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PRICES, PUNISHMENT OR PEDAGOGICS? HOW NORWEGIAN ENERGY-CONSERVATION POLICIES AFFECT HEATING AND VENTILATION ENGINEERING[1]

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1. INTRODUCTION

Energy conservation is an engineering agenda which has brought forward important technological changes.[1] However, even as a technological field it is quite heterogeneous in terms of the specialities and practical areas involved. From the point of view of public policy, energy conservation becomes even more heterogeneous and transdisciplinary. It may be understood as a sociotechnical packet of visions, options, and actions, where the role of engineers is challenged by other professional groups like economists, political scientists, architects and medical professions, in addition to various crafts.

While everyone is familiar with the idea of an information society, the energy conservation society seldom reaches the headlines. Nevertheless, there is an energy efficiency movement with quite dramatic claims about changes in energy consumptions.[2] A Worldwatch report summarizes its ambitions succinctly when it claims that: "*Improving worldwide efficiency by 2 per cent annually would keep the world's temperature within 1 degree Celsius of current levels*".[3] However, to realize the technological potential of energy conservation is a complex, multi-level challenge. It involves policy measures, engineering practices, construction practices, public understanding, information, new technologies, and so on. There are also at least three different policy agendas: (1) *energy saving*, (2) *economic optimalization of energy consumption*, and (3) *environmental goals*; the latter concerned with the effects of energy production and use on the global environment. They are addressed with different emphasis in different countries in different periods.

In this paper, the focal point will be the heating and ventilation industry, in particular the role of engineers in the planning and designing of heating and

[1]A shortened version of this paper is published in the proceedings from the ECEEE European Council for an Energy Efficient Economy 1995 Summer Study.

ventilation systems for buildings. We want to examine how different policy measures taken by the Norwegian government affect the design practices and design discourses of these engineers. In the first part of the paper, we give an outline of the Norwegian energy-conservation policy, with emphasis on the measures that may affect heating and ventilation engineering. The second part presents results from a study of the energy conservation discourse and design practices in the heating and ventilation industry.

2. THE SHAPING OF A NORWEGIAN POLICY FOR ENERGY CONSERVATION

Norwegian energy conservation policy has not at any time been "hot" in the sense of a high level of controversy. As in most industrialized countries, it came in the aftermath of the so-called energy crisis of 1973. The main agenda was in the beginning to contribute to a more economical exploitation of energy in Norwegian society, but also to counter an expected shift in energy consumption from oil to electricity.[4] This is evident from a Report to the Government from a Commission on energy conservation, presented in 1975. It was based on a traditional economic understanding of the whole issue: *The function of the price system is to contribute such that available resources are used in such a manner that they through production or consumption give the highest possible use-value. When the producer or the consumer adapts to the current prices, a further economization should not be needed ... When one says that there is a need for economization beyond what is suggested by the initial level of prices, this has to reflect that one wants a stricter limitation of the demand than follows from the current prices.*[5]

The main suggestion of the commission was thus to increase the price of electricity, partly to adjust to the price level of oil, but above all because it was argued that the price of electricity in Norway was below the level of long-term marginal costs of production. In addition, it proposed a public fund to support insulation of the existing mass of houses, changes in the regulation of constructions (in particular to demand that all new houses should have chimneys to allow alternative heating besides electricity), and information campaigns:

> *Priority must be given to show what may be achieved by small means without any substantial loss of comfort, but one must also aim to show the costs of comfort, so that the public itself will have a best possible basis for making choices.*[6] In terms of energy conserving technology, the implicit focus of the commission is *diffusion* of existing options. This diffusion is perceived as a matter of prices, regulations and knowledge, and in general terms. A support of Norwegian R&D in this field was not on the agenda.

When the government's first white paper on energy conservation came three years later, the emphasis was still on the economic aspects. Economically efficient energy conservation was defined by referring to: *that development, transformation and consumption of energy should take place in the best possible economical way. (...) Energy conservation covers both production, distribution and consumption within the existing energy system. For example, the recycling of waste and waste heat will be perceived as energy conservation.*[7] However, the use of alternative energy sources was not seen as part of energy conservation.

The featured means of energy conservation was energy prices, including the organization of the market for electrical energy. However, the white paper covered a broad set of actions, including technological improvements in the production and distribution of electric power, the use of heat pumps, increased production of oil and gas from the North sea, incentives to reduce the use of private cars, financial support through funds for energy conservation in industry and in buildings, recycling of energy from waste, information and education, and research and development. Compared to the report from the Commission, the white paper defined a broader agenda and signalled greater optimism about what might be achieved. The result could be interpreted as a compromise between an economic and an engineering point of view. There was a strong belief in the power of relative prices to make the production and use of energy efficient, but one also saw that the market systems occasionally needs help to do its job. The white paper thus outlined a very broad network of interests and institutions to be mobilized in the service of energy conservation.

