Evaluation of energy policy programmes in Schleswig-Holstein

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1. SYNOPSIS

This paper presents the evaluation of a series of energy policy programmes of the Government of Schleswig-Holstein.

2. ABSTRACT

Since 1989 the Government of Schleswig-Holstein launched a series of programmes to promote technologies for a more efficient use of energy. This paper presents a survey of these programmes and the results of their evaluation. The main part of the evaluation refers to an impact evaluation, which delivers qualitative results. The contribution to the reduction of energy consumption and to the greenhouse gas emissions was chosen to be criterion for the impact assessment of each of the programmes. Indicators for the comparison of the effectiveness of the financial support were developed and the results of calculations are presented and discussed in this paper. Finally the results will be commented.

3. INTRODUCTION

3.1 Energy policy programmes

After the inauguration of the new Government of Schleswig-Holstein in midyear 1988 a new energy policy has been implemented aiming above all to decrease the risks arising from climate change and nuclear power. Today 82 % of the annual electricity power production in Schleswig-Holstein is produced by nuclear power plants but only half of the production is used by Schleswig-Holstein itself. As a main instrument to change the existing energy system the Government brought in a first phase several subsidy programmes into action. They will be described shortly in the following.

3.1.1 Renewable energy programme

This programme includes different measures which are described in the following:

- wind energy
- water energy
- biomass
- photovoltaics
- solar collectors

First priority was given to the increase of wind energy capacity. Wind power is one of the most promising of the renewable energy technologies for electricity generation in Schleswig Holstein because of a lot of good and excellent wind sites. The aim of the government's wind energy programme is to build up a capacity of 1.200 MW i. e. about 2.000 wind turbines. This programme is partly connected with a federal wind power demonstration programme.

The second objective was to encourage the reconstruction of old small hydro power stations (<500 kW). The potential of about 120 water turbines is, however, small in terms of power production compared to the wind power potential.

No special technologies were specified to encourage the energetic use of biomass.

In the part of the programme which refers to photovoltaic generators with connection to the public electricity grid the installations of 150 photovoltaic generators should be subsidized in connection with a federal demonstration programme (known as 1.000-roofs-programme). Beyond that other photovoltaic demonstration projects (in the following called special projects) and solar thermal systems for domestic water heating (collector and storage) should be promoted.

3.1.2 Other programmes

The government implemented four more programmes:

- Programmes to encourage district heating and cogeneration of heat and power (CHP)
- Energy plants programme
- District heating expansion programme
- Space heating programme
- Low-energy-house programme
- Energy plans
- Electricity saving in public buildings

Actually the so-called energy plants programme is a cogeneration programme above all. It supports, apart from heat pumps, construction of new CHP plants and conversion of heat plants or condensing power generation to CHP plants. The district heating expansion programme supports especially grid construction and extension while the space heating programme grants financial support to the removal of conventional heating facilities in buildings and connection to a district heating grid.

The low-energy-house programme supports energy saving in new buildings by using better insulation than statutory norm and controlled ventilation combined with heat recovery systems.

The energy planning programme supports local energy plans made by communities to assure energy saving in end-use sectors and higher efficiency in energy supply.

Within the framework of each of the above mentioned programmes the amount of subsidy is related to the eligible costs of every single measure. The only exception is the solar thermal programme where a fixed amount per project is granted independent of the real investment cost if well defined conditions had been fulfilled.

In the programme 'Electricity Saving In Public Buildings' loans will be granted for extended measures to save electricity basing on a contract between the Government of Schleswig-Holstein and the main electric utility (VEBA-contract). The biggest part of the loan is given by the utility. This programme is object to a special evaluation.

Only the low-energy-house programme is an energy saving programme, all other mentioned programmes are supply-oriented and aim at the change of the supply system.

3.2 Goal of the evaluation

Goal of the study was to review the hitherto subsidy programmes and gibe answer to the questions

- in which dimension each of the programme has contributed to reach the most important goals saving of conventional energy carriers and reduction of greenhouse gases and
- is money given to the most effective measures to reach the energy policy goals.

4. METHODOLOGY

It was agreed upon that the evaluation should give answer only to the questions of how much conventional energy was saved and how much greenhouse gases were avoided by the supported projects in the different programmes. As a measuring rod for energy saving the amount of substituted conventional end energy carrier (fossil and nuclear fuels) was chosen. For greenhouse gas reduction carbon dioxide was used as a main parameter. Further the carbon dioxide equivalents which include also additional greenhouse gases expressed in terms of carbon dioxide unit was applied too.

