



## **SUSTAINABLE CONSTRUCTION IN NORWAY: Climate Change and Energy Challenges**

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**ABSTRACT:** The paper discusses sustainable construction in Norway and the role of buildings in Norwegian energy and climate policy. The Norwegian emissions of greenhouse gases are expected to be about 20 % higher than the Kyoto target in year 2010.

The authorities signal a need for a shift in the way energy is used and produced. However, very little is actually being done to influence the end use of energy in buildings. In the climate policy, no link is made between the steadily increasing demand for electric power in buildings, and greenhouse gases associated with the production of this power.

To bring about a sustainable shift in the way energy is used in buildings, a number of initiatives are needed. These include increasing a market demand for energy efficient and environmentally favourable solutions, increasing the energy competence and skills in the trade, increasing research and development, tightening the energy requirements in building regulations, and introducing a comprehensive grant scheme for improvements in existing buildings.

**KEYWORDS:** Buildings; Climate Change; Energy Use; Policy Instruments; Power Generation; Sustainable Construction.

### **INTRODUCTION**

Norway is a small country located in the north of Europe. The population of 4.5 million people is spread over a total land area of 324,000 square kilometres. The corresponding population density is 13 persons per square kilometre, which is close to 20 times lower than in Germany or the United Kingdom for example ([Statistics Norway, 1999](#)). Not only sparsely populated, Norway is also a very long, relatively narrow country. The total distance (direct line) from the south (58°N degree latitude) to the north (71°N) of the country is more than 1600 kilometres, and approximately one third of the land area is located north of the Polar Circle. The climate is rather cold in Norway. The annual, average temperature is 5.9 degrees Celsius in the capital Oslo, and range from -4.7 degrees Celsius as average temperature in January, to 17.3 degrees Celsius in July.

The majority of the population lives in the southern part of the country where the major cities are found. These cities are Oslo with 500,000 inhabitants, Bergen with 220,000 inhabitants and Trondheim with 140,000 inhabitants.

Crude oil and natural gas are Norway's main exports, and Norway is currently the second largest oil-exporter in the world. The large revenues from oil and gas extraction in the North Sea have made the

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Norwegian economy very strong. The Gross Domestic Product (GDP) per capita is higher than in most other OECD countries ([OECD, 2001](#)). Norway has substantial net external assets, and the Government's net cash flow from petroleum activities and returns on fund's investments are being invested in a special Petroleum Fund for future use. This way, the wealth from exploitation of non-renewable resources is being transmitted to future generations. By the end of 2002, the fund contained NOK 609 billion, corresponding to NOK 130,000 or USD 17,500 per capita ([Norges Bank, 2003](#)).

But, this strong, oil and gas dependent economy is also becoming a problem for Norway. The inland economy is rather weak, and high production costs and a strong currency make it difficult for the Norwegian industry to compete in the international market. Traditional, labour intensive Norwegian industry is suffering, and factories are being shut down and the production moved to countries with lower costs. The revenues from the North Sea will go down in the future as the oil and gas reserves are being extracted. It is considered important that Norway prepares for a future without the large revenues from the North Sea. In this perspective, it is important to maintain a competitive Norwegian, inland industry.

A characteristic feature of Norway is that the population in referendums have twice voted not to join the European Union (EU). As a result, Norway together with Switzerland, Liechtenstein and Iceland, are the only countries in Western Europe that are not members of EU. Through economic agreements with EU, however, Norway has kept an access to the European market.

## **SUSTAINABLE DEVELOPMENT IN NORWAY**

The concept of sustainable development was introduced on the political agenda all over the world when the United Nations commission World Commission on Environment and Development (WCED) launched their report "Our Common Future" in 1987 ([WCED, 1987](#)). By having Gro H. Brundtland as both the chairman of the commission and as the Prime Minister of the country, Norway was more or less obliged to follow up on the commission's recommendations and focus strongly on sustainable development. In the years following after 1987, sustainable development and environmental issues were important in the political debate, and Norway took on a self-imposed role as an international "forerunner" for sustainable development. Several White Papers were produced by the Government for the Norwegian Parliament about issues related to sustainable development, and in 1992, article § 110 b was included in the Constitution of the Kingdom of Norway, stating that:

*"Every person has a right to an environment that is conducive to health and to natural surroundings whose productivity and diversity are preserved. Natural resources should be made use of on the basis of comprehensive long-term considerations whereby this right will be safeguarded for future generations as well. (...)"*

However, concern for sustainable development and environmental issues fell significantly when the economic recession hit Norway hard in the beginning of the 1990's. Instead, the focus was put on full employment and economic issues. Whereas 37 % rated "energy and environmental policy" as the most important issue in the Parliamentary election in 1989, only 7 % considered this issue as being most important in the election in 1993 ([Aardal & Valen, 1995](#)).

The Norwegian economy improved rapidly after the recession in the beginning of the 1990s. The focus on sustainable development, however, remained rather low. Today, it seems as if issues related to sustainable development have lost much of the interest of the population and amongst politicians.

The general debate on sustainable development in Norway tends to focus on environmental aspects only, without including equity concerns and social aspects which are important parts of the sustainable development concept as defined by WCED. Furthermore, even though sustainability and environmental

concern are defined as primary goals for many development projects, economic profitability is in practice the primary and decisive factor.

## **SUSTAINABLE CONSTRUCTION INITIATIVES IN NORWAY**

There has been a rather low focus on sustainable construction and sustainability issues in the Norwegian building sector. The market for environmentally favourable buildings is limited, and very few building projects have been carried out with a sustainability ambition.

Some initiatives and programmes concerning buildings focusing on sustainability issues are presented in the following sections.

### **The EcoBuild Programme**

The EcoBuild programme was established in 1998 as a five year programme (1998 - 2002) with the aim to engage the whole trade in a co-ordinated and comprehensive effort on environmental improvements. The programme was a follow-up of the smaller project “Environmental Efficient Building Trade” which had been financed by the Norwegian Research Council from 1996 to 1998 ([EcoBuild, 1998a](#)).

The initial budget of the EcoBuild programme was NOK 347 million, with NOK 170 million in monetary support from governmental funds and NOK 177 million put into the programme by the building trade and industry ([EcoBuild, 1998b](#)). EcoBuild should support a number of initiatives and projects within seven main areas. But, it soon turned out that it was difficult to rise the required funding for the programme, especially from the government. The total budget for the EcoBuild programme ended on NOK 160 million for the five year period. Off this, governmental funding represented NOK 65 million, far less than the original intention of NOK 170 million.