The next white paper on energy conservation was presented six years later. This paper self-consciously develops the idea of a particularly Norwegian concept of energy conservation, emphasizing that actions should be profitable, in contrast to many other countries who wanted to save energy to a greater extent than current energy prices suggested. Economically efficient energy conservation was now defined as:

- *the use of the energy we produce, distribute and consume in the most efficient way within accepted frameworks of profitability*
- *reduction of costs by substituting one energy carrierer by another*
- *unchanged or reduced costs by the use of energy of lower quality than before the investment was undertaken.*[8]

Compared to the previous white paper, one had become more concerned with the problems of implementing energy conservation. A new section on barriers to energy conservation was added, noting that "*In practice, it turns out that many circumstances make it difficult to have a rational adaption based only on the price mechanism*" (p. 28). The white paper mentioned lack of knowledge about technical possibilities, mental barriers to a critical evaluation of the use of energy, organizational complexities, contradictory laws and regulations, financial limitations and price barriers.

To overcome these challenges, the white paper was seeking a redistribution of roles between different actors and a set of means. We will not go into details here, but first of all point to the reduced emphasis on the price mechanism as the prime tool to stimulate energy consumption. Compared to the white paper from 1978-79, we find greater emphasis on technological information, although it was the same areas that are being discussed: production and distribution of electricity and energy conservation in industry, households and transportation. There was an increased emphasis on information and economical support to help overcome conservatism and lack of interest. Still, relative prices were considered an important type of action, and it was emphasized that the main responsibility for energy conservation rested with energy users. Similar concerns were influential also in the next white paper in 1988-89, appropriately called "On energy conservation and energy research",[9] but economical means regained a more prominent place. There was no change in the formal definition of energy conservation, but this white paper included a substantial discussion of so-called alternative energy sources. This broadened the scope for energy conservation in Norway.

During a decade or so, the Norwegian government had constructed an energy conservation policy partly oriented towards increases in energy prices, but very much concerned with information, education and development of knowledge, including R&D. One aimed to make energy users more conscious of the profitability of conservation, but also more aware of the technological and economical possibilities through the use of so-called prototype and demonstration projects. There was also a growing concern for regulatory actions, for example changing building regulations to demand more energy conservation. In addition, there were continuous debates about the organization of the market for electricity. The white paper of 1988-89 signalled a new energy act to liberalize the electricity market i Norway.

The latest white paper, from 1992-93, suggests some changes in the main policy to give economists' considerations more weight.[10] Compared to the white papers of 1984-85 and 1988-89, there is greater emphasis upon economic rationality as a main pillar of energy conservation. The individual should receive economic motivation to make decisions that are profitable in terms of the national economy. The economic funds previously available to support investment in energy conservation is reduced. Instead, the white paper introduces a concept of an energy conservation strategy that is flexible and tailored to the needs of different industries and users. The emphasis is on motivation, analysis and planning.

To summarize, the construction of the Norwegian energy conservation policy may be seen as a dynamic and shifting compromise between two main strategies: *the engineering strategy* and *the economist strategy.* The first one is characterised by *technology push.* Its strength is in the priority given to concrete measures of energy conservation and the active support to bring forward new technological

solutions. Its weakness is the problems occurring from the efforts to diffuse new technology. Probably, the engineering strategy is based on a too optimistic belief in the ability of good solutions to so-to-speak diffuse themselves, it lacks a clear view of the role of users, and it puts to little emphasis on the shaping of institutional arrangements to support energy conservation. The economist strategy, on the other hand, assumes that effective demand will promote the development of appropriate technology of energy conservation. Thus, it is not necessary to support development of technology directly. The strength of this strategy is its focus on the construction of institutional arrangements of an economic character. Its weaknesses are in particular its neglect of institutional problems of a non-economic character, for example the assumptions made about adequate levels of knowledge and adequate reactions to changes in relative prices. Also, the conceptions of users are problematic, given the rather one-sided focus on information and relative prices as the means to affect behaviour. The main features of the two strategies are summarized in Table 1.

Table 1. Two ideal type strategies for governmental energy conservation policy: The economist strategy and the engineering strategy.

The economist strategy	The engineering strategy
Emphasizing the profitability of energy saving measures	Emphasizing energy efficiency and energy conservation
Focus on market structures	Concerned with development of measures to stimulate the development of new energy conservation technologies through r&d programmes
Use of relative prices and regulation of prices to stimulate energy conservation	Concerned with the need to stimulate diffusion of energy conservation technologies through prototype- projects, demonstration projects and economic support
Giving great importance to information about energy conservation, in particular about the profitability of such actions	Argues the importance of governmental rules and specifications to ensure the implementation of energy conservation

In a country with abundant energy resources and relatively low energy prices, energy conservation policy is not an easy challenge. The effects of Norwegian policy in this area are unclear. On a very general level, it is observed that the energy intensity of the Norwegian economy, measured as the relationship between energy consumption and gross national product, has dropped ca. 10 per cent from 1980 to 1991.[11] However, this may just as well have been produced by general trends in the development of technology, rather than by the measures

taken by the Norwegian government. The white papers themselves are not confident in the success of Norwegian energy conservation policy either. On the one hand, there are important and measurable effects in terms of government financial support of investments in energy conservation in industry and in building, information campaigns and training programmes have been developed and effected, and public buildings have been the object of conservation programmes of considerable size. Still there is a large potential of profitable energy saving which is not realized. This is above all considered to be an information problem: *Lack of information among users of energy about what possibilities of energy conservation that exist and about the profitability of energy conservation is a considerable barrier to a rational use of energy. An important means for the government is to arrange for suppliers of energy and energy conservation products themselves to inform about energy conservation and to market a more efficient use of energy.*[12]

