Wrocław University of Technology

Brandenburgische Technische Universität Cottbus - Senftenberg

11th EEEIC

International Conference on Environment and Electrical Engineering – Student Edition

Wrocław-Ostrava-Cottbus

7th - 12th of May 2012

Harald Schwarz, Przemysław Janik, Zbigniew Leonowicz,
Gono Radomir, Dirk Lehmann

co-sponsored by IEEE Poland and Czech Section

ISBN 978-3-940471-32-1

organiser / veranstalter

Wrocław University of Technology
Department of Electrical Engineering
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Walther-Pauer-Straße 5
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The German National Library – CIP

One of this publication is by the German National Library.

ISBN 978 – 3 – 940471 – 32 – 1

publisher / verlag

printing / druck

Technical University of Cottbus, Reprografie

comb-bound book / bindung

Buchbinderein Reinhard Kußagk Cottbus

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CHANGE FROM CONVENTIONAL TO RENEWABLE ENERGY SOURCES WITH REGARD TO GERMAN ENERGY POLITIC

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I. ENERGY SOURCES

"Energy Resources" is about ways of getting energy to generate electrical power. The term energy source is in the energy and power engineering chosen. Energy source in a closed system, the element which the energy usually is by conversion from another form of energy available, the energy source, however, is quantitative, balancing capable unit, which contains energy or transfers . Illustrate the leaves in the sun, which represents its core mergers with the main energy source for the earth and what their energy in the form of radiation (energy) provides. The useful energy sources on Earth originate mostly from the sun's radiation. The solar radiation can be converted directly (solar collector), mostly the use is, however indirectly, by an interaction takes place of the sun with the earth's surface an energy conversion (biological converted energy (wood, coal, petroleum), weather effects (wind, hydro) renewable energies and alternative energy called energy whose use is unlimited. The sources of energy are to remain measured for the human period, because they are continuously available, which in contrast to fossil energy sources and nuclear fuels is n

ot the case. Because their occurrence decreases continuously term renewable energy' is really unfortunate, as we will not renew the energies, but to convert existing, infinite energy use and thus can easily. The physics says that energy does not disappear but is transformed. The 'disappearance', of which we People often talk about, is thus rather a converted form of energy that is neither for us nor for the benefit of earth, perhaps even harmful. The concept of renewable energy is now in everyday life

Systems applied. In the nature of the ongoing processes taking place and energy is diverted by technical means for us humans, or our processes for the fulfillment of desire, the energy harnessed. This is called a rule, renewable energy.

By the following energy sources originate from the people of usable energy flows:

1. Radiation from nuclear fusion is the sun
2. Existing geothermal
3. Earth's rotation and tides

These energy sources for renewable energy to the earth in the form of sunlight and heat are hydroelectric, geothermal, biomass and wind power used. Renewable energies, also called alternative energy, is energy, whose use is unlimited. The sources of the measured energies remain for the human period, because they are continuously available, which in contrast to fossil fuels and nuclear energy sources is not the case. Because their occurrence is continuously decreasing. The term 'renewable energy' is really unfortunate, as we will not renew the energies, but to convert existing, infinite energy use and can thus easily. The physics says that energy does not disappear but is transformed. The 'disappearance' of the people we talk often, so rather a converted form of energy that is neither for us nor for the benefit of earth, perhaps even harmful.

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These energy sources for renewable energy to the earth in the form of sunlight and heat, are hydroelectric, geothermal, biomass and wind power used.

II. Transformation of World Energy Consumption

World energy demand is the amount of primary energy needed worldwide in the year. Currently the rate is 469 EJ (EJ) or 130 246 10^{12} Wh /per year (2009) [1]. The world demand for electrical energy accounts for about 17% of them from [2] In Germany, about 14 EJ in 2010 [3] (about 3,900 billion kWh) required primary energy. Of this total about 580 billion kWh of electric energy.

Currently around 85% of global energy demand is met by fossil fuels. The reasons for this are both technological as well as economic. According to the Copenhagen Consensus Center, the consumption of fossil fuels, rising despite the current efforts of climate policy in the coming decades. According to conservative estimates, the world energy demand will double by 2050 at least. This is a major reason that fossil resources will play until well into this century a large role in meeting world energy demand. [8]

Due to the limited fossil resources, the growing energy needs in developing countries do not close. Therefore, activities will be launched worldwide to develop new energy sources, renewable energies can still, even at current growth rates continue at the same time not replace the decline of fossil fuels and cause further increase in the amount of energy available. Therefore, as mentioned above, scenarios are also increasingly seen as critical.

III. 3. Renewable energy sources and problems

We're going to describe the main problems that arise from the use of renewables. One of the highlighted problems is landscape infrastructure. There are such kinds of places that we are not able to install our solar power panels. This places might be whether used areas by the public which having solar emission efficiency or high mountainous inappropriate areas which makes difficulties in installation.
This might belong to Wind power as well. Coastal and marine areas make have in avoidable disadvantages either. Wildlife should be considered here too. Exploitation of renewables have caused to extinction of animal life number of times so far (bats, other insects, birds).
Also connection of renewables to the power systems is well known problem by grid operators. Power quality issues come first in such situations. So that, it is a basic idea to keep the electrical powe parameter in indentified limits according to standards. It also interrupts an electrical power system to be operated symmetrically.
Coming to hydro power, we can say that, in many cases the dams cannot withstand to the pressure of water's potential energy and get destroyed. This causes undesirable floods, which makes huge amount of costs to be eliminated

However, today, in all over the world, the domestic consumption of Renewable power is lagging, mainly due to economic barriers, lack of legislative and regulatory framework and poor infrastructure.
While specific policies and regulations are recommended everywhere, it is also important for efficiency and effectiveness that communication and mechanisms for coordination/cooperation between ministries (i.e. energy, and environmental) and other related institutions be improved.
The private sector, which has the capacity to mobilize needed funds, must be motivated to participate in wind power and other renewable energy development. The process of liberalization, restructuring, and privatization in the today's energy sector is also vital; which will assist in creating a favorable environment for investment in wind power.

IV. German energy politics And Perspectives

The EEG (Erneuerbare Energien Gesetzte) deals with the power feed from the renewable energy sources and guaranties for the electricity producers fixed minimum retail prices. It considers the development of technologies for generating current from renewable energy sources.
The change from fossil fuels to renewable energy sources provides both duties and chances for German energy politics. The most important duty is the promotion of a balanced mixture of different renewable energy sources. On the one hand, this mixture is able to guarantee optimal utilization of neutral phenomena such as wind, tide, sun and others. But to relying on just one of the renewable energy sources is not comparable with nuclear power plants and cool plants in its efficiency. This is because of some renewable energy sources like photovoltaic and wind energy are not influencable by the humans.

Upgrading the German power grid is however extremely necessary and from essential importance to the further development of the renewable energy sources in Germany. For example it is very difficult to transport the generated energy from the offshore wind power plants to the southern or western part of Germany to the consuming factories. A possible solution is thinkable in enhancing the cross border cooperation in Europe. By doing this local problems could be solved.

While fossil and nuclear energy exist in stored form and are always available and can be used flexibly, a renewable energy system is largely dependent on meteorological and geographical factors.
German politics should invest in the research of storage technologies, as most of the regenerative energy sources cannot guarantee a constant and undisturbed supply with energy. But sometimes they produce more energy than it is actually needed.

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REFLECTION, ANALYSIS AND OUTLOOK OF THE WIND ENERGY IN GERMANY, POLAND AND THE CZECH REPUBLIC

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This paper shows the development and current situation of wind energy in Germany, the Czech Republic and Poland. After an introduction about the general construction of wind power plants the future development and the potential of its technology should be discussed based on an extensive literature research.

Construction;Wind energy; Feed-in tariffs; comparison; outlook

I. CONSTRUCTION OF WIND POWER PLANTS

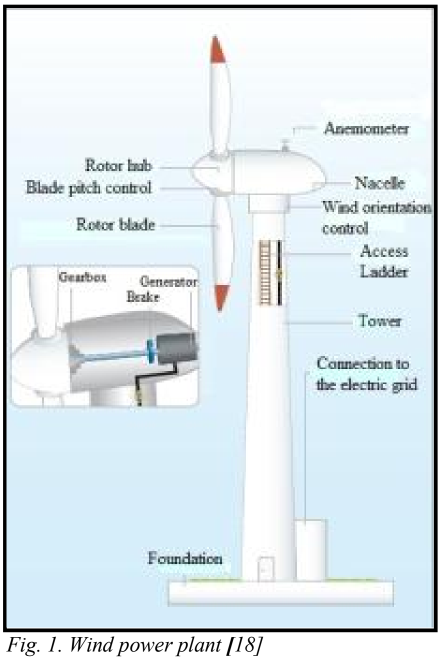

Fig. 1. Wind power plant [18]

The construction of wind power plants is in most cases similar and is as it is shown in fig.1.

Fig. 2. Wind power plant [18]

The first step is the installation of the foundation. Within this step it is important to pay attention to the particular condition of the soil. In offshore areas, this step is one of most difficult tasks for engineers. According to the level of requirement a distinction is drawn between different foundations [1], [2].

Once the foundation is build, the tower can be installed. The tower is necessary for the height of the construction, provides stability and has an interconnection and a feedback control system. Furthermore, concrete and lattice mast steel tubes are the main material used for building the towers. The steel tubes consist of 3 to 5 single lining segments. These single segments can have a length of up to 32m and a diameter of 4 to 6m on average. One tower has a total weight of 100 to 150t. A Tower in Germany has an average of 90 to 120m height, an installed plant capacity of 2,5 to 3,5 MW and a total weight of 320t [1], [11], [13], [16].

Each type of tower has advantages and disadvantages. For Example, concrete towers are cheaper than steel towers. Yet, they are heavier, thus the transport is mostly more costly and mode difficult. On the top of the tower the nacelle is attached. In most cases the nacelle is rotating and can orient itself towards the wind direction. Moreover, the core of the wind power plant is the generator. A generator and the gearbox is placed in the nacelle. The gearbox is connected with the rotor hub. The common type used for rotor hubs is the three-bladed turbine. With the help of a special system called Pitch control the rotor blades are able to change their angle of attachment depending on the wind direction. The blades are made of different materials. In most cases fiberglass, wood- and carbonfibre are used in the production of the blades [2], [3], [7], [12], [10].

A. Functionality:

The generation of wind energy essentially depends on the surface which is circled by the rotor blades, the cube numbers of wind speed and the air density. It can be calculated with the following formula (1).

$$P = \frac{1}{2} * \rho * A * v^3 \qquad (1)$$

<u>Legend:</u>
P = Wind energy [W]
ρ = Air density [kg/m³]
A= Rotated surface [m²]
v = Wind speed [m/s]

II. Wind energy and the problem of the based load

The Energy production from wind power plants fluctuates naturally depending on the wind supply. Compared to conventional energy production, the generation of wind power plants is not regulated by the load curve.
Fig. 2 shows in a raster (in 15 min. intervals) the feed-in power of a single wind energy turbine (blue), the feed-in power of a wind park (green) and the total feed-in of all wind power plants in Germany (red).

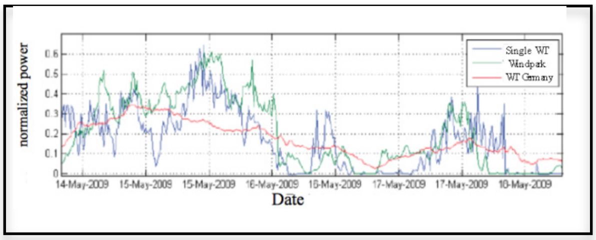

Fig. 2 raster (per quarter of an hour/ in 15 min. intervals) [17]

The growth of decentralized feed-in wind energy is becoming an increasing challenge for the integration into the power grid. This is partly due to the fact achieved that in some distribution systems, the installed wind power, the amount of the minimum load or above, and partly to the existing, constantly feeding in base load power plants [1], [15], [17].

§8 of the German renewable energy law obligates the network operators to give priority to renewable energies, accept it on a direct path, transmit and distribute it. At the same time, the operation plan of the energy power plants is carried out in accordance to the Day-Ahead-Procedure, which refers to the operation of the following day and replaced the concept of pro rata allotment in 2008 [5].
According to §11 any variation of the acceptance regulation and regulation of regenerative energy plants is only permitted if the grid in the concerned power grid area is overloaded through the supplied power (cf. §11 para. 1 renewable energy law.

The general problem which remains is the missing base load capacity and opportunity of load adaption.

The feed-in expectancy of the wind energy converters is based on the forecast and data given by the meteorological stations. Experience has shown that these data are often affected by errors. Despite the integration and allocation of these forecast errors through specific programs like the Intraday Redispatching in power plant schedules, the results for the forecast errors of 2006 show values of +5.8 GW and -6.8 GW in a 15 minutes-raster. Within these results positive forecast errors are predominat. A consequence of this is that additional controlling power ranges or power reserves have to be provided in the concerned period through conventional power plants. For the power plants it means that they have to regenerate as fast as possible full power from the part load operation. Consequently there are additional costs for transport and servicing because the plant components of base load plants are not designed for a rapidly changing output [15], [17].

This problem represents the future requirements for base load plants. Thermal power plants have to adapt, by the development of wind turbines, their mode of operation complementary to the wind generation. Studies have shown that the wind integration can be improved significantly by the modernization and improvement of power plant parameters, such as a lower minimum rate in the partial load operation, increased load change speeds and reduced minimum of operating and off time. So far in most cases a quick response to different wind power supplies is impossible because of technical restriction [1], [15], [16], [17], [18],

The continuing expansion of the wind power plants imply another conflict. If it can not be removed in the area in which it is produced, the installed capacity needs to be distributed throughout Germany and Europe. In 2005 the Dena published a grid study Aimed at exploring the necessary grid expansion. The results show that 850 km of the high-voltage and extra high-voltage grid have to be replaced by 2015. In November 2010 the Dena corrected the study and found out that a much bigger grid extension is required until 2020. This is, without storage of non-communicable performance, in case of using 380 kV AC lines about 3600 km and in case of using high temperature conductors about 1700 km. Besides the outbuilding to the pure on-and offshore wind power plants, the need for additional grid expansion from 2015 to 2020 is due mainly to the higher efficiency of future wind turbines. At European level the coordination of the grid extension in the European Union is carried out by the ENTSO-E. In 2009 a ten-year grid development plan was published, which provides new grid constructions of 35000 km and a grid extension of 7000 km in the European area. The focus is on the north-south connections in Germany, and connections for offshore wind farms in the North Sea, the grid expansion in Scandinavia and the connection between Spain and France over the Pyrenees [4], [15], [17], [18].

III. Support models

The different feed-in models are crucial factors for the support and importance of the EE in the energy production. In the following section the most important support models of renewable energies in Europe will be shortly introduced. Because of the limited scale of this paper, it is not possible to analyze and discuss them in depth. At the end of this section references about the entire topic are listed which can give further information.

A. System of minimum prices (feed-in models)

The core element of this model is the purchase obligation of power from renewable energy resources by the energy supply companies. Here, a fixed price is guaranteed.

B. Quota model

This model of the state of an amount (kw/h) or a fixed percentage of electricity from renewable energy, is provided by a group of actors who should be bought or sold. To comply with the respective amount of commitment, there are contract-awarding of certificates.

C. Tendering model

In this model prevails among producers of renewable electricity high competition. In individual bidding rounds a predetermined amount of quota will be offered. While maintaining the highest bidder after a temporary decrease in guarantee for the electricity they generated [16], [18].
Read more: [20]

IV. Comparison of the installed wind energy

A. Comparison of the installed wind energy in Germany, Poland and the Czech Republic

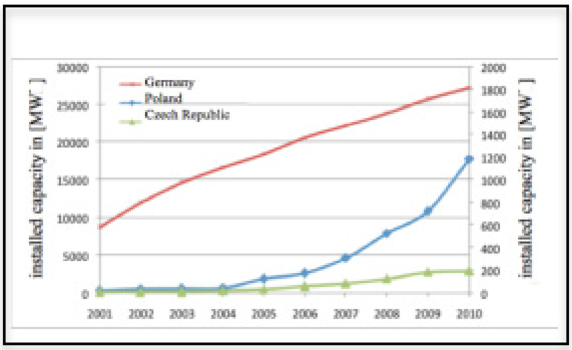

Fig. 3 cumulative installed wind power in Germany, Poland, Czech Republic from 2001 to 2010

Fig. 3 shows the development of wind energy depending on the installed power of Germany, the Czech Republic and Poland. The development of the installed wind power in Germany is illustrated on the left axis. The right axis shows the development of the installed power in Poland and the Czech Republic.
Within the last 20 years the installed wind power increased from 100 MW to almost 27000 MW in Germany. This rapid development was promoted and affected by the research and support program of the Federal Republic of Germany. At the beginning of 2011 the installed power of all wind power plants in Poland is about 1200 MW. Compared to the year 2009 this is an increase of 63 percent. In recent years Poland increasingly opened up the area of wind energy. Overall in comparison to Germany and Poland the wind energy potential of the Czech Republic can be considered as Average. At the end of the year 2010 the installed power of wind power plants in the Czech Republic was almost 180 MW. [6].

B. Reasons for the development

The differential development in the three countries had a significant impact on the national energy policy and will be analysed in the following.

Since the year 1991 the development of renewable energies and particularly of wind energy in Germany has been supported by the Electricity Feed Act (StrEG). In 2000 the Renewable Energy Act (EEG) replaced the StrEG. The aim is to increase the percentage of the regenerative energy supply in Germany to at least 30 percent and to even more than 50 percent by the year 2050. Thus the enormous development of wind energy is not surprising [4], [18].

In the end of 2004 the theoretical usable wind potential in Germany was 8-12 PWh. By then the Technology would have been able to produce 237 TWh. The actual use, thus the feeding into the grid, was only 10,5% of the technically possible potential of generating. This corresponds 25 TWh per year.
In Germany there are different levels of compensation rates for wind power plants. There is a difference between the level of compensation for energy generation on the land (onshore) and on the sea (offshore). The level of remuneration is depending on the income and set by a reference date. For wind power plants, which were commissioned until a particular date, there is an initial remuneration for a minimum period of 5 years. . Depending on the quality of location the feed-in remuneration is then reduced to a basic remuneration. At highly profitable locations the reduction of the remuneration is carried out directly after the period of five years. At locations with weak wind strength a payment of the higher remuneration rate is guaranteed for a longer time. For every derogation of 0.75 percent from the state reference day, a 2-month extension is granted. Moreover the remuneration rate for new plants depends on the calendar year in which the plant was first operating. For wind power plants, which went into operation after the 1st of January in 2010, an obligatory remuneration reduction of 1 percent p.a. is valid [4].

Example of a calculation for one wind energy converter:

(1) State reference value: 6300 MW/h
(2) Expected feed-in capacity: 6500 MW/h
(3) Relative ratio: (2) ÷ (1) =103 %
(4) 150% reference: 150%- 103% = 47 %
(5) Extension of the starting remuneration: 47÷0,75 =62
*(6) 62*2 months = 124 months*

Tab I. sample calculation wind energy converter

feed-in tariff	Cent/KWh	Time in years
starting remuneration	9,02	5
extension of the starting remuneration	9,02	10,3 (124 Months)
base remuneration	5,02	5

If one compares the political support and the remuneration concept between Germany and Poland, differences can be found.

Compared to most of the EU countries in Poland there is no possibility to receive directly a feed-in remuneration for power of wind power plants. The polish model is based on a mix of the amount of power and the profit from CO_2 certificates. First of all the generated power is regularly sold on the power exchange. Additionally CO_2 certificates are received, which are sold at a price fixed by the state. In total at current prices for power and certificates, it results in an even higher remuneration than in Germany [9].

Feed-in remuneration of wind energy in the Czech Republic: In the last few years the Czech Republic passed several new laws in the energy sector, as for example the National Energy Program, which contains fundamental aims for renewable energies by the year 2030. The law was passed to meet the condition of achieving the aim of 8 percent for the energy production from renewable energies by 2010.

As defined in the Czech energy law, only wind energy con-

verters and wind parks are supported, which cover an area smaller than 1 km² and have an installed capacity not exceeding 20 MW. Just like Germany the Czech Republic supports renewable energies through fixed energy prices and additional green bonuses. The energy regulatory authority calculates an energy lifespan of 20 years as basis for the amount of the remuneration for wind energy converters. Moreover the authority estimates a total investment of less than 1.481 EUR/kW$_{el}$ and a utilization of more than 1.900 kWh/kW$_{el}$ per year.
Similar as in Germany the basic remuneration is reduced by 2 to 5 percent every year. Production costs must be cut to react to decreasing feed-in remunerations and the increased competition.
Due to a missing long-term regulation for the feed-in remuneration for wind power, the development of the wind-energy use in the Czech Republic is still at it´s very beginning [5].

V. Wind potential of Germany, Poland and the Czech Republic by comparison

Germany, Poland and the Czech Republic differ in regard to their wind potential, the economic situation of the wind industry and hence the attractiveness to investors as well.

