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ANALYTICAL ASSESSMENT OF ENERGY EFFICIENCY POLICIES: A CASE STUDY OF NORWEGIAN POLICY MAKING

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This study provides a throughout review of Energy Efficiency policies in the Norwegian context. It examines specific policies and instruments which are designed for addressing Energy Efficiency issues. The aim is to grasp the extent and effectiveness of those policy arrangements that might serve as a model for others to learn from. Qualitative and quantitative data collected from evaluation reports and databases show a tendency of overall improvement of Energy Efficiency trends over the last four decades with inconsiderable fluctuations, which are an outcome of external economic factors and less accountable to policy making. Findings also reveal the complex nature of policy assessment and, indicate the need for further detailed research on Energy Efficiency policies in different contexts if recommendations from well performers are to be realized. Further research will also allow for a better evaluation of Energy Efficiency policy impacts and deepen knowledge in overall policy evaluation methods.

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Abbreviations and Acronyms

CO_2 – Carbon dioxide

CCS – Carbon Capture and Storage

EE – Energy Efficiency

ESMAP - Energy Sector Management Assistance Program

EU27 – European Union 27 member states

GCM - Green Certificate Market

GWh – Gigawatt per hour

GHG – Greenhouse gas

IEEP - Intelligent Energy Europe Program

ktoe – kilotonne (1000 tons of oil equivalent)

kWh – kilowatt per hour (1000 watt-hours)

Mb/d – million barrels a day (oil & gas)

MPE – Ministry of Petroleum and Energy

Mtoe – million tons of oil equivalent

MWh – Megawatt per hour

NCS – Norwegian Continental Shell

NVE – Norwegian Water Resources and Energy Directorate

NOK/m^2 – Norwegian kronor per square meter

ODEX – ODYSSEE Index

RES – EU Renewables Directive

SPCB – System Public Benefit Charges

TPES – Total Primary Energy Consumption

Toe/m^2 – tonne of oil equivalent/per square meter

Toe/ton – tonne of oil equivalent

Twh – terawatt per hour

UNFCC – United Nations Framework Convention on Climate Change

Öre/kWh – one Norwegian öre per kilowatt hour

Introduction

Global energy demand increases over time resulted by population rise and expanding economies, while production capabilities decrease. On the hand negative effects of energy intensive growth on the environment complicate the quest for economic prosperity. A tradeoff between economic growth and sustainable development emerges. Scholars claim that this tradeoff can be eliminated when proper strategies and policies, addressing energy efficiency, are in place and some states have already achieved sound results. One success story is considered to be Norway, which is a major global actor in petroleum production and a strong advocate of policies to combat climate change. Norway has recently gained a commendable status by policy makers. The annual report of 2010, published by the International Energy Agency on energy efficiency, has announced its policy instruments as recommendable to other countries. To achieve this status Norway has consistently developed its petroleum industry and invested a large part of derived profits in sustainable development. This study will seek out to provide a throughout review of energy efficiency policy instruments that are present in Norway. The aim is to grasp the extent and effectiveness of those instruments that might serve as a model for others to learn from. It will examine specific policies and arrangements which are designed for addressing issues and which together contribute to the process of decoupling energy-consumption from economic growth, thereby eliminating the tradeoff. The research will be divided into three parts each with its sub-parts. The first part will provide an overview of previous research in the area of energy efficiency measures in general and discuss them in the Norwegian context. This will make it possible to guideline data collection methods. The second part will deal with methods that will be used to carry out the study. A literature review on case study research will be presented and indicators that will be used for qualitative and quantitative assessment of the Norwegian case will be identified. The last section will summarize and interpret findings. Lastly a discussion, reflecting peculiar features of the research, will be provided followed by concluding remarks.

Importance of study

Sustainable development has for decades been a main concern for global development actors. In a report in 2010 the International Energy Agency (IEA) has laid down three case scenarios each with a different set of policies and outcomes in the global energy market by 2035. While outcomes will differ depending on the range of recommendations implemented, some conditions will stay unchanged. The rise in prices and demand of fossil fuels has been and will continue to increase. As such a fivefold increase in the price of oil has been recorded during the last decade alone, while global oil demand is predicted to rise to 99.7 mb/d (million barrels a day) in 2035, up from 87.4 mb/d in 2011. Demographic changes and economic growth contribute to ever increasing demand but production tends to decrease due to exhaustion of non-renewables (WEO, 2012:81). On the other hand there is the inevitable fact of environmental damage caused from utilization of non-renewables. The transport sector alone accounts for 23% of all CO2 emissions and15% of overall greenhouse gas emissions (GHG). CO2 emissions in the transport sector rose by 45% from 1990 to 2007, led by emissions from the road sector in terms of volume and by shipping and aviation in terms of highest growth rates (EIU Forbes, 2014). Four-fifths of CO2 emissions are locked-in by existing power plants, factories, buildings, etc. allowable by 2035. The average unit of energy produced today is as dirty as it was 20 years ago. If rigorous action is not taken by 2017, the energy-related infrastructure then in place will generate all the CO2 emissions allowed up to 2035, leaving no space for further industries unless they are zero-carbon (WEO, 2012: 241).

Questions that need to be answered do not lie in the core of fossil fuel demand and supply itself, since fossil fuels, as it looks for now, will remain the main source of energy at least for the coming decades, as they are more convenient to utilize in comparison to other sources of energy with the existing technology and institutional settings (WEO, 2012:49). The IEA along with other international and regional energy organizations recommend active policy exercise to governments around the globe if best case scenario with the least fossil fuel dependency and carbon emissions is to be achieved in the coming decades. Strategies that deal with energy conservation, improved renewable energy application, more energy efficient technologies and consumption driven behavioral changes need to be set as priorities in decision making (WEO, 2012:269-270). Issues discussed in this study will provide a deeper understanding of Energy Efficiency policy making in a given context. A throughout assessment of Norwegian policy arrangements will establish ground for further investigation on cross country comparisons with other major petroleum exporting countries that fall within the same category as Norway in terms petroleum production.

Research question

The following question will be devoted to the research in order to solve above mentioned tasks:

- *How and to what extent does the government of Norway contribute to more energy efficient development?*

ENERGY EFFICIENCY POLICIES AND GOVERNANCE

In order to provide a solid background to the issue, this chapter will be divided in two parts. The first part will present general aspects of energy efficiency policy instruments based on previous research about energy efficiency governance, while the second part will take that discussion into the Norwegian context. The aim is to establish a framework of policy arrangements that can be used as basis for organizing and categorizing information with regards to the research question and prevent spillovers of unnecessary information.

Energy efficiency measures

Energy Efficiency, from now on depicted as (EE), might be considered as the fundamental concept that guides countries, both producing and importing, towards sustainable development. Energy security, international competition and climate change are increasingly leading the way for development and implementation of EE policies. While the role of market forces in delivering EE is actively promoted, less is known about the legal, institutional, and coordination arrangements needed to scale-up EE. The governance of such arrangements helps to ensure that the right set of policies are chosen, that actions are co-ordinated and effective, and that they reach desired results without causing negative by-effects. Active governance has to establish EE agencies and hold them accountable for their results and level of effectiveness (Jollands et.al, 2009). According to the IEA, EE governance is defined as: “the combination of legislative frameworks and funding mechanisms, institutional arrangements, and co-ordination mechanisms that work together to support the implementation of EE strategies, policies and programs” (IEA, 2012: 14).

There are many great works associated with EE policy and governance of such assessed with qualitative as well as quantitative methods. The IEA attempts to summarize some of the most influential literature and distinguishes a few to be essential in EE measures. As such the book by (Laponche, Jamet and Attali, 1997 in IEA, 2012) Energy Efficiency for a Sustainable World stands out as it gives a structural review of the most important indicators for EE policy. Its main concerns are governance mechanisms in EE, key elements of which include strategy formation, stakeholder engagement and the creation of a national EE agency. According to the authors, key factors for effective EE agencies should comprise of: political support, legitimacy conferred by a political authority, independence and autonomy, and adequate human and financial resources. They must be able to actively mobilize and co-ordinate large number of delivery agents, since EE must ultimately be delivered at end-user level, meaning that developing partnerships and empowering others to make relevant decisions must be one of their prime concerns (IEA, 2012: 25). Another work on EE policies and institutions is "An Analytical Compendium of Institutional Frameworks for Energy Efficiency Implementation" by (Limaye et. al 2008, Heffner and Sarkar, 2008). It is administrated under The Energy Sector Management Assistance Program (ESMAP), a global knowledge and technical assistance partnership established by the World Bank and funded by bilateral official donors since 1983. It uses real-world examples collected from 27 developed and developing countries and 29 EE agencies to assess the interplay of structure, role, and function of institutional frameworks supporting EE implementation and concludes with recommendations for developing countries on EE legislation and institution building (Limaye et. al, 2008:4).

