase stakeholder trust. For transmission line planning this implies that people's trust in a TSO is likely to increase if the TSO shows commitment to stakeholder management by dedicating sufficient resources, implementing cultural change, involving top-management and training its personnel.

Hypothesis 6: There is a positive relationship between a TSO's organizational readiness and the level of stakeholder trust towards a TSO.

7.2.5 Economic benefits

Several interviewees claimed that they had not received sufficient compensation for the economic disadvantages they face through a new transmission line and therefore opposed the respective project. They argued that with sufficient compensation measures they would have accepted the transmission line. In the study by Bronfman et al. (2012, p. 246), perceived benefit had the greatest total effect on acceptability, thus emerging as a key predictive factor of social acceptability. More generally, Renn (2000, p. 41) argues that societal and individual benefits have a positive influence on the acceptance of risks. These findings indicate a positive relationship between sufficient economic benefits and increased acceptance of a project, i.e. a reduction in public opposition. Nevertheless, in the literature also examples can be found, which do not show such an effect (e.g. Kunreuther et al. (1990), Flynn et al. (1992) or Schweizer-Ries et al. (2010)). Findings are therefore contradicting or as Ibitayo & Pijawka (1999, p. 387) state, the effectiveness of compensation "is still not entirely clear". However, as some indications exist that there might be a positive linkage between economic benefits and reduced public opposition toward transmission lines, the following hypothesis is developed for further validation:

Hypothesis 7: There is a positive relationship between stakeholders' economic benefits and reduced public opposition against the TSO's transmission line projects.

7.2.6 Technical planning

Technical planning is one of the core activities in transmission line siting. It comprises the line design as well as the routing of the line. The majority of interviewees named planning measures through which the TSO could reduce public resistance against its transmission projects. Examples such as the definition of route alternatives, the application of technical options like UGC systems, the piloting of transmission innovations that reduce negative impacts or the bundling of infrastructure were mentioned. In their survey, Battaglini et al. (2012) state that project opposition could be reduced if a TSO applies underground cables nearby human settlements and fosters infrastructure bundling. Moreover, Furby et al. (1988b) argue that citizens' attitude towards transmission lines depends on the visual impact, environmental concerns and human health and safety issues. If technical transmission line planning can reduce or even avoid such negative impacts, citizens' attitudes are likely to change and the project becomes accepted. Hence, the following hypothesis is derived:

Hypothesis 8: There is a positive relationship between a TSO's technical planning and reduced public opposition against its transmission line projects.

7.2.7 Trust

As described in chapter 3.2.6, trust is one of the main contextual factors influencing stakeholders' attitudes towards an infrastructure development. It is the only contextual factor that can be influenced by the TSO directly. Although trust has not explicitly been considered in the identification of (manifest) potential success factors above, it must be considered in the validation hereinafter. This is because trust, as a latent construct, was identified as important factor for siting success in several analog infrastructure projects outlined in chapter 5.1.2. For instance regarding nuclear or hazardous waste repositories, the studies of Chung & Kim (2009), Kunreuther et al. (1990), Flynn et al. (1992), Bassett et al. (1996), Ibitayo & Pijawka (1999), Sjöberg & Drottz-Sjöberg (2001) and Sjöberg (2004) identified a positive relation between stakeholder trust in the project developer and the acceptance of the planned facility. Moreover, Bronfman et al. (2009) analyzed the acceptance of hazards and found that trust had a positive correlation with social acceptability. Similar results have been identified by Upreti & van der Horst (2004) for biomass power plants, Midden & Huijts (2009) and Terwel et al. (2011) for CCS, Heiskanen et al. (2008) for geothermal power plants, Jobert et al. (2007) for wind, and finally Baxter et al. (1999, p. 503) for the siting of a landfill, who state that trust is "a principle of effective siting". Transmission lines have a similar characteristic compared to the listed infrastructure projects, i.e. they are also large in size and have negative impacts on the affected people. Therefore, the numerous outlined examples are strong indications that trust in a TSO is also a success factor for reduced public opposition against transmission lines.

Hypothesis 9: There is a positive relationship between stakeholder trust towards a TSO and reduced public opposition against its transmission line projects.

7.2.8 Summary of hypotheses

After the individual outline of each hypothesis, table 12 summarizes all nine expected causal relationships of the latent variables, i.e. exogenous and endogenous constructs that will be transferred into a path diagram for structural modeling in the following chapter.

Table 12: Hypotheses of the research model.

Hypothesis	Exogenous construct	Endogenous construct	Expected relationship
H1	Stakeholder liaison	Trust	positive
H2	Participation	Trust	positive
H3	Participation	Reduced public opposition	positive
H4	Communication	Trust	positive
H5	Communication	Reduced public opposition	positive
H6	Organizational readiness	Trust	positive
H7	Economic benefits	Reduced public opposition	positive
H8	Technical planning	Reduced public opposition	positive
H9	Trust	Reduced public opposition	positive

7.3 Development of path diagram and model specification

The next step in preparing a SEM is to translate the identified potential manifest and latent success factors as well as their causal relations into a path diagram. This is to reduce complexity and visualize the different relationships (Fuchs, 2011, p. 11). In other words, the different hypothetical success factors "should form a cause-map with success as the outcome; some factors affecting the outcome directly, and others affecting the direct factors and the relationship between the direct factors and success" (Williams & Ramaprasad, 1996, p. 254). In the following the two general types of submodels, namely structural and measurement model, as the inherent parts of a SEM, are specified in detail.

7.3.1 Structural model

As already described earlier in this work, the structural model, also known as inner model, defines the relations between the exogenous and endogenous constructs. This work aims to identify success factors in order to reduce public opposition against transmission line projects. Hence, the focal endogenous latent construct is REDUCED PUBLIC OPPOSITION[181] and represents the final effect, i.e. success, in the model. The testified groups of manifest success factors outlined in the chapters 6.3.1 to 6.3.6 represent the exogenous constructs, or latent success factors, influencing the construct REDUCED PUBLIC OPPOSITION according to the defined hypotheses described in the previous chapter. TRUST is a construct of second order, which basically means that it is defined as an endogenous construct influenced by other latent success factors as well as an exogenous construct influencing the focal construct REDUCED PUBLIC OPPOSITION[182]. Figure 63 on the next page illustrates the path diagram of the structural model with the respective hypotheses.

[181] For better distinction, all latent variables in the model are written in capital letters hereinafter.

[182] For details about the distinction between first and second-order in SEMs please refer to Jarvis et al. (2003).

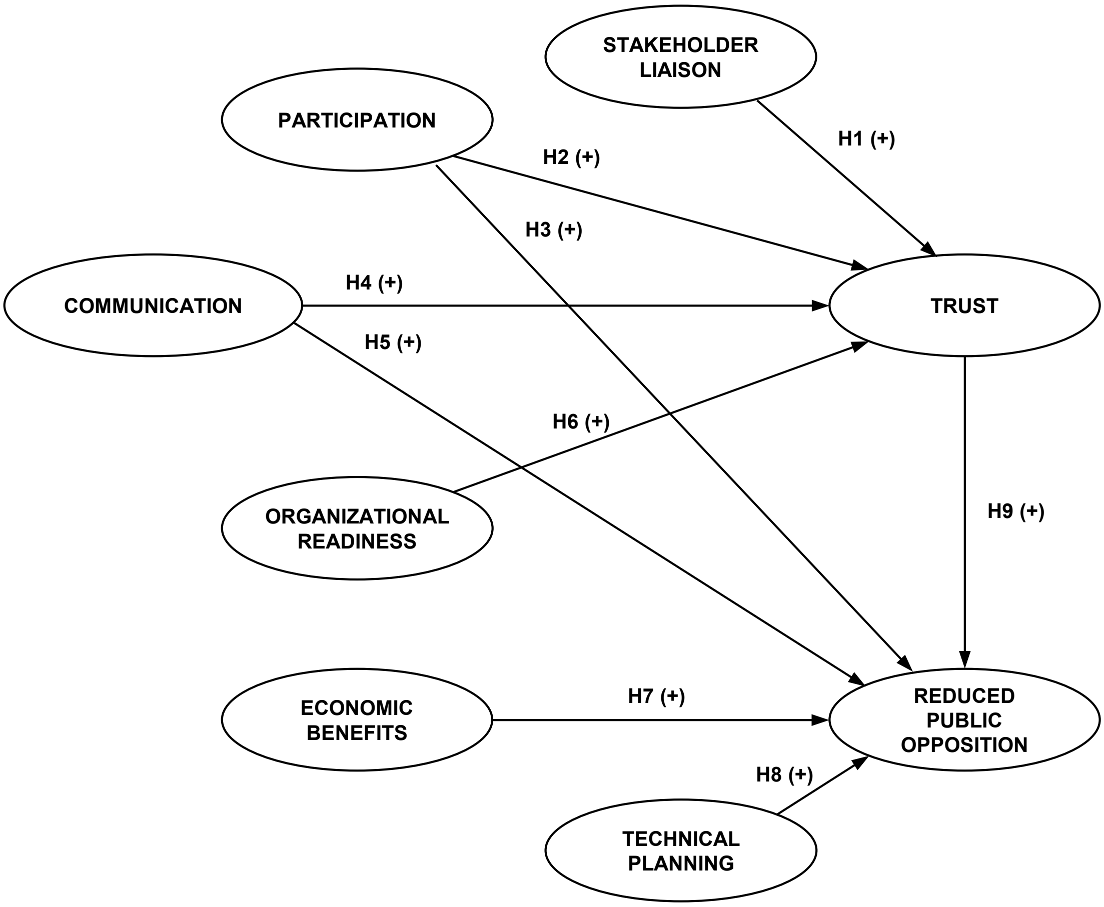

Figure 63: Structural model.

7.3.2 Measurement model

All latent constructs included in the structural model have to be measured by manifest variables. This can be done in either a formative or reflective manner. To identify the appropriate approach, Huber et al. (2007, p. 18) postulate that it is sufficient to analyze the theoretical relations between indicators and constructs. The central question thereby is if the change of a construct will change all related indicators or in turn if the change or elimination of an indicator will change the respective construct significantly (Herrmann et al., 2006). Furthermore, the objective of the researcher is decisive. If he aims to identify measures that can influence and shape a construct, then the formative approach is the better one to use (Herrmann et al., 2006, p. 49). In contrast, if a latent construct that cannot be observed directly, is intended to be completely reflected by measureable substitutes, the reflective approach is the better choice.

7.3.2.1 Formative measurements

The work's objective is to identify factors that influence success. Latent constructs such as COMMUNICATION are potentially reducing public opposition against transmission line planning. However, management needs to know how to specifically ensure sufficient communication. The identified underlying potential success factors like the development of a communication strategy, the provision of comprehensible information, sufficient post-communication etc. together lead to sufficient communication. They thus 'form' the latent success factor COMMUNICATION. The elimination of one of them would change the latent success factor significantly. This not only holds true for COMMUNICATION, but also for all the remaining latent success factors such as PARTICIPATION, ORGANIZATIONAL READINESS, ECONOMIC BENEFITS, TECHNICAL PLANNING and STAKEHOLDER LIAISON. According to Jarvis et al. (2003, p. 203), the non-interchangeability of manifest variables of a latent construct clearly indicates the use of a formative measurement approach. Moreover, Albers & Hildebrandt (2006, p. 3) suggest that for success factors in terms of clear implementable recommendations to management, the formative approach is the most appropriate one. Hence, it is applied for the above listed latent constructs. In contrast to the covariance based LISREL method, the selected PLS method complies with formative measurement models which is a further reason for its choice.

7.3.2.2 Reflective measurements

There are two latent constructs that are measured in a reflective manner: TRUST and REDUCED PUBLIC OPPOSITION. According to Kim et al. (2010, p. 362), a minimum of four indicators per construct should be used for the sufficient measurement and testing of unidimensionality. The level of TRUST is measured by the prejudices against the TSO organization (7b_PREJU), the degree to which the company is committed to protecting the environment and people's health and safety (7a_COMMI) (Kunreuther et al., 1993, p. 316), the organization's reputation (7c_REPUT) (Helm, 2005, p. 96; Rosaci, 2012) and the level of confidence which individuals have in the project developer (7d_CONFI) (Chung & Kim, 2009, p. 12; Ho et al., 2003, p. 73). As each and every of these variables can be eliminated from the measurement without significantly changing the meaning of the construct, a reflective measurement approach has to be applied according to Jarvis et al. (2003, p. 203).
Regarding the second latent construct, there are several studies available which measure the level of social acceptance. In most cases, such as in the work of Bronfman et al. (2012, p. 248), Yuan et al. (2011), Miller (1976) or Tokushige et al. (2007, p. 105), the authors either specified social acceptance in a completely different context and meaning or directly asked "how acceptable" e.g. a proposed project or technology is. For TSOs, such a general and high-level question would be difficult to answer. It is hard to directly judge to what extent stakeholders accept a transmission line project, or not. Also Cote & Buckley (1987, p. 317) found through a meta study that measurements of abstract attributes lead to a significantly lower explained variance of the respective construct than the measurement of more concrete aspects. Moreover, Podsakoff & Organ (1986, p. 533) state that surveying abstract attributes engages respondents "in a higher-order cognitive process – a process that involves not only recall but weighting, inference, prediction, interpretation, and evaluation". In contrast to social acceptance, public opposition as its opposite can be expressed by certain stakeholder actions and forms of resistance. Thus, REDUCED PUBLIC OPPOSITION should be used as suitable

contruct for the work at hand and represents the success a TSO is aiming to achieve in its project. It is measured through the number of protests and demonstrations (8a_PROTE), raised legal inquiries (8b_INQUI), the number of concrete topics of conflict (8c_TOPIC) and the number of formed action groups (8d_GROUP). The less of these acts of opposition occur in a project, the higher is its acceptance. As any change in the construct REDUCED PUBLIC OPPOSITION would cause changes to these indicators, the reflective measurement approach is the appropriate one (Jarvis et al., 2003, p. 203). The final path diagram, i.e. the structural equation model comprising the structural and the measurement models, is illustrated in figure 64 on the next page.

7.4 Identifiability of model structure

Before the SEM can be estimated, it needs to be checked for identifiability. According to Backhaus et al. (2006, p. 366), a model structure is identifiable if all equations are uniquely solvable. A SEM is a multiple-equations system, which can only be solved if the number of equations is at least equal to the number of parameters that have to be estimated. The amount of equations in the SEM is determined by the number of different elements of the correlation matrix of the model. Backhaus et al. (2006, p. 366) propose calculating the number of correlation coefficients, which represent the different elements in the correlation matrix, through

$$\frac{n(n+1)}{2} \tag{7.1}$$

with n as the total number of manifest indicator variables in the model.

The overall amount of formative and reflective indicators in the model is 49[183], leading to a total of 1,225 correlation coefficients or different equations. Subtracting the unknown parameters of the model, i.e. all loadings, weights and measurement errors in the measurement models as well as the path coefficients and error terms in the structural model results in the degrees of freedom of the model equation system. In the case of this work, 74[184] unknown parameters lead to 1,151[185] degrees of freedom. As this number is positive, the model structure can be regarded as identifiable and thus allows for clear parameter estimation (Backhaus et al., 2006, p. 366).

[183] 41 formative and eight reflective indicators.

[184] 49 indicators plus eight latent constructs and eight error terms plus nine structural equations.

[185] 1,225 minus 74.

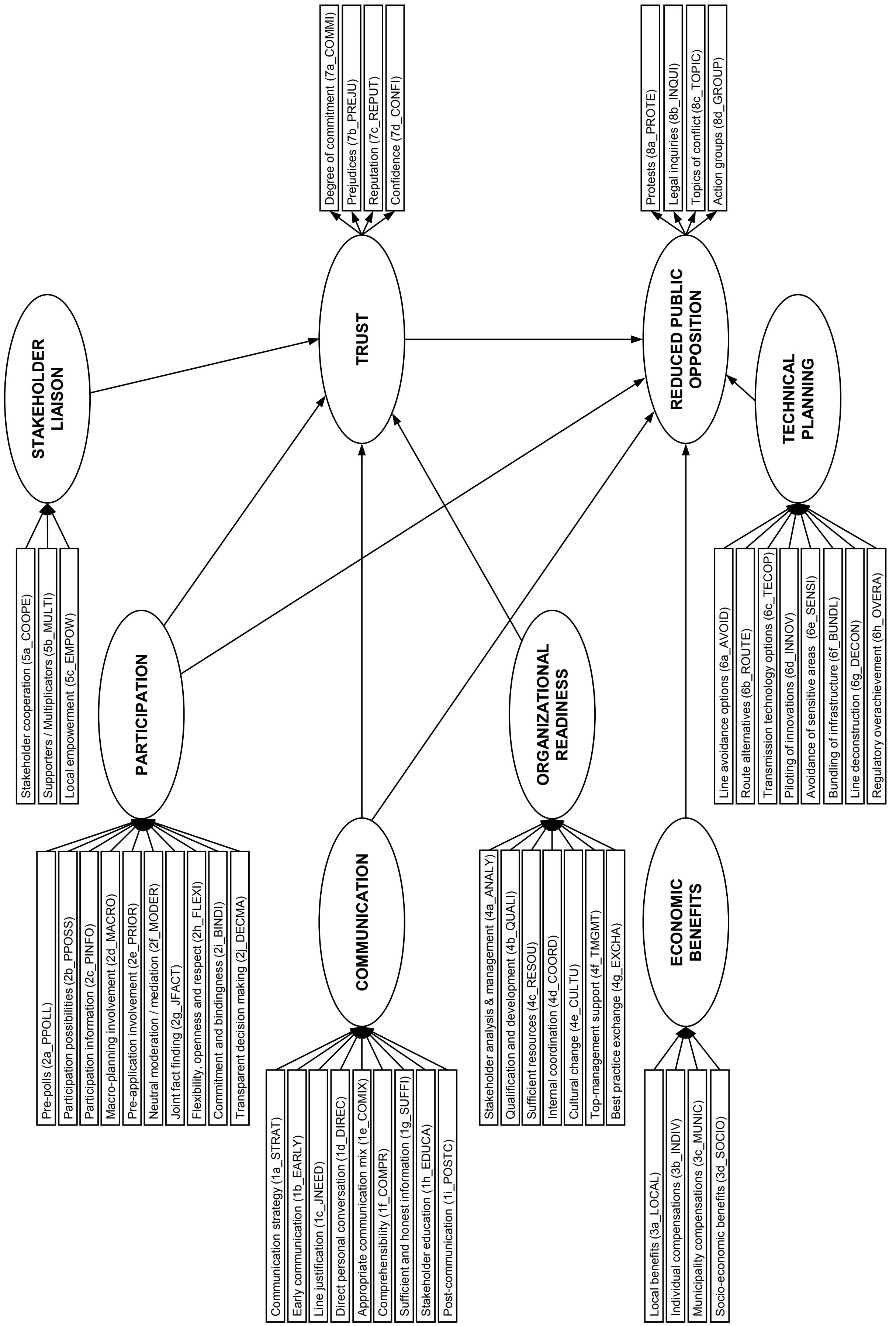

Figure 64: Path diagram of research model.

8 Empirical validation of potential success factors

The identified potential success factors from the interviews and the literature are validated in the following through the TSOs. The subsequent chapters provide details on how the respective data was acquired and evaluated as well as provide an interpretation of the results.

8.1 Data acquisition

8.1.1 Concept of using questionnaires for data acquisition

For the validation of potential success factors, the data was collected through a written questionnaire. Porst (1998, p. 21) defines the questionnaire as "a standardized compilation of questions, which are presented to people for answering with the aim to use their responses for the validation of theoretical concepts and relations which underlie the questions. It is therefore the link between theory and analysis"[186]. Using a standardized questionnaire instead of conducting personal interviews has several advantages here. First, a questionnaire reduces the costs of data acquisition[187]. Second, it lists in detail all potential success factors and allows the respondents to take enough time and patiently go through all items and evaluate their relevance. It even gives people the flexibility to move forwards and backwards through the questionnaire. According to Schnell et al. (2005, p. 359), this results in more honest and thought-through answers. The same would not, or only to a very limited extent, be possible in personal interviews or interviews via telephone. Third, the target group, i.e. TSO managers, are usually very busy and have limited time only. It is rather hard to get personal interviews scheduled. A written questionnaire allows them to decide when to fill it, e.g. during travel time, etc. Fourth, potential interviewer bias is avoided (Podsakoff et al., 2003, p. 885).

A major disadvantage of questionnaires is the risk of missing items when respondents forget or refuse to answer certain questions (Porst, 2011, p. 54). In contrast to open interviews, questionnaire respondents cannot express additional ideas as they have to stick to the provided questions and predefined answer categories (Atteslander, 2006, p. 147). Moreover, the respondent cannot ask for clarification in case some questions are not clear. Chapter 8.1.3.1 provides information on how these downsides were addressed. Finally, the researcher cannot make sure that the questionnaire is filled out by the correct person (Porst, 1998, p. 17). To minimize that risk, additional control questions were included in the questionnaire as described in chapter 8.1.3.2.4.

[186] Own translation.

[187] As all European TSOs fall within the scope of this work, personal interviews would have meant significant travel costs and time.

8.1.2 Target group and sample size

The scope of this work comprises the TSOs of all ENTSO-E member countries. Among the 42 ENTSO-E members, there are three DSO[188]: Scottish Power Transmission plc (UK), VKW-Netz AG (AT) and TIWAG Netz (AT). However, as they have transmission line assets of voltage levels 220 kV and above, they are included in the scope of this work. The TSO System Operation Northern Ireland Ltd operates grids for the Irish TSO EirGrid, but is not responsible for the development of new transmission lines. Thus, it is excluded from the scope which results in a total of 41 TSOs[189]. A complete list of all organizations can be found in appendix 4. The question remains, what types of TSO employees are most adept at answering the questionnaire. Talks with energy experts and TSO members at transmission conferences revealed that the TSO departments Asset Management / Project Management as well as Communications / Stakeholder Management[190] are most suitable, as they deal with transmission line development and stakeholder opposition almost on a daily basis. Getting answers from both departments is essential for a diverse range of responses. Moreover, approaching two employees, who are each from a different department, also ensures that they fill out the questionnaire independently from each other. Hence, one respondent from each of the two department categories was selected per TSO organization as target group to answer the questionnaire. Most of the relevant contacts were identified with the help of ENTSO-E. All remaining employees were identified through company websites, annual reports or simply calling the respective organizations by telephone and asking for the person in charge. The total population is therefore defined by 82 possible respondents. As the total population is very small, it makes further drawing of samples out of it virtually pointless (Riesenhuber, 2007, p. 11) and a sampling procedure or design obsolete as sample (Schnell et al., 2005, p. 270). The sample size would be too small to reveal any statistical significant results with a sufficient confidence level. Hence, the total population should lie within the scope of the survey (Strunk, 2008, p. 10).

Although the PLS method has less restrictive requirements for sample size, it needs to be assessed whether or not the small number of potential respondents is sufficient to conduct a SEM. According to Chin & Newsted (1999, p. 309), insufficient sample sizes increase the potential for type II error, i.e. not rejecting the null hypothesis, whereby a poor model can still falsely achieve adequate model fit. In the literature, one can find several rules-of-thumb on how to determine the minimum required samples size for a PLS model. Chin & Newsted (1999, pp. 326–327) propose defining the minimum sample size as 10 times greater than either the largest amount of formative indicators loading on a construct (i.e. the largest measurement equation) or the largest amount of independent constructs influencing a

[188] Distribution System Operators.

[189] To facilitate readability, the included three DSOs will be subsumed as TSOs hereinafter.

[190] Please note that two similar descriptions per department are listed here as there is no standard department description across all TSOs. Similar departments were also used in the survey by EPRI (2001).

dependent one in the model (i.e. the largest structural equation). In contrast, Barclay et al. (1995, p. 292) suggest 5-10 times and Tabachnick & Fidell (1989) propose only five times. Harris (1975) recommends not multiplying the largest number of indicators or independent constructs, but adds 50 to it in order to determine the minimum required sample size. Green (1991, p. 504) warns that "[t]raditional rule-of-thumbs have two problems associated with them. First, their mathematical simplicity does not offset their inability to take into account effect size. The number of subjects required for conducting a regression analysis with a small effect is dramatically different from the number of subjects required for an analysis with a larger effect size. (…) Second, even if effect size is held constant, the number of subjects is not linearly related to the number of predictors as indicated by the general form of the rule-of-thumb". Moreover, Goodhue et al. (2006, p. 9) and Chin (1998a) suggest that researchers should not rely on such heuristics, but should rather calculate the exactly required sample size based on power and effect size which is done for the work at hand in the following. The power of a test is defined as the probability, i.e. 1-β, of rejecting a false null hypothesis. Effect size (f^2) is "the degree to which the criterion variable is related to the predictor variables"[191] (Green, 1991, p. 499). As a convention for behavioural research, a value of 0.80 is usually used for power (Baroudi & Orlikowski, 1989; Cohen, 1977a; Hair et al., 1998, pp. 10–13) and effect sizes of 0.02 are regarded as small, 0.15 as medium and 0.35 as large (Chin, 1998b, p. 317; Cohen, 1977a)[192]. Therefore, the researcher needs to have a sample size which allows his SEM to at least identify large effects of 0.35 as significant. Green (1991) and Cohen (1988) provide guidance as to how exactly determine the minimum required sample size from the regression analyses. The software G*Power[193] by Faul et al. (2007) was used to do these calculations. In particular, an F test was performed with $\alpha = 0.05$ and power = 0.80 as proposed by Green (1991). Moreover, the largest number of predictors in the model required for calculation was 10[194]. Figure 65 on the next page shows the G*Power output. The graph determines a minimum required sample size of 57 to detect large effects and a minimum of 118 samples to detect medium ones. Small effects can be significantly identified through at least 811 samples[195].

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[191] Criterion variable is the same as dependent variable.

[192] To avoid the risk of misunderstanding, 'large" must not be understood as absolute but rather relative. Large effects do not mean that they are "fairly perceptible to the naked observational eye" and their quest by statistical methods is not "wholly a labor of supererogation" (Cohen, 1977a, p. 13).

[193] Available for free from http://www.psycho.uni-duesseldorf.de/abteilungen/aap/gpower3/.

[194] The construct PARTICIPATION has the highest number (= 10) of predictors in the model.

[195] Not illustrated in the graph anymore.

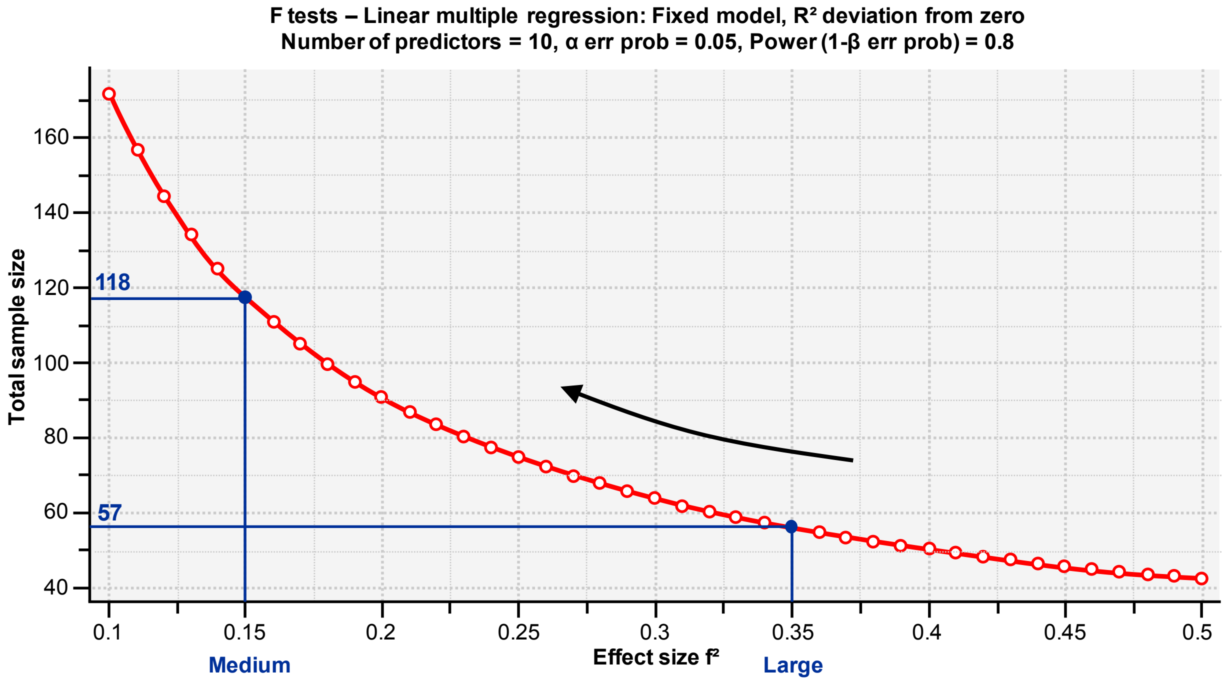

Figure 65: Determination of minimum required sample size with G*Power.

This means that the total population of 82 respondents can meet the minimum required sample size of 57 if a response rate of at least 70%[196] is achieved. This fits also recommendations by scientists regarding a sufficient response rate of a mail survey (Weinberg, 1983, p. 356). The identification of medium or even small effects is unrealistic with a power of 0.80 given the small total population.

