Feasibility Study Cases

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This chapter presents two cases of feasibility studies. The two cases are chosen with the dual purpose of showing how the tools of the previous chapter are implemented and, at the same time, illustrating some of the important differences between traditional neoclassical cost-benefit analyses and feasibility studies emphasising the context of technological innovation.

Identifying political objectives is a very important part of conducting feasibility studies within the field of environmental management. Very often environmental projects are evaluated against narrow sector objectives, such as securing “a sufficient energy or water supply” and/or securing “reasonable prices”. Established technologies are chosen, while less polluting, new technologies are regarded as too risky or too expensive. Meanwhile, most countries have a number of important national objectives beyond environmental concerns, such as decreasing imports, increasing employment, developing new products for export, etc. Very often such objectives are not directly included in feasibility studies of energy projects, even though new technologies are likely to fulfil these objectives better than many established technologies.

The first case illustrates the importance of including all relevant objectives in the feasibility study. Based upon a planned new 1,400 MW coal-fired power station in Prachuap Khiri Khan, Thailand, this case presents a feasibility study in which a power plant project and a proposed technical alternative are assessed in relation to a wide range of specific and general official development objectives for Thailand. The case shows that the plans to implement a coal-fired power plant at Prachuap Khiri Khan were indeed not very rational; there are alternatives which are more suitable for Thailand in terms of economic growth, employment, rural development, industrial development, and environmental sustainability.
The second case is an evaluation of the Danish environmental policy within the energy sector during the 1990s. The study was made by the Danish Economic Council (DEC) in 2002, and it was carried out as a traditional cost-benefit analysis based on neoclassical economy and ideology. Consequently, the study illustrates some of the technical points from the previous chapter such as the significance of sunk costs, and the importance of handling employment, balance of payment and technological innovation issues. Here the study is supplemented with alternative calculations in accordance with the tools described in the previous chapter. Thus the case illustrates both the difference between neoclassical ideology and institutional economy, and the consequences of designing feasibility studies in one way or the other.

The Case of Prachuap Khiri Khan Power-plant

The following feasibility study case is based on the result of a workshop in Bangkok arranged by the Thai-Danish Co-operation on Sustainable Energy and Sustainable Energy Network for Thailand (SENT) in 1999. The workshop resulted in the report “Sustainable Energy Alternatives to the 1400 MW Coal-Fired Power Plant Under Construction in Prachuap Khiri Khan” (Lund et al. 1999).

Power sector development projects are well known to be contentious issues in many countries around the world. Such was the case of the planned 1400 MW coal-fired power plant in Prachuap Khiri Khan. On one hand an institutionalised collection of public power companies, private power producers and industrial companies was setting the pace for establishing a power sector based on fossil fuels. On the other hand the society was badly affected by an economic crisis, unemployment and degradation of natural habitats. The political system was facing the difficult task of regulating the energy sector, in order to most effectively meet the social and economic objectives of Thailand. Politicians and stakeholders who wanted to establish a rational basis for decision making needed to continuously examine whether the situation and development was rational and, if not, whether alternatives existed which would be able to meet the societal and economic targets more effectively.

In Thailand, as in many other countries, energy projects were evaluated against narrow energy sector objectives such as securing a sufficient energy supply and/or securing reasonable energy prices. By 1999 this had led to the planning of a new 1400 MW coal-fired power plant to be constructed at Prachuap Khiri Khan. Meanwhile, the project would interfere with the fulfil-
ment of a number of other important objectives for Thai society. The workshop performed a feasibility study in which the coal-fired power plant project and a proposed technical alternative were assessed in relation to a wide range of specific and general official development objectives for Thailand and Thailand’s energy sector. The case illustrates that the plan of implementing a coal-fired power plant at Prachuap Khiri Khan was indeed not very rational, and that more suitable alternatives existed.

**The Hin Krut power plant in Prachuap Khiri Khan**

The Hin Krut power plant project in Prachuap Khiri Khan was located at Kok Ta Horm village, in the Thongchai sub-district of Prachuap Khiri Khan Province. The owner of the project was Union Power Development Co., Ltd., a joint venture with 85% foreign capital. The joint venture proposed its project in June 1995, received the initial power purchase agreement in December 1996, and signed a 25-year independent power production contract with the Electricity Generating Authority of Thailand (EGAT) in June 1997.

