Reports of Two Energy Commissions: Sweden and Norway

In the past few years, energy policy considerations have led various contries to establish Energy Commissions, Inquiries, Royal Commissions and so forth.

Two of these bodies (in Sweden and Norway) have recently issued reports on nuclear power and its place in overall energy strategies. A summary of the report by the Swedish Energy Commission ("Energi Betankande av energikommissionen", Stockholm, 1978) and the findings of the Norwegian Government Committee on Nuclear Power and Safety Questions (in "Kjernekraft og Sikkerhet", Oslo, 1978) are reproduced below.

SWEDISH ENERGY COMMISSION: TERMS OF REFERENCE

The Energy Commission's main task is to collect, evaluate and document materials, and to make necessary supplementary studies which may serve to underpin the positions taken by the Swedish Government and its proposals to Parliament in 1978 on the direction for Swedish energy policy for the period up to around the year 1990 The Commission's documentation should take the form of setting forth alternative energy programmes for this period

The report layout

Chapter 1 contains the terms of reference for the Energy Commission and gives an account of those who have participated and of how the work has been planned. *Chapter 2* describes in synoptic form the interaction of man, energy and environment, and also presents various concepts used in the energy field. It also sets forth which categories of energy resources are to be found in nature A more detailed review of units, concepts, etc , is given in Appendix 1.* *Chapter 3* presents a survey of (1) the development of energy usage and energy supply in Sweden during the postwar period; and (2) the main features of Swedish energy policy during this same period

Chapter 4 describes existing connections between energy policy and other societal goals. In so doing it maps out those factors which affect energy policy's long-term thrust. Among these factors are the society's goals with respect to economic growth, employment, balance of payments and income distribution. Also included hereunder is a series of restrictions on freedom of action for energy policy imposed by the situation which prevails as regards the supply of energy raw materials and the allowance that must be made for the energy sector's health, environmental and safety effects Lastly, this chapter discusses the feasibility of adapting the energy system to altered preconditions and the significance of the time perspective for freedom of action

* Refers to an appendix in the Commission's report not reproduced here

Chapter 5 summarizes the forecast made by the Swedish National Board of Industry for energy usage up to 1995. Given the assumptions that have governed the estimates, the requirements for total energy supply in 1990 are stated at between 490 and 545 TWh[1] with a rated value of 510 TWh. Derived from this is the need to produce electric power of between 140 and 155 TWh with a rated value of 145 TWh.

Chapter 6 presents in summary form the evidence furnished by the Commission's expert groups with regard to possible savings, preconditions for supply, likely means of control and risks and effects on safety and environment. *Chapter 7* describes the starting points for the Commission's investigated alternatives Descriptions of the alternatives for their characteristics and consequences are then given in *Chapter 8.* The Commission makes an evaluation of the alternatives in *Chapter 9.*

Chapter 10 contains the Commission's considerations and proposals. To start off with it sets forth the general grounds for energy policy and which special interests must be borne in mind when energy policy is designed. Proceeding on the basis of certain central considerations, the chapter concludes with a number of proposals and recommendations.

Summarized in the following are the starting points for the Commission's choice of investigated alternatives, what the investigations have resulted in, and the Commission's considerations and proposals. Further, a brief account is given of the main purport contained in dissents.

Starting points

A point made by way of introduction in *Chapter 7* is that two epochs may be distinguished in the design and function of energy systems over a very long-ranging time perspective The one is the future epoch, when the flow of energy from solar radiation may account for the greater part of the energy supply, the other is the present epoch, when stored energy dominates. During an intervening period a gradual changeover occurs, but for a long time to come stored energy will be utilized alongside of flow energy

In the long-term perspective solar energy, coal and uranium are deemed to be those alternatives which may be available to Sweden. These may in their turn be combined in various ways.

The decision-making situation is now marked by uncertainties in several respects Among other things, uncertainty still prevails as to when and on what scale new energy types can be introduced. The options must be retained for striking a later choice between the available long-term alternatives.

Given this background the Commission discusses starting points and other parameters for alternative energy programmes. With regard to oil, attention is called to the risks both of supply problems and of sharply increased prices. As regards coal it is observed that the present-day environmental problems are great. A massive commitment to coal can therefore not be made in Sweden for the time being. But a degree of domestic competence should be built up in this area. Natural gas is favourable from the environmental aspect, but it is expensive and requires capital investments in large systems. Besides, natural gas has just as little staying power as oil.

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[1] 1 TWh = terawatt-hour = 1000 million kilowatt-hours

Nuclear power per se commands potentials for becoming a wholly domestic energy source and it is estimated economically favourable. On the other hand it is fraught with problems and risks. Opinions are divided as to what kind of uncertainty nuclear power implies

Hydropower is domestic, renewable and economically attractive, but harnessing more of it invites conflict with ecological interests. However, it should be feasible to go in for a limited expansion programme which pays great deference to these interests. Peat requires activity even in normal situations if it is to be an active stand-by resource. Moreover, it might prepare land for the cultivation of energy forests. In addition to hydropower other renewable sources are the sun, wind, wood, energy forests, etc. The possibilities of utilizing these energy types on a big scale should gradually become clearer. It is generally expected that they will render their major contributions after, rather than before, 1990

All available long-term alternatives (except solar heating) are suited to electric power generation and/or hot water production. Some of them also lend themselves to the production of synthetic fuels, e.g. methanol.

An important starting point on the usage side is to conserve energy resources, oil in particular. Planning should also focus on measures which reduce energy requirements longer-term, as exemplified by proper design of building structures. Trade-offs should be struck (a) between other societal goals and energy conservation, (b) between energy conservation and energy supply; and (c) between energy conservation measures in different usage sectors. There should also be a quest for measures which permit flexibility.

In the case where uncertainties about the risks of nuclear power signify that this energy type cannot be accepted, the likely supply alternatives will have to be amended at certain points. Above all, an intensified commitment must be made even now to bring in the renewable energy types Then too, depending on the time factor, it is probable that one or more of the conventional energy types — coal, oil and natural gas — must be deployed.