In all of the studies, including IEA's own comprehensive research with surveys conducted in 110 countries, findings show that the degree of effectiveness of EE policies relies on many factors and varies greatly in country contexts. Factors like *enabling frameworks, institutional arrangements and coordination mechanisms* are in the center of EE policies (IEA, 2012:14). Enabling frameworks are integrated in concrete decrees and laws that form the basis for an overarching strategy linked to national development objectives, and accumulate the resources needed for government action. Laws can be of comprehensive and incremental style, the former covering a wide range of issues concerned with EE such as renewables, energy security, CO2 emissions etc. and strict legislation while the latter focuses on the most important intensive industries such as end use consumer sector, buildings and transport (IEA, 2012: 38). The second action is to outline plans and strategies. Strategies are sought to provide a comprehensive description of the rationale and approach to designing and implementing EE policies and programs. Some countries use national strategy formulation or an action planning process to engage stakeholders and build consensus between actors. The difference between a strategy and a plan lies in the scope of intention. A strategy should focus on long term goals and high level services. It should establish relations between EE policy and broader social, developmental and environmental policies. A policy plan is more of a programmatic document, focused usually on implementation activities than broad strategy. It should identify barriers to scaling up EE activities and find solutions to those through intervention policies. Eventually it should provide monitoring services and updates for further revisions. Strategies are usually outlined by general governmental entities like ministries while plans are implemented by other intermediary public and/or private agencies (IEA, 2012: 51-52).

The last and most important step is that of the technical issue of funding mechanism. It will assess, allocate and provide resources needed for application of EEPs (IEA, 2012: 60). There are distinct types of funding mechanisms each with its advantages and disadvantages. For instance grants from government budgets tends to be vulnerable to economic shocks when revenues decrease or political influence is present but is more dedicated when connected to higher stationed government agencies like ministries. Energy and environmental taxes are effective in a way that they address several issues at one time. They create price signals that encourage investment in EE and they generate government revenue going either back to the general treasury or being earmarked for special EE programs (e.g. reducing pollution or investing in clean energy). Another example is taxes on carbon emissions in the transport sector which besides accumulating revenue affect also consumption behaviors. Ultimately they encourage usage of public transport and/or consumption of diesel instead of gasoline (IEA, 2012: 61). Experiences show that many EE programs and agencies rely on several funding mechanisms to support their operating and program expenses (IEA, 2012: 68).

<u>Institutional arrangements & Coordination mechanisms</u> are arrangements that set up agencies and establish coordination networks to implement EE strategies and plans. The main role of EE organizations is to engage in management tasks for scaling-up EE projects by coordinating stakeholders from different sectors, multiple public, private agencies, energy providers and consumers in order to achieve pending results (Limaye et. al, 2008). Their potency usually depends on several factors: overall national development goals and EE objectives, policy context, type of interventions, and available resources. Therefore the interrelationship of enabling frameworks and institutional arrangements is reciprocally. The following set of skills is needed for functioning: independence and flexibility in decision making, technical expertise, financial expertise, private sector experience, regulatory expertise and specialized analytic skills/monitoring skills (Limaye et. al, 2008). Limaye (2008) distinguishes seven institutional

Models that have proven effective in promoting EE[1] (Limaye et. al, 2008). In recent years a new form of organization has been invented. It combines the practice of an energy supplier and experience of an EE agency, called Energy Efficiency Utilities. Coordination is the practice of establishing networks that operate on behalf of various agencies from different organizational structures in order to implement outlined plans. At first sight it is the job of governments to coordinate policies, but the government encourages also other institutions to take active part in cooperation and independent joint activities (IEA, 2012: 20).

Norwegian context

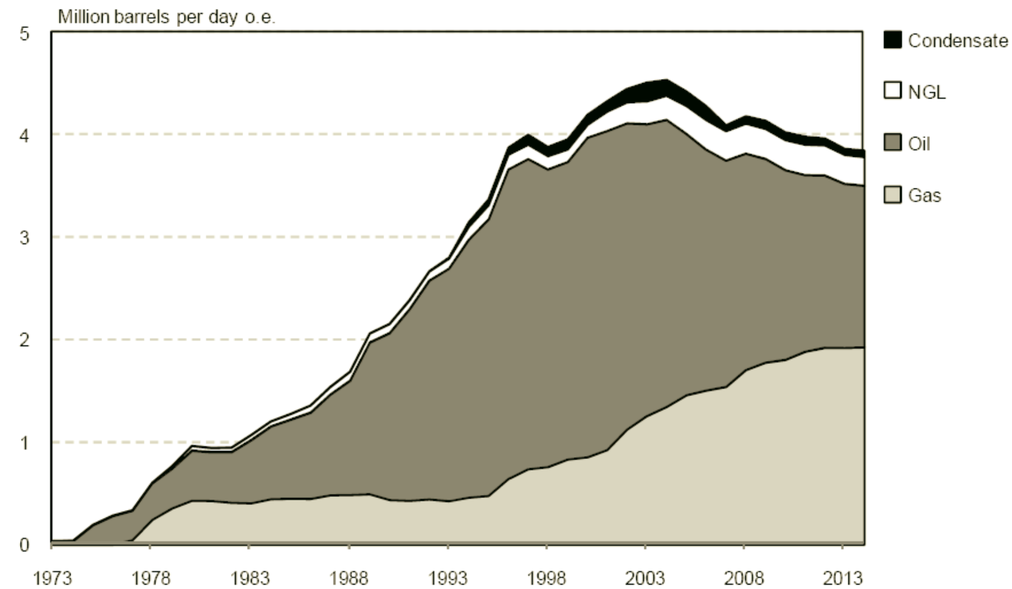
Energy production and consumption trends

Norway is one of the richest countries in the world. According to OECD statistics, it ranks second to Luxembourg among OECD countries in terms of GDP per capita, at USD 61 415 as of 2009. Unemployment is low in comparison to other member states, at 3.2%. Norway is the third-largest exporter of energy in the world, after Russia and Saudi Arabia (IEA, 2011: 13). The petroleum sector is the main source of wealth in the economy accounting for 22% of total share of GDP and 47% of total exports. As of 2010 production stood at 2.16 mb/d, making it seventh largest world oil producer and fourth largest OECD producer. It also accounted for one quarter of investment in the country and provided 27% of government revenue. Norway contributes considerably to energy security of consuming countries. Over Nine tenths of the oil and gas production is exported with over 90% headed to OECD countries. Net exports of oil (including petroleum products) stood at 1.9 mb/d in 2010 (IEA (2), 2011: 5).

For over three decades crude oil and natural gas resources on the Norwegian Continental Shelf (NCS) have been the main driver of economic prosperity. Since 2002, oil production has been declining while natural gas production on the other hand has been steadily increasing since 1985 (Figure 1).

[1] Limaye (2008) identified seven distinct institutional models ranging from government agency to privately owned entities: 1. Government agency with broad energy related responsibilities 2. Government agency focused on clean energy technologies (e.g., EE, renewable energy, sustainable energy, global climate change) 3. Government agency focused on EE only 4. Independent statutory authority (ISA) with a government appointed board 5. Independent corporation (IC) owned by the government 6. A public–private partnership (PPP)

Figure 1.Petroleum production



Source: Ministry of Petroleum and Energy.

