STRATEGIES TO REDUCE ENERGY CONSUMPTION OF HOUSEHOLDS in NORWAY & FRANCE

- How long term regulation beats large public spending

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Abstract

Through a data and qualitative analysis of the French and Norwegian household energy consumption, I argue that the energy price, energy costs, and ownership percentage; interact and strengthen the effect of regulations, policies and financial incentives. The goal is to reduce consumption without spending too much on financial incentives. Consistent and long term regulation combined with a high volatile market price can reduce the need for financial incentives and thus public expenditure. Over time effects like high prices, high energy costs for households and high percentage of ownership have an interaction effect with the national regulation. It is clear in the case of Norway that having those favorable structural factors and an ambitious and constant building regulation over time leads today to an efficient housing stock. The energy consumption per person is reducing and investments in energy efficient technology are high with a minimum of financial incentives. The French case suggests the opposite that with reducing energy costs over time and a late and less ambitious historic building regulation, consumption per person rises. This can explain why France is currently spending large amounts in financial incentives (tax credits, lower V.A.T. and zero-interest loans) to launch energy investments in France. The results are positive, but the amount spent may be larger than necessary.

Preface

This paper is written as my final part of the Master of Science in Economics and Business Administration, major in Energy, Natural Resources, and the Environment at the Norwegian School of Economics (NHH). This master's thesis represents 30 ECTS.

The work on this paper started early and lasted long. Already during the spring 2011, after a week of conversations with professors and potential supervisor it was clear that Johannes Mauritzen would be the supervisor for my master thesis. At that time I wanted to write about ”planned obsolescence” and how increasing the lifetime of fast moving consumer goods like light bulbs would reduce emissions and save energy. Theory about "planned obsolescence" was limited and a series of master thesis had already been written on the phasing out of "inefficient lighting". In addition, in Norway incandescent light bulbs of 100W and 75W had already been phased out (1st September 2009 and 2010) for the benefit of LEDs or Compact Fluorescent lighting.

Summer 2011 I decided to write about public financial incentives for Norwegian households for energy efficient renovation, construction or investments, and why they were so low. At that time only a small subsidy (10-15% of the costs) were granted for the purchase of expensive energy efficient heating systems (water to water heat pumps, pellet ovens, solar heaters, etc…). In July 2011, in France, a country I also know well, the "Grenelle de l'envirronement 2" (Environmental laws) was making god progress one year after its introduction. It was the 2nd version of the new environmental law[1] introduced in 2008. For the building sector it introduced the ambitious 2012 thermal building regulation (RT2012) increasing the standards for much better energy performance of buildings. It made mandatory energy performance labeling mandatory for all buildings and reinforced many financial incentives. I knew both countries well and I wanted to find the reason between the large gap in policy. I started with the hypothesis that French had the best incentives to stimulate energy efficiency among households. It started as a theoretical paper discussing optimal policies in the literature and how the EU was leading its members to more energy efficiency in buildings.

When analyzing the consumption data of households I quickly noticed that Norwegian consumption per person was declining while the French one was increasing. Households' energy consumption depends on heating and construction investments made many decades ago. What became the new research question was why consumption in Norway was decreasing and was that the reason for less financial incentives. The change came late and I knew then I wouldn't finish in time (December 2011).

[1] In Buildings, Transport, Biodiversity, Energy, Risks Health and Waste, and Governance.

During the spring semester 2012 I was on exchange in Madrid and had a course which helped me with finding the right indicators to analyze national policy, “Economics of Public Expenditure”. That period I redefined the papers objective, gathered and formatted all the data so it was comparable and adjusted for temperature, inflation and GDP. Consumption data is for households’ stationary use (excl. transport) per person and weather adjusted. Energy prices data are in nominal €/MWh (or NOK/kWh)[2], in real prices (or nominal adjusted for GDP), including or excluding taxes.

This enabled me to start in August 2012 with a clear definition of the paper, consumption data, articles on optimal policy and summaries of the current building reforms. From there it didn’t take long to set up the analysis on temperature, price, energy costs, ownership and building regulation through time. When writing such a paper on policy and regulation I chose to keep it short and to the point. There is much information that is interesting in this context but not necessarily relevant for the research question.

In that sense I thank my supervisor for very good and precise corrections; good communication and good advices! Buildings and Policy were subject areas that were new to both of us and I thank him to help formulating and orienting this into an actual, original and pertinent paper.

[2] 1 Euro = 8,1 NOK (Annual Average 2000-2010) (Norges-bank.no, 2012)

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Glossary

Greenhouse Gas (GHG): a gas, such as carbon dioxide, that contributes to the greenhouse effect by absorbing infrared radiation and causing global warming. (wordreference.com)

Heat pump: A device that transfers heat from a colder area to a hotter area by using mechanical energy, as in a refrigerator. (wordreference.com)

Heating Degree Days (HDD): The daily average difference between the temperature indoor (set to 18°C) and the temperature outdoor (when below 15°C) (Eurostat, 2009). It illustrates the need for heating, and can be used to adjust the consumption for temperature variations (i.e. on colder years, the need for heating and thus the energy consumption is higher. We adjust by reducing consumption accordingly to get the consumption of a normal year (base=1980).

Heating fuel (fuel oil): A distillate fuel oil, it is used in burners for domestic heating to heat home and water. Moderate capacity is used for commercial/industry burner units. Also, residual fuel oil for production of electric power and space heating. (EIA.gov/glossary: fuel oil)

Insee: “Institut Nationale de la Statistique et des Études Éconornoique” French for Nationale Institute of Statistic and Economical studies.

Primary energy consumption: It is the final energy delivered to the customer plus the energy lost in production and transmission. In France $1kwh_{fe}$ = $2,58kwh_{pe}$ (Ademe, 2011a), while Norway uses mainly $1kwh_{fe}$ ($1kwh_{pe} > 1kwh_{fe}$). The unit of measure, kwh_{pe}/m^2 can be used to state the average consumption of buildings in one country or as a standard/regulation for new constructions.

SSB : ”Statistisk Sentralbyrå” Norwegian for Statistical Central Agency.

1. Introduction

1.1. Context

In January 2007 the commission of European communities published the communication report: "Limiting Global Climate Change to 2 degrees Celsius The way ahead for 2020 and beyond". This report announced the targets for 2020, the European Union's strategy for sustainable growth. The three objectives for Climate Change and Energy[3] are clear (European Commission, 2012):

"1. Reducing Greenhouse Gases (GHG) emissions by 20% compared to 1990 levels by 2020
2. Increasing the share of Renewables in final energy consumption to 20%
3. Moving towards a 20% increase in Energy Efficiency"

The main arguments behind these targets are supply security, environmental and resource management; and energy saving to increase competitiveness and growth. Supply security is at risk as for example 80% of European natural gas imports originated from only three countries: Russia, Norway and Algeria (in 2009) (Eurostat, 2012a). Prices of fossil fuels are on the rise due to increased scarcity, increased production cost and costs on CO2 emissions through emission quotas. Consuming less energy reduces the impact we have on the environment, by building less generation capacity but also by polluting and emitting less. Consuming less also means saving energy and energy costs. This will reduce costs, increase competitiveness which in turn will stimulate growth and create employment.

Households and residential buildings represent a 26,5% of the European consumption of final energy (Eurostat, 2012a). There is here a very large consumption and emission reduction potential. This can be obtained through investments in for example more efficient heating, better isolation of exterior facades and/or by better managing energy consumption using smart meters or central heating control mechanisms. Due to market barriers and failures specific to the residential building sector there is a large gap between the actual investments in energy efficiency and the higher investment level that is cost beneficial. High upfront costs, little interest for energy efficiency, little information on the benefits of such investments or simple conservatism create the so-called "efficiency gap".

This gap is the one responsible for the lag in households' investment in energy efficiency and the large potential consumption reduction that lies in the building sector. With the ambitious European 2020 targets there has been a new turn in government intervention this last decade. New and improved building regulation combined with generous financial incentives has been introduced to promote energy efficient investments.

[3] More objectives exist for Employment, R&D, Education, and Poverty.

1.2. Definition of the research statement

In this context of ambitious consumption reduction targets and a building sector that is hard to reform it is relevant to look for cost efficient ways to reduce households' consumption without too high public spending. The traditional approach of government intervention goes through the energy reforms in the building regulation. This sets standards on materials and the efficiency of new constructions. In addition and especially since 2000, governments have introduced financial incentives to promote and accelerate the transition to more energy efficiency. They encourage households to invest in equipment and/or constructions respecting future regulation or very high levels of energy efficiency.

The argument is that the effect of regulation is strengthened with favorable factors such as high and volatile electricity prices, high energy costs and high percentage of ownership. Other characteristics of the building regulation such as consistency and stable increase of the standards over time have the positive effect of accustoming the building sector to higher standards. Forcing the industry to innovate, invest in quality, and eventually reduce the market price of more efficient building materials. More specifically, the long term increase of energy prices and building standards changes the consumers' traditional perception that energy is cheap and energy efficiency irrelevant. The long term increase in energy costs sets a more favorable investment environment. Consumers will thus perceive the savings from energy efficiency much more attractive.

Energy prices and weather conditions affect the households through their energy bill. The evolution of the energy price can have the same or even a stronger effect than support measures like building regulation or public financial incentives (tax credits, zero-interest loans, etc…). The weather influences the consumption as more heating days imply a higher need for energy. Higher energy consumption leads to higher energy costs, which makes saving energy more interesting. Ownership is crucial for creating energy efficient investments, as it is only owners that are responsible of the heating equipment and paying the energy bills. Harsh weather, high energy costs, and high percentage of house ownership can all give strong incentives to invest in energy efficiency.

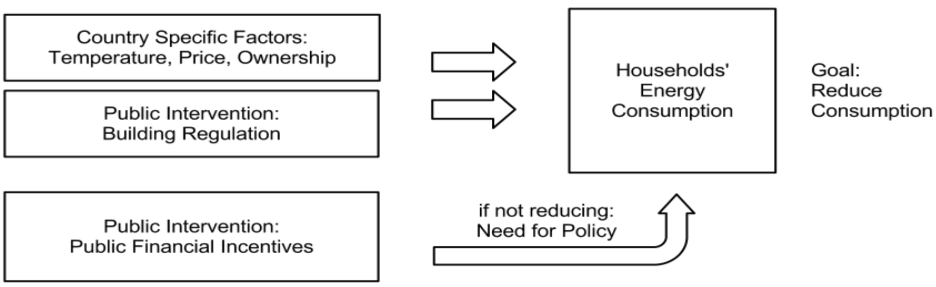

Figure 1: Factors affecting housholds' stationary energy consumption and need for policy

1.3. *Case study*

To illustrate this argument I will use the energy consumption of French and Norwegian households as case studies. The factors mentioned above, the building regulation and financial policies are different for both countries and their evolution has affected consumption differently. As a result the households' energy consumption has had different trends over the last two decades. Norway's energy consumption per person and energy prices is higher than the French. Public expenditure in financial incentives as a percentage of GDP to reduce consumption through energy efficient investments is much larger in France than in Norway. Still the consumption per capita is declining in Norway, and not in France. Public expenditure in countries like France is a sensible subject due to the increasing public debt. Finding methods to get higher results with less money should be a priority for economies like the French one.

French households' energy consumption per capita is on the increase. The peak in 2000 can be due to reconstruction efforts after the extreme weather conditions during the December 1999. From 2007 the consumption started reducing due to financial crisis, but we can see that the reduction or at least the stabilization started already after the small peak in 2002.

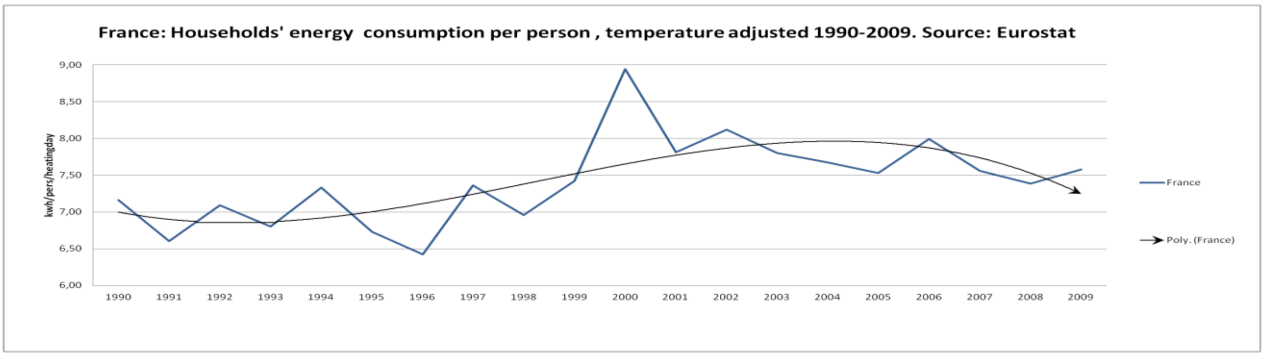

Figure 2: French energy consumption of households in kWh per person, temperature adjusted. 1990-2009. Source: Eurostat (nrg_100a)

The trend line for Norwegian consumption is declining over the period and especially since 2001/2002, the years where the price peaked. Price increase has an important effect on electricity consumption through the price elasticity of demand. Not only does it reduce consumption when it increases, but it has an effect on the interest for energy efficient technologies (see part 3.2.2.).