8.1.3 Questionnaire design

8.1.3.1 Form and structure

As a critical response rate of 70% had to be reached, certain premises were followed when designing the questionnaire in order to increase the likelihood for response:

- Appealing design
- Brevity
- Simple and interesting questions
- Clear structure
- High usability (reception, filling, return)
- Incentivization of respondent

The final questionnaire can be found in appendix 15. As recommended by Porst (2011, p. 31) and Scholl (2009, p. 176), an appealing title page was designed to attract the interest of the respondents. This was followed by an introductory page, which explained the context and the purpose of the study

[196] 57 / 82 = 0.7

and emphasized the potential benefits of participation to the respondents (Porst, 2011, p. 138). To increase the likelihood for participation further, it was emphasized that the respondent is clearly regarded as a transmission expert and that his input would be essential for this work. Other incentivization measures such as money, gifts, charity donations or lottery as discussed in Stadtmüller (2009, p. 168), Mangione (1995, p. 79), Kirchhoff (2010, p. 31) or Hwang & Xu (2008) to increase return rates was not considered as appropriate in this context. Rather the current relevance and value add of this works was emphasized and the provision of the final results offered. Furthermore, the introductory page provided formal guidance for filling in the questionnaire and included the estimated time it takes to complete it. The introduction also emphasized that all provided input would be treated absolutely anonymously (Dillman, 1978, p. 172). Finally, a deadline of four weeks was given and contact details of the author in case of further questions and clarifications were provided as well (Scholl, 2009, p. 47).

The main part of the questionnaire began with a 'cheap talk' script in order to reduce hypothetical bias. Details on this are given below in chapter 8.1.3.3.3. It was followed by questions on the potential success factors (I.), questions on trust (II.) and public opposition (III.) and questions regarding the control variables (IV.). The different sections were clearly visually separated though a line (Scholl, 2009, p. 176). The questions themselves were structured into several groups according to the above identified success factor categories to ensure consistency (Scholl, 2009, p. 175). They were arranged in a way that ensured a clear and orderly flow (Frey, 1983, p. 100; Rossi et al., 1983, p. 221). As suggested by Porst (2011, p. 138) and Rossi et al. (1983, p. 362), the queries on basic information, i.e. control variables, were put at the end of the questionnaire. The questionnaire thus started with questions on potential success factors which are more interesting for the respondents. The pattern of questions was explained at the beginning of every new section to avoid any misunderstanding or misinterpretation and was marked with attention signs (☛) (Ganesh & Mehta, 2010, p. 67; Scholl, 2009, p. 177). The specification of questions and the respective scale development are outlined in the subsequent chapters on operationalization. The questions in general were kept short and were written in comprehensible English (Atteslander, 2006, p. 146)[197]. The form concluded with a profession of gratitude (Porst, 2011, p. 157), provided a free text field for comments (Rossi et al., 1983, p. 362; Scholl, 2009, p. 178) and gave the possibility to enter an email address if the respondent was interested in receiving the study results[198].

The questionnaire was created as an electronic document for distribution via email. This had several advantages. First, the distribution via email was cheaper than by standard mail, and second, it also

[197] As TSOs regularly interact and exchange information also on a European basis (e.g. through ENTSO-E), the employees in charge were able to correspond in English. Thus, English was chosen as questionnaire language.

[198] Also here, a note was included which stated the ensurance of anonymity.

allowed for improving the usability considerably. The enhanced PDF version[199] allowed respondents to directly fill out the PDF on the computer. In addition, interactive choice boxes and radio buttons were integrated to ease filling. A ‘save button’ as well as an automatic email link were included on the last page to facilitate questionnaire return. To avoid missing values, the document was programmed to produce an alert message if not all questions had been completed when the respondent tried to save or print it. Moreover, the radio buttons ensured that respondents did not select more than one answer per question by accident. A distributed PDF file was preferred over a classical online survey (Scholl, 2009, p. 53), as the questionnaire could also be filled out ‘offline’, i.e. either when the computer is not connected to the internet or as a print-out e.g. during a business flight[200]. Another advantage of the enhanced PDF document, rather for the researcher than for the respondents, was the possibility to automatically consolidate the data of all returned questionnaires into a Microsoft Excel file without manual processing. Typing mistakes during consolidation could therefore be avoided. The final questionnaire was attached to a brief correspondence email for distribution.

8.1.3.2 Operationalization

The development of measurement specifications for the identification of manifest indicators’ attributes is described as operationalization (Kubicek, 1975, p. 94). It is basically the transformation of theory based indicators into specific questions in the questionnaire and the development of scales measuring the respective attributes (Schnell et al., 2005, p. 127). Operationalization can thus be regarded as the translation of the theoretical into the practical level (Wohlgemuth, 1989, pp. 96–97). The individual indicators for each construct have already been identified in chapter 7.3.2. The following subchapters will now outline the selection of appropriate measurements and scales.

8.1.3.2.1 Operationalization of potential success factors

Scientists regularly suggest basing the measurement design and scaling development on existing studies to increase measurement reliability, as they have already been proven successful in other cases. Researchers can draw on established scales from previous studies and available scale books such as Schäffer (2007), Shaw & Wright (1967) or Miller (1976), which can make the development of one’s own scale obsolete. Nevertheless, Bortz & Döring (2009, p. 253) warn against adopting existing scales too frivolously. Due to their formative characteristic, the identified potential success factors in the model form the respective constructs. This means that all facets of the construct are covered by them. They are therefore unique and non-interchangeable. Moreover, they are specified in the special context of transmission line planning. Suitable questions and scales from existing studies could thus not be

[199] The questionnaire was created with the Adobe LifeCycle Designer software as a Portable Document Format (PDF) form with increased functionality. PDF is today a commonly used format to display documents on computers independently of any hard- or software. Compatibility problems could thus be avoided.

[200] A print-out of course does not provide the increased functionality anymore.

identified. As a consequence, the identified potential success factors were directly included into the questionnaire by phrasing them as statements (Miller, 1976, p. 93). Moreover, the subsequent steps proposed by Porst (2011, p. 67) were followed in order to develop the respective scales:

1) Select scale type
2) Define end points, direction and dimension of scale
3) Determine number of scale points
4) Verbalize scale points.

Bortz & Döring (2009, p. 221) provide a detailed overview of available scale types. As the most commonly used scale type in success factor research is the Likert-scale (e.g. see Ganesh & Mehta (2010)), it was also chosen for this operationalization. The scale was developed by Likert (1932) and belongs to the group of rating scales. It lets the respondent to choose from a limited set of scale points that usually have an equal content-distance. It provides a suitable possibility for people to express their attitudes towards something (Miller, 1976, p. 92; Schnell et al., 2005, p. 188). The end points of a scale limit the range within which a respondent can give his answer. For the case at hand this meant, TSO representatives could regard a proposed success factor either as 'not relevant at all' or as 'absolutely essential'. The scale direction defines if the scale increases from left to right or the other way round. As in the Western world, people tend to read from left to right, an increasing scale is usually used and was also selected here as well (Porst, 2011, p. 88). Regarding the dimension, either positive values only (unidimensionality) or negative as well as positive values (two-dimensionality) are possible. The two-dimensional scale has a real mean (in most cases 0). Hence, in order to avoid that respondents evade a question and select the middle, the unidimensional scale was used, which does not have a natural mean (Porst, 2011, pp. 90–91).

A high number of scale points provide for more differentiated survey results. However, respondents face increasing difficulties to make judgements if too many scale points are offered (Konrad, 2007, p. 59; Porst, 2011, p. 85). As in the literature, the use of five-point Likert scales has proven most successfully, it was also selected for the scale development in this case (Cox, 1980; Stadtler, 1983). According to Porst (2011, pp. 77–80), the verbalization of the middle point for scales with an odd number is often very difficult and can even destroy the ordinal character of the scale. He therefore proposes to rather verbalize only the extreme points, which was followed. Thus, to evaluate the relevance of the individual potential success factors, a five-point Likert scale ranging from 'not relevant at all' (1) to 'absolutely essential' (5) was developed and can be found in the questionnaire in appendix 15.

8.1.3.2.2 Operationalization of construct TRUST

The indicator operationalization of the construct TRUST, i.e. the definition of the respective questions and scales, was based on Kunreuther et al. (1993, p. 316), Bronfman et al. (2012, p. 248), Tokushige et al. (2007, p. 105) and Shaw & Wright (1967). All authors used a Likert-scale. For some questions, dimension and number of scale points had to be adapted for the work at hand to ensure consistency across the questions and to avoid any mistakes in the answering process. The final scales ranged from 'strongly disagree' (1) to 'strongly agree' (5). As already outlined above, current or recent transmission line projects are too rare that a broad survey could be based on them. Hence, TSOs had to hypothetically evaluate how they expect stakeholders' trust to develop in their future projects[201]. The questions were formulated accordingly.

8.1.3.2.3 Operationalization of construct REDUCED PUBLIC OPPOSITION

As outlined earlier, the construct REDUCED PUBLIC OPPOSITION is defined reflectively by the number of formed action groups, legal inquiries, protests and concrete topics of conflict. As these factors are very context specific, there are no similar examples available in the literature on which to base the measurement and scale design on. Thus, the questions, or rather statements, were formulated in a hypothetical manner, similar to those for TRUST above, as the following example shows: "There will be less legal inquiries / objections against your future transmission line projects". Similar to the operationalization of TRUST, a five-point Likert scale ranging from 'strongly disagree' (1) to 'strongly agree' (5) was used.

8.1.3.2.4 Operationalization of control variables

Besides the potential success factors and the endogenous latent constructs, some control variables were also included in the questionnaire. As already described above, TSO employees from Project or Asset Management departments as well as personnel responsible for Communications or Stakeholder Management were defined as target group. Thus, to make sure that the questionnaire is filled out by the targeted people and to ensure homogeneity across the target group, a basic question about the respondent's current job position was included (TITLE) according to Robertson (1989). The respective answer had to be given in a free text form as job titles can differ slightly from TSO to TSO[202]. To avoid bias through employees who have only little experience in the field of subject, their respective job experience was surveyed. This was done through two further questions. Based on O'Reilly III (1982), the first enquired as to the duration of employment, i.e. the tenure in the current position (PTIME) and the second was on the total employed time with TSO organizations (TTIME) according to Taylor (1975). The purpose of the first questions was to analyze to what extent the respondents had gained significant experience in their current job position. If someone was new to the position, the second question helped to identify the extent of already gained experience regarding

[201] The problem of potential hypothetical bias will be treated in chapter 8.1.3.3.3 below.

[202] For instance, some TSOs have a 'Project Development Department' whereas others name their similar departments 'Transmission Development Department' or 'Grid Connections Department'.

transmission system planning and dealing with public opposition. This included also former experience in other positions or even other TSO organizations. For both questions, the following four discrete answer categories were provided similar to Cooper & Phillips (2004, p. 502): 10+ years, 5-10 years, 1-5 years, 0-1 year. Discrete categories were chosen as people usually tend to refuse to or not accurately provide personal data, even if this meant losing a certain amount of information.

8.1.3.3 Bias

When conducting a survey, the researcher needs to be aware that certain biases can occur. A bias is defined as a measurement distortion that is systematic rather than caused by statistical probability. "Although both types of measurement error are problematic, systematic measurement error is a particularly serious problem because it provides an alternative explanation for the observed relationships between measures of different constructs that is independent of the one hypothesized" (Podsakoff et al., 2003, p. 879). Ernst (2003, p. 1252) distinguishes several types of possible bias from which three are relevant for the work at hand: common method bias, key informant bias and hypothetical bias. All three are introduced in more detail in the subsequent chapters and measures are outlined as to how they have been reduced in this work.

8.1.3.3.1 Common method bias

Common method bias[203] comprises all measurement errors that are induced by the measurement method itself (Söhnchen, 2007, p. 135). It describes a distortion of the correlation between the exogenous and endogenous variables in the model (Campbell & Fiske, 1959). One's own position and subjectivity as well as profiling can lead to distorted correlations between the variables (Ernst, 2003, p. 1251; Podsakoff & Organ, 1986, p. 535). Common method bias can have several potential sources[204]. In the context of this work, one relevant reason is the fact that the independent and the dependent variables, or in other words, the potential success factors and the effects on the reduction of public opposition were evaluated by a single source: the TSOs. As introduced earlier in this work, the potential success factors have been identified mainly through interviews with respective stakeholders of transmission line projects (e.g. action groups, NGOs, etc.) without the involvement of TSOs. The validation of the hypotheses, i.e. the SEM, through a questionnaire was then conducted through the TSOs only, which essentially represents a single-source of validation. There are several reasons why this approach can still be regarded as the most appropriate one. First, applying two sources to validate the model would mean that the TSO has to evaluate the potential success factors (independent variables) and the stakeholders rate their level of acceptance (dependent variables). This is only

[203] Please note that in literature the term ‚common method variance' is often used equivalently (Greve, 2006, p. 110).

[204] For a complete overview see Podsakoff et al. (2003, p. 882).

possible, if both assessments can be connected through the focus on a particular project. However, there is a scarcity of recent or actual transmission line projects in Europe to base a project specific survey on. Second, focusing the study on a specific project and region would have limited the transferability of study results (Wuppertal Institut et al., 2008, p. 46). Third, the focus on a single project would have also implied difficulties for sample size because a minimum of 57 TSO employees as well as 57 project specific stakeholders (e.g. local residents) would have been needed[205]. Identifying such a high number of willing respondents in a single TSO organization is almost impossible. Fourth, an alternative would have been to use stakeholders only as a single source. However, as they have proposed most of the potential success factors, it is very likely that they would have rated their proposals as highly successful. The fact that the potential success factors have been derived through the stakeholders without any TSO involvement, the risk of single source bias in terms of self-fulfilling prophecy is significantly reduced. Riekeberg (2003, p. 95) argues that such a two-step approach is not problematic as long as the identification of hypotheses and their validation are not conducted with the same set of information carriers. Nevertheless, as a potential single-source bias still could not be completely ruled out, the following ex-ante remedies as suggested by Podsakoff et al. (2003) and Söhnchen (2007) were applied:

Combination of data sources.

To reduce the effect of single source bias, Söhnchen (2007, p. 141) proposes surveying more than one representative per research subject. For the work at hand, this was done by approaching two different representatives per TSO organization, which was necessary anyway in order to fulfill the minimum sample size requirement.

Psychological separation

The probability of single-source bias can be decreased by separating the measurement of independent and dependent variables in the questionnaire through clear structure (Söhnchen, 2007, p. 141). As outlined in chapter 8.1.3.1, this was considered during questionnaire development. In particular, different sections were used for the independent and dependent variables. Moreover, lines were included to clearly separate the sessions visually.

Protecting a respondent's anonymity and reducing evaluation apprehension

Another possible measure to reduce the risk of common method bias, is assuring a respondent's anonymity in the questionnaire. Thus, a relevant statement was included on the introductory page of the questionnaire as described above. Furthermore, on the same page, respondents were told that there are no right or wrong answers. "These procedures should reduce people's evaluation apprehension and make them less likely to edit their responses to be more socially desirable, lenient, acquiescent, and consistent with how they think the researcher wants them to respond" (Podsakoff et al., 2003, p. 888).

[205] As calculated in chapter 8.1.2.

Besides these ex-ante remedies, Podsakoff et al. (2003) propose statistical ex-post measures. These measures basically conduct either a factor analysis (e.g. Harman's single-factor test) or include an additional latent method variable in the SEM and link it to the respective indicators to control and partial out method bias. However, this is only possible if all indicators measure reflectively (Rönkkö & Ylitalo, 2011, p. 1). In case formative factors are involved, as for the work at hand, statistical ex-post mitigation of method bias is not possible[206] (Podsakoff et al., 2003, p. 900) and was therefore not applied in the context of this work.

8.1.3.3.2 Key information bias

Another potential distortion, which is similar to the common method bias, is key information bias. It can occur if only a single representative of an organization is surveyed who has to give representative answers for the company as a whole (Ernst, 2003, p. 1250). As the work at hand independently involved two employees per TSO, the probability of this kind of bias was largely reduced. Furthermore, Ernst (2001, p. 89) proposes that the key informants should have relevant competences in the field of study. This was ensured in this work by surveying respective control variables, in particular job title and job experience.

8.1.3.3.3 Hypothetical bias

The third relevant potential distortion is the hypothetical bias. “Hypothetical bias occurs when (…) respondents state that they will pay for a good when in fact they will not, or they will actually pay less, when placed in a similar purchase decision” (Whitehead & Cherry, 2007, p. 248). It is therefore the tendency to overstate hypothetical willingness to pay and is rooted in intentions being typically free of charge to express, which means that they may not be considered to the same extent as are real consumption choices (Neill et al., 1994, p. 145). It has already been mentioned that due to the scarcity of recent or actual transmission line projects in Europe, a specific project related survey was not possible. Thus, TSOs had to validate hypothetically what potential success factors are relevant in their eyes and which they want to implement in their future projects. Furthermore, they had to hypothetically rate how public opposition may develop in general in their future projects. Hence, this approach was similar to a willingness-to-pay situation and carried the risk of hypothetical bias. In particular, TSOs could have named several potential success factors as relevant but might not implement them in reality. One ex-ante mitigation measure for avoiding hypothetical bias, which has proven successful, is to inform respondents enough about such potential bias so that they self-correct for it (Brown et al., 2003). One possible way to do so is the use of an introductory script in the

[206] As explained previously, formative indicators' measurement errors are included in the respective latent variables. Focusing on the structural model and including a latent method variable would then lead to the fact that the model is not identifiable anymore. For details please refer to Podsakoff, et al. (2003, p. 900).

questionnaire, which makes the reader aware of this potential problem[207]. This had been developed first by Cummings & Taylor (1999) and called 'cheap talk'. It includes three general points. First, it describes the hypothetical bias phenomena. Second, it provides a concrete empirical example of how people have overestimated their willingness to pay in hypothetical bidding situations. Third, the script encourages the participants to give their answers as if it was a real situation (Cummings & Taylor, 1999, p. 651). Thus, for the work at hand, the following cheap talk script, incorporating these three aspects, was used:

> *Recent empirical studies in which questions on future hypothetical behaviour were asked have shown that people usually give different answers than they would do in a real situation. For example, 18% more people answered 'yes' to the hypothetical question "Would you donate 1,000 EUR to XYZ?" than in a real situation/question "Do you want to donate now 1,000 EUR to XYZ?". That's quite a difference, isn't it? This phenomenon is called "hypothetical bias". As we also ask you hypothetical questions in this survey, it could be that you give different answers than you would do it in a real situation. Thus, we want you to be aware of this phenomenon and ask you to answer the questions as if it were a real situation.*

The effectiveness of such a cheap talk script in reducing hypothetical bias has been confirmed amongst others by Ajzen (2004), Brown et al. (2003), Aadland & Caplan (2003) or Lusk (2003).

8.1.4 Pretest

Porst (2011, p. 186) states that pretesting the developed questionnaire is an essential prerequisite for successfully conducting the main survey. Pretesting "provides a critical means for reducing ambiguity and bias in the meaning of measures" (Anderson & Gerbing, 1991, p. 732). In other words, a pretest is simply a check of the prepared questionnaire with a set of test persons to see if

- the questions are understood correctly,
- the order of questions is appropriate,
- the duration needed to fill the questionnaire is estimated correctly,
- the respondent's interest can be kept up throughout the whole questionnaire,
- technical problems in filling or returning the questionnaire exist (Schnell et al., 2005, p. 437).

The pretest was conducted in three stages. First, the questionnaire was presented to five persons from academia who were asked to comment specifically on structure and the introduction as well as the usability and technical functionality of the PDF form. In a second stage, the questionnaire was

[207] Other possibilities are the use of budgetary constraints (Neill, 1995; Posavac, 2001; Loomis et al., 1996) and the ex-post calibration through asking the respondents about their certainty of the given answers (Champ et al., 1997; Li & Mattsson, 1995). However, both options were regarded as not suitable here.

distributed to four electricity transmission experts who were not members of TSOs but either worked as transmission consultants or were employed by transmission technology manufacturers. They were asked to focus on content, i.e. the comprehensibility and specification of the questions. The final stage of pretesting was conducted with TSO representatives and used as the final rehearsal. In particular, next to the respective contacts for the final survey mentioned above, three additional employees from three different TSOs were identified and won for a pretest. Two of them worked in the Asset Management department and one in Stakeholder Management. Individual meetings were scheduled and the candidates were requested to think loudly while conducting the survey, which helped the present author to identify any difficulties the test, persons had with the questionnaire. This technique is called 'think-aloud' and based on cognitive-psychological research (Porst, 1998, p. 38). It allows the researcher to gain information on the comprehensibility of the questions (Prüfer & Rexroth, 2000, p. 2). After each pretest stage, the respective feedback of the test persons was incorporated and the enhanced questionnaire was used for the following stage.

Upon some minor feedback regarding formatting and design, a more compact questionnaire layout was chosen leading to a reduction from seven to six pages in total[208] and thus making it look less extensive for the respondents. Moreover, the test persons mainly suggested rewording or rearranging certain questions as well as adding some examples or further details in brackets to improve comprehensibility. For instance, the potential success factor 'foster joint fact finding' was changed into 'foster joint fact finding (i.e. agree on independent studies & experts)'.

Finally, the tests showed that the time required to fill out the survey took 30 rather than 20 minutes. This information was worked into the introductory section accordingly. The new time was still below the maximum reasonable questionnaire duration of 45-60 minutes proposed by Konrad (2007, p. 57). Some text books suggest conducting pretests with around 12-25 candidates (e.g. Rossi et al. (1983, p. 226)). If cognitive techniques are used, the number can be also lower (Prüfer & Rexroth, 2000, p. 10). Given the small total population of only 41 TSOs in Europe and the fact that the cognitive 'think-aloud' technique was applied, the total number of 12 pretests can be regarded as sufficient.

8.1.5 Questionnaire return and data preparation

To increase the response rate, ENTSO-E was approached and asked to help in distributing the questionnaire. It was expected that TSOs would be more likely to answer a questionnaire if an official body was involved. In particular, a predefined email containing a brief correspondence, the attached questionnaire file and respective contact details were provided to ENTSO-E, which forwarded it to the respective TSO employees. According to a suggestion made by Bortz & Döring (2009, p. 258), questionnaire returns were tracked to create respective return statistics which are illustrated in figure 66 on the following page.

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[208] Including cover page.

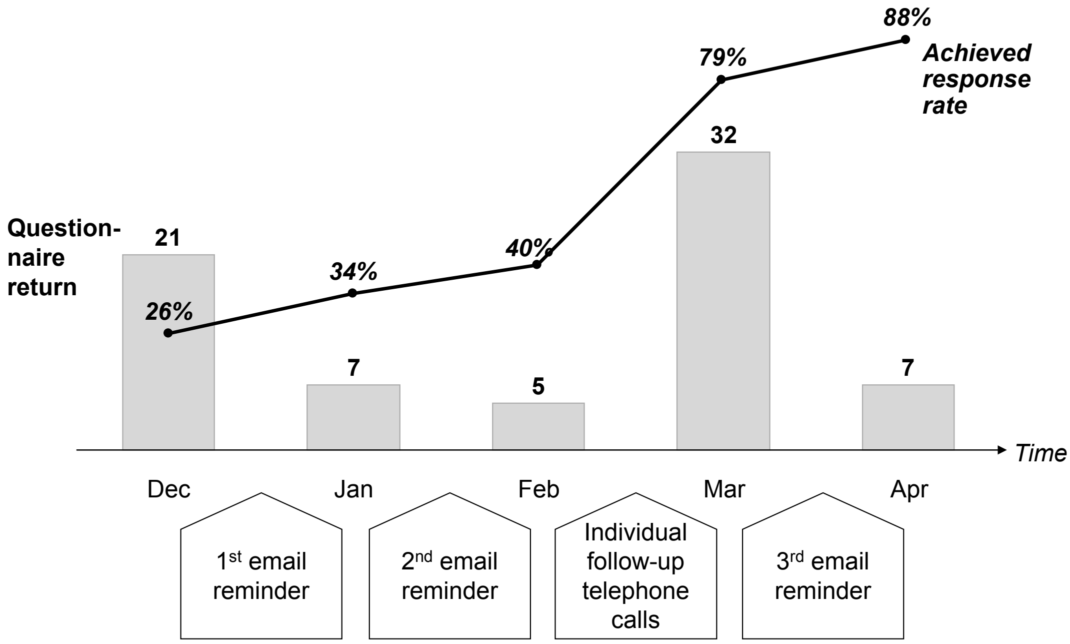

Figure 66: Questionnaire return statistics.

The questionnaire was distributed in December 2011 leading to a first set of 21 returned questionnaires by the end of the year. A comparably long deadline of four weeks was set for response in order to allow the busy TSO staff sufficient time to reply. A deadline of 1-2 weeks, as suggested by some researchers (e.g. Rossi et al. (1983, p. 366) or Bortz & Döring (2009, p. 258)) was not regarded as appropriate in this context. After the deadline had expired in January 2012, a first reminder was sent out via email through ENTSO-E providing an extended deadline, as proposed by Scholl (2009, p. 206) and kindly asking the pending TSOs to participate in the study[209]. This led to seven further answers. When also the extended deadline expired, ENTSO-E sent out a second email again asking for survey participation, which yielded five further filled questionnaires by the end of February. By this time, the critical response rate of 70% had still not been reached. Hence, individual follow-up telephone calls were conducted by the author as suggested by Bortz & Döring (2009, p. 259). Approaching TSO employees personally by telephone and kindly asking for survey participation increased responses significantly and 32 additional questionnaires were received in March. A third reminding email was then finally sent by the author to all those TSOs who had promised in the previous calls to participate. It resulted in another seven answers leading to a total of 72 returned questionnaires, which is a response rate of 88% and thus exceeds the required threshold of 70%. Overall, 36 of 41 TSOs have participated. Of the five missing TSOs, one had explicitly refused to take part in the survey. Further three could be reached via telephone, they also promised to send back the questionnaire, but actually did not do so, even not after the final email reminder. The last of the five pending TSOs could not

[209] Please note that all email reminders were sent with the questionnaire attached again to eliminate the barrier for pending respondents of having to search for the originally sent email response.

even be reached for an individual follow up telephone call. All returned questionnaires were complete, i.e. they had no missing data. Given the total of 72 complete questionnaires, the exact power could be calculated. This was done through the software G*Power with an F test for α = 0.05 and a large effect size $f^2 = 0.35$. As illustrated in figure 67, the achieved power of the model was 0.92 and exceeds the threshold of 0.80. In other words, the research model is able to identify large effects with a probability of 92% at a confidence level of 95%. The power reached for moderate effect sizes was only 0.51 and that of small effect sizes was only 0.09[210]. Small and moderate effect sizes thus could not be significantly identified by the model given the limited sample size. Similarly, the minimum effect size that could be identified significantly was calculated. For the given sample size of 72 and the power of 0.80, the effect was 0.26 which is between medium and large in size.

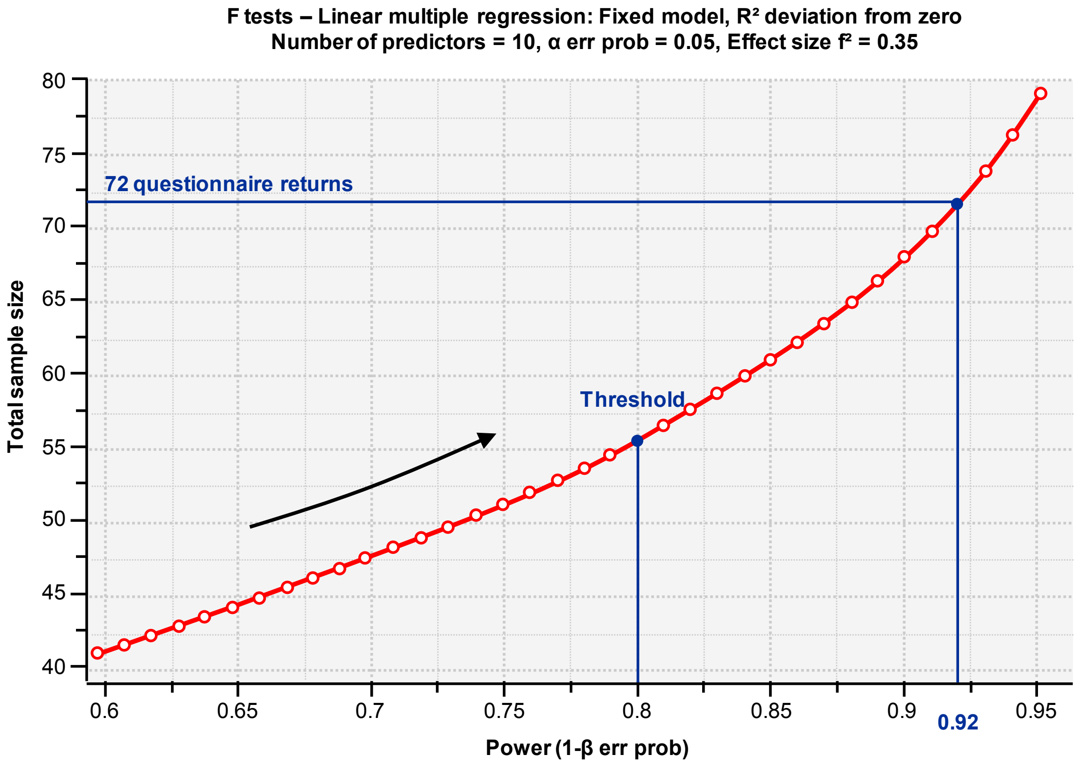

Figure 67: Determination of achieved power.

The analysis of the control variable TITLE showed that all respondents belonged to the TSO departments of interest. All provided job titles could be clearly assigned to one of the focus departments as shown in table 13 on the next page. Hence, an appropriate homogeneity of respondents was achieved across the different TSO organizations and respective bias avoided.

[210] Both not illustrated in figure 67.

Table 13: Job titles of respondents assigned to departments in scope.