In such a case the energy conservation efforts must be especially aimed at saving electricity. Among other things, thought could be given to reducing the electricity that is used to heat buildings Only in exceptional cases, however, should direct restrictions on electricity consumption be considered. In the long run a suitable level for such consumption will depend on the long-range possibilities of producing electricity in Sweden by means of renewable energy types and by means of other, environmentally acceptable energy types.

In case the problems that are associated with nuclear power are not deemed to be such as to warrant stopping the expansion of nuclear power, the quest to lower dependence on oil can be satisfied to a greater extent by changing over from fuel to electricity in the heating sector and in manufacturing industry

For the supply side, consideration could then be given to other aspects, among them designing future nuclear power blocks as combined generation plants (power plus heating) and gradually building up a complete domestic nuclear fuel cycle. In a case where greater resort to nuclear power can help to lower dependence on oil imports, a capital-intensive commitment to bringing natural gas into Sweden should be avoided With regard to energy usage in this case there are no motives to aspire to electricity savings in particular. Advantage should be taken instead of opportunities to replace oil with electricity.

With these starting points, the Commission has picked out four alternatives for more penetrating study These alternatives are·

- A, where nuclear power is to be phased out by around 1985,
- B, where energy policy focuses on phasing out nuclear power over a 10-year period, with 1990 as target year;
- C, where some continued expansion of nuclear power is accepted during the 1980s, but binds for the period thereafter are avoided;
- D, where expansion of nuclear power is accepted during the 1980s to a somewhat larger extent than in C, but where a more pronounced thrust towards continued nuclear power utilization is contemplated, as in the form of commitment to a domestic nuclear fuel cycle.
- B^1, C^1 are modifications of alternatives B and C respectively.

Investigated alternatives

The results arrived at by the expert groups after investigating these different alternatives are set forth in *Chapter 8.*

Energy usage, energy supply, and need for controlling instruments are described at length, alternative by alternative.

The total level of energy usage (in TWh) is summarized in the table below.

	Alternative A/B	Alternative C	Alternative D
Fuel	326	345	330
Electricity	103	125	140
Total	429	470	470

Identical savings are assumed in all alternatives with regard to communications or transport services. Under alternative A/B greater conservation efforts are made in manufacturing industry as well as in the building stock. The cost of these efforts has been estimated at slightly more than SKr* 20 000 million all told. Electricity savings are also considered practicable to a greater extent in alternative A/B, while in alternative D a changeover from oil to electricity is assumed to take place for certain purposes.

On the supply side the alternatives part company when it comes to the supply of oil and oil products and, naturally, when it comes to utilizing nuclear energy. A summary is given in the following table. It includes the supply in the case where nuclear power is phased out but has the same higher usage level as in alternative C(B^1). It also shows the case where nuclear power utilization is continued but has the same lower usage level as in alternative B (C^1).

The electricity sector differs very noticeably between the alternatives Alternatives A and B assume a maximum commitment to combined power and heat generation and to industrial back-pressure power. Further, alternative A and in particular alternative B assume a very vigorous commitment to wind power. Despite substantial efforts to expand electricity production as a replacement for the phased-out nuclear power, the time margins will be tightly squeezed both in alternatives A and B during the 1980s. Implementation of alternative A would require extraordinary measures in the form of rationing and the like, or granting exemptions in the award of licenses for new power plants, if the situation around 1985 is going to be coped with satisfactorily

* SKr = Swedish crowns

Energy supply in 1990 (TWh)

	A	B	B^1	C	C^1	D
Oil and oil products	271	280	330	249	207	232
Coal and coke	46	46	46	45	45	55
Natural gas	11	11	11	11	11	0
Hydropower	66	66	66	66	66	66
Wind	4	6	10	2	2	2
Sun	3	3	3	3	3	3
Bark, pulping wastes	40	40	40	40	40	40
Cultivated biomass	20	5	5	5	5	5
Forest waste, straw, rubbish	26	26	26	10	10	11
Waste heat	2	2	2	2	2	2
Peat	20	20	20	15	15	15
Nuclear power (electricity)	0	0	0	58	58	71
Nuclear power (heat)	0	0	0	13	13	16
Total	509	505	559	519	477	518
Losses in conversion and transmission	80	76	89	49	48	48

The total investment requirements for the period 1979–1990 are, in alternatives C and C^1, about SKr 90 000 million and in alternative D, about SKr 120 000 million, assuming commitment is made to a domestic nuclear fuel cycle. Investment outlays are figured at about SKr 110 000 million in alternative A and about SKr 100 000 million in alternative B For the case B^1, the investment requirement is stated at just under SKr 125 000 million.

By contrast the difference between the alternatives is not as great with respect to operating costs and the costs of importing fuel. The strong decline in oil imports under alternatives C and D compared with A is offset by higher imports of nuclear fuel.

Also discussed for each alternative are the kinds of controlling instruments that may be necessary. However, it is pointed out that the choice of such instruments is to be guided more by the intentions which the alternative in question represents than by any wishes to reach uncertain quantitative goals at specified points in time.

It is pointed out for all alternatives that taxation and pricing of different types of secondary energy play a major role One of the subjects discussed is revising the present system of energy taxation so that the tax will be levied on the importers and producers instead of on the end users. This could be combined with a revision of the energy taxation into a system that comes under the purview of value added tax.

Further, the discussion of all alternatives takes up different kinds of selective controlling instruments on the usage side. Among other things, it is pointed out that present-day systems

of economic inducements to conserve energy need to be evaluated and adjusted. For manufacturing industry it may be advisable to augment the ruling subsidy system with loans. Both as regards private enterprise and the housing sector there is need in alternatives A and B for administrative controlling instruments which go beyond the voluntary line.

Thus for industry it is assumed that provision can be made to enlarge energy scrutiny under section 136 a of the Building and Planning Act, with discretionary power to introduce stipulations for existing industry as well In the heating sector alternatives A and B contemplate calling a halt to installation of electric heating in new buildings as from 1980, as well as e.g. mandatory inspection of heating devices installed in buildings, etc.

Within the communications sector the same conservation level is assumed in all alternatives Among likely controlling instruments are those which affect prices — such as changed taxation of motor vehicles and more stringent rules for car benefits in connection with filing income tax returns — as well as administrative rules and restrictions. Further examples of such controlling instruments are parking restrictions, standards for highest permissible fuel consumption in new passenger cars, mandatory economic tune-ups of cars, etc.