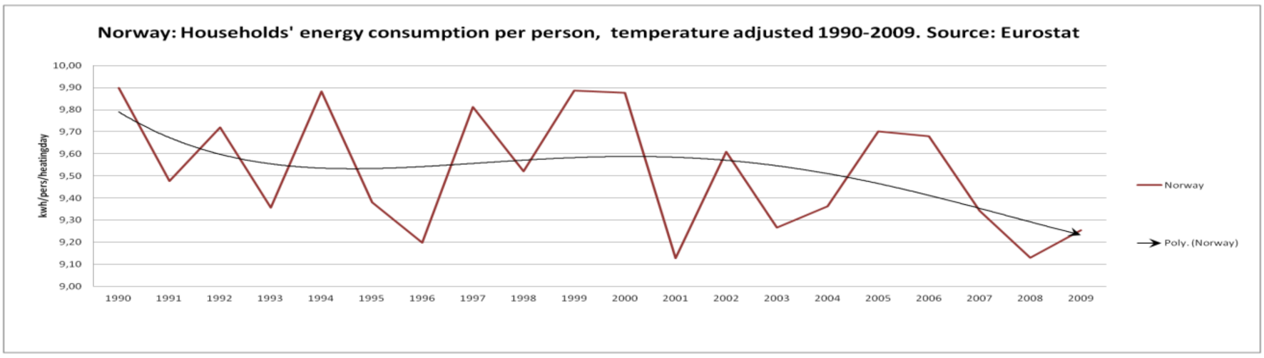

Figure 3: Norwegian energy consumption of households in kWh per person, temperature adjusted. 1990-2009. Source: Eurostat (nrg_100a)

The main reasons for better results in Norway are consistent increase of prices and regulation. Historical conditions of the national building sector play a much bigger role than the policies and situation today. Consumption takes time to change. Strong incentives to reduce consumption can for example come from high energy costs (as a percentage of households' total expenses) or a bigger share of house owners. More importantly continued regulation in Norway and an early start on energy efficiency programs have contributed to reduce consumption "sakte, men sikkert!" (Norwegian for "slowly but surely").

The effect of country specific factors such as rough climate, higher energy prices and a larger share of owners with predictable regulation led to a declining Norwegian energy consumption over the period 1990-2009. In France the situation is the opposite; households' energy costs are lower and have declined over the last 20 years (Insee, 2008a). The climate in France is milder explaining the smaller consumption. The increase in consumption can result from many shifting from efficient heating sources such as gas or heating fuel to electricity which is less inefficient for heating[4]. Another factor in France has been the late introduction of building regulation, 1974, compared to 1928 in Norway.

Nevertheless, France has been much more active in the recent years in promoting and subsidizing energy efficiency in buildings, it is not clear yet whether it will succeed. Hopefully France will see results from the policies in the longer run.

[4] For the same amount of heat produced, electrical radiators require more energy than radiators working on fossil fuels.

1.4. Plan

The first part consists of a presentation of the challenges with the building sector and the central aspects of the "efficiency gap". The second part will be an analysis of the households' energy consumption and how evolution of the electricity price, energy costs, climate, owners, etc. can affect and be favorable to energy efficient investments. The country specific factors will interact with the regulation in place and can create significant changes in consumer behavior. A special attention is given to energy prices and what signals price peaks send to the consumers. Another factor for success highlighted in the theory is the importance of stable policies over longer time to succeed. Finally, Norwegian regulation will be compared to the French. On one side early introduction of regulation combined with ambitious increase in standard and on the other an ambitious French spending program to compensate for low historic attention on building regulation. Current spending levels in France reflect this as it seeks to catch up lost effort.

1.5. Limitations

Clearly a statistical analysis would have shown significance and effect of the factors on energy consumption. Halvorsen & Larsen made such a consumer analysis in 2001 and the results are transcribed in the section on energy costs in Norwegian households. Such analyses require large amounts of historical and standardized data. The collection of data for households' stationary consumption was not straight forward. Data on public spending, especially in France was also not always accessible. France is a large country with much more bureaucracy and a tendency to not share all information.

Better data on the national spending levels would have allowed performing an impact evaluation analysis (Gertler P.J et al., 2011), comparing the effect of public spending on consumption. Another difficulty preventing this analysis is the absence of a control group (consumption without the public spending). A more subjective evaluation is found in national result reports from the corresponding energy and environment ministries (Enova and Ademe). None of these two evaluations are introduced due to the lack of standardized information to properly compare the two programs.

Eurostat has been a great tool for comparison, providing standardized and historic data for both countries. More specific information found in the respective national statistical agencies had to be handled with caution. Ideally a third country could have been used as a control to see if similar evolution of the factors and regulation leads to similar consumption reduction; lowering the need for public spending in the form of financial incentives

2. The “Efficiency Gap”: Barriers for Energy Efficient Investments

The “efficiency gap” is the difference between the actual level of investment in energy efficiency and the higher level of investments that would be cost beneficial for the customer. In other words the investments in energy efficiency would be much higher without the barriers that increase the consumers’ transaction costs. Light bulbs, refrigerators and televisions are all examples of technologies that had cost beneficial versions that weren’t or took time before being adopted.

The market failures of the energy efficient technologies are the following: Misplaced incentives (principal agent problems), misplaced fiscal and regulatory policies, unpriced costs and (public goods), and finally insufficient and incorrect information. The market barriers include little interest for saving energy among consumers, capital market barriers, and incomplete markets for energy efficiency. The barriers can be grouped in three: knowledge barriers, motivation barriers and financial barriers. The lack of information returns as a reason for the slow development and availability of relevant information could help households invest (Golove and Eto, 1996; Lorenzoni. et al, 2007).

2.1. Market failures: Principal-Agent problem, unpriced goods and insufficient information

One of the most important barriers to energy efficiency and a strong contributor to the energy efficiency gap is the owner-tenant dilemma. The problem occurs in rented buildings as the owners have little incentive to invest in more efficient heating if they don’t get returns on their investment through reduced energy costs (since the tenants pay the energy bill). Therefore if countries like Norway have a high share of owners it is more likely that the households of that country become more conscious and inclined to invest. If an owner reduces its consumption he will benefit from the energy savings to payback his investment. In Norway 77% (SSB, 2001) of the households are owners of their house, and the rest rent. In France this share is down to 57,8% in 2009 (SOeS, 2011 pp58-59). This is another argument why structural factors are more favorable to energy efficient investments in Norway than France.

The misplaced incentives refer to the principal agent dilemma. In the building sector it is known as the owner-tenant dilemma. Only the one paying the electricity bill will have an incentive to invest in less consuming equipment. When the tenants pay the electricity bill the owner has no incentive of investing in less energy consuming equipment if he doesn’t get any returns on his investment.

Also in the event of contracted construction the more intermediaries there are between the buyer and the user the less focus on energy efficiency and the more focus on available and standard equipment. When the constructor is not the same person as the one who will live there is often an under emphasis on energy efficiency. (Brown, 2001). When looking for a new investment one generally looks at risk exposure, the payback time and the rate of return of the investment. Payback times can be used to benchmark projects and since energy efficiency investments can have longer payback times they don't get picked (Golove and Eto, 1996).

Other misplaced incentive is the absence of time-of-use pricing of our energy consumption. This would allow the consumer to be more careful and consume less during high price periods. Current technology like smart meters allows consumers to follow and manage better their energy consumption. Their introduction will reduce this market failure and hopefully encourage to lower consumption.

The consumer would also be more motivated to consume less if it had to cover the negative externalities from energy production in the energy price. Most of the energy production technologies generate externalities such as pollution, alteration of the scenery, radioactive waste, etc. If those externalities were to be internalized, then normal consumption would be more expensive and it would give more incentives to households to consume less.

Many of the actors in the investment process lack of knowledge to properly sell or finance an energy efficient project. Professionals like suppliers, manufacturers, promoters and financers are not trained well enough to promote energy efficiency (Brown, 2001). Education of both consumers to recognize the need for lower energy consumption and to train professionals is expensive and often under invested. The result is a lack of training and education around the topic and a slower diffusion of the technology. Also more education around energy efficiency in schools would lead to more research and development.

Another important market failure is the insufficient and incorrect information. Good information is expensive due to the difficult access to good technical solutions. The time and cost of obtaining good information are a part of the transaction costs. The complexity of these investment decisions adds up to the low information available. As a result consumers tend to go for the "rule of thumb", and focus on the low initial cost (Brown, 2001). The benefits from energy savings to individuals may be outweighed by the transaction costs (e.g. costs of gathering information and perceived inconvenience of installing new equipment).

Recent policies have been introduced in an attempt to address these market failures**.** The European Emission Trading System helps pricing the GHG emissions. Mandatory energy performance labeling for white goods and buildings provide information to the consumers about the life cycle costs of the equipment, as well as energy performance and emission of the building.

2.2. Market barriers: low interest and incomplete markets for Energy Efficiency

Market barriers are the elements that contribute to the slow diffusion and adoption of energy efficient investments. The main barriers are: low priority among consumers and thus among producers as well, capital market barriers, and incomplete markets for energy efficiency.

The low priority comes from the low cost of energy compared to other costs in the household. However, for low income households these costs can actually represent a relatively large share of their total expenditure. All in all the energy costs are easily ignored especially when adding the difficulty to gather good information to the transaction costs.

Low priority can come from low knowledge. There are people that simply don't have access to relevant information. The other reason is that most information is in technical terms that most people don't know, and therefore cannot base an investment on it (IEA, 2007).

Finally, unpriced goods such as education and training, and negative externalities like pollution, little information and the owner-tenant dilemma, are all failures of the market to get a cost-beneficial level of investment in energy efficiency. In other words, if public regulations could sponsor more training, add taxes on polluting activities or set a price on emissions this would reduce the efficiency gap. There are actually many national support programs working on those issues in France and Norway. Energy efficient and passive house prototypes are being built, training and research is offered and the European Trading System helps setting a price on emissions.

The market barriers such as low interest, little information that reduce the access to capital markets are the reason why governments have introduced financial policies and informational campaigns to counter these barriers. In France where the ownership level is low they have introduced a law helping house owners' increase the rent when installing energy efficiency equipment to enable a return on investment. Such policy would not be necessary if there was a higher level of ownership, which would naturally give incentives to more households to consume energy more efficiently. Price peaks, higher energy costs and high house ownership are all structural factors that reduce the market failures and barriers and hence lower the need for policy.

3. Country specific factors: Temperature, Energy price, Energy costs and Ownership

Factors like temperature, price and ownership do affect households in their consumption of energy. Cold temperatures lead to high consumption. Consumers are price sensitive, with some delay but they react to price changes. The price elasticity of demand for electricity[5] in Norway is -0,5% (Holstad & Pettersen, 2011) and -0,2% in France (Insee, 2008b). The fact that the occupant is the owner of the house makes him able to earn savings from an energy efficient investment. Renting is temporary, implying that even though they usually cover energy costs they are not responsible nor have the long term incentives to change the heating equipment. Thus, renting introduces a market failure and creates barriers for investing in energy efficiency. From here I will present the evolution and situation of these factors in France and Norway, and how they affected households' consumption.

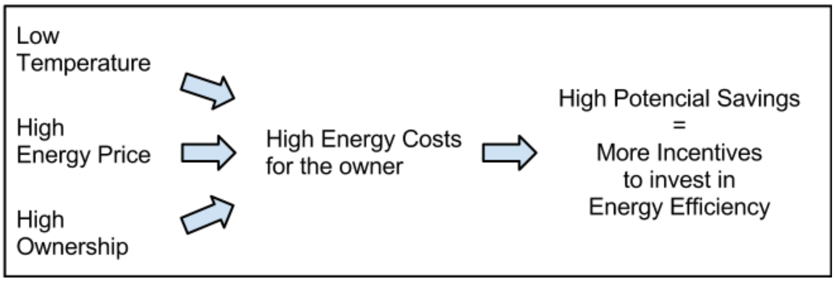

Figure 4: Country specific factors & Incentives for investing in Energy Efficiency

3.1. Heating days and household consumption

Colder temperature requires more energy for heating and is thus more costly for households. Higher costs make households more aware of their energy consumption and give them more incentives to look for cheaper heating alternatives. In Norway 75% of the population live on the coast from the Swedish border ("Sør-Østlandet") to Bergen in the West ("Vestlandet"). In this area[6], the number of heating days (HDD) (see glossary) ranged between 3985HDD in the Oslo region in 2000 and 5249HDD in the South-Eastern region in 2001. On average in this area and between 2000 and 2009 the number of heating days was 4549HDD.

In France, 50% of the population lives in the Northern part (35% in Paris, and the rest in neighboring regions[7]). There, since the year 2000, the number of heating days varied between 2218 HDD in Ile-de-France in 2002 and 2942 HDD in Lorraine (in the East) in 2004, averaging at 2505HDD (2000-

[5] When the price of electricity raises by 1% the general consumption reduces by 0,05% within the first month of the price change. After two months the changes are marginal.
[6] Vestlandet, Rogaland og Agder, Oslo og Akershus, Sør-Østlandet.
[7] Ile-de-France, Bassin parisien (Haute-Normandie, Basse-Normandie, Centre, Champagne, Picardie, Bourgogne), Nord – Pas-de-Calais, Est (Franche-Comté, Alsace, Lorraine).

2009). Then, 35% of the French population lives along the south-western coast[8] and along the Mediterranean Sea[9]. And only 12% lives in the colder region around the Alps[10]. Along the southern coasts the temperatures are much milder, with an average between 2000 and 2009 of 2004HDD. In the Alps the average on the period was 2750HDD.

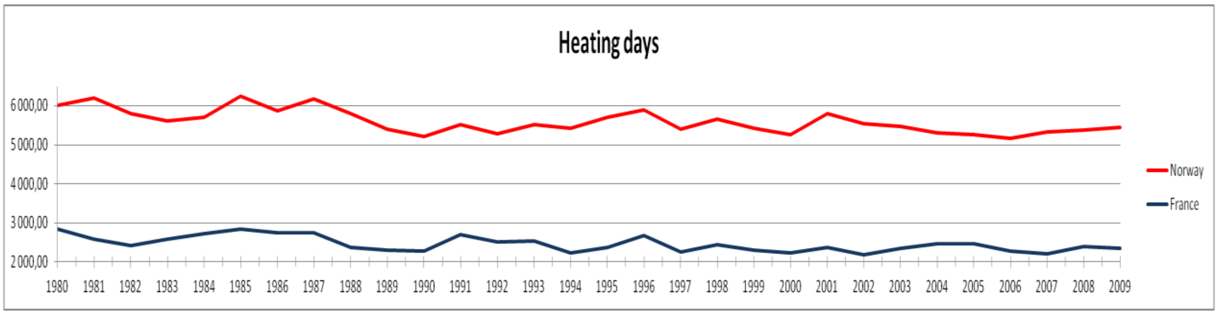

Figure 5: Norwegian and French heating days. 1980-2009. Source: Eurostat (nrg_esdgr_a)

The need for heating is twice as high in Norway as in France due to the temperature difference, with a reference temperature of 18C inside and less than 15C outside. This can explain why on average the finale consumption of households per person (temperature adjusted was on average 30% higher in Norway than in France between 1990 and 2009. The difference between the two countries households' consumption has reduced over this period from 40% higher Norwegian consumption in 1990 to 22% in 2009.