Asset Management / Project Management	Communications / Stakeholder Management
▪ Asset Manager	▪ Manager Public Affairs
▪ Member of Asset Management	▪ Head of Communications
▪ Head of Planning Division	▪ Project Communication Manager
▪ Head of Planning Department	▪ Communication Specialist
▪ System Development Manager	▪ Communication Consultant
▪ Senior Vice President Project Development	▪ Press Officer
▪ Manager Transmission Development Department	▪ Manager Development and Institutional Affairs Department
▪ Grid Development Manager	▪ Member of Institutional Relations
▪ Head of Project Management	▪ Stakeholder Manager
▪ Project Manager	
▪ New Grid Connections Manager	
▪ New Investment Director	
▪ Planning Manager	

As employees from two different TSO departments were used as target group, there was a theoretical risk that the results were biased through repondents' association with one of the two departments. Therefore, a t-test was conducted according to Bortz & Schuster (2010, pp. 124–125) and Raab-Steiner & Benesch (2010, pp. 120–122). At a confidence level of 95%, all calculated t-values were below the critical threshold of 2.01[211]. As a consequence, the null hypothesis could not be rejected, which meant that the results did not systematically differ between the respondents from the Asset Management / Project Management departments and those from the Communications / Stakeholder Management divisions. In case there is a discrepancy among survey participants regarding their response time, Bortz & Döring (2009, p. 260) suggest analyzing the results for non-response bias. It could be possible that those persons, who responded immediately, differed significantly from those who did so much later (Armstrong & Overton, 1977, p. 396). Therefore, the first and the last tertile of returned questionnaires were compared through a t-test according to Bloch et al. (2003, p. 554) and Müller (2007, p. 113). At a confidence level of 95%, the critical threshold was not exceeded, which meant that early and late respondents did not differ systematically. Non-response bias did therefore not exist. It is important that the participating TSO employees have gained sufficient experience in their current role in order to provide valuable input and judgement for the questionnaire. This was checked through the control variable PTIME, which evaluated the respondent's job tenure in his current

[211] With 48 degrees of freedom (derived from 49 different main questions) and under the assumption of normal distribution.

department. The chart on the left side in figure 68 shows that more than half (54%) of the TSO employees had been in their current position for at least five years. In contrast, only 10% had just recently started within the last year. To calibrate this finding, a second control variable TTIME was surveyed, asking for the total time employed at TSO organizations. There can be cases, in which people, although having only just recently enrolled in their current position, may have previously worked in other departments of the same or other TSO organizations and thus have gained relevant experience there already. The chart on the right side in figure 68 reveals that 62% of all respondents had already been employed by TSO organizations for at least five years. Almost 50% had transmission system experience of even more than 10 years. Only 4% of respondents had just recently started working for a TSO. As this number is negligibly low, the overall characteristics of the target group can be regarded as sufficiently experienced and as such appropriate for answering the questionnaire.

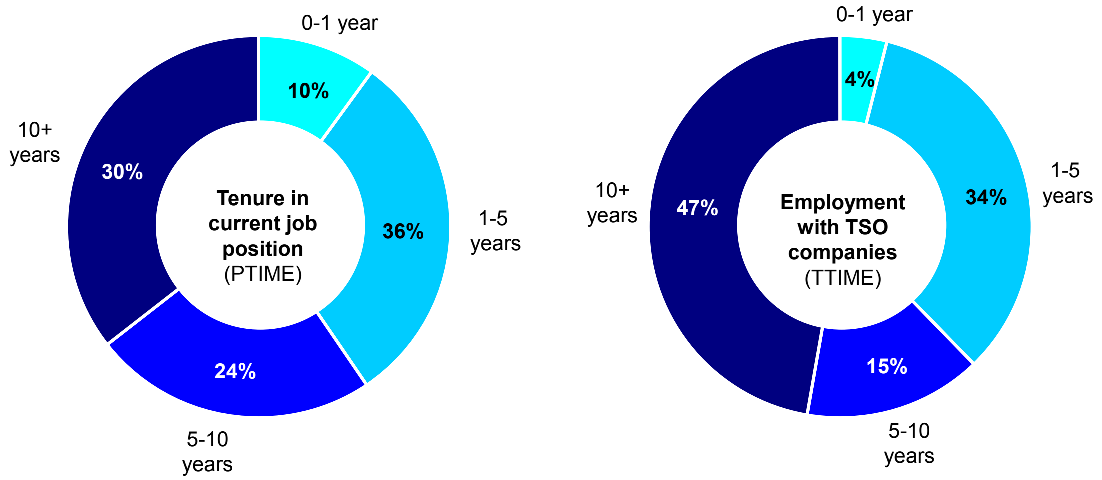

Figure 68: Tenure and job experience of questionnaire respondents.

The free text field included at the end of the questionnaire for comments was filled by some of the respondents. As the following examples show, they primarily proposed further regulatory changes:

- "For higher public acceptance of electricity transmission projects, they should be declared of public interest. Now just market players drive benefits of transmission of electricity. Findings of this study should be a good contribution in a process of accepting a new EU Directive."
- "Create EU priority legislation and infrastructure corridors, implement mandatory support from national and regional political bodies for projects of European importance, adopt a legal framework that ensures efficient authorisation procedures and building lines of European top priority should be possible in nature protection areas."

However, as regulation and legislation is not within the scope of this work, these comments will not be considered hereinafter. Recent or currently planned changes in national or European law were already briefly outlined in chapter 2.5.3 earlier.

Finally, the respondents had the chance to provide their email address at the end of the questionnaire if they were interested in receiving the study results. The fact that 60 out of 72 candidates included their contact details demonstrates a clear interest on the part of TSOs for this research topic.

8.2 Model estimation

8.2.1 Software selection for modeling

There are several software packages available today with which to estimate PLS models. Temme et al. (2010) provide a comprehensive overview of available programmes and evaluate them according to their features, ease-of-use and performance. In contrast to LISREL, PLS software packages were developed rather late. However, the rising need to model SEMs with formative measurement models has made PLS software becoming increasingly popular in recent years. PLS packages are today very user-friendly. Currently, researchers can choose between LVPLS, PLS-Graph, PLS-GUI, Visual PLS, SPAD-PLS, WarpPLS and SmartPLS. Table 14 compares these packages according to several criteria.

Table 14: Overview and evaluation of available PLS software packages based on Temme et al. (2010).

Software	Operating system	User-friendliness		Resampling (bootstrapping & blindfolding)	Free-ware
		Graphical model specification	Graphical output		
LVPLS	DOS	No	No	No	Yes
PLS-Graph	Windows	Yes	Yes	Yes	Yes
PLS-GUI	Windows	Yes	No	Yes	Yes
Visual PLS	Windows	Yes	Yes	Yes	Yes
SPAD-PLS	Windows	Yes	Yes	Yes	No
WarpPLS	Windows	Yes	Yes	Yes	No[212]
SmartPLS	Independent	Yes	Yes	Yes	Yes

User-friendliness is evaluated by assessing whether or not the respective software provides graphical model specification and output. Especially for complex SEMs, a graphical visualization is advantageous for the user. Except LVPLS, all products provide both features. To gain information about the variability of estimated parameters and their respective significance, resampling procedures are important. Bootstrapping is regarded as the most suitable method[213] (Temme et al., 2010, p. 755). To test the model for validity, blindfolding is necessary. All software packages except LVPLS provide both resampling procedures. According to this comparison, Visual PLS, SPAD-PLS, WarpPLS and

[212] Three month trial version with full functionality available.

[213] It supplements blindfolding and jacknifing resampling routines.

SmartPLS can be regarded as the best software solutions in terms of features. As SmartPLS is the only software that is available for free and works on any operating system, the work at hand used it for the estimation of the SEM. Temme & Kreis (2005, p. 208) also prefer SmartPLS as a result of their software comparison.

8.2.2 Estimation results

For the model estimation the following default settings in the software package SmartPLS were applied:

Weighting Scheme:	Path Weighting Scheme
Data Metric:	Mean 0, Var 1
Maximum Iterations:	300
Abort Criterion	10^{-5}
Initial Weights	1.0

Figure 69: SmartPLS setting for parameter estimation.

For details regarding the weighting scheme, abort criterion or initial weights, please refer to chapter 5.3.2.2.4 about the PLS algorithm. SmartPLS successfully finalized calculations after nine iterations for the model at hand. Figure 70 on the next page illustrates the respective estimation output which is evaluated and interpreted in the following chapters.

Researchers who empirically apply structural equation modelling often assume that their investigated sample stems from a homogeneous population unless specific characteristics indicate a necessary division of the sample into several mutually exclusive and homogenous groups (Görz et al., 2000). This leaves the potential risk of unobserved heterogeneity, which means that the interpretation of results on the aggregate data level could theoretically be misleading (Sarstedt et al., 2008). In order to identify a possible heterogeneity of the sample, a multi-group analysis needs to be conducted. This can be done for instance with the Finite Mixture PLS (Hahn et al., 2002; Ringle et al., 2010). Regarding the work at hand, one can argue that TSOs might differ in their behaviour and characteristics across regions. This theoretically could influence how they act in dealing with public opposition. However, a multi-group analysis requires a sufficient sample size of minimum 30 per group (Tuma & Decker, 2013). Given the fact that there are only 42 European TSOs in 34 different countries, any split into two groups would make a test for homogeneity impossible. Thus, a homogeneous sample needs to be assumed with the potential risk of unobserved heterogeneity.

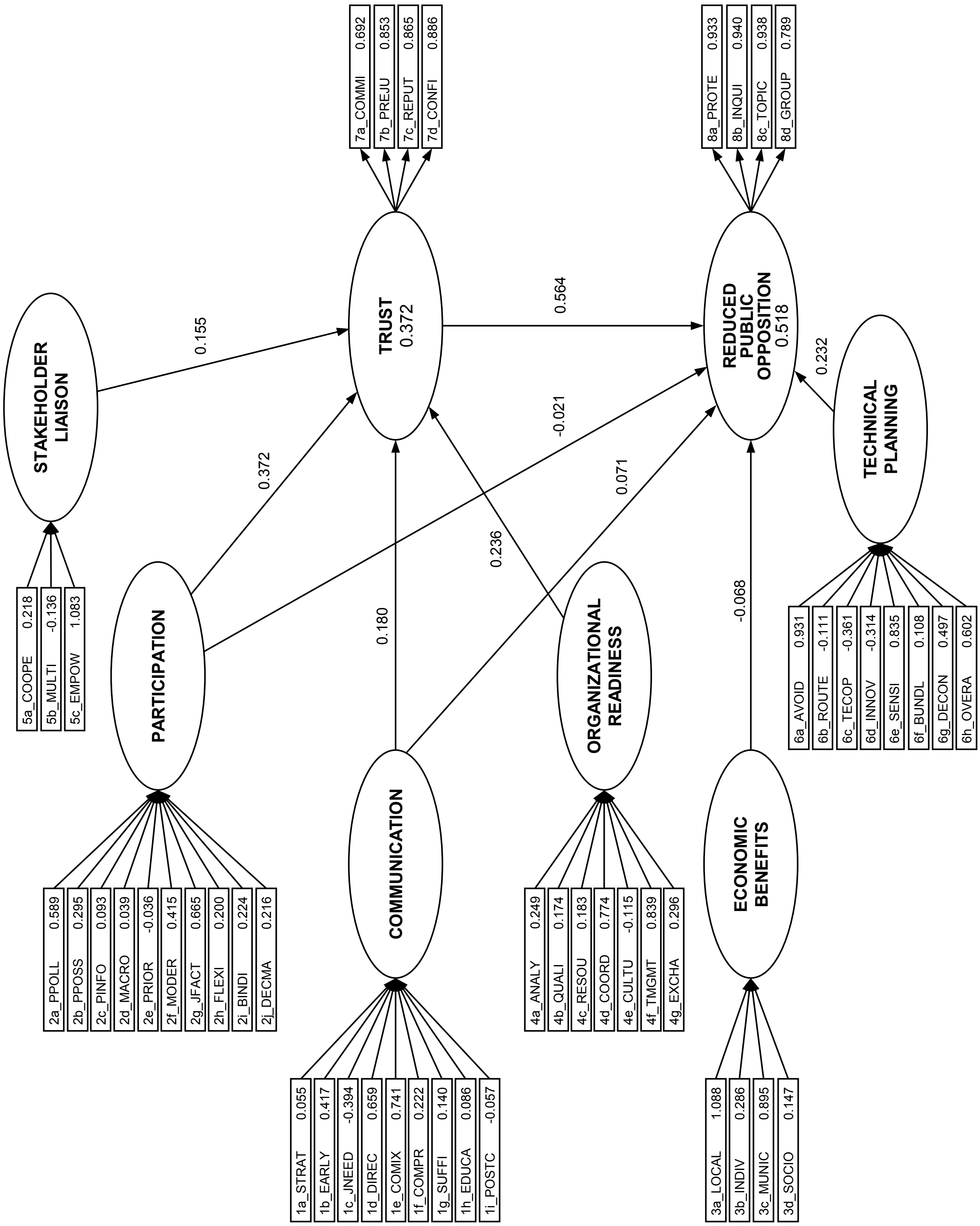

Figure 70: SmartPLS results of model estimation.

8.3 Model evaluation

The evaluation of the PLS parameter estimations plays a central role in SEM. The researcher needs to demonstrate to what extent his specified model is appropriate for describing the effects between the latent constructs under investigation (Götz et al., 2010, p. 693). However, there are fewer quality criteria for variance based PLS models compared to covariance based LISREL models. Typical tests for significance to evaluate the model are not suitable for PLS (Ringle, 2004c, p. 13). According to Wold (1980, 1982a), only tests that do not require data to have a certain distribution are appropriate. Until today, there is no systematic standard process of model evaluation (Ringle, 2004c, p. 13). Nevertheless, Chin (1998) has put forward a catalogue of criteria with which to assess PLS model parameters. Authors of recent studies (e.g. Ringle (2004c), Hemminger (2010), Götz et al. (2010) or Henseler et al., (2009)) have evaluated their models similarly according to these criteria in four main steps (see figure 71). First, the outer model, i.e. the formative and reflective measurement models respectively, is assessed. This is followed by an analysis of the inner model, i.e. structural model. Finally, the model is evaluated as a whole.

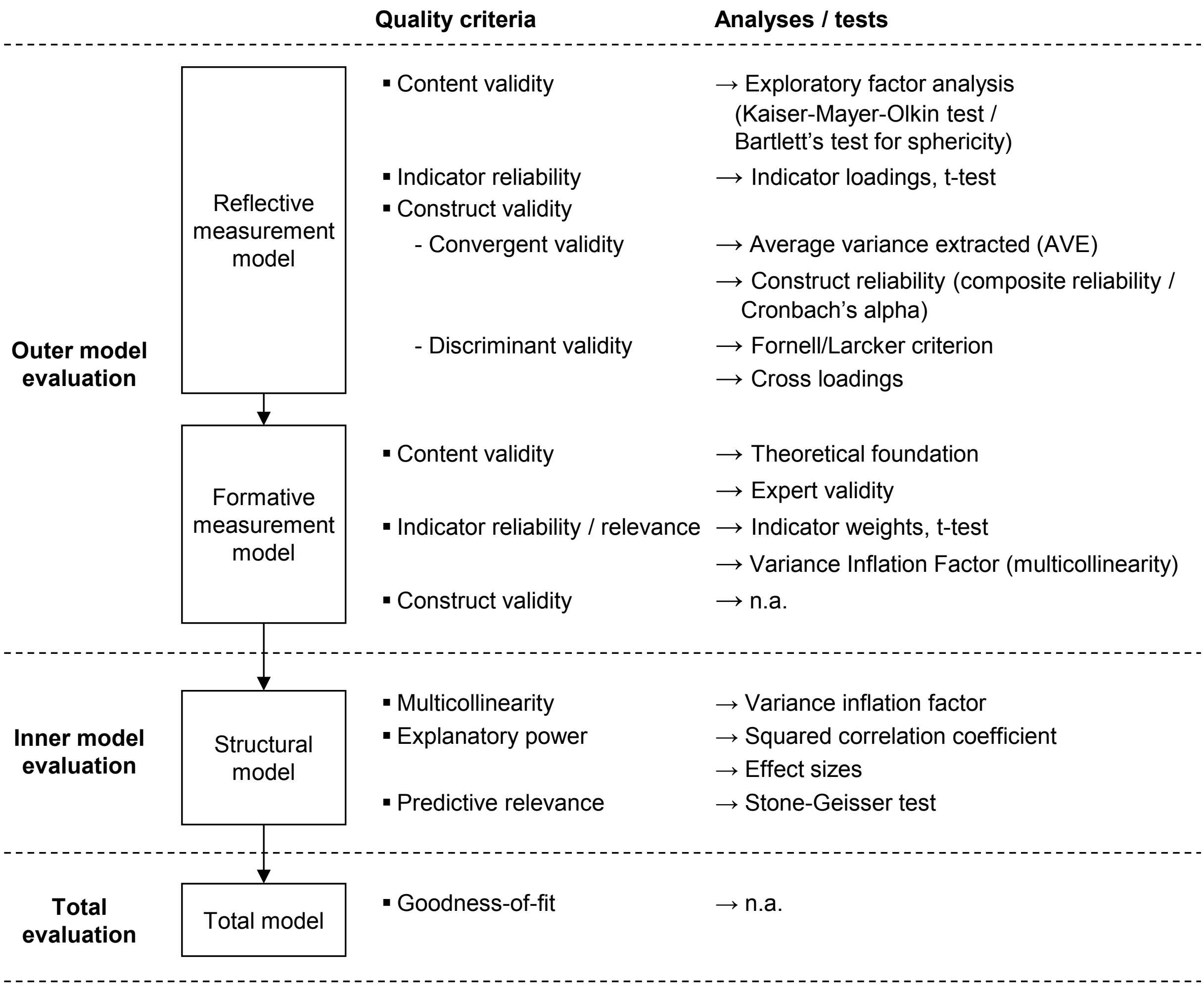

Figure 71: PLS model assessment steps.

In the outer model assessment several reliability and validity criteria are assessed. Reliability is "the degree of consistency between multiple measurements of a variable" (Hair, 2006, p. 137). In other words, reliable measurements can be repeated and always lead to comparable results (Weiber & Mühlhaus, 2010, p. 109). Thus, the more reliable a measurement is, the fewer statistic or systematic measurement errors exist (Peter, 1981). "Reliable measures allow one to generalize from one particular use of the method to a wide variety of related circumstances" (Nunnally & Bernstein, 2006, p. 214). In contrast, "[v]alidity indicates the degree to which an instrument measures the construct under investigation" (Rossi et al., 1983, p. 97). It thus evaluates the conceptual appropriateness of the measurement.

Similar to reliability, absolutely valid measurements do not have statistical or systematic errors (Weiber & Mühlhaus, 2010, p. 127). Reliable measurements are a necessary but not sufficient requirement for validity (Jahn, 2007, p. 18). For all cases where the literature has not agreed on certain tests or analyses yet and different possibilities are postulated, the work at hand evaluates at least two alternatives. Before starting the analyses, Homburg & Hildebrandt (1998, p. 23) suggest to first conduct a plausibility check of the estimation results in the model. In particular, variances must not be negative and correlations must not exceed a value of 1.0 (Baltes-Götz, 1994; Hildebrandt & Görz, 1999). In case estimation values fail the plausibility check, this means that the model itself has been misspecified. However, checking the research model at hand revealed only plausible values. A model misspecification could therefore be ruled out.

8.3.1 Evaluation of reflective measurement models

Researchers have proposed three main quality criteria for testing reflective measurement models: content validity, indicator reliability and construct validity (e.g. Krafft et al. (2005)). In the research model at hand, there are two reflective measurement models. In particular, they measure the latent variables REDUCED PUBLIC OPPOSITION and TRUST and are evaluated in the following along the quality criteria.

8.3.1.1 Content validity

Content validity is the degree to which the indicators of a measurement model belong semantically to the domain of the respective construct (Bohrnstedt, 1970, p. 92). In other words, content validity is given if all measured indicators define the meaning of the construct exhaustively (Weiber & Mühlhaus, 2010, p. 128). It therefore attests the success of the researcher in applying measurement items that cover the content domain of the construct being measured (Badri et al., 1995). All reflective indicators of a construct need therefore to be highly correlated and thus to be tested for unidimensionality. According to Vinzi et al. (2003, pp. 5–6) and Huber et al. (2007, p. 93), an exploratory factor analysis is suitable for evaluating the factor structure. A minimum required sample size for factor analysis is not required if the latent constructs are defined by at least four indicators each and if each indicator has a loading greater than 0.6 (Thompson, 2004, p. 24). As shown in figure 70 on page 237, this is the case for both reflective measurement models of TRUST and REDUCED PUBLIC OPPOSITION which have loadings between 0.692 and 0.940. Next to sample size, the data needs to be analyzed for factor analysis suitability. In particular, the Kaiser-Mayer-Olkin (KMO) test and Bartlett's test for sphericity were used (Bartlett, 1950; Kaiser & Rice, 1974). The former measures the sampling adequacy and is based on partial correlations between indicator pairs (Fromm, 2010, p. 64). Kaiser & Rice (1974, p. 112) suggest a minimum value of 0.5 and define the ranges of 0.7's as middling, 0.8's as meritorious and the 0.9's as marvellous. Bartlett's test determines if the correlation matrix is an identity matrix, in which case a factor analysis would be meaningless (Ghosh & Jintanapakanont, 2004, p. 635). In other words, it tests the null hypothesis that the indicators belong to an uncorrelated population. The null hypothesis should be rejected which is the case if Bartlett's test is highly significant, i.e. if it has a significance value of less than 0.05. Both tests were conducted with the statistical software SPSS. Figure 72 illustrates the results that fully comply with the above mentioned requirements. The KMO of 0.883 can be regarded as almost very good and Bartlett's test is highly significant with a p-value less than 0.000. The variables are therefore suitable for factor analysis.

	Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	0.883
Bartlett's Test of Sphericity	Approx. Chi-Square	412.300
	df	28
	Sig.	0.000

Figure 72: SPSS results for KMO and Bartlett's test.

In a next step, the number of potential latent variables, i.e. factors, needs to be extracted. In SPSS this was determined with the principal axis factoring option as recommended by Weiber & Mühlhaus (2010, p. 107) and Gerbing & Anderson (1988, p. 189). The method identifies a factor structure which maximizes the explained variance through the latent constructs. One decision criterion is the constructs' eigenvalue. A factor's eigenvalue characterizes the amount of information it represents. It is recommended that all factors with eigenvalues under 1.0[214] are dropped (Guttman, 1954). The following eigenvalues could be calculated for the eight reflective indicators with SPSS:

214 Please note that sometimes this logic is attributed to Kaiser, and called the 'Kl' rule (Thompson, 2004, p. 32).

Factor	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	5.020	62.744	62.744
2	1.036	12.949	75.693
3	0.671	8.388	84.081
4	0.402	5.021	89.102
5	0.385	4.816	93.918
6	0.187	2.337	96.255
7	0.170	2.125	98.379
8	0.130	1.621	100.000

Extraction Method: Principal Axis Factoring.

Figure 73: SPSS output for eigenvalues.

The results show that two factors have an eigenvalue greater than 1. Both factors together explain the total variance by more than 75%[215] which is higher than the required 60% (Ghosh & Jintanapakanont, 2004, p. 635).

An alternative method to identify the number of factors is graphical testing via a scree plot. According to Cattell (1966), factor extraction should be stopped at the point of an 'elbow' in the graph above the eigenvalue of 1. Figure 74 displays the scree plot generated by SPSS. The elbow can be clearly recognized at a factor number of two and thus determines the number of factors to be extracted.

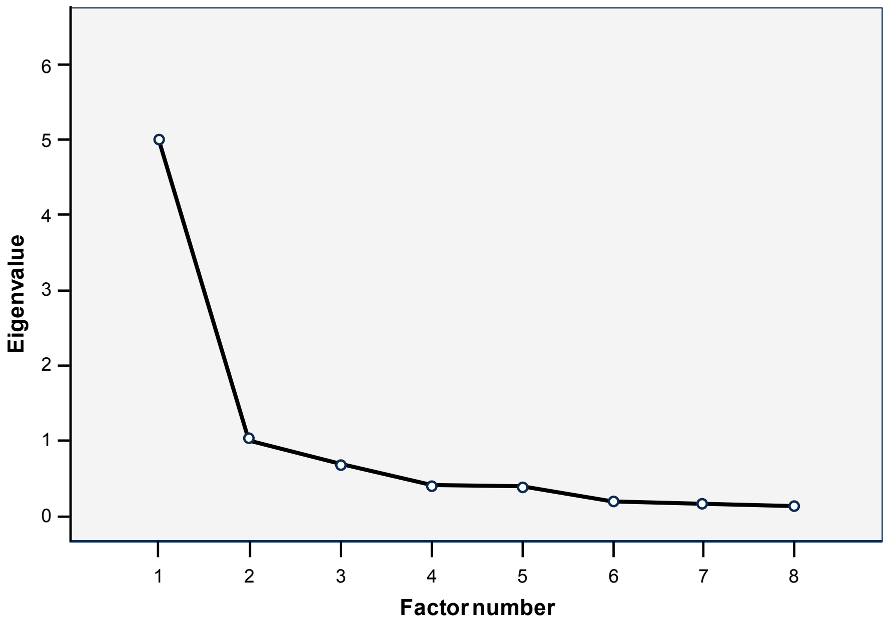

Figure 74: SPSS scree plot.

Both assessments revealed the same amount of latent constructs (i.e. factors) as in the research model. In a second step, it was analyzed whether or not the reflective indicators were correctly assigned to these two constructs. This was done in SPSS by conducting a factor analysis with two predefined

[215] Cumulative variance of 75.693%.

constructs. To prepare the results for interpretation they were orthogonally rotated with the varimax-rotation as proposed by Churchill (1991). Figure 75 shows the results in a rotated factor matrix.

	Factor	
Factor	**1**	**2**
8c_TOPIC	**0.835**	0.387
8a_PROTE	**0.831**	0.371
8b_INQUI	**0.821**	0.430
8d_GROUP	**0.678**	0.237
7d_CONFI	0.361	**0.806**
7c_REPUT	0.263	**0.803**
7b_PREJU	0.364	**0.668**
7a_COMMI	0.251	**0.505**

Extraction Method: Principal Axis Factoring.
Rotation Method: Varimax with Kaiser Normalization.

Figure 75: SPSS rotated factor matrix[216].

The reflective indicators 'topics of conflict' (8c_TOPIC), 'protests' (8a_PROTE), 'legal inquiries' (8b_INQUI) and 'action groups' (8d_GROUP) have their largest loading on factor 1, whereas the remaining indicators have their largest loading on factor 2. This is the same assignment of indicators to factors as in the research model. It should be mentioned that the indicator 'legal inquiries' (8b_INQUI) also loads with more than 0.4 on the other factor. Nevertheless, the indicator assignment in the research model can be regarded as appropriate and unidimensionality can be affirmed for each latent construct. The reflective measurement model has therefore sufficient content validity.

8.3.1.2 Indicator reliability

Indicator reliability indicates the degree of an indicator's variance, which can be explained by the related latent construct (Homburg et al., 2008, p. 286; Krafft et al., 2005, p. 73). In other words, indicator reliability measures the extent to which blocks of indicators strongly agree in their representation of the underlying construct. A proposed threshold is that at least 50% of the indicator variance should be explained by the construct. This in turn means that the standardized loading of a construct on an indicator should be at least 0.7 (Carmines & Zeller, 1979, p. 27). Indicators with loadings between 0.4 and 0.7 should only be considered for removal from the measurement model if the elimination leads to an increase in composite reliability above the suggested threshold value (Hair et al., 2011, p. 146). Indicators with a value less than 0.4 should definitely be eliminated. Weak indicator loadings in reflective measurement models often occur in cases where the researcher cannot rely on proven measurement indicators from the literature and has to identify and develop own variables (Hulland, 1999, p. 198). As explained above, new indicators had to be determined also for this work, as no measurement of social acceptance specifically in transmission line projects had yet

[216] Indicators are sorted according their loadings.

been made. As illustrated in table 15 below, the factor loadings in the reflective measurement model showed values above 0.7. Only the factor 'degree of commitment' (7a_COMMI) is slightly below 0.7. Nevertheless, its value of 0.692 is so close to the threshold that it can be regarded as satisfactory. Significance of the factor loadings was tested through resampling, as classical parametric significance tests are not appropriate for the variance based PLS method (Ringle & Spreen, 2007, p. 213). SmartPLS provides the option of resampling via the bootstrapping[217] procedure, which approximates a sample distribution of an indicator by resampling with replacement from the original sample (Temme et al., 2010, p. 747). Bootstrapping was conducted in SmartPLS with the settings[218] recommended by Temme et al. (2010, p. 747), Hair et al. (2011, p. 145), Tenenhaus et al. (2005, p. 171) and Hennig-Thurau & Henning (2005, p. 219). The bootstrap results were then analyzed via a two-tailed t-test for significance. As illustrated in table 15 below, all reflective indicator loadings in the model are significant at a confidence level of 99%[219] and therefore exceed the required level of 95% (Huber et al., 2007, p. 35). Hence, the reflective measurement model has sufficient indicator reliability.

Table 15: Parameter evaluation of reflective measurement model.

Indicator	Loading	t-value
TRUST		
Degree of commitment (7a_COMMI)	0.692***	8.531
Prejudices (7b_PREJU)	0.853***	20.545
Reputation (7c_REPUT)	0.865***	23.244
Confidence (7d_CONFI)	0.886***	40.259
REDUCED PUBLIC OPPOSITION		
Protests (8a_PROTE)	0.933***	48.908
Legal inquiries (8b_INQUI)	0.940***	65.646
Topics of conflict (8c_TOPIC)	0.938***	49.464
Action groups (8d_GROUP)	0.789***	6.983

Confidence levels: *** = 99% (t = 2.576)
** = 95% (t = 1.960)
* = 90% (t = 1.645)

[217] Bootstrapping was first introduced by Efron (1979). There are also the resampling methods jackknifing and blindfolding. However, Temme, et al. (2010, p. 747) state that for deriving t-values, bootstrapping is the superior resampling method.

[218] Individual sign changes; sample size as number of cases; 2,000 bootstrap samples (∞ = degree of freedom for t-test).

[219] Indicators exceed the t-value of 2.576 of a two-tailed t-test that is required for a 99% confidence level and a degree of freedom of ∞.