On the supply side, alternatives A and B in particular contemplate controlling instruments and governmental measures to establish a market for new energy raw materials, including a suitable organizational set-up for extraction and distribution. Alternative A puts special emphasis on supporting a rapid introduction of fuels derived from biomass, while alternative B especially points up the need for controlling instruments to help introduce wind power. A governmental guarantee to cover the risks of production failure is discussed.

Weight is stressed in all alternatives on providing information, education and training, as well as on backing continued commitments to research and development Also pointed up is the role that the municipalities play for energy planning, etc

Lastly, a preliminary assessment is made of the risks that the various energy alternatives might entail for health and environment. Here the documentation is based on material furnished by the Commission's expert group for safety and environment.

It is pointed out that this group has not yet finished its work. Certain questions relating to waste and safety problems in the nuclear power area, together with possible problems posed by radon in connection with certain types of energy conservation in buildings, will be reported on later

Evaluation of the alternatives

The Commission's recapitulatory evaluation of the energy alternatives is put forward in *Chapter 9,* which underlines that the documented alternatives are in the nature of examples. The intention has been to show some alternative main thrusts or directions for energy policy

Presented in this section are the results of rough estimates for the macroeconomic consequences of alternatives A—D. These estimates were carried out with the aid of the general economic model used by LU (the Economic Planning Council in the Ministry of Finance) in its long-term surveys. The starting point for the analysis is the reference forecast made in October 1977 by the Swedish National Board of Industry. In its turn the reference

forecast has been based on a revision of the long-term calculations in LU 75 (the long-range economic forecast published by the Economic Planning Council in 1975).

The design of the alternatives in connection with the model calculations has been made specific by the Commission's expert groups The estimated parameters with regard to investment costs, energy saving, production of domestic energy raw materials and effects on fuel imports have been inserted in the model

In all alternatives the line of sight is focused on an energy supply system which reduces the country's dependence on imported fuels. More substantial curtailments of Sweden's dependence on imported fuels will not be attained until in the time perspective after 1990. The greatest reduction is realizable in alternative D. The changes in the energy supply system which the alternatives denote will entail very heavy investment costs for energy-saving measures and domestic production and conversion plants. The biggest capital investment effort over and above the reference forecast is noted for alternatives A and B. In these cases extra investments of about SKr 75,000 million in 1976 money will be required for the period from 1979 to 1994, or on an average of about SKr 5 000 million per annum. In alternatives C and D the corresponding extra investments come to SKr 1 500 million and 3 500 million per annum, respectively.

An investment programme of this magnitude will have macroeconomic consequences because other activity is going to be pushed off to one side. The effects on the national economy will notably depend on whether the extra investment is to be taken from the margins available to consumption or to production. In the estimates, the investments in domestic energy production have been taken from the business community's investment funds, while other extra investments have been taken from those for private consumption.

Up to the mid-1980s all alternatives will lead to lower production and consumption levels than in the reference forecast. The same holds for the time perspective up to the mid-1990s except for alternative C, where the change in the energy supply system matures into slightly increased scope for private consumption compared with the reference forecast.

Considering the demand to bring foreign trade into balance, the scope for increasing private consumption is already extemely restricted in the reference forecast.

Bearing in mind those commitments which the government authorities have undertaken towards improving the real living standards of the growing number of pensioners, it is evident that the active working population will experience a very weak development of its material standard. This applies with greater force to alternatives A and B than to alternatives C and D. Restrictions in the already narrow scope for increased private consumption which the alternatives give may lead to tensions on the labour market. The changes which the alternatives signify also seem to entail demands for increased mobility on the labour market. If this increased mobility is not achieved, the result may be productivity losses

The degree of import dependence and the global endurance of different energy sources are two important factors for the security of supplies. A high import dependence always involves risks that the supply pattern will be disrupted.

Our import dependence is currently high (about 80%). The global endurance for oil, natural gas, coal and uranium is limited in varying degree.

Over and above the element of renewable energy sources, considerations of susceptibility to disruptions as well as flexibility and endurance make a combination of oil and nuclear power preferable to oil alone if we look at the supply security in 1990. Alternatives C and D therefore have better security characteristics precisely in 1990 than A and B. The potentials of nuclear power, when combined with vigorous conservation measures, for cutting down on the oil dependence and thereby increasing security stand out with special clarity in alternative C

A comparison of alternatives C and D makes the former stand out as a slightly more secure alternative due to increased flexibility in the short term flowing from the natural gas element and the increased predictability that will result when nuclear power is not further expanded. Seen from the security aspect alternatives A and B are largely equivalent.

The following summary evaluation can be made on the basis of the foregoing remarks:

Alternatives A and B

Least secure in 1990 but on its way to a high security level provided that the new energy types will arrive on time and in sufficient quantities.

Alternatives C and C[1]

More secure in 1990 than A and B, and with freedom of choice when it comes to the future thrust of the energy system For C[1] the supply security improves through increased commitment to conservation

Alternative D

More secure in 1990 than A and B, and leading to a high security level provided that nuclear power does not show characteristcs which make it unacceptable.

In order to make the alternative illustrative, measures are contemplated in several cases where implementation will depend on satisfying a number of necessary conditions. Among other things, this has to do both with the expected results of an ambitious research and development programme concerning new energy sources and with the effects of necessary controlling instruments It may therefore be very much doubted whether it is possible to carry out any of the alternatives in accordance with the design they have had.

One implication of the foregoing is that it has not been possible to describe the alternatives in more finely shaded terms. By way of exemplifying issues that have not been illuminated, there is the possibility, contained in the phasing-out alternatives, of operating the nuclear power stations longer than originally envisaged, the better to cushion the adverse macroeconomic impacts of a forced dismantling process Another example is the possibility of combining alternative C with domestic uranium mining

It follows that the documented alternatives cannot be seen as proposals for concrete action programmes dedicated to achieving certain energy policy goals. An overly categorical interpretation should therefore not be put on the reported consequences

However, comparing the alternatives for their consequences vis-a-vis one another has made it possible to clarify characteristic features of the alternatives which bear crucially upon the taking of future positions in energy policy. The Commission's considerations and proposals in these respects are set forth in Chapter 10.