Up to the middle of the nineties most of the wind power plants in Germany were installed in coastal regions, because the local wind conditions of the coastal regions can most easily provide the economic use. In Germany the average wind speed measured as standard is 6 m/s and increases with rising height. For instance, on the North Sea coast the average wind speed increases from 6 m/s in 10 meters height to 6.5 - 7 m/s in 30 meters height. Due to today's standard mast heights of up to 120 m, wind speeds can be reached at non-coastal locations, which are similar to wind conditions on the North coast. Areas with good wind conditions in Germany are the coastal states, the coastal lowlands and the exposed locations of the low mountain range. Over the years wind power plants in Germany were more and more installed in inland areas and low mountain range areas. In the North of Germany the installed capacity per square kilometer is significantly higher than in the South. With 25 percent of the worldwide wind market the German wind industry takes the second place behind the United States in international comparison. The industry profits particularly from the export business. In 2008 the export rate of producers in Germany was almost 81 percent [5], [7], [18],

In recent years the Polish wind market became increasingly interesting to foreign investors. This development is not surprising: Compared to other European countries Poland offers good to very good wind conditions. Particularly the east coast of Poland has high wind speeds of up to 9 m/s. Due to flat landscapes there are also good wind conditions for the generation of wind energy in the inland of Poland. In this area wind speeds of 4-5 m/s can be observed. Because of some ridges of mountains in the inland there are increasing wind speeds of up to 7 m/s at some places. These ridges provide good locations for wind energy converters, because at these places the plants are located at a height of 20 to 50 meters [8], [9].

Moreover the general economic situation of Poland arouses the interest of foreign investors. Apart from the rotor blades of the wind energy converters all parts, like the power generator or towers of the plants, are imported from abroad. Investors, in particular from the neighboring countries, profit from this situation [9], [10].
The obsolete power network is the biggest problem and main challenge for Poland. This problem makes some investors more and more cautious. This caution is particularly shown with regard to the targets of the Renewable Energy Law, where Poland committed itself to cover 20 percent of the polish energy needs by regenerative energies until the year 2020. Currently there are only 7.5 percent of energy generated by renewable technologies. Poland has to invest massively in new power grids and transformer substations to achieve these targets by 2020. Thus a total modernization of the grid and a massive grid expansion is necessary to achieve the value of 20 percent [8], [19].

In the last years the Czech Republic passed several new laws in the energy sector as for example the National Energy Programs (SEP), which contains fundamental aims for renewable energies by the year 2030. The law was passed to meet the condition of achieving the aim of 8 percent for the energy production from renewable energies by 2010.

In the Czech Republic there are good conditions for the construction of wind parks in particular in the mountain areas Krusne hory, Jeseniky and Zdárské Vichy. One of the most suitable areas in the Czech Republic is the almost 400-kilometers-long mountain range of the Ore and Sudeten Mountains along the German-Czech and Polish-Czech border. In this area there are very good wind speeds of up to 9 m/s -7.5 m/s on average-. However, high grid connection costs must be expected in this region.
Within the Czech Republic wind conditions vary strongly. Suitable areas are often in landscape areas or nature reserves. Therefore the construction of wind parks is only allowed under strict conditions or even prohibited by law.
Just as in Germany and Poland the Czech energy grid also needs a fundamental modernization and further expansion.
Compared to Germany and Poland the Czech wind energy sector is economically rather uninteresting. The Czech government particularly focuses on the support for solar power plants and conventional generating plants [5].

VI. Conclusion and outlook

Finally a short summary, a conclusion and an outlook about the future development of wind energy will be presented. The introduction described the construction of wind power plants. Additionally, the main related problem of wind energy was discussed at the beginning of this paper. This problem affects particularly those countries, which attach greater importance to wind energy. Within the European integrated network Germany and Spain have the highest installed capacity. Due to the missing base load capacity, energy converters do not adjust to the consumer demand and the feed-in varies strongly. That is why the network operators need to invest a great effort and need to disregard the original intended driving style to keep the transmission grid stable. Meanwhile, conventional power plants should be able to withstand quick changes from part-load to full-load operation and vice versa. One reason for the lack of coordination is the slow proceeding expansion of the grid within the integrated network ENTSO-E. Germany, in particular, which wants to become a pioneer and wants to serve as an example in the area of renewable energies, is behind planning and expectations of the grid expansion due to bureaucracy and the growing resistance of the population. If Germany wants to achieve its ambitious objectives by 2050, it will inevitably need to invest a lot in the network infrastructure. However, even if Germany is willing to finance a rapid grid expansion, approval procedures for high-voltage power lines would today take about 10 years.

Finally a combination of renewable energies and the grid expansion must be found. There is no use, when Germany has an installed rated power of 50 percent from renewable energies, but only 25 percent can be fed due to the old power grid.

Over the last 5 years, from 2005 to 2010, Poland increased its installed wind power by 975 percent. A particular reason for this development is the interesting feed-in remuneration model, which generates a higher remuneration than in Germany due to CO_2 certificates and certainly the accession of Poland to the European Union in 2004. That is why wind energy in Poland becomes very lucrative for investors, especially foreign investors. However, there is a similar problem as in Germany: The power grid in Poland is also old and not suitable for the increased grid expansion. If Poland does not invest in the grid expansion, the investors could lose their interest in further investments into the area of wind energy converters in Poland.

There is a different situation in the Czech Republic: the Czech Republic focuses more on photovoltaic plants than on wind energy. This is not because of a missing potential for wind energy converters in the Czech Republic, but rather because of the Czech energy policy. The photovoltaic plants are heavily subsidised by the state. Thus the wind energy is more or less unattractive to investors. In Comparison to Germany and Poland the Czech Republic has not such good wind conditions. At areas with good wind conditions, like in the Ore and Sudeten Mountains, important tourism areas are located, which makes the construction of wind energy converters difficult for the Czech Republic. Moreover, within its energy policy the Czech Republic concentrates more and more on conventional power plants and particularly on nuclear energy, which is used mostly for the export.

This literature research about the current situation of wind energy in particular in Germany, Poland and the Czech Republic shows, that the European countries, specifically Germany and Spain, increased their efforts for a sustainable and green energy supply. With regard to the climate change and the Kyoto protocol lots of countries, including Poland, reorganize and fundamentally change their energy policy. Despite this positive trend important years still lie ahead to continue the current path of a clean and sustainable power supply. To pursue this course it is necessary to invest in the national and international grid expansion and the development of power plant types. The future of energy supply lies in the integration of renewable energies through modern and more efficient power plants. Thus an increased communication and cooperation between the European states is needed to achieve these aims, because it is not possible to manage this coming task alone.

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ENERGETIC REDEVELOPMENT OF RESIDENTIAL BUILDING STOCK

The heat insulation and a change of climate

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After years of experience and support, the making of wall insulations on existing buildings does not anymore seam to be the best choice. The unreflecting and fast spread of dubious solutions threaten the cultural heritage. The established way of thinking actually provokes vivid debates on principles that may finally lead to new dimensions of energy efficiency.

Keywords-component; Heat insulation; building stock; energetic redevelopement; monument preservation; architectural culture

I. THE BACKGROUND

Since the oil crisis in 1973 and 1979 and since the consciousness of a possibly anthropogenic global climate change was raising and since it was discussed that the resources of fossil fuel were limited, the political reaction towards these questions and so the effect on every single citizen has been rising. International treaties and directives have been made and become national law. There is possibly no area of our life, that is not yet touched by these circumstances. In my field, the architecture, this development is very important and demanding. Especially the building industry and the national directives of Energy Performance of Buildings are a direct link to people in their role as landlords, owners or leaseholders. Following the official arguments, emissions of greenhouse gas have to be reduced, regenerative energy has to be supported and therefore resources have to be saved. In Germany, as well as in other countries the existing residential buildings, which were designed under low standards of energy efficiency (about 70% of the hole building stock) are hiding a big potential of saving energy. To reach the required high efficiency standards, old residential buildings are frequently being equipped with so called Exterior Insulation Finishing Systems (EIFS) to lower the thermal energy loss through exterior walls. Besides, also roofs are being insulated, windows are being replaced, and the entire house technique of old building is being optimised. But what consequences cause these redevelopment actions for the ordinary, existing buildings? Buildings that were planed and constructed in many different ways, fulfilling many different specific physical requests of there individual situations. Buildings that were traditionally planed to store the energy of the sun inside their massive walls, to regulate the interior climate. Buildings, that last but not least are signs of a specific regional history and culture, not even talking about protected historical monuments.

Demanded max. overall heat tranfer coefficient (W/(m²K) for exterior walls

unt. 1977 (WVO)	1978 (WVO)	1984 (WVO)	1995 (WVO)	2002 (EnEV)	2004 (EnEV)	2007 (EnEV)	2009 (EnEV)
2,0-1,0	1,0	0,60	0,40	0,35	0,35	0,35	0,24

Figure 1. Chronological comparison of German heat insulation request, taking effect for existing residential buildings (touch upon u-value).

II. THE HEAT INSULATION THROUGHOUT THE HISTORY

The significance of heat insulation for residential buildings changed in the last 70 years from one extreme to another. In 19th century the main themes have been the strength and the stability of buildings. The first requests of heat insulation appeared in the 30th of last century, but still then, heat insulation and soundproofing were part of the last of 20 requests connected with the authorization of new building methods. For a long time the regulations for heat insulation just corresponded the thickness of a wall and had no scientific background. Because of the energy crisis in the 70th, the unit of heat-transfer (u-value) became a kind of magic number for the materials of the building envelope. Following regulations strengthened the trend to lower the transmission of thermal energy [1]. (cf. Fig. 1)

III. THE POTENTIAL OF SAVING RESOURCES IN THE STOCK OF BUILDINGS IN GERMANY

In a statement to the press published by Fraunhofer Institute of Building Physics (IBP) in 2011, the potential of energy safe in the entire German building stock is described:
Climate Change and rising prices for energy - that is why the industrial nations and with them the building industry have to take up a big challenge today. They have to reduce drastically their need for fossil fuel, to fulfil the lofty goal of reduction of CO_2 emission, formulated by the federal government (Bundesregierung) and the EU. 140.5 terawatt hours of electric power was produced by nuclear power plants in Germany in 2007. The potential of saving energy in the entire building stock is, in comparison, about five times higher. Altogether this would correspond to the power of 85 nuclear power plants. Around 35 l of heating oil per m² and year is consumed by single family house, which was build in the 50th and has not yet been redeveloped. (passive house standard: less than 1.5 l /m²a). According to investigations of Frauenhofer IBP, up to 80% of the costs for heating and hot water could be saved after appropriate rede-

velopment [2]. Unfortunately there is not yet a sufficient and loadable information about the real conditions of the efficiency of the entire building stock, nevertheless such vivid calculations are actually being made by numerous professional institutions before they are consumable in media.

IV. Different Methods of wall heat insulation for existing walls

Although for different specific circumstances exist different established systems, such as the Rain Screen Cladding (cf. Fig. 2) , the Cavity Insulation (cf. Fig. 3) or the Inside heat insulation (cf. Fig. 4), the EIFS (cf. Fig. 5) is still the most popular and convenient choice for investors in Germany and is unfortunately unifying almost all situations. All of these systems have their benefits and disadvantages, and each of them serve for different situations. The rain- screen- cladding reduces thermal bridges, lowers the temperature fluctuations and because of its ventilation cavity, the interstitial condensation is preserved. The system is still critical due to its unknown effect it may have on the existing building structure, but it can be called less problematic then unventilated alternatives like the EIFS. Among the established ways of heat insulation they are the solutions for buildings of, so to say, lower cultural value. These systems are hiding and distorting the existing building. The inside- heat- insulation, as well as the cavity- insulation find their field of application, in case of higher needs of protecting and conserving specific qualities of building appearance. These systems optimise the u- value of the building envelope in different ways, but also involve risks of building physics that are not inconsiderable. On the one hand, the inside- heat- insulation (cf. Fig. 4) leaves the problem of thermal bridges unanswered (wall/ceiling flashing) and apart from this the useable inside space is getting smaller. On the other hand, the infill of cavity- insulation (cf. Fig. 3) needs an existing hollow space inside the wall construction, which is not always given. The technical conditions and exact importance of old buildings wall cavities are frequently just unclear, that is how a variety of consequential damages may do harm to buildings.

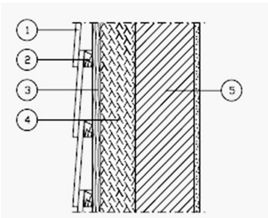

Figure 2. Rain-screen-cladding scheme. 1 exterior facade panels, 2 cavity for air circulation, 3 subframing, 4 PUR heat insulation, 5 exterior wall.

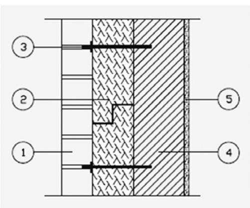

Figure 3. Cavity insulation scheme. 1 inside leaf of exterior wall, 2 PUR heat insulation, 3 wall fastener, 4 outside leaf of exterior wall, 5 interior plaster.

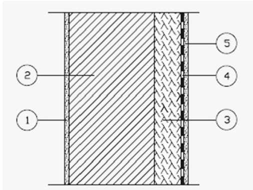

Figure 4. Inside heat insulation scheme, 1exterior plaster, 2 exterior wall, 3 PUR heat insulation, 4 drainage plane, 5 drywall.

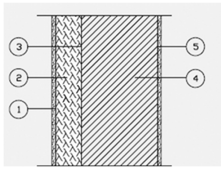

Figure 5. Exterior Insulation Finishing System (EIFS), 1 finishing plaster on reinforced ground, 2 PUR heat insulation 3 fixing mortar, 4 exterior wall, 5 interior plaster.

V. The way an EIFS is working and what are discussed benefits

As it is the most popular heat insulation system in the field of energetic rehabilitation in Germany, it makes sense to have a closer look on pros and cons of the EIFS (cf. Fig. 5). Reading advertising information of relevant companies and economy associations, the reasons that speak for EIFS appear complex, they touch upon structural physic of old buildings, the economical profit and the environment. Frequently the mentioned benefits first of all begin with the consumer saving of money and energy. At first sight, this seams logic, as the highly efficient insulation wall keeps the thermal energy inside, while the problematic loss of energy via transmission is being reduced. Thermal bridges are being avoided in this way, that the hole construction stays under the insulating shelter. Due to the warm exterior walls, the frost line is being kept outside the construction (cf. Fig. 6), which has various positive effects. For example, in comparison with not insulated exterior walls, unpleasant indoor drafts are being prevented (cf. Fig. 7). Apart from that also the dew point is being kept outside the exterior walls, which may prevent moisture inside the construction as well as harmful mould growth. Concerning the economic efficiency, it is often mentioned that the amortization of investment costs is fair and mostly finished after 10 years. Government aid in addition may back these assumptions.

VI. The discussed disadvantages of EIFS

Although the German energy efficiency directive (EnEV) was since the introduction in 2002 constantly accompanied by massive criticism of relevant experts, only now one has the impression that these objections finally reach the public perception. More and more critical reporting appears in media, which enable a deeper insight what effects the ironically called “current insulation delusion” may have on existing buildings and on peoples health. Contrary to the mentioned benefits, the real investment costs are often much higher than relevant companies and associations are advertising. Crucial, can be called the fact, that changes to the geometry of the façade often bring about the consequent need to change the roof construction too. Along with this considerable costs of special skilled workers are arising, as it is strongly advised not to self- practice such kind of sensitive interventions. Not even talking about modern, airtight double- or triple- plan windows, which are according to popular opinion another consequent need to make the new system more efficient and less prone to errors. “Already little implementation mistakes may cause a high state of damage”. This is the official statement, published by supporters of heat insulation against a possibly immanent physical weakness of the system, that is taking into consideration. Thermal bridges may arise concentrated and hardly comprehensible, water may gather inside the façade and will remain unnoticed for long time, mould growth may easily appear and will disturb the occupant health and safety. In the long run the state of building constantly deteriorates and with it the property and possible cultural value will decline too. But there are considerations that already lead to tangible results, which confirm, that there are immanent demerits of the system, which should not be underestimated. One of this points touch upon the special quality of an EIFS, that is connected with the comparatively low heat capacity of the façade. Former, traditional, solid walls are able to store the solar energy during the day, while they are emitting this energy during the night. That is why on traditional façades the accumulation of condensation is rather insignificant. As shown in Fig. 8, the surface temperature of the insulated façade falls under the dew point temperature during a comparatively long time. This surface moisture is dramatically encourage microbial vegetation, as it is visible on numerous facades in present Germany (cf. Fig. 9).

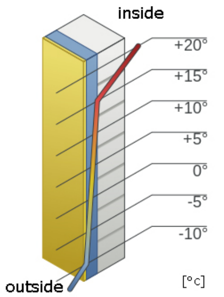

Figure 6. Scheme of temperature gradient inside EIFS wall

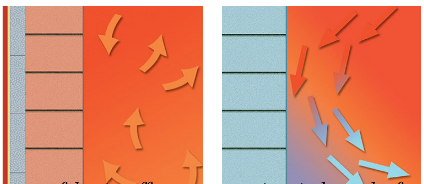

Figure 7. Scheme of basic effects concerning indoor drafts: (left) external insulated wall, (right) uninsulated wall

Temporal change of the wall surface temperature in comparison to the dew point temperature. Both walls have west orientation.

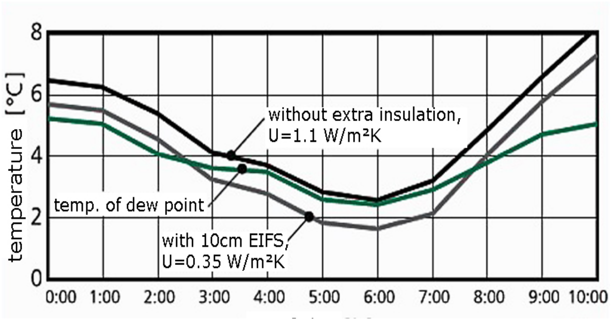

Figure 8. Algal growth on EIFS. The lighter dots are comparatively warmer insulation fasteners below plaster (left). Effect of warm air from the inside and condensing on cold EIFS, visibly above windows. (right)

Heat Energy consuption "Blauer Kamp"
5.066,90 m²- *living space*

season	nat. gas m³	(cons./m² liv.sp.) m³/m²
1988/89	80.119,00	15,81
1989/90	72.248,00	14,26
1990/91	82.509,00	16,28
1991/92	81.459,00	16,08
1992/93	82.671,00	16,32
1993/94	75.268,00	14,85
1994/95	75.814,00	14,96
1995/96	89.844,00	17,73
1996/97	74.903,00	14,78
1997/98	70.320,00	13,88
1998/99	69.341,00	13,69
1999/00	61.237,00	12,09
2000/01	67.384,00	13,30
Average consuption/m²		**14,93**

EIFS equipped since 1996/97

Energy consuption Trockener Kamp
6.623,60 m²- *living space*

season	nat. gas m³	(cons./m² liv.sp.) m³/m²
1988/89	77.287,00	11,67
1989/90	74.236,00	11,21
1990/91	86.272,00	13,02
1991/92	84.548,00	12,76
1992/93	90.479,00	13,66
1993/94	81.985,00	12,38
1994/95	90.172,00	13,61
1995/96	109.035,00	16,46
1996/97	83.575,00	12,62
1997/98	83.294,00	12,58
1998/99	72.806,00	10,99
1999/00	67.519,00	10,19
2000/01	80.109,00	12,09
Average consuption/m²		**12,56**

EIFS equipped since 1994/95

Figure 9. Energy consumption before and after energetic redevelopment.

To moderate this unpleasant effect, biocides are added to façade paints, which are washed out by rain and have not yet known impact on the hydrologic balance. And currently appears another dubious aspect, that causes sensation. Investigations of the german tv channel “NDR Fernsehen” discovered in 2011, that EIFS Facades are possibly dangerous accelerators in case of building fire. Although frequently used industrial insulation materials such as polystyrol panels (about 80% market share) are being regarded as hardly flammable (according to german fire prevention class b1), during an experiment carried out on these panels, they cached fire after alarmingly less than 20 minutes. As consequences the fire may suddenly spread out all over the entire façade and from one flat or house to the other. Firemen who actually were confronted with such kind of fire dynamics, mentioned not to have seen such situations before. A last aspect, often appearing among critics of heat insulation systems, is a challenge posing to the skill to reach the generally accepted promise of high energy and money safe. In buildings where air density is at all costs to be kept, the humidity of the air is dramatically rising and so is rising the need to ventilate the heated indoor spaces. One can understand why before and after studies on the heat energy consumption of residential dwellings before and after energetic redevelopment are indicating no significant differences. The suspicion of such critics is, that the resulting energy safe is nowhere near as high as it was calculated before.

As shown in Fig. 10, in two residential dwellings energetic rehabilitations took place. The building called “Trockener Kamp”, is since 1994/95 equipped with an EIFS. The former u-value of the exterior walls is documented as 1.059 W/m²K, the after value as 0.408 W/m²K. The second building on the left called “Blauer Kamp”, is since 1996/97 equipped with an EIFS. The former u-value of the exterior walls is documented as 1.032 W/m²K, the after value as 0.454 W/m²K. The example shows how much distance is between a stationary established u-value, assuming constant temperature differences and the dynamical weather change, in reality. Calculating the exterior walls merely through u-value, i.e. the loss of heat energy per m² of wall surface, leads to the conclusion that efficiency improvement of about 50% is possible. As in the example “Blauer Kamp” from 1.032 W/m²K to 0.454 W/m²K. Looking at the consumption values of the dwellings called “Blauer Kamp” and “Trockener Kamp” one can not identify a resulting dramatic decrease. Prof. Fehrenberg points out, that the distinct influence on heat energy consumption is coming from the fact, that there are different cold winter. Apart from that he assumes, that before redevelopment took place, there must have been physical features of the wall which enabled similar efficiency balance like afterwards. Among other decisive circumstances, the solar irradiation on walls during the heat period hinders the energy transmission loss. Nevertheless such facts are not taken into consideration by the established calculation method. While doing this, a rigid weather is assumed, with temperature of constantly minus 10°C or even minus 15°C [3].