Between 1990 and 2009 the Norwegian consumption per household (temperature adjusted, 1990=100) reduced by 7% (0,3% reduction per year on average). In France, however it increased 6% over the period (0,6% increase per year on average) (Eurostat, 2012). French household has a diversified energy use for heating. Gas, heating fuel and electricity represent approximately each 30% of French households' energy consumption. In France, consumption of electricity has increased by 40,5% the last two decades. Gas consumption also increased, by 25,6% over the same period, on the expense of heating fuel. More electricity in households can result from more electrical goods or/and more electrical heating. The increase in French energy consumption can partly be explained by the increase in electricity for heating. An electrical radiator/boiler needs more energy than gas to produce the same amount of heat. Electricity is thus less efficient than gas or heating fuel for heating purposes and a shift from gas or heating fuel to electricity requires higher energy consumption. The increasing interest for electrical heating from French households can have its roots in the decline of the electricity price and low installation costs of electrical heating devices.

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[8] Pays de la Loire, Bretagne, Poitou-Charente, Aquitaine, Midi-Pyrénées and Limousin
[9] Languedoc-Roussillon, Provence Alpes Cotes d'Azur and Corse
[10] Rhone-Alpes and Auvergne

Generally, the interest for energy efficiency in households can be related to the share of energy costs in the households' total expenditure. Those costs depend on outside temperature, which are lower in Norway, but have increased in both countries. Therefore, as global warming causes increasing average temperatures it will reduce the need for heating. Reduced consumption can lead to lower energy costs and less incentive to invest in energy efficiency in the future. This emphasizes the need for future regulation and public policy. Historically, Norwegian households have been (and are) exposed to a higher need for heating, making them more conscious of their heating technology and more specifically its efficiency.

3.2. Energy prices' effect on household electricity consumption

3.2.1. Declining French real energy prices

The data on energy prices (all tax included) differ slightly between the sources but the peaks and the trends remain the same. Eurostat provides the best standardized data for comparing countries.

In nominal terms the retail price of electricity in France between 1995 and 2011[11] increased by 10% from 0,1296ECU[12]/kWh to 0,1423€/kWh. With a very small annual nominal growth rate of 0,36%/year. Adjusted for purchasing power (Eurostat, 2009), the prices decreased by 0,56%/year between 1995 and 2009. In 2010 and 2011, the prices went high, increasing by 8%/year (See figure 6 below). 14 years of declining prices can have tended to increase consumption.

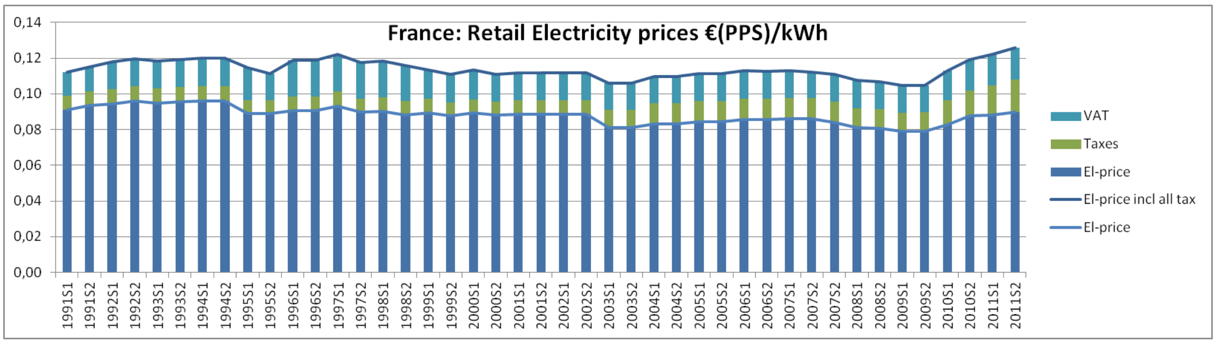


Figure 6: French retail electricity prices in €/kWh adjusted for Purchasing Power. 1995-2011. Source: Eurostat, (nrg_price)

Real French energy prices since 1960 show declining electricity prices and a smaller but similar trend for gas (see figure 7). Real domestic fuel (see definition) prices on the other hand have increased. Real electricity prices declined by 53,5% and gas prices by 50,5% on a 46 year period (1960-2006). Real prices clearly declined in France, giving consumers little incentives to save energy (Insee, 2008).

[11] Time span according to available data (Eurostat, nrg_pc_204_h)
[12] Equivalent of Euro in Eurostat before 1998

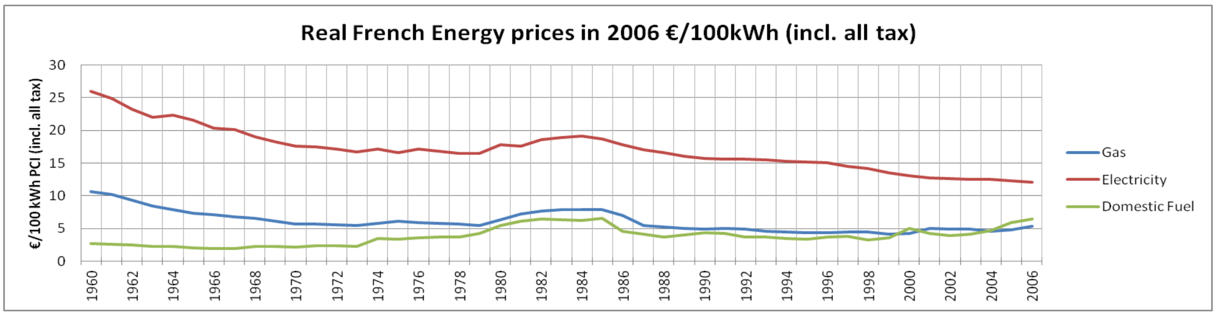


Figure 7: Real French Energy prices by source, 1960-2006 (in constant 2006-euros, all tax incl.) Source: Insee, 2008

The reason for the low energy prices is related to the production technology but especially the yearly tariffs decided by the government. They were increased yearly with a percentage slightly below the inflation rate. After the Second World War, reconstruction and scarcity of resources led to very high inflation, up to 40-60%/year (1945-1948) (Insee, 1996). To control production and prices, and hinder excessive inflation the government nationalized sectors like banking, coal, electricity and air transport. In the 50's and until the 90's price control measures continued to be used like maximum and minimum prices, price freeze or forced price reduction. In that period started the electrification of the country side and the introduction of white goods in households increasing the demand for electricity (60's and 70's). French households have historically used coal and heating fuel (oil distillate) for heating. The extensive use of oil in French household for transportation and heating made them particularly affected by the oil crisis in 1973 and 1979 - 1981. In that period the nominal energy prices increased on average by 16,5%/year, pushing inflation to 10-12%/year (1971-1981) (Insee, 1996). This explains partly why France kept the regulation on electricity and gas prices for so long (until 2000). Then the European Union opened a case against the French regulated energy market and after this decade of transition it has opened to competition.

The motivations behind price regulation and investments in nuclear power were to achieve supply security and stable low prices for a more competitive industry. France having little fossil energy resources on its own, it needed an energy production technology that made it less dependent on foreign countries. Nuclear power became the solution increasing the energy independence of France from 23,9% in 1974 to 50% in 2006 (MEDDE, 2007). Hence electricity production from nuclear power plants have strongly increased since the 70's to reach a production of 408TWh of electricity from nuclear power in 2010 (75% of Frances electricity production) (Insee, 2012) (see Annex 1 for production of primary energy by source). Large investments in nuclear power in the 70's quickly gave France cheap electricity, making it net exporter of electricity.

Although low and stable prices can have been positive for the industry's costs, it didn't give them incentives to become more efficient. The same applies for households. The declining trend of French energy prices cannot have given French households many incentives to reduce consumption. The high upfront cost, which is one of the main barriers behind the efficiency gap, will definitely seem high when the energy costs remain low.

3.2.2.Norwegian energy prices on the increase

In Norway, the nominal retail electricity prices (all tax incl.) between 1995 and 2011 increased by 140%. With a quite high average annual nominal growth rate of 9,6%/year. Adjusted for purchasing power the prices still increased, by 100% between 1995 and 2011, increasing by 6,93%/year over the period (see figure 8). The Norwegian price profile is rising with peaks in 2003, 2007 and 2010 and 2011. The price increase in the year 2003 was especially important as record high prices were highly commented in media. That year the prices were 50% higher than in the same period in 2002 (adjusted for PPS, all tax incl.). In the years 2007 and 2010 the prices went up by 16% and 18% compared to the previous year. Periods with unusual weather conditions and saturated capacity lead to periods with high energy prices. This gives strong signals to the consumer to reduce its energy consumption by using a heat pump or alternatives to electricity like heating with wood.

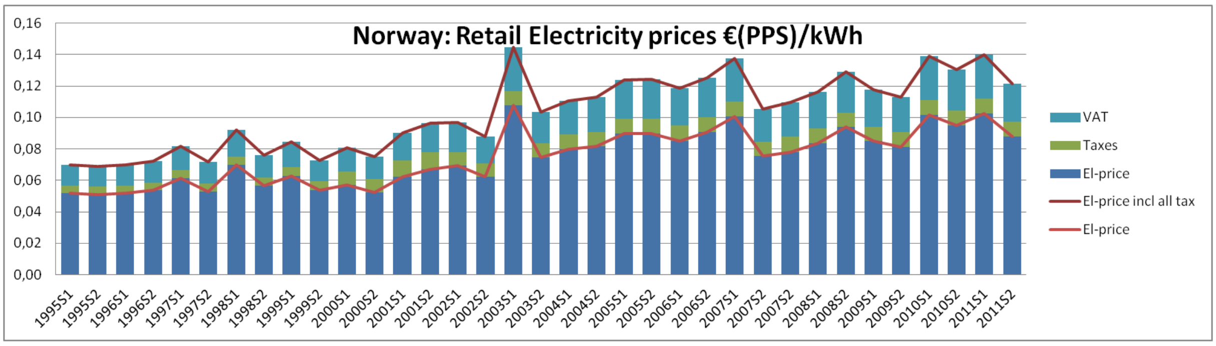


Figure 8:Norwegian retail electricity prices 1995-2011,€/kWh adjusted for Purchasing Power. Source: Eurostat (nrg_price)

Norwegian real energy prices (in 1998-prices, all tax incl.) have increased since 1980 (see figure 10). It increased by 110% over the period and on average 4,07%/year during 27 years. Nearly constant increase in real prices must have had an effect on how people invest and manage their energy consumption.

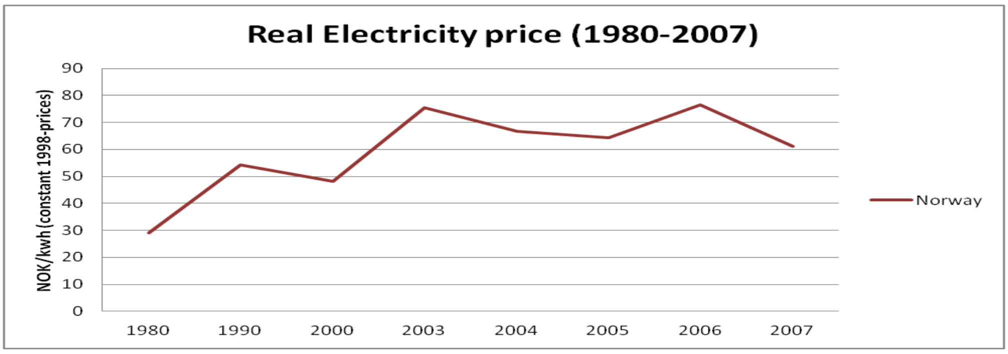


Figure 9: Real Norwegian electricity prices, 1980-2007 (Constant 1998-NOK, all tax incl.). Source: Bøeng & Larsen, 2008

Norwegian electricity prices were set by the state owned and only energy company, Statkraft. On the contrary of France Norway was a pioneer in deregulating its energy market. The energy law of 1990 allowed electricity to be exchanged on a common Nordic market. This created a volatile price that reflected supply and demand. (For price evolution before and after deregulation see Annex 1).

The nominal monthly electricity spot prices obtained through Nord Pool Spot (January 2000 to October 2012) show a volatile electricity price in Norway this last decade (see figure 11). The price peak that occurred winter 2002/03 comes to light together with peaks during the falls 2006 and 2008, and winters 2010 and 2011.

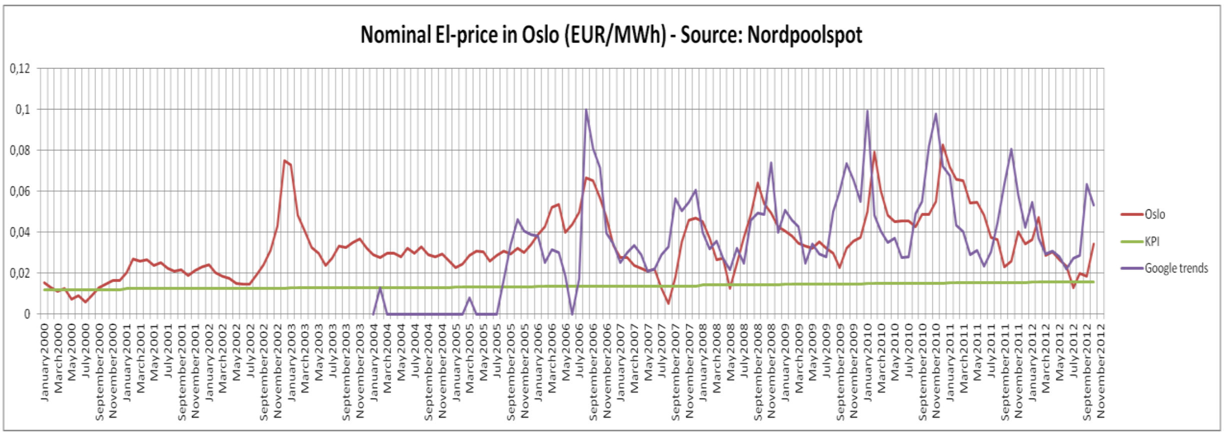


Figure 10: Norwegian retail nominal electricity prices, 2000-2012 (current prices, excl. tax). Searches for "heat pump" in Google. Consumer price index (KPI), Source: Nordpoolspot, Google trends, SSB.