The number of projects and activities supported by the programme had to be reduced as a consequence of the limited budget. The activity was especially low the last two years of the programme. A main activity the last year was to host the Sustainable Building Conference 2002 in Oslo. More than 1000 delegates from over 60 countries attended this conference.

The EcoBuild programme ended in 2002. The Building, Construction and Real Estate Council, which includes the most important participants in the building and real estate trade, is now planning a follow-up of EcoBuild.

Some important projects which received funding by the EcoBuild programme are presented below.

### **National Action Plan for Building and Construction Waste**

The EcoBuild Programme supported the development of the National Action Plan for Building and Construction Waste. In 1998, the development of this action plan was initiated by the most important trade organisations to reduce the building and construction waste and increase the share of the waste being reused or recovered. A state of the art report was published in 1999 ([Wærner & Oddekalv, 1999](#)) and an action plan including 27 specific actions to be taken was launched in February 2001 ([NHP, 2001](#)). In November 2002, the final report from the work was published ([NHP, 2002](#)). The action plan presented in 2001 includes four main targets:

1. All environmentally hazardous waste is to be treated in an appropriate and responsible way.
2. Waste shall not be illegally dumped.

3. By the end of year 2005, a maximum of 30 % of the building waste shall be disposed.
4. New buildings shall within the end of year 2005 be designed and produced to:
  - half the amount of waste generated per square metre during the construction of the buildings, as compared to the amount in 1998;
  - integrate, where possible, the sorting of the waste into fractions as a natural part of the construction process;
  - facilitate future deconstruction and reuse and recovery of materials and products.

The targets are ambitious and the action plan comprehensive. But, due to limited funding through the EcoBuild programme, it has not been possible to carry out all of the 27 actions specified in the plan.

A main effort of the action plan has been to improve the statistics and the knowledge about the waste generated by building and construction activities. For 2001, the estimate is that the construction, renovation and demolition of buildings annually generate about 0.94 million tons of waste ([Statistics Norway, 2003](#)). It is also estimated that the construction of bridges, ports, roads, railroads, airports etc generate about 22 million tons of waste per year ([Wærner & Oddekalv, 1999](#)). This latter construction related waste however mainly consists of non-polluted soil and rock, and is more considered as a space problem than a pollution problem by the authorities. The waste is often used for road subbase and in foundations.

A large share of the 0.94 million tons of waste from building activities is treated in an unknown way. Based on information from the waste treatment plants, about 0.54 million tons of buildings and construction waste were delivered to the plants in 2001. The treatment of the remaining 0.40 million tons of building and construction waste is unknown. Some of it may be delivered directly to companies recovering materials, and thereby not included in the figures from the waste treatment plants, but it is assumed that a considerable part of the waste is being treated illegally ([Statistics Norway, 2003](#)).

Three national targets were established for waste management in Norway ([MoE, 2002a](#)):

1. The growth in the quantity of waste generated shall be considerably lower than the rate of economic growth.
2. The quantity of waste delivered for final treatment is to be reduced to an appropriate level in economic and environmental terms. Using this as a basis, the target is for 25 % of the total quantity of waste generated to be delivered for final treatment in 2010.
3. Practically all hazardous waste is to be dealt with in an appropriate way; so that it is either recycled or sufficient treatment capacity is provided within Norway.

It will be ambitious to decouple the generation of waste and economic growth. Up to now, there has been a close link between economic growth and the waste being generated. This link has been very profound in the household sector. The total amount of household waste per capita increased from 174 kg in 1974, to 235 kg in 1992 and 334 kg in 2000 ([Statistics Norway, 2002a](#)). The economic growth, and the consumption of products, is expected to continue, and this is likely to contribute to increase the amount of waste being generated. However, an increasing share of the household waste is being recovered, and the total amount being disposed of has been reduced.

Of the total amount of waste being generated in 2000, 44 % was either reused directly, material recovered or energy recovered. The target is to increase this share to 75 % within 2010. These figures do not include hazardous waste.

The 0.94 million tons waste from building activities represent about 11 % the total waste volume in Norway. The aim of the Action Plan to dispose maximum 30 % of the building waste by year 2005

corresponds well with the national waste target of delivering maximum 25 % of the total quantity of waste to final treatment by 2010.

## **EcoProfile**

The development of the *EcoProfile* method was supported by the EcoBuild programme. EcoProfile is an official, environmental classification method for buildings. The method is based on a classification of a number of performance parameters within three separate areas: external environment, resources and indoor climate. The parameters describe the building itself, as well as maintenance, operation and use of it. A single index is presented for each main area by classifying and weighting the parameters within the area. EcoProfile was originally developed for existing commercial buildings, but separate versions have been developed for other building types as well.

The development of the EcoProfile method started back in 1994 under the name “Environmental Profile”. The name was later changed to EcoProfile and was merged together with another Norwegian building assessment method (the MRN-method).

The method was launched in the beginning of 2000 and about 60 commercial buildings were assessed and given an official EcoProfile in 2000 and 2001. During these two years, the development of the organisation and the training and marketing of EcoProfile was supported by the EcoBuild programme. Since 2002, EcoProfile has been owned by the foundation Building Certification. There was no marketing of the method in 2002 because of very limited funding, and no buildings were assessed. The demand in the market for EcoProfile classifications is practically non-existent, and so far, the method can not be said to have been a success. To establish the method in the market, some changes have to be made. It may for instance be necessary to change the whole concept and reduce the requirements for qualifications and training of the personnel doing the assessment.

## **EcoDec - environmental declarations**

The EcoBuild programme funded the development of a standardised scheme for environmental declarations of building materials. The intention is that the schemes will increase the knowledge about the environmental impact of the different building products. It is also an aim that the publication of environmental data will make it easier for the customers to choose the most environmentally favourable products.

The work was conducted by the Norwegian Building Research Institute in co-operation with the manufacturers of building products. A prototype scheme was originally presented in the report “Energy and Environmental Account for Buildings” back in 1995 ([Fossdal, 1995](#)). The development of the scheme thus started almost 10 years ago, and so far, declarations have been worked out for about 70 building products. Considering that there are about 50,000 building products in Norway, it is a long way to go before environmental declarations can be said to have some influence.

At present, the schemes only include the presentation of different environmental data, without any weighting or interpretation of the data. The plan is to develop a standardised method for assessing the data, but the development of such a standardised method for interpreting environmental data is a difficult and controversial task. The challenge is to make the interpretation so easy that architects and contractors can use the information effectively when they are selecting materials and technical solutions. Considering the time it has taken to develop the declaration scheme, it may take years before such a standardised method is up and running.