In the meantime, locals and environmentalists were growing increasingly more concerned about the project’s negative impacts on the surrounding environment. The coal-based power plant would not contain scrubbers to reduce sulphur dioxide emissions, and was therefore expected to become a hazard to local people's health. Because of disputes surrounding the project, it was still awaiting the government’s permission when the feasibility study was made in 1999. Though already contracted, EGAT was able to cancel the project by paying a compensation of approximately THB five to six billion (USD 110 to 140 million).

The coal-fired plant was expected to have an installed capacity of 1,400 MW from two 700 MW units. Union Power expected the plant to consume 3.85 million tons of bituminous coal per year, producing 7,125 GWh/year at an efficiency of 44.77%. The construction costs for the turnkey-plant were USD 900 million plus an additional USD 300 million to cover the financing costs, consulting costs etc. Thus, the expected construction price was THB 45 billion (USD 1.2 billion). The expected operations and maintenance costs were THB 450 million per year (USD 12 million per year).

Union Power projected a coal price of USD 40 per ton which, according to EGAT, was similar to the prevailing cost of coal. Furthermore, EGAT expected the real price for coal to increase at 2.08% per year. According to the contract, Union Power would receive both a fixed payment covering the available power supply of the plant (capacity payment), and a reimbursement of variable costs associated with fuel consumption and operations and maintenance.

The actual payment terms were kept confidential, but the agreement between EGAT and another producer was known to hold a capacity payment
of 422 Bath per kW per month (USD 11.3). According to the agreement EGAT was obliged to pay this amount whether or not the power plant produced electricity. This favourable contract was intended to secure for the investor an internal rate of return of 15%.

Official social and economic objectives for Thailand

The official social and economic objectives for developing Thai society were formulated by the Thai government in the 8th National Development Plan (1997-2001) (NESDB 1996). The National Energy Policy Office of Thailand (NEPO) was obliged to develop policies, management and development plans and measures related to Thailand’s energy sector in accordance with the National Economic and Social Development Plan and government policies, to be presented to the NEPC (National Energy Policy Council). In other words, NEPO was required to relate all plans and base all decisions on the wide range of official objectives found in the National Economic and Social Development Plan and other government policies.

The 8th National Development Plan was influenced by an economic crisis in Thailand in 1997, and was considered to be a turning point in the way it recognised the globalisation process and the need for a continuous and long-range process of planning, decision-making, implementation, monitoring and evaluation. The plan was said to be moving toward holistic, people-centred development. The social and economic objectives formulated in the plan were intended to be the basis of planning and decision making throughout all economic sectors – issues included economic policy, security of supply, employment, rural development, technological innovation, the environment and others. Energy plans and projects were also to be assessed on this basis. In the feasibility study, the following main official objectives were referred to and discussed.

Secure sufficient and efficient energy supply at a reasonable price

The national Thai objectives included traditional energy sector targets. Thus the National Energy Policy Office, NEPO stated that in order to develop the international competitiveness of the country, a supply of energy sufficient to meet the demand in various economic activities was essential, since energy is a crucial fundamental production factor.

“The supply of energy must be at reasonable prices with sufficiently high quality consistent with consumer’s requirements. At the same time, production activities must utilise energy in an efficient and economical manner.”
**Improve the balance of payment and stimulate employment**

In the “Revision of the 8th Economic and Social Development Plan” (NESDB 1999), the National Economic and Social Development Board stated that in light of the lower growth rate after the economic crisis the overall expenditure, both public and private, must be controlled to be in line with the country’s economic and financial conditions.

“The criteria for screening public investment projects will strictly consider the projects with low import content and stimulate employment, or has adequate foreign currency generation capacity to cover foreign currency cost”.

**Strengthen rural development, employment and empowerment**

The disparity between urban and rural areas was considered to be a problem to Thailand’s economic and social development, and the official policy was to stimulate rural development. At a regional level, the largest initial increase in unemployment after the advent of the Thai economic crisis in 1997 occurred in the rural areas and in the Northeast region, where the concentration of poverty was highest. The absolute increase in the unemployment rate was highest in the rural Northeast.