The price peaks are two to three time higher normal level and occur usually during the winter season as a result of high demand and low level in the reservoirs (after the rainy autumn and before the melting of the snow in the spring). These peaks are usually highly commented in the media and sometimes followed by political declarations such as the introduction of a subsidy for heat pumps (air-to-air), like during the winter 2002. In August and September 2006 the minister of oil and energy announced the introduction of a new subsidy of 4.000NOK (around 495€) for a heating control system and 10.000NOK (approximately 1.235€) for the purchase of en energy efficient heating system (i.e. heating pump, excl. air-to-air) (adressa.no, 2006). The goal of the subsidies was only to promote technologies that are yet not ready for market. Judging from the searches on Google.com, the interest for heat pumps exploded in August 2006 (data for the winter 2002/03 are not available) (see Annex 2 for specific searches on other types of heat pumps). There was a peak in the searches in Google in August 2006 and remained high in September, coinciding with the high prices and the declaration of the minister. The peaks in the searches on heat pumps are at the same time as the price peaks during the fall 2006 and the winters 2007 and 2008. Surprisingly, from the winter 2009 on, the peaks in the searches seems to precede the price increase. It seems that consumers were anticipating the price increase and looking for an investment opportunity that could hinder the coming winter's high electricity prices. The correlation between the price and the searches on heat pumps comes to light when overlapping the two datasets (see figure 10).

Price peaks aren't good news for the consumer, especially in winter times. Demand for energy is high and increasing prices in that period really increases the energy bill. On the other hand concerning the efficiency gap and energy efficient investments it seems that price spikes have a positive effect. By increasing the prices two to three times normal level it gives a clear signal to the consumer that something has to be done. The purpose of a deregulated energy market is that the prices represent supply and demand. High prices give a strong signal to consumers to reduce demand either by turning down the thermostat or by changing to more efficient heating technologies such as heat pumps. This price phenomenon helps the consumers to psychologically accept that an investment in energy efficiency needs to be done. Very high temporary energy costs reduce the perceived high transaction and upfront costs from investing in energy efficiency. Information becomes more available through media exposure and the consumer's interest for the topic rises. The higher cost during the winter period makes energy efficiency a priority for the consumers, solving one of the major barriers of the efficiency gap which is little interest for these investments.

The sales of heat pumps strongly increased in the years 2003 and 2006. A figure from Enova illustrates the sales of heat pumps between 1992 and 2010. This figure is taken from the result report of Enova and shows the effect of the subsidies that were introduced in 2002/3 for heat pumps (incl. air-to-air) and other efficient heating technologies. The sales went slightly up naturally and even more as a consequence of the subsidies and media exposure around energy efficiency.

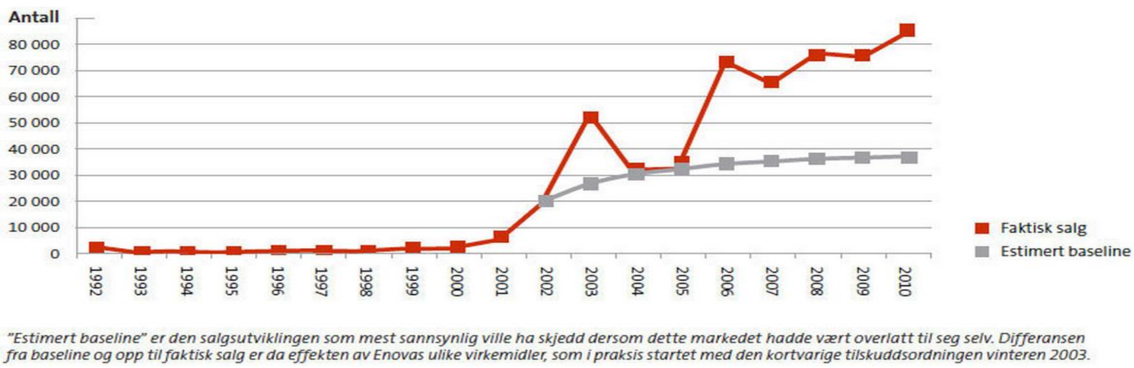


Figure 11: Development of Norwegian air-to-air heat pumps. Source: enova.no. 2011

The subsidies that were introduced the winter 2002 and in august 2006 were not too generous. In 2002 more, as the maximum subsidy of 10.000NOK represented approximately 20% of the price of an air to air heat pump (in 2003). In 2006, the subsidy didn't include air to air heat pumps anymore.

Then the 10.000NOK subsidy represented approximately only 10% of the costs of the subsidized technologies (i.e. water to water type heat pump). This illustrates the low level of financial incentives provided by Norway. Since the price peaks have such a strong psychological effect, the consumers only need a small push to make the investment. It can be argued that with more financial incentives there will be more energy efficient investment, but in Norway the expenditure are minimized. A more generous incentive has been made available to constructors of a passive house. This is a more ambitious standard with very high energy savings compared to average house consumption for a regulation level that is expected for 2015.

3.3. Share of Energy costs' effect on households incentives to invest in Energy Efficiency

The data on household expenditure in France and Norway are available for both countries in Eurostat adjusted for power purchase standard and with consumer price index. The data is also available in the respective national statistics institutions (insee.fr and ssb.no) but they are not as fit to compare the levels of each country since the criteria for what defines energy costs and total household expenditure can vary between the two institutions.

The share of the energy costs using disposable income in power purchase standard (PPS) [13] (Eurostat, 2009) gives us an idea of the importance the energy costs in the households' annual budget, which in 2009 represented 3,5% in France and 3,65% in Norway. The levels are approximately the same with similar evolution between 1995 and 2009. A possible explanation for the similar levels between the two countries is the higher GDP and disposable income per capita of Norway. Thus, when adjusting for purchase parity the Norwegian energy costs ends just above the French.

The differences between the two countries are not enormous. It is two rich countries where energy costs represent a relatively small expense in the households' budget. The shares in both countries went down from 4,3% to 3,1% between 1995 and 2000. Then, both rose back 3,9% in 2001. In France, the share of the energy cost fell back down and seemed to stabilize around 3,6% in 2009. In Norway the share peaked in 2003 where the costs reached 4,3% of the disposable income and remained high after that, 3,9% on average between 2003 and 2009.

[13] They are fixed in a way that makes the average purchasing power of one euro in the European Union equal to one PPS (stationary use, excl. transportation).

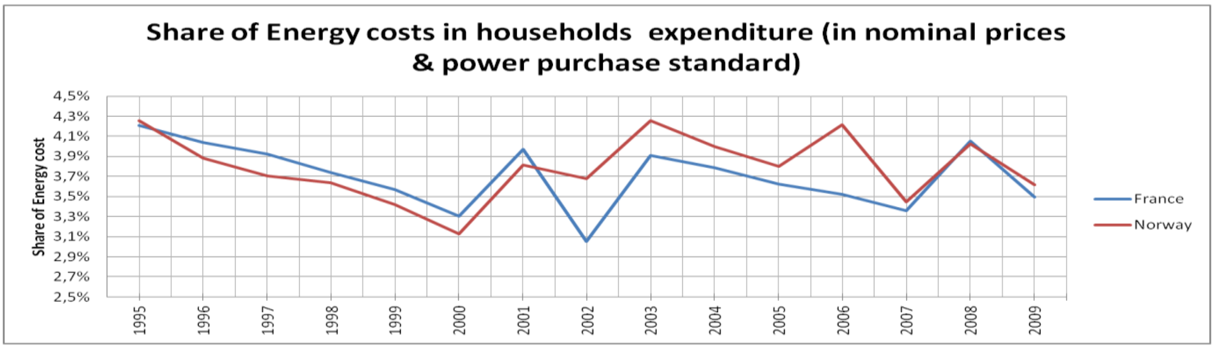


Figure 12: Share of Energy costs (PPS). Source: Eurostat (nama_co3_c)

The consumer price indexes and the data from the national statistics bureau will give an idea of the evolution of the energy costs in price volumes (price multiplied by the volume), and in real costs over time. The evolution of the costs over the time horizon show how the incentives (in terms of high costs and thus high potential savings) have evolved over time for each country.

3.3.1. Declining share of French energy costs since 1974

French households have much more diversified energy consumption. Heating fuel and coal were very common before 1974. With the first and second oil crisis (1973-74 and 1979-81) the prices of oil and its substitutes like coal went to the roof. Households consumption of coal and wood went from representing 42% of households energy consumption in 60's to 3,6% in 1985. In 1974 when the first oil crisis occurred, 70% of the energy consumed by households was heating fuel. Due to the price increase, the consumption of heating fuel declined from 1974 to 1990 to level with electricity and gas. Today French households' energy consumption is divided between these three energy sources like in the 90's. Electricity consumption has had a strong increase over the period due to low installation cost and a moderate nominal price increase (3,1%/year between 1960 and 2006) compared to the prices of the other households' expenses (4,9%/year) (Insee, 2008b). Increased adoption of electricity as primary heating can have the effect of increasing consumption per capita as it uses more primary energy than fossil fuels for heating purposes. That can partly explain the increase in consumption of households (per person, temperature adjusted) observed between the 90's and 2002[14].

[14] Consumption increased steadily till 2002 if we take away the extreme data of 2000, a year with extreme weather conditions in France.

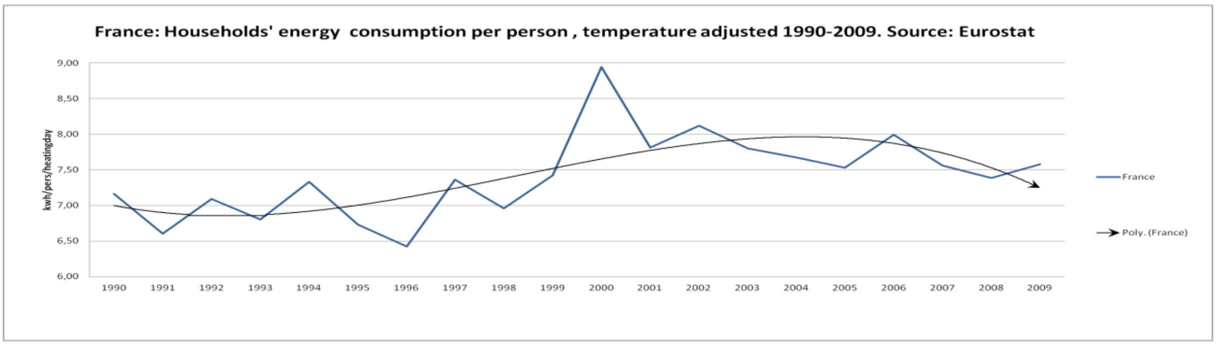


Figure 13: Energy consumption of households (in kwh) per person, temperature adjusted (1990-2009). Source: Eurostat (nrg_100a)

The price index of the final consumption expenditure in constant 1998-prices shows the variations of the households' expenditure over time (in price volumes). In France, the total consumption of households increased steadily by on average 1,4%/year (1990-2000). The expenditure in household energy (electricity, gas and other fuels[15]) increased by 0,6%/year on the same period. In a more recent time frame (2001-2010) energy expenditures increased by 3%/year while total expenditure only rose on average 1,6%/year. Over the entire 20 year period the value of the spending in energy increased by 1,8% on average, and total consumption of households rose by only 1,5%/year. In France, only in the last decade the energy costs have risen faster than total consumption. Hence, only in the last decade energy costs have given signals to consumers that energy consumption can become more expensive. In the first decade analyzed the energy costs actually raised slower than total consumption. This alone cannot have given incentives to invest in energy efficiency, quite the contrary.

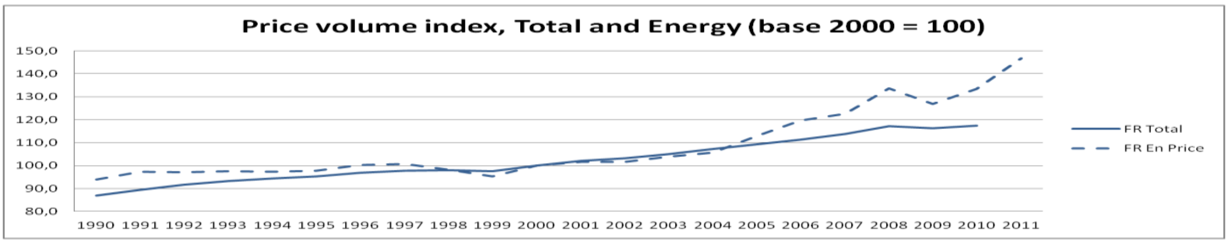


Figure 14: French Energy costs index & Total household expenditure price index (in price x volumes) 1990-2011. Eurostat (nama_co3_p)

Data from the French statistics in chain linked prices[16] presents the evolution of the French households' real energy costs. In 1960, their domestic energy costs[17] represented 3,7% of the households total costs (in constant 2000-prices). Due to two oil crisis, in the end 70's and 80's the share jumped to 5,8% in 1985. Finally it went back to a lower level of 3,5% in 2002 and increased

[15] Stationary purposes (excl. transport)
[16] adjusted compared to the previous year (real terms)
[17] Electricity, gaz, fuel (heavy and LPG), wood and coal, and district heating.

slowly to 3,8% in 2006. In other words costs have been reducing by 0,2%/year since 1974 (Insee, 2008b).

Other figures from the French statistical bureau show a low but increasing share of energy costs from 2,8% (in 2000) to 3,1% (in 2010) (Insee, 2011a)[18]. All those figures show declining or low French energy costs (under 4%), hence households have had little economic incentives to invest in energy saving technologies.