It is interesting to note that the Norwegian energy conservation policy does not make any of the common, simple-minded assumptions about new technology automatically paving the way for social change, here energy conservation. Energy conservation is understood as a heterogeneous and contingent activity, involving technical as well as economical and cultural considerations. New technology, able to save energy in a profitable manner, has to be demonstrated, communicated, marketed, and taught in order to be diffused throughout society. A continuous problem is in finding or constructing an actor or groups of actors able to enrol Norwegian society to do energy conservation. There is not an established energy conservation industry, the research institutes seem to operate in the shadows, the energy producers have contradictory interests, and the government either cannot or does not want to carry the responsibility on its own. Still, there is a puzzling belief in rational action. With sufficient information, sufficient training and sufficient economic incentives, individuals, companies and institutions are supposed to acquire and implement economically optimal energy conservation technology.

From our point of view, it is important to note that Norwegian energy conservation policy does not interact directly with the industry and the professions that supplies designs, products and installation of heating, ventilation and sanitary systems in building. At least in principle, they should be in a strategic position to implement energy conservation since its designs and actions have a great impact on energy consumption. On the other hand, the energy conservation policy does intend to affect heating and ventilation activities. Returning for a moment to our ideal type strategies, both make problematic assumptions. The engineering strategy views the heating and ventilation industry as an institution for diffusing energy conservation technology. The industry is assumed to be active and radical in its effort to receive, diffuse and use information about such technologies. In a similar vein, also the economist strategy assumes that the industry is well-informed. Moreover, it maintains that

practical energy conservation actions are produced by demands from knowledgeable consumers and/or that energy conservation is more profitable to the industry that other designs. Thus, both strategies makes the very critical assumption that the heating and ventilation industry is fluid and quick to adapt to changes in economic and technological factors.

3. METHOD

The effect of the governmental energy conservation policy upon the heating and ventilation industry is in the final instance a question of whether or not the industry is doing its job according to the policy aims. More precisely, we would ask:

* does the heating and ventilation industry note an increased demand after energy conservation designs or does it see economic possibilities in marketing such designs?
* is the industry sufficiently aware of policy aims, and is it sufficiently informed about technological and economic possibilities?
* does the industry mediate energy conservation designs and equipment, in accordance with existing technological options?
* what are the effects of changes in building regulations, standard, etc.?

In other words, what are the effect of prices, punishment (regulations), and pedagogics (information and training)?

The political conception of energy conservation in Norway emphasizes, as shown previously, the potential for profits in 'optimal' energy savings. The concept is talked about as *enec*, energy economisation, i.e. economically efficient energy conservation. This policy is promoted through a set of tools: prices, including economic support and market reorganization, regulations, and information and education, including prototype and demonstration projects. We wanted to analyse the effect of these measures on consultant engineering companies in the heating and ventilation industry. How do people working in such firms perceive of public policy, and how do they react to it?

Our study was designed to clarify such issues. It is a qualitative analysis, mainly based on open-ended interviews, loosely structured by an interviewguide. The questions asked concerned major aspects of the heating and ventilation business, seen from an enec point of view. We have collected data about the perceptions of enec and enec policy, the organisation of the heating and ventilation business, their strategies and procedures, relationships between different companies and professions and with public authorities. The interviews lasted between 1 and 1 1/2 hour. They were taped and transcribed. In total, 45 interviews have been conducted with different actors in the industries. We have focused particularly on consulting heating and ventilation engineers, but our study also includes interviews with building contractors, architects, suppliers and

producers of heating and ventilation equipment, representatives of the professional organisations of the industry, and craftspeople.

This paper is mostly concerned with effects of enec policy on consultant engineering companies, specialising in heating and ventilation designs. We have interviewed in seven such firms, between 1 and 4 persons in each company. The selection of these firms was made strategically, to obtain variation in terms of size and business profile. The transcribed interviews have been collected in a file for each company and given an alias to conserve the anonymity of our informants. Interview quotes used in this paper are identified by reference to the company file.

Our analysis is structured around the following four issues:

* How the engineers perceive of enec (section 4)
* How the companies say they are affected by direct enec policy measures (section 5)
* The economic aspects of enec: How to find a market for enec designs (section 6)
* How the engineers acquire information about enec (section 7).

This covers prices, punishment and pedagogics. We will begin by taking a closer look at the way these engineers conceptualise energy conservation.

4. THE CONSTRUCTION OF ENERGY CONSERVATION AMONG NORWEGIAN HEATING AND VENTILATION ENGINEERS

Enec is a well-known concept among consultant engineers within heating and ventilation. Generally, enec is seen as important, at least as long as it may be sold. The market has been interested in enec if these technologies may help reduce energy costs. The accepted period of payback on investment has normally been 2-3 years, according to our informants. That implies a substantial calculation rent. Moreover, enec sales are time-consuming. The client, the future owner of the building, evaluates the prospect for a long time, until -- eventually -- it becomes a contract.