In the 8th Economic and Social Development Plan the Thai government outlined the framework for enhancing the development potential of the region’s rural areas, by redistributing income on a more equitable basis; decentralising development activities to regional and rural areas; promoting popular participation in development through the empowerment of community organisations; supporting and expanding community learning networks; promoting the role of the private sector and non-governmental organisations (NGOs) in job creation; and managing development at all levels through cooperative partnerships.

The government specified the following objectives:

“To create employment opportunities for approximately eight million of rural poor, so that they can gain sufficient income and economic security”; “to provide rural people working in the agricultural sector with a wider range of non-agricultural employment options”, and ”to distribute economic activity evenly and create development and employment opportunities appropriate to the potentials of different people and communities”.

**Support industrial and technological innovation**

In the 5th National Research Policy and Agenda (1997-2001), the National Research Board (1997) stated that research to increase competitiveness of industrial sectors must be promoted, and that the industrial sector should
improve efficiency in its use of resources and energy. From the “Follow up Plan 1998-2002”, NESDB (1998) stated that one of the most important goals for industrial development should be incubation and strengthening of small and medium supporting industries. In the “Industrial Restructuring Plan 1998”, the Ministry of Industry (1998) stated that conditions should be established to upgrade technological capabilities, modernise target industries, and enhance product development, design and global marketing channels.

**Promote clean technologies and a clean environment**

In The 8th Economic and Social Development Plan, the Thai government also formulated objectives in relation to the environment, namely to utilise, preserve and rehabilitate the environment and natural resources in such a way that they could play a major role in economic and social development and contribute to a better quality of life for the Thai people.

“Natural Resources and Environmental Management, including directions of conserving and rehabilitating natural resources that will promote balance in the ecosystem; maintaining and upgrading environmental conditions to enhance quality of life and to provide an enduring resource base to support development; improving management systems for natural resources and the environment in order to ensure proper supervision, efficient utilisation, and fair distribution of benefits to the community and society; and management guidelines for the prevention and relief of natural disasters”.

**Summary of social and economic objectives**

As stated in the “Revision of the 8th Economic and Social Development Plan”, both private and public projects must be assessed in relation to current social and economic objectives. In conclusion, all private and public energy sector projects therefore had to be assessed on their ability to provide:

- a) sufficient energy supply
- b) reasonable energy prices
- c) high energy efficiency
- d) high cost efficiency
- e) low import content
- f) new products for export
- g) more and better employment
- h) positive effect on public budgets
- i) rural development
- j) decentralisation of the planning and decision making process
- k) technological innovation
- l) a healthy environment
Technical alternatives to the power plant at Prachuap Khiri Khan

In order to show the influence the abovementioned objectives had on the results of feasibility studies; an alternative to the coal-fired reference was produced for comparison. The alternative consisted of three components: industrial CHP (combined heat and power production) based on biomass, demand side management, and micro hydropower. The alternative combined the utilisation of indigenous fuels with Thai industrial and technological development, and was intended to create employment, technological innovation, export opportunities and other benefits. The alternative had been carefully composed to consist of 1000 MW industrial CHP based on biomass, 350 MW DSM, and 40 MW micro-hydro power (See Table 1). Consequently, the alternative provided exactly the same capacity as the 1,400 MW reference coal-fired power plant.

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<tr>
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<th>Alternative</th>
<th>Estimated Thai potential</th>
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<tr>
<td>Industrial CHP - biomass resources</td>
<td>1,000 MW, 2,200 ktoe/year</td>
<td>10,000 MW, 20,000 ktoe/year</td>
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<tr>
<td>DSM</td>
<td>350 MW</td>
<td>2,200 MW</td>
</tr>
<tr>
<td>Micro Hydro power</td>
<td>40 MW</td>
<td>8,000 MW</td>
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Table 1: Alternative compared to the estimated technical potential.