In France, the price curve has been declining steadily till 2000, and then it stabilized and increased a little (as seen with the price volume index). Electricity has gotten cheaper and hence households can increase its consumption without spending more. While in Norway, electricity is getting more and more expensive, pushing them to consume less.

3.3.2. Energy costs, an increasing share Norwegian households' expenditure

Norwegian households' consume mainly electricity as their primary energy source. Over investments in hydro electric generation capacity the 1920'-30's created low electricity prices from early on. As the investments in new capacity reduced and consumption continued to increase, the prices increased. A statistical analysis from Halvorsen and Larsen (2005) depicts the factors behind the electricity consumption from 1960 till 2003. The increase in consumption was mainly due to the increase in the house size and the increase in white goods such as dishwashers. The increased number of bathrooms and growth in income had also a significant positive effect on consumption. On the reduction side prices had the strongest absolute effect. The numbers of persons per households have an increasing effect on the households' consumption, but since the number of persons per household declined, so did the consumption per household. The consumption per person on the other hand increases due to loss of synergy effects from many people in one household. The increase in 1-person households and the amount of households living in apartments had a small reducing effect on the households' energy consumption. The combination of the increase in white goods, size of houses, bathrooms per household, and income pushed the consumption upwards between 1960 and 2001. Although, since the 90's the energy consumption of households (per person and temperature adjusted) have had a declining trend (see figure below).

[18] Source: : Insee, comptes nationaux, base 2005.

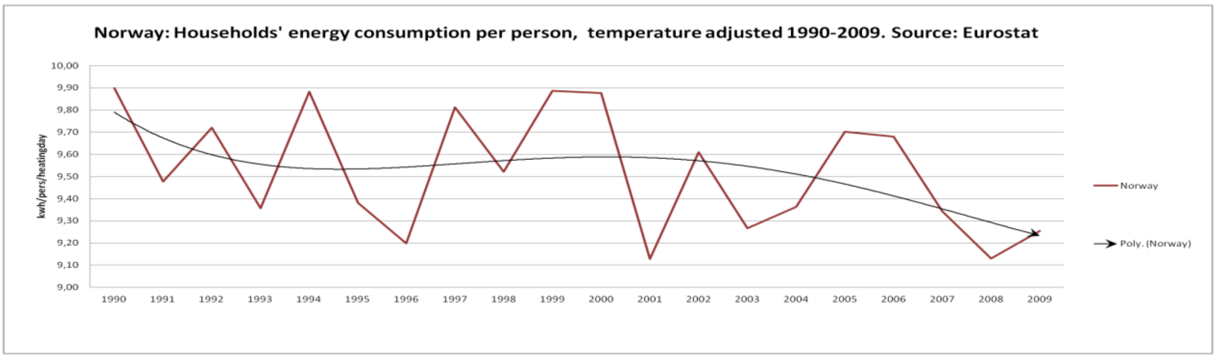


Figure 15: Energy consumption of households (in kwh) per person, temperature adjusted (1990-2009). Source: Eurostat (nrg_100a)

The share of the nominal energy costs adjusted for Purchase Power Standard didn't give much information (as seen in figure 12), but overall the energy costs were higher in the households' budget in Norway than in France. It can be due higher prices and higher consumption in Norway compared to France. What is important is the evolution from low to a high costs and the resulting signals given to the consumer.

The price-volume indexes (Eurostat) show that the total households expenditure in real prices (constant 1998 prices) in Norway increased by 2,1%/year on average between 1990 and 2009. The energy costs, households expenditure for electricity, gas and other fuels[19] increased by on average 3,4%/year between 1990 and 2000, and 6,8%/year on average between 2001 and 2009. Clearly energy costs for Norwegian households have risen faster than general consumption over the last 20 years. This is evidence that the energy costs' weight in the households budget has grown over the last 20 years. Increasing costs indicate higher incentives to save energy and can explain the downward trend of consumption the last 20 years, and especially the last decade.

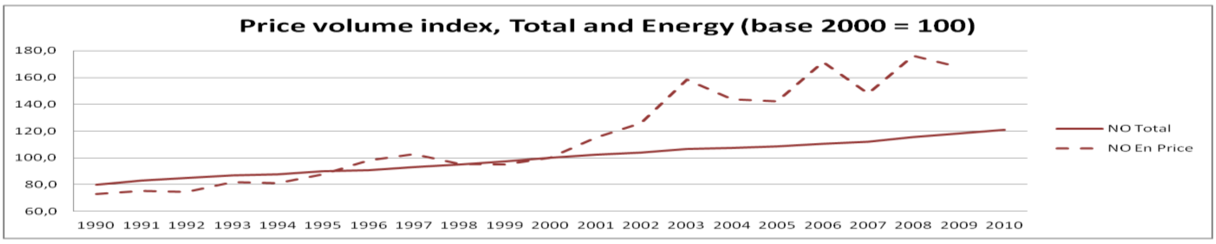


Figure 16: Norwegian Energy costs index & Total household expenditure price index (in price x volumes) 1990-2011. Eurostat (nama_co3_p)

Data from the consumer surveys gathered by the Norwegian statistics bureau, SSB, show that the share of energy cost in Norwegian households are high (with prices constant for each consumer survey 1996 to 2009) (SSB, 2010). The share was 4,5% between 1996 and 1998 (in 1998 prices), and

[19] Stationary purposes (excl. transport)

increased to 4,6% in 1999-2001 (in 2001 prices) and continued to 4,8% in 2002-2004 (in 2004 prices) and 4,7% in 2006-2008 (in 2008 prices) (SSB, 2009). This indicates that Norwegian households had energy costs closer to 5% of the households' budget compared to 3-4% in France.

Hence, with nearly constant share of energy costs since the 90's French households had probably little incentives to reduce their consumption. However, in Norway the expenditures related to energy costs increased much more than normal consumption. This must have made Norwegian households more conscious of their energy consumption.

The market failures and barriers under the efficiency gap are evidence that the building sector is difficult to reform. Large upfront costs, little interest or information on energy efficiency and the "owner-tenant" dilemma prevent households from improving their energy performance. Public intervention such as regulation and incentives are therefore necessary to address these barriers. A part from regulation, the French and Norwegian case have shown that certain factors can play an important role in creating awareness among households on energy efficiency.

Data from the French and Norwegian statistical agencies show that energy costs vary between 2% to 5% of the households' total expenditure. The two oil crises were the first wakeup call for European countries. With rising energy prices they realized that they were very dependent on foreign resources and that something needed to be done. France which suffered greatly due to the extensive use of heating fuel in households started a series of actions. It invested in nuclear power, continued to regulate energy prices and gradually switched over to electricity. The oil crisis had very different consequences in Norway. During those years it became oil producing country and experienced a period of high growth and increasing disposable income for households leading to an extensive electrification of households (heating and white goods). In the 90's Norway deregulated its energy market which led to an increasing and volatile electricity price. Other factors such as a colder temperatures and a large share of electrical heating made Norwegian households consume much more energy per person (for households' stationary use) than the French ones.

So far, Norwegians' high and volatile electricity prices have proven very effective in making households conscious of their energy costs. This has raised interest for energy efficiency and a small push from the government has lead to high investments in air to air heat pumps and a declining consumption of households (per person). In France, low and reducing prices have led to increasing consumption which makes the challenge of reducing it even bigger. Recently France has introduced a vast set of regulations and financial incentives to make the 2020 targets a possibility. Due to the characteristics of the building sector and the long lifetime of houses, it is the historic evolution of the regulation that will define better current evolution of households' energy consumption.

4. Building regulation and public financial incentives in France and Norway

Energy efficiency for households really became a priority for European governments after the first and second oil crisis. French households in particular were very dependent on oil for heating and transportation. The share of heating fuel among French households was around 70% until 1974 and declined slowly to represent 46% in 1990 and 35% in 2007; on the same level as gas (33%) and electricity (27%) (Eurostat, 2012). The oil embargo (1973), the Iranian revolution (1979) and the Iran-Iraq war (1980) led to very high prices and shortages that started to encourage lower consumption and energy efficiency. Some can say OPEC shot itself in the foot by cutting production in 1973. High prices led to changing consumer behavior and government intervention. Households have since the two oil crisis gradually excluded oil as heating source, in favor of gas and electricity. In Norway early investments in hydropower led to an early and extensive electrification. During the 60's, early 70's heating fuel represented 25% to 40% of households energy consumption. From 1974 it reduced strongly to 10% in the 90's and 6% in 2000 (Eurostat, 2012; see Annex 1.1 for temperature adjusted energy consumption of households by source)

A consequence of the rising oil prices in France was the energy reform for buildings. This started in France with the oil crisis, while in Norway the construction of new buildings was already regulated since 1949 with mandatory standards. The first important Norwegian building regulation with specific standards for materials was introduced already in 1928.

Norway has been early with regulation and houses are generally well isolated. Social security level is high and there are generally less problems with energy poverty than in France. In Norway, the construction of new houses has been regulated since 1928 and 1949, with specific standards for wall thickness and isolation. Combined with increasing energy prices the energy performance of Norwegian buildings has been improving. Data on insulation standards of exterior facades are available in the energy reform of France and Norway are here used as an indicator of the level of standards in both countries. French regulation hasn't been as consistent as the Norwegian and due to the factors seen previously the efficiency gap seems to be bigger in France than in Norway.

4.1. Efficiency standards in national building regulation

4.1.1. *French building reforms (1974-2012)*

In France, finale consumption of the residential sector represents 523TWh in 2007. This was 28% of the total French final energy consumption (1850TWh in 2007 and 1809TWh in 2011) (Insee, 2011b). For buildings, in 2008, the average total energy consumption was 203kWhpe/m2 (varies greatly according to building year and size), for heating it is on average 138kWhpe/m2.

In 2008, 58% of the French housing sector was built before 1974 and 37,3% during the worst period for energy efficiency of buildings 1949-1974 (Ademe, 2011). From 1949 to 1974 there was high demand for new houses and apartments. Reconstruction after the war, immigration from old colonies and rural exodus combined with little regulation led to poorly isolated houses. As for many European countries the first laws to encourage energy efficiency in households and fuel efficiency for transportation came as a consequence of the fuel price increase from the oil crisis of 1974. That year France introduced its first mandatory building code. It sets standards for the construction of new houses; with for example maximum authorized levels of heat loss or minimum thickness of the isolation material for exterior facades, windows, etc.

Houses built before 1974 have shifted from running on gas (27,8%), domestic heating fuel (26%) and independent heating devices like cooking stoves or heaters running on coal and wood (25,6%) in 1989 to gas (47,2%) and domestic heating fuel (19,5%) in 2009. Houses built after 1974 have kept equal shares between 1989, 1999 and 2009 of 46,4% electricity, 34,2% gas and 9,5% heating fuel. (SOeS, 2011).

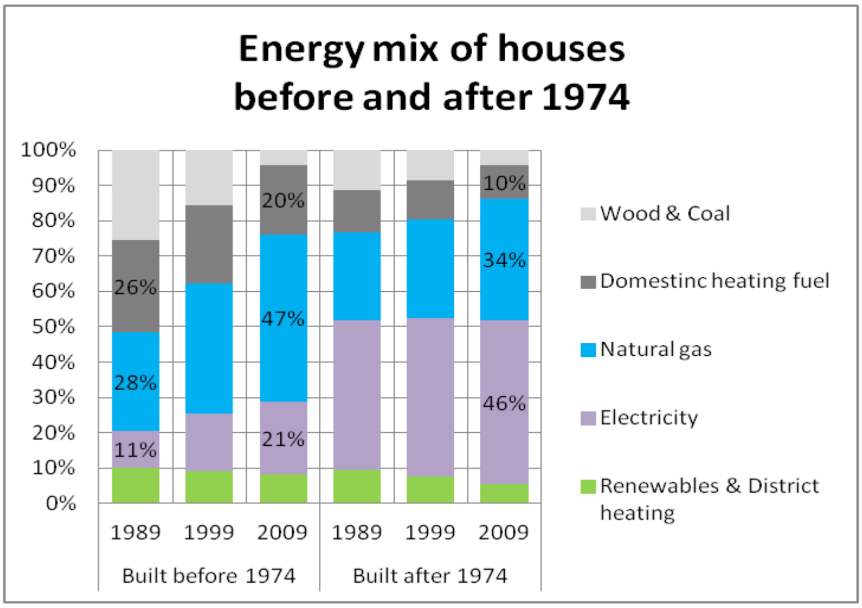


Figure 17: Energy mix of french houses built before and after 1974. Source: SOeS, 2011

Essentially until the 1930's the French buildings were made mainly of stone with rather thick walls and good thermal isolation. Between 1930 and 1950 it was a difficult time for the building sector in terms of energy efficiency. Two World Wars created a high need for new buildings, and the industrialization of the building processes combined with little legislation created very little energy efficient houses. The first binding building reform ("Régulation Thermique", RT) including mandatory thermal regulation for new buildings came in 1974 (actu-environnement.fr, 2011).

The objective of the 1974-building reform was to reduce by 25% the consumption level in 1950. It set minimum standard for isolation of the external facades (roof and walls), and regulated air ventilation within the house. It also introduced two new coefficients to measure quality of the installation and respect of legislation: the thermal transmission coefficient and the global heat depredation of the building (loss of energy in $W/m^3.K$).

8 years later, in 1982, a new reform increased the standards by 20% compared to the 74-version. Requirements for heating were introduced (in $W/m^3.K$). Also introduced were solar intakes from windows, higher insulation standard and a maximum allowed loss of energy of the building[20]. The insulation of exterior facades had to be max 0,52-0,66W/m2.K. In 1988 was added the new coefficient that grouped global need for heating and hot sanitary water (HSW). The other standards remained unchanged.

Only in 2000, 18 years after the last change they reinforced the standards and increased by a further 20%. The insulation requirement got stricter and reduced to maximum range of heat loss to between 0,42 and 0,53$W/m^2.K$. An important addition was the new requirements to improve the efficiency of heating, hot sanitary water and lighting technologies. This combined with the labeling of the energy consumption of white goods set the basis for the versions installed to today, in line with the European Energy Performance of Buildings Directive (EPBD, 2002). Later, from 2011 the labeling was introduced for residential buildings. This 2000-regulation also launched: the “summer comfort” which included positioning of the building, glass openings towards the sun, and aeration- and air-tightness of the building.