One of our informants responded to our questions about energy conservation by saying that: "*By enec investments I mean actions that are profitable from an enec point of view or as energy economisation through their ability to produce a reduction in the energy costs of the building*".[13] This is the most common understanding which is close to the political definition. Many also emphasize that enec is something the industry has done for years. It is just a new name for an established practice like we were told by a managing engineer with 17 years of experience in the industry: "*Enec concerns windows and outer walls, the reduction of the heat loss of buildings and heat recovery on the ventilation side. And this is what we have been doing all the time -- I cannot remember that we have been doing anything else*".[14] The same informant also added that today there

is an improved understanding of the fact that technical systems and control rooms need space.[15]

A lot of people in the heating and ventilation industry argue that the focus on enec has given the heating and ventilation profession a defining status as a separate and important player in the design of buildings. It is a fact that an increasing part of the investments needed to raise a new building, is related to technical installations. While the increase related to electrical engineering is spent on computers, the increase related to heating and ventilation is connected to indoor climate. This is measured in terms of improved air quality, reduction in the prevalence of asthma and allergy, and reduction of other physical strains.

Today, the technical installations represent between 20 and 30 per cent of the total building costs, and this part is expected to increase.[16] "*By the year 2010, we are probably coming close to 50 per cent. Or call it technical systems. Include the electronic systems too. (...) The building itself is becoming relatively cheaper, in relation to the technical systems*".[17] If the visions of this representative of the industry is correct, it may provide a new basis for a discussion about the meaning of enec and how to make priorities among different aspects of buildings, costwise. There is a strong belief in technical systems. However, what may prove problematic is the lack of a broad perspective. Cost reductions may result from the use of materials with more hazardous emissions, demanding more ventilation to provide a good indoor climate. We should not forget that the concern for energy saving that followed the energy crisis, among other factors has caused a relative decline in the quality of indoor climate. Today, indoor air quality and indoor climate in general have become integrated into enec and broadened the concept.[18]

The consulting engineers have tried to make enec concerns a standard part of the planning of new building. In this respect, they believe to have earned considerable success. Our informants see this development in part as caused by a change in the Norwegian real estate market. After the boom of the mid-eighties, the employer is usually the future owner and user of the building. This has brought forward a greater concern for running and maintenance costs and greater interest in energy consumption as well as indoor climate. Restoration projects are very often initiated by the need to upgrade technical systems. The goal is to make the systems more effective, thus reducing running costs. In these instances, the consulting engineers present as their task to bring forward energy efficiency as well as air quality and indoor climate.

Most of the informants agree that enec is an ambiguous concept, but in relation to heating and ventilation they focus two issues: (1) energy saving, and (2) optimal air quality. To succeed in practice, the planning needs to be coordinated between different professions. Some companies report close collaboration with fields like electrical engineering, medicine, and architecture, but most complain that the present level of cooperation is insufficient. There is a lack of communication between different professions, and well-established

differences of professional culture complicates collaboration. Failure-stories are usually explained through reference to lack of coordination at the planning stage. Often, deficiencies are not discovered until construction has started. Then it is too late. Some report limited success with multiprofessional planning groups, but they experience a problematic lack of clear decision criteria.

The consultant engineers also see a problem in the trend towards the use of total commissions where they are sidestepped in the planning process. The employer leaves the commission with one contracting company, putting the total responsibility in their hands, or they may even go directly to suppliers and craftsmen to save money. In the accounts of the heating and ventilation engineers, this trend is reported to be negative with respect to enec seen as a whole. One argument challenge the ability of craftsmen to manage the situation: "*Plumbers are clearly interested in learning more, to think about the total challenge, and such. But in the bitter hum-drum, when they have got an order in harsh competition with other plumbers, at a very low price, they have to see to it that the installation becomes as simple and cheap as possible*".[19]

Plumbers may challenge the argument, and we will not pass judgement on the controversy. However, the existence of this kind of controversy is interesting in itself. It points to the fact that it is not clear what is gained by using heating and ventilation professionals in the planning process of new buildings and restoration projects. To some extent, this may indicate that the enec field has not become professionalised. However, enec, as it is described to us by our informants, is not a discipline proper. In fact, it may come very close to be what is called a *transdisciplinary* activity.[20] Enec challenges as outlined by our informants as well as by Norwegian policy cover a broad and heterogeneous problemfield, an arena of negotiations between different competencies and points of view. No discipline may make a legitimate claim to the field as a whole.

Transdisciplinarity may mean that available professional criteria for passing judgements and making decisions are vague and unclear. To balance e.g. the concern for energy efficiency and indoor climate is complicated. So-called enec reports may conclude that it is necessary to increase energy consumption to provide necessary improvements in indoor climate. It is an open question whether government policy give notice to such issues. As previously indicated, Norwegian enec policy seems to be grounded in a belief in costs and prices as sufficient common denominators to allow employers and planners to balance the different concerns in an optimal way. On the other hand, many of our informants hope for governmental regulations to set up guidelines and criteria that simplify the decision-making by mandating certain solutions and qualities. While the governmental efforts of the last 20 years have been reasonable successful in making enec in general terms a concern of the heating and ventilation industry in Norway, we need to have a closer look at their ability to support the idea of an optimal economic energy conservation practice.