## **The Norwegian State Housing Bank**

The Norwegian State Housing Bank under the Ministry of Local Government and Regional Development offers loans, grants, subsidies and housing allowances for construction, renovation and low-cost housing. To qualify for a loan from the Housing Bank, a project must meet certain minimum standards with a set of functional requirements. These requirements shall ensure satisfactory housing quality in terms of environmental qualities, design and accessibility.

## **Architects**

NABU (*Norwegian Architects for a Sustainable Development*) was established in 1994 as a project under the Norwegian Association of Architects (NAL). NABU's goal is to integrate awareness and knowledge about sustainable planning and building into the everyday practice of architects, planners and others in the building sector. NABU arranges conferences, courses, workshops, information activities, reports and other initiatives. These activities have architects as their primary target group, and also entail extensive interaction and cross-disciplinary cooperation with engineers, researchers, public bodies, the building industry and public.

The *GAIA* group is a small group of professional architects sharing an interest in ecological issues in house building and planning. The group was established in 1983. The members of the GAIA group promote the use of traditional building materials, well-known and simple technology, and rather labour intensive construction methods. Many of their solutions are therefore controversial, and sometimes difficult to implement in modern, industrialised construction.

## **CLIMATE CHANGE AND ENERGY USE**

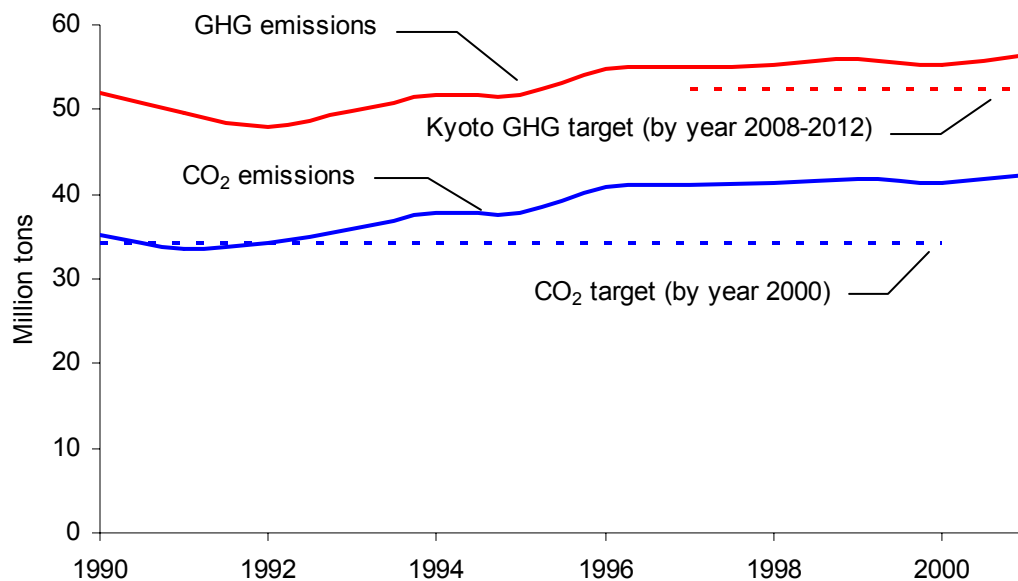
Climate change caused by anthropogenic emission of greenhouse gases (GHG) is considered as one of the most important challenges of today, and a core issue with regard to a sustainable development. Reductions of GHG emissions will have serious consequences for the oil-dependent economy of Norway. It is claimed that the issue of climate change and reductions of GHG have been the single most important factor slowing down the Norwegian follow up of the Earth Summit in Rio in 1992 ([Langhelle, 2000](#)).

## **Norwegian Emissions Of Greenhouse Gases**

[Figure 1](#) shows the total Norwegian emissions of CO<sub>2</sub> and greenhouse gases (GHG) from 1990 to 2001. The emissions of CO<sub>2</sub> have been steadily increasing up to 2001. A preliminary, national goal of stabilising the CO<sub>2</sub> emissions on the 1989 level by year 2000, established by the Norwegian Government in 1989, was not reached. In 2000, the CO<sub>2</sub> emissions were 20 % higher than in 1989 ([OECD, 2001](#)).

The Norwegian Kyoto target is that the GHG emissions in the period 2008 - 2012 shall not exceed the 1990 level by more than 1 %. In 2001, the emissions were 8 % higher than in 1990. The emissions in 2010 are prognosticated to be about 17 % higher than the Kyoto target for a "business as usual" scenario, and even higher if gas-fired power plants are constructed in Norway. Increasing emissions of CO<sub>2</sub> is the main reason for the increasing emissions of GHG, whereas the total emissions of the other five GHG gases regulated by the Kyoto Protocol are declining ([MoE, 2001](#)).

Increasing emissions of CO<sub>2</sub> from the petroleum activity and the transport sector is the main reason for the prognosticated growth in the GHG emissions towards 2010. The total emissions of CO<sub>2</sub> are assumed to be 36 % higher in 2010 than in 1990. The CO<sub>2</sub> emissions from the petroleum activity are expected to be close to 90 % higher in 2010 than in 1990 ([MoE, 2001](#)).



**Figure 1:** Norwegian Emissions of CO<sub>2</sub> and Greenhouse Gases from 1990 to 2001 ([Statistics Norway, 2002b](#)).

## Norwegian Climate Policy

The Norwegian climate policy changed considerably during the 1990s ([Hovden & Lindseth, 2002](#)). When climate change came on the political agenda in the late 1980s, it was a clear focus on national measures and commitments to reduce the emissions. The fact that the leading Norwegian politician Gro Harlem Brundtland was the chairman of the WCED, may have influenced Norway to take on a role as a forerunner in climate change issues.

As one of the first countries in the world to do so, the Norwegian Storting (Parliament) adopted the use of CO<sub>2</sub> taxes in 1991. But, the taxes introduced turned out to have little impact on the total emissions level ([Statistics Norway, 2002a](#)), and the national emissions of CO<sub>2</sub> kept on increasing. The same tax level was not applied for all sectors, and in order to not weaken the competitiveness of Norwegian industry, many sectors and emission sources did not have to pay the tax. Totally, about 40 % of the Norwegian emissions of CO<sub>2</sub> were exempt from the tax.