VII. THE INTERESTS OF HISTORICAL MONUMENT PRESERVATION AND REGIONAL ARCHITECTURAL CULTURE

Changing materials and shapes of innumerable, anonymous, existing buildings just by installing exterior insulation finishing has not only a deep impact on the individual architectonical quality but also changes the appearance of entire villages, cities and in the end of the cultural landscape. The popular opinion seems to be, that sustainable energy efficiency is equal to heat insulation, like it is demanded and supported by the government. The german building stock is actually being put on warm winter coat, only to undress in summertime. Industrial prefabricated uniformity removes regional diversity of architectural tradition. Regional specific building parts and details are covered by more and more opulent insulation packages. Houses swell as if suffering under mumps disease. Window openings are being distorted as they are becoming slits and roof geometries are being changed, unifying plasters, colours and covering [4].

This is how Prof. Theresia Gürtler Berger describes the serious worries which move numerous involved conservationists, architects and landscapers today. The most problematic circumstance seems to be, that several influential institutes and comities talk about huge saving potentials of the entire building stock, as if millions of houses would be of the same typology, age, material, location, size and state. As if just a few known parameters have to be easily adjusted to optimise an apparently homogenous majority of objects for low energy standard. Such suppression of the real diversity and the necessary individual approach dramatically endangers our cultural heritage (cf. Fig. 11).

But what is our cultural heritage more than our historical monuments? In his essay “The cybernetic priciple- the other method of energy efficiency ”, Prof. Günter Pfeifer, similar like Gürtler Berger, points out, that it is not going only about historical monuments. These buildings have a portion of only about 3% of the entire building stock. It is going about the architecture of the city. Always, the architectonical appearance of cities have been the expression and identity of their inhabitants. Constantly embedded in an unseen sphere, animated by the character of place, the natural landscape and the climate. Its rather subcutaneously perceivable existence is divided up and more or less hidden in the proportions of the buildings themselves and the open space between them, i.e. the surface areas created by streets and plazas, the colours and structures of a material. For many cities a sort of architectural acronym represents their particular architectural reality, and thus display a special connection. As examples there might be given the brickwork structures of hanseatic cities, like Wismar, Stralsund and Rostock, with differentiating colours, shapes on walls, grounds and stairs[5].

Figure 10. Energetic redevelopment of a housing estate in Dortmund, Germany. Entrance of Kronprinzenstraße 129 before and after. The left side shows unpretantious ornaments and patina on the facade. On the right side the former charm is covered under insulation packaging and brick imitation.

Although the authors are valuing the present development in similar way, their conclusions are different. Two main positions are representing the actual area of tension in what the interests of historical monument preservation is involved today. While Prof. Gürtler Berger supports a more retrospective strategy, the position of Prof. Pfeifer is of a rather prospective kind. These positions are being in conflict with each other mainly in the way energy efficiency should be realized in existing buildings. As Gürtler Berger points out, changes on historical buildings have to be additive, reversible and appropriate to the existing substance. One should respect the functionality of buildings even with individual technical and physical limits. The focus should be more on traditional dealing with actual problems like the classical summer and winter use by differentiating several building zones. If old buildings are filled up with unsuitable high-tech installation, hidden and covered not to demolish the historical beauty, a deep loss may arise in the way a building becomes merely a façade. The alternative position makes clear, that every building above all should be seen in its individual context. Strategies to safe energy in buildings should be inspired by efficiency of nature and should be ecological related. Buildings should be flexible regarding the temporal changes of needs. As the building stock throughout the time was changed constantly, interventions in substance should not be impossible, as long as they are appropriate results of critical examination. For Prof. Pfeifer the problem of energy performance is not answered by pure heat insulation. The hole variety of ecological architecture strategies: to collect, to distribute, to store, to protect and to unload energy, should be projected on existing buildings too. Therefore a creative, interdisciplinary planning is needed, which examines the existing potentials under observance of each individual contextual situation.

VIII. Results

The future focus should be set rather on respectable analyse, planning and design. Architects, civil engineers and various other relevant experts should closely work together. Energy efficiency has to be interpreted much wider than it is made now. The individual building with its individual possibilities, inside its physical, regional and social context should be subject of more reasonable governmental directives and supporting. Means of bringing pressure and rigid thinking are rather unproductive and endangering the true aim. Apart from this, the following years will show what kind of impact the practiced egalitarianism of energy efficiency policy really had on the residential building stock.

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Figure 1

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Figure 2- 5

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Figure 8

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Figure 9

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Figure 10

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Figure 10

Foto: Alexander Pellnitz, Deutsches Institut für Stadtbaukunst, TU Dortmund

HYDROGEN-HYBRID POWER PLANTS FOR STORAGE AND RECONVERSION OF WIND ENERGY

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Part of the 11th EEEIC Conference Student Edition in Poland and Czech Republic in 2012.

Keywords-component; power supply; energy turnaround; wind energy; electrolysis; hybrid power plant.

I. INTRODUCTION

The constant and fast growth of the renewable energies in electricity production is accompanied by some problems, regarding grid stability and the security of supply. Reasons for this are for example the strong fluctuating feed-in of renewable energies and the geographical allocation between production and consumers. In this paper, we would like to introduce the technology of Hydrogen Hybrid Power Plants as an opportunity to compensate the fluctuations and contribute to an environmentally sound and sustainable power supply. Therefore a brief introduction into the current German power supply is given, before going into the technology and functioning of a Hydrogen Hybrid Power Plant. Afterwards the system will be explained on the basis of the pilot project of the ENERTRAG AG, put into operation in the end of October in 2011. The ENERTRAG AG supplies energy from exclusively renewable sources, mainly wind energy. Concluding, governmental projects and advises are mentioned, before finishing with a conclusion.

II. ENERGY SUPPLY IN GERMANY

During the last years, the German production of electrical energy went through a lot of changes. The main reasons for the development towards a renewable energy supply were the Renewable Energy Sources Act and the so-called “Energiewende” (Energy Turnaround). The Renewable Energy Sources Act (Erneuerbare- Energien- Gesetz, EEG) was replacing the Energy Feed-In Law from 1991 (in German: Stromeinspeisungsgesetz, StromEinspG) in 2000 and was revised in 2004, 2009 and 2011 [1].

The EEG assures a preferred feed-in of electrical energy produced by renewable sources into the grid, guarantees fixed minimum sale prices for the producers and allocates the extra costs to consumers [2].

The ”Energy Turnaround” was the reaction of the German government to the disaster of the Fukushima nuclear power plant in Japan in March 2011 and its unforeseeable impact on the environment [3]. After the reconsideration of the risks the decision to a step-by-step phase out of the nuclear energy production by 2022 was made [3]. Furthermore, the eight oldest nuclear power plants were shut down immediately. In June 2011 the federal government defined the further steps and long-term objectives in a key issue paper [3]. These were the general switch to renewable energy resources, greater energy efficiency and an environmentally sound and competitive supply [3]. Therefore the greenhouse gas should be reduced by 40% until 2020, by 55% by 2030 and by 70% by 2040 based on the reference year of 1990 [3]. To make a rapid expansion of renewable energies possible, the coordination between conventional power plants and electricity production by renewables should be optimized, to archive stability in system and supply, by generating power accordingly to the demand. To balance the fluctuation of renewable energies, the storage capacities should be expanded and the fleet of conventional power plants made more flexible [3]. To make a 35% share of renewable energies by 2020 possible, the storage possibilities and rapid grid expansions play a key role [3]. This opens great opportunities for a hybrid power plant, because new storage facilities will also be exempt from the normal grid charges. To make the grid expansion possible, a Grid Expansion Acceleration Act (Netzausbaubeschleunigungsgesetz, NABEG) shall be adopted to make the energy transmission from the power plants in the north to the electricity intensive industries in the south possible [3].

By following the principles of the EEG, the tariffs and investment security shall be improved and the windfall profits and excessive funding restricted [3].

Due to these influences into the market, the share of renewable energies in relation to the gross domestic consumption developed as shown in figure 1.

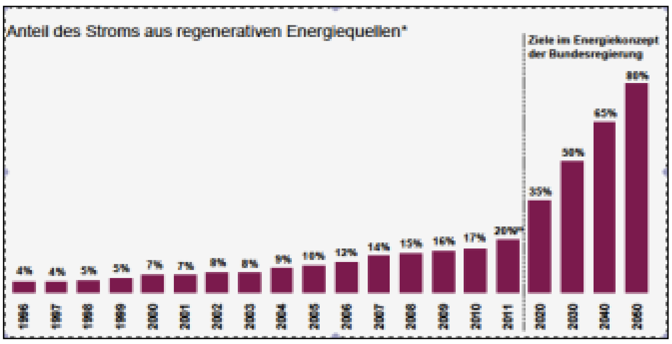

Figure 1: Share of electricity from renewable energy sources in relation to the gross domestic consumption in Germany [6].

The share of the renewable energies grew from 4% to 20% between 1996 and 2011 and is estimated to grow up to 80% by 2050.

The remuneration rates of the EEG rose from 1,2 billion Euros to 13 billion Euros between 2000 and 2010 and will be around 17 billion Euros in 2011 [4]. The extra costs of the renewable energies compared to fossil fuels and nuclear energy were 8,2 billion Euros in 2010 and will be approximately 13,5 billion Euros in 2011 [4].

	Ins-gesamt (1 000 t RÖE)	Anteil in %				
		Stein- und Braun-kohle	Rohöl	Natur-gas	Kern-energie	erneuer-bare Energien
2008						
Deutschland	132 488	37,8	2,3	8,5	28,9	22,4
Belgien	13 561	0,0	.	0,0	86,7	13,3
Bulgarien	10 060	47,9	0,2	1,6	40,4	9,9
Dänemark	26 537	.	54,1	34,0	.	11,9
Estland	4 217	82,1	.	.	.	17,9
Finnland	16 251	7,1	.	.	36,4	56,4
Frankreich	135 027	0,0	0,8	0,6	84,0	14,7
Griechenland	10 022	83,3	0,6	0,[illegible]	.	15,9
Irland	1 520	42,4	.	23,3	.	34,3
Italien	26 447	0,3	20,0	28,7	0,0	51,0
Lettland	1 784	0,2	.	.	.	99,9
Litauen	3 584	0,5	3,6	.	71,2	24,6
Luxemburg	84	.	.	.	.	100,0
Malta	.	.	.	.	.	.
Niederlande	66 319	.	3,3	90,3	1,6	4,7
Österreich	10 610	0,0	9,4	12,4	.	78,2
Polen	70 445	85,9	1,1	5,2	.	7,7
Portugal	4 441	0,0	.	.	.	100,0

Figure 2: Primary energy production in EU-27 [5].

As shown in the figure 2, the share of renewable energies in the primary energy production in Germany reached 22,4% in 2008 of an overall production of 132,488 million tons of crude oil equivalent (toe). Poland reached a share of 7,7% of an overall production of 70,445 million toe and Czech Republic a share of 7,6% of an overall production of 32,496 toe.

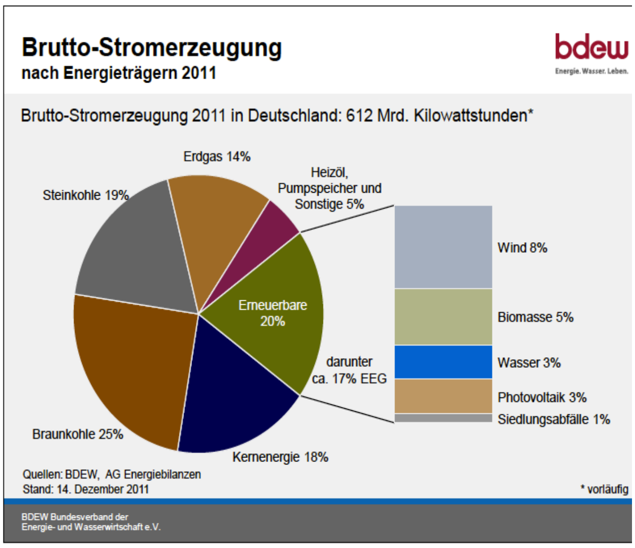

Figure 3: Composition of gross power generation in Germany [6].

As mentioned above, the grid expansion and security of supply should be maintained in its present quality. With an overall grid length of 1,8 million kilometres the German blackout times are still the lowest in all Europe[4].

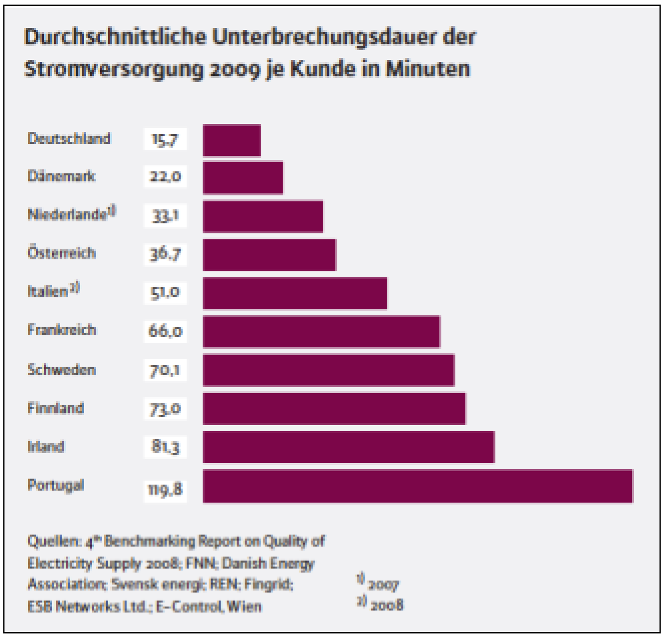

Figure 4: Blackout times per customer in minutes in 2009 [4].

The rapid shut down of the eight nuclear power plants had a big impact on grid stability and security [7]. The Federal Network Agency came to the conclusion, that the German grid situation especially in cold winter times would be more critical but manageable. Nevertheless, more frequently and deeper interventions in the market will be necessary to control the situation [7].

III. Wind Energy

Wind energy is a very fast growing energy sector [8]. But not every location has wind resources that are strong and steady enough for exploitation [8]. Wind energy is hard to predict and fluctuates with the different seasons, years and times of the day [8]. The power grid can only absorb to a certain degree, making storage of wind energy very important [8]. The ENRTRAG Hybrid Power plant has a mode dedicated only to predict the fluctuating wind, called the Wind Forecast Mode and is able to regulate up to a power of 500 kW [9].

A. Technology

The most commonly used configuration of a wind turbine uses a horizontal axis, three-bladed rotor and an upwind orientation [8]. The main components are a low-speed shaft connecting the rotor to the gearbox, a speed-increasing gearbox and a high-speed shaft connecting the gearbox to an asynchronous generator [8]. The generator usually operates at a voltage of 550-690 V (AC) [8]. The main components and the design can be seen in Figure 5.

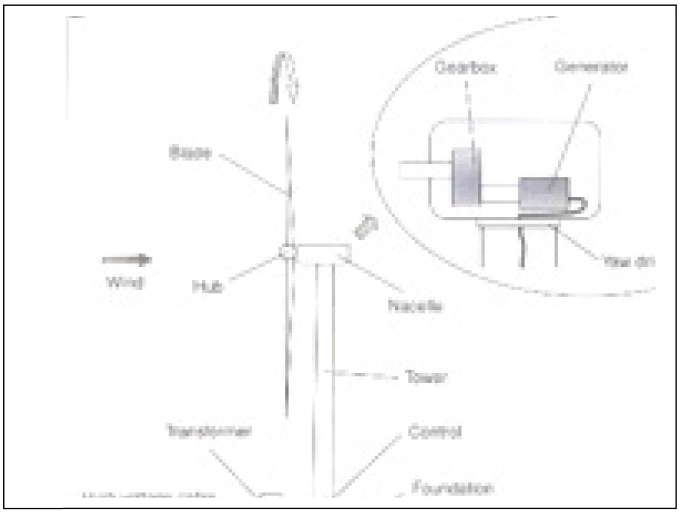

Figure 5: Wind converter [8]

Some turbines feature a second, smaller generator to improve production in times where wind speed is low [8]. In addition, each turbine is equipped with a transformer to increase the voltage to the on-site collection system voltage of 25 to 35 kV [8]. The ENERTRAG Hybrid Power Plant uses three Enercon E82 wind turbines with a nominal power of 2 MW, which are directly connected to the electrolyser [9].

Figure 6 shows that the power production from a wind turbine depends on the wind speed [8].
This relationship is defined by a unique power curve, which is different for every wind turbine [8].

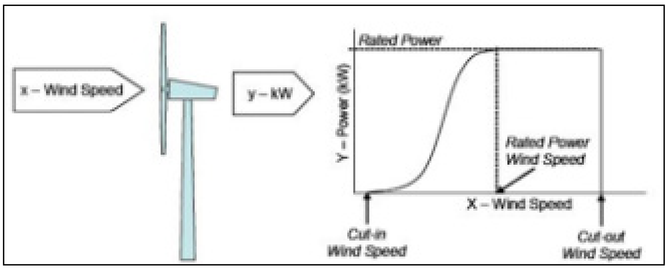

Figure 6: Power Curve [8]

Typical wind turbines start to produce power at wind speeds of about 4 m/s, which is called the Cut in Wind Speed [8]. They achieve their nominal power at about 13 m/s and stop production at 25 m/s, which is called Cut out Wind Speed [8]. Due to the changing wind speed, the turbine operates at continually changing power levels [8]. Turbines at locations with lower wind speeds usually have larger rotors than turbines at locations with high wind speeds to improve energy yield [8].

B. Electrolysis

Electrolysis is a process, where electrical energy and water are converted into hydrogen, oxygen and heat [8]. According to the reaction in Equation 1

$$H_2O \rightarrow H_2 + \frac{1}{2}O_2 \quad (1),$$

hydrogen, oxygen and heat are created by electrolytic water decomposition when an electric DC current is passed by two electrodes in water [8]. This is shown in Figure 7.

Water electrolysers have the possibility of a direct connection to renewable energy sources such as wind turbines, photovoltaic modules or hydropower stations [9]. In addition to this, electrolysers can act as adjustable power consumers and help to regulate the electrical grid [9].

As pure water is not a good ionic conductor, a conductive electrolyte must be added so that the reaction can proceed at a technically acceptable voltage [8]. The electric voltage applied to the two electrodes must exceed a certain value, called the decomposition voltage [8]. According to Gibbs´ enthalpy of water splitting that is at 1,23V given a temperature of 25°C

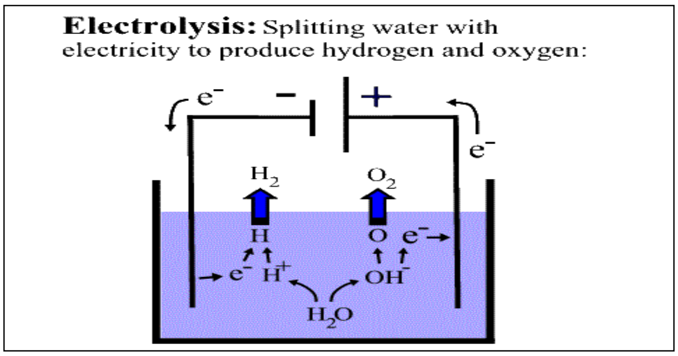

Figure 7: Electrolysis process [14].

and a pressure of 1 bar [8]. If the cell operates below the reversible voltage of 1,23V, no water splitting occurs [8]. Equation 2 $\Delta H = \Delta G + T\Delta S$ (2) expresses the required energy for the electrolysis reaction [8]. With ΔH being the enthalpy change, ΔG the change of Gibbs free energy, T the temperature and ΔS the entropy change [8]. Under standard conditions of T=298,15 K and P=1 bar, ΔH equals 285,8 kJ/mol and ΔG equals 237,2 kJ/mol. [8].

A water electrolysis cell consists of the cathode, anode and separator, while an electrolyser consists of multiple amounts of electrolysis cells or pairs of electrodes [8]. It is important, that the cathode is resistant to corrosion, a good electronic conductor and has good structural integrity [8]. There are two main design types of electrolysers: monopolar and bipolar. While a monopolar electrolyser has each of its electrodes fed by a separate current and has a single polarity, a bipolar configuration has each cell connected in a series and its current is fed to the end plate electrodes [8].