5. FROM POLICY INTO PRACTICE: THE EFFECTS OF DIRECT POLICY MEASURES

It is generally known to be difficult to transform policy into practice. We have no reasons to believe that it should be otherwise with energy conservation and enec. In section 2, we gave an outline of the changes in Norwegian energy conservation policy from 1973 onwards, with an emphasis on the policy instruments that have been employed. We described Norwegian policy as an outcome of two strategies, one stressing relative prices and market organization (the economist strategy), the other supporting the technological avenue of energy efficiency (the engineering strategy). The emerging policy has used a varied set of means, with emphasis changing somewhat from one period to another.

Norway has a tradition of public regulations to promote a relatively high level of quality in buildings. There are technical rules for most aspects of the construction of a buildings, including technical systems. However, dwellings are excepted from many of the latter regulations. The State Labour Supervision has made instructions for indoor air quality at work. They also provides a check-list that demands information about heating and ventilation systems, to be filled out when a project has been finished. To use the list is voluntarily, and many companies do not apply it.

Our informants are ambivalent to the public regulations. To some, regulations simplify their work of persuading clients to provide for enec and a good indoor climate. Others find it difficult to use state bodies: "... *it is not our method to call upon the State Labour Supervision to force our point of view upon the client. We have to try to give advice, to tell them what we believe is in their best interest. And to carry the argument successfully through, is often difficult*".[21] Employers frequently ask what installations that are mandated. The consultant engineers tell us that it is difficult to provide a clear answer to this because the building regulations and the instructions of the State Labour Supervision have the common characteristic of being both normative and instructive. This makes them ambiguous, a quality with advantages and disadvantages. The Office of Building Authorities who makes the regulations, claims that buildings are too diverse to make it fruitful with strict, mandated rules. Nevertheless, in relation to enec, the office has seen the need to clarify the instructions. The new building regulations, to be active from January 1 1996, will be more concrete, at least about the balancing of concerns for indoor climate and for energy consumption.

The majority of our informants are positive towards this change: "*I have to say that we are looking forward somewhat to have a new building code now, regulations that are a little more demanding* ".[22] They believe this will ease their job of persuading employers to invest more in technical systems: "*The building code is about recommended minimum standards. So everyone is free to exceed these. (...) However, if we start to go beyond the minimum set by the building code, we have to explain this to the employer. Otherwise, we might be taken with*

our trousers down, to phrase it that way".[23] The ambivalence is still there. On the one hand, stricter minimum standards provide good arguments for greater efforts concerning enec and heating and ventilation systems. On the other hand, most of the informants know from experience that often the mandated minimum standards in practice also become the *maximum* standards.

Thus, our consulting engineers are caught in a complex argumentative situation. When they go for the minimum standards, the mandating of such standards simplifies their job. They may just refer to the building code. If they believe that stricter standards and more advanced solutions are more appropriate, they need particularly good arguments to convince the employer. Norwegians trust the government to set standards that are at least sufficient. This situation also complicates the job of producing an appropriate building code. If it is common to use the minimum requirements as a standard not to be exceeded on either side, it is tempting to mandate rather strict regulations. However, this is costly and it also confirms the belief that minimum requirements should be seen as maximal requirements too.

Some clients operate differently, partly because they can afford higher standards, partly because their businesses are particular. The State Pollution Supervision as well as the State Labour Supervision may also demand of some industries and companies that they take special measures. Those of our informants that work with clients from e.g. off-shore industry or pharmaceutical industry say that such companies often choose more advanced solutions than what is mandated. They are more wealthy, but they also give particular priority to safety, good working conditions, and -- in the case of the pharmaceutical industry -- of cleanliness. Such clients seem to be an exception.

To encourage the use of enec products and solutions, the government used to provide some financial support for enec actions. However, in recent years, the authorities have cut these sources of funding. In the latest white paper on energy conservation, the government argued that the arrangement was misused, in particular that there was a considerable problem with free riders.[24] The consulting engineers had made a lot of money from the support system which included a subsidy of NOK 5000 (600 ECU) to make enec reports about relevant activities for a given house or building. However, very frequently the reports led to nothing because the owner of the building had to pay for the implementation of the suggested actions. When this support for enec surveys was terminated, the heating and ventilation industry experienced a marked downturn in the demand for enec. In fact, when we did our interviews, very many of our informants hinted that there no longer was a market for enec: "*I'm disappointed with the follow-up of the latest white paper on enec. On the one hand, what is signalled on a high political level, and on the other, what comes out of budgets and such. It has become increasingly difficult to do proper work with enec because the energy market has been liberalised, something which has lowered the prices of energy. (...) And when you at the same time remove a considerable part of the financial supports*

and limit them so they cover only a part of the community working with these issues, you get a considerable difference between political statements and political practice".[25]

The reduction of energy prices is an important explanation of the diminishing interest in energy conservation. Other informants disagree: "*When the authorities have closed this financial tap now, they state clearly that this is because they discovered that many of the projects that received support only had a small enec element. And* ***they*** *would have been realized anyway*".[26]

It is interesting to note that our informants disagree in their evaluation of both of the two direct policy measures we have analysed in this section. Some think that building codes are very important and that stricter codes is a great improvement. Others perceive the codes as a problem because they help set a standard which is difficult to transcend. Some said the subsidies of enec surveys and implementation of enec was efficient because it supported a basic demand for enec services, while others thought the government was right to cut these funds. Some of these differences of opinion is related to different positions in the heating and ventilation market. The ambivalence and disagreements show, nevertheless, that both policy measures made enec more important for the heating and ventilation industry. In that respect, they should be judged as effective.