The composition of the alternative was guided by the following principles:

- The alternative was generally composed to meet the official social and economic objectives for Thailand, i.e. it should be cost-effective, reliable, stimulate employment, rely on indigenous resources, etc. The micro-hydro power component of the alternative was not likely to prove as financially feasible in the short-term. It was, however, included due to its potentially positive impacts on technology development, employment and others.
- Each element of the alternative takes up only a minor part of the estimated technical potential for that element, which means that this type of alternative is generally applicable to future coal-fired projects in Thailand (See table 1).
- In the period from 2001 till 2010, the coal-fired power plant was expected to replace electricity produced by oil-fired steam turbines with an efficiency of 33%. Over the 10-year construction period, the alternative was consequently supplemented by such units. All costs of the supplemental electricity production were included in the feasibility study.
- The alternative and the coal-fired power plant produced (or saved) identical amounts of electricity – both in total and year by year.
While the coal-fired power plant was to be constructed over a period of no more than two years, the alternative took advantage of the surplus capacity in power production expected to be available until 2010, spreading the construction efforts over a 10-year period from 2000 to 2010. This would also allow industries time to develop and market even better biomass CHP and micro-hydro power technologies.

**Comparative Feasibility Study**

The alternative and the coal-fired reference were compared over a period of 25 years on their energy, environmental and economic characteristics. Economic costs were calculated using factor prices, i.e. investment costs and O&M costs excluding VAT and other taxes. The economic investment costs for the coal-fired power plant were represented by the capacity payment that EGAT had agreed to pay Union Power as an IPP, instead of implementing the power plant project themselves. However, for the employment calculation, the actual investment costs according to the Union Power were used. Please refer to the report “Sustainable energy alternatives to the 1400 MW coal-fired power plant under construction in Prachuap Khiri Khan” for further details on conditions and assumptions, as well as specific technical-economic technology data used in the analyses (Lund et al. 1999).

**Energy and environmental consequences**

Over a period of 25 years the final energy consumption of bituminous coal for the coal-fired plant was found to be 68 PJ/year, adding up to 1,689 PJ. Meanwhile, the alternative was to be introduced over a period of 10 years, with the final energy consumption remaining highest in the beginning, where the alternative depended on electricity production from older, low efficiency oil-fired power stations. Consequently, the fuel consumption decreased from an initial 86 PJ/year in 2001 to 2.2 PJ/year in 2010 and onwards. The very low net fuel consumption of 2.2 PJ/year was partly due to high savings from replacing old boilers in the industry by new CHP plants, and partly from introducing DMS and hydro power with no fuel consumption. Total energy consumption reached 468 PJ.

For the coal-fired power plant, the emissions of SO$_2$ and NO$_X$ were 1,216 thousand tons over the period, or 49 thousand tons per year. Emissions of CO$_2$ from Prachuap Khiri Khan reached 578 million tons, or 23 million tons per year. The alternative resulted in negative atmospheric emissions, as coal and oil used in industrial boilers were substituted with biomass used in industrial co-generation plants. The implementation of the alternative would consequently:
- reduce fuel consumption by 72% over a period of 25 years
- reduce emissions of CO₂ by 670 million tons over a period of 25 years
- reduce emissions of SO₂ by 1.5 million tons over a period of 25 years
- reduce emissions of NOₓ by 1.5 million tons over a period of 25 years

**Production costs and consequences for the balance of payment**

The net present value of economic costs was almost the same for the coal-fired power plant at Prachuap Khiri Khan and the alternative, totalling THB 152 to 153 billion when using an annual discount rate of 7% on 1.60 THB/kWh electricity produced. The division between capital costs, O&M costs and fuel costs influenced the contribution to e.g. employment and the rural economy. While the production costs at the coal-fired power plant at Prachuap Khiri Khan included 53% capital costs, 44% fuel costs and only 3% O&M costs, the alternative was made up of 39% capital costs, 40% fuel costs and 22% O&M costs. The cost of the coal-fired power plant at Prachuap Khiri Khan was THB 117 billion in foreign currency, while the economic costs of import for the alternative was only THB 39 billion. Furthermore, the feasibility study showed that the coal-fired power plant at Prachuap Khiri Khan only contributes THB 35 billion to Thailand’s economic wealth (GDP), while the alternative contributes THB 115 billion. The implementation of the alternative consequently would:

- imply practically identical economic costs of 1.60 to 1.62 THB per kWh electricity produced over a period of 25 years,
- incur lower capital and fuel cost, but higher O&M costs, which indicates an advantageous contribution to employment and the rural economy,
- save foreign currency worth THB 78 billion (USD 2.1 billion), thereby reducing the negative impact on Thailand’s balance of payment by 67%,
- contribute an additional THB 80 billion to Thailand’s GDP.