8.3.1.3 Construct validity

According to Weiber & Mühlhaus (2010, p. 132), construct validity is given if the measurement of a latent variable is not distorted by other latent variables or other systematic errors. In particular, construct validity can be attested when convergent as well as discriminant validity exist (Peter, 1981, p. 135). Both validity evaluations are outlined in the following.

8.3.1.3.1 Convergent validity

"Convergent validity assesses the degree to which two measures of the same concept are correlated" (Hair, 2006, p. 137) or in other words, convergent validity exists if a construct is measured by two different methods and the results are in agreement (Ghosh & Jintanapakanont, 2004, p. 636; Weiber & Mühlhaus, 2010, p. 132). Convergent validity can be assessed through the average variance extracted (AVE) as well as construct reliability (i.e. internal consistency).

8.3.1.3.1.1 Average variance extracted (AVE)

The AVE calculates the amount of variance a latent construct captures from its indicators relative to the amount due to measurement errors (Chin, 1998b, p. 321). The AVE is therefore determined by

$$AVE(\eta_k) = \frac{\sum_l \lambda_{lk}^2}{\sum_l \lambda_{lk}^2 + \sum_l \mathrm{var}(\varepsilon_l)} \tag{8.1}$$

with λ_{lk} as the loadings of reflective indicators y_l and $\mathrm{var}(\varepsilon_l)$ as the variance of the measurement error which is equal to $1-\lambda_{lk}^2$ (Huber et al., 2007, p. 35). An AVE value of 0.5 or higher is regarded as acceptable and means that the latent variable explains more than half of its indicators' variance (Hair et al., 2011, p. 146). The AVE value of the reflective measurement model at hand was calculated by SmartPLS and amounts to 0.685 for TRUST and 0.814 for REDUCED PUBLIC OPPOSITION, i.e. both exceed the required threshold.

8.3.1.3.1.2 Construct reliability

Although small indicator loadings may point to a given indicator's inadequate measurement of a construct, it is usually more important that all indicators of a construct jointly measure the construct adequately (Bagozzi & Baumgartner, 1994, p. 402). Therefore, construct reliability as a second element of the convergent validity assessment was evaluated. It requires indicators which are assigned to the same construct to reveal a strong mutual association (Götz et al., 2010, p. 695). Huber et al. (2007, p. 87) state that if a latent variable's construct reliability is satisfactory, then also individual indicator loadings of 0.6 instead of 0.7 can be accepted. Again, there are two alternative assessments for construct reliability: composite reliability, i.e. internal consistency, and Cronbach's alpha.

Composite reliability[220] is an estimate of a construct's internal consistency. "The rationale for internal consistency is that the individual items or indicators of the scale should all be measuring the same construct and thus be highly intercorrelated (Hair, 2006, p. 137). It is calculated as

$$p_c(\eta_k) = \frac{\left(\sum_l \lambda_{lk}\right)^2}{\left(\sum_l \lambda_{lk}\right)^2 + \sum_l \mathrm{var}(\varepsilon_l)}. \quad (8.2)$$

Composite reliability can range between 0 and 1 (Fornell & Larcker, 1981, p. 45). Values of 0.6 to 0.7 in exploratory research and values of 0.7 to 0.9 in more advanced stages of research are regarded as satisfactory (Nunnally & Bernstein, 2006), whereas values below 0.6 indicate a lack of reliability (Huber et al., 2007, p. 35). The calculated composite reliability of the model at hand is 0.896 for the construct TRUST and 0.946 for the construct REDUCED PUBLIC OPPOSITION. As both reach the minimum required values for construct validity, a threshold of 0.6 can be applied to the individual indicator reliabilities (Huber et al., 2007, p. 87). As stated above in chapter 8.3.1.2, the lowest indicator loading measured in the reflective measurement model is 0.692 and therefore exceeds the minimum required value.

In some cases, **Cronbach's alpha** is also used in the literature to measure construct reliability. It quantifies how well a set of indicators measures a unidimensional latent construct (Cronbach, 1951). However, a downside of it is that it does not consider real factor loadings. Furthermore, the alpha is influenced by the number of indicators (Ringle et al., 2006, p. 87). It is calculated as

$$\alpha(\eta_k) = \left(\frac{N}{N-1}\right)\left(1 - \frac{\sum_{l=1}^{N} \sigma_l^2}{\sigma_t^2}\right) \quad (8.3)$$

with N as the number of reflective indicators of the respective construct and σ_l^2 representing the variance of an indicator y_l. σ_t^2 is the variance of the sum of all scores of indicators that reflect the construct (Götz et al., 2010, p. 695). Cronbach's alpha can vary between 0 and 1 and is required to reach a minimum of 0.7 as a sufficient threshold (Fuchs, 2011, p. 27). SmartPLS calculated for the model an alpha of 0.844 for TRUST and 0.923 for REDUCED PUBLIC OPPOSITION. Both values thus meet the requirement.

220 Also other synonyms like ‚factor reliability', ‚Jöreskog's rho' or ‚internal consistency' are often used (Krafft et al., 2005, p. 74).

Due to the fact that the assessment of composite reliability as well as Cronbach's alpha demonstrate sufficient results, satisfactory construct reliability can be attested for the reflective measurement models. Furthermore, as AVE and construct reliability are sufficient, the reflective measurement models in turn have a satisfactory convergent validity.

8.3.1.3.2 Discriminant validity

According to Weiber & Mühlhaus (2010, p. 134), discriminant validity of a reflective measurement model exists, if the measurements of distinct constructs are significantly different. The evaluation of discriminant validity requires reliable indicators (Weiber & Mühlhaus, 2010, p. 125), which has already been confirmed above. Discriminant validity can be assessed by the Fornell/Larcker criterion as well as the cross loadings of the reflective indicators. Both are explained in the following.

8.3.1.3.2.1 Fornell/Larcker criterion

To assess for sufficient discriminant validity, Fornell & Larcker (1981, p. 46) provide an index, which is also known as the Fornell-Larcker criterion. It requires the AVE of each latent construct η_k to be greater than its highest squared correlation with any other latent construct ξ_j. Mathematically the AVE is defined as

$$AVE(\eta_k) > Cor(\xi_j, \eta_k)^2 . \quad (8.4)$$

For the model at hand, the squared correlations of the two reflectively measured latent variables with the other latent variables are as follows:

Table 16: Squared correlations of latent constructs.

	TRUST	REDUCED PUBLIC OPPOSITION
COMMUNICATION	0.122	0.104
ECONOMIC BENEFITS	0.001	0.005
ORGANIZATIONAL READINESS	0.135	0.048
PARTICIPATION	0.234	0.105
REDUCED PUBLIC OPPOSITION	0.456	-
STAKEHOLDER LIAISON	0.075	0.006
TECHNICAL PLANNING	0.182	0.249
TRUST	-	0.456
AVE	**0.685**	**0.814**

As all correlations with other latent variables are below the respective AVEs (TRUST = 0.685, REDUCED PUBLIC OPPOSITION = 0.814), the Fornell-Larcker criterion is fulfilled and discriminant validity is given for the reflective measurement models.

8.3.1.3.2.2 Cross loadings

An alternative criterion for evaluating models regarding discriminant validity is the use of cross loadings. In particular, a reflective indicator's loading on the assigned latent variable has to be higher than its cross loadings with all remaining latent constructs (Hair et al., 2011, p. 146). In other words, if an indicator loads higher on other latent variables than the one it is intended to measure, the researcher should adjust the model (Chin, 1998b, p. 321). As illustrated in table 17 on the following page, all cross loadings of the indicators are lower than their respective loading on the intended construct. This means that also the assessment through this alternative criterion shows sufficient discriminant validity for the reflective measurement models.

Thus, next to the already determined convergent validity, discriminant validity is also given and leads to the reflective measurement model having sufficient construct validity. Consequently, all above outlined quality criteria are fulfilled. The reflective measurement models of the research model can therefore be regarded as sufficiently specified.

Table 17: Cross loadings of reflective indicators.

	COMMUNI-CATION	ECONOMIC BENEFITS	ORGANIZA-TIONAL READINESS	PARTICI-PATION	STAKE-HOLDER LIAISON	TECHNICAL PLANNING	TRUST	REDUCED PUBLIC OPPOSITION
Degree of commitment (7a_COMMI)	0.293	0.046	0.297	0.261	0.115	0.377	0.692	0.423
Prejudices (7b_PREJU)	0.313	0.016	0.483	0.440	0.274	0.387	0.853	0.588
Reputation (7c_REPUT)	0.255	0.080	0.250	0.462	0.294	0.354	0.865	0.558
Confidence (7d_CONFI)	0.300	0.055	0.176	0.411	0.200	0.309	0.886	0.644
Protests (8a_PROTE)	0.400	0.071	0.168	0.352	0.131	0.484	0.628	0.933
Legal inquiries (8b_INQUI)	0.268	0.019	0.394	0.333	0.010	0.499	0.678	0.940
Topics of conflict (8c_TOPIC)	0.291	0.053	0.176	0.227	0.068	0.509	0.642	0.938
Action groups (8d_GROUP)	0.182	0.130	0.012	0.258	0.069	0.257	0.455	0.789

8.3.2 Evaluation of formative measurement models

Due to the reversed direction of causality between indicators and the constructs in formative measurement models, the statistical evaluation criteria for reflective measurement models cannot be applied directly (Diamantopoulos, 1999, p. 453). Therefore, only a limited set of criteria can be used for the evaluation.

8.3.2.1 Content validity

In contrast to reflective measurement models, the content validity assessment of a formative measurement model, i.e. if the indicators sufficiently describe the construct's domain, does not make sense (Bollen, 1989, p. 222; Bollen & Lennox, 1991; Cohen et al., 1990). This is because "the error term in a formative structure has no measurement error but rather a disturbance term, which represents the remainder content of the construct domain unexplained by the presented indicators" (Diamantopoulos (2006) in Andreev et al. (2009, p. 5)). To minimize the disturbance term and to ensure that the formative indicators capture the entire scope of the construct, Straub et al. (2004) alternatively propose conducting a thorough literature review as well as using qualitative research methods such as interviews for a sound **theoretical foundation**. The collection of potential success factors as formative indicators is based in the present work on a broad review of the literature as well as on 66 semi-structured interviews. Furthermore, the proper assignment of formative indicators to the respective constructs (grouping) has already been confirmed in chapter 6.3. In particular, the indicators' proportion of substantive agreement and the substantive-validity coefficient, which is also known as **expert validity**, have been evaluated and confirmed. Thus, content validity can be assumed for the formative measurement models.

8.3.2.2 Indicator reliability / relevance

The correlations between formative indicators can either be positive, negative or even zero (Bollen, 1984). Hence, an assessment for indicator reliability is meaningless for a formative measurement model (Bollen & Davis, 1994; Hulland, 1999). Nevertheless, Krafft et al. (2005, p. 82) propose evaluating indicator relevance, i.e. their individual contribution to the respective constructs. They suggest to assess the individual indicator weights and their statistical significance. In contrast to reflective indicators, multicollinearity is undesirable as it then becomes difficult to separate the distinct influence of individual indicators on the latent variables (Diamantopoulos et al., 2008, p. 1212).

8.3.2.2.1 Indicator weights and significance

Through the analysis of indicator weights, one can compare to what extent the manifest variables contribute to the relevant construct (Sambamurthy & Chin, 1994, pp. 231–232). "Analogous to beta weights in a multiple regression, the weights of formative indicators provide the unique importance of each indicator by partializing the variance [of the construct] that is predicted by the other indicators"

(Cenfetelli & Bassellier, 2009, p. 9). It can be argued that the higher an indicator's weight is, the larger is its contribution in defining the construct (Krafft et al., 2005, p. 78). Table 18 lists the formative indicator weights. T-values of a two-sided t-test indicate the respective significances of the weights which haven been determined through bootstrapping according to Andreev et al. (2009, p. 6).

Table 18: Parameter evaluation of formative measurement model.

Indicator	Weight	t-value	Loading	t-value	VIF
COMMUNICATION					
Communication strategy (1a_STRAT)	**0.055**	**0.274**	**0.347****	**2.040**	**1.953**
Early communication (1b_EARLY)	**0.417**	**1.628**	**0.517*****	**2.748**	**1.748**
Line justification (1c_NEED)	-0.394	1.480	0.026	0.172	1.724
Direct personal conversation (1d_DIREC)	**0.659*****	**2.831**	**0.352****	**2.022**	**1.364**
Appropriate communication mix (1e_COMIX)	**0.741*****	**2.660**	**0.701*****	**3.839**	**1.695**
Comprehensibility (1f_COMPR)	0.222	0.923	0.130	0.854	1.923
Sufficient and honest information (1g_SUFFI)	0.140	0.674	0.016	0.098	1.522
Stakeholder education (1h_EDUCA)	0.086	0.470	0.057	0.390	1.595
Post-communication (1i_POSTC)	-0.057	0.292	0.207	1.235	1.585
PARTICIPATION					
Pre-polls (2a_PPOLL)	**0.589*****	**2.633**	**0.605*****	**3.224**	**1.206**
Participation possibilities (2b_PPOSS)	0.295	1.485	0.009	0.074	1.773
Participation information (2c_PINFO)	0.093	0.571	0.203	1.278	1.397
Macro-planning involvement (2d_MACRO)	0.039	0.214	0.469***	2.817	1.942
Pre-application involvement (2e_PRIOR)	-0.036	0.201	0.143	0.997	1.689
Neutral moderation/mediation (2f_MODER)	**0.415****	**2.092**	**0.485*****	**2.670**	**1.280**
Joint fact finding (2g_JFACT)	**0.665****	**2.533**	**0.357****	**2.061**	**1.767**
Flexibility, openness and respect (2h_FLEXI)	0.200	0.819	0.190	1.252	2.833
Commitment and bindingness (2i_BINDI)	0.224	0.984	0.159	1.136	2.037
Transparent decision making (2j_DECMA)	**0.216**	**1.095**	**0.449****	**2.410**	**1.595**
ECONOMIC BENEFITS					
Local benefits (3a_LOCAL)	**1.088*****	**3.094**	**0.457***	**1.743**	**1.572**
Individual compensations (3b_INDIV)	0.286	0.934	0.422	1.598	1.299
Municipality compensations (3c_MUNIC)	**0.895****	**2.278**	**0.395**	**1.472**	**1.898**
Socio-economic benefits (3d_SOCIO)	0.147	0.538	0.196	0.760	1.015

Table 18 (continued): Parameter evaluation of formative measurement model.

Indicator	Weight	t-value	Loading	t-value	VIF
ORGANIZATIONAL READINESS					
Stakeholder analysis and management (4a_ANALY)	**0.249**	**0.890**	**0.543*****	**2.719**	**2.451**
Qualification and development (4b_QUALI)	0.174	0.621	0.266	1.468	2.849
Sufficient resources (4c_RESOU)	**0.183**	**0.714**	**0.441****	**2.192**	**2.160**
Internal coordination (4d_COORD)	**0.774****	**2.225**	**0.463****	**2.308**	**2.532**
Cultural change (4e_CULTU)	-0.115	0.441	0.066	0.408	2.445
Top-management support (4f_TMGMT)	**0.839*****	**2.782**	**0.427****	**2.163**	**1.603**
Best practice exchange (4g_EXCHA)	0.296	1.372	0.100	0.620	1.295
STAKEHOLDER LIAISON					
Stakeholder cooperation (5a_COOPE)	0.218	0.827	-0.046	0.200	1.172
Multiplicators (5b_MULTI)	-0.136	0.533	0.247	1.102	1.311
Local empowerment (5c_EMPOW)	**1.083*****	**4.759**	**0.963*****	**5.034**	**1.252**
TECHNICAL PLANNING					
Line avoidance options (6a_AVOID)	**0.931*****	**2.871**	**0.379****	**2.288**	**3.413**
Route alternatives (6b_ROUTE)	-0.111	0.562	0.137	0.971	2.242
Transmission technology options (6c_TECOP)	-0.361	1.138	0.190	1.281	4.049
Piloting of innovations (6d_INNOV)	-0.314	1.463	0.158	1.080	1.616
Avoidance of sensitive areas (6e_SENSI)	**0.835*****	**4.037**	**0.571*****	**3.522**	**1.425**
Bundling of infrastructure (6f_BUNDL)	0.108	0.830	0.057	0.454	1.148
Line deconstruction (6g_DECON)	**0.497****	**2.567**	**0.505*****	**2.736**	**1.086**
Regulatory overachievement (6h_OVERA)	**0.602*****	**3.073**	**0.077**	**0.602**	**1.374**

Confidence levels: *** = 99% (t = 2.576)
** = 95% (t = 1.960)
* = 90% (t = 1.645)

It can be seen that only 14 out of 41 potential success factors have a significant weight at a confidence level of 95% and above. According to Krafft et al. (2005, p. 78), the formative weights are in general lower than the reflective loadings. The PLS algorithm optimizes the weights with the aim of maximizing the explained variance of the endogenous variables in the model. Therefore, Chin (1998b, p. 307) states that relatively low absolute weights should not be interpreted overhastily as an insufficient measurement. Furthermore, Cenfetelli & Bassellier (2009) argue that weights and significances highly depend on the number of indicators per construct, i.e. the more indicators the lower are the weights, and sample size, which means the lower the sample size the lower is the significance. Given the comparably low sample size of the study at hand and the comparably high number of indicators per construct, the results in table 18 are not surprising. Next to the weights, which indicate the relative importance of a manifest variable for a construct, Cenfetelli & Bassellier (2009, p. 697) strongly propose that researchers should also "evaluate the absolute importance of an indicator to its construct. This is provided by the loading of the indicator and so its bivariate correlation with the formatively measured construct". Diamantopoulos & Winklhofer (2001) agree with this proposal. Formative indicator loadings must not be compared with each other as the intraset correlations for each block of indicators have never been taken into account in the PLS estimation process (Chin, 1998b). Nunnally & Bernstein (2006, p. 192) mention that the bivariate correlation between a predictor and a criterion "describes the information a predictor provides about the criterion, ignoring all other predictors". Thus, although an indicator might have a low or non-significant weight, it may still account for significant absolute contribution to the construct. As a result, if the evaluation is based solely on the indicator weights, there is the risk of misinterpretation. The difference between weights and loadings should be explained through the following example. Assume a car (comparable to an exogenous latent variable) is used to transport people (i.e. endogenous latent variable). The car consists of several parts (comparable to the formative indicators), each with an individual weight, not in terms of volume or kilogram, but in terms of relative importance. Imagine that due to limited resources the driver can either chose between the steering wheel or the right front door, both formative indicators of the car. Whereas the car would still be able to successfully carry passengers to their destination without the front door, this would not be possible without the steering wheel. Therefore, the steering wheel has a higher weight than the door, i.e. it is more important than the door. Although the door has a low relative weight, it nevertheless significantly contributes to the 'construct' car in absolute terms. It would therefore be wrong to eliminate the variable 'door' just because of its low relative weight.

Back to the model at hand, the assessment of indicator loadings shows that although having an insignificant weight, six additional potential success factors have a significant loading on their construct (see table 18 above). Cenfetelli & Bassellier (2009, p. 695) propose to retain those indicators that have a significant loading. In terms of interpretation, it means that these factors are important contributors to their constructs, while not providing additional explanatory power once other indicators are taken into account (Cenfetelli & Bassellier, 2009, p. 698).

The elimination of an indicator with a non-significant weight or loading might seem logical but could lead to the omission of a substantial part of the latent construct (Bollen & Lennox, 1991, p. 308; Jarvis et al., 2003, p. 202). Diamantopoulos & Winklhofer (2001, p. 273) also argue that "[i]ndicator elimination – by whatever means – should not be divorced from conceptual consideration when a formative measurement model is involved". Hence, the remaining indicators should not be excluded here based on their insignificant weights or loadings. Rather, the elimination of an indicator from a formative measurement model is recommended if substantial multicollinearity exists (Götz et al., 2010, p. 698; Hansmann & Ringle, 2005, p. 225; Krafft et al., 2005, p. 78). Compared to reflective indicators of a construct, which should have a high correlation among each other, substantial collinearity in formative models can lead to biased results. In other words, multicollinearity of formative indicators consequently complicates ascertaining the individual indicators' distinct influence on the latent construct (Diamantopoulos & Winklhofer, 2001, p. 272; Götz et al., 2010, pp. 698–699). "As formative measurement models are based on the principles of multiple regression analysis, the beta-coefficients' standard errors inflate with increasing multicollinearity, and their estimation becomes less reliable (inefficiency of estimates)" (Götz et al., 2010, p. 698). Thus, an assessment whether multicollinearity exists or not is conducted in the following chapter.

8.3.2.2.2 Multicollinearity

Cenfetelli & Bassellier (2009, p. 693) argue that "[t]he greater the level of multicollinearity among the indicators, the more likely many of the indicators will have low or non-significant path weights. This would lead to interpreting these indicators as being unimportant and/or invalid facets of the construct's domain". It should also be emphasized that while collinearity is a threat to the interpretation of individual formative indicators in the measurement model, it is not a threat to the effects of the structural model (Cenfetelli & Bassellier, 2009, pp. 693–694; Chin, 1998b). In general, there are two ways to detect multicollinearity: the inspection of the indicator correlation matrix for pairwise collinearity and the Variance Inflation Factor (VIF) (Andreev et al., 2009, p. 6; Krafft et al., 2005, p. 82; MacKenzie et al., 2011, p. 317). If the pairwise correlation coefficients of formative indicators are close to the value of 1.0, collinearity between both indicators can be assumed. The correlation matrix of all formative indicators in appendix 16 shows that all except one pairwise correlations are below the stringent threshold of 0.9 suggested by Cenfetelli & Bassellier (2009, p. 694) or Green et al. (1988, p. 456). Thus, from the analysis of the correlation matrix, there is no indication of multicollinearity in the formative measurement model.

The correlation matrix can only assess pairwise correlations. Therefore, in order to identify multicollinearity between more than two indicators, the VIF must be used. "The term VIF is derived from the fact that its square root is the degree to which the standard error has been increased due to multicollinearity" (Götz et al., 2010, p. 699). It is calculated as the inverse of the tolerance value

$$VIF = \frac{1}{1 - R^2} \tag{8.5}$$

with R^2 as the coefficient of determination of the respective multiple regression.

The VIF can have a minimum value of 1, which means that multicollinearity is absent. According to Götz et al. (2010, p. 699), there is no clear threshold value in literature for multicollinearity. Whereas Hair et al. (1998, p. 227) suggest an allowed maximum of 10, Mathieson et al. (2001, p. 108), Rossi et al. (1983, p. 535) and Diamantopoulos & Riefler (2008, p. 1193) state a threshold of 5. Moreover, Petter et al. (2007, p. 641) even argue for a maximum of only 3.3. As SmartPLS is not able to directly calculate multicollinearity, the respective VIF values were determined with SPSS according to Huber et al. (2007, p. 99) and listed in table 18 on page 251 above. All VIF values are below the threshold of 5 and only two indicators exceed the most stringent limit of 3.3. These are the potential success factors 'line avoidance options' (6a_AVOID) with a VIF of 3.413 and 'transmission technology options' (6c_TECOP) with a VIF of 4.049. If indicators are highly correlated, this means that they are tapping into the same aspect of the construct (Petter et al., 2007, p. 642).

The literature proposes different approaches for dealing with multicollinearity. Unfortunately, there is no consensus among scientists (Diamantopoulos & Riefler, 2008, p. 1191). Some researchers suggest eliminating indicators if they have non-significant weights and loadings and 'severe' multicollinearity (Diamantopoulos et al., 2008; Green et al., 1988, p. 457; Vinzi, 2010, p. 417). However, other authors such as Cenfetelli & Bassellier (2009, p. 694), Bollen & Lennox (1991) or Rossiter (2002) warn that the removal of a formative indicator purely on statistical grounds can alter the meaning of the construct. It is crucial for formative measured constructs to ensure that all of the essential aspects of the construct domain are captured by the remaining indicators (Bollen & Lennox, 1991). Thus, one faces the trade-off between the removal of problematic indicators and the risk of decreasing the content coverage of the respective construct. Andreev et al. (2009, p. 6) argue that an indicator should only be removed "if it is theoretically approved", i.e. if conceptual overlap has been identified. Regarding the case at hand, the two intercorrelating variables 'line avoidance options' and 'transmission technology options' cover two different conceptual aspects of the construct TECHNICAL PLANNING. Whereas the former represents making the installation of a line obsolete (e.g. through an upgrade or capacity increase of existing lines), the latter proposes evaluating several technical alternatives of installing a new line (e.g. the use of an OHL versus a UGC system). Hence, as conceptual overlap does not exist, none of the two indicators should be removed. Henseler et al. (2009, p. 302) argue that as long as the indicators are conceptually justified, the researcher should keep both significant and insignificant formative indicators in the measurement model. Moreover, the fact that the weight and loading of the variable 'line avoidance options' are both significant, contradicts an elimination. Finally, both indicators' VIFs are slightly above the most stringent threshold of 3.3 and easily meet the other proposed thresholds of 5 or 10 respectively. Hence, they cannot be regarded as having 'severe' multicollinearity. All these aspects support keeping the variables in the model.

As an alternative to elimination, the aggregation of intercorrelating indicators has been proposed by Cohen et al. (2003) or Diamantopoulos & Winklhofer (2001). They argue that indicators with a high correlation are almost perfect linear combinations and thus quite likely contain redundant information. As a consequence, they suggest combining formative indicators either into a limited set of indicators through principal component analysis or even combining them into a single index. However, this practice contradicts the original goal of success factor research, which is to identify manifest aspects that influence a construct. A good overview of the downsides of item aggregation can also be found in Little et al. (2002). By combining the variables into a single index the researcher then also faces the problem of how to name and interpret the consolidated factor (Green et al., 1988, p. 458). It would be

nearly impossible for a manager to derive any concrete actions or measures from a combined index that has itself been validated as a success factor. Combining not all but only a limited set of indicators is not an option if they capture different theoretical aspects of the construct (Diamantopoulos & Riefler, 2008, p. 1192). This is the case here as explained above. Thus, a combination of the two factors 'line avoidance options' and 'transmission technology option' was not done.
As the above assessments show no indication for considerable multicollinearity, all formative indicators are kept in the measurement model.

8.3.2.3 Construct validity

Bagozzi (1994, p. 333) argues that an assessment of "construct validity in terms of convergent and discriminant validity [is] not meaningful when indexes are formed as a linear sum of measurements", i.e. in a formative way. As explained above, formative measurement models are error-free, making an assessment of indicator reliability irrelevant (Henseler et al., 2009, p. 301). In particular, formative indicators are not required to be correlated with each other (Chin, 1998b, p. 306; Fornell & Larcker, 1981, p. 46; Götz et al., 2010, p. 701). Bollen (1984, p. 381) even warns that the "use of internal-consistency checks on cause-indicators may lead researchers to discard valid measures improperly". Hence, construct validity is not assessed for the formative measurement models at hand.

8.3.3 Evaluation of structural model

8.3.3.1 Multicollinearity

Scientists propose several quality criteria for the inner, i.e. structural model. Similar to the formative measurement model assessment, a test for multicollinearity through the VIF is recommended for all latent constructs that are determined by at least two other latent constructs (Huber et al., 2007, pp. 108–109). In the context of the research model at hand, there are two endogenous constructs: TRUST and REDUCED PUBLIC OPPOSITION. Both are defined by at least two exogenous constructs. The test for multicollinearity was conducted through the combination of SmartPLS, SPSS and Microsoft Excel as outlined by Huber et al. (2007, pp. 108–112). Again, the same thresholds apply as in the formative measurement model assessment. As the results in table 19 on the next page show, all VIF values are below the most stringent threshold of 3.3 (Petter et al., 2007). The existence of multicollinearity in the structural model can therefore be ruled out.

Table 19: Multicollinearity test results of structural model.

Endogenous constructs	Exogenous constructs	VIF
TRUST	COMMUNICATION	1.155
	PARTICIPATION	1.098
	ORGANIZATIONAL READINESS	1.081
	STAKEHOLDER LIAISON	1.065
REDUCED PUBLIC OPPOSITION	COMMUNICATION	1.242
	PARTICIPATION	1.348
	TRUST	1.550
	ECONOMIC BENEFITS	1.092
	TECHNICAL PLANNING	1.279

8.3.3.2 Explanatory power

Explanatory power involves an assessment of the coefficient of determination R^2 and explores the effect sizes of the exogenous constructs (Andreev et al., 2009, p. 9). In other words, it evaluates if the exogenous latent constructs sufficiently explain the related endogenous ones. The **coefficient of determination R^2** indicates the amount of variance of the endogenous latent variable that can be explained by the exogenous variables (Chin, 1998b, p. 316). It measures how well the respective regression functions of the model fit the empirical data (Backhaus et al., 2006, p. 63; Hansmann & Ringle, 2005, p. 226). The value of R^2 can range between 0 and 1 and its interpretation is the same as for multiple regressions, i.e. "variance explained by the independent constructs compared to the total variance retrieved from the actual data" (Andreev et al., 2009, p. 8). This means, the higher R^2 is, the better the exogenous latent variables explain the respective endogenous construct (Krafft et al., 2005, p. 83). Scientists differ in their threshold recommendations. According to Huber et al. (2007, pp. 107–108), R^2 should exceed a value of 0.3 so that the research model can be assured of having sufficient explanatory power. Chin (1998b, p. 323) states that a R^2 of 0.67 can be regarded as substantial, 0.33 as moderate and 0.19 as weak. In contrast, Cohen (1977b, p. 83) suggests that R^2 values of 0.1 should be interpreted as low, 0.3 as moderate and 0.5 as high. Table 20 on the next page lists the respective coefficients of determination of the model at hand, which were calculated with SmartPLS. The R^2 values of 0.372 for TRUST and 0.518 for REDUCED PUBLIC OPPOSITION mean that around 37% or 52% respectively of the total construct variance are explained by the related exogenous constructs. Both values exceed Huber et al.'s minimum requirement of 0.3. According to Chin's proposed thresholds, both constructs' R^2 can be regarded as moderate. Regarding Cohen's thresholds, TRUST is in the moderate and REDUCED PUBLIC OPPOSITION even in the highest category. Thus, it can be concluded that the research model has a sufficient explanatory power and the exogenous latent constructs sufficiently explain the related endogenous ones.