An underlying story in many of the statements used in this section is related to the relationship between the consulting engineers and their employers. This relationship is partly an economic one and partly one of communication and negotiations. In the next section we will explore this user-producer relation to analyse some features of the market for enec.

6. VISIBLE COSTS AND HIDDEN PROFITS? IS THERE REALLY A MARKET FOR ENEC?

The most central dimension of Norwegian enec policy is the concern for energy prices and the structure of energy markets. While relative prices of energy was important in the early stages of enec, there has in the last few years been a greater interest in efforts to reorganise the market for hydro-electric power. Also, as mentioned in the previous paragraph, economic support for enec analyses and implementation has been cut dramatically. When examining the impacts of the economic dimensions of the enec policy on the heating and ventilation industry, other aspects, implicit in the enec concept, become more important. The main point is that enec policy is based on the general assumption that the market provides correct economic signals about energy conservation. The future owners of buildings are supposed to be knowledgeable about the impact of heating and ventilation systems on future running costs and on the building's ability to provide a productive environment for the activities that are going to take place there. This

knowledge they should get from consulting engineers who are supposed to find it to be in their best interest to provide such information.

Our informants claim that the advice they give their clients is not influenced by the size of the investment resulting from the advice. Their earnings are not affected by the choice of the client to go for an expensive or a cheaper system: "*The choice between an expensive or a cheaper solution doesn't really matter to us. Our earnings are affected by other dimensions, so we don't profit from the choice of the one or the other alternative. We have our to advice to give, at a certain price*".[27] Anyway, the consulting engineers say they have a moral obligation to act according to their professional beliefs in their interaction with clients. When they recommend a set of solutions, they should also be able to explain their advice a convincing way. If the client choose a different option that the design suggested by the consultant, the latter shall outline the consequences for the quality of the building.

The client's choice is usually affected by a set of different considerations; knowledge, economy, the planned use of the building, etc. However, builders are a heterogeneous group with large, professional employers at one extreme; those who build for the first time at the other. Many of the large builders have their own professional staff, specialising in building projects. The rest is dependent on hiring the necessary expertise. The resources they command to plan, evaluate and implement are different, and thus their ability to obtain and process the information they need to decide on heating and ventilation systems. Consequently, we expect different abilities to react "rationally" to available information and knowledge. If one assumes that advanced systems on certain premises are cost-effective in terms of energy savings and improved indoor climate, we would also expect that the large and knowledgeable builders more often decide to use such systems.

However, our informants do not confirm this hypothesis. In general, they say that presently, their clients are overly concerned with investment cost, including the length of the planning and construction period. In the late 1980s, the interest on building loans increased substantially. This meant much more emphasis on reducing the time spent on construction. Even if the interest today (1994) is much lower, this does not seem to have been of consequence: "*The planning time may in fact have become even shorter on some projects. Then, you can't be very creative, you know. You just have to pick a solution you know is going to work and get things done*".[28]

According to many of the building contractors and consultant engineers we have interviewed, the time for planning as well for construction has been cut to the bone. In addition, there has been a long period of crisis and low activity in the building industry. Rather than stimulating renewal and innovation, this situation has brought on conservatism and design-by-routine. Since diffusion of energy conservation and enec presupposes a reorientation in the heating and ventilation

industry, a focus on innovation and new designs, the crisis of the building industry has countered official policy.

As mentioned earlier, today indoor climate is a greater concern than energy saving. Experience with problems produced by insufficient quality of indoor climate combined with research has created a greater awareness and made employers more willing to give priority to technical systems which improve indoor air quality. Of course, this is favourable for the heating and ventilation industry and for the building industry in general. Even if employers are very cost-conscious and demand solid documentation to support the advice from consulting engineers, the indoor climate concern has made an impact. One of our informants told the following example from a retrofitting project: "*You have to come to terms with the employer about the kind of indoor climate one wants to achieve. If you give priority to indoor climate, then you cannot use for example recirculated air. And the economic calculations have to be made on the assumption that recirculation should not be used. Of course, then you get very different results than when you calculate on the basis of an old system based on recirculation. Consequently, it became profitable to install a new system. But if you were thinking in terms of running costs only, they should have kept the old one*".[29] The costumer, characterised as professional and cost-conscious, turned down several of the proposal from the consultant when their profitability could not be documented. However, they knew from experience that indoor climate was a problem. Even if the impact of such investments are difficult to calculate, they went for improvements on this front.