The core of the ENERTRAG Hybrid Power Plant is a 500 kW

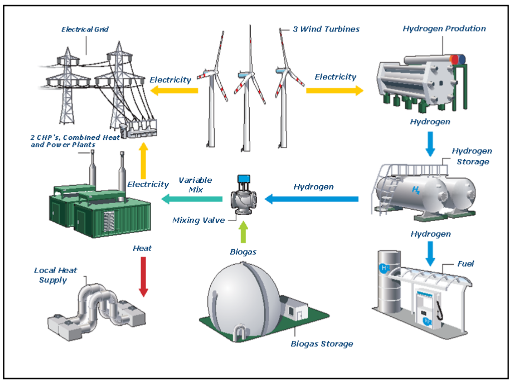

Figure 8: Function of the ENERTRAG Hydro Power Plant [9]

electrolyser, which is able to produce hydrogen, oxygen and heat out of wind energy [9]. In times of a low demand for wind energy it produces hydrogen, while maintaining a hydrogen purity of 99,997% [9]. The electrolyser operates at a pressure of 15 – 20 mbar [9].

C. Storage Methods

The storage of hydrogen can help to overcome daily and seasonal differences between energy availability and demand [8]. It can be stored in the form of gas, liquid, and a hydride [8].

As hydrogen is very light, and has a small density, a small amount occupies a large volume [8]. This makes it necessary to increase the volumetric density [8]. Depending on the materials of the storage tanks, they can be filled up to the pressure of 600 bar [8]. The stationary gas storage at the ENERTRAG Hybrid Power Plant is composed of five pressure vessels with a total storage capacity of 1.350 kg of hydrogen at a pressure of 31 bar [9].

IV. Function of the Enertrag Hybrid Power Plant

The hybrid power plant is based on four components:

1. Three wind power plants (ENERCON E82),
2. An 500-kW-pressure-electrolyser,
3. A compressor, which is connected to five pressure reservoirs,
4. Two block-unit heating power plants.

A. Overview

The three wind power plants (WPP) with a nominal power of 2 MW are connected over a medium voltage link with the medium voltage grid and the electrolyser [9].
If the markets energy demand is high enough, the produced energy will be directly fed in to the grid but if the WPP produce more energy than the grid can store, the energy is used for the production of hydrogen [9].

The electrolyser is able to produce 120 Nm^3/h hydrogen and 60 Nm^3/h oxygen which can be stored with a compressor in five pressure reservoirs, together they can store 1.350 kg hydrogen at a pressure of 31 bar [9].
With this technology the renewable energy is now able to be stored to use it when the energy demand is low [9].
The stored hydrogen can be used as a motor fuel for fuel cell-powered cars or it can be used to produce electrical energy in peak times when the energy demand is high [9].

To produce electric energy ENERTRAG combine the hydrogen reservoirs and the biogas reservoir
over a mixing valve, which is connected to two block-unit heating power plants (BHPP) [9]. This is necessary because the two BHPP need a gas mix of minimum of 30 % biogas and maximum of 70% hydrogen to produce energy.
Each BHPP has a maximum electric power output of 350 kW and a maximal thermal power output of 340 kW, the power output depends on the gas mix [9]. Together they can feed 700 kW into the grid and 680 kW can be used for district heating [9].

B. Operating Modes

It is possible to run the hybrid power plant in four different modes by means of controlled and monitored software:

1. Hydrogen production,
2. Base load,
3. Forecast,
4. Peak load (EEX).

1) Hydrogen Production

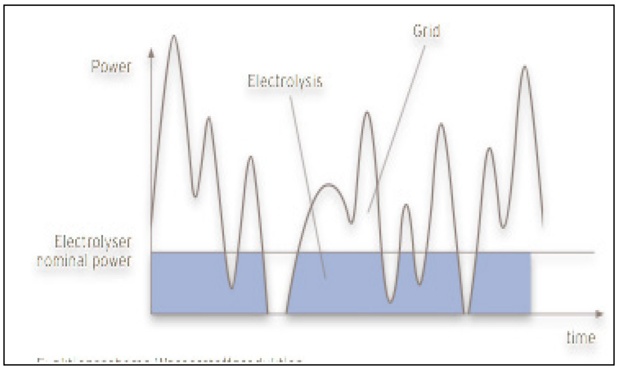

Figure 9: Operative schema hydrogen production mode [9]

In this mode the HPP is only used to produce hydrogen to guarantee a nominal supply of hydrogen [9]. The electrolyser is in use till the reservoirs are at maximum capacity [9]. At this point the electrolyser switches into standby and the no longer required energy will be fed into the grid [9].
With this mode it is possible to produce hydrogen for decentralized hydrogen issues, without producing CO2 [9].

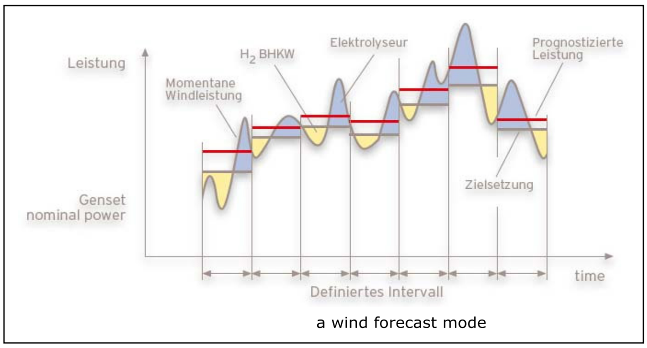

Figure 10: Operative schema wind forecast mode [9]

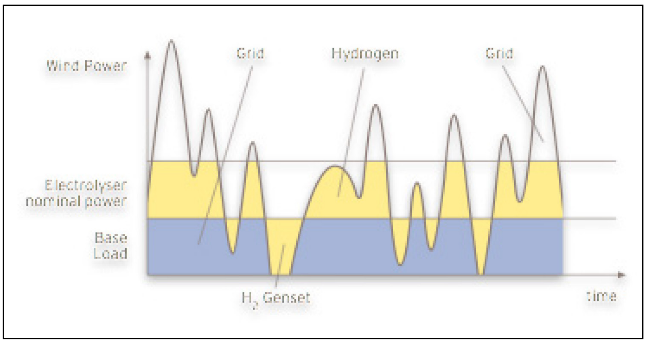

Figure 11: Operative schema base load mode [9]

2) Base Load

This mode makes the HPP able to adjust the wind fluctuations, which puts stress on the grid [9]. The goal is to produce a constant current of energy over a specific period like a base load power plant [9]. With this purpose the overproduced load of the WPP in windy times, is used to run the hydrogen production [9]. That has the effect that the not needed energy is stored in reservoirs and the grid is discharged of the wind fluctuations [9].

In windless times when the WPP don not produce energy, the stored hydrogen is used in the BHPP to adjust the power breakdown of the WPP and fit the goal to produce a constant specific current of energy [9].
The benefit of this mode is that it is possible to make a WPP base-loadable by means of an electrolyser and the BHPP. With these combination the load can be controlled like the power output of a base load power plant [9].

3) Forecast

The goal of this operating mode is, to be able to forecast the amount of wind power required to run the HPP [9]. This is based on an hourly wind power forecast, with the intention to in fed this anticipated amount in eight hours [9].
If the wind quantity is not the same as the previous forecast eight hours ago, the HPP is able to correct this fluctuation by producing hydrogen, when there is too much wind, or using the stored hydrogen in the BHPP to produce energy, when the wind quantity is too low [9].
This mode makes it easier for the grid operator because he has mostly an exact forecast of the WPP [9]. Also we have an effective use of the electrical power supply [9].
In comparison the HPP works like in base mode only that the capacity changes hourly [9].

4) Generation against peak demand or best tariffs

With this mode the operator can integrate the renewable sources into the market [9].
The production of energy in the BHPP is only running, when a certain minimum tariff level is attained (peak demand) [9].
Otherwise the HPP is producing hydrogen or in fed the generated energy directly into the grid [9]. It is possible that a forecasted constant power value can be held constant throughout a previously defined period [9].
The electricity market evolution is the main control parameter [9].

V. Research Project

The ENERTRAG hydro power plant is the first of its type and it is connected to the grid.
The purpose of the HPP is to explore how it can support the grid and how the production of hydrogen can be optimized for industrial issues.
It is important to optimise the efficiency of the electrolyser for an economic production [10]. One partner of the ENERTRAG AG is the University of Cottbus, which is building a hydrogen research-centre under the direction of Professor Dr. Hans Joachim Krautz [10].
He is the head of the power plant technology professorship and wants to build and explore a pressure electrolyser [10].
ENERTRAG is using a conventional electrolyser, which produces hydrogen with a pressure of 1 bar [10].
To store the hydrogen in the pressure reservoirs it has to be compressed [10]. This needs large amount of energy and is not economical [10]. With a pressure electrolyser it is possible to compress the hydrogen during the production up to 60 bar, so that it is not necessary to compress it afterwards [10]. The hydrogen production is also more efficient because the pressure electrolyser adjusts the fluctuating current of the WPP [10].
If the scientists of the University of Cottbus are successful with the research it will be more economical to invest in a hybrid power plant, which can make renewable energy base-loadable [10].

VI. Governmental Projects and Advises

The “Deutsche-Energie Agentur (dena)” is a public corporation with the purpose to give basic conditions for an efficient energy supply and to support new renewable technology.
“Power to Gas” is a project of the “dena”, which gives guidelines how the German government can fulfil the intention to generate 80% of the energy demand with renewable energy technology in 2050 [11]. The renewable energy demand depends on the weather conditions, which results in a fluctuating energy production [11]. To adjust these fluctuations it is important to find an efficient way to store the overcapacity [11].
One topic of “Power to Gas” is how renewable energy can be stored in the natural gas system and reservoirs [11].
The natural gas system can store renewable energy in a form of gas like hydrogen or synthetic natural gas [11].
Today it is allowed to store 5% of the reservoirs volume with hydrogen [11]. The dena is researching if it is possible to store 15% hydrogen in the reservoirs to enlarge the renewable energy storage [11].
The ENERTRAG HPP is a part of the research, it explores how hydrogen can be economical produced and stored [11].
The “Power to Gas” project recommended to optimise the hydrogen production and to use this technology as a new energy storage, which can be integrated in the existent natural gas system [11]. This is a promising technology to ensure a reliable, economical and environmentally friendly energy supply in the future, when fossil fuels become rare [10].

VII. Hydrogen as Fuel for Cars

TOTAL is one of the biggest oil and gas companies in the world and has interests to use hydrogen as a motor fuel [12]. With more than 1000 gas stations in Germany it is an important actor in the German energy market [12].

The company is a partner of the ENERTRAG Hybrid Power Plant cooperation and supports the research to produce hydrogen for industrial issues [12]. Because the production is running with wind power, the whole process is completely CO2 free and the hydrogen is more environmentally friendly [12].
To make it possible that cars can drive in the future with hydrogen it is necessary to have a good infrastructure of hydrogen gas stations [12].
TOTAL is already running two hydrogen gas stations in Berlin and one in Munich to test the system in the daily operation [12].
The HPP produced hydrogen can enable a secured supply at these stations in future [12]. Also the public transport company "Berliner Verkehrsbetriebe" (BVG) started a pilot-project with 16 fuel-cell busses in cooperation with TOTAL in the year 2008 [13].
All these projects to integrate hydrogen as a fuel gas makes it possible that the mobility in cities becomes more environmentally friendly, CO2 free and sustainable [12].

VIII. Conclusion

The Energy Turnaround in Germany requires the share of renewable energies to grow within the next years. This trend will lead to more wind, solar and hydro power plants, making it harder to predict future energy yields. With the electrical power grid already running at its limits and a big local discrepancy between power generation and demand, it is necessary to regulate excess energy. As The ENERTRAG Hybrid Power Plant is able to act as an adjustable power consumer, it helps to regulate the grid. Furthermore, the consistent electrical power supplied by the HPP helps to stabilize the grid and can provide a base load of electrical energy. Adjustable and flexible generation systems will become more and more important as the Energy Turnaround in Germany goes on. Hybrid power plants can contribute a lot to this cause by not only supplying electrical power, but also district heating and even motor fuel for electric cars. Due to on-going research projects, it is becoming more economical and efficient to produce and store hydrogen. This promising technology can ensure a reliable, economical and environmentally friendly energy supply and help to make renewable energy base-loadable.

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SMART GRID

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Abstract—**This essay is about the rebuild and future of the power grid. The potentials and research projects are be considered equally as the technical and political problems, which are ahead of us.**

Keywords-component; Smart Grid; Smart Meter; Potentials; E-Energy; Storages; Security; Standards; Data Privacy; Costs;

I. INTRODUCTION

While innovation and technology have dramatically transformed other industrial sectors. The electric system has continued to operate in the same way for decades, but the raising rate of the renewable energies require a redesign of the power grid. Therefore the concept of smart grid is developed in the last few years. Some of the elements are already installed in the grid, but there might be much more potential to increase the efficiency. In order to specify the potential and to figure out in which way the smart grid can be built and operated several research projects like E-Energy and web2energy were born, since a smart grid is related to a bunch of technical, economic and politic problems.

II. SMART GRID

A. *Why do we need to change the grid?*

Most of the world's electricity system was built over the last 40 to 60 years. The aging electricity infrastructure has to be modified due to new challenges, which came along with the increasing share of renewable energies. The higher share of the renewables is officially supported and required by law by the European Union and the government in Germany.

With the designated 20-20-20 targets by the EU they want to accomplish a decrease of the carbon dioxide emission by 20 percent, an increase of the efficiency by 20 percent and a 20 percent rate of the renewable energies till 2020 compared with 2005. The German government would like to go even further with a goal of 30 percent quota of the new energies. The renewable energies have reached 20 percent in Germany last year (see figure 1). That causes growing troubles in grid operation. Tennet for example, one of the four transmission system operators, had to make nearly thousand special adjustments on 306 days in 2011 to guarantee the network stability, which was 3 times more than 2010. The 50Hertz Transmission had to disconnect wind power plants on 41 days, 2010 only on six days. These two examples prove that everything from 20 percent share of the renewables and more set up numerous issues and therefore it has to be managed in a special way to remain the high reliability of the grid.

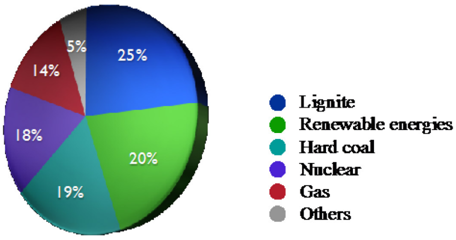

Figure 1: Distribution of energy sources in Germany 2011

B. *Definition*

An official definition of a smart grid does not exist. But in general it describes an intelligent grid aiming an active regulation of the power flow, which contains the communication, coordination and controlling between consumers, producers and storages to make the grid more efficient, more reliable, more secure and greener. [1]

One of the key elements will be a communication network like the Internet. The smart grid introduces a new way dialogue, where electricity and information can be exchanged between the utility and it's customers. Smart meter take over the communication, display and choice of tariff options. The concept is aiming, that the grid is managed to a certain point by itself by guaranteeing always a balance of generated and consumed power through communication between all participants in the electricity network. (see figure 2)

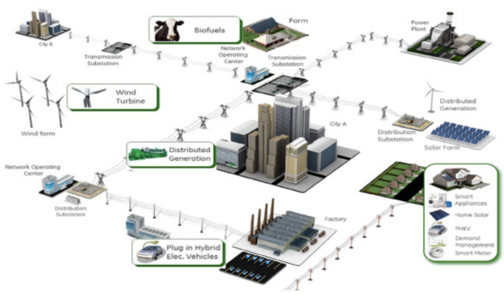

Figure 2: Infrastructure of a smart grid

The old grid contains few huge power plants (nuclear, gas, lignite, hard coal) and a one-way interaction. The power feed in the grid gets more and more decentralized with the increase of renewable energies. That implies there are much more little power plants such as wind turbines and photovoltaic systems, but a single one produce much less power compared to the classic power plants. The biggest problems for the network operator is on the one hand, that a photovoltaic or wind turbine is just partially controllable and one the other hand the grid has to deal with large fluctuations of the renewable energies in their power feed and with load flow reversals. Additionally they don't have the actual feed in of the new little power plants, so they have to work with weather forecasts to estimate the power feed and to schedule the classic power plants.

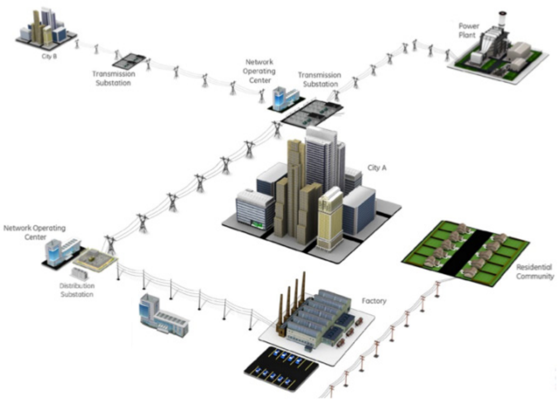

Figure 3: Old infrastructure of the current grid

In order to solve these issues they came up with the idea, that the power consumption follows the power generation, at least a little. Nowadays the power generation is based on the consumption that leads to an uneven load in the grid, i.e. peak loads at noon and load ales at night. Using the smart grid the load is partly adjustable in the future; thereby a reduction of the peak load is possible by shifting the peak load in the load valleys. This U-turn is a completely new way of thinking and operating our grid. As part of this new demand side load management variable tariffs will be launched, which are depending on the current load in the grid, to control the power consumption of the customers by the utility and to control actively the power flow in the distribution and transmission grid.

C. State of the Art

Overall, the technology is still in the early stages. Two things have to be done first. On the one hand a new communication network hast to be built in the existing grid by the network operators and one the other hand a high occurence of smart meter is needed.

Smart meters replace the old electric meters and they provide a communication interface between the network operator and the consumer. These devices allow the network operator to determine the power consumption automatically in short time periods (e.g. 15 minutes for consuming). When a photovoltaic system or other generators are installed it is necessary to get the information of power producing every minute. This allows to improve the forecast of the peak loads and to reduce them through financial benefits for the customer avoiding expensive peak loads, e.g. operating huge consumers in non-productive times (at night or on weekends). The customer gets a variable tariff, where the price varies continuously depending on the current situation in the grid. The consumer can also monitor his power consumption every fifteen minutes, which leads him to a better overview of his costs. Overall it is hoped that the awareness of consumers for their power consumption will be improved.

Another EU guideline regulates that the smart meter should be installed in 80 percent of the households in 2020. The installation of smart meters in Germany is required by law since the first January 2010 according to the Energy act (EnWG). But on the other hand the deadline for variable tariffs (30.12.2010) was eliminated in the newest version of the law. The other European countries are partly progressed much further when it comes down to the distribution of smart meter. 92 percent of the households in Sweden were equipped with them in 2009 and Italy has completed last year the comprehensive launch since they begun launching smart meter in the late 90.

Right now several IT companies like Cisco or Telekom express their interests to build the communications network and the devices in cooperation with the utilities. Cisco provides already several devices for pilot projects to develop and define standards. The IEC has already published nearly 300 standards related with smart grid appliances.

D. Potentials and Opportunities

The potentials and opportunities can mainly be find in three areas: security of supply, environmental sustainability and profitability. A crucial point for the society is to maintain the security of supply. It can be improved respectively maintained through enhanced monitoring of the grid. The profitability will increase due to price adjustments over the day, which can be get passed to the end user. Since the concept of smart grid is directly related with the renewable energies the environmental sustainability will be increased.

The energy supply companies get a great opportunity to increase their profits, because they can sell the peak loads to high prices. Therefore the peak load will be reduced, because of the financial benefits, which are provided through the usage of smart meter. A middle size energy company for example can save 326.000€ assuming 50.000 consumers with a consumption of 3000 kWh. The smart meter will be paid by the customers and they try to rollover the costs of the grid expansion either to the consumers or the governments. Smart meter could also offer the opportunity to change the energy supplier company on the fly in short time periods.

The potential for savings in the reduction of peak load by load management was estimated according to a simulation as part of a doctoral thesis at the ETH Zurich at about 17 MW at a summer day and 9 MW on a winter day in Germany (see Table 1). A VDE study estimates energy savings up to 10 percent. The Federal Network Agency evaluates the cost savings for a household up to 50 € per year. The precise and fast data acquisition of consumption and production of smart meters help to optimize the network operation.

The full potential of savings and load control is not available in the short term, because therefore a widespread distribution of smart appliances is needed. The current vision and long term target in the final stage is a Smart Home (see Figure 4). A smart home connects various appliances in a network, which includes different devices to control (smart meter with two way communication), consume (LED-Lighting), generate (PV) and store energy (battery). Such a Smart Home is mainly comfort, but it could become an active participant in the electricity market with prescribed rules. An implementation in the short term will not be appear, because nearly all communication interfaces and standards have not yet been determined and therefore only very few devices are on the market right now.

Figure 4: Final stage of smart home

Maintaining or even improving the security of supply is the most essential issue. due to increasing distributed power generators and associated power supply to ensure continued unknown. Thus, certain producers or consumers have to be switched off selectively or switched on step by step after a dysfunction. Likewise, supply disruptions, such as on 27.05.08 could be avoided in England. Over half a million homes were without power for about an hour. What had happened? Two large power plants and some smaller units in total 1714 MW were dropped in 2 minutes, the frequency dropped to 49.15 Hz, which triggered the under-frequency relays of the decentralized energy generators. That led to a failure of other 297 MW, which surprised the power company National Grid completely. The grid frequency was further decreased to 48.975 Hz. Smart meters would have helped on the one hand to determine the power feed, on the other hand they could've helped to stabilize the grid through selective load shedding.