From 2000 there is an effort and a complete regulation for new buildings, with the update in 2005 and ambitious Regulation Thermique 2012 (RT 2012). In 2005, the standards were reduced by 15% from 2000. It was decided to make a revision of the thermal regulation (RT) every 5 years, with an ambition of a 40% reduction by 2020. The maximum heat loss of exterior facades were then 0,36-0,45$W/m^3.K$ depending on the geographical area. The minimum yield for the boilers was 89%, and it became mandatory to use a central control system for the installation of an electrical heating system. For windows the max value was 2,3$W/m^3.K$ (MECSL, 2006). In 2007 was that the “Grenelle de l’environnement” launched. It’s a set of laws, regulation and stimulation packages that were introduced to reach the national targets for the EU-2020 goals.

The latest regulation came in 2012. It is very ambitious and announces big changes in the construction of houses. It will apply by 1st January 2013 for residential buildings and has already been

[20] Loss of energy happens mainly through the filtration and ventilation system, exterior walls, roof and ground

mandatory for offices and public buildings. The new regulation has such a low maximum consumption that it requires the most efficient heating systems. An example of the effect of new regulation is that constructors of apartment complexes have started to rule out electrical heating, not being as efficient as gas. Heat pumps offer an interest yield for electrical heating but “the offers” from the producers were until then not yet adapted to collective buildings (Lemoniteur.fr, 2012). The RT 2012 has three main requirements. First, it sets a max consumption level on primary energy for new houses of $50kWh_{pe}/m^2$ [21]. This is a 67% reduction from the consumption respecting the earlier 2005 reform (approx. $150kWh_{pe}/m^2$). The second is to control the heat delivered by the sun to maintain it at a livable level. This is done by having an as low as possible BBio ($<BBio_{max}$). It takes into consideration the energy brought by the sun, net lighting, loss of heat, compactness and the assembling. The last important and innovative introduction with the RT2012 is that the maximum interior temperature after five hot days (<25C) (Tic) has to be lower than a reference temperature (Ademe 2011a).

Tableau 1: Maximum consumption of houses and isolation of exterior walls. Source: siel, 2012

Introduction of Building Reforms	Maximum Consumption	Reduction of Maximum consumption	Standard for isolation of exterior facades
1974	300 kWh_{ep}/m^2	25% (from 1950 level)	-
1988	225 kWh_{ep}/m^2	25%	0,52-0,66 W/ m^2.K*
2000	170 kWh_{ep}/m^2	25%	0,42-0,53 W/ m^2.K*
2005	150 kWh_{ep}/m^2	15%	0,36-0,45 W/ m^2.K
2012 (actual)	50 kWh_{ep}/m^2	66%	0,31 W/ m^2.K

* Estimated from 2005-standards.

Since 1974, there has passed 38 years and the maximum consumption of new buildings is set to $50kWh_{ep}/m^2$ per year, approximately 85% reduction. Standards have been gradually increased and the regulation has been updated at a good pace, at least since 2000. There are discussions whether the next regulation will make $40kWh_{ep}/m^2$ for buildings after 2014 and $0kWh_{ep}/m^2$ by 2020.

[21] +- $20kWh_{pe}/m^2$ depending on the geographical area, houses in colder regions are allowed to consume up to $70kWh_{pe}/m^2$

4.1.2. Norwegian building regulation (1928-2010)

The first regulation was introduced already in 1928 with the "Regulation of materials and structures" ("Forskrift om materialer og strukturer"). It is an extensive document with minimum criteria for thickness of the walls and roofs and the materials involved. Also, there are safety regulations for water boilers, central heating system, ventilation, etc.

The first binding building reform came in 1949, 25 years before France ("Byggeforskrift 1949"). There was introduced the thermal transmission coefficient and the global depredation coefficient (both introduced in France in 1974). The max thermal transmission (k_{max}) of the exterior facades in a tree building was then set to 0,9 W/m^3.K for south-western Norway and down to 0,6W/m^3.K for northern Norway (DSB, 2012). The colder the region is, the higher was the isolation requirement. The 1949 regulation came in three volumes, two were published in 1949 and the third volume in 1965 as it is called, "temporary addition of the 1st December of 1965 to the building regulation of 1949, volume III".

Temporary because four years later in 1969, a new building reform was published ("Byggeforskrift 1969") and the maximum standards were reduced by more than 50%. The new k_{max} of exterior facades went down to 0,45W/m^3.K (DSB, 2012). The same level was introduced in France in 2005. This regulation was updated in 1985, to "Byggeforskrift 1985" but the k_{max} remained the same.

Two years later, and 18 years since last change, in 1987 a new building regulation was published. This time the k_{max} was further reduced by 30% to 0,3W/m^3.K.

In 1997, 10 years later, the k_{max} changed name to U value (still W/m^3.K). That year they set down the standard to 0,22W/m^3.K. This was approximately a 30% reduction since 1987. This standard remained unchanged until 2007 where it went down to 0,18W/m^3.K. This standard for exterior facades kept its U-value in the latest regulation TEK10 from 2010.

Recently it is passive and low emission houses that are on the agenda. The standards to respect to get the "passive house" label are exposed in the NS3070 and NS3071, but the standards cost money to access the standards (Standard.no, 2007). According to the latest announcement from the ministry of the Environment (regjering.no, 2012b) is that passive houses and zero-emissions houses are planned to be introduced by 2015 and 2020. This will be decided based on the research on the economical health-related consequences of the passive houses. The standards are already available and many passive houses are already constructed for early moving households or as preliminary projects by the governments to demonstrate and experiment this new type of houses. The norms are getting more and more concrete but the regulation is yet unsure. It seems to go in the direction of passive houses. Representatives from the building sector have expressed their agreement with the necessity of the new standards but stand negatively to a too early introduction of the passive house standard in the regulation (like 2015). Unlike France the focus is less on the max consumption of the building but on the quality and the performance of the materials. That is why it is difficult to find an estimated evolution of consumption for the different standards.

Tableau 2 : Maximum consumption and isolation standards. Source: Arnstad rapport, 2009 ; DSB, 2012.

Introduction of Building Reforms	Maximum Consumption	Reduction of Isolation standards	Standard for isolation of exterior facades
1949 (1st binding)	-	-	0,9 W/ m^2.K
1969	-	50%	0,45 W/ m^2.K
1987	-	30%	0,3 W/ m^2.K
1997	-	30%	0,22 W/ m^2.K
2007	160 kWh_{fe}/m^2	18%	0,18 W/ m^2.K
2010 (current)	120 kWh_{fe}/m^2	unchanged	0,18 W/ m^2.K
Passive house standard	70 kWh_{fe}/m^2		

To sum up Norwegian building regulation, it started early and has consistently reduced standards since 1949. The reduction rate is also quite important. Between 1949 and 1969 the standards went down 50% (in 20years), then 30% in 1987 (in 18years). In 1997 it went further down by 30% (in 10years), and 18% in 2007 (10years later). As the government points out there will be new regulations in 2015, the last decades' trend points to major changes. Mandatory regulation for buildings started in 1949, 25 years before France. By introducing this standard early Norway avoided a period of poor isolation and energy consuming houses. The thickness of isolation has gradually increased and the types of isolation have also evolved. All in all, Norwegian regulation is consistent in time with an increase of the standards every 20-10 years with significant increase in standards.

To push households in consuming even less and invest in future high standard with even higher energy performance governments need to look into new technologies for heating. Heat pumps and solar boilers are technologies that are affordable today and considerably reduce the need for heating. To stimulate the introduction of these technologies the government has set up support policies. Information about the advantages and subsidies are distributed to encourage investments in energy efficiency.

4.1. National energy agencies and their policies

In Norway, Enova is the agency responsible for the information and the subsidies for new and efficient heating technologies. The Norwegian strategy is to provide as much as information as possible and only contribute a little financially to push consumers into buying products that are yet a little too expensive to be on the market. Country specific factors showed that some factors like price plays in Norway on its own a big factor of investment in heat pumps for example.

The French market is not as favorable for investments in energy efficiency, with stable to declining prices and more tenants. Also on the regulation France has lacked consistency and anticipation with a late start. Previous French president Nicolas Sarkozy launched the “Grenelle de l’environnement” in 2007. A “round table” organized by the ministers of Ecology and Sustainable development, Transport, and Ecology. They had open discussions between the state, work unions, employees, NGO’s and local authorities (mayors and local politicians). They set up an ambitious 5 year plan 2007-2013 for areas like biodiversity, natural resources, climate change, environment and health, production and consumption, etc[22] (MEEDDM, 2008) The building plan introduced many good policies to reduce households energy consumption.

4.1.1. How France goes late but ambitious (and costly)

France is in the difficult situation that there is a relatively large share of households suffering from energy poverty. Poor households that use more than 10% of their budget on their heating costs can’t afford good inside temperature during the winter. That is why there has been help and lower taxes for households with difficulties. France has also been conscious of the little incentives to be energy efficient when the prices are regulated and thus stable. Therefore there has been since 74, credits helping low income households in investing in better heating technology and other measures to stimulate efficiency in households and in the industry.

The French agency in charge of distributing subsidies and other financial incentives, and general information on energy efficiency for households is the “Agence de l’Environnement et de la Maîtrise de l’Energie” (Ademe) (2012). Ademe was until 2002 primarily a waste management company. Today its activity has diversified to most environmental areas[23]. The 2009-2012 contract states Ademes mission: Organize and finance research and statistical observation; help consumers with energy performance through communication campaigns; and help in the realization of projects with financial incentives and provide regional best-practice examples.

[22] … Governance and education, competitivity and employment, Genetically modified organisms and waste.
[23] Pollution mitigation with focus on: air, buildings, sound, climate change, waste, energy savings, renewable energies, eco-management and eco-products, polluted land sites, and finally transportation.

There are many different public organizations under Ademe with similar objectives. It is therefore important to clarify who is doing what. The variety of organizations providing similar support can create inefficiencies if several agencies overlap or work on the same cases. In that context the court of auditors (ministry of finance) has seen a progress after the reorganization of 2010 (Senat, 2010). They commented that Ademe could improve the stimulation of innovation and anticipation of new technologies. Here the court of auditors want Ademe to focus less on general solutions with repetitive actions and more on specific new and innovative solutions to assure diffusion. This last point goes towards the Norwegian strategy to focus mostly on products that are not ready for the market without a subsidy. In France the focus is on general solutions which are possibly a costly alternative.

A result of the many public environmental organizations is the confusion on how to apply for financial support for renovation or the construction of an energy efficient house. Ademe proposes direct support with local information offices, a telephone number and an internet site (www.infoenergie.org). In addition there is a description of the financial aides in www.ecocitoyens.ademe.fr (linked from www.ademe.fr). More information can then be found on www.vosdroits.service-public.fr or on www.anil.org (national housing agency). Finally all these agencies will show you to a bank or credit issuing agency to pursue with the zero-interest loan (one of the many proposed financial subsidies). The tax credit and the lower V.A.T are available through energy service companies. Businesses that help you purchase, install and renovate the building.

The Financial subsidies are central in the current French regulation system. Many different options are available for the consumer like zero-interest loans, tax credit[24], eco-loans[25], 5% V.A.T. and subsidies (see Annex 3 for more details). All these aids apply to different types of investments: construction, renovations, passive house standards and more. The amounts of Euros spent in those campaigns are considerable, and the measures have had a good success, but with the crisis some of the incentives had to be limited. The tax credits percentages have been reduced, the lower V.A.T for the purchase and the installation of energy efficient materials or equipment went from 5,5% to 7% and now 10% (Lemoniteur.fr, 2012b)

The positive effects of the lower V.A.T.s and the tax credits have been the increasing use of professionals for improving the energy performance of buildings. This develops the sector and prevents undeclared workers. As a result of the lower V.A.T.s and the tax credits the use of

[24] Allows a certain percentage of the purchase of an efficient heating system, heat pumps and isolating materials to be exempted from taxes, with a maximum of 8.000€ tax reduction over a 5-year period.
[25] Allows up to 20-30.000€ loan for a period of 10 years and the amount depend on the number of different improvements (max 3). Payback time of 15 years in 2012.

professionals increased by 7% between 2006 and 2008 and further by 1,7% between 2008 and 2010 (OPEN, 2011). The tax credit was introduced in 2005 and was more decisive for smaller investments between 1.500 and 15.000€ (OPEN, 2009). Over 15.000€ it is bank credits that are mostly decisive. When asked what was the contribution of the measures on the decision process to invest? 47% responded (in 2008) that the tax credit limited the impact on personal finance but didn't really have an impact on the decision to invest. For 21% the tax credit did have the effect of "launching" the investment. "Other priority expenditure" is the second biggest reason for not investing behind "lack of financial resources and unwillingness to borrow". The tax credit cost 1.680 million € to the French state and participated in investments for 6.775 million €. Hence, for every 1€ spent by the state 4€ are invested by households in energy efficiency. (OPEN, 2011)

The same survey, OPEN 2011, for 2008-2010 observes a general increase in the combination of renovations including heating, isolation and ventilation. The amount households who invested in this "triple improvements" increased by 30% in between 2006 and 2008, and 35% between 2008 and 2010. Of those who did this type of "triple investment": 13% used an architect or a research bureau; 24% followed an evaluation of the buildings energy performance (mandatory labeling for all buildings in transaction from 1st jan 2010); 10% were made by a craftsman recommended by the advisory service of Ademe (infoenergie); and 16% were financed by a "zero-interest eco-loan" (see Annex 3 for more details on financial incentives).

Due to tightening of the conditions for the tax credit only 57% of the households that made energy related investments made use of this incentive (against 62% in 2008). The zero interest eco loan that was introduced in 2009 was adopted by nearly 5% of the households. It is mainly used for bigger investments (7.500€ and more). This and the eco-loan had a strong effect on the decision making as 36% of the users say it was determining to the launch of the project.