An interesting example of a new procedure was given by another company. In this case, a new building should be "clean" when finished. By agreement with the employer, the consulting engineer got the responsibility to control that all materials and construction procedures satisfied the requirements of no indoor pollution. The main contractor had to send the names of all materials to be accepted by the consultant. In cases where materials were unknown to the consultant, he declined them. In some instances there were disagreements, and if the supplier insisted that proposed material was clean and environmentally friendly, they had to prove this and be responsible that the material really met the requirements. This forced everyone to be conscious about enec and indoor climate: "*That was the nice thing about it, suddenly they had to look out, them suppliers. Suddenly* ***they*** *became responsible*".[30] He also intervened in work routines, for example by insisting that the floor covering could not be put on until the concrete had dried sufficiently, even if the craftspeople insisted to do it to keep on schedule.

This kind of procedure with its particular system of quality control breaks with the standard patterns in the building industry, including the priority given to short planning and construction periods. In this case, both the employer and the consultant gave lectures to the craftspeople to teach them what they were

expected to do. It exemplifies that a total effort to realise enec and a good indoor climate is possible, but also -- in its particularity -- that such efforts are rare.

The building industry represents a complex market. To make "rational" decisions about enec, one may need information that is unavailable, e.g. the consequences for future productivity of choosing the one or the other ventilation system. The process of planning and constructing a building is characterised by negotiations where strict optimalisation is impossible because not all arguments let themselves translate into numbers and money. This may be a main reason why the building code is so important as a standard-setting device -- this removes the burden of balancing the one argument against the other. To rely on the market to promote enec, is possible but problematic. With a few exceptions, our informants describe the design processes of the building industry as conservative, where strict concern for short-term cost and building loan interest stifles innovation. Building codes and other regulations and controls seem to play a very important role to counter this effect, although the present enec policy measures does not appear to be very efficient in promoting sustainable and profitable energy conservation. A crucial reservation to this conclusion is the impact of the information and educational efforts to provide a better knowledge about enec. We will now turn to this dimension.

7. BRINGING THE GOOD WORD ABOUT ENEC

To educate about enec has proved to be a complex task. There are many different target groups with different needs and qualifications, and there are in principle a lot of different providers of enec information. The government white papers have been concerned with the challenges to inform about enec, but not so much interested neither in the building industry in general, nor in the heating and ventilation industry. Centralised information and campaigns have received most attention, but there has also been a sustained effort to develop enec competence through refresher and training courses for professionals.

An important example of such an effort has been the education programmes established at the Norwegian Institute of Technology (NTH) and other institutions for higher technical eduction in Norway. The Royal Ministry of Industry and Energy has supported this work by contributing to the funding of a position of "Coordinator for education on energy efficiency" to intensify and improve education about energy efficiency. The coordinator has been operational since 1989. Since 1994 it has been turned into a professorship.

The climate of the country as well as the interdependence between energy efficiency, the environment and indoor climate, make strong demands on expertise and comprehensive solutions. To achieve increased efficiency of energy systems it is necessary to take into account all particular aspects of the energy chain; generation, distribution and end use, considering also environmental

impacts. Furthermore, a real interdisciplinary approach to energy efficiency is of vital importance. This professional task gives also the scientific framework for the educational program on energy efficiency at NTH. The programme consists of three courses. The course "Energy planning for the future" covers mainly energy generation and distribution matters, both on a regional and national, as well as on global level. "Energy efficiency in buildings" and "Energy efficiency in industry" are courses dedicated to the end-use in different sectors. The three courses are developed as multidisciplinary courses in cooperation between three different faculties: Faculty of Electrical Engineering and Computer Science, Faculty of Mechanical Engineering, and Faculty of Civil Engineering. Both teachers and students are from the three different faculties. Separate courses are also developed for continuous education of professionals.

Special attention in development is paid to the area of buildings and technical installations. The main goal for the course is to build up the right attitude to the use of energy considering also all environmental consequences, both outdoor and indoor. Furthermore, the intension is to develop a multidisciplinary approach to the energy supply and use in new and existing buildings taking advantage of knowledge from architecture, building technology, applied thermodynamics, electrical power engineering, heating, refrigeration, air-conditioning, control engineering, economics, management and data processing. The textbook on the subject developed to be a support to teachers and students has become an indispensable tool to professionals.

The undergraduate course was first time given in 1992. Approximately 60 students, almost evenly divided between the three faculties, take part in the course every year. The course for continuous educations was arranged three times, and gathered about 60 professionals. First three courses for continuous education by use of distance learning have been established last year with the total amount of 30 participants.