The Commision's considerations

In *Chapter 10* (sections 10.1–10.3) the Commission presents its considerations with a basic proviso: no part of the energy system must bring unacceptable environmental, health or safety risks in its train. At the same time the energy supply is to be designed so as to provide maximum guarantees against energy shortage and make it possible to achieve maximum supply security In view of the foregoing and having regard to the international solidarity, our energy supply should build upon our country's natural endowments and resources.

The viewpoints that are now put forward will be valid provided that nothing emerges from the subsequent investigations which decisively alters the conclusions reached

Today's public debate on environment and safety has harboured a tendency to claim that the overwhelming part of environmental problems in society stems from the energy sector. The Commission cannot endorse such a view Proper judgement cannot be passed on energy usage if it ignores other phenomena in society.

The Commission notes that warnings have emanated in recent years from scientific quarters against combustion of fossil fuels owing to their allegedly adverse impact on the climate. Another group of serious environmental risks are those which derive from side effects which build up cumulatively. Subsumed under this group are discharges of heavy metals, sulphur oxides, hydrocarbons and radioactive emissions. Yet another negative side effect is the accumulation of solid waste, especially ashes from coal combustion and radioactive waste In both these cases the waste must be handled to prevent serious adverse reactions arising.

With regard to the new energy sources, a body of industrial experience is lacking Given the present state of the art, the renewable energy sources are deemed favourable from the environmental aspect, with the exception of the possible impact that intensive cultivation of fast-growing trees may have on nature and, perhaps, the presence of hydrocarbons in combustion gases from wood-firing

The Commission cannot pass final judgement on the storage of highly active waste, since no data base for this purpose will be available until the latter part of spring 1978. Here the Commission has assumed that satisfactory technical solutions will be in hand.

The Commission submits that no energy system should be condemned on grounds of feared sabotage or terrorism, nor that it is necessary for environmental, health or safety reasons to abstain now from any of the energy types which enter into our supply system

Further, the Commission submits that energy policy must make special allowance for the energy requirements of private enterprise, from which it follows that industrial capital would be substantially eroded if nuclear power were to be phased out now. A considerable burden would be imposed on the national economy.

International solidarity plus various other factors, among them the threat of an oil shortage during the 1980s, suggest that we must reduce our oil consumption

The prudent management and development of our domestic energy sources will make us less vulnerable. In the short term peat can supersede oil for some purposes. In the longer term – looking to the 1990s – wood from cultivated energy forests as well as other forms of plant-growth material can probably render important contributions to the energy supply. However, extensive research, development and demonstration will be required over the next ten-year period to permit making more accurate assessments of possible contributions to the energy balance.

Sweden's oil dependence could be reduced even more if heat from the nuclear power stations were to be tapped for heating purposes

Apart from uncertainty about future economic trends, the Commission points out that uncertainty prevails as to the efficiency of the resources management programme. Another vital question is the supply of capital and the rate at which manufacturing firms make their capital expenditures. There is reason to assume that the national economy, notably with reference to the limited scope for investment, cannot bear investment outlays to the extent that is required in order to replace nuclear power at present with other energy production methods, without inviting severe strains.

The Commission emphasizes that an energy policy which provides for decisions to phase out nuclear power amounts to a strategic undertaking the effects of which will not manifest themselves for a long time to come, irrespective of whether the phase-out is supposed to be completed by 1990 or 1985. Such a decision would inevitably entail a rapid cutback of the competence and industrial capacity that is needed if nuclear power is to be retainable for the time being.

The Energy Commission's analyses and considerations indicate that the guidelines included in alternative C correspond at great length to the Commission's demands for increased supply security, reduced oil dependence, flexibility and readiness to act when the need to adopt a standpoint arises.

To sum up its conclusions, therefore, the Commission contends that the main thrust for energy policy laid down by Parliament in 1975 should not be radically changed at the present time. However, a limited reappraisal of the energy programme should be untertaken as part and parcel of the energy policy decisions that are taken every fiscal year, with this work to be done on a continuing basis as new discoveries are made A more definitive choice of a long-term line of action can probably be struck before 1990. The final stance for or against nuclear power should be deferred for the time being.

The Commission's proposals

The question of a tax revision is being investigated in line with the construction discussed in Appendix 3* – a taxation system within the ambit of value added tax in combination with an energy tax levied on importers and producers. Particular attention should be called to the feasibility of underlining the energy tax's controlling function through tax-rate differentials and exclusions intended to (a) satisfy a macroeconomically weighted tax system which allows for environmental effects, supply security, etc; and (b) facilitate the introduction of back pressure power and new energy sources In connection with the foregoing, investigations should be made to determine which principles should be applied in future to pricing within the energy area.

The energy forecasting work is to be further developed and carried to greater depths. Energy statistics should be improved, especially those regarding fuels.

Supplying the energy sector with capital may pose great problems. Among other things, there are vast differences today as regards financing prospects for different parts of this sector. Proposals should be drafted calling for measures to rectify such differences.

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* Refers to an appendix in the Commission's report not reproduced here

A broadened system of energy planning under local authority auspices is being built up. The municipalities should also be able to shoulder greater responsiblity for making efforts on behalf of energy conservation.

Within the next few years it will be imperative to find out more about the preconditions for enduring zero growth in energy usage as a basis for evaluating the consequences of such a policy for employment, productivity, the balance of trade, etc.

Resources management

The support given to energy conservation measures in connection with existing industrial processes should be evaluated. As part of this effort consideration should be given at the earliest to the question of whether the present system of subsidies should be supplemented or replaced by a system of loans.

The support given to prototypes and demonstration facilities in the energy sector should be expanded. It should also be feasible to give support to future plants which use renewable energy sources such as the sun, wind, biomass and solid waste.

Greater provision should be made for rendering information, training and counselling services to private enterprise.

Plans should be implemented to go ahead with further investigations into energy usage and potentials for energy savings among manufacturers, especially those engaged in the energy-intensive industries.