Worries about climate change fell significantly in the population during the 1990s. According to surveys on the environmental awareness in the population, the share of the population being very worried about the greenhouse effect and climate change fell from 40 % in 1989 to 9 % in 2001 ([Hellevik, 2002](#)).

As the Norwegian GHG kept on increasing, the Norwegian climate policy shifted focus from national measures to international co-operation. In the international negotiations about climate change and GHG commitments, Norway became a committed supporter of cost-effectiveness and the need for international collaboration ([Hovden & Lindseth, 2002](#)). The argument is that since global warming is a global problem, it does not matter where the reductions take place. The emissions should therefore be reduced where it is cheapest. According to this principle, measures should preferably be carried out to reduce CO<sub>2</sub> emissions in countries with low abatement costs, and not in Norway where the costs are higher.

The Kyoto Protocol allows the use of some flexible mechanisms. It is possible to trade GHG emissions between the Kyoto countries and the “Joint Implementation Mechanism” allows two Kyoto countries to co-operate to achieve reductions. In addition, the “Clean Development Mechanism” allows Kyoto countries to be credited emission reductions in developing countries not regulated by the protocol.

The Kyoto Protocol, however, states that these mechanisms are supplementary to national measures. It is not clear yet how much of the reductions will occur in Norway, and how much will be traded. The current Bondevik II Government (Christian Democratic/Liberal Party/Conservative Party) states that a considerable part of the emissions reductions should be achieved in Norway ([MoE, 2002b](#)). The government also signalled that it will work for more ambitious, international emissions commitments after 2012 when the Kyoto Protocol expires.

During the international negotiations on climate change, Norway argued heavily for some special circumstances affecting GHG emissions ([Langhelle, 2000](#)):

- electric power production in Norway is close to 100 % based on hydro power without CO<sub>2</sub> emissions, whereas fossil fuels are used to produce electric power in most other countries. Other countries can therefore easier reduce the GHG emissions by reducing the use of electric power or by using gas instead of coal in the power plants;
- because of a clean and cheap energy supply, Norway has built up a large, energy intensive industrial system. This industry, which claims to be among the most environmentally efficient in the world, would suffer hard if energy taxes are imposed. Much of the industry would close down in Norway and the production moved to countries with lower tax levels and production costs;
- Norway is a long country with a decentralised settlement pattern. The need for transport work is thus greater in Norway than in most other countries. Much of the energy intensive industry is also located in the district, and the matter of industry survival is therefore also about regional politics.

To a large extent, Norway has been credited with these special circumstances. According to the Kyoto Protocol, the Norwegian GHG emissions in 2008-2012 shall not be more than 1 % higher than in 1990, whereas most EU-countries have a target 5 % below the 1990 level.

### **Increasing use of electric power**

The production and use of electric power is closely linked to climate change. Norway has benefited from a plentiful supply of cheap and clean hydropower, and today, the country has the highest use of electric power per capita in the world. Direct electric heating is widespread, and electricity covers about 80 % of the total use of energy in buildings.

Earlier, hydropower provided more than 100 % of the inland use of electric power, and Norway was a net exporter of power. But this picture has changed. During the 1990s, the use of electricity increased by about 1.5 % per year ([NVE, 2002](#)). At the same time, most of the hydro power resources were developed or permanently protected for environmental reasons. It was not possible to develop the hydro power production capacity enough to cover this steadily increasing demand. Demand eventually exceeded the production capacity, and since the mid 1990s, Norway has in practise been a net importer of electric power. In a standard year with normal precipitation and temperatures, Norway has to import 6 to 7 % of the power to cover the demand. This imported power is mainly coal power involving large emissions of CO<sub>2</sub> during the production process.

The demand for electric power is expected to continue to grow in the future if appropriate measures are not taken. To cover this increasing demand, Norway has to import even more coal power from abroad, or construct domestic gas-fired power plants to supply the power.

## Construction of gas-fired power plants

The construction of gas-fired power plants in Norway has been a controversial issue for several years. Norway produces a lot of gas, but almost of all of this gas is exported and very little is currently used in the country. In the middle of the 1990s, the plans evolve to construct domestic gas-fired power plants. A main argument was to utilise more of the gas resources in Norway instead of exporting it to Europe. Another argument was that the gas-power should be exported to Europe where it would substitute more polluting coal-power. This way, it was claimed, the construction of the gas-fired power plants would be good for the environment. It was not intended to use the gas-power in Norway. This was clearly stated when the Labour Government of Jagland, supporting the construction of gas-fired power plants, in 1997 established a national goal that the Norwegian inland use of electric power in a standard year should be covered by renewable energy sources ([MoE, 1997](#)).

But this goal of renewable power supply was reduced as the domestic demand for power kept on increasing. Today, all major political parties support the construction of gas-fired power plants, but they differ on the type of technology to be used in the plants. Some parties claim we have to develop technology for CO<sub>2</sub> sequestration to reduce the CO<sub>2</sub> emissions from the plants. Others say we cannot wait for 10 or 15 years until this technology is fully developed, but should rather start constructing conventional gas-fired power plants now and convert them to the new technology when it is available in the future. This issue has been so controversial, that the Centre Party/Liberal Party/Christian Democratic Government of Bondevik, replacing the Jagland Government after the general election in 1997, even resigned in protest in 1999 when it was instructed by the Norwegian Parliament to grant license to build three conventional gas-fired power plants.

The licenses were granted in 1999 by the new Labour Government of Stoltenberg replacing the Bondevik Government. The construction of the plants has however not yet started. The price of electric power has been too low in the market to make the plants profitable for the developers. Conventional gas-fired power plants require a long-term price of electric power of about NOK 0.23 per kWh (USD 0.03) to be profitable. Long-term contracts on electric power are currently traded in the market for lower prices than this.

The Norwegian hydro power production depends on precipitation and varies from one year to another. The annual power production is 118 TWh in a standard year, ranging from 89 TWh in a dry year to 150 TWh in a wet year ([NVE, 2002](#)). The price of electric power will increase in dry years with lower production in the hydroelectric power plants.

[Figure 2](#) shows the average, monthly spot price of electric power in the Norwegian market (Oslo region) from January 1996 to February 2003 ([Nordpool, 2003](#)). The market price has been higher than NOK 0.23 per kWh for only a few months during this period. The price was higher most of the months in 1996, which was a rather dry year. The average price for the whole year 1996 ended on NOK 0.26 per kWh. The year 2002 was a very special year. The autumn was exceptionally dry and the filling of the water reservoirs lower than normal. This lifted the spot price significantly at the end of the year. In December, the average spot price became as high as NOK 0.55 per kWh. However, due to significantly lower prices most of the year, the average price for the whole year ended on only NOK 0.20 per kWh.