Our informants in the heating and ventilation industry disagrees about the need for such competence build-up. Some say the level of knowledge within the industry is sufficient, others say there are large holes. In the consultant engineering companies, it is usually the younger engineers who take care of enec projects. They have received at least some training in the field. That has given them competence in and interest for enec and indoor climate problems: "*In my opinion, the reason (for our concern for enec) was that we graduated from the Norwegian Institute of Technology in a period when these issues were of great interest. (...) So we are using a kind of enec and indoor climate glasses when we look at most of our work*".[31]

The general effort to re-educate and update their employees in enec and indoor climate issues seems to be rather low. Many of our informants tell us that in practice, it becomes an individual responsibility to take care of professional updating in a field like enec. Very few companies are said to have a conscious policy for continuous eduction on enec. The enec-related knowledge many

companies have is based on experience and may easily be conservative. The result some say is poor work: "*Is this due to bad intentions? No, it isn't, but it is a combination of many aspects, not the least poor training, poor education, lack of foresight, hopeless research projects*".[32] Again, we are confronted with the argument that the crisis of the building industry has created a poor climate for continuing education and professional up-grading on energy and environmental issues. "*Whether you talk to the consultant engineers or to the building constructor industry, you will certainly get the same answer. And that answer is that due to short construction periods and poor economy and a low level of activity, many of the companies has spent their reserves. That means that continuing education and professional updating -- people do not have time for that*".[33]

Since information is critical to "rational" decisions, we see again how the crisis in the building industry has hampered the diffusion of enec and the efficiency of the enec policy. The overall picture is contradictory. On the one hand, there are education initiatives that in time will mean a considerable strengthening of enec and indoor climate competence in the heating and ventilation industry. On the other hand, the lack of resources for continuing education and professional updating will delay a necessary strengthening of the general level of competence in the field. Enec policy measures have not failed, but they have not been quite up to the challenges either.

8. CONCLUDING REMARKS

We set out to discuss the construction of Norwegian enec policy and its effect on the heating and ventilation industry. On the policy level, we have analysed a situation of change in the use of policy instruments towards an emphasis on the market mechanism. We identified three major set of instruments: regulatory, economic, and information. All three types of instrument has effected the heating and ventilation industry and the concern for enec in buildings, but not quite to the extent one has wished for.

The latest government white paper on enec argues that the economic measures, in particular the efforts to make the market work more efficiently, are the backbone of Norwegian policy. In reality, it seems as the most important set of instruments is regulations, in particular the building code. Through such regulations, the government set standards with interesting side-effects, some positive, some negative. The most negative effect is the tendency to treat the rules and suggestions of the building code as both a minimum and a maximum. The rules of the code are seldom surpassed in the design of technical systems in buildings. The major positive effect of regulation is their ability to provide a push for renewal and readjustment of competence and technology. In addition, regulations ease the burden of having to argue the gainful effects of new designs

(which often have been developed to satisfy new rules). Thus, regulations rectify some of the problems that may occur due to "market imperfects" like insufficient knowledge, incompatible information, and uncertainty about future use of buildings.

There is no doubt a concern for enec in the building and the heating and ventilation industries. 20 years of enec policy has at least had that effect. There has also been important gains in terms of research and education, at least partly supported through enec policy measures. Still, it seems that the policy measures have been made with too little analysis of the workings of the building industry and the negotiation games in which the heating and ventilation engineers have to participate.

9. **REFERENCES**:

1. For an overview, see the articles in *Scientific American*, 263 (3) 1990.

2. Loren Lutzenhiser: "Embodied technology: A pragmatic theory of energy use and culture", unpublished PhD-dissertation, University of Calfornia, Davis, 1988, pp. 111. See also the articles in *Scientific American*, op. cit. (note 1).

3. C Flavin and A Durning: *Building on success: The age of energy efficiency*, Washington DC: Worldwatch institute, p. 57.

4. *Om tiltak for energiøkonomisering*, NOU 1975:49 (On measures of energy conservation)

5. NOU 1975:49, p. 7.

6. NOU 1975:49, p. 62.

7. Stortingsmelding nr. 42 (1978-79): *Om energiøkonomisering* (On energy conservation), p. 10.

8. St. meld. nr. 37 (1984-85): *Handlingsplan for energiøkonomisering* (Plan of action for energy conservation), p. 14.

9. Stortingsmelding nr. 61 (1988-89) *Om energiøkonomisering og energiforskning* (On energy conservation and energy research).

10. Stortingsmelding nr. 41 (1992-93): *Om energiøkonomisering og fornybare energikilder* (On energy conservation and renewable energy sources).

11. Op. cit., p. 10.

12. Op. cit., p. 11.

13. Interview in the "Olstad" company, file "Olstad", p. 2.

14. Interview with the manager of the "Gaarder" company, "Gaarder" file, p. 24.

15. "Gaarder" file, p. 26.

16. "Godt råd" file, p. 13.

17. Ibid.

18. "VVS Energi og miljøteknisk forening" file, p. 3.

19. Interview with the manager, "Werner Wang" file, p. 7.

20. Michael Gibbons et. al. (1994): *The new production of knowledge*, London: Sage.

21. "Godt rad" file, p. 13-14.

22. Ibid. p. 14.

23. "Aktivum" file. p. 34.

24. Stortingsmelding nr. 41 (1992-93).

25. "Werner Wang", R&D file, p. 3-4

26. "Gaarder" file. p. 7.

27. "Godt Rad" file, p. 11.

28. "Godt Rad" file, p. 18.

29. "Godt Rad" file. p. 6-7.

30. "Bakke" file. p. 25-26.

31. "Aktivum" file. p. 23.

32. "Bakke" file. p. 4.

33. "Godt Rad" file. p. 18.