The scrutiny of applications for energy usage now being made under section 136 a of the Building and Planning Act should be overhauled. For this purpose consideration should be given to extending the purview of such scrutiny to embrace both new and existing plants, by analogy with the procedure which governs under the legislation on environmental protection.

Far-reaching restrictions on private transport should be introduced in the urban cores of the larger metropolitan areas, especially in the three largest cities (Stockholm, Goteborg and Malmo) Mass transit facilities are to be given priority, expanded and made more comfortable for the passengers.

Mandatory economic tuning-up is to be considered to ensure that existing cars will operate more efficiently.

Standards should be introduced for newly registered cars which specify maximum fuel consumption.

Information and training for motorists should be improved. Instruction in driving schools should attach special weight to driving technique and maintenance so as to cut down on fuel consumption.

Measures should be taken which permit using fuels other than petrol and diesel oil.

A system of differentiating motor vehicle taxes which favours lighter and more fuel-efficient cars should be implemented.

Long-distance freight should be shifted from road to rail. Special measures should be initiated on behalf of energy conservation in the truck sector.

Shipping should absorb a larger proportion of the transport work with encouragement of coastal and canal shipping.

Energy resources management in newly built residential and non-residential premises should be primarily controlled through the Swedish Building Code. Additions are to be made to the Code as more knowledge and experience is gained of different structural solutions for their energy conservation effects.

Steps should be taken to safeguard the financing of energy conservation measures in existing built-up areas for the property owners. An evaluation of the loan and subsidy systems so far in effect should be undertaken. In connection therewith alternative designs of the financial assistance programmes should be tried out.

The municipalities should greatly strengthen their activities concerned with providing service and advice to property owners and caretakers.

An official commission should be appointed to consider making such changes in the building by-laws as will enable e.g. local building committees to inspect buildings for their energy conservation practices. If making remarks and giving advice do not suffice, the commission should consider the feasibility of promulgating orders requiring special measures to be taken.

A system for fuel charging should be introduced which denotes that tenants are debited for the actual fuel costs incurred. This should encompass checking to make sure that the heating devices are run as effectively as possible and that conservation measures are taken by the property owners.

An investigation into the technical and administrative problems that are bound up with a changeover to individual hot-water measurement should be implemented.

Inquiries into the possibilities of adjustment to solar heating of heating systems, mainly in newly built houses which are suited to central solar heating systems should be made and support given to development of components and systems for solar heating. Consideration to be given to making solar heating mandatory for certain purposes, e.g. swimming pools

Urban and regional planning should attach greater weight to energy management aspects. This holds not only for planning new areas and buildings but also for improvements and renewal of existing areas. Suitable ways for this within the ambit of planning legislation should be investigated.

To encourage more efficient usage of electricity in households, domestic appliances should bear informative labels describing their energy consumption. Measures are to be carried out as part of the governmental machinery for advancing housing loans in order to stimulate a changeover to energy-efficient appliances.

More effective fittings should be used in street lighting.

Investigation of alternative and supplementary heating forms for electric heat in secondary dwellings (summer bungalows, weekend cottages, etc.) should be made.

Intensified efforts should be made to communicate information to and from the general public and also provide education and training on energy matters. This applies not least to the instruction given in schools.

The supply of oil

Today's oil picture is characterized by a temporary glut of crude, which has had a damping effect on prices. Better conservation practices should be aspired to, and efforts should be made at the same time to stimulate a changeover to alternative fuels. The government authorities should investigate which measures can be taken for this prupose. One example

could be to introduce a supply-warranted fee on oil. Such a system is to be designed so that oil prices are not permitted to fall below a designated floor level. Commercial guarantees would thereby be created for those who go in for introducing fuels as alternatives to oil. It is of crucial importance to devise clear-cut and long-term incentives for desirable development and readjustment measures.

Much more vigorous commitments should be made to explore for oil abroad

Acquisition of shareholdings in already established oil strikes and participation in investments for extraction are a faster and surer way to improved supply security. This requires immense economic resources. The governmental credit guarantee of SKr 2 000 million that is available for this and related purposes should be raised.

Sweden should also aspire to form long-term contracts for deliveries of crude oil and products from certain oil-producing countries. The negotiations opened with Norway should be followed through at the earliest Initiatives should be taken to enter into negotiations with other oil-producing countries as well.

Measures should be taken at the earliest to safeguard the domestic refinery capacity.

Planning is to be carried out so that already designated measures for better economic management, changeover to alternative fuels and measures of oil policy can be accelerated and expanded.

Natural gas

An assessment as to whether natural gas should be introduced in Sweden will depend on various factors, notably where such gas would come from and what costs it would fetch Negotiations, efforts to follow international trends and studies of different expansion alternatives should be pursued.

Coal

Even if it were technically possible and economically justified, a major changeover to coal should not get under way at once. However, efforts should be made to permit later usage of coal in our country on a large scale A vigorous commitment should be made primarily to research, development and demonstration of combustion technology and flue-gas desulphurization. These measures should be taken in international partnership

Regulations should be introduced which require newly built, larger firing plants to be designed from the very outset so that firing can make use of solid fuels such as coal, peat and biomass In the long run, too, existing firing plants are to be made convertible to solid-fuel firing.

Not least in order to build up domestic competence in the coal sector and gain practical experience, steps should be taken even now to increase coal usage to a certain extent For instance one or more of the present electric-power and/or heat-producing plants could be coal-fired

The international coal market is to be followed through contact with different producer countries. Investigation is to be made of the possiblities for future long-term contracts. The same holds for participation in exploration and extraction of coal, e g through acquisition of shareholdings in mines

Uranium

Exploration for uranium is to be continued. Extraction of uranium deposits is to be prepared, provided that mining operations subject to due permission can be done in a manner that is environmentally acceptable

A central depot for intermediate storage of spent nuclear fuel is to be erected so as to come on stream during the first years of the 1980s.

Plants for other activities as part of the nuclear fuel cycle, e.g. for enriching or reprocessing, should not be erected in Sweden at the present time.