The high prices of electric power at the end of 2002 came as a shock on most Norwegians, and the economic consequences for the many households with no alternatives to electric heating were top news for many weeks. Politicians were urged to do something about the situation. But most of the measures they suggested aimed at increasing the production capacity of electric power, whereas measures to improve the energy efficiency, and thereby reducing the demand for power, were barely mentioned.

Low attention was also given to environmental issues when the politicians debated the power situation. They stressed the need for constructing gas-fired power plants to increase the power supply, but did not mention that this would make it more difficult for Norway to fulfil the Kyoto commitments. Neither did they question the current development with steadily increasing demand for electric power, nor how this trend could be turned.

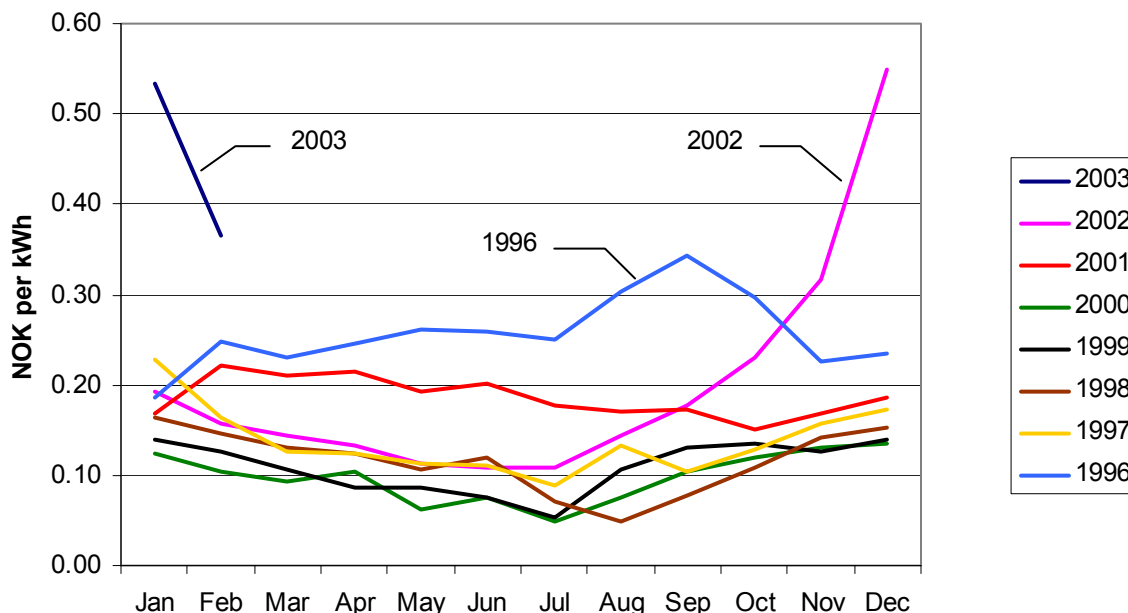


Figure 2: Monthly Mean Spot Price on Electric Power from 1996 to 2003 ([Nordpool, 2003](#)).

### Shift in Energy Use and Energy Production

In 2001, the total use of energy commodities in Norway was 240 TWh (864 PJ) excluding the use in the energy sectors and international maritime transport ([Statistics Norway, 2002a](#)). From 1976 to 2001, the average growth in energy use was about 1.4 % per year in Norway. The growth in the use of electric power was a little higher.

The authorities have signalled the need for a shift in the way energy is produced and used in Norway. Some goals have been established for this shift ([MoPE, 1999](#)):

- to limit energy use considerably more than would be the case if developments were allowed to continue unchecked;
- to increase the annual use of central heating based on new renewable energy sources, heat pumps and waste by 4 TWh by the year 2010;
- to construct wind generators with a production capacity of 3 TWh per year by the year 2010.

### Enova SF

To promote a shift in energy use and production, Enova SF was established in 2001 as a subordinate agency of the Ministry of Petroleum and Energy. All governmental efforts concerning energy use and energy production are now funnelled through Enova. The role of Enova is to be a “leading star” in the shift and contribute by funding activities and investments leading to reduced energy use or conversion from fossil fuels and electric power to renewable energy sources. Enova is financed by a fund that receives revenues from a levy on the distribution tariff on electricity (NOK 0.003 per kWh) and by

ordinary grants on the state budget. Enova's total budget was about NOK 430 million in 2002 ([MoPE, 2002](#)).

Strict requirements apply for Enova's activity and the projects they can support. The success of Enova is measured by how many kilowatt-hours they contribute to reduce or convert. The kilowatt-hours are reported to the Ministry. To receive funding from Enova, quantified savings or conversions must in principle be promised for every project. This strict reporting of quantifiable kilowatt-hours, however, limits the type of activities that Enova can support. Enova are only allowed to support short-termed projects which lead directly to energy savings or energy conversions, and not all the activities that are needed to achieve a long-term shift in the energy use and production. Examples of such other activities are information campaigns, education programmes, demonstration projects and development of new technology and systems solutions. In the present situation, where all governmental efforts concerning energy use and energy production are canalized through Enova, such activities will not be funded by the authorities.

Enova's main focus is on energy producing measures such as the construction of large district heating plants and large scale bio-mass plants, whereas only a small effort is directed towards measures to influence the end use of energy in buildings. This focus on energy production corresponds with the general attitude in the Norwegian energy and climate policy which is to focus on the supply side rather than the demand side. In the Governmental policy papers, there are neither any quantified targets for energy efficiency ([OECD, 2001](#)), nor any quantified targets for the total energy use in an important sector as the building sector.

One reason for this limited focus on end use of energy might be the large oil and gas reserves in the North Sea and the large production of hydro power. With such large energy resources, it does not seem so important to the Norwegians to reduce the demand. In 1999, for example, Norway produced nine times more energy than it consumed ([Statistics Norway, 2002a](#)).