Table 20: Coefficients of determination of the endogenous latent constructs.

		Explanatory power		
Latent construct	**R²**	**Huber et al. (2007, pp. 107–108)**	**Chin (1998b, p. 323)**	**Cohen (1977b, p. 83)**
TRUST	0.372	sufficient	moderate	moderate
REDUCED PUBLIC OPPOSITION	0.518	sufficient	moderate	high

To give a comparision, other success factors studies, which use SEM, have calculated R²s in similar ranges (e.g. 0.220 – 0.500 (Hemminger, 2010), 0.379 – 0.502 (Li Kam Wa, 2001), 0.34 – 0.41 (Hwang & Xu, 2008), 0.087 – 0.581 (Magnus, 2007), 0.464 (Davčik & Rundquist, 2012), 0.160 – 0.435 (Wixom & Watson, 2001), etc.). **Effect size** (f^2) indicates to what extent an exogenous latent variable has a substantial influence on an endogenous one relative to other latent variables. It is determined by estimating the structural model with and without the exogenous latent variable in scope (Cohen, 1988, pp. 410–413). Mathematically, this is defined as

$$f^2 = \frac{R^2_{incl.} - R^2_{excl.}}{1 - R^2_{incl.}} . \tag{8.6}$$

Effect sizes of 0.02, 0.15 and 0.35 determine that the exogenous latent variable has either a small, medium or large influence on the respective endogenous construct (Chin, 1998b, p. 317). As listed in table 21, PARTICIPATION has a medium effect on TRUST and TRUST in turn has a large effect on REDUCED PUBLIC OPPOSITION. Thus, both have a high explanatory power for their respective dependent constructs.

Table 21: Effect sizes.

Endogenous construct	**Exogenous constructs**	**R² incl.**	**R² excl.**	**f²**	**Effect**
TRUST	PARTICIPATION	0.372	0.249	0.196	medium
	ORGANIZATIONAL READINESS	0.372	0.327	0.084	small
	COMMUNICATION	0.372	0.344	0.045	small
	STAKEHOLDER LIAISON	0.372	0.348	0.035	small
REDUCED PUBLIC OPPOSITION	TRUST	0.518	0.381	0.284	large
	TECHNICAL PLANNING	0.518	0.475	0.089	small
	COMMUNICATION	0.518	0.514	0.008	-
	ECONOMIC BENEFITS	0.518	0.514	0.008	-
	PARTICIPATION	0.518	0.516	0.004	-

The constructs COMMUNICATION, PARTICIPATION and ECONOMIC BENEFITS have literally no relative effect on REDUCED PUBLIC OPPOSITION. This is in line with their respective low path coefficients as described above. All other constructs have small effects. The amount of relative small effects might seem surprising. However, this is rather common in success factor studies (see e.g. Hansmann & Ringle (2005, p. 233), Boßow-Thies & Albers (2010, p. 600) or Magnus (2007, p. 175)). Content wise interpretation is done in chapter 8.4.

8.3.3.3 Predictive relevance

Next to explanatory power, the structural model has to be evaluated for its predictive relevance. This can be analyzed by the Stone-Geisser Q^2 for all endogenous latent constructs that are measured reflectively (Geisser, 1975; Stone, 1974). It postulates that the model must be able to provide a prediction of the endogenous latent variable's indicators (Henseler et al., 2009, p. 305) and evaluates to what extent the empirical data can be reconstructed through the model (Fornell & Cha, 1994, p. 72). Wold (1982a, p. 30) therefore describes it as a test of how well the 'hand fits in the glove'. The Stone-Geisser test compares the measurement errors of the reflective indicators with the residua of a trivial prediction that is based on the means of the indicators (Fornell & Cha, 1994, pp. 72–73). Mathematically it is defined as

$$Q_k^2 = 1 - \frac{\sum_l E_{lk}}{\sum_l O_{lk}}. \tag{8.7}$$

with E_{lk} as the squared prediction errors and O_{lk} as the squared errors from the trivial predication given by the mean of the remaining data points (Fornell & Cha, 1994, p. 72). Moreover, l is the indicator index and k the index of the respective latent construct. A positive Q^2 indicates that the sum of measurement errors in the latent variable is below the predicted ones. In other words, it implies that the exogenous construct has predictive relevance for the endogenous construct under consideration (Chin, 1998b, p. 318; Hair et al., 2011, p. 145). A Q^2 value of 0 would mean that the model is not better in predicting the empirical data than an estimation of the means (Weiber & Mühlhaus, 2010, p. 258). The Q^2 is calculated through the blindfolding resampling procedure[221] that omits a part of the data for a particular block of indicators and then estimates the omitted part through model parameters (Chin, 1998b, p. 317). Table 22 on the next page shows the results for the research model calculated with SmartPLS. Q^2 is positive for both reflective by measured constructs. Hence, the exogenous constructs have predictive relevance for the endogenous constructs under consideration.

[221] For details on blindfolding please refer to Chin (1998b, p. 317).

Table 22: Stone-Geisser test results for reflective measurement models.

Endogenous construct	Q²
TRUST	0.246
REDUCED PUBLIC OPPOSITION	0.416

8.3.4 Evaluation of total model

In contrast to the covariance based SEM method, there is currently no global quality criterion in terms of 'goodness-of-fit' (GoF) for variance based PLS path models (Herrmann et al., 2006, p. 58; Jahn, 2007, p. 28; Ringle, 2004c, p. 23). This is because the PLS algorithm does not optimize the model as a whole when estimating the parameters as outlined previously in this work (chapter 5.3.2.2.4). Thus until now, there is no criterion available with which to evaluate the validity of the structural and the measurement models as a whole (Lehner & Haas, 2010, p. 85). Nonetheless, Tenenhaus et al. (2005, p. 173) propose a total measure for PLS models. In particular, it is defined as the geometric mean of the average communality, which is equal to the AVE, and the average R^2 (for endogenous constructs):

$$GoF = \sqrt{\overline{AVE} * \overline{R^2}} \, . \tag{8.8}$$

However, according to Jahn (2007, p. 29) and Wetzels et al. (2009, p. 191), this mainly serves a diagnostic value and cannot be employed as a measure of global model fit. Also Henseler & Sarstedt (2012), who evaluated several GoF indices for PLS path modeling, come to the conclusion that they are not suitable for model validation. Therefore, no global quality criterion is assessed for the total model at hand.

8.4 Verification of hypotheses and discussion of results

As the model evaluation above revealed an acceptable, i.e. a reliable and valid SEM, the developed hypotheses can be tested. In case the path coefficients in the structural model are significant and have the same direction as the respective hypotheses, the researcher can confirm the hypotheses[222]. The individual path coefficients represent the strength of the relation between the respective exogenous and endogenous constructs. They are regression coefficients of the structural equations and describe to what extent an incremental change of the exogenous construct causes an effect on the endogenous one (Backhaus et al., 2006, p. 61). Path coefficients can range between -1 and +1 and should not lie between -0.1 and +0.1 (Lohmöller, 1989, p. 60). Path coefficients' significance should be at least at a

[222] 'Confirming the hypothesis' in fact means the rejection of the null hypothesis (i.e. no relationship) and thereby the acceptance of the alternative hypothesis (Magnus, 2007, p. 182).

90% confidence level for a two-tailed t-test[223]. Significance was tested via the bootstrapping procedure in SmartPLS and results are listed in table 23 below.

Table 23: Verification of hypotheses.

Hypo-thesis	Exogenous construct	Endogenous construct	Expected relationship	Path coefficient	t-value	Verifi-cation
H1	**STAKEHOLDER LIAISON**	**TRUST**	**positive**	**0.155***	**1.838**	**yes**
H2	**PARTICIPATION**	**TRUST**	**positive**	**0.372*****	**3.484**	**yes**
H3	PARTICIPATION	REDUCED PUBLIC OPPOSITION	positive	-0.021	0.257	no
H4	**COMMUNICATION**	**TRUST**	**positive**	**0.180***	**1.898**	**yes**
H5	COMMUNICATION	REDUCED PUBLIC OPPOSITION	positive	0.071	0.837	no
H6	**ORGANIZATIONAL READINESS**	**TRUST**	**positive**	**0.236****	**2.265**	**yes**
H7	ECONOMIC BENEFITS	REDUCED PUBLIC OPPOSITION	positive	-0.068	0.807	no
H8	**TECHNICAL PLANNING**	**REDUCED PUBLIC OPPOSITION**	**positive**	**0.232****	**2.155**	**yes**
H9	**TRUST**	**REDUCED PUBLIC OPPOSITION**	**positive**	**0.564*****	**4.761**	**yes**

Confidence levels: *** = 99% (t = 2.576)
** = 95% (t = 1.960)
* = 90% (t = 1.645)

It shows that there are three path coefficients that do not exceed an absolute value of 0.1 and which are insignificant at a 90% confidence level. If the path coefficients are non-significant or have a different direction, the respective hypotheses have to be rejected[224] (Henseler et al., 2009, p. 304; Jahn, 2007, p. 30). In particular, the hypothesized effects of the constructs PARTICIPATION (H3), COMMUNICATION (H5), and ECONOMIC BENEFITS (H7) on REDUCED PUBLIC OPPOSITION could not be validated whereas TECHNICAL PLANNING (H8) and TRUST (H9) have significant positive effects on REDUCED PUBLIC OPPOSITION. TRUST in turn is positively influenced by STAKEHOLDER LIAISON (H1), PARTICIPATION (H2), COMMUNICATION (H4) and ORGANIZATIONAL READINESS (H6).

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[223] Degree of freedom = 1,000; this means that the t-values must exceed a threshold of 1.645 for being significant at a 90% confidence level.

[224] Analog to footnote 222.

For better visualization, figure 76 illustrates the results in a path diagram. All confirmed causal relations are marked with a bold arrow and a check mark

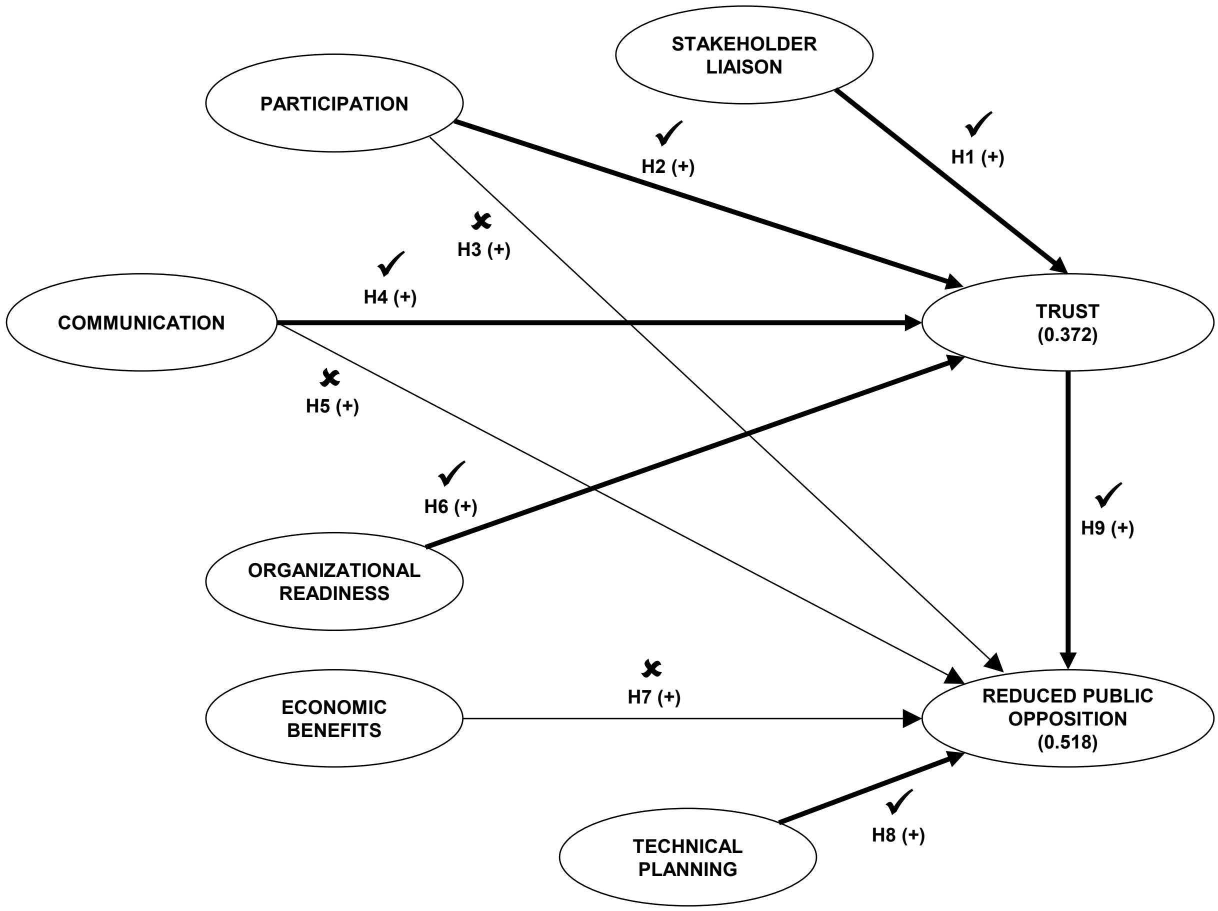

Figure 76: Test results of hypotheses.

Constructs without a significant direct effect on a latent variable can still have an indirect effect on it via another construct. For the model that means that the four constructs STAKEHOLDER LIAISON, PARTICIPATION, COMMUNICATION and ORGANIZATIONAL READINESS might indirectly have a significant effect on REDUCED PUBLIC OPPOSITION via the latent variable TRUST. In other words, TRUST "transmits the effect of an independent variable to a dependent variable" (MacKinnon et al., 2002, p. 83). These indirect effects can be calculated through the multiplication of the respective path coefficients (Huber et al., 2007, p. 71) and tested for significance through Sobel's z-test (Sobel, 1982) as proposed by Eggert et al. (2005, pp. 105–106):

$$z = \frac{a * b}{\sqrt{b^2 * s_a^2 + a^2 * s_b^2}} . \qquad (8.9)$$

with a as path coefficient between the exogenous variable and the variable in between, and b as the respective path coefficient between the variable in between and the endogenous variable. s_a and s_b represent the respective standard deviations of the path coefficients.

As listed in table 24 below, all z values exceed the critical value of 1.645 for a confidence level of 90%. Thus, all indirect effects can be regarded as significant.

Table 24: Calculation of indirect effects.

Exogenous construct		Endogenous construct	Multiplied path coefficient	z-value
PARTICIPATION	→	**REDUCED PUBLIC OPPOSITION (via TRUST)**	**0.210*** **	**2.829**
ORGANIZATIONAL READINESS	→	**REDUCED PUBLIC OPPOSITION (via TRUST)**	**0.133** **	**2.058**
COMMUNICATION	→	**REDUCED PUBLIC OPPOSITION (via TRUST)**	**0.101* **	**1.726**
STAKEHOLDER LIAISON	→	**REDUCED PUBLIC OPPOSITION (via TRUST)**	**0.087* **	**1.743**

Confidence levels: *** = 99% (z = 2.576)
** = 95% (z = 1.960)
* = 90% (z = 1.645)

As a result, all latent variables expect ECONOMIC BENEFITS can be regarded as success factors reducing public opposition – either directly or via the construct TRUST. The insignificance of ECONOMIC BENEFITS which might seem surprising as there are some indications in the literature that monetary compensation and financial participation models can reduce public opposition against infrastructure facilities. In particular, positive experiences have been made with financial participation models for wind turbines. However, as already discussed in chapter 6.3.3, there is no overarching consistent picture in the literature on the effectiveness of economic benefits and in particular monetary compensation in reducing public opposition. Several authors argue that economic compensation fails to effectively overcome public opposition (Flynn et al., 1992; Kunreuther et al., 1990; Schweizer-Ries et al., 2010; Sjöberg & Drottz-Sjöberg, 2001). Baxter et al. (1999, p. 520) also warn that compensation payments should not be offered directly to people without having had an extensive discussion with them in advance. Thus, the public needs to be initially convinced before any compensation is offered (Kunreuther et al., 1990, p. 469; Rabe, 1992). Otherwise, people will regard monetary offerings as an attempt of bribery by the project developer as the comment “I am not for sale” shows, which was made by a resident in Sjöberg & Drottz-Sjöberg’s (2001, p. 90) study. Schweizer-Ries et al. (2010) also state that monetary compensation does not automatically increase acceptance. The rare existing case of a financial participation model for a transmission line, which was recently piloted by the the German TSO Tennet (Tennet, 2013), can be regarded as unsuccessful. Tennet expected citizens to contribute about 15% of the total investment volume of 200 million Euro, which is around 30 million Euro. Instead, only about 100 out of the 160,000 affected households subscribed for the issued bond, resulting in a citizen investment of only one million Euro (Bayerischer Rundfunk, 2013). This was far behind the expectations. Thus, money will not increase acceptance as long as the perceived risks are serious. People regard their health as the most valuable commodity. They are much more concerned about their safety than about financial disadvantages (Portney, 1984). Hence, when severe health concerns exist, e.g. due to the fear of EMF, monetary compensation is less likely to increase acceptance effectively. In contrast to transmission lines, wind turbines do not create EMFs and thus carry less severe health risks. People oppose wind turbines mainly due to their visual impact. This difference explains also why private financial participation in wind turbine projects works more successfully in reducing public resistance than this can be expected for transmission line projects. Instead of comparing transmission line siting with the development of wind parks, one should rather draw comparisons from the siting of hazardous facilities such as nuclear power stations or nuclear waste repositories. Due to their characteristics these facilities carry significant health risks and are therefore more comparable to transmission lines than wind turbines are. For instance in their case study about the siting of a nuclear repository, Sjöberg & Drottz-Sjöberg (2001, p. 90) surveyed the residents and only 60 of 667 (i.e. 9%) indicated that they would accept the repository if they were given monetary compensation. 20 out of these 60 people raised further demands in addition to money such as additional safety measures or more information and openness.

Both, the fact that ECONOMIC BENEFITS do not demonstrate a significant effect on REDUCED PUBLIC OPPOSITION in the model and the fact that literature findings are ambivalent, lead to the interpretation that TSOs should not focus on providing monetary compensation in order to reduce public opposition. The recently failed pilot approach by Tennet of issuing a 'citizen bond' supports this finding. Nevertheless, this does not mean that TSOs should avoid offering economic compensation in a second step per se. Kunreuther et al. (1993) and Rabe (1992) recommended that the topic of compensation should be raised only, once residents have been convinced that adequate prevention and mitigation measures are in place.

8.5 Success factors for reducing public opposition in transmission line planning: Recommendations for TSO management

Given the fact that TSOs face limited resources in terms of time, money and resources, they have to focus on the most effective success factors. According to Boßow-Thies & Albers (2010, p. 599), "[f]or managerial purposes it is not so much the significance that counts but the differential effects of the variables". Thus, in order to prioritize the identified latent success factors, a ranking according to their individual effect sizes f^2, which were already calculated in chapter 8.3.3.2, has to be determined. For the above indentified indirect effects, the individual effect sizes along the paths need to be multiplied. This results in the following ranking of the latent success factors:

Table 25: Ranking of latent success factors.

Rank	Latent success factor	Effect size f²
1	TRUST	0.284
2	TECHNICAL PLANNING	0.089
3	PARTICIPATION (via TRUST)	0.056[225]
4	ORGANIZATIONAL READINESS (via TRUST)	0.024[226]
5	COMMUNICATION (via TRUST)	0.013[227]
6	STAKEHOLDER LIAISON (via TRUST)	0.010[228]

According to this, TRUST has the largest and therefore the most substantial effect on REDUCED PUBLIC OPPOSITION of all constructs, i.e. it explains most of its variance. Striving for stakeholders' trust can thus be regarded as the critical or key success factor in transmission line planning for TSOs in order to reduce public opposition. Model results reveal that TECHNICAL PLANNING has the second largest effect on REDUCED PUBLIC OPPOSITION. It means that TSOs can reduce public opposition through a thorough technical planning of new transmission lines. The other latent constructs listed in table 25 above can only be regarded as success factors for REDUCED PUBLIC OPPOSITION in combination with the success factor TRUST as they are the main contributors in forming it. Nevertheless, TSO managers want to know what these latent success factors in particular mean for them and what specific implications and actions they should derive. As Albers (2010, pp. 419–423) and Martilla & James (1977, p. 77) state, valuable information from success factor studies is only generated for the business community, if the identified success factors are simple, concrete and implementable. Each identified latent success factor is formed at the end by a set of manifest success factors[229]. The significances and weights of these manifest success factors have already been identified in chapter 8.3.2.2.1. A detailed description of each manifest measure can be found in chapter 6.3 above. They provide action orientated recommendations for TSOs to successfully reduce public opposition. Thus, the empirical findings of the work at hand are summarized in the following subchapters in terms of concrete recommendations for TSO management. In particular, the following management questions are answered:

- How can we explicitly create trust in our transmission line projects? (Chapter 8.5.1)
- What should we especially consider in our technical planning? (Chapter 8.5.2)

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225 0.196 * 0.284.

226 0.084 * 0.284.

227 0.045 * 0.284.

228 0.035 * 0.284.

229 Except TRUST which is formed by several other latent success factors. However, they in turn are formed by manifest success factors again.

8.5.1 Measures to create stakeholder trust

As outlined earlier in this work, interviews revealed a considerable lack of trust of stakeholders in TSOs. Nevertheless the question remains, how TSOs can gain or regain the required level of trust that is necessary to reduce public opposition. The four constructs PARTICIPATION, COMMUNICATION, ORGANIZATIONAL READINESS and STAKEHOLDER LIAISON are latent success factors for creating TRUST. That means first, stakeholder participation is key for creating trust between people and the respective TSO. Second, TSOs have to communicate properly with their stakeholders. Third, the TSO organization needs to be ready for dealing with stakeholder management. Fourth, TSOs should try to form liaisons with stakeholders to reduce public opposition. Again here, the success factors are latent variables and managers need to know what they explicitly have to do and consider. In other words, they need implementable recommendations. Thus, the manifest success factors in form of specific measures are outlined for each of these four latent success factors below. The measures are ranked according to their individual weights, i.e. their relative importance or criticality regarding the particular construct. This ranking helps TSO management to prioritize and focus on certain aspects when striving for the creation of trust in transmission line planning.

8.5.1.1 Sufficient stakeholder participation

Stakeholder participation is key for a TSO to create trust in transmission line planning. Among the identified 10 potential manifest success factors, five turned out to significantly[230] contribute to successful stakeholder participation:

1) The most effective measure in facilitating proper stakeholder participation is **joint fact finding**. TSOs need to agree with the stakeholders on independent experts and respective assumptions when conducting studies and assessments. Double assessments need to be avoided.
2) Early in the transmission line planning process and especially before the submission of applications to authorities, TSOs should **conduct a pre-poll** to identify the general attitude of the local population for a possible transmission line project in order to get a first feeling for conflict potential and identify main stakeholders and their concerns.
3) **Neutral moderators and mediators** should be employed for the discussion with stakeholders. TSOs need to ensure that these facilitators are absolutely independent. Moderators and especially mediators must not be used as ‘fire fighters’ but should be involved early in the discussion process.
4) Any major **decision** regarding the transmission line that affects the stakeholders has to be **made in a transparent manner**. In particular, TSOs should lay out how different route or transmission technology options have been evaluated upfront and why a certain option was selected.

[230] Either having a significant weight or a significant loading.

Furthermore, the TSO should provide transparency to what extent it has considered stakeholder concerns and give clear reasons in case they could not be taken into account.

5) Certain interested stakeholder groups, e.g. local politicians, NGOs or other large action groups should be **involved already during macro-planning**, i.e. during the high level identification of grid requirements and definition of rough route corridors.

8.5.1.2 Proper stakeholder communication

Overall, nine potential success factors have been derived from the literature and interviews which help conducting a proper stakeholder communication. Four of those success factors could be validated in the model:

1) The foremost success factor for sufficient stakeholder communication is the use of an **appropriate communication mix**. TSOs must not only rely on conventional media such as newspaper or flyers for communicating with affected people. Rather, they should diversify their communication channels and also utilize new media to inform the stakeholders appropriately.
2) TSOs should seek **direct personal communication** with the individual stakeholders where possible in order to create trust. In particular, a TSO needs to determine at least one of its employees as a key contact for concerned residents, who has to show extensive local presence. This reduces anonymity and gives the TSO organization a ‘face’.
3) TSOs need to **communicate proactively at the earliest possible stage** with the respective stakeholders. Waiting too long to inform concerned people about the transmission line project increases the risk of distrust as the lack of information raises fears and concerns among stakeholders.
4) TSO management needs to develop a **communication strategy** at the beginning of every transmission line project. This includes the identification of relevant stakeholders and their preferred communication channels. Moreover, a clear roadmap has to be defined when, how and about what concerned people need to be informed.

8.5.1.3 TSO’s organizational readiness for stakeholder management

The organizational readiness of a TSO revealed to have a positive effect on stakeholders’ trust. In general it emphasizes that a TSO organization needs to make necessary preparations and commitments in order to be able to effectively deal with stakeholders. Out of seven potential success factors, four contributed significantly to the construct ORGANIZATIONAL READINESS:

1) **Top-management support** is essential to ensure that stakeholder management receives adequate attention and acknowledgement within a TSO organization. Furthermore, the top-management should also show local presence from time to time to give the concerned stakeholders the feeling that their concerns matter.

2) TSOs need to ensure a proper **internal coordination** of all departments involved in stakeholder management. The assignment of clear roles, responsibilities and authority as well as a regular information exchange is a prerequisite.
3) A comprehensive **stakeholder analysis** has to be conducted at the very beginning of a transmission line project in order to identify all relevant stakeholders, their main interests and concerns. This is followed by the development of a **stakeholder management strategy** that defines how to deal with each stakeholder group. Both, analysis and management strategy have to be reviewed regularly throughout the planning process.
4) TSOs must **deploy sufficient resources** for stakeholder management. In particular, they need to dedicate a sufficient amount of budget, personnel and time to the related activities.

8.5.1.4 Creating liaison with stakeholders

The construct with the least but still considerable influence on TRUST is STAKEHOLDER LIAISON. Three potential success factors have been identified throughout the work at hand and one could be validated in the research model:

During and after a transmission line project, TSOs should **empower local stakeholders** who have relevant skills and involve them closely in the planning process. In particular, environmental assessments, EMF measurements, communication activities or other monitoring tasks can be delegated to residents. This gives them greater control in the process and creates trust.

8.5.2 Important aspects in technical planning

Next to TRUST, TECHNICAL PLANNING also had a significant positive influence on REDUCED PUBLIC OPPOSITION. Conducted interviews and the literature research have revealed eight potential success factors in total. Thereof, four turned out to be statistically significant and are ranked in the following according to their respective weight:

1) Foremost, TSOs should **evaluate technical options that can make new transmission line installations obsolete**. TSOs need to make these upfront evaluations transparent to stakeholders and discuss with them why certain options are selected and others not.
2) When planning new route corridors, TSOs have to **avoid sensitive areas** wherever possible. The planning goal of achieving the shortest line length possible should be sacrificed in order to bypass densely populated or environmentally sensitive areas.
3) TSOs should try to **overachieve regulatory requirements** such as EMF levels, environmental requirements, etc. on a voluntarily basis and thus show exceptional commitment.
4) In case new transmission lines with higher capacities make existing lines obsolete, TSOs should proactively **deconstruct the old lines**.

Interestingly, although undergrounding of power transmission lines is often preached as the key for reducing public opposition, the relevant potential success factor 'Transmission technology options' did not turn out to be significant.

8.5.3 Consolidated overview

Figure 77 below summarizes all above mentioned recommendations in a comprehensive way for TSO management. It structures the latent success factors, i.e. the constructs, as well as the manifest success factors according to their individual criticality, i.e. their importance. Furthermore, a crisp and memorable paradigm is given for each latent success factor, illustrated in the ellipses. These six paradigms will help TSO managers to define their overall strategy in dealing with stakeholders and public resistance.