Peat, biomass

Resources of land that are suitable for peat extraction and later cultivation of biomass should be mapped out. A commitment to development of peat technology and peat refinement for future applications is to be implemented. At the same time already established technology should be exploited towards starting a peat industry for energy extraction Thus some thermal plants or combined generation plants which use peat are to be erected. Initiatives are to be taken, on the basis of organizational measures, to prepare for peat production and refinement and trading in peat.

An increased utilization of forest waste, hardwood, straw, reeds, etc., could have great importance. Efforts of mainly an organizational nature should be initiated by the government authorities and be carried out in partnership with the forest products industry, forest owners, farmers, municipalities and manufacturing firms. Development of combustion technology should be pursued.

The environmental and ecological consequences of biomass cultivation must be better illuminated and evaluated. For this purpose it will be necessary to implement a research and development programme for several years.

Investigations should be commenced to determine an appropriate technical and organizational structure of systems for biomass production and usage.

A development programme in accordance with what has been outlined is to be evaluated within 5—10 years to permit more definitive determinations about the extent to which cultivated biomass can be utilized for energy purposes

Synthetic fuels

Research and development work is to be carried out to find a suitable technology for gasifying domestic biofuels and perhaps shales Semi-scale and full-scale experiments and demonstrations are to be made which aim first of all at producing methanol. Biochemical methods of producing ethanol are to be investigated as adjuncts or alternatives.

Preparations are to be made for domestic production of synthetic motor fuels, already during the 1980s and 1990s, from coal and high-sulphur residual oils The prospects for importing non-oil-based motor fuels and motor-fuel components should be studied.

Efforts are to be implemented which seek to develop a flexible solid-fuel carburetor useful for different fuel raw materials.

Power and heat supply

The harnessing of water power from small hydropower stations is to be encouraged. This can be done by enjoining the local electricity distributors to receive power at a specified price from such power stations and also from other local production untis, for example certain wind power plants.

The Commission proposes that an investigation be made into the feasibility of providing southwestern Skåne, the Goteborg area and the Uppsala-Stockholm area with district heating from the nuclear power thermal units in Barseback, Ringhals and Forsmark. In its deliberations the investigating committee must also bear in mind the ongoing and planned activity at the OKG power station in Simpevarp.

If the investigations come up with positive results, Forsmark 3 should be carried out as a nuclear power thermal station or with a tapped turbine in lieu of condensate plant. Considering that many people, companies and municipalities are affected, it will be necessary to pursue the investigative work with the utmost speed so that a decision can be taken not later than the autumn of 1978.

The proposed investigation should encompass:

- studies of power and heat generation,
- engineering assessments of tapping and bleeding technology and long distance transmission of hot water,
- an expansion plan;
- economic, organizational and safety assessments.

Investigative results should guide and control coming negotiations and decisions concerning continued expansion of the nuclear power system.

Nuclear thermal stations are to be evaluated with reference to technical; economical, safety and organizational aspects The Energy Commission recommends a thoroughgoing inquiry whose results ought to be a guide for the future thrust of the nuclear heating sector.

An evaluation of the Swedish nuclear industry for its development potentials should be performed. It shall embrace not only the nuclear power industry but also the nuclear fuel cycle. Improved safety and waste management practices should enter in as major components.

Guarantees must be created to uphold the maintenance and service organization for the nuclear power stations, as well as for competence among the monitoring government agencies.

The long-range planning conducted by the government authorities and power companies is to be amplified with plans of a stand-by emergency character which show how an extensive and prolonged nuclear-power outage can best be met.

The development work on behalf of wind power is to be further pursued. Full-scale prototypes are to be built in different parts of Sweden. In order to improve knowledge of domestic wind conditions, increased resources should be given to SMHI (the Swedish Meteorological and Hydrological Institute) and other organizations which can perform similar investigations

Combined generation plants are to be built in urban settlements where the extent of the district heating network is such that the thermal base justifies an expansion of combined power and heating generation on macroeconomic grounds. With a view towards stimulating

such an expansion, improved financing is to be arranged for combined generation plants. Collaboration between the established power industry and power consumers is to be encouraged.

Installation of back pressure plants in connection with existing industrial processes should continue to qualify for receipt of financial assistance.

Advantage is to be taken of waste heat emanating from industrial processes. Any obstacles of a microeconomic or institutional nature in the way of such utilization should be removed at the earliest

Direct restrictions against electric heating are rejected. Here the local authorities in charge of energy planning are called upon to shun electric heating in areas where district heating may come up for consideration.

Development of heat-pump systems based on e.g. surface geothermal energy, industrial and municipal sewage heat, etc., and adapted to Swedish conditions, is to be encouraged.

District heating networks and local hot water networks are to be designed so as permit a changeover to solar heating. An improved financing of district-heating expansion is to be guaranteed for the long run.

Knowledge of solar conditions is to be improved by having SMHI and other institutions collect, analyze and tabulate basic data.

To permit a gradual expansion of solar heating, steps should be taken to make sure that the heat distribution systems are waterborne and suitably dimensioned to the greatest possible extent. Solar heat is recommended for larger systems which allow heat uptake and heat storage to be arranged in an economically favourable manner.

A broadly conceived programme of research, development and practical demonstration is to be organized to promote the development of solar heating technology. Improvements in heat storage technology are of great importance.

The introduction of solar heating technology is to be promoted through organizational measures and support chiefly given to the municipalities. Consideration should be given to whether solar heating installations can be included in the governmental system of financing residential construction. Programmes of information, education and training about solar heating should be enlarged. The manufacture of components is to be stimulated by guaranteeing certain appropriations. For instance, the State can procure solar heating systems for designated public buildings.

NORWEGIAN GOVERNMENT COMMITTEE ON NUCLEAR POWER AND SAFETY. SUMMARY OF OPINIONS AND CONCLUSIONS*

Introduction

The Committee has undertaken a broad analysis of safety in connection with the use of nuclear power. The analysis concentrates, in the first place, on the normal operation of light-water power reactors, the risk of accidents and the treatment and disposal of radioactive

* The Committee reached its conclusions after hearing presentations from a range of individuals and organizations These included the views of such nuclear opponents as A Lovins and W Patterson

waste as well as problems related to the proliferation of nuclear weapons. The framework of the analysis was, however, the safety of the operating staff and the public in connection with the entire nuclear fuel cycle, from the mining of uranium, enrichment of fuel and fabrication of fuel elements to the reprocessing of spent fuel Environmental impact and the decommissioning of power reactors have also been taken into account

Furthermore, a comparison has been made with coal, oil, and gas-fired power stations In all cases it was assumed that the station was located on the coast so that seawater could be used for cooling.