**Employment effects**

The coal-fired power plant only creates 0.2 million man-years of employment over a period of 25 years, i.e. an average of approximately 7,000 man-years per year. The alternative creates 1.8 million man-years over a period of 25 years, i.e. an average of approximately 71,000 man-years for every year in the period. The implementation of the alternative consequently would:

- create an additional 1.6 million man-years over a period of 25 years, i.e. when the coal-fired power plant at Prachuap Khiri Khan creates 1 man-year, the alternative creates 10 man-years.
- create an additional approximately 64,000 man-years for every year over the period.
Consequences for the rural economy
The consequences for the rural economy (i.e. economic activity which stems from biomass production and O&M activities) were also analysed. The net present value of the economic activities contributing to the rural economy was THB 5 billion for the coal-fired power plant, while the alternative contributes to the rural economy with THB 93 billion. The implementation of the alternative consequently would:

- contribute to the rural economy an additional THB 88 billion, i.e. for every billion the coal-fired power plant contributes to the rural economy, the alternative contributes THB 19 billion.

Consequences for public finances
Finally, the consequences for public finances (primarily from personal income taxes) for the coal-fired power plant and the alternative were also analysed. The net present value of the public revenue created by the coal-fired power plant is THB 7 billion, while the alternative would create public revenue of THB 22 billion. The implementation of the alternative consequently would:

- contribute an additional THB 15 billion to the public revenues, i.e. for every billion contributed to public revenue by the coal-fired power plant at Prachuap Khiri Khan, the alternative contributes 3.3 billion.

Conclusion
Two energy projects were analysed and compared with respect to the national Thai objectives – the planned coal-fired power plant at Prachuap Khiri Khan (Reference) and the Biomass, Energy Efficiency and Micro-Hydro Power Alternative (alternative). The feasibility study showed that the proposed alternative is in all aspects essentially equal to or better than the reference. The alternative is noticeably better in terms of economic import costs, contribution to Thailand’s GDP, creation of employment, contribution to public revenue, contribution to rural economy, contribution to technology development, and environment, whereas the alternative is almost the same as the reference in terms of economic costs of production. The main economic results are summarised in table 2.
# The Evaluation of Danish Energy Policy in the 1990s

Denmark has conducted an active and innovative energy policy for many years. During the period from 1972 to 1990 the major objective was to decrease dependency on oil imports, while during the 1990s Danish energy policy’s main objective, expressed by several national energy plans and further supported by the Kyoto protocol, was to reduce the CO₂ emissions.

In the 1970s and 1980s, the strategic objective of energy reliability of supply was met by: 1) energy savings, 2) increasing domestic production of oil and natural gas and 3) replacing oil with other fuels, mainly coal and natural gas. Houses were insulated and central heating systems were converted from oil to natural gas or district heating based on coal-fired CHP plants. Power plants replaced oil with imported coal and, over a period of five years the Danish electricity production changed from 90% use of oil to 95% use of coal. Over the same period Denmark itself began to produce oil and natural gas from the North Sea. By the turn of the century, Denmark had become a net exporter of oil and natural gas.

In the 1990s a number of environmental energy policy measures were adopted, including the expansion of wind power, and the replacement of more than a hundred district heating boilers with small-scale CHP-plants distributed throughout the country.

In spring 2002 the Danish Economic Council (DEC) published an evaluation of the environmental elements of the Danish energy policy measures during the 1990s. The analysis was carried out as a cost-benefit analysis based on neo-classical economic and ideology. Costs were calculated as investment and maintenance costs while benefits were calculated as saved fuel costs and environmental benefits. Additionally, the analysis calculated tax and consumer misallocations, which were included as costs. The study included a number of different policy measures, and reached a general con-