III. Research Projects

A. E-Energy

E-Energy is the largest and most famous development program in Germany, which includes of 6 pilot project in which the implementation of smart grids is researched. It is supported by the German government with 140 millions euro.

eTelligence follows the approach of a virtual power plant, which is a system to compensate the fluctuation of wind turbines. A virtual power plant consists of consumers, producers and energy storages, which can be regarded as a regulated entity. It creates a regional, digital power market where the current is distributed intelligently. For example, in strong wind periods, a refrigerated warehouse is cooled more than the nominal value, the water in a swimming pool is heated more strongly compared to weak wind phases. The first results from the model region Cuxhaven have shown that the fluctuations of wind farms can be compensated because of the flexibility on the consumer side. Nevertheless it should be noted that the model region (Cuxhaven) was selected wisely since there are bulk customers, which are well controllable. What works well for a cold store to reduce the power consumption at higher prices is likely going to be difficult in other manufacturing industries.

E-DeMa examines the potential of energy savings for end users by being an active participant in the electricity market. The end user can decide by himself when he refers being a supplier or a consumer on the market. An internet based stock exchange helps to analyze and visualize the power consumption to bring producers and consumers together.

The practical effect of the future-oriented technology is particularly illustrated in another model region. **MeRegio** is working on a "Minimum Emission" certificate. Regions are counseled and awarded for lowest possible greenhouse gas emission and improved energy supply systems. Industrial companies with high electricity consumption are analyzing their single facilities regarding the electric power consumption. Therefore power hogs can be identified quickly and easily. An energy systems is also installed in 1000 households which was developed by EnBW to determine the energy consumption and to heighten the awareness.

The **Modellstadt Mannheim** merges several segments of the energy consumption (electricity, heat, gas, water) with a broadband powerline infrastructure. They trying to keep the distance between production and consumption as close as possible to avoid transport losses. Therefore the energy butler has been develop to realize it and to support the customers. Because another key issue is consumer acceptance. The use of the energy butlers was tested in twenty households. This small computer controlled various electricity consumers in households based on the electricity price and the wishes of the homeowner. It turned out that the inclusion of such a system was perceived by consumers as very useful.

The pilot project **Harz** has been finalized their one year analysis. It comes to the conclusion that this model region produce with the full use of renewable energies such as solar or biomass and the integration of pumped storage power plants more energy than it consumes. This result of the analysis may well be transferable to some other regions and illustrate what an enormous potential is behind of renewable energy in conjunction with a smart grid.

Smart Watts was launched in Aachen to develop standards for communication, interaction and controlling between household appliances from different companies. The EEBus was introduced 2009 on the annual E-Energy conference for example. The development of suitable hardware and the implementation were supported by several companies like Texas Instruments and LG Electronics.

B. Web2energy

While E-Energy already examined the various aspects of a smart grid in the six different model regions, the European Union came up with another research project, which is called WEB2Energy. Web2energy is a consortium of ten European companies led by the HSE (HEAG Südhessische Energy Ltd) and plans a three-year research project in Hessen. Hundreds of electricity customers and electricity production will be connected to a smart grid. The power consumer, whether a private home or a major customer, respond also flexibly to the current prices and regulate their electricity consumption on their own. Similarly, wind turbines, biogas systems, photovoltaic systems, combined heat and hydroelectric power plants connected together for load control, but in a different order of magnitude as in the individual regions of E - Energy.

Web2energy consists of 3 pillars: smart metering, smart energy management and smart distribution automation. The first meaningful results are expected in 2012. Overall, this project is funded with five million euros, 2.9 million euros will be contributed by the European Union. In comparison to the 140 million euros subsidy from the German Ministry for Environment and Economy, it is a very small project.

IV. Problems

A smart grid provides some advantages, but is also associated with problems.

A. Technical problems

The biggest problem currently are the non-existing energy storages. They have to be massively enlarged with the redesign of the grid regarding the renewable energies. The problem is, that all current storage technologies are too expensive to use them on large scale. The only energy storages, which are payable and uses in Germany, are pumped storage power plants. On the one hand they provide energy in peak load periods, but on the other hand they fill up the load valleys in the night. Several other ideas have been developed in the last years like buffering some energy in the batteries of electric cars to smooth down the load curve. Furthermore compressed air storage power plants and double layer capacitors are discussed. There are only two compressed air storage power plants, but they are geologically bound because they require hollowed out and airtight salt domes. Salt domes are especially present in the north, where the coming offshore wind power plants will need local energy storages. Another approach is the use of virtual power plants. A virtual power plant is a fusion of small power plants like photovoltaic or wind turbines and consumers in a well defined region. And with the combination of adjustable consumer and renewable energies a controllable grid operation is possible. These regions provide and manage their energy independently. When one virtual plant can not operate normally other virtual plants can help out.

Due to the new communication and information technology the vulnerability of the smart grid against hacker attacks increases, because the attack surface is much larger. In the United States (U.S.), where smart meter are already installed nationwide, the CIA confirmed 2009, that hackers mainly from Russia and China have attacked the U.S. power grid and got in. The goal was not to fail out the grid, but rather industrial spying. Another example is the computer worm Stuxnet, which has become known 2010. Stuxnet infected millions of windows computers with very smart and unknown exploits. And Stuxnet proved in an impressive way that such a worm can get in a highly secure and sensitive network and can attack industrial facilities. It had infected industrial plants with a Siemens programmable logic controller (PLC) around the world, but where he did no damage. Because his goal was the Iranian nuclear program. Stuxnet nestled in one of the Natanz enrichment facility and destroyed there, probably for months without being noticed, one thousand uranium centrifuges by manipulating PLC. It had changed the operation parameters, but showed the right values for the normal operation in the display. The newest exploits of PLC's occur in the beginning of 2012 when a group of researchers discovered and published serious security flaws in industrial control systems of General Electric (GE), Rockwell Automation, Schneider Modicon, Koyo Electronics and Schweitzer Engineering Laboratories, which are widely used in critical manufacturing facilities and critical infrastructure such as water, power plants, nuclear facilities or aircraft assembly lines. The exploits include even weak password storage which can be used to gain access to the systems and crash or manipulate critical devices or processes. And it gets even further. Because a large majority of the security holes were already known for years respectively decades, but the companies had simply chosen to live with them rather than do anything about them. And it looks like that the old products do not get any updates in the future, which can be taken as an open invitation for all hackers. The security problem is not very often discussed when it comes down to smart grid, but it might be very crucial.

Another problems are the missing standards. The International Electrotechnical Commission (IEC) had indeed published nearly 300 standards developed over the last few years. But firstly is that just the beginning, because much more standards are needed and secondly it takes minimum 5 years till these standards are built in some devices, because right now almost every manufacturer uses proprietary systems. And of course everyone wants as much as possible from their systems to incorporate into the standards, therewith the development costs of the future devices are as small as possible.

B. Political problems

The costs are the next huge issue, because everybody want to upgrade the grid to 21st century, but nobody want to pay for it. The financing aspect represent the biggest market barrier for the energy companies. The actual costs of building the infrastructure and network expansion can only be predicted. A study of TrendResearch estimates that the market will grow from 99 billion euro to 263 billion euro till 2030 in the studied European countries. The main costs come down to the grid expansion of the transmission and distribution grids with 115 billion euro, 46 billion for the communication network and 66 billion for the storages. And the energy enterprises try to roll-over these costs either to the customer or to the governments, which was proved with the launch of the smart meter. The costs for a single household of a smart meter are between 100 and 300 euro. But according to various studies the savings are maximum 50 euro. Whether the savings increase with the launch of smart appliances has to be seen.

And finally the data privacy is an issue, which has to be solved by the governments. Because some people are concerned about the collected data of the smart meter and what is going to happen with them. For this reasons area-specific privacy laws are needed to allay fears of personalized profiles by the grid operators.

V. Result

In absolute terms, the need for a smart grid is quite clear. Network operators see themselves against the problem that the current electric structure was not designed for a distributed generation. Therefore information and communication technology (ICT) will find their way into our power grid to compensate and mange the fluctuating renewable energies. In addition, an increase in efficiency is achieved through an effective load management, whereby the network operation can be further optimized. But probably the biggest obstacle to a quick launch in the coming years remains affordability and energy storages. There are costs for network expansion, building the communications infrastructure and energy storages. But energy storages have to be brought in to the grid, because the availability of electric vehicles, which could serve as energy storage, and corresponding charging stations is questionable. Furthermore, the development of open standards is essential, otherwise research and development will be thwarted. Another crucial aspect is way too much underrated and far too little discussed is the security of the new communication network. The legislator has to create conditions, for example, in data privacy, in order to complete the transition as quickly as possible successfully. On the other hand there are the consumers, who can indeed save power through smart meter, but the cost of the new meter technology exceed the savings.

In summary, it should be noted that smart grids will be introduced in the coming decades. This long process is needed primarily from the perspective of network operators to deal with the renewable energies in the power grid. Whether the customers pay extra at the end or is not yet clear, since it will depend on how much of the investment costs will be shifted to the customers.

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ENVIRONMENTAL AND ECONOMICAL ASPECTS OF GEOTHERMAL ENERGY IN EUROPE

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This paper deals with geothermal energy as a sustainable and clean method of using renewable resources in an appropriate way. Being one amongst many, there are certain advantages and disadvantages to discuss. Therefore economical aspects are as important as the environmental ones and the interaction among themselves.

I. INTRODUCTION

The power consumption of the earth has dramatically increased in the last 50 years. Future prospects show, that the energy use will be three times as high as today, caused by the continuous increase of the world population.
Contemporaneous there is a global climate change through heating of the atmosphere, caused by Co2 emission. That's why it is more and more necessary to rely on renewable resources. Renewable resources are not only significant to conserve fossil resources but to reach certain climate goals.
In addition to hydraulic energy, biomass, solar- and wind energy, the use of geothermal energy gains more and more a higher importance.

Geothermal energy is defined as heat from the earth. It is sustainable, clean and provides energy in a variety of applications and resources. There are two major contributors to this energy, the heat in the earth's interior and the heat energy from the sun. The sun influences the earth's temperature just to a depth of 10-20m. Below, the temperature is affected by the heat that is stored in the interior of the earth as a result of radioactive decay (80%) and planetary accretion (20%) [1].While the temperature at the surface changes with day-and nighttime and seasons, the temperatures in the depth are relatively stable [2].
The heat travels primarily by conduction from the inner to the outer layers and is estimated to be equivalent to 42 million megawatts [3]. It can be drawn from several sources like hot water and steam reservoirs deep in the earth. These sources are accessed by drilling. Moreover, there are geothermal reservoirs located near the earth's surface with a relatively constant temperature. Because of this variety of sources, it can be used in many different fields [4].

Geothermal energy is generally subdivided into deep (heat from the interior of the earth) and near-surface geothermal energy (heat from the sun). The near-surface geothermal energy is mainly used to heat or cool buildings.
A deep geothermal system on the other hand is used for drinking water heating systems, as process heat for industrial purposes and more. Technological advancements made it possible to use geothermal energy for electricity production too.
The usage depends on the needed temperature thus from the depth. The methods differ in a depth from about 400m and there are different types of drawing out of geothermal energy for heat generation. The most popular is the direct use, where the heat is directly produced from hot water within the earth. The use of the earth's shallow ground temperature for heating and cooling is possible with the help of heat pumps, because the temperature is too low for a direct use. The generation of the electricity from the earth's heat is a special case of using geothermal energy.
However, the depth-geothermal energy primarily generates electricity and heat for power plants, since this method is too complex to be used for cooling or heating individual buildings. In the following the direct use of depth geothermal energy for heat- and power generation will be the central issue [5].
The maximal amount of energy that can be gathered from the earth and the specific abstraction capacity only depends on the thermodynamic properties of the underground and it's independent from the construction of extraction systems [6].
Except for the Hot-Dry-Rock method the existence of water-bearing sedimentary structures is indispensable for the use of the Earth heat. These structures are called aquifers [1]. A geothermal system requires heat, permeability and water. It can be formed when water is heated by the earth's heat and hot water or steam traps in permeable and porous rocks. The geothermal water sometimes comes to the surface as hot springs or geysers but mostly it stays deep in the underground [3]. Only a few places around the globe provide these special conditions needed to generate geothermal energy profitably. These regions are seismically active [7].

II. SYSTEM OF GEOTHERMAL ENERGY EXPLOITATION

Geothermal energy systems differ according to the enthalpy, which is a measure of the total energy of a thermodynamic system.

Hydrothermal systems with low enthalpy use the water in the subsoil for supplying district heating networks. Most common is an aquifer, or groundwater reservoir, where water from 20 to 100°C is extracted by doublets, a system consisting of a discharge pump and an injection grout pump. This technology has been nearly perfected. After cooling the water it circulates in a closed circuit, the extracted thermal energy is fed in a secondary circuit (e.g. district heating networks). The cool water is recharged by injecting the same aquifer (to prevent potential precipitation). Temperatures higher than 100°C can also be used for generation of electricity [18].

Hydrothermal systems with high enthalpy are the steam- or two-phase-system.
Ascending magma from deeper layers produces steam, which can be transported to the surface by drilling. Afterwards this steam is used for generation of electricity. This technology is not common in Europe because of the missing geological terms and conditions [19].

Petrothermal systems use the energy stored in rocks. They can be divided into the Hot-Dry-Rock-System (HDR), also called Enhanced-Geothermal-System (EGS) (Fig. 2), and the system of using deep thermal ground probes.

The HDR-system uses the hot rocks as heat exchanger and therefore acts independently of water-bearing structures. With temperatures ranging from 150 to 200°C in a depth of 3000m, this system is primarily used for generation of electricity. The main principle is stimulation: with the help of pumping water into the rocks (Hydraulic Fracturing), artificial cracks develop in an area of several square kilometers and produce a heat exchanger. The water, inside the rocks, heats up and exits at the borehole again [18]. The HDR-system includes an impressive potential, because if 1km³ rock volume would be cooled about 20°C in a few kilometers depth and the extracted warmth would be used for electricity, this could be compared to a power of 10 megawatt per 20 years [20].

Deep thermal ground probes are only used for heat supply. Vertical heat exchangers are installed in boreholes and a heat transfer fluid (often ammonia) circulates through the probe in a closed circuit. This system can be applied in depths of more than 400m. It could be installed nearly everywhere, but the limitation of high investment costs make it more economical to apply it in locations, where there already is a depth drilling. The transfer surface is small (curved surface area of the drilling), which causes a lower output than other systems. Advantageous are the closed circuit, because it does not affect the equilibrium of the rock mass (no risk of precipitation), and the missing risk of not finding energy.

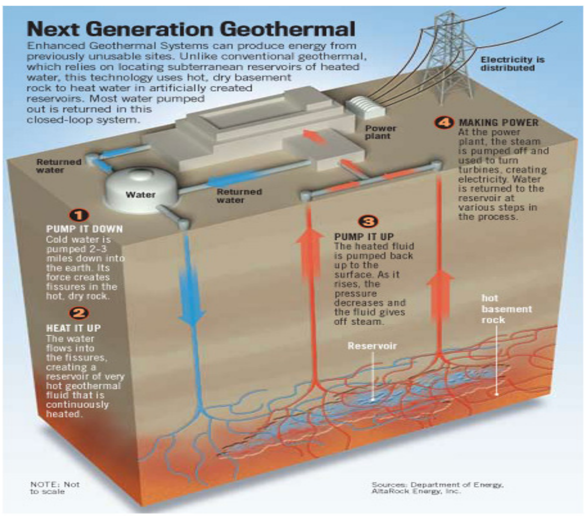

Figure 11. Enhanced Geothermal-System

Mines, caverns and tunnels should also be mentioned. They can be used effectively if there is a high pile of warm tunnel water (100l/s). The 12-24°C warm water has to be heated by application of a heat pump [18]. Switzerland is a representative of this technique and already produced an energy amount of 17MW with five plants since the 1980´s.

Comparision of geothermal energy in Germany ans other countries

In some regions of Europe geothermal energy plants already contribute to an environmental and sustainable energy supply.
The situation differs from country to country according to the natural resources. The spectrum is wide spread. It varies from power generation in Iceland, Italy, Greece and Turkey to the direct use of hydrothermal resources in sedimentary basins like France, Germany, Poland and Romania up to regions where no direct use is possible (e.g. Great Britain).
The highest temperature level (about 240°C) exists in Iceland, Italy and Turkey (Fig. 2) where the earth makes high enthalpy deposits available, because of volcanic activities. Geothermal power in Europe is provided mostly by Italy (5200 GWh/yr), followed by Iceland (1500 GWh/yr).

Although Turkey and Greece have a great geothermal potential, there are currently just a few geothermal power systems installed [8]. Areas with high temperature basins (160°C), which can be used to produce energy and for heating systems are located, beyond others, in some parts of Germany, Spain, Portugal and France. The other basins in Europe provide just a medium temperature and distribute only shallow geothermal energy.
The heat supply from geothermal energy is mainly achieved by using hot water from deep aquifers.

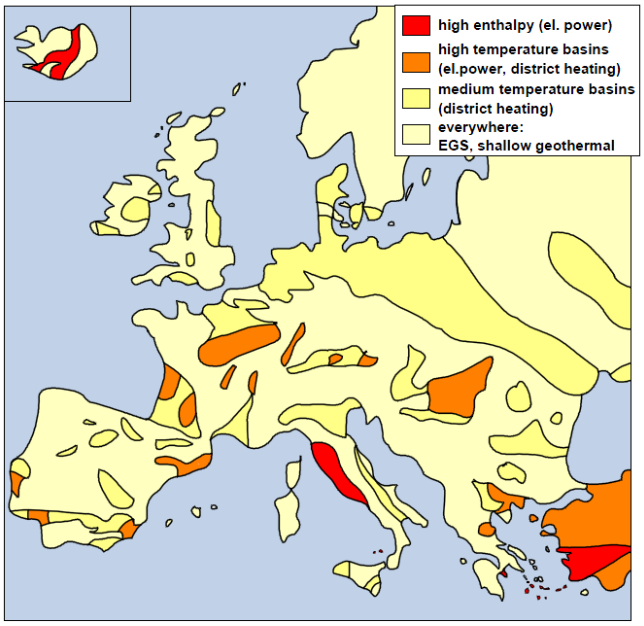

Figure 2. Main basins and geothermal resources of Europe

The most favorable geological conditions in Germany are situated in the areas of the North German Basin, the Upper Rhine Rift and the North Alpine Molasse Basin. Furthermore there are numerous small- and medium-sized geothermal heat

pump units [9].
While positive experiences has already been made with using heat from the Earth to provide it in these regions (about 450000 households), generating electricity from geothermal heat represents a far greater challenge. The relatively low temperature gradients in central Europe make deep drillings to over 3000 meters necessary to provide the minimum required temperatures of 120°C [10]. Nevertheless there are about 7700 households in Germany which are served by electricity from geothermal energy. That corresponds to an output of about 7 MW and 27 million kWh [11].
The first pilot unit for electricity generation was installed in Neustadt-Glewe in November 2003. Many other power plants are planned in southern Germany. The most advanced project is located in the Molasse Basin (Unterhaching), where heat generation is realized by the Hot-Dry-Rock method with a thermal output of about 36 MW and an electric energy of about 3,36 MW.

III. ECONOMICAL AND ENVIROMENTAL ASPECTS

The question about economic efficiency is nowadays more relevant than just a few years ago. Geothermal energy seems to be a reasonable alternative for accepted heating systems but is it sufficiently economic and what are the differences to other renewable energy sources?

A. Economical aspects

Regarding a geothermal energy project there are different cost types to consider. The most expensive part of a geothermal project is the drilling for geothermal heat probes in a depth about 80-100 m [12].
Heat pumps are not only more expensive than oil and gas burners but they are accompanied by cost of power. However, geothermal power plants incur high capital costs at the beginning of the project and are an economic disadvantage to conventional fossil fueled power plants in the beginning. That changes during the lifetime of geothermal power plants [13].
There are just a few publications or articles dealing with the economics of geothermal energy. It is widely known that a plant is just economical up to a temperature of 120°C.
But there are other aspects that influence the efficiency of a geothermal power plant. It is necessary to reach a high efficiency factor of the facility technology.
The power requirement for heat pumps and the re-cooling of the groundwater should be as low as possible to avoid financial penalties.

In Germany, the aspects mentioned above are supported by the Renewable Energy Sources Act (EEG), which makes Germany the world's first major renewable energy economy [14] and helped the green movement advance till the present day [13].

The objective is to speed up the market launch of technologies for electricity production from renewable resources as a central issue of climate protection and environmental conversation. The core element is the duty of grid operators to give priority to electricity from renewable resources and to pay for it according to fixed tariffs.
The tariff is mainly dependent on the technology used, the year of bringing the installation into service and the size of the plant [15].

Source: EEG

Output range of the plant	Remuneration in cents per kWh	
Up to 5 MW	15.00	8.95
Up to 10 MW	14.00	8.95
Up to 20 MW	8.95	8.95
Over 20 MW	7.16	7.16
Remuneration period	2007	before 01.08.2004

Electricity from geothermal power

Figure 3. Electricity from geothermal power

The feed-in tariffs have been continually optimized through constant evaluation and adaption to market developments. So, the EEG was revised in 2004, 2009 and in 2012. Since 2012 the tariffs amount 25 cent per kWh for the basic service. Furthermore there are some bonuses, e.g. for the use of petrothermal techniques (Fig. 4).
As a result the geothermal power generation will be advanced while the pressure to potential investors increases.