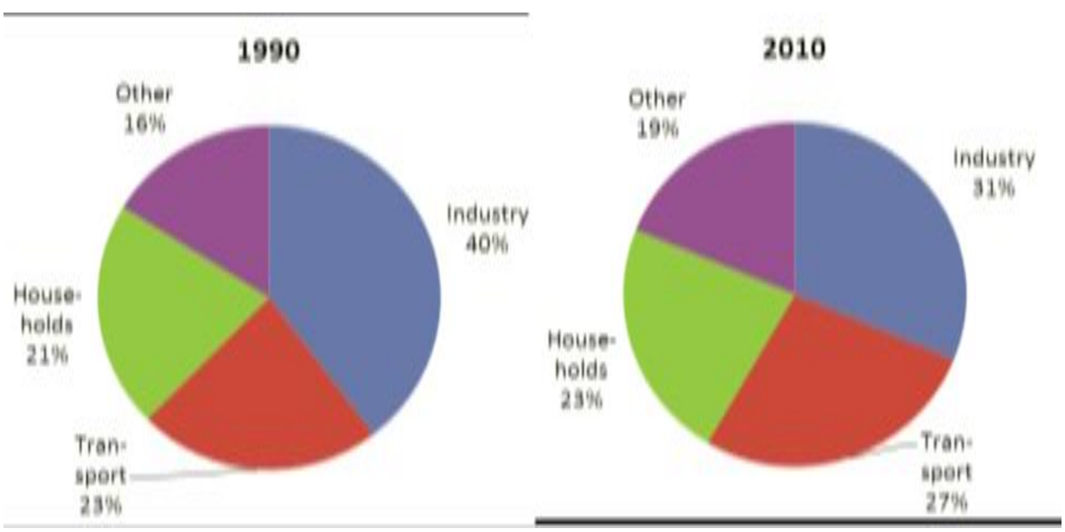
Retrieved from IEA, 2012

In the absence of significant new discoveries, the peak of oil production may already have happened. The newest discoveries in the Barents Sea and the Arctic Ocean, an area of 175 000 square kilometers has been an issue of dispute between Norway and Russia. Nevertheless, in April 2010, authorities reached an agreement on the demarcation of their maritime borders in those territories, which will allow for new upstream exploration in both Norwegian and Russian waters (IEA (2), 2011: 5). Oil and gas resources form the basis for an industrial cluster (refineries, petrochemical industry), and account for about one quarter of Norway's greenhouse gas emissions during production, distribution and consumption (IEA, 2011).

Final energy consumption (end-use energy), one of the indicators for EE, has increased from 195 terawatt per hour (TWh) in 1990 to 229 TWh in 2010. All sectors have performed well; especially industry sector had the highest increase. It should be noted however that the share of fossil fuels in total energy consumption (primary plus final consumption), especially oil, in has been declining. This is due to increased use of natural gas in exploration and transformation processes (primary energy consumption) and ever increasing share of hydropower in electricity generation, which accounts for half of end-use energy (Rosenberg, 2012: 3). According to the

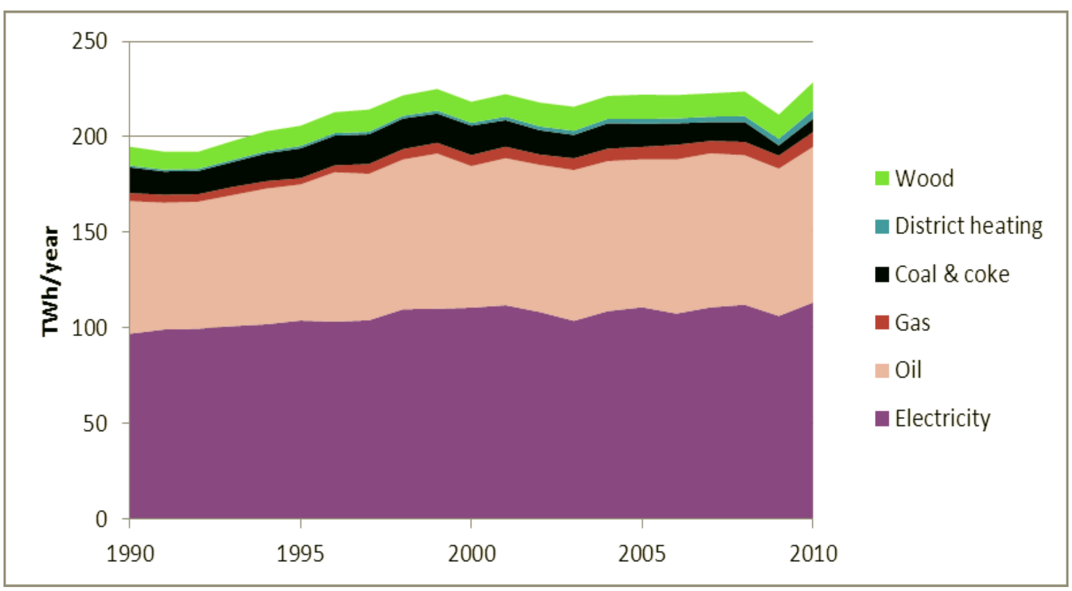
IEA the latter trend has also resulted in higher electricity use per capita than in any other IEA member country. In 2008, average use per capita was more than 23 megawatt-hour (MWh), while the IEA average amounted to 9MWh per capita and the world average to 2.5MWh (IEA, 2011: 17). Figure 2 and Figure 3 depict final energy consumption trends by sector and by fuel type respectively.

Figure 2.Total Energy consumption in Norway by sector (1990-2010), TWh (terawatt hours)



Source: ODYSSEE database

Figure .3Total energy consumption in Norway by Fuel type (1990-2010), TWh

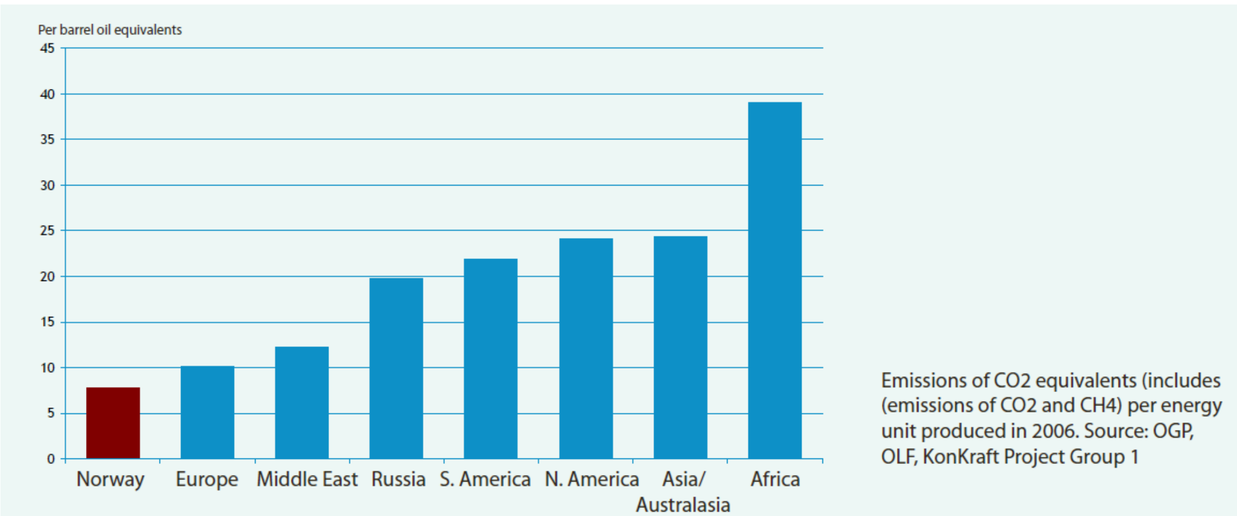


Source: ODYSSEE database

Energy Efficiency in Norway

Norway is the largest producer of hydroelectric power in Europe supplying more than half of the energy in final consumption. Norway also has the world's largest solar energy company and offers major potential for development of wind power both on land and at sea. According to a collaborative forum of Konkraft[2] from an environmental perspective, Norway should be the first choice as an oil and gas supplier. Greenhouse gas emissions from petroleum production equal only one-third of the world average (Figure 4).

Figure 4. Greenhouse gas emissions, 2012



Source: NEA, nvironment.no

These trends are the result of a number of fiscal policy instruments for limiting CO2 emissions either having been implemented or being planned. Taken altogether, these emissions have contributed to a reduction in CO2 emissions per unit on the NCS from 1990 to 2005 of 19% (Konkraft, 2014).