The Committee has based its work on very extensive background information and on special studies. Its conclusions are based on the material and experience available today and on an evaluation of this material by outstanding experts.

General points of view and requirements

Nuclear power has now been used for 25–30 years. Experience and knowledge gathered during this period are very extensive. Within certain areas of the nuclear fuel cycle, however, there is limited practical experience. This applies above all to reprocessing of fuel from civilian reactors and to waste disposal The long-term consequences of ionizing radiation are also an aspect of the use of nuclear power that involves several issues which cannot be resolved satisfactorily today.

The problems connected with the use of nuclear energy are not insignificant. This means that the evaluation of planning and safety must be carried out thoroughly Concern also arises out of our awareness of the environment's vulnerability and our responsibility to future generations Uranium resources and their limitations pose a further question

The introduction of a new technology has consequences in several areas, it requires a sound factual basis and good relations between specialized bodies, authorities and the public. It will be important to have complete information about expected requirements and about the planning of a Norwegian reactor This applies in particular to the safety and regulatory aspects of nuclear power which could have psychological and social consequences.

All the stages in this process, from planning to construction, operation and regulation should be based on the safety requirements and release limits prescribed by Norwegian law and practice, and the best technical solutions should be used Safety should be the most important element to be considered during planning, construction and operation. Continuous and independent regulatory review of releases which could expose the population to ionizing radiation must be carried out

Working routines and instructions should be established based on the most recent experience gained from power reactor operation The regulatory authorities should be free to decide at any time whether new and stricter requirements should be set There should also be a provision for check-up of workers exposed to radiation.

The use of nuclear energy would require an expansion of the responsible regulatory bodies. These should be sufficiently staffed and able to carry out the regulation of all aspects of the use of nuclear power freely and independently. Important regulatory data and results should be made public.

The necessary competence in the areas of regulation, operation and administration should be secured by the expansion of training and research.

Prior to a decision on the construction of a nuclear power reactor there must be fixed plans for waste disposal or the assurance to treat or dispose of waste in a safe and satisfactory manner.

The siting of a nuclear power station should be carefully considered particularly in view of the consequences of an accident. An accident could, under the worst conditions, reach great proportions and expose large groups of the public to ionizing radiation Therefore there must exist an emergency plan to be implemented in case of an accident

There must be provision for the protection of fissile materials against theft and diversion, and Norway should continue to participate in international controls in the area.

With world-wide construction of nuclear power plants, the levels of radiation in Norway will in any case be about the same as those in other countries, if one disregards the areas close to power reactors. In the opinion of the Committee, it is therefore of importance that Norway under all circumstances continues to work actively to secure good standards for and control of nuclear power installations through international treaties and inspection.

Other important aspects

The Committee would like to draw attention to some important aspects which are not within its terms of reference.

The Committee has not analysed the economic consequences of the safety requirements that it lays down in this report. In most cases, there is a close connection between level of safety and cost These two factors must be taken into account in considering each individual case.

In a comparison of coal, oil, gas and uranium, the cost of the electricity generated will influence the choice of energy source. This will apply to the short term as well as the long term and will include the safety requirements involved. The costs of electricity from different energy sources have not been evaluated.

Available reserves of the different energy sources on a national or international basis is an important element in energy policy. Particular interest is shown in the availability of uranium. Uranium reserves known today represent an amount of energy greater than the total oil reserves.

The report gives no analysis of Norway's electricity needs or general need for energy Future energy needs are a very important aspect to be considered in drawing up a long term energy policy and in evaluating the nuclear issue

The *main* task *of the* Committee

In its terms of reference, the Committee was asked to carry out an investigation and to evaluate certain areas. These evaluations are given below and conclusions drawn.

Releases and other operating problems of nuclear power reactors

The analysis has shown that releases of radioactivity and other problems during normal operation of a reactor do not produce serious risks either for the operating staff or the general public. This supposes, however, that the installation was built according to the highest technical standards and that in addition it is subject to effective regulatory control and is operated according to strict safety standards.

A Norwegian power reactor would be dependent on the operation of uranium mines, production of fuel, storage and reprocessing of spent fuel and treatment and disposal of waste

The biggest radiological risks are linked with the uranium mines and with the reprocessing plants. These activities would go on outside Norway.

It is technologically possible to reduce even further the releases from today's power reactors The Committee has, where possible, indicated which limits can be reached at each stage of the fuel cycle.

Established dose limits can be met with available technology and allowing for the foreseen expansion of nuclear power. Releases of long-lived gaseous radioisotopes (tritium, carbon-14, krypton-85, iodine-129) should be given particular attention. Nevertheless, there will be certain radioactive materials representing health hazards

The majority of the Committee is of the opinion that nuclear power reactors under normal operation will not produce radioactive releases or problems of any other kind entailing risks greater than those possible in the context of other complicated industrial processes The majority of the Committee is of the opinion that, all in all, a nuclear installation can be operated in such a way as to ensure adequate safety.

Probabilities, proportions and consequences of reactor accidents

Even with high technical standards and the strictest safety measures, the possibility of a considerable reactor accident cannot be excluded Such an accident could result in immediate deaths as well as a large number of cancer deaths over a longer period, but without causing damage to genetic material. In addition, the evacuation of large numbers of people may be necessary.

The theoretical probability of large reactor accidents, such as core meltdown, is small. This evaluation is based on the presumption that the installation is operated according to today's best technical standards and that safety is a central consideration in the construction as well as the operation of the installation. The majority of the Committee is of the opinion that the risk of a large accident to a nuclear power reactor in Norway is not greater than that which can be accepted

Protection of installations against acts of war and sabotage

The safety structures which consist of the containment and the concrete shield around the reactor would be sufficient to resist even considerable attacks with explosives It should be stressed, however, that nuclear power reactors above ground cannot be totally protected against acts of war. A special analysis should be carried out to evaluate the particular provisions and measures necessary for nuclear power reactors during time of war.