The fees paid for the use of geothermal power increased in the EEG from 2004 in order to support the geothermal power. In relation to the output range of the plant the fees change (Fig.3). Currently the degression is still about 1%, but according to predictions of the EEG it will increase to 5,0% in 2018 (Fig. 4).
Fixed feed-in tariffs are very effective instruments for the promotion of renewable electricity generation in the EU. According to German standards further 18 EU countries have introduced electricity feed-in tariffs [15]. The feed-in tariff in France is for example 20 cent per kWh for basic service [24].

Degression: 5,0 % ab 2018.
Vergütungszeitraum 20 Jahre

Jahr der Inbetriebnahme	Vergütung in ct/kWh	Vergütungserhöhung bei Nutzung petrothermaler Techniken
2012	**25,00**	**5,00**
2013	25,00	5,00
2014	25,00	5,00
2015	25,00	5,00
2016	25,00	5,00
2017	25,00	5,00
2018	23,75	4,75
2019	22,56	4,51
2020	21,43	4,29
2021	20,36	4,07

Figure 4. Degression future prospects (EEG 2012)

B. Enviromental aspects

To combat the global warming and other problems that are associated with fossil fuels, renewable energy sources become more and more important. Geothermal energy plays an important role, because it has the potential to offer the base load of power generation.
The geothermal energy exploitation is free of Co2- and flue gas emission. In contrary to fossil and nuclear energies there are no environmental impacts like transmission, storage and use of fuels [16].
Geothermal energy is considered to be a renewable resource

because the heat from the interior of the earth is almost limitless. But in fact it isn't really renewable but inexhaustible by human standards. In the long-term there will be a local cooling of the earth's heat, which is accompanied by a necessary reheating phase.
In contrast to other renewable resources, geothermal energy is omnipresent and available. Furthermore it is space-saving, inconspicuous and it has nearly unlimited potential. It is theoretically possible to transfer the energy into the district heating system.
But as with conventional energy production there are environmental issues to be considered. These are amongst others air polluting, through the release of toxic and foul-smelling gases, and the noise load while drilling.
The factor of geothermal energy exploitation that influences the environment the most is the danger of contamination of the groundwater. Drills and geothermal probes influence the sedimentary structures and the groundwater horizons, which lead to a danger in the area of geology and groundwater protection. Not only is the character influenced, but the temperature, too. The environmental consequences aren't investigated yet [17].
Furthermore the extraction of geothermal energy possesses a danger of causing subsidence and triggering earthquakes. In most cases the projects were successful but in 2006 [2] the geothermal power plant "Deep Heat Mining" in Switzerland caused an earthquake with the magnitude of 3.4 on the Richter scale.

IV. Perspectives, Future Prospects

In the past, geothermal energy had a bad start because of high costs and the loss of secureness to find energy. Furthermore, business competition (e.g. with biomass) complicated the development [21].
But today one can assume that the energy consumption will increase to three times in the next 50 years. Fossil fuels (coal, mineral oil, natural gas) will be used up and it is essential to intensify the focus on geothermal energy [18].
Not only because geothermal energy can be named as the only form of regenerative energy that is neither directly nor indirectly fed by insolation [22] but because it is safe and has a low-emission rate. Thus, investor´s confidence and governmental aid has increased in the past such as supporting research institutes and passing bills (EEG, Germany) [18].

Josef Daldrup, CEO of the Daldrup & Söhne AG stated in 2011, that currently there are many drilling projects in progress of realisation. "Der Geothermie-Sektor steht vor einem starken Wachstumsschub". Eng.: The geothermal sector is facing a strong burst of growth. Although the industry is still struggling with the consequences of the financial crisis, for the next few years a growth of the market can be reckoned [23].

This statement is supported by various ideas and concepts for the future.
One concept is the ambition of Norwegian researchers, who want to develop technologies, which can extract energy from much hotter layers of rock than up to now. With 400 to 500 °C hot steam ("supercritical water") the energy yield would be a multiple of the current use of geothermal energy in geothermal power plants. The applied system would be the hot dry rock method with the present restriction, that a possible change of the characteristics of the rock (could plastically deform) is still not analysed. Furthermore, the development of technologies to bore at a depth of 10 kilometers could last approximately 25 years. This leads to the economical aspect. The drilling is highly expensive, not to mention the advancement of the technologies [24].

All in all it is in evidence that the support of geothermal energy has increased in the past. Nevertheless it is inevitable to continue research and development work to decrease investor´s costs, to engineer new technologies, to low the risk of not finding energy and to also make geothermal energy asseccible in less favorable regions.

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CARBON DIOXIDE CAPTURE AND STORAGE (CCS)

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I. INTRODUCTION

Carbon Dioxide Capture and Storage is a method to capture CO2 emitted by fossil fueled power plants and save it in a secure location to prevent it from being released into the atmosphere and further accelerating the climate change.

II. TECHNOLOGY

A. *Post combustion capture*

After the combustion of the fossil fuel the CO2 is removed. The form of removing the CO2 is also called "scrubbing of flue gases". The CO2 is chemical combined with the washing liquid. With warmness you can split the pure CO2 and transport it to the geological storages. It is a well-known method but it is very expensive and the loss of efficiency is high. In add to this you need about the same dimension of the power plant to build the structure for this method.

B. *Oxy-fuel combustion*

The fuel is burned in pure oxygen instead of air. After this it is easy to split the CO2 and the power plant processes based on this method are without emissions, but the initial air separation step demands a lot of energy.

C. *IGCC (Integrated Gasification Combined Cycle)*

This method adds a wash of the CO2 before the combustion of the synthetic gas (pre combustion capture). It is very complicated and difficult to build.

D. *Geological Storage (geo-sequestration)*

This method implies the injection of carbon dioxide directly into underground geological formations. Generally the carbon dioxide is in supercritical form. Examples for these geological formations are exhausted oil fields or gas fields, you can extract the oil, deep saline formations, nondegradable coal stratums. The CO2 could be attached for millions of years and the storages could retain over 99% of the injected CO2 over 1000 years. [1]

E. *Ocean Storage(very risky)*

There are several concepts that include forms of carbon storage in the oceans.
Injecting CO2 by ship or pipeline into the ocean water (deepness of 1000-3000m) Using a chemical reaction to combine CO2 with a carbonate mineral to form bicarbonates
Store the CO2 in solid clathrate hydrates (generally on the ocean bed)[2]

III. USAGE OF THE STORED CO2

One of the most debate options for the utilization of carbon dioxide is the cultivation of algae. There are two ways for Algae cultivation, the plant breeding in open ponds or in a photobioreactor. A photobioreactor is a big closed diaphanous tube which provides a controlled environment. At present the scientist are searching for the best composition of „carbon dioxide supply, water supply, optimal temperature, efficient exposure to light, culture density, pH levels, gas supply rate, mixing regime, etc." and which algaes are sprouting and growing the most in this tubes to earn the most biomass. After this cultivation is following a concept with a very easy idea, you have to separate the algaes from the growth medium and extract the oil of the algaes. For this treatment exist two methods: The mechanical methods are further classified into the Expeller press and the Ultrasonic-assisted extraction and the chemical methods into Hexane Solvent Method, Soxhlet extraction and Supercritical fluid Extraction. The problems of all these methods are that the mechanical press generally requires drying the algae, which is energy intensive, the use of chemical solvents presents safety and health issues and the supercritical extraction needs high pressure equipment which is expensive and energy intensive, too. These techniques are very costly so they're not decent for the massive revertive transfomation into Oil.

Another point of the usefulness of CO2 is that the storaged carbon dioxide can be used to enhance oil recovery in mature oil fields. For example „Anadarko Petroleum Corporation will build a pipeline to inject CO2 in existing Salt Creek Oil Field for enhanced oil recovery. Anadarko has injected 5.12 billion cubic meters of carbon dioxide into the field." [8,9,10,11]

IV. CSS AROUND THE WORLD

A. United States

The United States is the most dynamic market as it has the highest number of projects in operation (four), in construction (three) and in development planning (18). CSS technology also receives significant government funding. CCS also continues to play a major role in Canada's carbon emission reduction strategy and therefore great efforts were made to advance the financial support base for projects and the policy regime. In June 2011 the Australian Government announced AU$60.9 million in funding to find suitable sites to store captured CO2 and develop transport infrastructure near major CO2 emission sources. The Government also expressed it's will to continue to progress other large-scale CSS Projects. Since the March 2011 earthquake and tsunami, Japan has revised its Basic Energy Plan which will likely rely heavier on fossil fuels and could include CSS. There is currently one project in development to demonstrate CCS which aims to capture more than 100.000 tons per year of CO2 for storage more than 1000 meters under the seabed. To support this, Japan CCS Co. Ltd is undertaking a 3D seismic survey and drilling a test borehole to identify and explore suitable formations for CO2 storage.

B. Germany

In Schwarze Pumpe, Germany, the first pilot-scale coal-fired power plant to integrate carbon capture and storage technology has been in operation from the middle of 2008. The initial testing program will run for three years and after that, the pilot plant will be available for others tests and is planned to be in operation for at least 10 years. Vattenfall will participate in the European research project “CO2SINK”. The project aims to develop the basis for the underground storage technology by injecting CO2 into a saline aquifer near the town of Ketzin. The European Union passed a directive in 2008 that CSS technology has to be made national law by June 2011. The EU wants to see 10-12 full-scale power plants demonstrating CO2 Capture within the the next few years. In September 2011, Germany's Bundesrat rejected a Bill that had already been passed by the German parliament in August and would have allowed testing for Carbon Capture and Storage (CSS) technology at former gas storage facilities. The failure to pass the law in the Bundesrat means that Germany could now be subject to proceedings by the European Union.
As a result, Vattenfall stopped their pilot project in Jänschwalde. Greenpeace is one of the many environmental groups expressing reservations. They say that the sideeffects of the storage are not yet fully explored and that the technology is used as a justification to build even more coal power plants because the problem of the CO2 is solved. The public in Germany, especially in the states of Lower Saxony and Schleswig-Holstein, has been protesting against the technology as they are concerned that the CO2 might leak out of the designated areas, poison the groundwater and damage animals living in the soil.

C. Poland

In Belchatów, Poland, a lignite-fired energy plant of more than 858 MW is planned to be in operation in 2013. It is funded with 180.000.000€ by the European Energy Programme for Recovery (EEPR). No others projects are planned as of yet.[3,4,5,6,7]

V. Evalutation

CCS is an innovative technology and could have a bright future if it would be possible to use the stored CO2. The first usage is the Enhanced Oil Recovery (EOR) but that is combined with a lot of Problems. The danger of the storage and the effort to hold the CO2 in the supercritical form is enourmous. It has to be controlled and monitored over more than thousand years which would be very expensive.

So it could be merely a solution if the scientists keep on searching for an utilization as a resource, for example to convert algeas into oil. But still there is no reasonable method for exploitation and it isn't a serviceable solution. Even with the use of CCS, fossil fueled power plants still emit large amounts of CO2 into the atmosphere and furthermore the storage of CO2 is not yet fully researched and dangerous.

So at the moment it is not possible to fully evaluate CCS as it is still in development, but it may turn out to be a very useful technology if the stored CO2 can be used.

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ALPHA VENTUS

The first German OFFSHORE-WIND PARK

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Abstract— **Offshore and not visible from the coastline, great hope is being placed on the use of wind energy without the restrictions found onshore, but with other significally greater challanges such as long distances, water depth and climate.**

Wind parks; Alpha ventus; RAVE; research; North Sea

I. Introduction

Because there are stronger winds in the ocean and a relatively small area is needed, generating electricity from offshore wind power is a very attractive proposition. However, organizational and technological requirements are much higher than on land. For example: long distance to the sea, the ocean depths to 40 m, the harsh climate of the sea, salty moist air, large temperature fluctuations, severe thunderstorms, squall, a wave of heavy loads must all be taken into account. For the construction of wind turbines at sea, proven systems engineering and management must all be adapted to the harsh conditions of the ocean. Not only the appropriate foundations and encapsulation for Nacelles and materials with long-term stability must be developed, but safe and economical integration of the electricity network must be implemented [1].

II. Milestone

The first German offshore wind park "Alpha Ventus" is at the same time, demonstration and research project. It consists of twelve turbines, of which six turbines of 5 megawatts (MW) Areva Multibrid (M5000) and six REpower 5MW turbines (Fig.1). Utilities Energy, EWE, E. ON and Vattenfall is working to raise Offshore surveys in the North Sea, 70 km from the German coast in water depths of 30 m (Fig.1). Federal Ministry of the Environment, which is sponsoring joint research on-site examination of all the actions consolidated under the acronym "RAVE" [2].

A. 25 Gigawatts by 2030

The 25 Gigawatts by 2030 wind energy in the foreseeable future will make the greatest contribution to the growth of renewables in the electricity sector in Germany. Offshore technology, as well as the repowering of the wind farm will become more important as a result. Federal Government's "Strategy for the use of wind energy at sea," is the purpose to rise the offshore capacity to level of 20 - 25 Gigawatts in 2030, what represents approximately 15% of German electricity demand [2].

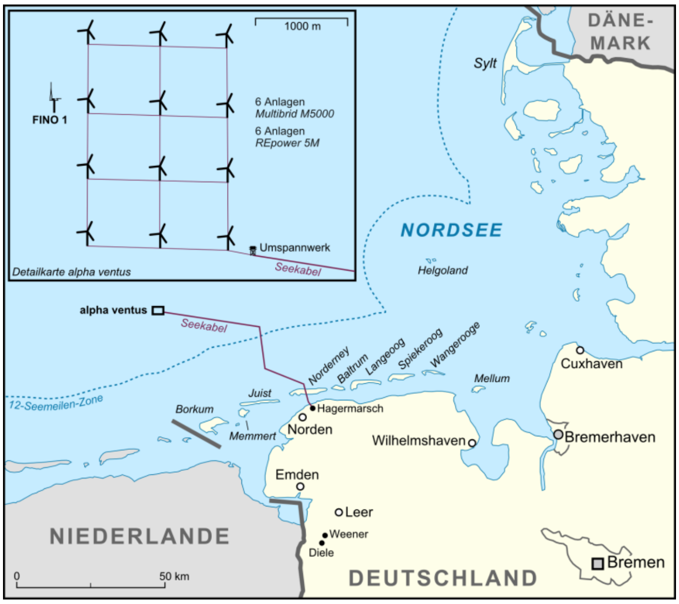

Figure 1. Location of Alpha Ventus [6]

B. Joint research, development and testing

Comparing to the other existing international projects the state of the art German technology of wind power generator in the North Sea is far away, in deeper water. German research initiative RAVE (Research at Alpha Ventus) conducts various measurements and tests in order to further promote Germany as a technology leader in this field. Over the next few years, the main objective of the research will reduce costs, increase profits, enhancing the availability of wind power generators, improving the technology of building offshore wind, accompanying ecological research, as well as technical optimization of wind power generators in relation to environmental impact [2].

III. Research at the Offshore Wind Energy Test Site Alpha Ventus

A. Profitable, cost effective and durable

"Alpha Ventus", the first German wind park of marine research and demonstration project that initiates the use of wind power in northern Germany and the Baltic Sea. The main focus is reducing costs, increasing efficiency, enhancing the availability of wind turbines, improving the technology for the development of offshore wind energy, its use of environmentally responsible, as well as optimization of turbine technology for ecological effects [3].

B. Secure foundation

Who is standing on the beach or on board a ship during a storm can imagine, forcing 1,000 tons of wind turbines in the sea are raging against. Two newly developed steel bases are used in the "alpha ventus" offshore wind farms. The first uses a "tripod" concept and it looks like three legs spaced structure (Fig.2). The second type is the so-called "jacket" foundation, which uses similar components as much as possible (Fig.3). In addition, the project examines the impact of RAVE basics of wind, waves and foundations. Next project operations subsidiary, RAVE GIGAWIND, intends to improve the support structure through the integrated concept of dimensioning and turn it into a mass-market position produceable. RAVE Geology project explores the ocean floor, especially its suitability for marine structures [3].

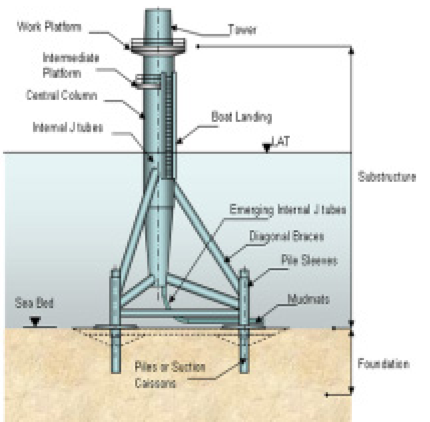

Figure 2. Tripod foundation [7]

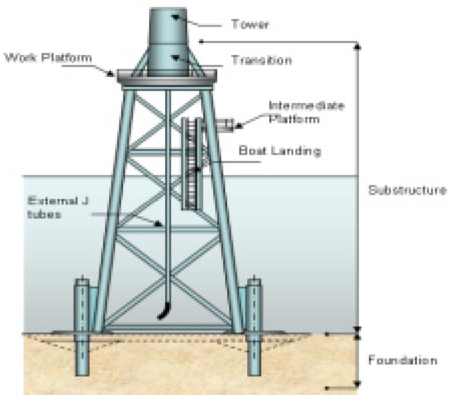

Figure 3. Jacket foundation [8]

C. Developing and optimising new technologies

Prior to construction of offshore wind farms begins on a larger scale, it is necessary to incorporate the experience and knowledge of planning, construction and operation of "alpha ventus" to research for further development and optimization technology. Further development of the rotor blade will be the focus of the project RAVE Blades REpower, while the interdependence of the whole system will be analyzed by the RAVE project REpower Components. Improvement of selected components will be the responsibility RAVE Multibrid M5000 Improvement Project. The project RAVE OWEA, key aspects of reliable design and operation of offshore wind turbines are verified. The RAVE LIDAR (Light Detection and Ranging) project using modern measurement techniques for offshore wind turbines is the subject of investigation as well as potential improvements to operations management. Finally, project monitoring, RAVE Offshore WMEP, records and interprets the basic operation of data to help identify such issues as the influence of particular meteorological conditions, energy revenues peak load, downtime, cost of electricity production, availability, maintenance and network connections [3].

D. Safe transfer of the electricity to land

Energy from offshore wind farms must be brought to the coast by subsea cables. The RAVE project network integration of offshore wind energy to the grid are developed and implemented. The aim is to reduce the energy balance and provisions for reserve capacity using a newly developed offshore wind predictions, while ensuring high availability and security of the network [3].

E. Ecological consideration

The purpose of supplementary ecological studies in Ecology RAVE project is to gain extensive knowledge on the impact of building and operating conditions on the marine environment, for example, benthos, fish, birds resting migratory birds and marine mammals. The main aim of Geology RAVE is to strive for the acquisition and evaluation of sediment dynamic processes and the general movement of sand in order to obtain reliable information on the basis of design of offshore structures and the behavior of the upper seabed liquefaction. The RAVE project volume of work, operational underwater acoustic noise of wind turbines, different boundary conditions, as well as the overall stress of noise to marine life, particularly marine mammals, are determined. RAVE noise reduction project is to study the reduction of noise during construction by pumping air bubbles into of water. Safety of wind farms to increase in the RAVE project through the technical integration of sonar transponders in the overall structure [3].

IV. Challenges for Effective Installation

The weather conditions are crucial for offshore work in the North Sea. Work is only possible for a total of about 3-4 months a year. This time is however divided up into in small sections, and to some extent individual days. While work is in progress the weather conditions are kept under close observation with an eye to the detailed local weather forecast. Construction planners have to take account of the difficult weather conditions by keeping plans in reserve that enable them to abort operations or adopt alternative approaches – and have to be able to respond flexibly at all times. The installations are designed for an operating life of 20 years. Reliable corrosion protection and thorough encapsulation of the systems are crucial for successful operation of the wind farm. The important electrical systems of each wind turbine are redundant, in other words provided as multiple systems. This ensures that they can continue to produce power even if individual components fail. The wind farm will be accessible by ship for only about 20 to 30 percent of the time (taken over a year). Even when seas are moderate, it is not possible to approach the wind turbines accurately enough to permit transfer of personnel. The journey to the site alone takes 2.5 hours. Helicopters can only land on the offshore transformer station. It is not possible to land on the individual wind turbines, but each has a small landing pad onto which service personnel can be winched down from a helicopter. With helipad, workshop, equipment and amenity room, the two-storey platform of the transformer station is the on-site service centre. Accessibility by helicopter is better than by sea and is expected to be around 60 percent of the days in a year [4].

V. Summary

On the occasion of the official commissioning of alpha ventus, Federal Environment Minister Dr. Norbert Röttgen says: "The use of wind power will play a key role in the energy mix of the future. Offshore wind farms are a decisive factor in this role. Alpha ventus is the beginning, the pioneering work which has truly opened the door for us into the age of renewable energies. Investors, turbine manufacturers and grid operators have all taken a great risk with this test field. Their steadfast commitment, perseverance and creativity have paid off: The experience gained during the construction of alpha ventus will benefit all future offshore wind farms." [5].