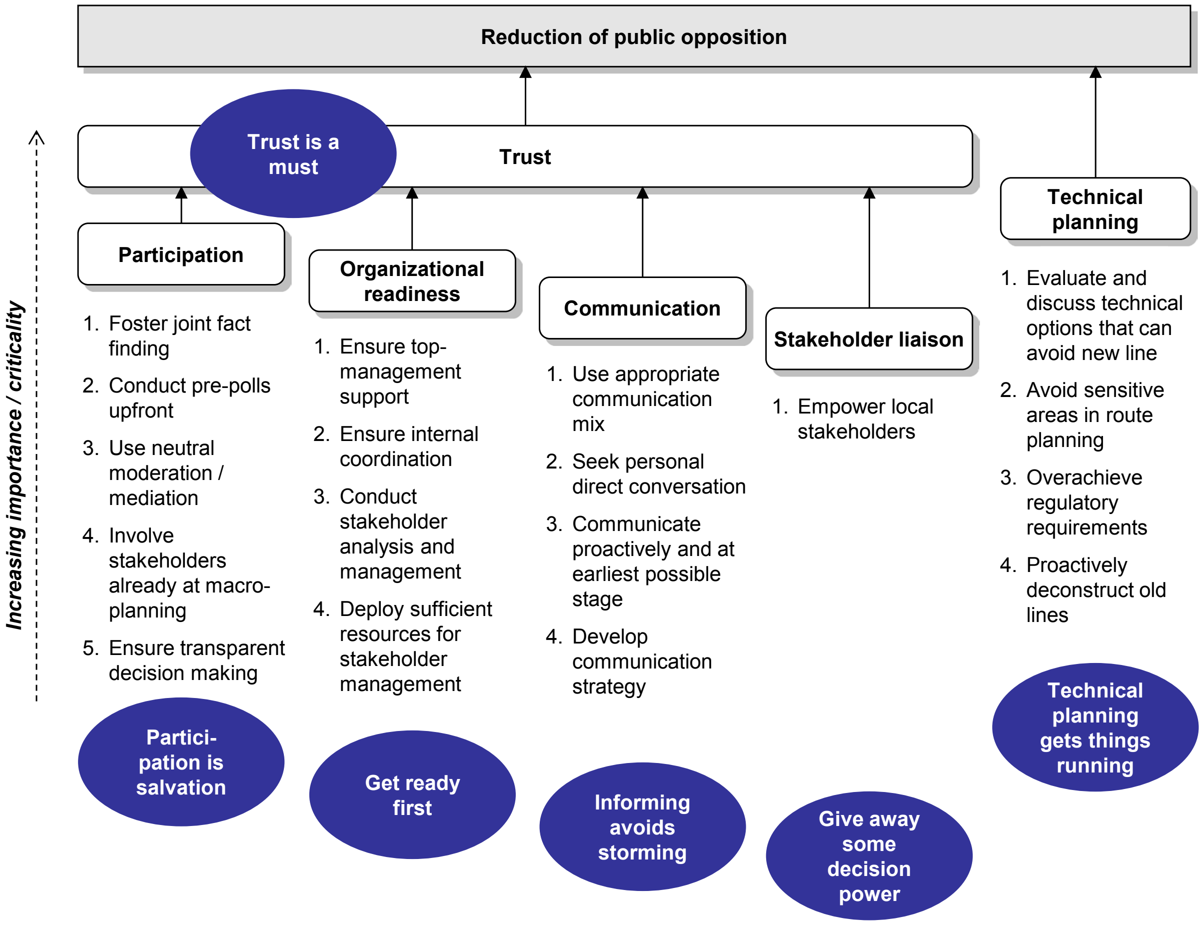


Figure 77: Success factors for TSO management to reduce public opposition in transmission line projects.

Reducing public opposition in transmission line projects is not an easy task for TSOs. Providing a panacea to completely solve the issue of public resistance in all future transmission line projects would be too idealistic and virtually unrealistic. Nevertheless, the above illustrated set of success factors can be regarded as a comprehensive toolbox from which TSOs can pick measures in order to considerably reduce public opposition in their transmission line projects. Although TSO management should focus on these statistically proven general success factors to increase the likelihood of project success, this does not mean that all other identified potential success factors throughout this work, which have not shown statistical significant relations, should be ignored. Rather, TSOs can use the set of non-significant factors and collected ideas as further input when dealing with public resistance. As transmission line projects are unique, there might be special cases or certain situations in which non-significant factors turn out to be useful.

9 Concluding remarks

9.1 Summary of results

Europe requires significant transmission grid expansions in order to foster the integration of electricity markets, enhance security of supply and integrate RES. However, next to lengthy authorization processes, TSOs currently face extreme public opposition in their transmission line projects leading to project delays of many years. These delays imply significant additional costs for TSOs as well as for society as a whole and put the transformation of the European energy system at risk. Whereas insufficient authorization processes have recently or are currently being addressed by new legislations and regulations on national as well as on European levels, the issue of public opposition has remained unsolved. Thus, the problem needs to be tackled by the TSOs themselves which therefore require solutions in form of success factors in order to overcome public opposition to their transmission line projects. As until today, the existing scientific literature has failed to provide such generally applicable solutions, the goal of this work has been to focus on the identification of generalizable success factors for European TSOs in order to reduce public opposition in transmission line projects and therefore to close the research gap. Seven potential latent and 41 potential manifest success factors were collected through an extensive literature review as well as 66 conducted semi-structured interviews throughout Europe with respective stakeholders such as citizen action groups, NGOs or energy experts. Experiences from analog large infrastructure projects like wind parks, CCS, hydro dams, nuclear waste repositories, etc. were also used to form the hypotheses. The findings were transformed into a structural equation model, which is a predominant methodology used in success factor research. The model was tested through a questionnaire survey with two representatives per European TSO. In particular, respondents from the competent TSO departments Asset Management / Project Development as well as Communications / Stakeholder Management were approached. In total, 36 of 41 TSO organizations in Europe participated in the validation process amounting to a total of 72 respondents. Out of the hypotheses, six latent and 18 manifest success factors turned out to be significant. Specifically, results show that people’s trust in the TSO is of utmost importance for reducing public opposition against transmission lines. It can be regarded as the critical success factor. TSOs can create trust by four other latent success factors: proper stakeholder participation, sufficient communication, internal organizational readiness and liaison with stakeholders.

Regarding stakeholder participation, TSOs should jointly agree with opponents on facts and assumptions relevant for line planning, conduct upfront pre-polls in the affected areas, use neutral mediators and moderators if dispute arises, make decisions in a transparent manner and involve key stakeholders already during network planning on the national macro-level.

Stakeholder information should be done through a mix of communication channels and media with direct personal communication as preferred option. TSOs need to proactively communicate with the people at the earliest possible stage. An overall communication strategy will support that.

TSOs should have a sufficient and committed internal organizational setup for stakeholder management to be able to effectively deal with opponents. For instance, top management should be involved when dealing with public opposition. Several internal departments involved in stakeholder management, e.g. technical planning, asset management, communication, etc. need to be coordinated internally. TSOs must conduct a comprehensive stakeholder analysis at the beginning of a transmission line project to identify the key players and their interests and then derive a dedicated strategy how to deal with them. For that, a sufficient number of resources and money is needed.

Moreover, the collaboration with stakeholders needs to be strengthened. That means stakeholder liaison is important and TSO should actively involve concerned people into the planning process and empower them for certain activities and assessments.

Furthermore, appropriate technical planning can help to reduce public opposition against transmission line projects. Specifically, TSOs should evaluate technical options that can avoid new lines. Moreover, they need to avoid sensitive areas in the route planning, overachieve regulatory requirements and proactively deconstruct old lines if they become obsolete after a new installation.

The identified six latent success factors were transformed into six paradigms helpful for TSO strategy development. In addition, the identified manifest success factors provide implementable actions for TSO management. They will help European TSOs to successfully reduce public opposition in their future transmission line projects and therefore in turn create more social acceptance for transmission line expansion.

Interestingly, model results show that the potential latent success factor ‘Economic benefits’ did not have a significant impact on the reduction of public opposition. Although positive experience with financial compensation and participation payments has been made in wind projects, the same effect could not be proven for transmission lines. An explanation could be the severe health and safety issues which people fear. Compensation by money may be ineffective because concerned people regard their health as the most valuable commodity. Also social acceptance studies of hazardous facilities such as nuclear power stations or nuclear waste repositories which impede significant health and safety issues show that monetary compensation was ineffective in these projects, too (e.g. Sjöberg & Drottz-Sjöberg, 2001, p. 90). Such health and safety issues do not exist for wind turbines which are opposed mainly due to their visual impact.

9.2 Contribution, limitations, and directions for further research

The work at hand contributes to the research in a way that it identifies and closes a research gap by combining the research streams social acceptance, electricity transmission line planning and success factor research in general. In particular today, the existing scientific literature is lacking comprehensive studies that have attempted to identify generalizable success factors for overcoming public resistance in transmission line projects. At most, there are some very regional and project specific outcomes and learnings. Their value-add must be questioned as these findings can hardly be transferred and adopted to other transmission line projects. Furby et al. (1988b, p. 38) also constitute that "the individual studies are of limited validity or generalizability, due to small or non-representative groups of respondents". Furthermore, these studies have often only focused on a single problem (e.g. visual impact, health effects, property values, etc.) in transmission line siting. Next to an extensive literature review, the work at hand provides an empirical tested set of general success factors for reducing public opposition against transmission expansion and thereby closes the research gap. The success factors are not limited to a specific project and thus can be applied in general in transmission line planning. Until today, there has not been a study so far that covers all of Europe. In the course of this work, interviews were conducted with stakeholders across several European countries. Moreover, nearly all European TSOs were involved in the validation of potential success factors. This broad coverage is novel and leads to highly representative results.

Furthermore, the work focuses not only on a single but all major public resistance issues in transmission line planning. Another value-add is that potential success factors were primarily derived directly from the affected stakeholders. Their concerns and requests are the best source for identifying ideas and developing hypotheses. In terms of methodology, the study used a combination of qualitative and quantitative methods. Especially the use of structural equation model as a multivariate statistical method ensures a high validity of results and can be regarded superior to methods such as case studies or focus groups in identifying causalities.

Next to the core findings, the work at hand also contributes to research by having identified the underlying reasons and motives of stakeholder opposition to transmission line projects in Europe. In addition, contextual factors that influence people's attitude towards transmission lines were determined. Both results represent an essential input for any future research work on public opposition against transmission line planning in specific or even public opposition against other energy systems in general.

Besides the scientific benefits, the work also contributes to practice. The rapid deployment of RES and the consequential transformation of the European electricity system have led the European electricity transmission network to become the critical bottleneck. The delayed expansion of new transmission lines is one of the major, if not the most, currently discussed problems in energy industry and politics. The key benefit of this work is its provision of strategic paradigms and implementable success factors for TSO management to overcome public resistance in their current and future transmission line projects and therefore help to solve the issue of grid bottlenecks. Although the results of this work must not be regarded as a panacea resolving the issue of public opposition in every single transmission line project, they at least provide a general success factor catalogue, which TSOs can make use of and benefit from. The fact that the success factors have been derived in this work in the European context, does not mean they might not be valid also on other continents of the world. Researchers are thus invited to test the model's validity in other regional setups.

In terms of limitations, the study faced a comparably small sample size of 72 due to the limited number of existing TSOs in Europe as total population. This meant that the developed research model was only able to identify significantly large causal effects. It cannot be completely ruled out that some of the hypothesized causal relations, which turned out to be non-significant in the model, may still have a small effect on reducing public opposition against transmission lines. Future research could include considerably more employees per TSO organization in the survey or extend the study scope beyond Europe in order to increase the number of responses and check if further small effects exist. However, given the fact that it has already been very difficult to acquire data from only two respondents per organization (see the return statistics and the large required number of reminders in chapter 8.1.5), the chances for significantly higher returns per TSO are rather low. Alternatively, the non-significant causal relations can represent recommendations to other researchers for respective model modifications. A model modification throughout the work at hand would have caused the structural equation modeling to lose its confirmatory character (Chin, 1998a). Furthermore, a modified model must be retested with a completely new set of data (Backhaus et al., 2006, p. 387).

For the sake of identifying general applicable success factors, the study did not investigate any regional differences and specifics. The comparably small sample size restricted any test for heterogeneity and the use of multi-group analyses to test if proposals and responses differed significantly in terms of regional scope or even across stakeholder groups. The fact that almost no action group could be identified in Eastern Europe for interviews and the finding that the development level of the national energy system is a contextual factor in influencing people's attitude towards transmission lines (see chapter 3.2.7) are indications for certain regional differences and therefore predestine it for further research. Researchers could test the identified success factors in different regional case studies. Renn's (2000) work on cross-cultural risk perception might provide valuable input for further research in this direction.

It would be also interesting if a TSO's shareholder structure, i.e. either state-owned, privatized or mixed-ownership, has an influence on the ability to reduce public opposition against its transmission line projects.

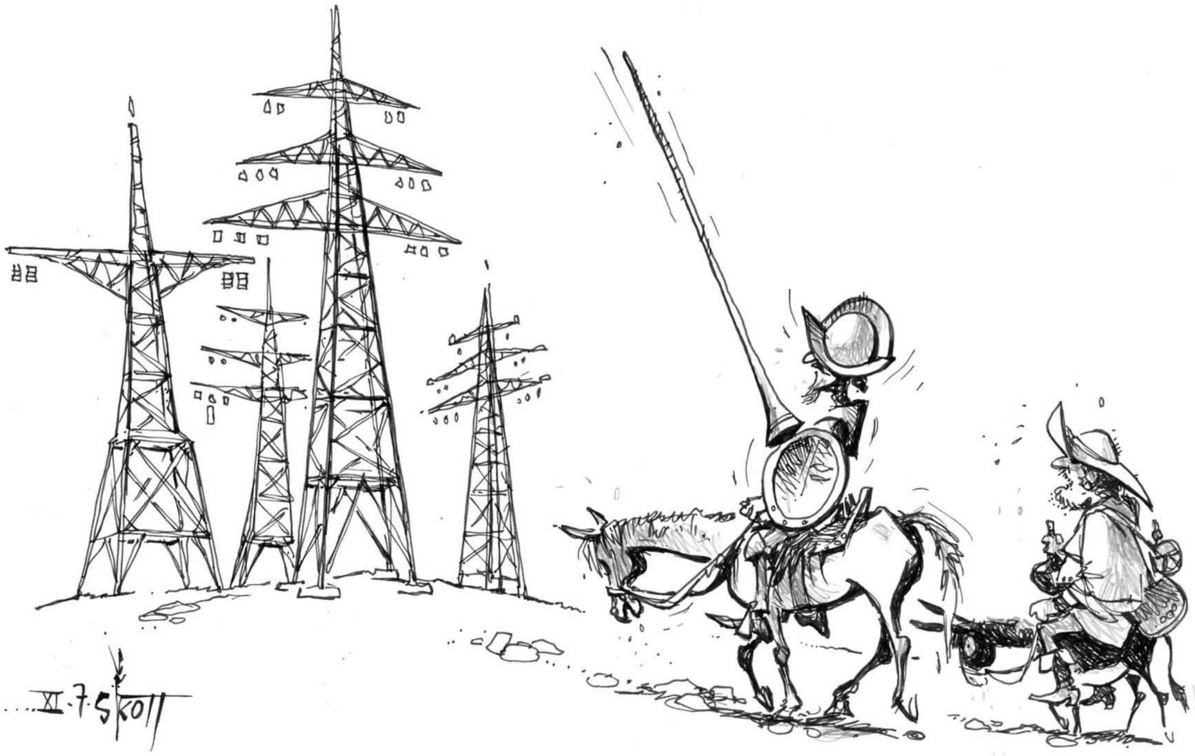
Measurement biases in research studies can cause distorted results. The fact that TSOs evaluated the independent variables, i.e. potential success factors, and at the same time also the dependent variable, i.e. the reduced public opposition, makes the study design prone to common method bias. For the sake of identifying generalizable success factors, a project specific case study design in which a TSO rates potential success factors and concerned people assess their level of opposition, could not be applied. The lack of currently ongoing or recently finalized transmission line projects in Europe made the selection of such a project specific study design virtually impossible. Thus, a rather hypothetical approach was selected. In particular, TSOs rated to what extent public opposition would be reduced in their future transmission line projects. This in turn implied an increased risk for hypothetical bias. However, the outlined potential risks of biases were recognized, discussed and appropriate mitigation measures were applied as proposed by several scientists in the literature. In particular, TSOs have not been involved in the identification of potential success factors leading to a clear two-step approach and separation of development of hypotheses and their respective validation (Riekeberg, 2003, p. 95). In addition, the combination of data sources, i.e. surveying two respondents per TSO organization, was applied (Söhnchen, 2007, p. 141). Finally, several mitigation measures were considered in the questionnaire design such as ensuring anonymity, stating that there are no right or wrong answers (Podsakoff et al., 2003, p. 888) or the clear formal separation of rating potential success factors and evaluating the reduction of public opposition (Söhnchen, 2007, p. 141). Moreover, a cheap talk script was introduced prior to the questions to mitigate hypothetical bias (Cummings & Taylor, 1999, p. 651).

Finally, besides a brief overview, transmission line legislation and regulation were excluded from this work's scope as this has recently or is currently being addressed by national governments as well as on the European political level. Nevertheless, research could check the effectiveness and sufficiency of these measures in detail and identify room for further improvement – especially in the context of public opposition.

"Fortune is arranging matters for us better than we could have shaped our desires ourselves,
for look there, friend Sancho Panza, where thirty or more monstrous giants present themselves,
all of whom I mean to engage in battle and slay,
and with whose spoils we shall begin to make our fortunes."

"What giants?" said Sancho Panza.

(Miguel de Cervantes Saavedra: Don Quijote de la Mancha)



Picture: Berndt A. Skott.

10 Appendix

Appendix 1: Main HVAC UGC installations with XLPE cables above 5 km

Length [km]	Voltage [kV]	Location	Country	Operation since
40	500	Shinkeyo - Toyosu	JP	2000
22+12	400	Copenhagen	DK	1999
39	345	East Devon - Norwalk (Connecticut)	US	2008
25	400	Abu Dhabi	AE	2012E
20	400	St-Johns Wood - Elstree (London)	UK	2005
17	500	Shanghai	CN	2010
16	345	Crawford - Westloop (Illinois)	US	2008
15	400	Aalborg-Aarhus	DK	2004
13	400	Madrid	ES	2004
13	400	Hong Kong	CN	2004
13	400	Abu Dhabi	AE	2009
6+6	400	Berlin	DE	2000
10	400	Liverpool	UK	2010
10	400	Wateringen - Blieswijk	NL	2012E
10	400	Blieswijk - Beverwijk	NL	2014E
10	400	Vienna	AT	2005
9	400	Milan	IT	2006
9	400	Istanbul	TR	2008
9	400	Turbigo - Rho	IT	2006
8	400	Mendrisio - Cagno	CH/IT	2008
6	400	Thessaloniki	GR	2005
6	400	London West Ham - Hackney	UK	2008
5	500	Medillin	CO	2010

E: Estimated.
Sources: EC (2003), ENTSO-E & Europacable (2011), Hoffmann & Noack (2007), Golder Associates & ECOFYS (2008), Borealis Group (2008), Stantec Consulting (2009), Europacable (2010), Rathke & Hofmann (2011, p. 21).

Appendix 2: Main HVDC UGC installations

Length [km]	Power rating [MW]	Location	Country	Operation since
180	220	Monash - Red Cliffs	AU	2002
90[a]	800	DolWin1 - Dörpen	DE	2013E
90[a]	900	DolWin2 - Dörpen	DE	2015E
75[a]	500	Woodland - Shotton	IE/UK	2012E
75[a]	400	BorWin1 - Diele	DE	2012E
65	2,000	Santa Llogaia - Baixas	ES/FR	2014E
50[a]	700	Nybro - Klaipeda	SE/LT	2015E
31[a]	350	Espoo - Harku	EE/FI	2006
28[a]	600	Fraugde - Herslev	DK	2010
23[a]	660	New Jersey - New York	US	2007

[a] Land cable length only.
E: Estimated.
Sources: Europacable (2011a), ABB (2011a), Siemens AG (2011b).

Appendix 3: Main GIL underground installations

Length [km]	Voltage [kV]	Location	Country	Operation since
12.7	550	Xiluodu	CN	2012E
5.4	380	Kelsterbach	DE	2009
4.0	420	Wehr	DE	1975
3.3	550	Jinping	CN	2011
2.6	300	Geneva	CH	2001
0.8	n.a.	Swawek ruacana	NA	1976
0.5	380	Limberg	AT	2010

E: Estimated.
Source: Siemens AG (2011a).

Appendix 4: Contacted European TSOs

Country	TSO	Ownership[a]
AT	APG-Austrian Power Grid AG	Semi-State
	TIWAG Netz[b c]	State
	VKW-Netz AG [c]	Semi-State
BA[d]	Nezavisni operator sustava u Bosni i Hercegovini	State
BE	Elia System Operator SA	Semi-Private
BG	Electroenergien Sistemen Operator EAD	State
CH[d]	Swissgrid AG	State
CY	Cyprus Transmission System Operator	State
CZ	CEPS a.s.	State
DE	50Hertz Transmission GmbH	Semi-Private
	Amprion GmbH	Private
	TransnetBW GmbH	Semi-State
	TenneT TSO GmbH	State
DK	Energinet.dk Independent Public Enterprise	State
EE	Elering AS	State
ES	Red Electrica de Espana S.A.	Semi-Private
FI	Fingrid OyJ	Semi-Private
FR	Réseau de Transport d'Electricité	State
UK	National Grid Electricity Transmission plc	Private
	Scottish Hydro Electric Transmission Limited	Private
	Scottish Power Transmission plc [c]	Private
GR	Independent Power Transmission Operator SA	State
HR[d]	HEP-Operator prijenosnog sustava d.o.o.	State
HU	MAVIR Magyar Villamosenergia-ipari Átviteli Rendszerirányító Zártköruen Muködo Részvénytársaság	State
IE	EirGrid plc	State
IS[d]	Landsnet hf	Semi-State
IT	Terna - Rete Elettrica Nazionale SpA	Semi-Private
LT	LITGRID AB	State
LU	Creos Luxembourg S.A.	State
LV	AS Augstsprieguma tÏkls	State
ME[d]	Crnogorski elektroprenosni sistem AD	State
MK[d]	Macedonia Transmission System Operator AD	State
NL	Tennet TSO B.V.	State
NO	Statnett SF	State
PL	PSE Operator S.A.	State
PT	Rede Eléctrica Nacional S.A.	Semi-State
RO	C.N. Transelectrica S.A.	Semi-State

Country	TSO	Ownership[a]
RS[d]	JP Elektromreža Srbije	State
SE	Affärsverket Svenska Kraftnät	State
SI	Elektro Slovenija d.o.o.	State
SK	Slovenska elektrizacna prenosova sustava, a.s.	State

[a] Private = 100% privately owned; State = 100 % state owned; Semi-Private / Semi-State = mixed private-state ownership with respective private / state majority.

[b] During this work, in January 2012, TIWAG Netz was incorporated into APG-Austrian Power Grid AG. However, as the distribution of questionnaires had already been started at the time, TIWAG Netz remains listed separately in this work.

[c] Distribution System Operator (DSO).

[d] Not an EU-27 Member State.

Appendix 5: National regulatory authorities in Europe

Country	National regulator
AT	Energie-Control GmbH (E-Control)
BA[a]	State Electricity Regulatory Commission (SERC)
BE	Commission pour la Régulation de l'Electricité et du Gaz (CREG)
BG	State Energy & Water Regulatory Commission (SEWRC)
CH[a]	Federal Electricity Commission (ElCom)
CY	Cyprus Energy Regulatory Authority (CERA)
CZ	Energy Regulatory Office (ERO)
DE	Federal Network Agency for Electricity, Gas, Telecommunications, Posts and Railway (BNetzA)
DK	Energitilsynet - Danish Energy Regulatory Authority (DERA)
EE	Konkurentsiamet - Estonian Competition Authority - Energy Regulatory Dept (ECA)
ES	National Energy Commission (CNE)
FI	Energiamarkkinavirasto - The Energy Market Authority (EMV)
FR	Commission de Régulation de l'Energie (CRE)
GR	Regulatory Authority for Energy (RAE)
HR[a]	Croatian Energy Regulatory Agency (HERA)
HU	Hungarian Energy Office (HEO)
IE	Commission for Energy Regulation (CER)
IS[a]	National Energy Authority (Orkustofnun)
IT	Autorità per l'Energia Elettrica e il Gas (AEEG)
LT	National Control Commission for Prices and Energy (NCC)
LU	Institut Luxembourgeois de Régulation (ILR)
LV	Public Utilities Commission (PUC)
ME[a]	Energy Regulatory Agency of the Republic of Montenegro (ERA)
MK[a]	Energy Regulatory Commission of the Republic of Macedonia (ERC)
MT	Malta Resources Authority (MRA)
NL	Dutch office of energy regulation (Nma)
PL	The Energy Regulatory Office of Poland (ERO)
PT	Energy Services Regulatory Authority (ERSE)
RO	Romanian Energy Regulatory Authority (ANRE)
RS[a]	Energy Acency of the Republic of Serbia (AERS)
SE	Energy Markets Inspectorate (EI)
SI	Energy Agency of the Republic of Slovenia
SK	Regulatory Office for Network Industries (RONI)
UK	Office for the Regulation of Electricity and Gas (Ofreg)
	Office of Gas and Electricity Markets (Ofgem)

[a] Not an EU-27 Member State.

Appendix 6: German citizen action groups against transmission lines

Action group	**Website**
Line 'Wahle – Mecklar'	
Bürger PROErdkabel Harzvorland e.V.	www.abindieerde.de
Keine 380-kV-Freileitung im Werra-Meißner-Kreis	www.keine-380-kv-freileitung-werra-meissner.de
Delligsen an der Hilsmulde	www.bi-hilsmulde.de
Umweltbeirat Hardegsen	www.umweltbeirat-hardegsen.de/landwirtschaft/032ded9ee9129310c/index.html
Region Sibbesse	www.bi-megamasten.de/html/bi-sibbesse.html
"Vorsicht Freileitung" Northeim	www.vorsicht-freileitung.de
Südkreis gegen die Megamasten	www.bi-megamasten.de
Lahstedt gegen Megamasten	www.buergerinitiative-lahstedt-380kv.de
Innerstetal	www.380-kV.de
Seesen/Bockenem	www.keine-trasse.de
Einbeck	www.bi-erdkabel.com
Keine 380 kV-Freileitung druch den Schwalm-Eder Kreis	www.keine-380kv-freileitung-schwalm-eder.de
Moringer Becken	*no website*
Salzgitter-Lebenstedt-Nord	*no website*
Pro Erdverkabelung Metelen	*no website*
BI gegen die Monstertrasse in Betheln	*no website*
Line 'Diele – Niederrhein'	
Pro Erdkabel NRW	www.pro-erdkabel-nrw.npage.de
380 kV (Lohhof)	www.gut-lohhof.com/buergerinitiative-380kv.html
Pro Erdkabel Neuss-Reuschenberg	www.pro-erdkabel-neuss.npage.de
Raesfelder Initiative 380 kV	*no website*
Gescher Initiative 380 kV	*no website*
Schöppinger Initiative Pro Erdkabel	*no website*
Pro Erdkabel Legden	*no website*
IG hochspannungsfreies Wohnumfeld Borken	*no website*
Pro Erdkabel Kaarst	*no website*
Line 'Halle – Schweinfurt'	
Bockstadt-Herbartswind-Heid-Eisfeld	www.gegen380kv.bockstadt.com
Achtung Hochspannung	www.achtung-hochspannung.de
Gegen die 380/110 kV Freileitungen	www.vorsicht380kv.de
NEIN! zur 380 kV Hochspannungstrasse durch Thüringen	www.schalkau.com

Action group	Website
Line ‘Neuenhagen – Bertikow’	
Neuenhagen-Letschin	www.gruppe-weimar.de/Freileitung
IG Uckermark	www.uckermark-ig.de
Biosphäre unter Strom - keine Freileitung durchs Reservat	www.trassenfrei.de
Line ‘Ganderkesee – St.Hülfe’	
Oldenburg/Diepholz	www.vorsicht-hochspannung.com
Hochspannung	www.hochspannung.widukindland-os.de
Line ‘Hamburg – Dollern’	
Quickborn unter Höchstspannung	www.380kvquickborn.de.tl
Quickborn gegen Riesenmasten	www.quickborn-gegen-riesenmasten.de
Other local lines	
Nürtinger Bürgerinitiative gegen Hochspannungsleitungen über Wohngebieten	www.nbi.richey-web.de
Freileitung raus aus Marquardt	www.abindieerde.de/Marquardt.htm
Husengut unter Hochspannung	www.hochspannunghussengut.de
Köln unter Hochspannung	www.koeln-unter-hochspannung.de
Hochspannung tieflegen	www.hochspannungtieflegen.de
Keine Freileitung Neuenhagen-Letschin	www.gruppe-weimar.de/Freileitung
IG Altbach und Fellbach	*no website*
Vorsicht Hochspannung Dortmund-Süd	*no website*

Source: Own research. Status 20.02.2012.