Although there is no central plan on EE as such, the government is actively practicing overall environmental/climate change policies and engaging in several international and regional

[2] Konkraft is a collaborative venue for Norwegian oil and gas, Norwegian Industry and the Norwegian Ship-owners' Association and Unions (LO). Through the work of KonKraft organizations focus on industry opportunities and challenges, and improve cooperation and increase awareness of the petroleum industry's importance to Norway

initiatives each of which focuses on certain aspects of EE and energy conservation with clear defined goals and expectations. It also acts as a legal and informative enforces in targeted domestic programs conducted by both public and private agencies. Norway is a member to the United Nations Framework Convention on Climate Change (UNFCCC) and to the Kyoto Protocol. According to the latter, it will have to reduce greenhouse gas (GHG) emissions to an average of 1% above their 1990 levels over the 2008-2012 period. Several ambitious national targets have been set by the Parliament in the 2008 Climate Agreement (IEA, 2011: 40, 27). Those are:

- Reduce greenhouse gases by 9% from their 1990 levels over the 2008-2012 period. That is 10 percentage points more than under the Kyoto Protocol.
- Reduce global greenhouse gas emissions by the equivalent of 30% of Norway's 1990 emissions by 2020.
- Become carbon-neutral by reducing global greenhouse gas emissions by the equivalent of 100% of Norway's emissions by 2050, at the latest

Norway has also taken a path to become carbon-neutral by 2030, at the latest, if an ambitious global climate agreement is reached in which other developed countries also take on extensive obligations (IEA, 2011: 28). The government encourages also global CO2 reduction by practicing certain fiscal policies on companies that operate internationally. According to Statoil, which is a member of the UN Global Compound, the company has successfully operated in Norway's carbon-constrained business environment since 1991, paying US$50 per tonne on carbon dioxide emitted by carbon-tax-regulated operations (Statoil, 2012: 18)

Institutional arrangements

Norway was the first country in the world to have a Ministry at cabinet level with special responsibility for environmental matters established in 1972. EE governance in Norway is organized in a hierarchical manner (CPA 2014, EEA 2014). The Parliament sets overall national climate change strategies, while the government implements and administers the most important policies and measures. At the top is the Ministry of the Environment, which is responsible for coordination of climate change policies. Several sectorial ministries are also involved in EE policies each specializing in sector-specific issues, including the Ministry of Petroleum and

Energy (MPE), the Ministry of Transport and Communications, the Ministry of Trade and Industry and the Ministry of Agriculture and Food (IEA, 2011: 30). The Ministry of Finance is responsible for financial and fiscal policies, including environmental taxes, or the government program for the purchase of emission credits under the Kyoto Protocol. Much of the targeted policies and measures at the local level are carried out by a set of subordinated directorates such as the Climate and Pollution Agency, Directorate for Nature Management etc. or other public or private agencies (IEA, 2011: 30.32).

Enova Sf. is a public enterprise for promoting EE. Its main focus areas are renewables and environmentally friendly natural gas solutions. It is owned by the Government of Norway and represented and ministered by the Ministry of Petroleum and Energy. Enova's main mission is to contribute to environmentally sound and rational use and production of energy. It organizes tenders for projects and uses financial instruments and incentives to stimulate market actors and mechanisms to achieve national energy policy goals. Alteration of energy use and production is financed through the Energy Fund. Enova set targets is to deliver 18 TWh in energy conservation and renewable energy production by the end of 2011 and 40 TWh by 2020. It had started projects with an estimated total energy result of 13.8 TWh per year by the end of December 2009. Of these, 5.1 TWh had been realised (Rosenberg, 2012:9; IEA, 2011:20).

Statnett SF, the transmission system operator, is cooperating with Enova. It owns about 87% of the transmission grid. It is like Enova owned by the government and administered by MPE. Statnetts' revenues are regulated by the Norwegian Water Resources and Energy Directorate (NVE), as part of NVE's regulation of monopoly operations (IEA, 2011:19; Rosenberg, 2012:9).

EE plans in the transport sector are implemented and coordinated by Transnova. It is a government agency in the field of low emission transportation and was established in 2009 as a trial R&D funding program. Transnova is managed by the Norwegian Public Roads Administration (NPRA). The goal is to halt the trend of the fast increase of greenhouse gas emissions from transport in order to reduce GHG emissions. Its largest funding operations are directed at hydrogen projects accounting to about 40% of the total funding (IEA, 2011:42; Rosenberg, 2012:9)

The different bodies have clearly defined roles along the innovation chain. Co-operation and coordination between MPE, Enova, Transnova, Stattnet, the Research Council and other public, private agencies is important to secure effectiveness in the different policy instruments. Cooperation is based on agreements and the different bodies cooperate through joint activities, such as common conferences, instruction booklets, fact books and common studies, commonly defined as informative instruments (IEA, 2011: 20).

Energy conservation, Renewable energy

In addition to central elements in the government's energy policies, which aims at limiting growth in energy consumption and make energy use more efficient, there is a strong tendency to encourage increased energy production from renewable sources. The EU Renewables Energy Directive (RES) sets a target for increasing the share of renewable energy used in the EU to 20% by 2020. The directive was implemented into the European Economic Area (EEA) Agreement at the end of 2011 and in 2012 Norway implemented the directive. The Norwegian goal for the share of renewable energy in 2020 is 67.5%, an increase from 60.1% in 2005. Recent developments in policy instruments include the common Green Certificate Market (GCM) between Sweden and Norway, in order to promote new renewable energy projects until 2020. The new market mechanism is expected to annually generate 26.4 TWh electricity by 2020, where each country is financing 13.2 TWh. Norway consistently has the highest share of renewable energy and waste in Total Primary Energy Supply (TPES) among the 28 IEA member countries, with only Iceland outweighing its levels. Renewable energy accounts for 46% of total primary energy supply. Hydropower covers for around 89% of the total, while the remaining share was traditional biomass 8% and waste 2%. Wood as a renewable is used for heat production in residential heating amounting to 0.6 Mtoe. Renewable energy use in transport mostly comprises of biofuels, but the use of electric vehicles is being promoted. The latter are fuelled by electricity from renewable sources Wind as renewable is also used in electricity production but the potential of wind power has not been fully explored yet. (IEA, 2011: 83, 86, 90)

Taxation and other public policy techniques

Fiscal instruments on energy use serve various objectives, raising government revenue, pricing of external environmental effects and meeting energy policy goals (see Table 1 in Appendix). A value-added tax of 25% is also applied to energy consumption for end users, after special taxes have been applied. Each of the sectors targeted by agencies has a separate program on EE. For example in the transport sector taxes have impacted consumption behavior of car users. Tax cuts on diesel cars promote diesel consumption. Taxes on petroleum production and CO2 emissions encourage new technologies on Carbon Capture and Storage (CCS) systems.

Norway practices a special surplus taxation for the production of petroleum and hydro power. There is considerable excess return (resource rent) associated with the extraction of oil and gas. Therefore, a special tax of 50% is being charged to petroleum extraction and 30% to hydropower generation in addition to the ordinary corporate tax of 28%. Consequently, the marginal tax rate within the petroleum sector is 78% and 58%, in hydropower. There are specific taxes on the purchase of certain end-products such as gasoline, diesel, heating oil and lubricant oil. As in many OECD countries, taxes on diesel are lower than taxes on gasoline, resulting in progressive "dieselization" of the vehicle fleets (IEA (2), 2011: 7). Many measures in the transport sector in Norway are local measures like road pricing, reduced speed limits in specific areas due to environmental reasons, tax for use of studded tires in city center etc. The registration tax on vehicles, are high. The purchase tax is correlated to CO2-emissions. An important step towards less gasoline consumption was the introduction of a purchase tax reduction on diesel cars (Rosenberg, 2012:4)

Funding & investments

Enova SF administrates the Energy Fund. The income of the energy fund comes from a levy of 1 øre/kWh (≈0.008 €/kWh) to the distribution tariffs that is mandatory and from allocation from the state budget (IEA, 2011:20, Rosenberg, 2012:34). Financial incentives for different sectors are being offered depending on the energy intensity of a sector. For example, Enova works to promote more environment-friendly and efficient use of energy in intensive industry sector through its program on Energy Consumption in Industry. On the basis of applications from mainland companies, the program can offer partial financing through investment support to trigger the implementation of: energy efficient work models; exploitation of waste heat; conversion to the use of renewable energy sources. Enova provides funding up to a level where the project achieves a normalized rate of return. Projects are expected to deliver at least 0.5 GWh per year. This may include both reduced energy consumption and use or production of renewable energy. Enova can contribute up to 20% of the total project cost (Rosenberg, 2012:39; IEA, 2011:44)

Enova also administers a program for new buildings which focuses on passive houses. The program grants investment aid for highly ambitious energy-efficient projects at a fixed rate (NOK/m2). In terms of existing buildings, the program has increased the focus on driving down the costs of best available technology. New appliances like lighting, ventilation, windows, etc. have to be in line with the passive house requirements to be eligible for support (Rosenberg, 2012:31, 34; IEA, 2011:43). According to the IEA, with resources from the Energy Fund, Enova has in cooperation with the market triggered annual energy results totaling 16.6 TWh during the period 2001 to 2011. The goal for this period was 18 TWh (IEA, 2011: 40). Enova Sf. is the only central agency representing interest of the Norwegian government in several international collaborations on energy efficiency including the EU Directive on energy efficiency of the European Commission, the IEA collaboration and many other small conferences and forums.