### **Missing link in Norwegian climate policy**

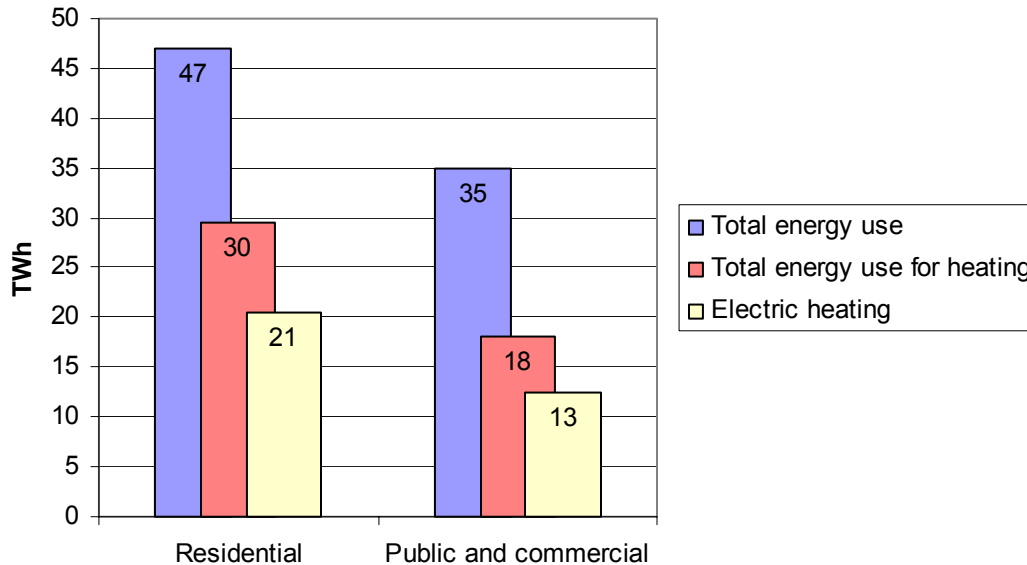
The growth in the use of electric power in the coming 10 to 15 years is expected to be greatest in households and in the service sector (public and commercial buildings) ([MoPE, 1998](#)). But, in the Norwegian strategy for reducing the GHG emissions, no link is made between the increasing electricity use in buildings and the CO<sub>2</sub> emissions from the production of the electric power. A report published by the Norwegian Pollution Control Authority in 2000 estimates the costs and benefits of alternative GHG abatement measures in Norway ([NPCA, 2000](#)). This report forms an important basis for the Norwegian climate policy. The only measure considered for buildings in the report is to reduce the current use of heating oils. No reference is given to the steadily increasing power demand in buildings and the way this power must be produced.

## **CURRENT STATUS OF ENERGY USE IN BUILDINGS**

### **Energy Use in the Building Sector**

The buildings stock is estimated to have a total floor space of about 325 million m<sup>2</sup> and a total value of NOK 3,200 billion (USD 427 billion) ([BAE, 2002](#)). The energy use connected to the operation of buildings is estimated to be about 82 TWh per year ([Enova, 2002](#)), corresponding to one third of the total energy use in Norway. Including the about 8 TWh that is estimated used for production and transportation of materials, and construction and removal of buildings, the share of the energy use that can be ascribed to buildings increases to close to 40 %.

[Figure 3](#) shows that 47 TWh is used for operation of residential buildings and 35 TWh in public and commercial buildings. Heating represents totally 48 TWh, whereof as much as 34 TWh is electric heating. Electric heating is widespread in Norway, and about 50 % of the total use of electric power in Norway takes place in buildings.



**Figure 3:** *Total Energy Use in Norwegian Buildings 2001* ([Enova, 2002](#)).

### Passive Authorities

Considering the large amount of energy being used in the building sector, and the CO<sub>2</sub> emissions associated with the steadily increasing demand for electric power in buildings, it should be a main effort in the Norwegian climate policy to bring about a shift in the way energy and electric power is used in buildings. The authorities have for many years signalled the need for such a shift. But, at the same time, the authorities have been very passive and made little effort has been made to influence the way energy is used in new and existing buildings. The development has to a large extent been left to the market forces, without much involvement from the authorities. Available policy instruments for influencing the end use of energy in buildings have not been taken into use.

One reason for this passivity might be that no ministry or governmental body is responsible for the energy use in buildings. Instead, the responsibility is spread among several ministries. The Ministry of Environment, for instance, is responsible for environmental issues and the emissions of greenhouse gases, whereas the Ministry of Petroleum and Energy is responsible for the national supply of energy and electric power. The Ministry of Local Government and Regional Development is responsible for the Building Regulations under the Planning and Building Act and focuses mainly on the construction of new buildings. The Ministry of Trade and Industry is responsible for the building industry and real estate trade.

### Weak Building Regulations

The Building Regulations regulate the construction of new buildings and the extension of existing buildings. New regulations were introduced in 1997 with stricter requirements for thermal insulation. The regulations indicate a minimum standard for the building's heating demand. The regulations were

intended to stimulate the use of energy efficient and environmentally favourable solutions. The general trend has however been that most new buildings have been constructed according to the minimum requirements in the regulations, and not with improved energy performance. Developers have normally chosen the cheapest solutions to reduce the investment costs, without considering the total life cycle costs. Many developers have even put much effort into getting around the minimum requirements in the regulations, in order to construct as cheap and poor buildings as possible with regard to energy qualities. Since energy efficiency and environmental qualities have not been in demand in the market, it has been possible for the developers to sell these cheap, unsustainable buildings at a good price.

The thermal insulation levels indicated in the regulations are far from optimum and could be made stricter. Especially for windows, improvements can easily be made compared to current requirements. Also for the ventilation and infiltration heat loss, great improvements are possible compared to current practise.

The regulations only consider the building's energy demand for space heating and not the energy demand for cooling, lighting, electric equipment and production of hot water. For modern, well-insulated houses, space heating represents less than 50 % of the total energy demand. For office buildings with high, internal heat loads, space heating represents an even smaller share of the total energy demand. Many Norwegian office buildings with large, glazed façades actually have a higher cooling demand than heating demand throughout the year. By only considering energy demand for space heating, the current regulations only address a minor part of total energy use in modern buildings.

### **Lack of Economic Incentives**

The low price of electricity in Norway is a main barrier to the introduction of renewable energy sources and energy efficient solutions in buildings. During the 1990s, household electricity prices decreased in Norway. In 1999, the average price for Norwegian households was about 40 % of the average price of household electricity in OECD Europe ([OECD, 2001](#)). In 2001 and 2002, the average price of electricity for Norwegian households was just above NOK 0.60 per kWh (USD 0.08 per kWh). The price consists of four parts:

- the price of electric power in the market (in average about NOK 0.20 per kWh excluding taxes);
- the price of transporting the electricity in the grid (the distribution tariff varies, but is normally around NOK 0.20 per kWh);
- a general tax on electricity (NOK 0.095 per kWh in 2003);
- and 24 % value added tax on top of it all.