Appendix 7: Conducted interviews

Action groups

Country	Surname	First name	Organization	Function	Interview type (location)	Date
AT	Hubmann	Richard	380kV ade	Coordinator	Telephone	2011, November 02
	Knoch	Martin	Culture Initiative "Gegenverkehr"	Spokesperson	Telephone	2011, October 06
	Zotter	Karl	Energy platform Austria	Spokesperson	Telephone	2011, November 10
	Kutil	Hans	Stoppt 380kV	President	Telephone	2011, November 09
CH	Jakob	Hans-U.	Gigaherz	President	Telephone	2011, October 24
	Durrer	Markus	Stopp Elektrosmog	President	Telephone	2011, October 14
DE	Schulze	Peer	Achtung Hochspannung Bayern / Action group Ilmtal	Vice President	Telephone	2011, October 06
	Siegel	Heinz-Jürgen	Delligsen in der Hilsmulde e.V.	President	Telephone	2011, October 05
	Rohmund	Klaus	Keine 380-kV-Freileitung im Werra-Meißner-Kreis	President	Personal (Berlin)	2011, September 07
	Messerschmidt	Ralf	Pro Erd-Kabel Bad Gandersheim/Kreiensen	Treasurer	Personal (Berlin)	2011, September 07
	Schulze	Wolfgang	Pro Erd-Kabel Bad Gandersheim/Kreiensen	Secretary		2011, September 07
	Franke	Guido	Südkreis gegen e-on-Monstertrasse	Spokesperson	Telephone	2011, October 04
DK	Bluhme	Sigrid	Bevaegelsen for Miljovenlig Eltransmission (Movement for environmentally friendly electricity transmission)	Vice President	Telephone	2011, November 04
ES	Llorente	Xavier	NO a la M.A.T.	Spokesperson	Telephone	2011, December 05
FR	Lopez	Pierre	Non a la THT	Member	Telephone	2011, October 07
IE	O'Reilly	Padraig	North East Pylon Pressure	President	Telephone	2011, December 02
IT	Orzes	Ezio Guido	Citizen action group alliance of Veneto	Coordinator	Telephone	2011, October 24
NL	Meijer	Luc	Delft zegt NEE tegen bovengronds 380kV	President	Telephone	2011, November 15
	van der Weij	Harry	Stichting de Groene Landscheiding N470	President	Telephone	2011, December 05
NO	Kvamme	Synnove	Hardanger campaign	Spokesperson	Telephone	2011, November 17
SE	Weinesson	Mats	Local opposition / LRF Östergötland	Opposition leader	Telephone	2011, December 05
UK	O'Carroll	Mike	REVOLT	President	Telephone	2011, September 20
	Woods	John	Safe Energy for Armagh/Tyrone (SEAT)	President	Telephone	2011, November 21
	Paterson	Caroline	Stirling before pylons	Spokesperson	Telephone	2011, December 07

Communication experts

Country	Surname	First name	Organization	Function	Interview type (location)	Date
DE	Ulmer	Frank	Communication Bureau Ulmer	CEO	Telephone	2011, September 27
	Neuenhahn	Hans-Uwe	European Institute for Conflict Management EUCON e.V.	CEO	Telephone	2011, November 07
	Fusser	Andreas	Hand & Fusser Concept & Communication	CEO	Telephone	2011, September 21
	Eggert	Ralf	IFOK	Head of Energy	Telephone	2011, October 13
	Mattis	Marcus	Multi-Utility Consulting	CEO	Telephone	2011, October 11
	Troja	Markus	Troja, Glässer, Kirchhoff, Schwartz	Member	Telephone	2011, September 27
UK	Stone	Ivan	3G Communications Ltd.	Director	Telephone	2011, November 30

Governments / Regulators

Country	Surname	First name	Organization	Function	Interview type (location)	Date
BE	Siefken	Nicole-Nabi	European Commission - Directorate-General for Energy	Security of Supply & Networks	Personal (Brussels)	2011, February 09
DE	von Ahlefeldt	Stephanie	Federal Ministry of Economics and Technology – Platform for Sustainable Energy Grids	Director (Coordination Office)	Telephone	2011, September 21
	Bourwieg	Karsten	Federal Network Agency	Head of Energy Law	Telephone	2011, October 14
	Pölzl-Viol	Christiane	Federal Office for Radiation Protection	Division Radiation Protection and Health	Telephone	2011, September 28
	Matthes	Rüdiger	International Commission on Non-Ionizing Radiation Protection (ICNIRP)	Vice President	Telephone	2011, December 09
SL	Uros	Gabrijel	Agency for the Cooperation of Energy Regulators (ACER)	Senior Officer Framework Guidelines and Network Codes	Telephone	2011, October 11

Industry experts

Country	Surname	First name	Organization	Function	Interview type (location)	Date
AT	Knapp	Eduard	IFK GmbH	Head of Ploughing Technics	Telephone	2011, December 07
BE	Wendt	Volker	Europacable	Director Public Affairs	Telephone	2011, November 18
DE	Kreusel	Jochen	ABB AG	Head of Smart Grids	Telephone	2011, December 01
	Spahic	Ervin		Senior Transmission System Consultant	Personal (Munich)	2011, October 05
	Godron	Philipp	Dii GmbH	Head of Transmission Working Group	Personal (Munich)	2011, November 24
	Lehner	Konrad	Frank Föckersperger GmbH	Construction Manager	Telephone	2011, December 06
	Retzmann	Dietmar	Siemens AG	Technical Director Marketing & Innovations HVDC/FACTS	Personal (Munich)	2011, November 01
	Stein	Robert	Stein & Partner GmbH	CEO	Telephone	2011, December 07

NGOs

Country	Surname	First name	Organization	Function	Interview type (location)	Date
DE	Becker	Thorben	Friends of the Earth Germany (BUND)	Energy spokesperson	Telephone	2011, November 29
	Krauss	Martin		Spokesperson Working Group Energy (Hessen)	Telephone	2011, December 02
	Hänlein	Rotraud	German Environmental Aid	Project coordination Grid Integration	Telephone	2011, September 26
	Krüger	Wolfgang	German Farmers' Association	Head of Agriculture Law	Telephone	2011, September 21
	Keiffenheim	Marcel	Greenpeace Energy	Head of Energy Politics	Telephone	2011, September 30
	Haas	Dieter	Nature and Biodiversity Conservation Union (NABU Stromtod)	Expert for Bird Protection	Telephone	2011, September 20
	Battaglini	Antonella	Renewables Grid Initiative	Executive Director	Personal (Berlin)	2011, September 07
	Axmann	Guido	Thema 1	Managing Director	Telephone	2011, September 27
	Duveau	Thomas	WWF Germany	Officer Climate & Finance Sector (RES & Infrastructure)	Telephone	2011, September 20
LU	Spautz	Roger	Greenpeace Luxembourg	Spokesperson	Telephone	2011, September 22

Research institutes / Universities

Country	Surname	First name	Organization	Function	Interview type (location)	Date
DE	Renn	Ortwin	Chair of Environmental Sociology and Technology Assessment, University of Stuttgart	Chair	Telephone	2011, October 14
	Brakelmann	Heinrich	Chair of Power Transmission and Storage, University of Duisburg-Essen	Chair	Telephone	2011, December 01
	Jenau	Frank	Department of Electrical Engineering and Information Technology, University of Dortmund	Chair	Telephone	2012, July 12
	Bruns	Elke	Environmental Assessment & Planning Research Group, Technical University of Berlin	Research Associate	Telephone	2011, September 27
	Guss	Hermann	Faculty of Business Administration, University of Applied Sciences Saarbrücken	Researcher	Telephone	2011, November 30
	Klobasa	Marian	Fraunhofer Institute for System and Innovation Research	Coordinator SUSPLAN	Telephone	2011, October 12
	Hagemeyer	Friedrich	IKEM (Institute for Climate Protection, Energy & Mobility)	Board Member	Telephone	2011, November 11
	Hübner	Gundula	Institute for Psychology, Department of Social and Organizational Psychology, Martin-Luther-University Halle-Wittenberg	Chair	Telephone	2011, November 21
	Hildebrand	Jan	Research Group Environmental Psychology, Otto-von-Guericke-University Magdeburg	Researcher	Telephone	2011, September 26
NL	Paukovic	Mia	Energy Research Centre of the Netherlands (ECN)	Researcher Policy Studies (Social Acceptance)	Telephone	2011, November 16
	Veum	Karina		Senior researcher Policy Studies (Renewable Energy & Infrastructure)	Telephone	2011, November 11

Appendix 8: Interview guideline

Introduction

1) Can you explain the current situation / status of the transmission line project you are opposing and your respective role?

Question to identify reasons for opposition against a planned transmission line?

2) What are your / your members' concerns regarding the new installation of transmission lines?
3) What are the most important concerns for you / your members?
4) What have been the biggest discussion points / biggest disagreements with the TSO?
5) Do you in generally see the need of the new line?

Questions to identify success factors

6) What do you / your members request from the TSOs and why?
7) Which requests are most important to you / your members?
8) To what extent have TSOs met your requests in the past?
9) Why do you / your members think that TSOs do / did not meet your requests?
10) What are / were the arguments of TSOs why they have not met your requests?
11) Do you trust TSOs? If not, how could they regain trust?
12) What should TSOs do better in the future in terms of
    a. Technical planning / choice?
    b. Early involvement / participation?
    c. Transparency, communication and education?
    d. Compensation and local benefits?
    e. Internal processes and resources?
13) What do you think went wrong most in the past in grid expansion projects?
14) Has the attitude of TSOs changed over the last 5-10 years?
15) What problems do TSOs face in dealing with public opposition? What could be their restrictions?
16) Are there any regulatory changes required in order to support TSOs in meeting your / your members' requests? What are boundary conditions for the TSOs?

Closing

17) Can you recommend further sources of information / contact persons / events regarding public opposition against transmission line projects?

Appendix 9: Exemplary EMF organizations

Non-governmental organizations

Country	Organization	Website
Inter-national	Bioinitiative	www.bioinitiative.org
	International Commission for Electromagnetic Safety (ICEMS)	www.icems.eu
	International EMF Alliance	www.international-emf-alliance.org
AT	Diagnose Funk	www.diagnose-funk.org
	International Institute for Research on Electromagnetic Compatibility (IIREC)	www.iirec.at
BE	Belgian BioElectroMagnetic Group (BBEMG)	www.bbemg.ulg.ac.be
CH	Gigaherz	www.gigaherz.ch
DE	Research Center for Bioelectromagnetic Interaction	www.emf-portal.de
	Radiation Protection Commission	www.ssk.de
	Working Group EMF & Environment of WIK GmbH	www.wik-emf.org
DK	Danish Association of Electrosensitives	www.ehsf.dk
ES	Foundation for Geo-Environmental Health	www.saludgeoambiental.org
FI	Finnish Institute of Occupational Health (FIOH)	www.ttl.fi
FR	Independent Centre for Research and Information on Electromagnetic Radiation (CRIIREM)	www.criirem.org
	Electrosmog.info	www.electrosmog.info
IE	Alliance for Irish Radiation Protection	www.eirewaves.com
IS	Valdemar Gisli Valdemarsson	www.isholf.is/vgv
IT	Association for the Prevention of and Fight Against Electrosmog	www.applelettrosmog.it
NL	Information platform EMF	www.kennisplatform.nl
NO	Norwegian Association for the Electro-Hypersensitive	www.felo.no
SE	Swedish Association for the Electrosensitive (FEB)	www.feb.nu
UK	Stakeholder Advisory Group on ELF EMFs (SAGE)	www.sagedialogue.org.uk

Bodies with legal or recognized international status

Organization	Website
European Commission' EMF-NET	web.jrc.ec.europa.eu/emf-net/
International Commission on Non-Ionizing Radiadion Protection (ICNIRP)	www.icnirp.de
International Agency for Research on Cancer (IARC)	www.iarc.fr
Scientific Committee on Emerging and Newly identified Health Risks (SCENIHR)	ec.europa.eu/health/scientific_committees/emerging
World Health Organization (WHO) EMF Project	www.who.int/peh-emf/en

Appendix 10: Expert validity evaluation of formative measurement model

Formative indicators	p_{sa}	c_{sv}
COMMUNICATION		
Communication strategy	0.71	0.43
Early communication	1.00	1.00
Line justification	1.00	1.00
Direct personal conversation	1.00	1.00
Appropriate communication mix	1.00	1.00
Comprehensibility	1.00	1.00
Sufficient and honest information	1.00	1.00
Stakeholder education	0.71	0.43
Post-communication	1.00	1.00
PARTICIPATION		
Pre-polls	0.71	0.43
Participation possibilities	0.86	0.71
Participation information	0.71	0.43
Macro-planning involvement	0.86	0.71
Pre-application involvement	1.00	1.00
Neutral moderation/ mediation[a)]	0.14	-0.71
Joint fact finding[a)]	0.29	-0.43
Flexibility, openness and respect	0.86	0.71
Commitment and bindingness	0.71	0.43
Transparent decision making	0.71	0.43
ORGANIZATIONAL READINESS		
Stakeholder analysis and management	0.86	0.71
Qualification and development	1.00	1.00
Sufficient resources	0.86	0.71
Internal coordination	0.86	0.71
Cultural change	0.71	0.43
Top-management support	0.71	0.43
Best practice exchange	0.86	0.71

Formative indicators	p_{sa}	c_{sv}
ECONOMIC BENEFITS		
Local benefits	1.00	1.00
Individual compensations	1.00	1.00
Municipality compensations	1.00	1.00
Socio-economic benefits	0.71	0.43
TECHNICAL PLANNING		
Line avoidance options	0.86	0.71
Route alternatives	0.71	0.43
Transmission technology options	1.00	1.00
Piloting of innovations	1.00	1.00
Avoidance of sensitive areas	0.86	0.71
Bundling of infrastructure	0.71	0.43
Line deconstruction	0.71	0.43
Regulatory overachievement	1.00	1.00
STAKEHOLDER LIAISON		
Stakeholder cooperation	0.86	0.71
Multiplicators	0.71	0.43
Local empowerment	0.71	0.43

a) Regrouped from ‘Communication’ to ‘PARTICIPATION’ after pretest.

Appendix 11: ELMOD generation capacities, electricity production and demand in 2015

	AT		BE		CH		DE		ES		FR		IT		MO		NL		PT		UK	
Generation	**MW**	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**	**GWh**
Solar PV	179	170	713	610	153	100	34,279	26,161	5,918	9,872	2151	2,617	5,500	6,122	100	212	317	250	540	797	1,070	890
Solar CSP	-	-	-	-	-	-	-	-	3,048	7,913	203	365	62	170	920	2,320	-	-	180	360	-	-
Wind	1,951	3,780	2,048	6,084	250	450	36,647	69,994	27,997	57,086	13,445	30,634	9,068	13,652	1,574	2,423	5,578	13,655	6,125	13,480	14,210	39,430
PSP	4,285	2,732	-	-	6,300	9,450	6,494	6,989	3,700	6,577	5,800	6,199	2,499	2,734	764	674	-	-	2,454	2,577	2,888	4,332
Hydro	8,423	39,423	123	391	7,440	34,819	4,165	19,000	20,049	36,732	21,552	64,953	14,691	39,337	1,476	2,636	68	200	4,623	11,176	1,920	5,730
Geothermal	1	2	-	-	-	-	79	377	-	-	53	314	837	6,191	-	-	-	-	40	260	1	6
Biomass	1,229	4,826	1,290	5,952	44	170	7,721	42,091	965	5,962	1,894	10,495	2,869	13,712	-	-	2,443	13,350	907	3,359	2,530	14,290
Nuclear	-	-	5,941	48,578	3,268	21,215	11,351	102,456	7,262	59,185	64,757	455,782	-	-	-	-	504	3,967	-	-	9,265	63,013
Fossil	6,758	18,350	9,029	30,944	845	2,230	88,761	379,978	48,862	161,800	28,622	37,723	67,567	246,399	6,737	28,454	22,856	94,290	9,498	24,305	71,281	280,426
TOTAL	22,826	69,283	19,144	92,559	18,300	59,065	189,497	647,046	117,801	345,127	138,477	609,082	103,093	328,317	11,571	36,718	31,766	125,712	24,367	56,314	103,165	408,117
Demand (adjusted by)		67,652 (0)		102,561 (-120)		60,140 (-1,570)		507,784 (-103,419)		292,634 (-36,076)		492,863 (-82,113)		319,993 (-45,945)		39,679 (0)		100,620 (-29,752)		47,370 (-11,664)		384,953 (0)
... thereof demand PSP		3,643				12,600		9,319		8,769		8,265		3,645		1,070				3,436		361

Appendix 12: ELMOD marginal generation costs of different power plant types

Plant type	Marginal cost [in EUR/MWh]	Plant type	Marginal cost in EUR/MWh
Hydro	0	Coal	46.1
Wind	0	PSP	47.0
Solar PV	0	CCGT	64.3
Solar CSP[a]	0	CCOT	67.9
Geothermal	0	Oil steam	85.2
Nuclear	9.7	Gas steam	87.5
Lignite	20.6	OCOT	96.7
Biomass	26.6	OCGT	99.6

[a] Cost for gas co-firing neglected.

Appendix 13: ELMOD country specific capacity factors 2015

In %	AT	BE	CH	DE	ES	FR	IT	MO	NL	PT	UK
PV total[a]	10.8	9.8	7.4	8.7	19.0	13.9	12.7	24.2	9.0	16.8	9.5
PV HS (1,432 hrs)	29.2	26.3	20.1	23.5	51.3	37.4	34.2	65.1	24.2	45.4	25.6
PV AS (3,644 hrs)	14.6	13.1	10.0	11.7	25.6	18.7	17.1	32.6	12.1	22.7	12.8
CSP total[a]	-	-	-	-	29.6	20.5	31.3	33.4	-	22.8	-
CSP HS (1,432 hrs)	-	-	-	-	79.8	55.3	84.3	89.9	-	61.5	-
CSP AS (3,644 hrs)	-	-	-	-	39.9	27.6	42.1	45.0	-	30.7	-
Wind total	22.1	33.9	20.5	21.8	23.3	26.0	17.2	31.7	27.9	25.1	31.7
Wind HW (3,329 hrs)	43.9	67.3	40.8	43.3	46.2	51.6	34.1	62.8	55.4	49.8	62.8
Wind AW (5,431 hrs)	8.8	13.5	8.2	8.7	9.2	10.3	6.8	12.6	11.1	10.0	12.6
Hydro	37.9	36.4	29.0	27.8	20.8	29.7	27.9	20.8	33.6	22.2	23.9
Geothermal	22.8	-	-	54.5	-	67.6	84.4	-	-	74.2	68.5
Biomass	44.8	52.7	44.5	62.2	70.5	63.3	54.6	-	62.4	42.3	64.5
Nuclear	-	93.3	74.1	97.2	93.0	80.3	-	-	89.9	-	77.6
Lignite[b]	78.0	78.0	78.0	78.0	78.0	78.0	78.0	78.0	78.0	78.0	78.0
Coal[b]	51.0	51.0	51.0	51.0	51.0	51.0	51.0	51.0	51.0	51.0	51.0

HS = high sun; AS = average sun; HW = high wind; AW = average wind.
[a] Considers also 3,684 hours without sunshine (night).
[b] As detailed data are not available for generated electricity by lignite and coal per country, an European average for capacity factors is applied according to EWI & Prognos (2005).

Appendix 14: ELMOD code

```
*------------------------------------------------------------------------*
SETS
*-----------------------------------------------------------------------
set
         l               lines
         n               nodes
         p               plants
         i               technologies
         f               fuels
         co              country
         hvdc_FRES(n)    hvdc FRES nodes
         hvdc_FRUK(n)    hvdc FRUK nodes
         mapip(i,p)      plant technology mapping
         mappn(p,n)      plant node mapping
         mapfi(f,i)      fuel technology mapping
         mapnc(n,co)     country node mapping;
*-----------------------------------------------------------------------
*                                  PARAMETER
*-----------------------------------------------------------------------
parameter
*        Lines
         lineup          line upload parameter
         P_max(l)        line capacity of line l
         react(l)        line reactance of line l
         resis(l)        line resistance of line l
         ZBase1          Base 1 (380 kV) for p.u. calculation
         ZBase2          Base 2 (220 kV) for p.u. calculation
         ZBase3          Base 3 (110 kV) for p.u. calculation
         LineVoltage(l)  voltage level of line L (110 220 380)
         ThermalLimit(l) Max. current of line L[A]
         incidence(l,n)  node-line incidence matrix
         b(n,n)          nodal suceptance matrix
         h(l,n)          branch suceptance matrix
         bvector(l)      series susceptance [p.u.]
         gvector(l)      series conductance [p.u.]

*        Generation
         c(p)            generation cost at node n
         g_max(p)        total generation capacity at node n
         techup          technology upload
         fuelup          fuel upload
         otherup         other data
         scale           scaling factor
         g_wind(n)       wind supply
         g_pv(n)         pv supply
         loadup          loadfactor upload
*        Demand
         q_ref(n)        reference demand at node n
         q_nopsp(n)      demand to be supplied without psp demand at node n
         q_psp(n)        demand of psp to be supplied at node n
```

```
        countryup       country upload
*       Nodes
        nodeup          upload node information
        slack(n)        slack node
        sh_dem(n)       demand share by node
        sh_wind(n)      wind share by node
        sh_pv(n)        pv share by node
        sh_dem_psp(n)   psp demand share by node
*       Data checks
        check_demand    check of demand and capacity in market - should be negative

* National welfare calculations
*       Spain
        WELF_ES         welfare Spain
        q_area_ES       demand area Spain
        cost_ES         cost Spain
        CR_ES           consumer rent Spain
        PR_ES           producer rent Spain
*       France
        WELF_FR         welfare France
        q_area_FR       demand area France
        cost_FR         cost France
        CR_FR           consumer rent France
        PR_FR           producer rent France
*       Germany
        WELF_DE         welfare Germany
        q_area_DE       demand area Germany
        cost_DE         cost Germany
        CR_DE           consumer rent Germany
        PR_DE           producer rent Germany
*       Italy
        WELF_IT         welfare Italy
        q_area_IT       demand area Italy
        cost_IT         cost Italy
        CR_IT           consumer rent Italy
        PR_IT           producer rent Italy
*       Belgium
        WELF_BE         welfare Belgium
        q_area_BE       demand area Belgium
        cost_BE         cost Belgium
        CR_BE           consumer rent Belgium
        PR_BE           producer rent Belgium
*       Switzerland
        WELF_CH         welfare Switzerland
        q_area_CH       demand area Switzerland
        cost_CH         cost Switzerland
        CR_CH           consumer rent Switzerland
        PR_CH           producer rent Switzerland
*       Austria
        WELF_AT         welfare Austria
        q_area_AT       demand area Austria
        cost_AT         cost Austria
```

```
        CR_AT           consumer rent Austria
        PR_AT           producer rent Austria
*       Portugal
        WELF_PT         welfare Portugal
        q_area_PT       demand area Portugal
        cost_PT         cost Portugal
        CR_PT           consumer rent Portugal
        PR_PT           producer rent Portugal
*       Netherlands
        WELF_NL         welfare Netherlands
        q_area_NL       demand area Netherlands
        cost_NL         cost Netherlands
        CR_NL           consumer rent Netherlands
        PR_NL           producer rent Netherlands
*       Morocco
        WELF_MO         welfare Morocco
        q_area_MO       demand area Morocco
        cost_MO         cost Morocco
        CR_MO           consumer rent Morocco
        PR_MO           producer rent Morocco
        WELF_UK         welfare United Kingdom
*       United Kingdom
        q_area_UK       demand area United Kingdom
        cost_UK         cost United Kingdom
        CR_UK           consumer rent United Kingdom
        PR_UK           producer rent United Kingdom;

*---------------------------------------------------------------------------
*                              SCALARS
*---------------------------------------------------------------------------
scalars
* HVDC lines
        P_max_hvdc_FRES capacity of new HVDC line FR-ES           / 2000 /
        P_max_hvdc_FRUK capacity of new HVDC line FR-UK           / 2000 /
        hvdcloss        station loss (both station default 2%)   / 0.034 /
* AC lines
        MVABase         for per unit calculation [MVA]             / 500 /
        VoltageBase1    for per unit calculation [kV]              / 380 /
        VoltageBase2    for per unit calculation [kV]              / 220 /
        VoltageBase3    for per unit calculation [kV]              / 110 /
        trm             transmission reliability margin [%]        / 0.2 /
* Demand
        p_ref           reference price for linear demand curve     / 60 /
        epsilon         demand elasticity                        / -0.20 /
;
```

```
*------------------------------------------------------------------------
*                                   ALIAS
*------------------------------------------------------------------------
* Set alias
         alias(n,nn),(co,cco);
         alias(hvdc_FRES,hvdc_FRES2);
         alias(hvdc_FRUK,hvdc_FRUK2);

*------------------------------------------------------------------------
*                                   UPLOAD
*------------------------------------------------------------------------
* Write gdxxrw option file
$onecho >temp.tmp
set=l            rng=Lines!A2             rdim=1 cdim=0
set=n            rng=Nodes!D2             rdim=1 cdim=0
set=p            rng=PlantNodeMap!A2      rdim=1 cdim=0
set=f            rng=fuels!A2             rdim=1 cdim=0
set=i            rng=technologies!B2      rdim=1 cdim=0
set=co           rng=country!A2           rdim=1
set=mappn        rng=plantNodeMap!A2      rdim=2 cdim=0
set=mapip        rng=plants!A2            rdim=2 cdim=0
set=mapfi        rng=technologies!A2      rdim=2 cdim=0
set=mapnc        rng=nodecountrymap!A2    rdim=2 cdim=0

par=lineup       rng=lines!A1:I10000      rdim=1 cdim=1
par=nodeup       rng=nodes!D1             rdim=1 cdim=1
par=fuelup       rng=fuels!A1             rdim=1 cdim=1
par=techup       rng=technologies!B1      rdim=1 cdim=1
par=otherup      rng=other!A1             rdim=1 cdim=0
par=g_max        rng=plants!B2            rdim=1 cdim=0
par=countryup    rng=country!A1           rdim=1 cdim=1

$offecho
$call "gdxxrw %datadir%%data%.xls @temp.tmp"
$gdxin %data%
$load l n p f i co mappn mapip mapfi mapnc
$load nodeup lineup fuelup techup otherup g_max countryup

*------------------------------------------------------------------------
*                              LINE PARAMETERS
*------------------------------------------------------------------------
* Normation
         ZBase1 = (VoltageBase1 *1E3)**2 / (MVABase * 1E6);
         ZBase2 = (VoltageBase2 *1E3)**2 / (MVABase * 1E6);
         ZBase3 = (VoltageBase3 *1E3)**2 / (MVABase * 1E6);

* Line characteristics
*        Thermal limit
         thermallimit(l) = lineup(l,"ThermalLimit");
*        Line voltage
         LineVoltage(l) = lineup(l,"Voltage");
```

```
*         Line reactance
          react(l) = lineup(l,"Reactance") / (ZBase1$(LineVoltage(l) eq 380)
                     + ZBase2$(LineVoltage(l) eq 220)
                     + ZBase3$(LineVoltage(l) eq 110));
*         Line resistance
          resis(l) = lineup(l,"Resistance") / (ZBase1$(LineVoltage(l) eq 380)
                     + ZBase2$(LineVoltage(l) eq 220)
                     + ZBase3$(LineVoltage(l) eq 110));
*         Capacity limit
          P_max(l) = sqrt(3)*LineVoltage(l)*ThermalLimit(l)*(1 - trm)/1E3;

* Create the incidence matrix
          incidence(l,n)    = 0;
          incidence(l,n)$(lineup(l,"FROM") eq n.val) = 1;
          incidence(l,n)$(lineup(l,"TO") eq n.val) = -1;
          bvector(l) = (react(l) / (react(l)**2 + resis(l)**2))$(react(l) or resis(l));
          gvector(l) = (resis(l) / (react(l)**2 + resis(l)**2))$(react(l) or resis(l));

* Calculation of final network matrices
          h(l,n) = bvector(l) * incidence(l,n);
          b(n,nn) = sum(l, incidence(l,n) * h(l,nn));

* Define slack (starting node)
          slack('1') = 0;

* Definition of HVDC nodes
*         HVDC line France -> Spain
          hvdc_FRES('829') = YES;
          hvdc_FRES('1167') = YES;
*         HVDC line France -> United Kingdom
          hvdc_FRUK('13') = YES;
          hvdc_FRUK('1170') = YES;

*---------------------------------------------------------------------------
*                                NODE PARAMETERS
*---------------------------------------------------------------------------
* Define demand per node
          sh_dem(n) = nodeup(n,"DemandShare");
* Define wind generation share per node
          sh_wind(n) = nodeup(n,"WindShare");

* Define pv generation share per node
          sh_pv(n) = nodeup(n,"PVShare");

* Define PSP consumption share per node
          nodeup(n,"PSPShare") = 0 + nodeup(n,"PSPShare")
          $nodeup(n,"PSPShare");
          sh_dem_psp(n) = nodeup (n,"PSPShare");
```

```
*-----------------------------------------------------------------------------
*                                  PLANT PARAMETERS
*-----------------------------------------------------------------------------
* Create the marginal cost
         c(p) = sum(i$mapip(i,p), sum(f$mapfi(f,i),
         fuelup(f,"Price"))/techup(i,"Efficiency")
         + sum(f$mapfi(f,i), fuelup(f,"Carbon"))*otherup("CarbonTax"));

*-----------------------------------------------------------------------------
*                         DATA ASSIGNMENT FRANCE AND SPAIN
*-----------------------------------------------------------------------------
* France
*        Demand per node without PSP consumption
         q_nopsp(n)$mapnc(n,"FR") = countryup("FR","Demand")*sh_dem(n);
*        PSP consumption per node
         countryup ("FR","PSPCharge") = 0 + countryup ("FR","PSPCharge")
         $countryup ("FR","PSPCharge");
         q_psp(n)$mapnc(n,"FR") = countryup ("FR","PSPCharge")*sh_dem_psp(n);
*        Wind generation share per node
         g_wind(n)$mapnc(n,"FR") = countryup("FR","Wind")*sh_wind(n);
*        PV generation share per node
         countryup ("FR","PV") = 0 + countryup ("FR","PV") $countryup ("FR","PV");
         g_pv(n)$mapnc(n,"FR") = countryup("FR","PV")*sh_pv(n);
* Spain
*        Demand per node without PSP consumption
         q_nopsp(n)$mapnc(n,"ES") = countryup("ES","Demand")*sh_dem(n);
*        PSP consumption per node
         countryup ("ES","PSPCharge") = 0 + countryup ("ES","PSPCharge")
         $countryup ("ES","PSPCharge");
         q_psp(n)$mapnc(n,"ES") = countryup ("ES","PSPCharge")*sh_dem_psp(n);
*        Wind generation share per node
         g_wind(n)$mapnc(n,"ES") = countryup("ES","Wind")*sh_wind(n);
*        PV generation share per node
         countryup ("ES","PV") = 0 + countryup ("ES","PV") $countryup ("ES","PV");
         g_pv(n)$mapnc(n,"ES") = countryup("ES","PV")*sh_pv(n);

*-----------------------------------------------------------------------------
*                          DATA ASSIGNMENT OTHER COUNTRIES
*-----------------------------------------------------------------------------
* Netherlands
         q_nopsp('5')=   countryup("NL","Demand");
         q_psp('5')=     countryup("NL","PSPCharge");
         g_wind('5')=    countryup("NL","Wind");
         g_pv('5')=      countryup("NL","PV");
* Belgium
         q_nopsp('24')=  countryup("BE","Demand");
         q_psp('24')=    countryup("BE","PSPCharge");
         g_wind('24')=   countryup("BE","Wind");
         g_pv('24')=     countryup("BE","PV");
* Italy
         q_nopsp('515')= countryup("IT","Demand");
         q_psp('515')=   countryup("IT","PSPCharge");
```

```
        g_wind('515')=  countryup("IT","Wind");
        g_pv('515')=    countryup("IT","PV");
* Germany
        q_nopsp('44')=  countryup("DE","Demand");
        q_psp('44')=    countryup("DE","PSPCharge");
        g_wind('44')=   countryup("DE","Wind");
        g_pv('44')=     countryup("DE","PV");
* Austria
        q_nopsp('343')= countryup("AT","Demand");
        q_psp('343')=   countryup("AT","PSPCharge");
        g_wind('343')=  countryup("AT","Wind");
        g_pv('343')=    countryup("AT","PV");
* Switzerland
        q_nopsp('383')= countryup("CH","Demand");
        q_psp('383')=   countryup("CH","PSPCharge");
        g_wind('383')=  countryup("CH","Wind");
        g_pv('383')=    countryup("CH","PV");
* Portugal
        q_nopsp('953')= countryup("PT","Demand");
        q_psp('953')=   countryup("PT","PSPCharge");
        g_wind('953')=  countryup("PT","Wind");
        g_pv('953')=    countryup("PT","PV");
* Morocco
        q_nopsp('1169')= countryup("MO","Demand");
        q_psp('1169')=   countryup("MO","PSPCharge");
        g_wind('1169')=  countryup("MO","Wind");
        g_pv('1169')=    countryup("MO","PV");
* United Kingdom
        q_nopsp('1170')= countryup("UK","Demand");
        q_psp('1170')=   countryup("UK","PSPCharge");
        g_wind('1170')=  countryup("UK","Wind");
        g_pv('1170')=    countryup("UK","PV");

* Define total demand (add PSP demand)
        q_ref(n) = q_nopsp(n) + q_psp(n);

* Import scaling factor
        scale = 1000000;

*---------------------------------------------------------------------------
*                              DATA CHECKS
*---------------------------------------------------------------------------
check_demand = sum(n, q_nopsp(n))+ sum(n, q_psp(n))- sum(p, g_max(p)) - sum(n, g_wind(n)) -
sum(n, g_pv(n));
abort$(check_demand gt 0) "**** NOT ENOUGH CAPACITY IN MARKET ****", check_demand;
```

```
*------------------------------------------------------------------------------
*                              VARIABLES
*------------------------------------------------------------------------------
Variable
         COST            objective value: total cost
         LINEFLOW        line flow
         NETINPUT        net injection
         DELTA           voltage angle
         WELF            welfare
         PR              producer rent
         CR              consumer rent
         Q_AREA          area under demand function
         np(n)           nodal price
         Gen_total(n)    total generation at node n;
Positive Variable
         G               conventional generation and PSP
         LOADSHED        Auxiliary withdrawal load
         WINDSHED        Auxiliary withdrawal wind
         PVSHED          Auxiliary withdrawal pv
         HVDCFLOW_FRES   flow of new HVDC line FR-ES
         HVDCFLOW_FRUK   flow of existing HVDC line FR-UK
         q(n)            demand at node n;

*------------------------------------------------------------------------------
*                            PARAMETER
*------------------------------------------------------------------------------
parameter
         m(n)            ascent of demand function
         a(n)            intercept point of demand function
         q_area_n        Demand area at node n
         cost_n          Cost at note n
         welf_n          Welfare at node n;

         m(n)$q_ref(n) = p_ref/(epsilon*q_ref(n));
         a(n)$q_ref(n) = p_ref-q_ref(n)*m(n);

*------------------------------------------------------------------------------
*                            EQUATIONS
*------------------------------------------------------------------------------
Equations
*        Objective functions
         OBJ_cost        objective function: total generation cost
         OBJ_welf        objective function: welfare
*        Demand function
         DEMANDAREA      area under demand function
*        Market clearing equations
         MKT_lp          market clearing equation wo network losses
                               (linear)
*        Thermal generation restrictions
         RES_gmax        maximum generation restriction
*        Network defintions and restrictions
         DEF_LINEFLOW    lineflow definition
```

```
        DEF_NETINPUT    netinput definition
        RES_pmax        maximum transmission restriction
        RES_pmax_hvdc_FRES   maximum transmission restriction new HVDC
                        line FR-ES
        RES_pmax_hvdc_FRUK   maximum transmission restriction new HVDC
                        line FR-UK
        RES_pmin        minimum transmission restriction
        DEF_slack       slack bus definition
*       Other Restrictions
        RES_WINDSHED    maximum amount of windshedding
        RES_PVSHED      maximum amount of pvshedding;

* Objective functions
*       1000 are costs in EUR
        OBJ_cost..
                COST =E= (SUM(p, c(p) * G(p)
                         + 1000 * SUM(n, LOADSHED(n))
                         + 1000 * SUM(n, WINDSHED(n))
                         + 1000 * SUM(n, PVSHED(n))));
        OBJ_welf..
               WELF =e= (q_area - cost) / scale;

* Market clearing equations
        MKT_lp(n)..
                0 =E= q(n) + NETINPUT(n)- LOADSHED(n)
                        - SUM(p$mappn(p,n), G(p)) - g_wind(n)- g_pv(n)
                        + WINDSHED(n)+ PVSHED(n)
                        + SUM(hvdc_FRES2, (1 - hvdcloss) *
                              HVDCFLOW_FRES(n,hvdc_FRES2)$hvdc_FRES(n))
                              - SUM(hvdc_FRES2, (1 - hvdcloss) *
                              HVDCFLOW_FRES(hvdc_FRES2,n)$hvdc_FRES(n))
                              + SUM(hvdc_FRUK2, (1 - hvdcloss) *
                              HVDCFLOW_FRUK(n,hvdc_FRUK2)$hvdc_FRUK(n))
                              - SUM(hvdc_FRUK2, (1 - hvdcloss) *
                              HVDCFLOW_FRUK(hvdc_FRUK2,n)$hvdc_FRUK(n));

* Demand function
*       Reference demand: linear function p = a + m*q
        DEMANDAREA..
               q_area =e= (sum(n, a(n) * q(n) +0.5 * m(n) * sqr(q(n))));

* Thermal generation restrictions
        RES_gmax(p)..
                G(p) =L= g_max(p);

* Network defintions and restrictions
        DEF_LINEFLOW(l)..
                LINEFLOW(l) =E= SUM(n$h(l,n), h(l,n) * DELTA(n));
        DEF_NETINPUT(n)..
                NETINPUT(n) =E= SUM(nn, b(n,nn) * DELTA(nn)) * MVABase;
        RES_pmax(l)..
                LINEFLOW(l) * MVABase =L= P_max(l);
```

```
        RES_pmin(l)..
                LINEFLOW(l) * MVABase =G= - P_max(l);
        RES_pmax_hvdc_FRES(hvdc_FRES,hvdc_FRES2)..
                HVDCFLOW_FRES(hvdc_FRES,hvdc_FRES2) =L= P_max_hvdc_FRES;
        RES_pmax_hvdc_FRUK(hvdc_FRUK,hvdc_FRUK2)..
                HVDCFLOW_FRUK(hvdc_FRUK,hvdc_FRUK2) =L= P_max_hvdc_FRUK;
        DEF_slack(n)..
                DELTA(n) * slack(n) =E= 0;

* Other Restrictions
        RES_WINDSHED(n)..
                WINDSHED(n) =L= g_wind(n);
        RES_PVSHED(n)..
                PVSHED(n) =L= g_pv(n);

*-------------------------------------------------------------------------
*                                SOLVE STATEMENT
*-------------------------------------------------------------------------
model OPF_ELMOD /all/;
OPF_ELMOD.Scaleopt = 1 ;
option QCP = CPLEX;
solve OPF_ELMOD max WELF use QCP;
```