A brief summary of some of the most important measurements towards specific EE aims is provided in Table 2 in Appendix.

METHODOLOGY

Case study research

Methodology used in this study is curtailed in order to find the most suitable research designs, data collection and data interpretation to answer the question, therefore comprising of a mixture of methodological considerations. The type of the study is a case study research but supported mostly with qualitative evidence. Yin (2003) and Stake (1995) note that case study research has the potential to deal with simple cases through complex situations. It enables the researcher to respond to a variety of questions, while taking into consideration how a phenomenon is influenced by the context within which it is situated (Baxter & Jack, 2008:556). According to Yin (2003 in Baxter & Jack 2008) a case study design should be considered in the following setups: "(a) the focus of the study is to answer "how" and "why" questions; (b) you cannot manipulate the behavior of those involved in the study; (c) you want to cover contextual conditions because you believe they are relevant to the phenomenon under study; or (d) the boundaries are not clear between the phenomenon and context" (Baxter & Jack, 2008:545).

The next step is to determine the case/unit of analysis (Baxter & Jack, 2008:545). This study analyzes the type and extent of *processes* that influence EE in *Norway* and therefore the case being studies are processes (policy instruments), while the unit of study is Norway.

Finally it is important to determine the boundaries/the scope of the study e.g. what it is and what it is not. Yin (2003) and Stake (1995) (in Baxter & Jack 2008) have suggested that placing boundaries on a case can prevent unnecessary spills of information. The following practices are used to bind: (a) time and place; (b) time and activity; and (c) by definition and context (Baxter & Jack, 2008:546). This study is limited to definition and context due to the country context "Norway" but does not exclude the factor time because energy efficiency measures had an establishment point in history and data available on monitoring results of each attempted or completed program depends on its length of application.

Research design

Yin (2003) distinguishes between explanatory, exploratory and descriptive designs, while Stakke (1995) describes the intrinsic, instrumental and collective designs. The research design in this study combines features of intrinsic and descriptive methods. *Intrinsic* research design is used when researchers want to know more about a particular individual, group, event, or organization etc., in this study "the prevalence of EE governance (policy instruments and institutions)". The point of interest is not necessarily on examining or creating general theories or, in generalizing their findings to broader populations (Dawson & Algozzine, 2006:32). This study pursues the same strategy. *Descriptive* research design is probably the most effective design in connection to question of this study. It attempts to present a complete description of a phenomenon within its context, in this case the phenomena being that of EE within the Norwegian context (Dawson & Algozzine, 2006:33).

Data collection

Data collection is thoroughly dependent on research question. This study uses data sources that comprise of documents and independent indicators provided by specific statistical databases.

Documents will be in forms of independently published articles, archival records, progress reports, annual evaluations etc. (Baxter & Jack, 2008; (Dawson & Algozzine, 2006:63). Indicators will be in forms of summary statistics, comprising of quantitative numbers and visual forms like charts, graphs and tables. Virtually all data will be collected from the internet, from university libraries, other internet libraries and public, private databases. The following detailed types of data, including documentation and indicators from databases, will be used: IEA annual reports, country evaluations; CO_2 reports from the National Environmental Agency of Norway; Total energy intensity reports from the European Environmental Agency (EEA); Resource productivity indicators from Eurostat databases; EE policy measure indicators from MURE database and EE index from ODEX index.

Each of the data sources are based on statistical analysis carried out by separate agencies that represent national and/or international interests and each of them carries its own responsibility duties towards quality assurance and documentation of the quality. However, some of them can be grouped together according to their point of establishment. MURE and ODEX are part of the ODYSSEE MURE project coordinated by ADEME (French agency on Environment and Energy Management) and supported under the Intelligent Energy Europe Program (IEEP) of the European Commission (EC). Eurostat is the statistical department of the EC and directly administered by it. The EEA is also an EU agency promoting energy efficiency. Eventually most of the data comes from separate EE departments established by the EU to monitor EE trends in member and collaborating countries. The quality of the accounts is only as good as the quality of the underlying basic statistics. Collected data is sorted according to their purpose in answering the question.

Analysis

According to Dawson (Dawson & Algozzine, 2006) there is no universal method when it comes to a case study research, however there are a few ways to represent documentation as answers to research questions in a case study e.g. description, analysis, or interpretation (Dawson & Algozzine, 2006:53). In this study information comes from multiple data sources that must be summarized into a meaningful construction that can solve the question. In relation to this, the research uses several methods. However considering data collection methods, it can be claimed that the type of analysis will be document analysis. “Document analyses are often summarized in narrative form or integrated into tables that illustrate trends and other significant outcomes" (Dawson & Algozzine, 2006:51)

Qualitative vs. quantitative

Although a case study cannot be referred to as qualitative research or quantitative research, it can be based on any mix of quantitative and qualitative evidence (Dawson & Algozzine, 2006; Baxter & Jack, 2008). This study uses methods of both. Quantitative data collected from reports and statistical databases will be interpreted qualitatively. Quantitative methods in reports and databases are used to evaluate the impact of EE policies. Eventually, qualitative interpretation of collected data allows for labeling of impacts by categorizing them as effective or ineffective. This kind of assessment will be provided at the end of the next section. EE can be measured in several ways using different efficiency indicators. This study uses the following indicators and indexes which are used to measure EE impacts:

The **MURE (Mesures d'Utilisation Rationnelle de l'Energie)** database provides an overview of the most important EE policy instruments by sector (households, industry, transport and tertiary), and general or cross-cutting measures. Quantitative impacts of policy measures are expressed in terms of energy savings and/or CO_2 emission reduction. Information about these measures is collected by national energy agencies or institutes. The measures are classified according to various criteria:

• status (completed, ongoing or planned); year of introduction and completion; type (shown in next section), qualitative impact (low, medium or high) based on quantitative measures (CO_2 levels), the targeted energy users, the actors involved, etc.

Impacts can be reflected through several is study will use measures that reflect their semi-quantitave impact

ODEX – ODYSSEE energy efficiency index is an aggregate bottom-up EE index. It measures impacts by final consumption levels of each sector. Unit consumption by sector is expressed in different physical units so as to be as close as possible to EE evaluation: (toe/m², kWh/appliance, toe/ton, liter/100 km...). EE gains are measured in relation to the previous year („sliding ODEX") and not to a base year (e.g. 1990), so as to avoid to have results influenced by the situation of the base year.

Total energy intensity - is the ratio between the gross inland consumption of energy and GDP, calculated for a calendar year. Gross inland consumption of energy is calculated as the sum of the gross inland consumption of five sources of energy: solid fuels, oil, gas, nuclear and renewable sources. To monitor trends, GDP is in constant prices (base year 2005) to avoid the impact of inflation. Gross inland energy consumption is measured in 1000 tonnes of oil equivalent (ktoe) and GDP in million Euro at 2005 market prices. (EEA 2013, Rosenberg, 2012:11) Taking into account that energy intensity can be affected by external factors such as: stochastic economic shocks such as disruptions of energy due to natural disasters, wars, massive power outages, unexpected new discoveries, but this study will use only indicators that reflect influence of internal factors like policy instruments.

Resource productivity - is GDP divided by Domestic Material Consumption (DMC). DMC measures the total amount of materials directly used by an economy (primary energy consumption-energy that is used for production, transformation and transportation). It is defined as the annual quantity of raw materials extracted from the domestic territory of the central economy, plus all physical imports minus all physical exports. The term "consumption" as used in DMC denotes apparent consumption and not final consumption. DMC does not include upstream flows related to imports and exports of raw materials and products originating outside of the focal economy (Eurostat 2014).

Each of the indexes and indicators reveal the impact of EE measures accorind to their specific unit of measurement.