### Table 2: Summary of main economic and employment results

<table>
<thead>
<tr>
<th>Main Economic Results (Billion Baht)</th>
<th>Reference</th>
<th>Alternative</th>
<th>Difference</th>
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<tr>
<td>Economic Costs</td>
<td>152</td>
<td>153</td>
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<tr>
<td>Import Costs</td>
<td>117</td>
<td>39</td>
<td>-78</td>
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<tr>
<td>GDP contribution</td>
<td>35</td>
<td>115</td>
<td>80</td>
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<tr>
<td>Income revenue contribution</td>
<td>7</td>
<td>22</td>
<td>15</td>
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<tr>
<td>Rural economy contribution</td>
<td>5</td>
<td>93</td>
<td>88</td>
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<table>
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<th>Main Employment Results (Discounted at 7% per year)</th>
<th>Reference</th>
<th>Alternative</th>
<th>Difference</th>
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<tr>
<td>Employment (man years/year)</td>
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<td>34,976</td>
<td>27,968</td>
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<tr>
<td>Rural (man years/year)</td>
<td>1,527</td>
<td>28,311</td>
<td>26,784</td>
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Conclusion that the resources had not been spent in the most cost effective way, since many of the elements exhibited negative net results. Consequently the main recommendation was that cost-benefit analyses should be relied upon much more in the future, in order not to make the same mistake again.

The expansion of wind power and small-scale CHP plants was included in the analysis, and as a side effect of the study the results showed these investments to have a negative net result, meaning that Denmark should never have implemented such investments. However, this statement was the result of an analysis which included an element of “sunk costs,” which would lead to negative results for almost any new investment, including traditional technologies such as coal-fired steam turbines. Benefits in relation to employment, balance of payment and technological innovation were not included or were underestimated, due to the premises of neoclassical cost-benefit methodology and ideology.

Consequently the study is an excellent case of the consequences of typical neoclassical premises on the implementation of technological innovation. The following description is based on a critique by the authors of this chapter. The critique of the Economic Council’s evaluation was discussed in the Danish public debate in the period after the publication of the study, together with critiques from others as well. Two important elements are included. The first is the issue of excluding the capacity benefits of small CHP plants, illustrating the “sunk costs” issue. The second is the issue of ignoring benefits of employment, import savings and technological innovation.

**Missing capacity benefits (sunk cost)**

The results of the cost-benefit analyses are divided into a number of Danish energy policy measures in the 1990s. Three of the elements are discussed in the following, namely the investments in 826 MW of small-scale CHP plants, 1,769 MW of private wind turbines, and 1,098 MW of wind turbines owned by the utility companies. The results of the analysis by the DEC are shown in table 3.
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<tr>
<td>- Investment</td>
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<tr>
<td>- Saved fuel</td>
<td>2.1</td>
<td>9.9</td>
<td>4.4</td>
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<td>- Saved capacity</td>
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<tr>
<td>- Saved maintenance</td>
<td>-</td>
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<td>-</td>
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<tr>
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<td>16.5</td>
<td>14.8</td>
<td>6.0</td>
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<td>Net Benefit</td>
<td>-4.7</td>
<td>-4.0</td>
<td>-0.7</td>
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Table 3: The results of the Danish Economic Council’s Cost-benefit analysis on Danish energy policy in the 1990s. (Det Økonomiske Råd 2002)

In the cost-benefit study all prices are given in terms of ‘consumer prices’. In this specific case the consumer price has been derived from factor-prices (Market prices of construction, maintenance and fuels costs) by multiplying by a factor 1.25, equal to the Danish VAT percent. Moreover, the prices are converted into year 2002 prices by the use of an annual inflation of two, while the present value is calculated on the basis of an interest rate of 6 percent.

Small-scale CHP plants totalling 826 MW were built in the period between 1992 and 1998. The investment costs were based on a survey of the Danish Energy Agency, leading to total costs of 5.3 billion DKK. These investments were converted into costs of approximately 12 billion DKK, when calculated as described above.

The crucial premise in the cost-benefit calculation is stated by the following sentence in the Economic Council main report:

“The reason for the negative net result is first of all that Denmark had plenty of electricity production capacity”. Furthermore, in the attachment it is stated that “consequently only variable costs in terms of fuel are saved”.