Until 2012, the "dispositive scellier" helped families and investors to build houses respecting the passive house standard (50kWh_{ep}/m^2) before the RT2012 applies for every new construction from January 2013. With this measure they could get tax credit on of 13% of the construction costs (maximum amounts according geography and revenue). To give an idea the 9 year plan offers for an investment of 100.000€ the reduction of 13.000€, 13% tax credit for 9 years, 1.444€/year (Scellier.org, 2012). This measure was only available till 2012; a new one is announced for beginning 2013, "Loi Duflot" after the current Ecology minister Cécile Duflot (from the European green party).

The positive aspect of French building policy apart from the variety of financial incentives is the inclusion of renovations (not only incentives for new constructions).

The tax credit was introduced in 2005. In April 2009, the eco-loan with zero interest was introduced and is still in place. This zero interest credit applies to the extra costs related to install or improve: the thermal isolation of walls, roof, and/or plumbing, and/or efficient heating. The lower V.A.T. is now reduced to 10% and still is in place (Lemoniteur.fr, 2012b). Although it was introduced in 1999 at a reduced V.A.T. of 5,5%, it was raised to 7% from the 1st of January 2012. There are numerous other small grants and subsidies but these are the central three for renovation. There is an additional type zero interest eco loan called PTZ that support households in the construction of their first house and respecting the current regulation of low consumption houses (<50kWh/m^2).

France has put a considerable effort in promoting the building sector, with all sorts of policies aimed at improving the market, the energy companies and stimulating investment. The practice is well in lined with research on optimal policies for reducing the upfront costs (and the efficiency gap). They are going the hard way, the administration of the tax credits and the lower VAT cost the state money. France is spending large amounts and the result is still not noticeable. Obviously most of the measures were introduced around 2002-2005. And the intensification of the regulation only came in 2007 and 2012 in France. The effect of the current regulation can be observed when a significant share of households live in houses built after the reform of 2005 or 2012. Although the state spends large amounts, it will pay off with lower energy costs and possibly making them reach the 2020 energy efficiency targets.

4.1.2. How Norway goes early and simple

The Norwegian equivalent to Ademe is Enova. It provides mainly information on how to reduce consumption without grants and provides small subsidies to more efficient heating technologies. It is small public enterprise under the Norwegian Ministry of Petroleum and Energy. It started in 2001 and has been financed by the Energy fund. This fund gathered 788million NOK in 2010 through a 0,01NOK/kWh- tax on the electricity price (0,44NOK/kWh in 2010) since 2004 (Nord Pool Spot, 2012). The Energy fund is also financed through the return of the Green fund for Renewable Energy and Energy Efficiency (25billion NOK with an additional 5billions will be allocated in 2013).

Enova's mission is slightly different from Ademe's. This agency was created in 2001 to sustainably restructure energy production and consumption. More specifically it aims at creating a market for new, sustainable and renewable climate- and energy solutions. It works closely with public and private actors to reduce the energy use and to promote the production of renewable energy sources. This will strengthen supply security and lower greenhouse gas emissions.

Concretely it is divided in two, the private sector (industry and service sector) and households. For households Enova proposes financing, advising and tools for improving/planning better energy efficiency. The tools are calculators (energy and investment) and a chat in the form of a hotline for information. The advising consists of the telephone line but also specific information on alternative heating methods with their costs and approximate pay back times. There are concrete articles related to windows and isolation, news on the subject and a list of certified suppliers on Enova's internet page. The financing is two-folded; on one side it allows a small subsidy, around 10% of the final price for the purchase of expensive but very efficient heating solutions (max 1.200€ subsidy for 120.000€ investment). On the other hand the financing of up to 60% of the extra cost related to building a passive house are more generous but still not extraordinary, as it only applies from June 2010 to buildings consuming min. 100.000kWh/year. That is five times the consumption of an average household. In other words this incentive is only for larger buildings wanting to renovate or construct in passive house standard (Enova.no, 2012).

The subsidy of max 1.200€ is mainly for the purchase of a heating system using renewable energy. For the tertiary sector and larger buildings in cooperatives there are more advantageous support systems. A part from the Passive house standard subsidy there are some regional incentives given to households, but those are not managed by Enova but by the municipality directly.

The country specific factors can be the explanation behind this system providing information technological and small financial support. The combination with constant increase in both regulation and energy prices has limited the need to actively and financially subsidize energy efficiency.

5. Conclusion

The energy consumption of households depends on several factors. Data on elasticity of demand of electricity, energy costs, heating days per year, household expenditure, and regulation permit adjusting and analyzing energy consumption. Evolution of these factors in Norway and France show the different scenarios. On one side, low, stable and regulated prices, combined with late building regulation. On the other side Norway has high energy costs and volatile electricity prices due to deregulation combined with a long history of building regulation.

France is a much populated country and explains the bigger size of the programs but historical delays in regulation and sinking energy prices has given little incentives to households to invest in energy efficiency. Low prices are good though for poorer households for whom energy costs can represent a very large cost. There are measures for households with low income to help cover the energy expenses. The declining French prices, the fewer owners, the reducing costs have all contributes to increase consumption. The goal is to reduce consumption and it seems that France is taking a strong turn with the new regulation for 2012 and further. In Norway, due to the high income, high volatile prices (leading to price peaks), large share of owners, the efficiency gap gets reduced. In addition it is very helpful that the regulation has been incremental and predictable. This has nearly on its own led to the wide introduction of new energy efficient technology (heat pumps). The need for financial policy and public spending to stimulate energy efficiency is reduced with favorable country specific factors and early and constant regulation.

5.1. Effect of the structural factors

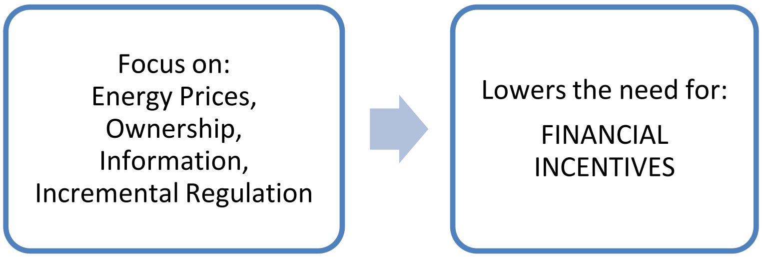
The energy costs are higher in Norway with extremely high prices during the winter 2002/03, 2008 and 2010. Combined with a small government financial help to purchase energy efficient heating technologies it created a very positive effect on the sales of heat pumps. In France the energy costs can be so low for households (<4%) that many aren't aware or neglect the potential energy savings that result from investing in energy efficiency. In Norway the price peaked to very high levels and was often exposed in the media. The high energy costs due to low temperatures, and high electricity prices, and the fact that 80% of Norwegian households own their house increased the level of information and the decreases the perceived transaction costs. The upfront costs do not seem as high when there is an expensive winter in sight. They get therefore more inclined than French households to invest in Energy Efficiency and save large costs already the first winter with the high prices and high consumption.

5.2. *Effect of the regulation*

Another important and significant difference between the two countries is the evolution of the regulation. Norway started very early in 1928 with regulation on materials and in 1949 with the first mandatory regulation for all new houses. In France the first mandatory regulation came in 1974. As a consequence the many houses built in the post war period between 1945 and 1974 were built without any strict regulation and thus very little energy efficient. That is one of the reasons why France is spending large amounts of money support energy efficient buildings. The energy gap is larger in France, both due to decreasing prices, and due to less building reforms. Another important reason for the large spending in France to fill up the gap is the large extent of heating fuel and gas consumption for heating. Those heating methods emit a good amount of GHG gasses and there are big savings to be made in terms of costs and emission from installing better and more efficient systems.

5.3. *Discussion of the results*

The two countries were affected similarly from the oil crisis but different investments in generation capacity and consumption patterns have led to different situations and thus strategies to reduce households energy consumption. The key findings are the strong signal volatile prices (peak prices during winter) and the importance of constant regulation over time. A market based energy price that reflects supply and demand with a high level of ownership addresses already a large part of the market failures and barriers better that form the efficiency gap. With these market failures addressed there is only a need for a small push in the right direction to engage the desired investment levels. Currently it seems that France is both focusing on financial incentives and stricter regulation. Time will show if the market can adapt so quickly, although it seems that with the current adjustments and political will it will be able to make the change by 2020.



5.4. Final remarks

This research could be led further by setting the factors mentioned in this paper into a statistical analysis, using effects of price peaks, ownership rate and regulation as factors affecting consumption. That would bring us one step closer to what are the important decisive factors for household's price? Ownership? Regulation? Or the combination? In other words find the most cost effective ways to reduce household consumption.

One can be tempted to say that higher energy prices are good energy efficient investment, for households to realize the costs and start investing. This is a bold statement as there are many low-income families where heating represents a much higher energy cost (up to 20%), more than for the average household (3-5%). In both countries measures exists to enable the least fortunate in covering their energy expenses by providing lower prices for those households. It is likely that this plays a much bigger role in Norway than France.

This sector is under large changes. The installation of smart meters is around the corner, network operators are starting to invest in smart-grids. Pricing has changed as the market deregulates more of Europe gets interconnected and renewable get connected to the European grid. This calls for continued volatile European energy markets. A new pricing to encourage low consumption is under discussion in France, a gradual price, the higher the consumption the higher the price. This can have a positive effect on the perception on upfront costs.

European countries have put a considerable effort on setting up the framework and stimulating reductions in households' energy consumption. The building sector is slow to change, and the new passive house standards are still very new. The construction and renovation to this standard together with large scale adoption of efficient heating will really change consumption levels. The question is if countries can learn from the past by following up and continue to increase gradually the building regulation until households invest in energy efficiency on a cost beneficial level. Focusing on country specific factors like price, ownership, and regulation can lead to the large adoption of efficient heating and increased energy performance of buildings and lower the need for large public spending.

Annex 1

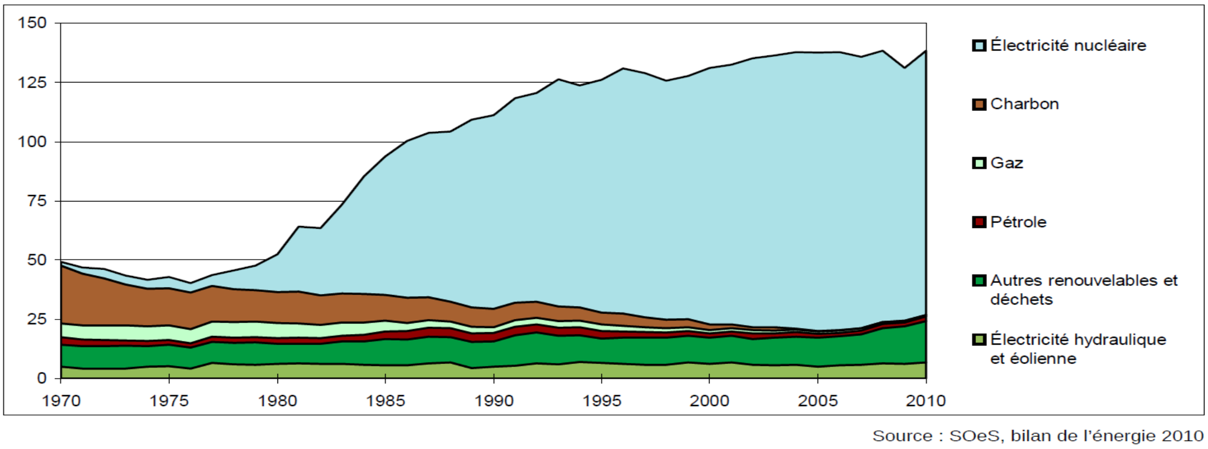
Annex 1.1. Eurostat (nrg_10): Energy statistics, consumption of energy, residential.

Energy consumption of Households temperature adjusted per energy source (MWh/pers/heating day)

	1990	1995	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008			
															1990/2007	
France	8,032	8,182	8,529	9,000	8,968	8,940	8,978	8,802	8,493	8,304	8,843	8,137		90-07 (%/year)	**1,3%**	
		1,9%	4,2%	5,5%	-0,4%	-0,3%	0,4%	-2,0%	-3,5%	-2,2%	6,5%	-8,0%		**0,2%**		
Norway	9,777	9,338	9,432	9,909	9,868	9,194	9,694	9,290	9,388	9,690	9,699	9,357	9,095		**-4,3%**	
		-4,5%	1,0%	5,1%	-0,4%	-6,8%	5,4%	-4,2%	1,1%	3,2%	0,1%	-3,5%	-2,8%	**-0,3%**		
- Electricity															1990/2007	
France	1,671	1,766	1,899	2,090	2,188	2,112	2,272	2,217	2,171	2,133	2,338	2,347		90-07 (%/year)	**40,5%**	
		5,7%	7,5%	10,1%	4,7%	-3,5%	7,6%	-2,4%	-2,0%	-1,8%	9,6%	0,4%		**3,3%**		
Norway	7,158	7,230	7,257	7,577	7,688	7,068	7,197	6,693	6,976	7,323	7,342	7,312	7,139		**2,2%**	
		1,0%	0,4%	4,4%	1,5%	-8,1%	1,8%	-7,0%	4,2%	5,0%	0,3%	-0,4%	-2,4%	**0,3%**		
- Gas															1990/2007	
France	2,138	2,373	2,563	2,729	2,818	2,806	2,777	2,854	2,817	2,750	3,093	2,685	2,686	90-07 (%/year)	**25,6%**	
		11,0%	8,0%	6,5%	3,2%	-0,4%	-1,0%	2,8%	-1,3%	-2,4%	12,5%	-13,2%	0,1%	**2,3%**		
Norway	0,000	0,000	0,000	0,000	0,000	0,005	0,005	0,005	0,007	0,015	0,009	0,010	0,010		**96,3%**	
							1,6%	-6,1%	43,3%	120,3%	-37,4%	4,2%	2,2%	**21,0%**		
- Coal															1990/2007	
France	0,345	0,188	0,175	0,158	0,137	0,126	0,091	0,086	0,078	0,069	0,073	0,072	0,067	90-07 (%/year)	**-79,1%**	
		-45,5%	-6,9%	-9,4%	-13,4%	-8,3%	-27,4%	-6,2%	-9,0%	-11,2%	5,9%	-1,6%	-7,2%	**-12,1%**		
Norway	0,017	0,010	0,009	0,007	0,007	0,003	0,007	0,005	0,005	0,002	0,002	0,002	0,002		**-90,2%**	
		-41,1%	-17,4%	-16,5%	2,7%	-55,6%	110,9%	-24,5%	3,0%	-66,7%	1,3%	-4,1%	-2,2%	**-9,8%**		
- Domestic heating fuel															1990/2007	
France	3,883	3,529	3,573	3,688	3,498	3,595	3,519	3,339	3,136	3,071	3,060	2,772	2,793	90-07 (%/year)	**-28,6%**	
		-9,1%	1,3%	3,2%	-5,2%	2,8%	-2,1%	-5,1%	-6,1%	-2,1%	-0,4%	-9,4%	0,8%	**-2,9%**		
Norway	1,166	0,729	0,780	0,834	0,606	0,637	0,718	0,803	0,655	0,536	0,563	0,447	0,354		**-61,6%**	
		-37,5%	7,1%	6,9%	-27,4%	5,2%	12,6%	11,8%	-18,4%	-18,2%	5,1%	-20,6%	-20,8%	**-6,7%**		
- Butane/propane															1990/2007	
France	0,332	0,326	0,319	0,334	0,327	0,302	0,318	0,307	0,291	0,281	0,278	0,261	0,241	90-07 (%/year)	**-21,4%**	
		-1,7%	-2,2%	4,7%	-2,0%	-7,8%	5,4%	-3,6%	-5,2%	-3,5%	-0,9%	-6,1%	-7,6%	**-2,1%**		
Norway																
- Wood															1990/2007	
Norway	1,327	1,231	1,288	1,375	1,454	1,347	1,619	1,619	1,567	1,678	1,594	1,402	1,411	90-07 (%/year)	**5,6%**	
		-7,2%	4,6%	6,8%	5,7%	-7,3%	20,1%	0,0%	-3,2%	7,1%	-5,0%	-12,1%	0,7%	**0,9%**		
- District heating																
Norway	0,068	0,061	0,061	0,070	0,053	0,064	0,069	0,078	0,090	0,092	0,110	0,119	0,147	0,150	0,223127953	1990/2007
		-10,4%	1,6%	14,6%	-25,0%	21,5%	7,7%	13,3%	14,5%	2,4%	19,1%	8,5%	23,6%		90-07 (%/year)	**75,9%**
															6,2%	