FINDINGS & DISCUSSION

MURE

Data collected from the MURE database (see Figure 5-9 in Appendix) depict EE policy patterns by sector. Below are twelve instruments which characterize type of actions taken towards EE.

Coop: Co-operative Measures
Cros: Cross-cutting with sector-specific characteristics
Fina: Financial
Fisc: Fiscal/Tariffs
Info: Information/Education/Training
Le/I: Legislative/Informative
Le/N: Legislative/Normative
Mark: New/Market-based Instruments
Infr: Infrastructure
Soci: Social Planning/Organizational
Gene: General Energy Efficiency / Climate Change / Renewable Programs
Nonc: Non-classified Measure Types

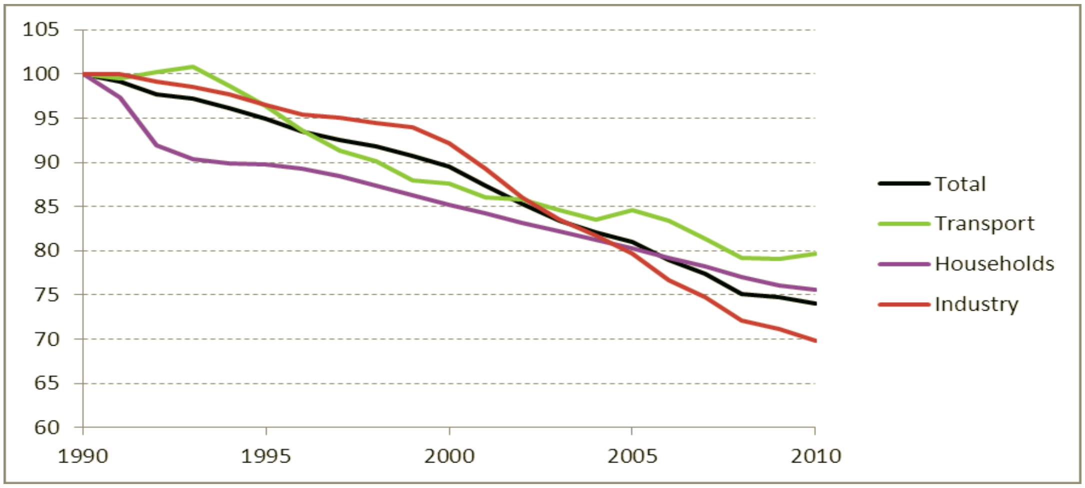
Figures 5-9 in Appendix measure policy effectiveness by type accorindg to their semi quantitative impact (CO2 emissions impact) and labels impacts as high, medium or low. Some details on specific types of most important measures is also provided in Table 2.

Figure 5 indicates that the industry sector has had the largest impact when adderesed with financial instruments. Those were mainy in the areas of energy consumption (Energibruk – industry 2003) and grants to renewable heat production and distribution (district heating and local heating plants) in 2008 (Rosenberg, 2012:55), with 80% impact, followed by informative measures, while cooperation and fiscal measures were the least effective. Figure 6 on service sector indicates highest influence under one single cooperative measure almost by a 100% increase in effectiveness in comparison to prior levels, and medium impacts under financial. The most important legislation was on the minimum EE standards for boilers in 1999 and mandatory climate and energy plans in municipalities act in 2010 (Rosenberg, 2012:55). The transport sector is characterized with high impact levels accomplished by financial and fiscal instruments like taxation on car purchase (1959), gasoline, diesel oil (1986) and EU-related promotion of Biofuels or other renewable fuels for transport (2009) and low impact measures by informative, cooperative and legal/normative (Rosenberg, 2012:54).Three medium and low-impact financial measures like grants for energy savings in the built environment or funding by local governments, show improvements in the residential sector along with zero improvement from three other measures. Finally four measures in the cross-cutting sector had low impacts. Those were of general EE type (energy conservation, climate change etc.) and market-based Instruments including funding, local energy studies, new technology support and the Eco-design directive (Rosenberg, 2012:53).

ODEX

The ODEX shows overall improvements by 26 % from 1990 to 2010 or by 1.3 % annualy, meaning that EE policies and measures implemented since 1990 have contributed to a decrease in the energy use of 2010 of approximately 59 TWh. This development has been positive for all sectors, according to the selected indicators. The sector using most energy both in 1990 and in 2010 was industry, but the share has decreased from 40 % in 1990 to 31 % in 2010 (see Figure 3) The highest decrease occurred especially from 2000 to 2010 with an annual improvement of 1.5 %. It is mainly an outcome of structural shifts (shifting from heavy manufacturing to service sector). The transport sector has in overall improved the EE index, but increased its share the most at the end of the period in 2010. The household sector has a rather constant improvement after 1992 and in total the annual improvement has been 1.2 % (Rosenberg, 2012:29) Figure 10 depicts overall and by sector efficiency progress from 1990 to 2010.

Figure 10. Energy efficiency progress (at normal climate), ODEX total, industry, transport and households, 1990-2010