Appendix 15: Questionnaire for success factor validation

Electricity transmission planning:
Critical success factors for TSOs to reduce public opposition

- An empirical analysis -

TECHNISCHE UNIVERSITÄT DRESDEN

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Foreword

Dear transmission expert,

The lack of social acceptance is one of the major reasons for delays in electricity transmission line planning nowadays. Up to date there are no comprehensive empirical results how Transmission System Operators (TSOs) can reduce public opposition. Thus, **this study aims** to **identify critical success factors for TSOs to reduce public opposition in the planning phase of electricity transmission projects.**

You as a transmission expert will help us to identify and validate these success factors. In turn, we are happy to provide you with the consolidated study results. If you are interested to receive a copy of the results please provide us with your email address at the end of this questionnaire. This empirical analysis is initiated by the **Technische Universität Dresden** (Germany) and is part of a PhD thesis in cooperation with **ENTSO-E.**

- Please answer and return the questionnaire by latest **February 5th, 2012**. You can find return details at the end of this questionnaire.
- There are neither wrong nor right answers. Please fill out the questionnaire completely, so that an accurate statistical analysis can be conducted.
- Your provided data will be treated absolutely anonymously.
- Answering the questionnaire will take around 30 minutes.
- Indicate your choice (with a cross) like this: ☐ ☒ ☐ ☐ ☐

  In case of a correction indicate like this: ☐ ■ ☐ ☒ ☐

For questionnaire return or in case of further questions please contact

Mr. Stefan Perras

Address: TU Dresden, Faculty of Business Administration, Chair of Energy Economics, 01062 Dresden, Germany
Email: stefan.perras@mailbox.tu-dresden.de
Phone: [redacted]

Thank you very much for your cooperation!

Prof. Dr. Dominik Möst	**Stefan Perras**	**Geoffrey Feasey**
Technische Universität Dresden	Technische Universität Dresden	Corporate Affairs
Chair of Energy Economics	Chair of Energy Economics	ENTSO-E

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Please note

Recent empirical studies in which questions on future hypothetical behaviour were asked have shown that people usually give different answers than they would do in a real situation. For example, 18% more people answered 'yes' to the hypothetical question "**Would** you donate 1,000 EUR to XYZ?" than in a real situation/question "Do you **want** to donate **now** 1,000 EUR to XYZ?". That's quite a difference, isn't it? This phenomenon is called "hypothetical bias". As we also ask you hypothetical questions in this survey, it could be that you give different answers than you would do it in a real situation. Thus, we want you to be aware of this phenomenon and ask you to answer the questions as if it were a real situation.

Questions

I. Success factors

☛ The following success factors have been collected from interviews with affected citizens, action groups, NGOs, independent institutions and literature. Please indicate to what extent you regard each factor as relevant for implementing it in your future projects.

Communication	Not relevant at all				Absolutely essential
1a) Develop a communication strategy (when, how, with whom, what and by which media to communicate)	☐	☐	☐	☐	☐
1b) Communicate proactively and at earliest possible stage	☐	☐	☐	☐	☐
1c) Clearly and honestly argue the need for a new line	☐	☐	☐	☐	☐
1d) Seek personal direct communication with stakeholders (face-to-face)	☐	☐	☐	☐	☐
1e) Use appropriate communication mix (internet, newspaper, etc.)	☐	☐	☐	☐	☐
1f) Provide comprehensible information about the planned line (incl. moderation / explanation if required)	☐	☐	☐	☐	☐
1g) Provide requested information in a sufficient and honest way (e.g. planning documents, load flow data, etc.)	☐	☐	☐	☐	☐
1h) Educate stakeholders regarding technical and legal aspects with independent information	☐	☐	☐	☐	☐
1i) Continue communication after project finalization ('post-communication')	☐	☐	☐	☐	☐

Participation	Not relevant at all				Absolutely essential
2a) Conduct pre-polls in affected areas upfront to determine the local attitude towards a possible new line	☐	☐	☐	☐	☐
2b) Provide additional and sufficient (beyond regulatory requirements) participation opportunities (e.g. round tables, etc.)	☐	☐	☐	☐	☐
2c) Proactively inform local stakeholders about possible participation opportunities and jointly agree on the participation process	☐	☐	☐	☐	☐
2d) Involve stakeholders already during high-level macro-planning (rough corridors) on national / regional level	☐	☐	☐	☐	☐

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	Not relevant at all				Absolutely essential
2e) Involve local stakeholders prior to the official application process	☐	☐	☐	☐	☐
2f) Use neutral moderation/mediation early on to avoid/resolve conflicts	☐	☐	☐	☐	☐
2g) Foster joint fact finding (i.e. agree on independent studies & experts)	☐	☐	☐	☐	☐
2h) Show flexibility, openness and respect	☐	☐	☐	☐	☐
2i) Show commitment and bindingness by considering stakeholders' objections to some extent in planning (modifications)	☐	☐	☐	☐	☐
2j) Ensure transparent decision making	☐	☐	☐	☐	☐

Economic benefits	Not relevant at all				Absolutely essential
3a) Ensure local benefits / benefit sharing (e.g. by offering financial participation models)	☐	☐	☐	☐	☐
3b) Provide sufficient individual compensations (e.g. direct payments to compensate for devaluation of property)	☐	☐	☐	☐	☐
3c) Provide sufficient compensations to local municipalities (e.g. direct payments, sponsoring of facilities / parks, etc.)	☐	☐	☐	☐	☐
3d) Clearly argue and communicate socio-economic benefits (line might be disadvantageous for locals but advantageous on national / international level)	☐	☐	☐	☐	☐

Organizational readiness	Not relevant at all				Absolutely essential
4a) Conduct a stakeholder analysis to identify relevant stakeholders (citizens, action groups, NGOs, politicians, etc.), their opinions and needs and develop strategies how to deal with them	☐	☐	☐	☐	☐
4b) Ensure proper qualification and training of TSO staff that deals with stakeholders (communication skills, conflict management skills, etc.)	☐	☐	☐	☐	☐
4c) Deploy sufficient resources (budget, staff, time) for dealing with social acceptance (communication, participation, etc.)	☐	☐	☐	☐	☐
4d) Ensure proper internal / cross-functional (communication, technical planning, etc.) coordination and alignment	☐	☐	☐	☐	☐
4e) Foster the development of a 'social acceptance' orientated culture in your TSO organization	☐	☐	☐	☐	☐
4f) Ensure top-management support	☐	☐	☐	☐	☐
4g) Drive best practice exchange with other TSOs regarding 'social acceptance'	☐	☐	☐	☐	☐

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Stakeholder liaison	Not relevant at all				Absolutely essential
5a) Cooperate with and get support from independent institutions, initiatives, NGOs, politicians, etc. on international / national level	☐	☐	☐	☐	☐
5b) Win / Persuade local decision makers and opinion leaders (e.g. mayors, politicians, companies etc.) as supporters and multiplicators	☐	☐	☐	☐	☐
5c) Proactively empower local stakeholders (e.g. for supporting environmental impact studies, measuring EMF emissions, etc.)	☐	☐	☐	☐	☐

Technical planning	Not relevant at all				Absolutely essential
6a) Transparently evaluate and discuss technical alternatives that could avoid a new line (e.g. temperature monitoring, etc.) prior to the application process for a new line	☐	☐	☐	☐	☐
6b) Transparently evaluate and discuss several route alternatives prior to the application process	☐	☐	☐	☐	☐
6c) Transparently evaluate and discuss technical alternatives (e.g. HVDC vs. AC, cable vs. overhead, etc.) prior to the application process	☐	☐	☐	☐	☐
6d) Proactively test/pilot technical innovations that reduce impact for affected citizens (e.g. new pylon designs, etc.)	☐	☐	☐	☐	☐
6e) Avoid sensitive areas in route planning (densely populated areas, environmental protected areas, etc.)	☐	☐	☐	☐	☐
6f) Foster bundling of infrastructure (e.g. lines along motorways, rail lines, etc.)	☐	☐	☐	☐	☐
6g) Proactively deconstruct old lines	☐	☐	☐	☐	☐
6h) Overachieve regulatory technical requirements (e.g. EMF level, minimum distances to buildings, etc.)	☐	☐	☐	☐	☐

II. Trust

☛ **This section deals with the question how stakeholders' trust in your organization will develop in your future projects. Please indicate to what extent you agree with the following statements.**

	Strongly disagree				Strongly agree
7a) Stakeholders will rate your organization's degree of commitment to protect environment and people's health & safety higher in your future projects	☐	☐	☐	☐	☐
7b) Stakeholders will have less prejudices against your organization in your future projects	☐	☐	☐	☐	☐
7c) Your organization's reputation / image will improve in your future projects	☐	☐	☐	☐	☐
7d) Stakeholders will have more confidence in your organization in your future projects	☐	☐	☐	☐	☐

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III. Public opposition

☛ **This section deals with the question how public opposition will develop in your future transmission line projects. Please indicate to what extent you agree with the following statements.**

	Strongly disagree				Strongly agree
8a) There will be less protests / demonstrations against your future transmission line projects	☐	☐	☐	☐	☐
8b) There will be less legal inquiries / objections against your future transmission line projects	☐	☐	☐	☐	☐
8c) There will be less topics of conflict / controversy with stakeholders in the planning phase of your future transmission line projects	☐	☐	☐	☐	☐
8d) There will be less citizen action groups against your future transmission line projects	☐	☐	☐	☐	☐

IV. Basic information

☛ **Please provide some basic information about you (information will be treated anonymously).**

9a) What is your role / job title in your TSO organization (e.g. asset manager, stakeholder manager, public affairs, etc.)		
9b) For how long have you already been employed in your current department / field of responsibility?	☐ 10+ years ☐ 5-10 years	☐ 1-5 years ☐ 0-1 year
9c) For how long have you been already employed by a transmission system operator (also incl. employment years at other transmission system operators)	☐ 10+ years ☐ 5-10 years	☐ 1-5 years ☐ 0-1 year

Thank you very much for your cooperation!

Do you have any further comments regarding additional success factors or this questionnaire?

If you are interested in receiving the consolidated study results please provide us with your email address. We will keep it separate from this questionnaire to ensure anonymity.
Your email address:

Submit the filled questionnaire:

1. Save the filled form on your hard disk
2. Send saved form as email attachment to stefan.perras@mailbox.tu-dresden.de

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Appendix 16: Correlation matrix of formative indicators

	1a_STRAT	1b_EARLY	1c_JNEED	1d_DIREC	1e_COMIX	1f_COMPR	1g_SUFFI	1h_EDUCA	1i_POSTC	2a_PPOLL	2b_PPOSS	2c_PINFO	2d_MACRO
1a_STRAT	1,000												
1b_EARLY	0,575	1,000											
1c_JNEED	0,263	0,327	1,000										
1d_DIREC	-0,389	-0,240	-0,241	1,000									
1e_COMIX	0,513	0,454	0,381	-0,269	1,000								
1f_COMPR	0,257	0,232	0,539	-0,368	0,323	1,000							
1g_SUFFI	0,110	0,093	0,456	-0,271	0,189	0,438	1,000						
1h_EDUCA	-0,142	-0,233	-0,347	0,224	-0,066	-0,497	-0,435	1,000					
1i_POSTC	0,500	0,439	0,138	-0,331	0,401	0,107	0,167	-0,209	1,000				
2a_PPOLL	0,246	0,279	0,152	-0,100	0,156	0,159	0,202	-0,166	0,238	1,000			
2b_PPOSS	-0,489	-0,280	-0,169	0,443	-0,392	-0,137	-0,049	-0,034	-0,442	-0,236	1,000		
2c_PINFO	0,339	0,306	0,427	-0,277	0,125	0,236	0,243	0,000	0,232	0,259	-0,399	1,000	
2d_MACRO	0,456	0,541	0,184	-0,123	0,366	0,140	-0,070	-0,178	0,414	0,264	-0,194	0,251	1,000
2e_PRIOR	0,584	0,407	0,248	-0,309	0,369	0,208	0,249	-0,302	0,521	0,229	-0,428	0,255	0,437
2f_MODER	0,358	0,314	0,193	-0,322	0,386	0,268	0,201	-0,122	0,360	0,148	-0,263	0,113	0,181
2g_JFACT	-0,160	-0,174	-0,490	0,382	-0,216	-0,540	-0,427	0,496	-0,189	-0,095	0,187	-0,136	0,009
2h_FLEXI	0,384	0,334	0,483	-0,456	0,402	0,480	0,130	-0,299	0,287	0,115	-0,330	0,112	0,415
2i_BINDI	0,217	0,327	0,359	-0,264	0,163	0,339	0,109	-0,234	0,211	0,047	-0,272	0,302	0,431
2j_DECMA	0,170	0,297	0,514	-0,358	0,411	0,363	0,471	-0,247	0,106	0,126	-0,029	0,131	0,293
3a_LOCAL	-0,162	-0,039	0,065	-0,010	-0,043	-0,002	-0,027	0,029	-0,032	-0,479	0,131	0,090	-0,083
3b_INDIV	-0,042	0,192	-0,142	0,009	0,159	0,006	-0,071	0,004	0,138	0,109	-0,096	-0,211	0,016
3c_MUNIC	0,180	0,177	-0,113	0,009	0,045	-0,054	-0,150	-0,079	0,092	0,317	-0,260	-0,093	0,125
3d_SOCIO	0,401	0,419	0,650	-0,253	0,492	0,426	0,257	-0,318	0,227	0,175	-0,193	0,299	0,387
4a_ANALY	0,475	0,397	0,270	-0,352	0,359	0,466	0,059	-0,068	0,262	0,217	-0,398	0,163	0,295
4b_QUALI	0,455	0,456	0,303	-0,344	0,449	0,367	-0,009	-0,126	0,378	0,309	-0,403	0,154	0,402
4c_RESOU	0,537	0,542	0,295	-0,360	0,398	0,399	-0,014	-0,214	0,249	0,098	-0,381	0,277	0,310
4d_COORD	0,363	0,283	0,475	-0,458	0,346	0,614	0,349	-0,386	0,134	0,160	-0,316	0,358	0,121
4e_CULTU	0,319	0,394	0,469	-0,338	0,345	0,596	0,389	-0,375	0,226	0,080	-0,253	0,203	0,043
4f_TMGMT	-0,120	-0,043	-0,514	0,274	-0,224	-0,599	-0,448	0,390	0,091	0,110	-0,073	0,000	-0,154
4g_EXCHA	-0,323	-0,239	-0,202	0,444	-0,263	-0,353	-0,296	0,369	-0,182	-0,273	0,188	-0,019	-0,056
5a_COOPE	-0,509	-0,178	-0,245	0,276	-0,300	-0,250	-0,196	0,220	-0,203	-0,116	0,303	0,002	-0,293
5b_MULTI	0,394	0,224	-0,020	-0,192	0,125	-0,116	-0,201	-0,071	0,167	0,067	-0,470	0,040	0,148
5c_EMPOW	0,275	0,225	-0,095	0,073	0,126	-0,035	-0,050	-0,160	0,274	0,190	-0,104	-0,034	0,267
6a_AVOID	0,325	0,268	0,540	-0,068	0,467	0,121	0,330	-0,058	0,228	0,159	-0,190	0,245	0,314
6b_ROUTE	0,157	0,169	0,594	-0,145	0,359	0,227	0,461	-0,122	0,134	0,164	-0,133	0,368	0,285
6c_TECAL	0,219	0,277	0,531	-0,228	0,410	0,188	0,417	-0,067	0,126	0,162	-0,160	0,204	0,214
6d_INNOV	0,119	0,167	0,434	-0,350	0,326	0,414	0,111	-0,104	0,011	-0,044	-0,320	0,134	0,030
6e_SENSI	-0,038	0,156	0,148	0,035	0,161	0,248	-0,104	-0,299	-0,038	0,049	-0,013	-0,130	0,222
6f_BUNDL	0,276	0,276	0,207	-0,356	0,211	0,106	0,176	-0,066	0,147	0,215	-0,365	0,310	-0,040
6g_DECON	-0,060	0,086	0,231	-0,200	0,192	0,298	0,196	0,013	0,046	-0,166	-0,065	0,056	0,018
6h_OVERA	0,087	-0,076	-0,124	-0,055	-0,056	-0,115	-0,187	0,360	-0,089	-0,128	0,040	0,108	-0,152

2e_PRIOR	2f_MODER	2g_JFACT	2h_FLEXI	2i_BINDI	2j_DECMA	3a_LOCAL	3b_INDIV	3c_MUNIC	3d_SOCIO	4a_ANALY	4b_QUALI	4c_RESOU	4d_COORD
1,000													
0,179	1,000												
-0,175	-0,128	1,000											
0,198	0,299	-0,535	1,000										
0,362	0,045	-0,398	0,567	1,000									
0,239	0,299	-0,241	0,482	0,408	1,000								
-0,065	-0,170	-0,042	0,009	0,121	-0,052	1,000							
-0,169	0,335	-0,209	0,167	0,136	0,049	-0,278	1,000						
0,016	0,137	0,006	0,133	0,060	0,004	-0,603	0,479	1,000					
0,262	0,259	-0,229	0,395	0,367	0,419	-0,074	0,065	0,124	1,000				
0,234	0,417	-0,103	0,463	0,255	0,241	-0,121	0,082	0,172	0,371	1,000			
0,225	0,419	-0,282	0,602	0,368	0,284	-0,181	0,366	0,308	0,549	0,682	1,000		
0,448	0,291	-0,327	0,536	0,500	0,267	0,011	0,236	0,199	0,401	0,535	0,631	1,000	
0,313	0,295	-0,526	0,545	0,460	0,425	-0,030	-0,002	0,008	0,295	0,493	0,371	0,533	1,000
0,194	0,309	-0,705	0,538	0,395	0,333	-0,052	0,235	0,101	0,330	0,293	0,456	0,546	0,651
-0,141	-0,256	0,524	-0,434	-0,334	-0,473	0,045	-0,071	0,027	-0,529	-0,231	-0,411	-0,310	-0,477
-0,260	-0,258	0,288	-0,321	-0,185	-0,470	0,260	-0,170	-0,348	-0,275	-0,258	-0,284	-0,252	-0,409
-0,357	-0,397	0,173	-0,300	-0,127	-0,185	0,271	-0,010	-0,253	-0,436	-0,390	-0,287	-0,334	-0,331
0,303	0,153	-0,066	0,208	0,263	-0,002	-0,282	0,317	0,541	0,093	0,179	0,278	0,468	0,148
0,304	0,142	-0,077	0,127	0,173	-0,029	-0,359	0,225	0,520	0,092	0,052	0,143	0,300	0,107
0,391	0,209	-0,053	0,148	0,135	0,440	-0,112	-0,037	0,076	0,524	0,190	0,265	0,239	0,221
0,387	0,316	-0,229	0,313	0,296	0,605	-0,044	-0,139	-0,024	0,414	0,107	0,264	0,210	0,325
0,245	0,332	-0,094	0,234	0,233	0,651	-0,086	0,064	0,075	0,490	0,299	0,348	0,319	0,269
0,106	0,339	-0,300	0,312	0,217	0,302	-0,041	0,211	-0,003	0,415	0,470	0,519	0,512	0,417
0,000	0,196	0,034	0,129	0,050	0,187	-0,161	0,148	0,133	0,172	0,051	0,098	0,096	0,214
0,212	0,114	-0,250	0,241	0,276	0,319	-0,184	0,065	0,398	0,114	0,180	0,093	0,340	0,464
-0,128	-0,069	-0,158	0,252	0,316	0,398	0,077	0,054	-0,163	0,006	0,040	-0,059	-0,009	0,145
-0,242	0,044	0,121	-0,054	-0,132	-0,200	0,035	-0,032	-0,224	-0,081	0,128	0,072	0,017	-0,163

	4e_CULTU	4f_TMGMT	4g_EXCHA	5a_COOPE	5b_MULTI	5c_EMPOW	6a_AVOID	6b_ROUTE	6c_TECAL	6d_INNOV	6e_SENSI	6f_BUNDL	6g_DECON	6h_OVERA
	1,000													
	-0,534	1,000												
	-0,430	0,275	1,000											
	-0,244	0,463	0,318	1,000										
	0,069	0,011	-0,107	-0,351	1,000									
	0,123	0,030	-0,128	-0,287	0,424	1,000								
	0,094	-0,354	-0,072	-0,326	0,172	0,207	1,000							
	0,208	-0,479	-0,108	-0,200	0,066	0,047	0,697	1,000						
	0,176	-0,420	-0,208	-0,261	0,124	-0,007	0,814	0,705	1,000					
	0,383	-0,502	-0,089	-0,250	0,202	-0,118	0,402	0,353	0,506	1,000				
	0,180	-0,187	-0,105	-0,135	-0,003	0,006	-0,041	-0,001	-0,071	0,266	1,000			
	0,342	0,061	-0,494	-0,194	0,315	0,352	0,204	0,216	0,253	0,191	-0,008	1,000		
	0,159	-0,106	-0,047	0,239	-0,123	-0,075	0,088	0,029	0,155	0,141	0,123	0,127	1,000	
	-0,176	0,173	0,336	0,183	-0,019	-0,321	-0,144	-0,121	-0,026	0,009	-0,380	-0,203	-0,144	1,000

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Abstract

Europe requires significant transmission grid expansions to foster the integration of electricity markets, enhance security of supply and integrate renewable energies. However, next to lengthy authorization processes, transmission system operators (TSOs) in Europe are currently facing extreme public opposition in their transmission line projects leading to significant project delays. These delays imply significant additional costs for TSOs as well as society as a whole and put the transformation of the European energy system at risk. Existing scientific literature currently lacks comprehensive studies that have tried to identify generalizable success factors to overcome public opposition in transmission line projects. The goal of work at hand was to close this research gap.

Potential success factors were collected through extensive literature review and interviews throughout Europe with respective stakeholders such as citizen action groups, NGOs or energy experts. Experiences from analogue large infrastructure projects like wind parks, carbon capture and storage facilities, hydro dams, nuclear waste repositories, etc. were also used to form hypotheses. The findings were transformed into a structural equation model and tested through a questionnaire answered by almost all European TSOs.

Results revealed that people's trust in the TSO is of utmost importance for less public opposition. It can be regarded as the critical success factor per se. TSOs can create trust through stakeholder participation, sufficient communication, proper organizational readiness and liaison with stakeholders. Furthermore, appropriate technical planning can help to reduce public opposition in transmission line projects. In total 18 concrete and actionable success factors were identified for TSO management to facilitate the establishment of these aforementioned aspects. They will help European TSOs to reduce public opposition and thus accelerate the implementation of new transmission lines. Interestingly, economic benefits for people did not turn out to be a significant success factor in reducing their opposition against new transmission lines.