In a first step the data on applications for subsidies were collected and special aspects of each programme - according to the available items - were analysed. In the second step the annual energy saving and reduction of greenhouse gases were estimated. Basic for this in the most cases were planning data from the consulting engineers. In some cases the annual energy production (or saving) has to be calculated with different methods. With the annual values and empirical data about the life time for the different applied technologies it was possible to estimate the cumulated values. The investment costs were also only al planning data available.

With the data of the absolute amount of energy saving and reduction of the greenhouse gas emission the following parameters were defined:

- Energy saving efficiency of the financial support, this means energy saving per financial subsidy unit [kWh/ECU],
- Reduction efficiency of the financial support, this means reduction of the greenhouse gas emission per financial subsidy unit [kg/ECU].

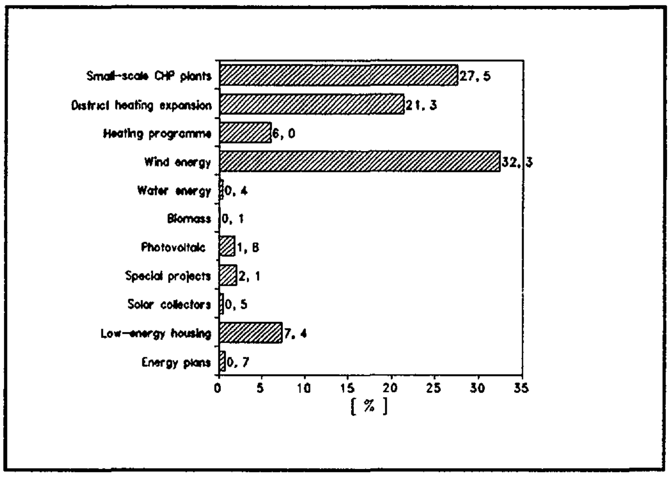

Figure 1. ***Distribution of the financial subsidies***

These parameters permit a comparative evaluation of the efficiency. The efficiency values which are based on the financial support are not usable regarding the selection of the projects because the height of the share of financial support on investment costs varies among the programmes. Therefore the above mentioned indicators were also related to the investment costs of the supported measures:

- <u>Energy saving efficiency of the measure</u>, this means energy saving <u>per investment cost unit</u> [kWh/ECU]
- <u>Reduction efficiency of the measure</u>, this means reduction of the greenhouse gas emission <u>per investment cost unit</u> [kg/ECU]

These parameters permit an evaluation whether it is reasonable to support a project or not. Together with the parameters which refer to the efficiency of the subsidy they build the basis for the evaluation of the programmes.

5. RESULTS

Within the scope of this article it is not possible to show the results of the in-depth analysis of each programme. It provides a comparative view over all programmes, beginning with a general survey of the measures and going on with the performance of the evaluation. It must be said, that all statements refer to granted supply. A lot of measures is already realized, but there are also measures which are just in realization or not yet built up.

5.1. Survey of the granted measures

Figure 1 gives a general view of the measures for which subsidy was granted and how much financial subsidies should be spent on the different measures.

Total subsidy granted between 1989 and 1992 amounts to nearly 55 MECU. The greatest part was granted to measures in the sector of cogeneration of heat and power, building and conversion of plants and connections of buildings to a district heating grid (totally 55 %). The next highest part of the subsidy was given to wind energy (32 %). This result reflects the essential energy policy objectives.

Water energy does not play an important part in financial support because there are little possibilities for water power plants in Schleswig-Holstein. Anyway the promoted water power measures (new turbines and recovering of existing plants) exhausted only 10% of the existing potential.

Although Schleswig-Holstein has rural character with a lot of cereal products and livestock husbandry energetic use of biomass and biogas takes an unexplainable low part of the promoted measures. Regarding biogas one reason might be that techniques using biogas still require a lot of R&D before entering the market.