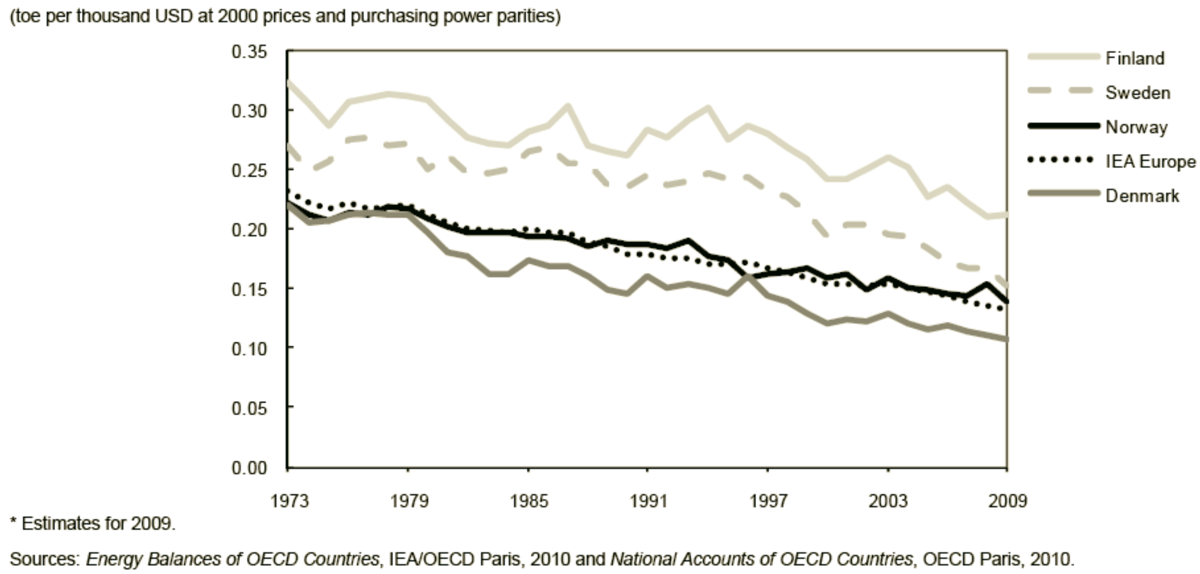


Source: ODYSSEE database

Energy intensity measures

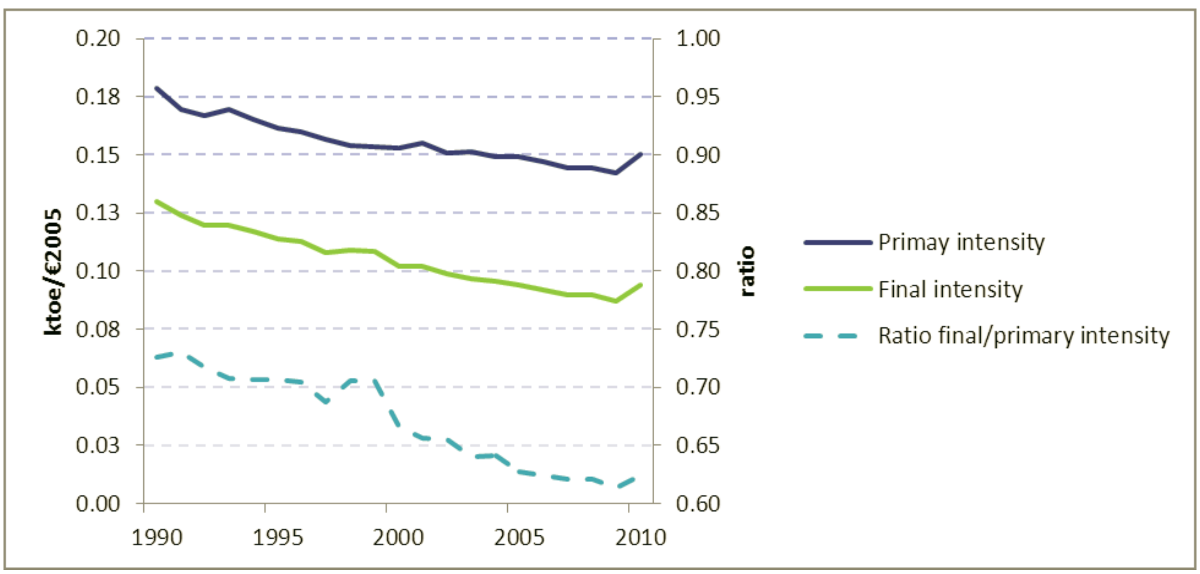
Measures of intensity more closely approximate changes in the underlying efficiency of energy use. Energy intensity in Norway is close to the IEA European average and has decreased on average by 1.4% per year from 1990 until 2009 but the last year there has been an increase, outgrowing its Swedish and Finnish neighbours (see Figure 11 and Figure 12). The National Environmental Agency of Norway indicates that this decline is partly due to EE measures, but largely attributable to fast economic growth. Changes in industrial structure (from manufacuring to service economy), changes in prices and market conditions and greater productivity resulted in GDP growing more strongly than domestic energy use throughout the period 1976–2006 (SEN, 2014; Rosenberg, 2012:11). The sudden jump in energy intensity from 2007 to 2008 mainly resulted from a demand decrease on Norwegian oil exports and was therefore not linked to EE (IEA, 2011: 39). From 2008 the GDP has declined due to economic crisis, the most in non-energy intensive sectors. In 2009 the final energy use of particularly some energy intensive industry increased again, but the overall GDP is almost unchanged, resulting in increased energy intensity (Rosenberg, 2012:11). Energy use from 1976 to 2006, increased by about 68%. For the period as a whole, non-renewable energy use has risen slightly more (69%) in comparison to renewable energy use (66%) (EEA 2014, NER, 2014). The trend of the ratio of final/primary intensity has been decreasing until 2008 but increased from 2009 to 2010. A decrease of the ratio final/primary intensity means that more primary energy is needed per unit of final energy consumption, suggesting therefore that an increasing share of the primary energy consumption is not going to end users, but is hence consumed by industry. This can be explained by increased activity in the oil and gas production and non-energy uses in chemical industry (Rosenberg, 2012:11).

Figure 11. Energy intensity in Norway and in other selected IEA member countries, 1973 to 2009*



Source: OECD, Retrieved from (IEA, 2012)

Figure 12. Primary and final energy intensity/ratio, 1990-2010

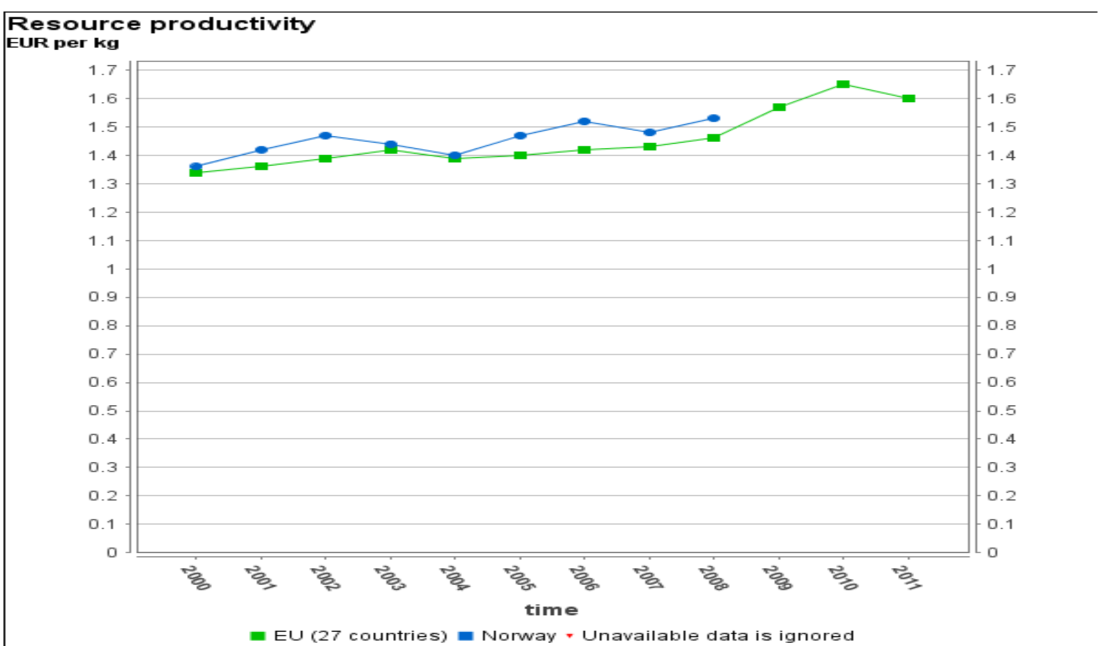


Source: ODYSSEE database, Retrieved from Rosenberg E. 2012

Resource productivity

Resource productivity has overall increased for the period from 2000 to 2008 (see Figure 13), for which data is avaliable. In comparison to the Eropean Union (EU27) Norway has a better performance increasing resource productivity from 2000 to 2008, but on average there is less difference. Since energy productivity measurements are based on primary energy consumption, the gradual increase in resource productivity can be explained by consumption levels of each fuel type. As Figure 3 indicates Electricity generation is the highest energy consuming source. However, production of electricity mostly relies on hydropower and is already efficient. Oil is the second highest energy consumer and reflects stable levels. This is due to a gradual decline of crude oil consumption and a recent increase after 2008. The gradual decline is an outcome of decreasing share of energy consumption of the industrial sector by 9% from 1990-2010, while the recent increase is linked to increasing share of consumption by the transport sector from 23% in 1990 to 27% in 2010, see Figure 2. Fluctuations in resource productivity could be explained by oil demand levels. Production, transformation and transportation of crude oil require massive amounts of energy and are most harmful to the environment. Like the decrease of oil and condensate production levels after 2003 indicate in Figure 1, resource productivity consequently increases. The presence of less energy consuming gas in oil production contributes also to less GHG emission in the industrial sector.

Figure 13.Resource productivity, EUR per kg (NOR & EU27)



Source: Eurostat, last accessed 24th January

Following key messages can be extracted

- Data retrieved from MURE database show that financial (funding of and investment in energy efficiency programs), cooperative (minimum EE standards for boilers in 1999 and mandatory climate and energy plans in municipalities act in 2010) and fiscal measures (vehicle registration tax, purchase tax related to CO2 emission, tax reductions on diesel cars etc.) had the highest impact with regard to CO2 emissions.
- ODEX has increased from 1990 to 2010 by 26% indicating that EE policies and measures implemented since 1990 have contributed to a decrease in the energy use of 2010 of approximately 59TWh. Each sector consequently has decreased energy consumption, except transport which has increased after 2008.
- Energy intensity decreased overall from 1976 to 2008 showing upwards trends afterwards, mainly caused by increased energy use in energy intensive industry sector after 2008 and economic crisis following in 2008 resulting in GDP decrease.
- Resource productivity trends move counter to oil production levels
- Overall GHG emissions have been reduced in comparison to previous decades but CO2 remain to be relatively high due to the intensive petroleum industry which pushes primary energy consumption levels up.

Discussion

Although total primary and final energy consumption has increased over a time-span of 40 years fluctuations are visible. Fluctuations are associated with the fact that energy consumption levels are sensitive to external factors, such as economic shocks, market prices; new field discoveries etc. That is why it is using consumption levels as base for calculating policy impact becomes risky, unless a detailed analysis of specific policy type at specific concerns is given. Overall EE developments have been successful if compared to other OECD countries. But one should keep in mind “country context”. Strong hydropower development in Norway allow for higher consumption levels without risking environmental damage and provide most of countries energy, therefore making petroleum production almost exclusive for export. Stable economic growth is not affected by decreasing petroleum production, because Norway has a diverse economy with strong non-petroleum sectors.