The low electricity price in Norway has been justified by the good supply of clean and cheap hydroelectric power. But, Norway is now a net importer of electric power. According to the "Polluter-Pays-Principle", which has been adopted as the central principle of the environmental policy in Norway, the tax on electric power should be increased to reflect the CO<sub>2</sub> emissions from the production of the electricity, and to promote a shift towards more environmentally favourable energy use.

The electricity price for households can easily be increased by raising the general tax on electricity. But, social aspects must be taken into account when considering doing this. Most Norwegian houses have direct, electric heating (resistance heating) and in practise no alternative to electric heating. Many low-income households will suffer hard if the price of electric power is raised since they have no alternative to the electric heating.

It has been suggested that a step-wise tax on electric power be introduced with a relatively low tax up to a certain level of use, and a higher tax above this level. The idea is to tax basic use and levy a luxury tax to

“punish” those using a lot of electricity. But, it will be difficult to determine what a fair level is and what wasteful use is. The heating demand, for instance, varies a lot between the different parts of the country, and the energy use increases with the number of persons in the household. Such parameters should be taken into account when considering what a fair level is for a particular house. This however, will require a lot of information about the building and the household, making the system rather time consuming and costly to administer.

Increased energy prices will benefit the profitability of energy improvements. But, raising the energy taxes is a controversial issue. Several political parties argue more for lowering energy taxes than raising them. In the current situation, it seems politically difficult to get acceptance for a general increase in the energy taxes.

From 1990 to 1993, the government had a general grant scheme for energy improvements in buildings. This grant scheme was scrapped in 1993. During the next ten years, no governmental grants or subsidies were offered for energy investments in new and existing buildings. The only exemption was some small grants awarded by the Norwegian State Housing Bank for environmentally favourable improvements in new houses financed by the bank.

Enova, the new agency organising the energy efforts of the government, has a clear focus on energy supply. Enova originally had no intention of introducing a general grant scheme for households. This was turned upside down when the Government in February 2003 instructed Enova to establish a grant scheme for households as a response to the high price of electricity in the market. Grants were awarded for the installation of heat pumps, pellet ovens and heating control systems in private homes. By applying, the house owners could get 20 % refund on the investments, limited to NOK 5,000 (USD 670). The system was established 1 February, and the house owners had to apply before 15 March 2003. The response was overwhelming. More than 50,000 households applied for the grants during these six weeks, ([Enova, 2003](#)), which is 2.6 % of all households in Norway.

However, this particular six-weeks “sudden effort” campaign must be said to be of more symbolic importance than a real contributor in shifting the energy use in the Norwegian residential sector. There is very limited documentation, if any, on the effect of the measures being supported. Most of the 50,000 applications concerned the installation of air-to-air heat pumps. These heat pumps use the energy in the outside air to heat the inside air. The performance of the heat pumps is based on an outside air temperature of 7 degrees Celsius according to the Eurovent Certification ([Eurovent, 2003](#)). The coefficient of performance (COP), however, decreases significantly when it gets colder outside, and there is no documentation of the energy savings obtained in practise for such heat pumps in Norwegian homes during a cold winter. Earlier experience also shows that short-lived grant schemes may harm more than they gain. The suppliers and installers have not the capacity to cover the demand, and many unqualified firms and installers enter the market. Instead of such short-lived grant schemes, the professional and industrial bodies representing renewable energy and energy efficiency in buildings, all have expressed the need for predictability and long-term strategies.

## **HOW TO BRING ABOUT A SUSTAINABLE SHIFT IN THE ENERGY USE IN BUILDINGS?**

In the following paragraphs it is discussed what could be done to bring about a sustainable shift in the way energy is used in new and existing buildings in Norway is discussed. Five issues are discussed:

- creating a market demand for energy efficient and environmentally favourable buildings;
- improving the qualification and skills of the professionals;
- increasing the funding of research and development;

- improving the energy performance of new buildings by enforcing stricter energy requirements in the building regulations; and
- making energy improvements in existing buildings more profitable.

### **Create a Market Demand for Energy Efficient and Environmentally Favourable Buildings**

The general awareness of energy related issues is rather low in Norway, and the market demand for energy efficient solutions is lacking, even though the high price of electric power this last winter has put some focus on energy efficiency and renewable energy sources.

It is important to create a market for energy efficient and environmentally favourable solutions. Today, it is difficult to obtain information about the energy performance of new and existing buildings. A typical example is the fact that the prospectus on properties for sale seldom contains any energy related information. More information about the energy performance of buildings will contribute to increase the demand for buildings with good energy qualities.

A new EU directive on the energy performance of buildings will be important since it instructs that all buildings that are to be sold or rented shall have a valid certificate providing information about the energy performance of the building ([EC, 2003](#)). It is fundamental that the Norwegian authorities and the building and real estate trade support the implementation of this energy certificate.

### **Improve the Qualification and Skills of the Professionals**

Due to rather low awareness about energy related issues over the last few decades, many of the professionals (architects, engineers, contractors etc.) are not aware that energy efficiency measures that can be carried out in buildings. The trade is also rather conservative, and uptake of new technology and new system solutions are slow. Most of the companies within the building, construction and real estate trade are small companies with few employees. Each company has an average of only 5 employees, and as many as 97 % of the 43,000 companies in the trade have less than 20 employees ([BAE, 2002](#)).

It is important to develop education programmes and courses to increase the energy competence in the trade. As a part of this, guidelines should be developed describing how the energy efficient and environmentally favourable solutions should be used in practise.

### **Increase the Funding of Research and Development**

There is need to increase the funding of research and development on cost-effective energy solutions for buildings. This is especially important with regard to the existing building stock, since very many of the energy efficiency measures that can be carried out in existing buildings today involve too high investment costs to be profitable. The potential for developing more cost-effective solutions should be large, particularly if the solutions could be standardised or prefabricated. Demonstration projects should be actively used to test out the new solutions and demonstrate them for the trade and the users.

### **Improve the Energy Efficiency of New Buildings**

When designing and constructing new buildings, the focus should be put on energy efficient solutions that reduce the overall energy and electricity demand for heating, cooling, lighting and ventilation to a minimum. The energy efficiency of new buildings can rather easily be improved by introducing stricter energy requirements in the building regulations. For new buildings, the overall goal should at least be to halve the total energy demand as compared to what is the current practise for new buildings.