The analysis does not even include saved variable maintenance costs, with no explanation given for this omission. To illustrate the importance of this crucial premise, the critiques produced a calculation including the benefits of both saved investments and saved O&M costs. Table 4 shows the result. The calculation is based on the alternative costs of electricity produced by coal-fired power stations, with capital costs of 8 MDKK/MW and maintenance costs of 60 DKK/MWh, as per the official expectations of the Danish Energy Agency. In the calculations small-scale CHP plants are assigned a capacity factor of 100 percent, while wind turbines are at 20 per-
The 20 percent availability of wind turbines represents the capacity likely to be available with the same probability as with big power stations. This percent has previously been used in the Danish energy planning (Munksgaard and Larsen 1996).

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<td>Sum</td>
<td>40.6</td>
<td>33.8</td>
<td>15.7</td>
</tr>
<tr>
<td>Net Benefit</td>
<td>+ 17.3</td>
<td>+ 5.1</td>
<td>+4.6</td>
</tr>
</tbody>
</table>

Table 4: Same calculation as figure 14B.3 apart from the inclusion of saved capacity and maintenance. The saved capacity of wind is included by 20 percent.

For small CHP plants the saved capacity costs are 6.6 billion in the period 1992-1998. Meanwhile, after including inflation and transforming into a year 2002 present value in consumer prices, as described above, the costs contribute 14.8 billion to the analysis. Using the same procedure the saved maintenance costs sums up to 7.2 billion. Table 4 shows how much this influences the results. A negative result totalling 9.4 billion for all three elements turns into a surplus of 27 billion instead. Consequently, the sunk cost premise of overcapacity totally dominates the entire analysis.

Such a “sunk cost” premise would probably make almost any power plant investment negative. Thus, the same cost-benefit analysis has been conducted for two large power stations built in the same period, namely in 1996 and 1998. The two power stations each have a capacity of 400 MW and consequently are comparable to the 826 MW of small-scale CHP plants. The two power stations have been evaluated on exactly the same premises and using the same methodology as shown before in the DEC study, with the results as given in table 5.
As seen in table 5 the results of building 800 MW of large power stations are even more negative than building 826 MW of small-scale CHP plants. The 800 MW large power stations have a deficit of 12.6 billion, while the 826 MW small-scale CHP plants had a deficit of only 4.7 billion. It should again be emphasised that both calculations have the premise that no new capacity is needed, and no maintenance costs can be saved.

The conclusion is then that based on the premise of overcapacity (because both wind and large and small power stations were built) no power production units should have been built; they all come out of the cost-benefit analysis with a negative result. The problem is that IF no power capacity had been built then the premise of overcapacity is not valid, and consequently the results have no meaning.

Meanwhile one can ask the question, how should Denmark have provided new capacity during the 1990s with the least cost? The response to such a question can be easily seen in tables 4 and 5. The answer is that the small-scale CHP plants should be preferred to the big power stations. Consequently, one can conclude that the premise of overcapacity is not valid, as it leads to the erroneous conclusion that small-scale CHP is not feasible.

**Balance of payment, employment and technological innovation**

Moreover, the DEC made the assumption that the innovation, employment and balance of payment effects of the green energy policy in the 1990s had no societal value.
Balance of payment effects

The Energy Policy of the 1990s has resulted in an increase in the export of green energy technologies from 4 billion DKK in 1992 to 30 billion DKK in 2001. Using an import share of 50%, the net effect on the balance of payment of the export of green energy technologies was around 15 billion DKK in 2001. Thus, the export of such technologies became as large as for instance the very important export of Danish bacon, or as important as the balance of payment effects of the Danish North Sea oil adventure.

The DEC was criticised for not including such positive effects in their cost-benefit analysis, but they refused to attribute these effects to the energy policy in the nineties, nor would they accept the concept that export should be accredited any benefit value in their analyses. They argued that the Danish surplus on the balance of payments and the present international financial situation made it of no importance to have positive balance of payment effects of a given technology.

The counter arguments to this position were:

a. that Denmark still has a rather considerable foreign debt amounting to around 200 billion DKK,

b. that the present Danish positive balance of payments is caused by amongst other factors self-sufficiency in oil and gas, giving us a balance of payment net income of around 15 billion DKK pr. year. This positive effect will disappear as Danish oil wells gradually run dry from 2005 to 2020.

c. that the present Danish positive balance of payment also is caused by the above-mentioned net effect upon the balance of payment of the export of green energy technologies worth 15 billion DKK.