CONCLUDING REMARKS

Although not entirely one of a kind achievement, the experience of Norway shows that policy arrangements have a huge impact on energy efficiency. This is all a result of a set of instruments that promote legislation, establish institutions and set up funding mechanisms. Collectively these policies encourage and promote energy efficient development. Nevertheless, the Norwegian context shows that the assessment extent of effectiveness of EE policies is itself an enduring task. Findings in this study indicate a need for further detailed assessment of energy efficient policies in a selected group of countries that will allow for cross-country comparisons on energy efficient policy. This will allow for a better evaluation of policy impact on energy efficiency in different contexts.

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Annexes:

*Table 1.Tax rates on energy products for 2010**

Tax rates on energy products for 2010*

*in Norwegian Kroner (NOK)***

Petrol tax		**Carbon dioxide tax**	
Sulphur-free	4.54	Petroleum activities, per litre or Sm^3	0.47
Low-sulphur	4.58	Mineral oil	0.58
		Mineral oil for domestic aviation	0.68
Auto diesel tax		Mineral oil for wood processing & fish industry	0.30
Sulphur-free	3.56	Gasoline	0.86
Low-sulphur	3.61		
Biodiesel	1.78	Natural gas, per Sm^3 - general rate	0.45
		Natural gas, per Sm^3 - reduced rate	0.05
Electricity consumption tax, per kWh			
General rate	0.11	LPG, per kg - general rate	0.65
Reduced rate	0.00	LPG, per kg - reduced rate	0.00
Basic tax on heating oil, etc.		**Sulphur tax**	0.08
Mineral oil	0.89		
Mineral oil for wood processing, prod. colorants/pigments	0.13		
Lubricant oil tax	1.80		

** per litre, unless if otherwise indicated* *** 1 NOK = Euro 0.12 = USD 0.17 (31/12/2009)* *Source: Norwegian government*

Retrieved from IEA 2011

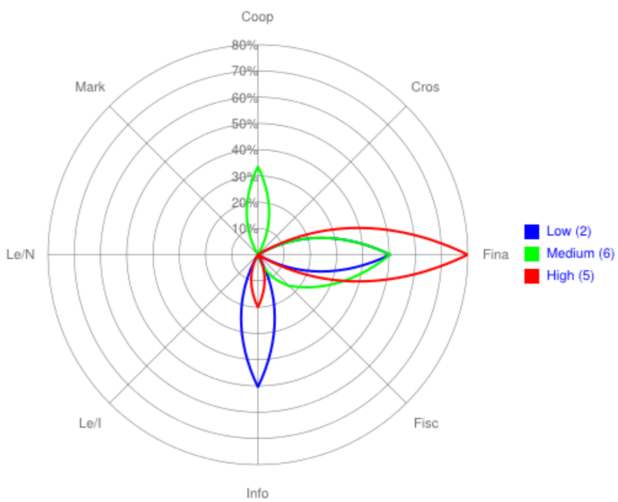
Table 2.Main policies and measures to improve energy efficiency, 2010

Measures	Sector	Comments
CO_2 tax and EU-ETS	General	
Electricity tax	General	
Fuel oil tax	General	
Investment support from Enova	Energy, industry, buildings	
Enova's household scheme	Households	
Research Council of Norway (RCN)	R&D	The RCN funds research and projects; several programmes are related to energy efficiency.
Programme for Energy Efficiency (PFE)	Wood-processing industry	Participants may be entitled to exemption from the electricity tax by pursuing certain measures in energy efficiency
Innovation Norway	Small and medium-sized enterprises	Energy efficiency is one of the main areas of focus in their Energy & Environment Programme.
Norwegian State Housing Bank	Buildings	Provides basic loans for building and renovating homes, with environmental requirements designed to stimulate environment-friendly buildings
Building regulations	Buildings	Directive 2002/91/EC
Eco-design regulations	Energy-using products	Directive 2005/32/EC
Energy labelling regulations	Energy-using products	Directive 92/75/EC
Energy labelling of buildings	Buildings	Directive 2002/91/EC
Enova's hotline	Households, companies	Enova funds a telephone and internet service for information and advice regarding energy and Enova's programmes.

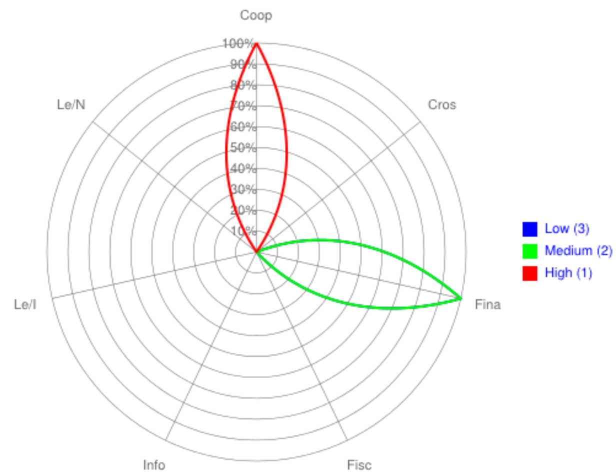
Retrieved from IEA 2011

Figure 5-9. Energy efficiency measure patterns by sector: development of measure by type over quantitative impact (NOR)

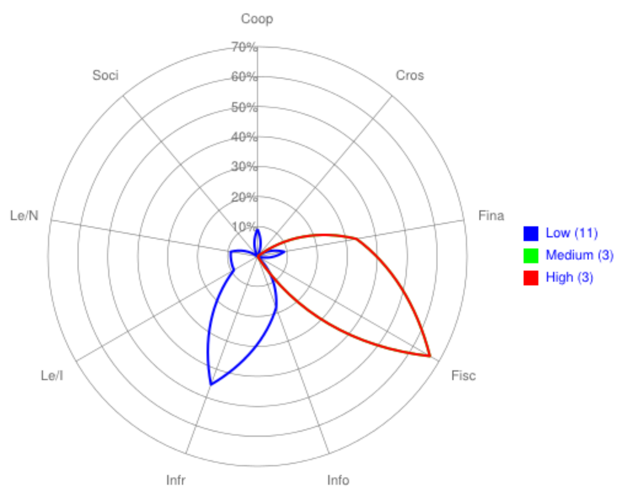
5) Industry



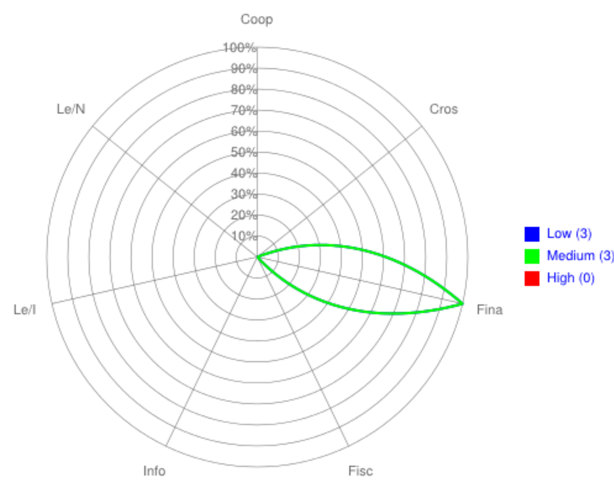
6) Service



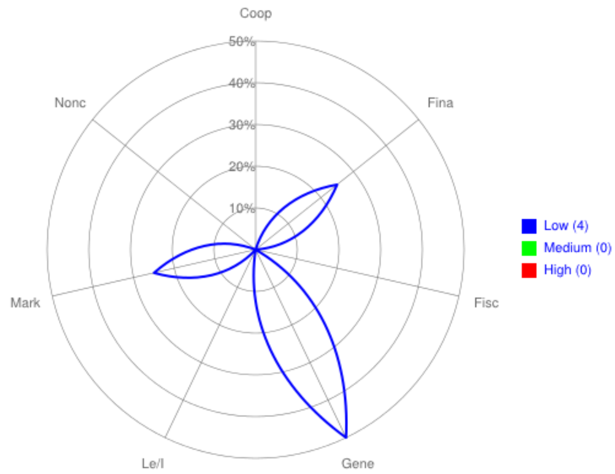
7) Transport



8) Residential



8) Cross-cutting sector



Source: MURE database