The new EU directive on the energy performance of buildings will be important for the introduction of stricter energy requirements. The directive was issued in December 2002 by EU (EC 2003). As an associated member of EU, Norway must put the directive into force by 2006. The directive instructs that the energy use in buildings shall be evaluated on a holistic basis where not only the space heating demand is to be taken into account, but also the energy use for cooling, lighting, appliances, fans, pumps etc. The directive also instructs that all buildings, including homes, that are to be sold or rented, shall have a valid certificate informing about the energy performance of the building and the measures that could be taken to improve the energy performance. The directive only instructs what to take into account when considering the energy use in new buildings. It is up to each nation to determine the energy requirement level as for instance the total energy use square metre floor space.

### **Improve the Profitability of Energy Investments in Existing Buildings**

It will be challenging to shift the way energy is used in existing buildings. A large number of building owners have to be influenced to carry out the energy improvements. The improvement measures often involve high investment costs, and low profitability at the current energy price levels. To improve the profitability, a number of policy instruments should be taken into use.

The main goal should be to improve the profitability of the energy improvement measures in existing buildings, and make these measures more attractive to the users. Significantly increased energy prices would improve the profitability, but is not politically realistic at the moment.

Governmental subsidies and grants could alternatively be used to reduce the investment costs and increase the profitability for the building owner. The overwhelming response on the grant scheme Enova administered this winter indicates that there is a large interest amongst the house owners to carry out energy improvement measures in buildings as long as grants are being awarded.

But it will be expensive for the Government to introduce a comprehensive grant scheme for energy improvements in existing buildings, and it may be difficult to get political acceptance for funding such a scheme over the state budget. An alternative way to fund the scheme could be to impose a surcharge on the current energy tax, and to earmark this surcharge for support of energy investments. A surcharge on the order of NOK 0.05 to 0.10 per kWh could be enough to finance a comprehensive effort to bring about a real shift in the energy use in buildings. Such a surcharge earmarked for energy improvements in buildings would probably also be more acceptable for the building owners than the current, fiscal taxes on energy.

Soft-loans with relatively low interest rates should also be offered house owners who carry out energy improvements in existing buildings. One barrier today is that building owners often have high loans, and have to pay unduly high rates to obtain additional loans to finance the energy improvement measures.

The Norwegian State Housing Bank currently has a system for offering loans for energy efficient renovation of existing houses. The drawback is that the rate offered is not lower than to the rate in ordinary, private banks. Considering that Norway has a Petroleum Fund worth more than NOK 600 milliard, it should be possible to use some of these funds to offer loans at favourable rates for energy improvements in existing buildings.

Finally, it is a need to develop more cost-effective energy solutions for existing buildings. It is especially important to integrate the energy improvements as a part of ordinary upgrading and maintenance works. It is further important to establish a system in co-operation with the trade that integrates energy

improvements as a natural part of ordinary upgrading and maintenance works being carried out in existing buildings.

## CONCLUSIONS

The gap is increasing between the Norwegian emissions of greenhouse gases (GHG) and the Kyoto target. Prognoses indicate that the Norwegian GHG emissions will be about 20 % higher than the target in the year 2010. A fundamental problem related to climate change is the steadily increasing demand for electric power in Norway and the GHG emissions associated with the production of this power in coal-fired or gas-fired power plants. The dependency on electric heating in buildings is large. About half of Norway's total electric power is used in buildings, and the demand for electric power is growing most rapidly in buildings. In the Norwegian climate policy, however, no link is made between the steadily increasing demand for electric power in buildings and the CO<sub>2</sub> emissions associated with the production of this power.

The Norwegian government has for several years signalled the need for a shift in the way energy is used and produced in Norway. But, with regard to buildings, the same authorities have been very passive and done very little to bring about such a shift. The last decade, the energy requirements in the building regulations have been weak, the tax on electric power low, and there has been no financial support from the government for energy improvements in buildings.

The authorities focus on the supply of energy, whereas low attention is given to the demand side and the end use of energy and electric power. The main objective of the Norwegian energy policy seems simply to be to satisfy expected future demand for energy ([Hovden & Lindseth, 2002](#)), and not to reduce the energy demand.

The principle of cost-efficiency is currently the guiding principle of Norwegian energy and climate policy. The authorities apparently consider it too expensive to reduce the Norwegian GHG emissions by influencing the end use of energy. The price of GHG quotas in the international market are expected to be low, much lower than the costs of reducing the GHG emissions in Norway. The fact that the flexible mechanisms of the Kyoto Protocol are supposed to be supplementary to national measures, and the statement of the current Bondevik II Government that a considerable part of the emission reductions will be taken domestically, will probably be neglected by politicians in the future. The experience with the previous national goals of stabilising the CO<sub>2</sub> emissions on the 1989 level within year 2000 (established in 1989), and the goal of covering the inland use of electric power in a standard year by renewable energy sources (established in 1997), shows that environmental goals are easily rejected when they are difficult to reach.

A sustainable shift in the energy use in new and existing buildings is not likely to take place with the current energy and climate policy. To bring about a significant shift in the way energy is used in new and existing buildings, several measures and initiatives are needed:

- Create a market demand for energy efficient and environmentally favourable solutions. A successful introduction of the energy certification scheme according to the new EU directive on the energy performance of buildings will be important for creating such a market.
- Increase the energy competence and skills of the professionals in the building, construction and real estate trade. The market demand for energy efficient and environmentally favourable solutions has been low for several years, and the professionals do not know about the most favourable solutions.
- Increase the support for research and development.
- Significantly tighten the energy requirements for new buildings in the buildings regulations.

The goal should at least be to halve the total energy demand in new buildings as compared to the current practise. For existing buildings, the challenge will be to influence the large number of building owners to carry out energy improvement measures. To increase the profitability of the measures, the authorities should introduce a grant scheme for the investments and offer soft loans with favourable rates of interest. Such a financial support from the government will require considerable funding. Parts of this funding can be obtained by imposing a surcharge on energy, and earmark the revenues for energy improvements in buildings.

The authorities have a clear responsibility in taking a leading role in a shift for sustainable energy use in buildings. The experience with the EcoBuild programme (1998 - 2002) shows that the trade is more than willing to contribute in a joint effort for environmental improvements, but that a heavy financial support and involvement from the authorities will be a prerequisite for their contribution.

## ACKNOWLEDGMENTS

The work presented in this article has been supported by the Norwegian Research Council through the strategic institute programme "Environmentally Favourable Energy Use in Buildings 2000 – 2004".

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