A former member of DEC argued along the same lines, and the Danish Minister of foreign affairs even said that successful export was the backbone of the Danish economic development. Consequently, the export values could be included in the analysis based on a political “willingness to pay” study of the public subsidies to export activities compared with their resulting export increases. The export subsidies from the Danish Export Council show exports of 6 DKK for each DKK subsidy. This number is an indication of the politician’s willingness to pay, leading to the conclusion that an export of 6 DKK has a societal value of 1 DKK. This means that an export of 30 billion DKK in 2001 can be accredited an extra social value of 5 billion DKK.

If the annual export of green energy technologies for the period 1992 to 2001 and the expected effects until 2011 are included in the calculations, the accumulated 2001 value of these benefits amounts to between 40 and 60 billion DKK, depending on the interest rate and prognoses for export after
2001. These 40 to 60 billion DKK should be added to the benefits shown in
Tables 3 and 4.

As can be seen, the inclusion of the balance of payment effect of the en-
ergy policy in the 1990s totally changes the results of the calculations.

**Employment effects**

The development of the green energy sector in Denmark has created around 30,000 new Danish jobs. Thus, these technologies are one of the contributors to the relatively low unemployment rates in Denmark in 2002 compared with other European countries. The employment linked to these technologies was to a large extent located in rural areas, where there is relatively high unem-
ployment when compared with the Danish average.

The DEC argued that unemployment in general was not a problem in Denmark, and that the people employed in the green energy sector, espe-
cially the wind power sector, would, if the green energy sector had not ex-
isted, have been employed in other sectors. Since 2002 the DEC argument has been contradicted by the reality of an increase in unemployment from around 150,000 to around 190,000 persons.

**Innovation effects**

The DEC also argued that the energy policy of the 1990s had no specific innovation effects, and therefore excluded this type of consideration from their analysis. Thus far, there has not been a systematic analysis of the inno-
vation effects of the energy policy in the 1990s, and it is rather obvious that the analytical tools linked to neo-classical economic theory cannot be used for such analyses. Nevertheless the hypothesis that the innovation effects can be of great significance is valid, and innovation analysis based on economic theories working with innovation theory might be able to qualify and quan-
tify these effects.

**Reflection of method and its application**

The feasibility study for the Prachuap Khiri Khan power plant had three main implications for technological innovation in the Thai energy sector.

First, it enabled energy planning to link with broader aspects of sustain-
able development and national development goals. Therefore, energy plan-
nings are no longer recognized as a stand-alone exercise which aims only to meet system demand and reliability with the old technological system. The study stressed the importance of inter-sectoral policy very clearly.
Second, it raised public awareness on the potential benefits of renewable energy development in the longer and broader perspective, especially the social benefits which had previously been subject to little discussion in Thai society. The increasing public awareness urged the Thai government to introduce more supportive programs for renewable energy development. In 2001, the Thai government developed a strategic plan for renewable energy. Two years later the Thai government decided to set up targets for overall renewable energy development and for each specific renewable technology.

Last, the feasibility study provided the opportunity and tools for meaningful public participation in validating government decision-making, which can prevent excessive and inappropriate investments. In this case, in 2001 the Thai government opened the house for public discussion, partly based on this feasibility study. In 2002, the Thai government decided to postpone this power-plant and change its location and fuel. In short, the feasibility study is one of the essential tools for Thai society to collectively find the most appropriate development path to reach its own development goals and objectives.

The discussion of the results of the Danish Economic Council in 2002 illustrates how traditional cost-benefit thinking has severe problems when being used to evaluate political strategies and measures in a situation of technological change, as well as in a situation with objectives of decreasing unemployment and improving the balance of payment by increasing exports.

Based on the premise of overcapacity, the Economic Council concluded that wind and small-scale CHP were not feasible. However, such a premise would make other production units, including traditional power plants, even less feasible. Consequently, the premise of overcapacity is not valid for the analysis of wind and small-scale CHP. After correcting such a misleading assumption the result changes from “not feasible” to “feasible”. If the value of exports were included based on a “willingness to pay” basis the feasibility becomes even better.

Both cases illustrate the importance of relating the feasibility studies to the objectives of the decision makers for whom the analyses are intended.
References

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