The most effective protection against sabotage is the provision of strict guarding and security measures.

Aspects of underground siting in the mountains

According to information available to the Committee, locating installations in the mountains would make the construction of power reactors more expensive.

It has not been sufficiently clarified whether locating a reactor underground in the mountains would lead to greater safety than if it was located above ground. If technical solutions for mountain locations can be found as well as possibilities for reducing the resulting additional costs and operating problems, mountain locations could offer advantages Hence this possibility should be kept in mind.

Transport and storage of radioactive material

Transport of radioactive material can normally be carried out with considerable security precautions thereby reducing the possibility of accidents and their consequences.

The possibility of theft of fissile material during transport will exist, particularly if there is extensive use of nuclear power with many transport journeys between fuel fabrication plants, power reactors and reprocessing facilities. It is therefore necessary to provide for protection and strict security during transport. Storage of spent fuel without reprocessing will reduce the possibility of theft and diversion.

In no country has there so far been final disposal of high-level waste. In this study there is a description of the disposal of high-level waste at a depth of some 500 metres in stable mountain formations. With such disposal the radioactive waste should not reach living creatures for 10 000 years.

There have been no geological investigations in Norway sufficiently extensive to indicate locations for final disposal of high-level waste On the basis of general knowledge and existing studies it can be presumed that there are several sites in Norway where such disposal of high-level waste would be possible. The majority of the Committee is of the opinion that a safe solution for Norway would be the disposal of high-level waste in stable mountain formations.

If Norwegian spent fuel is reprocessed abroad, Norway should be prepared to take back the waste.

Nuclear power reactors can be shut down and taken care of in a responsible manner. The analysis of the Committee shows that if decommissioning is taken into consideration during construction, the actual decommissioning operation can be performed safely

The international safeguarding of fissile materials

Extensive and commendable safeguards are undertaken by the IAEA. The NPT is an agreement between sovereign States; its ratification is voluntary and any State can withdraw at very short notice. Controls based on NPT cannot prevent diversion of fissile material but any violation of the Treaty that is detected would be reported to the United Nations Security Council. The Committee is of the opinion then that the NPT has considerable

weaknesses and provides insufficient guarantees against proliferation and misuse of fissile materials.

Terrorist groups and sub-national groups also represent a serious problem with regard to the danger of misuse of nuclear material. It is difficult to indicate effective general measures to prevent such groups procuring fissile material. Strict regulations could turn out to have negative effects in a free democratic society.

From an international point of view, it cannot be ignored that the existence of civilian power reactors could increase the possiblity of proliferation of nuclear weapons and this should be taken into account if nuclear power is introduced to Norway. A total halt to the global expansion of nuclear power would, according to the Committee, decrease but not stop the proliferation of nuclear weapons. It should be pointed out that the production of bomb-grade plutonium could be carried out in small research reactors. Such reactors already exist in about 100 countries.

The greatest danger in the long term lies in proliferation among countries but terrorist groups and the like also present a serious problem. There has to be sufficient physical protection of nuclear installations and materials in Norway It is important to work towards achieving extensive and effective international controls

The Committee is of the opinion that Norway should work actively to create effective international sanctions to be used against a State withdrawing from NPT. Such sanctions could also be applied to a country not party to NPT.

Safety aspects in the context of possible long-term mining and processing of uranium in Norway

No economically viable deposits of uranium have been found in Norway. The Committee can see no reason for considering uranium mining in Norway during the period it has been requested to evaluate. The Committee has therefore not given any particular thought to this activity.

A reprocessing plant for spent fuel should serve 30 reactors to be financially viable. Hence such a plant is of no current interest to Norway. It is important that international trade in nuclear fuel and fuel cycle services be subject to NPT control

Comparison of environmental effects for different forms of thermal generation
Conclusion

A comparison of the health and environmental damage due to the generation of electricity from uranium (light-water reactors) coal, oil and gas has been made.

An important condition is that the installations meet a high technical standard and that safety and environmental requirements are given due attention during construction and operation. In view of anti-pollution technology expected to be available in the near future, particularly for coal and oil, the normal operation of these power stations will bring few drawbacks

When making this kind of comparison, one must consider such diverse aspects as radioactivity (uranium and to a certain extent coal), waste disposal (uranium), large accidents (uranium, gas), manufacture of weapons (uranium), CO_2 release (coal, oil, gas), SO_2 release (coal, oil),

NO_x release (coal, oil, gas), and release of toxic materials (coal, oil). Release of waste heat which contributes to raising the Earth's temperature is about the same for all these forms of electricity generation.

The most important short-term elements of danger are risks of large accidents (uranium, gas) and illicit weapons production (uranium) The uncertainty of comparisons over the long term applies in particular to the consequences of CO_2 release to the atmosphere from oil, coal or gas-fired power stations, and the consequences of the most long-lived isotopes (in particular iodine-129, and carbon-14) from nuclear power reactors.

It may be expected that technological developments will reduce releases from nuclear power installations in the future whereas CO_2 release from fossil-fuelled power stations will not be reduced

To sum up, the majority of the Committee is of the opinion that coal-fired power stations constitute the greatest environmental risk. In a comparison of oil, gas and nuclear power stations, none appears to be clearly preferable in terms of the environment

Conclusion

No form of electricity production is without drawbacks and risks. Negative effects in the form of health and environmental damages are added to the direct costs in crowns and oere As for nuclear power, there is the particularly delicate problem of fissile material being used for military purposes or terrorist activities. The introduction of nuclear power to Norway should be evaluated from an international safety-oriented point of view Such an evaluation is not part of the terms of reference of the Committee.

Any decision to introduce nuclear power to Norway will give rise to several serious problems which must be considered. In view of the existing elements of danger, safety requirements must be paramount.

On the basis of existing knowledge and experience the Committee has reviewed the conditions and requirements that will give sufficient safety.

The majority of the Committee is of the opinion that it would be justified to use nuclear energy in Norway on condition that safety requirements are met.