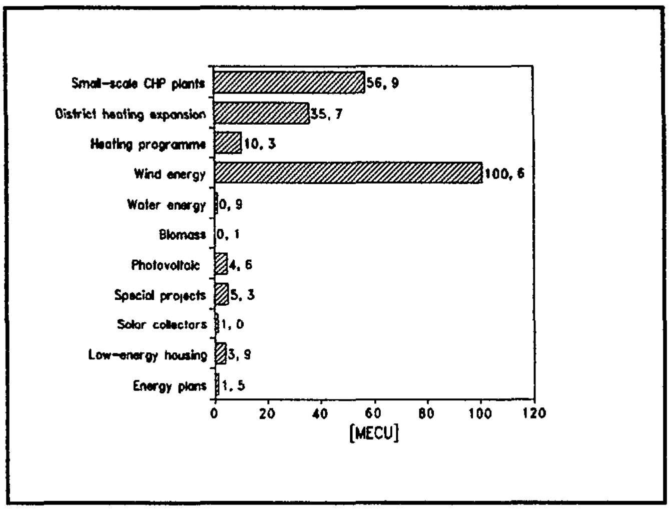

Figure 2. ***Necessary capital investments for realization of the programs***

Financial supports given to other renewable energy projects than wind energy-projects amount to nearly 5 %. That is less than the sum given for low-energy-houses (7 %).

In Figure 3 the investment costs being necessary to realize the projects are presented.

To realize all measures for which subsidy was granted a total capital investment of about 220 MECU will be necessary. 45 % of this sum falls upon wind turbines. With the planned costs for wind energy of about 100 MECU 63,3 MW power capacity can be installed. 26 % of the investment costs fall upon 38 small-scale CHP plants. They are planned to have an electric capacity of 25,8 MW and a thermal capacity of 41,5 MW.

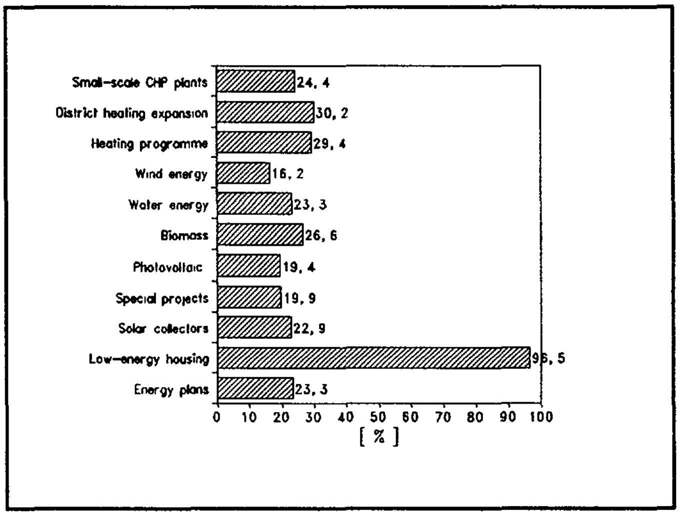

Figure 3. ***Percentage of capital investment per program***

Finally Figure 3 shows the share of

the government promotion on the necessary capital investment sum of each programme.

Except in the case of low-energy-houses the values ranges between 16 % and 30 %. The high percentage at the low-energy-houses is based on the fact, that instead of the full costs for the construction of the buildings only the additional costs for energy saving measures could be considered.

It should be noticed, that a great part of the wind turbines and the photovoltaic generators were additionally supported by the federal government.

5.2. Performance of the evaluation

In this section the question about how much the supported measures contributed towards the energy policy aims and how effective granted subsidies are regarded. The presentation refers only to the renewable energy programme, small scale CHP plants and low-energy-houses.

Figure 4 shows the total amount of energy that might be reduced when all measures for which subsidies were granted are realized. The diagram of the resulting reductions of greenhouse gas emissions is presented in figure 5.

As expected, the greatest amount of energy saving respectively reductions of greenhouse gas emissions is due to wind turbines and CHP plants. The total energy saved by the analysed programmes (shown in Figure 4) amounts to approximately 9.680 GWh. The annual saving amounts to 650 GWh and this represents about 4,5 % of the annual electricity demand in Schleswig-Holstein. The comparison of figure 4 and figure 5 shows, that over the life time CHP-technologies reduce more greenhouse gas emissions, while the energy savings over the life time is less than these of wind turbines. This result depends on the different life times of the technologies.

The supposed value for small-scale CHP plants is 15 years (grids and buildings 30 years), wind turbines 12 years, water turbines 40 years, photovoltaic generators 30 years, solar thermal systems 10 or 15 years depending on the different types of collectors, and insulation of the low-energy-houses 50 years.

To make the different measures comparable the above described parameters were built.