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GASIFICATION THROUGH DISPOSABLE RENEWABLE ENERGY

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I. INTRODUCTION

Nowadays it gets more and more important to integrate renewable energy technologies into the existing way of energy supply – especially in Germany where there is a need to find a substitute for nuclear power. Additionally, CO_2 emissions should be reduced (aim of the European Union: minus 20% compared to 1990 [1]) and the dependency of fossil fuels has to be lowered as the resources are limited.
One of the main problems of integrating renewable energy sources are the unpredictable environmental conditions which lead to a high fluctuation rate and incalculable grid conditions. Because of the slowly-progressing grid expansion there is a necessity to find alternative ways of storing generated energy. A new concept allows transforming excessive wind and solar power into hydrogen and methane.

II. TECHNICAL BASICS

Hydrogen is produced from water by using electricity generated by wind turbines or photovoltaic cells for electrolysis.

$$2\ H_2O\ (l) \rightarrow 2\ H_2\ (g) + O_2\ (g)$$

When the energy could threaten the grid stability, capacities are normally taken from the grid and the energy that could be generated is simply wasted. By using electrolysis the electrical energy can be converted to chemical energy with an efficiency factor of up to 82%. Alkaline electrolyser systems are operated at 90°C and 'consume approximately 47 kWh kg^{-1} hydrogen'[2].The hydrogen can then be stored either in a high-pressure gas cylinder or as liquid hydrogen; on both ways the gas has to be compressed because '1kg of hydrogen at 25°C and a pressure of 1 bar requires a volume of $11m^3$'[2]. A first pilot plant with a power of 500 MW was built in the north-east of Brandenburg by Enertrag in 2011 [3].

The hydrogen can be used for methanation by adding CO_2. The product of this concept referred to as 'power-to-gas' is called Substitute Natural Gas (SNG).

$$4\ H_2\ (g) + CO_2\ (g) \rightarrow CH_4\ (g) + H_2O\ (g)$$

It is possible to use CO_2 from biogas plants where there is a high percentage in the raw gas. For that the wind gas can simply be mixed with the methane gas in the plant. Another advantage would be the usage of the same injection point to the gas grid where the SNG could easily be integrated because it matches the norms of the DVGW (German association for gas and water). Because of the additional transformation the production of methane has a lower efficiency factor which lies about 5-12% below that one of hydrogen generation [4]. The first pilot plant was built by the ZSW Stuttgart (centre for sun and wind energy research) on behalf of SolarFuel in 2009 [5].

III. IMPACTS

Hydrogen can either be used for generating methane or for driving gas turbines for electricity generation or fuel cells e.g. in cars. A problem is that hydrogen must not simply be transported via gas grid because the operating equipment is not designed for the molecular structure of hydrogen: the molecules are smaller and the density is low. That is why it has to be compressed up to 80-200 bar which lowers efficiency (see table 1). Problematic is also the restriction of hydrogen rate in the gas grid to only 5% by volume.
Methane can be compressed and directly fed into the gas grid. From there it can be converted into electricity by gas turbines or combined heat and power plants as well as it can power gas cars or simply be used for heating systems.

TABLE I EFFICIENCY FACTORS OF POWER-TO-GAS-TO-POWER OPERATIONS [4]

	Efficiency	Basic condition
Power-to-gas		
Electricity → hydrogen	54 – 72 %	Compressed to 200 bar (working pressure of most gas reservoirs)
Electricity → methane	49 – 64 %	
Electricity → hydrogen	57 – 73 %	Compressed to 80 bar (feed-in to transmission pipeline)
Electricity → methane	50 – 64 %	
Electricity → hydrogen	64 – 77 %	Without compression
Electricity → methane	51 – 65 %	
Power-to-gas-to-power		
Electricity → hydrogen → electricity	34 – 44 %	Compressed to 80 bar; converted into electricity with 60 % efficiency
Electricity → methane → electricity	30 – 38 %	
Power-to-gas-to-combined heat and power		
Electricity → hydrogen → combined heat and power	48 – 62 %	Compressed to 80 bar; converted into electricity with 40 % efficiency; converted to heat with 45 % efficiency
Electricity → methane → combined heat and power	43– 54 %	

IV. FUTURE PERSPECTIVES

It can be assumed that both hydrogen and methane contribute heavily to the improvement of the basic load compatibility of renewable energy sources: fluctuation can be lowered and the consumption and generation of energy can be balanced which is a very important step to a no-fossil and no-nuclear power generation. An advantage of converting the electricity is that the gas grid is highly expanded and also can get further expanded comparatively easily whereas the building time of a new electric line in Germany is in average 10 years [6]. As already mentioned the gas grid also has a much higher storage capacity. The system of linking the gas and electric grid can be seen in fig. 1.

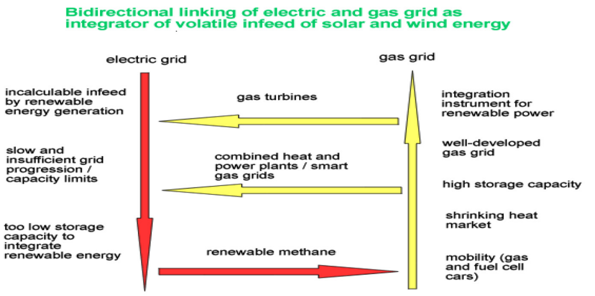

Fig. 1: Bidirectional linking of electric and gas grid as integrator of volatile infeed of solar and wind energy (modelled on picture 1 of [7])

Another important fact is that if Germany is able to produce its own natural gas its dependency from imported gas decreases which leads to a higher self-reliance.

The production of both hydrogen and methane is CO_2 neutral if you neglect the emissions caused by producing the PV cells and wind turbines. Although methane sets free CO_2 when burnt the balance is zero because it is generated by using CO_2. Probably one can rather say that the carbon balance is negative by arguing that emissions are saved by not using conventional power plants.

V. CRITICISM

Although the power-to-gas(-to-power) technologies are definitely setting trends for the future there are still some problems that have to be mentioned and which mostly deal with hydrogen. Firstly, hydrogen has only about one third of the energy capacity of methane [4]. Its structure is not compatible with the operation equipment of the gas grid: it can lead to corrosion, lowers the fuel value of the gas mixture but increases its point of inflammation. Newer statistics show, that in only some places of the gas grid a higher infeed of up to 10% by volume may be possible.

Secondly, hydrogen's costs of transportation are about 50% higher than that of methane because of the needed strong compression. Furthermore, the capacity of gas storage tanks is decreased to a third compared to methane at same pressure. [4]
Another problem is the undeveloped network of gas stations where cars with fuel cells could refuel. At the moment there are only 12 public hydrogen gas stations in Germany in comparison with about 900 for methane [9].

But there is also a negative aspect of methane that has to be mentioned: its climate harming effect is very high. As the methane should normally not be released into the atmosphere, this only gains in importance when there are leakages in the pipes or tanks.
Another general issue is that for accounting a constant composition of the gas in our gas grid is indispensable. This could be reached by storing the gas until a certain amount is reached and then feeding it in.
Moreover, it is quite sure that by reason of high investments the electricity price will arise. In addition to that it would be more effective to use the electricity in first step rather than

transforming it into gas but this needs an immediate extension of the electric grid which will definitely not proceed. By using the chance of converting electricity to gas this important extension is delayed into the future.

VI. CONCLUSION

Gasification through disposable renewable energy helps saving CO_2 emissions by giving the possibility to produce fuel wherever there is sun or wind. Furthermore, it increases decentralisation of energy generation structures what in turn may boost an autarchic energy supply in which there is a sinking dependency of fossil fuels. By adjusting how much energy of renewable fluctuative generation is fed into the grid, the grid gets released. Moreover planning of other (conventional) plant capacities is made easier which also stabilizes security of energy supplies. But there are some problems that still have to be solved, too. Probably the best alternative in using wind and solar gas is first generating hydrogen until the limitation of 5% by volume is reached. Although, this is more expensive it is still reasonable because of the higher efficiency compared to methane production. Then the hydrogen is used for methane generation which is although there is a lower efficiency still cheaper because no operation equipment has to be adjusted.

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ARCHITECTURE AND ECOLOGY

The German Parliament

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Abstract—**This paper is an early attempt to familiarize ourselves with the question of sustainability in a built environment by drawing our attention to an extraordinary example of sustainable architecture, the building of Reichstag located in the heart of reunited Berlin.**

Ecology, sustainable architecture, green building, energy, vegetable oil, solar energy, natural ventilation, Bundestag, Reichstag, Norman Foster, revitalization. (key words)

I. REASON FOR CHANGES

One of the most important issues of today's world is to learn how to become a sustainable civilization. To achieve that fragile balance we must profoundly rethink and reorganize many fields of our life. The architecture is one of them.

“Buildings currently account for half the energy used in the Western world; and the three-quarters of the world's annual energy total is presently consumed by just one-quarter of the Earth's population.”[1] Furthermore, in the global world a phenomenon of urbanization is progressing vary rapidly. Erla Zwingle in her article entitled ‘Cities: challenges for humanity’ published in the National Geographic magazine runs the alarming information: “In 1950 there was just one city with a population of more than ten million—New York. In 2015 there will be 21. By 2030, two out of three people will live in an urban world, with most of the explosive growth occurring in developing countries.”[2]

The ability to produce new abstract components of our newly generated life space without disrupting a perfect cycle of nature seems to be a decisive step into the future world. The Reichstag building as a case study of the use of an environmental strategy for the architecture provides innovative solutions and inspires with its beautiful vision. Redressing the ecological balance it sends an optimistic message about the future.

II. DEFINITION OF SUSTAINABILITY

Ecology (from Greek: οἶκος, "house"; -λογία, "study of") is a science about the relations that living organisms have with respect to each other and their natural environment. Sustainable architecture aims to reduce the negative environmental impact of buildings. It relies on the conscious approach to the design by enhancing efficiency of the entire structure und construction process. Sustainability may be also defined as meeting the needs of present generations without compromising the ability of future generations to meet their needs.

“Green building (also known as green construction or sustainable building) refers to a structure and using process that is environmentally responsible and resource-efficient throughout a building's life-cycle: from siting to design, construction, operation, maintenance, renovation, and demolition. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort.”[3]

III. ARCHITECT AND HIS MISSION

Norman Foster was born in Manchester in 1935. After graduating from Manchester University School of Architecture and City Planning in 1961 he won a Henry Fellowship to Yale University, where he gained a Master’s Degree in Architecture. He also became the 21st Pritzker Architecture Prize Laureate in 1999. The prize is awarded each year to honor 'a living architect whose built work demonstrates a combination of those qualities of talent, vision and commitment, which has produced consistent and significant contributions to humanity and the built environment through the art of architecture'. It is being very often aptly described as the Nobel Prize of Architecture. Norman Foster founded his office early known as Foster Associates in 1967 shortly after leaving Team 4. It was renamed in the 1990s to Foster and Partners in order to accent the role of the other architects and reflect the philosophy of an inner democracy of the design studio as a work place. Naturally, he is the chairman of the office.

Foster writing about his attitude towards sustainability mentioned a great personality the American architect, engineer, inventor, and futurist, who explored among other things principles of energy and material efficiency. “From my first days in practice, environmental issues and a concern for economy of means have been a fundamental part of my thinking. It was the late Buckminster Fuller who asked - far from rhetorically - 'How much does your building weigh?' What he wanted to know, of course, was how efficient it was.”[4]

Over the past four decades Norman Foster has been working on various buildings. Every single project designed by his architecture office was an impulse to create something new, to move further and get some experience. The company has been responsible for a wide range of work, from urban master plans, public infrastructure, airports, civic and cultural buildings, offices and workplaces to private houses and product design. In all those fields there were chances to get involved in a creation of the environment-friendly structures allowing them to develop their philosophy and practical application.

IV. Past projects

The design is never a separated process enclosed only in its own time. There are origins and influences. This is why there are many past projects made by Foster and Partners being essential for the success of Reichstag's transformation and this is why the Reichstag can now be seen as something fundamental to the architecture in the future. Sometimes going back to the very first level can bring us the new solutions. They could be more vital and useful than any other methods. This is the power of an idea. We need to factorize a complex issue and then analyse using a knowledge and an imagination how to connect the old elements in a new way. More importantly, this particular approach can always respond to a new situation. A building for the Stansted Airport, the third airport of London, designed and built between 1981 and 1991 was the first terminal in Britain where the designers took the environment into consideration. It challenged a common airport terminal design breaking with all accepted rules. As Norman Foster describes it "the new clarity was achieved by turning the building 'upside down', banishing the heavy environmental service installations usually found at roof level to an undercroft that runs beneath the entire concourse floor."[5] This skilful transformation allowed to design a new lightweight roof structure and to use the natural daylight. In the result the running costs are half those of any other British airport terminal. Another important project was the Commerzbank Headquarter in Frankfurt am Main, which was the first ecological high-rise building in the world. In this building an open atrium at the center of the floor plan is used as a distributor so well that all 50 floors can have natural ventilation.

V. Energy hungry dinosaur becomes a model to follow

"Almost from the beginning of its history the Reichstag has provided a popular focus - a world stage - for public events, from political demonstrations to pop concerts."[6] Right now in the era of a dawning ecological awareness, this significant architectural object sets an example for the other projects.

"The transformation of the Reichstag is rooted in four issues: the significance of the Bundestag as a democratic forum; a commitment to public accessibility; a sensitivity to history; and finally a rigorous environmental agenda."[7] The Reichstag in its original state was a vast consumer of energy, discharging 7000 tonnes of carbon dioxide, also known as a greenhouse gas, into the atmosphere. After the transformation that emission has been reduced about 94 percent, giving the result less than 400 tonnes. The building's energy demands are very modest, so that the object can perform as a local power station supplying adjacent buildings in the new government quarter. In the 1990s the building was consuming enough energy annually to heat 5000 modern houses.

The oil crisis in the mid-1970s caused a world wide debate about the current source of power. Then, as now, the fossil fuels, predominantly oil, was a main derivation of the energy. It is a finite resource and no to be find everywhere. Slowly, the people have started to arrive at an obvious conclusion and realize the inevitable. The challenge appeared. The Reichstag eschews wasteful technologies and relies on alternative techniques for energy production. It is a complex collaboration of many elements.

A. *Clean and renewable resources*

All engines and the boiler in the Reichstag Building run on biodiesel. The plants have the ability to store the energy of the sun. This organic matter being full of the energy potential was named as the biomass. Refined vegetable oil is mostly derived from rape or sunflower seeds thus can be considered as a special kind of solar energy. Additionally those growing plants can absorb almost as much carbon dioxide in its lifetime as is released in its combustion. The clean and renewable resource already guarantees the high energy efficiency rating and enforces the strategy.

B. *Daylight and natural ventilation*

Applying traditional conditioning technology to a building like the Reichstag would destroy the whole effort put into the environmental strategy. The Reichstag's condition in the 1960s was critical. The buildings interiors were closed off to the fresh air and natural light. The whole system depended almost entirely on mechanical equipment. One of the crucial elements proposed in the competition was the cupola and the funnel. It was one architectural concept that was able the change an entire situation and breathe life into the building. This new symbolic marker on the Berlin's skyline was simple the key part of the revitalization. The ducts, which the Reichstag has in its original state back in the 1890s, were used once again playing a vital role. As Foster observes: "without them our natural ventilation strategy would not work".[8] Together with the cone in the cupola they create a system, which encouraged by the flue effect works naturally. The cupola is also a physical source of daylight. The giant skylight provides light for the chamber and other adjacent rooms in some parts divided only by an elegant wall of glass. Additionally, the fascinating funnel aside from serving as an air chimney holds the mirrors installed on its surface reflecting the light down to the inner space. In the inside of the cupola a sunshade structure follows the trajectory of the sun and blocks the direct sunbeam to avoid the overheating and the glare.

C. *Solar power*

Photovoltaic cells cover a part of the roof converting the sunlight into electrical energy to drive the mobile sunshade.

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NATURAL GAS PROJECT IN CHINA

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***Abstract*—this report focuses mainly on the Sichuan-East China natural gas transmission project. Of course this project is very giant and this report is only a brief introduction of it, including background, building process and its influence.**

Keywords: natural gas distribution; transmission; pipeline; construction; security; influence.

Statistics from the International Energy Agency (IEA) indicates that, the total primary energy supply in China increased from 779 million tons of oil equivalents in 1994 to 2,116.4 million tons of oil equivalents in 2008. Among this, gas was usually used as a local fuel or as a feed stock in chemical fertilizer. The reason behind this was lack of infrastructure, especially long-distance pipelines connecting inland gas fields to major consumer provinces, particularly the areas along the coast in China. Since 1990s the government of China has actually promoted the construction of natural gas transport infrastructure and this has really improved the inter-regional connections between regional networks hence the growth of natural gas consumption in China. One is the West-East natural gas transmission project which is 4000km long and was finished in 2004, can now transport 20billion cm^3 natural gas per year. Another one is the Sichuan-East China natural gas transmission project, which will be briefly introduced in this report.

I. BACKGROUND

A. Natural Gas Distribution in China

Nature gas in China lies mainly in the middle and west basins and the northern regions. At the present time, the biggest nature gas exploration and development area of China is in northwest. Among them, the Tarim oil-gas field, Changqing oil-gas field and Puguang gas field are currently the main gas production fields. As the giant fossil fuel resources are stored mainly in the northern part of China but not in southeastern coasts where the economy is much more developed. China do has a huge energy potential, but at the same time, facing a critical problem --- a huge requirement of energy as well in southeastern coastal cities, where the oil and gas are much lacked.

Therefore, in order to guarantee a safe and steady natural gas supply in Shanghai, the country has to transport natural gas primarily from the far away Xinjiang and Shanxi instead of its nearby provinces. .

B. Original Oil Field and Operator of the Project

Puguang gas field (Figure 1.1) is the origin of Sichuan-East gas transmission project. Discovered in 2003, it is the deepest average oil well depth in China. So far, the storage gas capacity of Puguang is verified as approximately 500 billion cubic meters. [1]

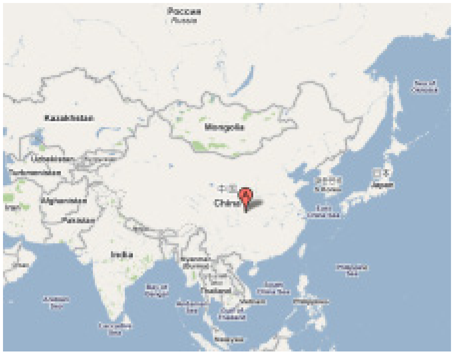

Figure 1: Location of Puguang oil-gas field. [2]

Puguang gas field in Sichuan Province is the first large-scale gas field China has ever found in its marine strata, and is also one of the country's largest gas fields.

Sinopec Limited, or China Petroleum and Chemical Corporation Limited, is the operator of the Sichuan-East gas transmission project. It is a majority owned subsidiary of state owned company Sinopec Group. By the end of 2009, Sinopec had discovered 498.1 billion cubic meters of geological gas reserves and 403.2 billion cubic meters of controllable reserves at the Puguang site and its surrounding regions. [3]

As the largest oil refiner in Asia by annual volume processed, Sinopec produces around 1/4 as much raw crude oil as Petro China, but produces 60% more refined products per annum. In 2007, it ranked first in the Top 500 Enterprises of China ranking. In 2009, it was ranked 9th by Fortune Global 500 becoming the first Chinese corporation to make the top ten and in 2010 it was ranked 7th. In 2011 it ranked as the 5th largest company in sales in Forbes Global 2000. [4]

II. SICHUAN-EAST CHINA NATURAL GAS TRANSMISSION PROJECT

Sichuan-East China gas transmission project is the key project designated by the state council under China's 11th Five-Year Plan. The project transmits gas from Puguang, Sichuan to Shanghai (Figure 1.2) with a main lines' length of 1700km, mainly supplying Jiangsu, Zhejiang and Shanghai areas. It consists of one main trunk-line, one secondary line, and three spur pipelines that will feed other cities near the pipeline route.

Figure 2: Path of Sichuan-East China gas transmission project [5]

This long distance gas pipeline goes through totally 6 provinces. It starts from Pugang gas field in Dazhou, Sichuan Province and finally reaches Qingpu District of Shanghai. A branch line with a length of 842 kilometers connects Yichang in Hubei with Puyang in Henan Province. Two shorter branches are located near the Puguang gas field, another one is in the east near Shanghai.

A. *Statistics of the Project*

The Sichuan-East China natural gas transmission project started from 31.08.2007 and was put into use on 31.08.2010. The design working pressure of gas pipelines is 10Mpa. Annual gas transmit capacity at the moment is approximately 12 billion cubic meters. [6] The Sichuan-East China gas transmission project was one of the most technically challenging in China's history, due to the need to construct gas gathering and purification plants and build 800 kilometers of pipeline through steep mountains and valleys, which required construction of an elaborate tunnel system. The whole project crossed Yangtze River totally 6 times with a sum of 8925m. It went through 43 highways, 23 railways, 73 mountain tunnels and numerous rivers.