Annex 1.2. French primary energy production since 1970.

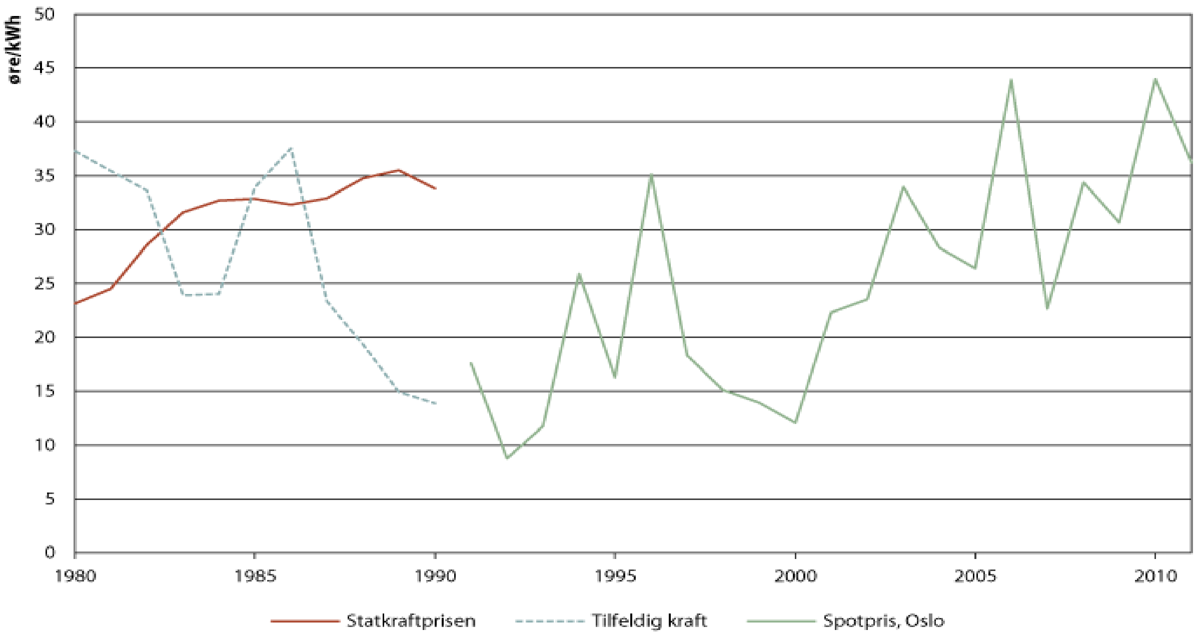
There has been a strong increase of the production of electricity from nuclear since 1980. Hydropower has always had a significant share in France's energy mix.



French pimary energy production by Source: (in Mtoe). 1970-2010. Source: SOeS, 2010
From top to bottom: Electricity, Coal, Gas, Oil, Renewables, Hydro and Wind.

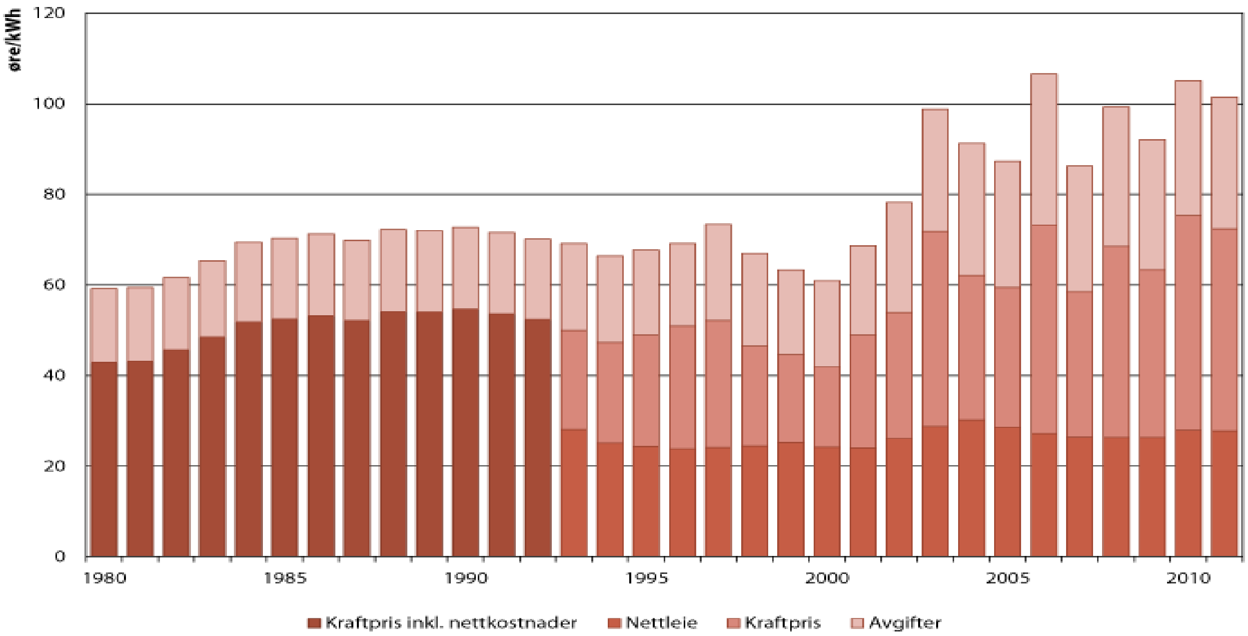
Annex 1.3. Norwegian real electricity price since 1980.

Increase in monopolistic government electricity price, a change to a lower but increasing market price fixed by competitive bidding on Nord pool spot.



Real Norwegian Electricity price in NOK cents/kWh (2011-prices). 1980-2010. Source: Regjering.no, 2012. From left to right: Statkraft ("regulated price"), Retail price before 1990, Spot price Oslo.

Annex 1.4. Real Norwegian households electricity price since 1980



Real Norwegian households electricity price in cNOK/kWh (2011 prices) (incl. taxes). 1980-2011 Source: Regjering.no, 2012. From left to right: Electricity price (incl. network costs); Transportation cost; Electricity price; and taxes

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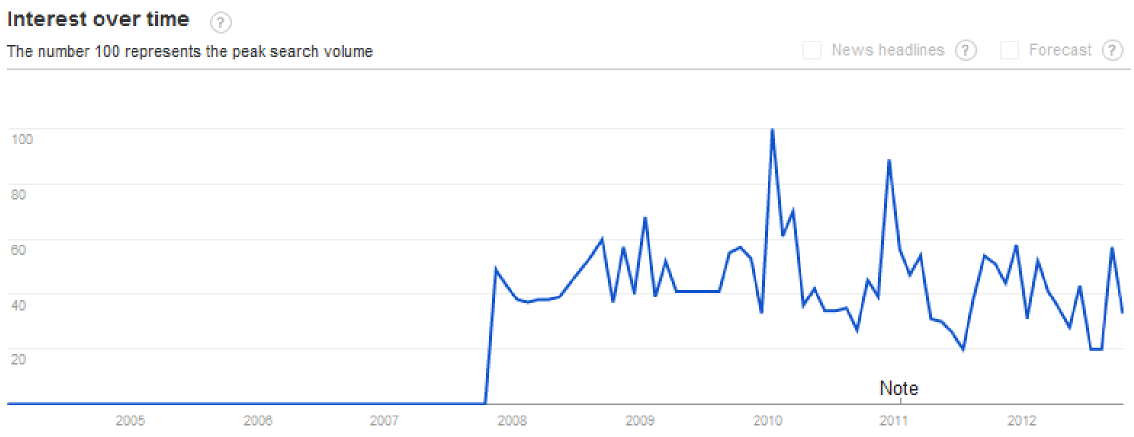
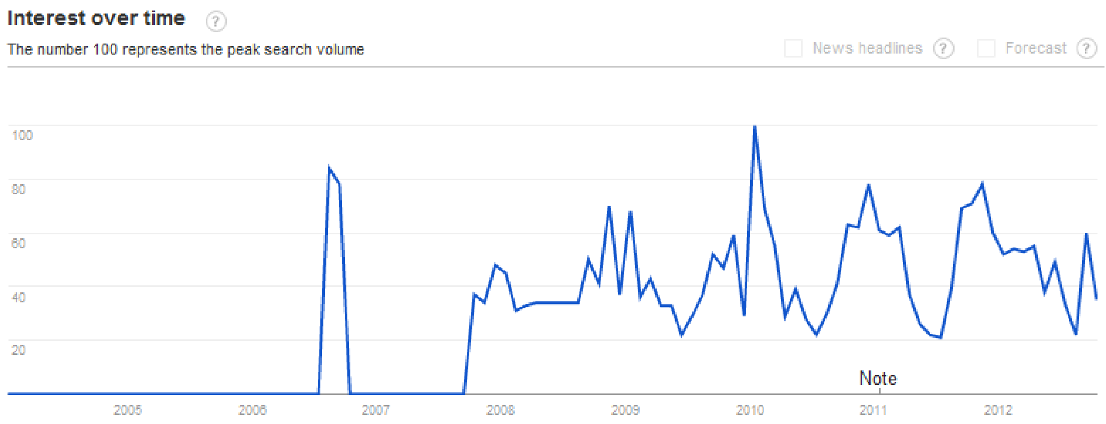
Annex 2

Annex 2.1. Search on air to water heat pumps (“luft vann varmepumper”)



Searches peaked in January and December 2010.

Annex 2.2. Search on air to air heat pump (“luft luft varmepumper”)



Annex 3

Annex 3.1 Main French financial policies (Ademe, 2011)

Tax Credit (« Crédit d'impôt développement durable »)

Can be applied to:	House:	Conditions
- Tenants - Owners - Lessor	- Primary residence - Individual house or Apartment - For Lessors: House has to be more than 2yrs old; rented as primary residence at least 5yrs.	- The installation of the materials has to be done by the company that furnishes them - Technical characteristics has to attached with the invoice
Max Amount	- 8000€/pers. and 16000€ for a couple with extra 400€/pers. (dependent) - For Lessors: 8000€/house (max 3houses) - Max amount is appreciated over 5years	
Cost for the state	- In 2005: 400 millions €/year - to 2,5 billions €/year in 2009 (Ademe, 2011) - 1.680 millions € in 2010 (OPEN, 2011)	

Zero-interest Eco loan (« Éco-prêt à taux zéro»)

Can be applied to:	House:	Conditions
- Owners - Lessor - Condominium (tenants in apartment house) - A civil society/ organization	- Primary residence - Individual house or Apartment - Built before 1990 For total renovation: built between 1948 and 1990)	- Materials and equipment shall respect the minimum standards. They also have to be supplied and installed by professionals. - One loan per household - The installations have to be ready two years after receiving the loan. - One must invest in a "package" of at least two energy saving measures*.
Max Amount	- 20.000€ for investments in two different energy saving measures* - 30.000€ for investments in three different energy saving measures* - More if it is for a total renovation	
Distributed loans	- 1,2 billions € in zero interest loans in 2009 (Ademe, 2011)	

PTZ + (Zero-interst loan for new buyers/builders)

Can be applied to:	House:	Conditions
- First time buyers (hasn't been owner of a primary house last two years	- New - Primary House	- BBC- label (low consumption house) - Before 2012 it also applied to existing houses based on their energy performance.
Max Amount	- No max amount - Depends on the location of the house, nbr of people in the household, energy performance. - Time of repayment depends also on the same criteria above	

VAT ("TVA") 5,5% (1999) → 7%(2011) → 10% (2012)

Can be applied to:	House:	Conditions
- Tenants - Owner (resident) - Lessor - Civil society (syndicate)	- Primary residence or secondary house - Individual house or apartment - It has to be finished since at least two years.	- Only furniture and installations by a company are accepted - The company involved uses directly the reduced VAT rate
Max Amount	- The reduced VAT of 5% should appear as a 12% reduction on the customers' final costs.	

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