B. *Pipelines*

- Pipeline transportation has the advantages of high efficiency, low leakage and low cost. It is not as confined by geographic conditions as water transportation.
- Pipeline's capacity is higher than that of road transportation. Its cost is lower than that of railway transportation and it is not limited by the capacity of the national railways. Therefore, it is especially suitable for long-distance transport.
- Diameters of the main pipelines along this gas transmission project are the same. They are all required and processed with the same standard diameter of 1016mm. Only the thicknesses of them are different. It depends on the pipelines' surroundings. Totally four kinds of pipeline thickness can be used in this project, including 17.5mm, 21mm, 26.2, and 32.5mm. However, in terms of branch pipelines, the diameters can be different.
- The development in facilities for pipeline transportation and storage has propelled the soar of petroleum and petrochemical industry and carried energy blood into the growth of Chinese economy.

C. *Important Stations along the transmission line*

- Normally the pressure of the natural gas explored from underground is 20-40MPa, but when transmitted, the pressure needed on the long distance transmitting way is only 4-10MPa. Therefore, the pressure must be decreased before entering the pipelines. This can be done by a so called gas collecting and transmission station (Figure 1.3) that settled around gas wells.

Figure 3: Gas collecting and transmission station

- The function of a gas collecting and transmission station is to collect explored natural gas, decrease its pressure to a required level, and then transmit it to the next natural gas purifying center.
- Some filter and purify systems are also installed in a gas collecting and transmission station. Natural gas is explored and collected from tens of thousands of gas wells in gas collecting and transmission stations. With their pressure being released, and then transmitted to the next natural gas process center.
- Similar to the electricity transportation, there are natural gas losses during the transmitting way as well. The pressure of natural gas decreased on the long distance transmitting way.
- In order to ensure a safe and steady gas pressure level at each using point, the pressure of natural gas can be increased within a particular range in advance in starting regions, or be improved by compressing in a gas compressing station (Figure 1.4) that arranged every hundreds of kilometers along the project pipelines.

Figure 4: Hudong natural gas compressing station and compressor [7]

- The function of a natural gas compressing station is to supply the transmitting pressure loss of natural gas by compressing. Natural gas will be compressed in such stations to a new higher level. Then be transmitted to next pipelines.

- As gases are compressible, their pressure will be increased by compressing their volume. The compressor works like a pump. They supply the pressure loss of natural gas, and then send them to the following pipelines.
- In case of emergency, such as explosion or breaking of the pipelines, a safety station (Figure 1.5) is demanded every hundreds of kilometers. It is like a giant valve along the pipeline which will cut down the gas transmission immediately when unexpected issue happens.

Figure 5: Safety station

- The red color high straight "chimney" on left side of the above picture is the symbol of a safety station. It will release the excess gas pressure in case of overpressure. Other dangerous occasions such as erosion, perforation, and gas leakage are also considered to control in such stations.

III. Challenges and Influences

The Sichuan-East China gas transmission project, which includes a 2,700 kilometer trunk line, can pump 12 billion cubic meters of natural gas from the Puguang gas field in China's western Sichuan province to the eastern city of Shanghai via eight provinces and municipalities, equivalent to 14% of the country's total natural gas consumption in 2009.[5] It has conquered many worldwide challenges and made the history.

A. Challenges

a) Cross River

Figure 6: Adding heavy stuff onto gas pipelines

When setting pipelines cross a river, some heavy stuff must be added onto the gas pipelines in case the pipelines float on the underground water.

b) Cross valley and cliff

Figure 7: Picture of Yesanhe cross-cliff river pipeline-bridge

Yesanhe river pipeline-bridge, completed in 2009, is located in Hubei Province, China. It is not only the first suspension bridge built by Sinopec, but also the only suspension bridge in the Sichuan-East China gas transmission project. It crosses the Yesanhe river valley and has a total length of 332 meters. The natural gas pipelines with a diameter of 1016mm are settled on the surface of the bridge. [8]

B. Influence

a) Influence on economy

Without a doubt, the accomplishment of the Sichuan-East China natural gas transmission project not only relief obviously the lacking energy problem in eastern China cities, but also promote the economy in the cites along the project line. The construction process helps to offer more working opportunities and positions. It increases especially the regional economy.

The gas pipelines are like the Internet. It connects most of the major cities in southern China. Considering the increasing of international oil and liquid natural gas price, China can now ensure its energy supply in big cities with this project.

Due to high exploration and development cost of the Puguang gas field, operating margins would be relatively low compared to similar projects in China. Because of the very big investment in large-scale, complex structures, during the construction period and operation of a long period, it would take at least 10 years to recover the construction investment of the pipeline, and between nine and 10 years for the gas field to recover exploration costs.

What's more, with the increasing demand of green energy in international market, this long distance gas pipeline helps to adjust the structure of energy consumption in China.

b) Influence on environment

The constructing process influence on the environment of Sichuan-East China natural gas transmission project is not as big as that of the Three Gorges Dam. Although it also faces numerous challenges during both the construction and operation period, some are even worldwide unparalleled, it overcame most of them with minimizing the damages to the environment. Generally speaking, it is an eco-friendly project.

Natural gas is one of the clean energy, it releases less carbon dioxide compared to coal and petroleum when combustion.

Therefore, with this project more people in regions along pipeline get the natural gas as energy. The ratio of natural gas in energy consumption is increased by 1-2 percents. It means more coal and oil are replaced and less toxic waste is released.

ACKNOWLEDGMENT

Sincere thanks to Prof. Dirk Lehmann, Prof. Dr. Janik and Prof. Dr. Leonowicz. Without your help and support, I could not have completed this presentation. I would like to express my gratitude to my parents, my family and my friends, for encouraging and comforting me all the time. Thank you all.

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NUCLEAR POLICY IN GERMANY, POLAND AND THE CZECH REPUBLIC

Comparison of future prospects

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I. INTRODUCTION

Nuclear phase or phase-out? Throughout Europe dominate a lively discussion about the future of nuclear energy. Ensuring the power supply is not the most important fact, also the decision of the European Commission for the third legislative package for European internal market plays a great role. It should intensify the standardization of the European electricity market. The acceptance of society is also one of the main points, because nuclear energy is usually denied only for emotional reasons. Even the European institutions support the use of nuclear energy as part of the energy mix and so Germany belongs to a minority with the nuclear phase. Overall, the European area can be divided into different sub-groups who share similar political positions on nuclear energy. In our discussion, we want take a closer look at Germany, Poland and the Czech Republic, because they border an each other and everyone of them wants to realize different plans in the future.

II. GERMANY

In Germany, the debates on nuclear power increased after the accident in Fukushima in spring 2011. In its final report in May 2011 the Ethics Commission thinks that a phasing out of nuclear energy within the next 10 years is possible. The current bill provides a final shutdown of the last nuclear power plant for 2022nd. The phasing out of nuclear energy has long been politically decided, just the time to the final exit differentiates the political opinions (Knopf et al. 2011, S.14). It stays a most important question whether the energy supply is endangered in Germany. 9 from 17 nuclear power plants still operating in Germany, there are owned by the four largest German energy companies EON, RWE, EnBW and Vattenfall. The first nuclear reactor in Garching was connected to the power grid in 1957. Good 50 years later, the German energy policy is at a turning point. It is about nothing less than the reconstruction of the entire energy system of a highly developed industrial nation, which has the receipt of stability and prosperity of the community as an essential condition. The primary energy consumption by nuclear power was approximately 11% in Germany 2010 (Arbeitsgemeinschaft Energiebilanzen, Tabelle Primärenergieverbrauch 2010, 02/2011). In order to save the energy supply it would be necessary to expanse the renewable energies or build new fossil power plants or allow older systems to be longer than originally planned at electricity network (Knopf et al. 2011, S.9). The expansion and re-use of existing coal power plants seems to make sense, but is incompatible with the climate policy goals, since coal-fired power plants cause enormous CO_2 emissions. Furthermore, it is expected that the electricity prices remain constant after a short rise in prices (Holm-Müller/Weber 2011, S.296f).

III. POLAND

In contrast to Germany Poland wants to invest long term in atomic energy (Focus Online). About 25 years ago the polish population protested against the government's plans to build an atomic plant in Zarnowiec, which is a town in the north of Poland and located 70 kilometres from Danzig. At that time the schemes about the Chernobyl disaster and the end of the communism were crushed. But today there are almost no protests against the current plans of the politicians, who wants to construct two new nuclear plants with power of 6000 megawatt (they will cover up to 25 % of the total demand of electricity) in the north of Poland until 2025. Not even past the nuclear disaster in Fukushima (Zeit Online).

What caused the opinion to change? On the one hand the infrastructure has been improving till today and on the other hand they don't need to fear any military attacks (Zeit Online). Also Polish politicians want to reduce the dependence on coal, because nowadays 94 % of the whole electricity generation is drawing by carbon-based energy. Another reason is the decision of the EU, in which Poland also accepted, to cut CO_2 emission in quarter to 2020. This is why carbon-based power is an energy source with one of the most CO_2 emission. Furthermore the usage of another energy source is connected with the Polish dependence on Russian natural gas source. 66 % of natural-gas import and 40 % of overall consumption of gas in Poland is provided by Russia (Dradio Online). So they need an alternative to coal-based and to natural-gas based power.

But what about the critics opinion? In addition to the standard slogans against nuclear energy like terrorism, custody and transport of radioactive waste produced, technological span and natural disasters, what are some facts of each conventional news broadcast. On the one hand German politicians presented violations against the EU-law, e.g. risks of nuclear energy will be presented incomplete, also an alternative program in terms of energy efficiency and to expand renewable energies are not met (EURActiv Online). The critics also noted that the entire environmental testing, e.g. natural disaster testing was not properly implemented (Bund Online).

IV. CZECH REPUBLIC

Like Poland the Czech Republic is since the 1990 on the economical fast track. After the political changes in 1990, and the statehood 1 January 1993, the country has to renew itself completely. In addition to that, the Czech Republic was willing to get accession to the European Union, which succeeds 1. May 2004. These policy changes affected the energy sector in a very significant way. The people were accustomed to the low price of electricity, because it was subsidized by the government and because of the missing polluter-pays principle (PPP) they weren't ready to take responsibility for the environment. This resulted in the inefficient use of energy and massive emissions of greenhouse gases. This changed with launching of the Environmental Protection Act of 1991, which included the PPP (GERTEC GmbH 2001, p. 11). Demanded by the EU the energy liberalization, and thus the elimination of subsidies, put a huge price increase for the households. The price of electricity rose up to 182% between 1991 and 1998 (GERTEC GmbH 2001, p. 34). Consumer behavior, the price increase and the guidelines for compliance the emission limits constrict the political space for the government. To fulfill all requirements the Czech governments focus on nuclear energy. The substitution of coal power plants with nuclear power plants is generally assumed to be positive in the Czech population (Peiß 1999, p. 234) and regarded as a necessity, to fulfill the sustainability demands (Peiß 1999, p. 248)

Apart from a few research reactors around Prague, there are two nuclear plants. These power plants are located in the south of the country, where is just a little coal occurring. Because of the geographical position they`ve got stress with the neighboring countries. One of these locations is Dukovany. The plant was taken into operation between 1985 and 1987. It has got four reactor blocks and in 2010 the showing power was 13.288 GWh. This Russian-style power plant is deemed to be unsafe, because there is no containment against crashing airplanes. The other power plant is located in Temelin, it qualifies as modern. The start-up must be postponed a few times because of changes in construction and other incidents. Today there are two reactor blocks with the power of the whole Dukovany plant. Parts of the extension of the plant in Temlin are political frictions between Poland, Germany, Austria and the Czech Republic, because they all would be involved in a nuclear disaster-struck.

V. SUMMARY

Nuclear power offers a cheap and safe fulfillment of demand and additional the reduction of CO_2 emissions, although the disadvantages take the top priority. In case of a nuclear disaster the consequences are horrible and for the next generations not affordable. There is no power plant in the world, which has got insurance, so anybody can control the consequences. Also the permanent disposal and effect of nuclear waste is unresolved. Additional the nuclear power reduces the competition in the energy market because there are only a few big companies which have got nuclear plants.

All in all it is not enough, if countries make nuclear policy just for their own. It doesn't make any sense, if some countries phase and other countries phase-out. We need a solution for all countries in Europe without exceptions. Another solution is the promotion to decentralization of energy supply. It would support the competition and the independence of the people.

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THE ENERGY EFFICIENCY HOUSE PLUS

Innovating the building sector

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Figure 1. (http://www.forschungsinitiative.de/PDF/Effizienzhaus-Plus_Barrierefrei2.pdf, 17.03.2012, 14:07)

I. INTRODUCTION

In times of frequent discussions of global warming and possibilities to defeat the effects, energy efficiency in buildings has become more and more significant. Looking at the total of energy consume in national economics, it occurs that more than one third is needed by houses and buildings. 46% of CO2-emissions caused in the private sector were due to heating and warm water heating, afterwards the transport sector with further 20% [1].Therefore a new approach is needed for both fields to generate a sustainable use of resources. The project "research future building", initiated by the Federal Ministry of Transport, Building and Urban Development, has supported research and development related to energy efficiency in buildings and the use of renewable energy there. The concepts developed and proved can make modern buildings produce more energy than they need for their own use. This is how the concept of Energy Efficiency House Plus has arisen, which offers an innovative

first approach for reducing CO2-Emissions of private homes. One of these houses is located in Berlin-Charlottenburg, Fasanenstraße 87a. Its size is 130m² [2]. Furthermore it will be the framework this article is dealing with, focusing on technical challenges and the progress in electricity supply. In addition the concept of sustainable electricity supply and its fulfillment of the requirements due to international contracts (e.g. the Kyoto Protocol) will be clarified during the article[1]. The option to use energy for E-mobility (for example cars, motorcycles and bikes with electrical drive) has led to cooperation with several car producers and also created a potential for Germany to make new fields of the energy market accessible [3]. The house in Fasanenstrasse serves for the time being for the test of the efficiency of the single components and collects experiences for the later wide use. Visitors can catch up on site information by which at the same time an interest should be woken up in the population [1]. To guarantee the practical use and not to do research merely at lab level, enters in March, 2012 a 4-headed test family which checks the house 15 Months for his efficiency and the applicability of the technologies [4].

II. BUILDING PHYSICS

This is happening with the challenge of using Products with the highest efficiency class and smart energy meter. In addition you have to use materials with a great degree of recyclability, which is possible through today technical standards. In order to link the modern architecture and the technical side the products should be esthetic as well. Especially the connection between the energy efficient building and the usage of renewable energy has to be communicated. The Effizienhaus-Plus is not tied to any particular technology. It can be realized by various combinations of renewable systems. That is how it represents the open use of technology [1].

The most energy gets lost through heat, because of a lack of isolation. By using different isolation materials it is the aim to cut down those power losses. Therefore monolithic walls and multilayered pieces are taken. The coefficient of heat transmission plays a very important role. It describes the amount of heat that gets lost through one layer of material if the two temperatures on each side are different. The lower the U-amount the better the heat isolation. You can calculate it by using the formula:

$$U = \frac{1}{R_{si} + \left(\frac{d_1}{\lambda_1}\right) + \ldots + \left(\frac{d_n}{\lambda_n}\right) + R_{se}} \quad (1)$$

Houses that are separated by yards or streets usually have higher energy consumption than row houses. This is due to the bigger surface of the building. Building a house like a bowl is not possible and that is why the energy efficiency house plus has to be build cubic in order to have to smallest surface. A oriel or pitched roof is not planed, because they would increase the surface and are not as well isolated as other roofs [1].
The requirements for the isolation are dictated by a security plan, which is supposed to assure the air tightness of the house surrounding. You can decrease the heat losses by using controlled ventilation systems with heat recovery. Up to 80% heat recovery can be realized today. Still the power consumption rises with the recovery of the heat. This is why the ventilation systems with heat recovery have to be planed individually so the power consumption for the ventilation is not bigger than the power you save through the heat recovery.

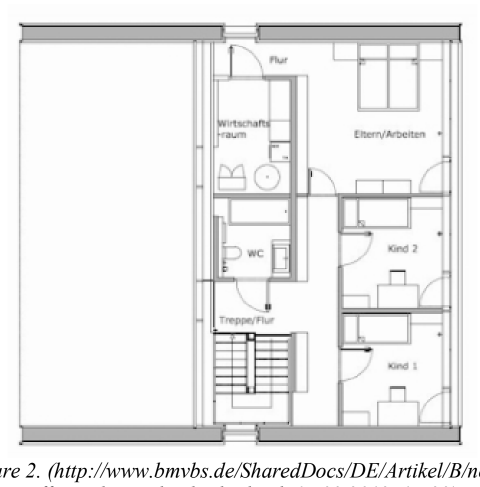

Figure 2. (http://www.bmvbs.de/SharedDocs/DE/Artikel/B/neues-effizienzhaus-plus-berlin.html, 17.03.2012, 14:23)

The spot in a house with lowest isolation mark are usually the windows. In the energy efficiency house plus the windows are used for a passive solar energy profit. Important is the triple glazing, location and orientation of the windows, through which the energy profits can equal the heat losses. The Wall of the house divides the building into different functional areas. The Walls facing north are built out of brick, because the direct sunlight is not enough to generate an efficient amount of energy. The south of the building is a window front in order to generate energy through passive solar energy. This is how two zones are created and separated by walls. The south zone does not have to be heated, but the north zone does.
Because of the two different zones the heat streams form the not heated part to the heated part are decreased and the losses are down to a minimum. The following picture illustrates the energy efficiency house plus in the Fasanenstraße and shows the two different areas inside of the building.

The usage of electrical light in the south can also be limited by the direct sunlight coming through all the windows.

III. Facilities Engineering

Next to the already described techniques the facilities engineering plays an important part.
The technical constructions have to meet certain requirements. For example the temperature of the rooms, the warm water and the fresh air supply have to be controlled through the constructions. The heat losses by the heat production can easily equal the heat that has to be generated for the house. The heat is generated by geothermal energy with the assistants of heat pumps or solar collectors that are located on the roof.
Warm water can be also generated by solar collection. By doing so one-third of the needed energy can be saved.

Because of the premise of the installation of always energy efficient constructions in the building, no normal light bulbs are installed, but compact fluorescent lamps and LED lights are mounted. Usual light bulbs only use 5 % of the energy for the light. The rest gets lost through the heat. That percentage rises up to 4-5 times when compact fluorescent lamps and LED lights are used. Those effects are even strengthened by pointing the light to areas where it is needed the most. For example the work desk or the kitchen table.
The Wall should be white, because this way the walls can reflect the light to other zones of the rooms. Dark colors would absorb the light and reduces the brightness of the room [1].

Next to the geothermal energy other renewable energy can be used as well. In general PV or wind turbines are common, but heat profits through heat loss or thermal solar power can be put into the heat system as well. The usual utilization ratio for PV constructions is between a few and up to 25 %. In most cases wind turbines in urban neighborhoods are not very useful, because the production is limited due to other buildings and the profitability sinks.
Never the less small wind turbines can deliver the energy needed for a single home and only in this way worth building.

Just as important as the use is the individual administration. Only through a skilled use of the constructions can be guaranteed that the goal of a more efficient living can be provided [1].
The technology is brought together in a separate room and can be viewed and controlled through Toolpanels and Smartphones. This gives the home owner the chance to always view and control the energy consumption of his house.

The Core of the house is a high performance battery, which can save all the produces but not used energy during the day and supply it to the house owner. The system is linked to the weather forecast and can accommodate the energy supply and use depending on the weather. The saved energy can also be used to fill up the electrical car.
This innovation represents a difference to the other low energy homes, because in this example the home can function separate and does not have to be tied to the power supply of the city. At the same time it is possible to inject the energy into the power supply, but that is against the idea of the energy efficient house plus, because only the switch to a different frequency already involves many losses which are unnecessary.

IV. END

There are several of concepts next to the energy efficient house plus. Many of those concepts where put into reality in the "Fertighauswelt" in Cologne.
The Frauenhofer Institute is monitoring the buildings in Berlin and in Cologne.
The important data like the used heating energy, electrical energy, electrical energy profit, the level of owner-occupation of the renewable energy, primary energy consumption and the feelgood factor are collected and analyzed.

To keep this as realistic as possible a family with the average energy consumption is taken as an example. Through analyzing all this data it is hoped that a breakthrough in the individual usage of energy efficient technologies can be reached. The first step is the realization of the various concepts and this step is already taken.

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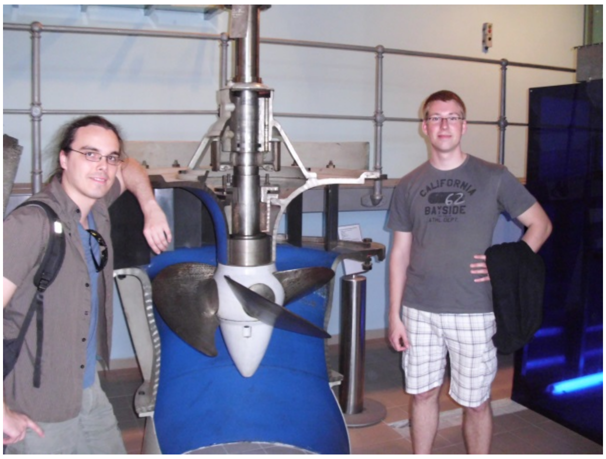
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