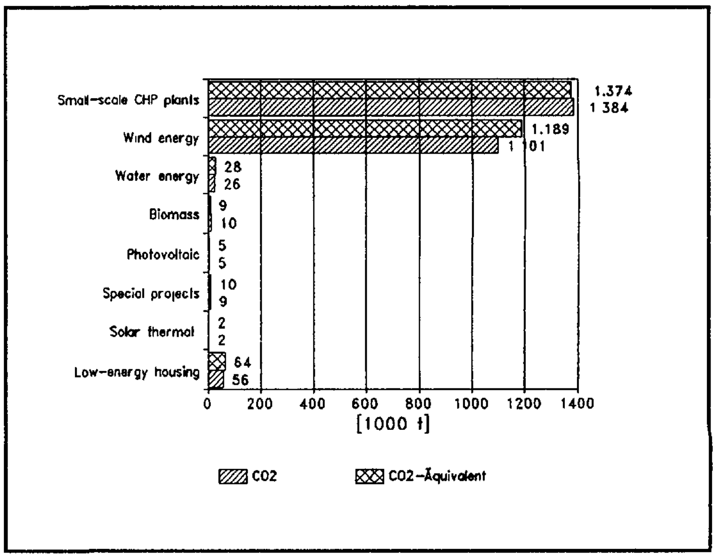

Figure 4. ***Total reductions of greenhouse gas emissions***

Figure 6 shows the values of the parameter "reduction of greenhouse gas emissions per financial support unit" (kWh/ECU), Figure 7 the values of the parameter reduction of greenhouse gas emissions per investment cost" (kWh/ECU).

The efficiency values relating to energy saving are analogous to the value relating to reductions of carbon dioxide and carbon dioxide equivalents. While the values shown in Figure 6 allow the assessment of the efficiency of the financial support (efficiency of the subsidy) those of Figure 7 demonstrate the efficiency of the measure.

6. CONCLUSIONS

The findings of the efficiency evaluation lead to following conclusions:

The highest efficiency both of subsidy and investment costs can be identified for the programme "energetic use of biomass". Next highest are the efficiency values for hydro power hard followed by the values for CHP and wind energy. By an order of magnitude smaller as the efficiency values for the other programmes. The relatively high efficiency for low-energy-houses in figure 7 are caused by the fact that only additional costs for better insulation etc. were considered. These costs are not comparable with the investment costs of the other programmes.

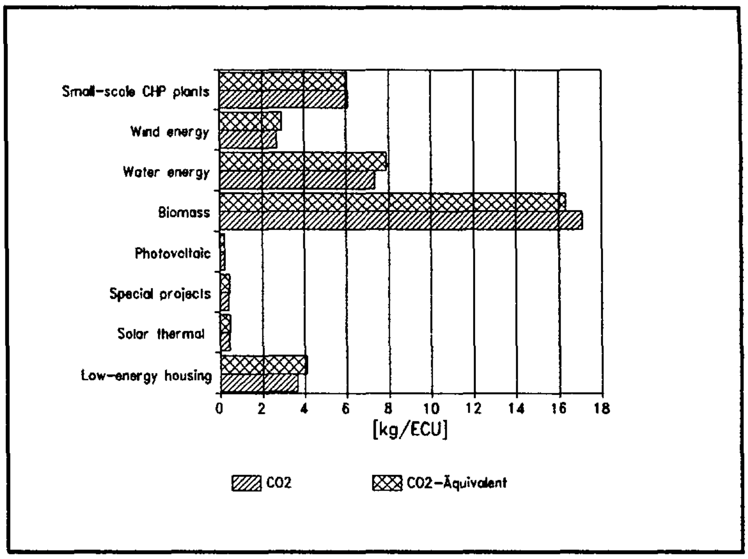

Figure 5. ***Reduction of the greenhouse gas emissions per investment costs unit***

Relating to the programme "energetic use of biomass" which shows the highest efficiency values, it must be argued that in this programme only two measures have been supported. Therefore this is a very uncertain statistical basis. The essential contribution to this result is brought by a straw heating plant. Even though it is not certain that this plant is an especially cheap one, it has to be stressed that the efficiency of the subsidy is almost twice as high as of the water energy programme, which is placed second. Therefore it is obvious that even if straw heating plants would require higher investment costs energetic use of straw is in a high degree an efficient measure to save conventional energy and reduce greenhouse gas emissions. If this is also valid for the use of straw in CHP-plants has to be examined.

In respect to subsidy and investment the utilisation of water energy shows relatively high efficiency although Schleswig-Holstein is a rather flat state. It has to be considered that the measures refer to a reactivation of old or former existing water mills. The specific cost per installed capacity are different. If the costs were up to 50 % higher than in the examined case the efficiency is similar to that of CHP-plants.

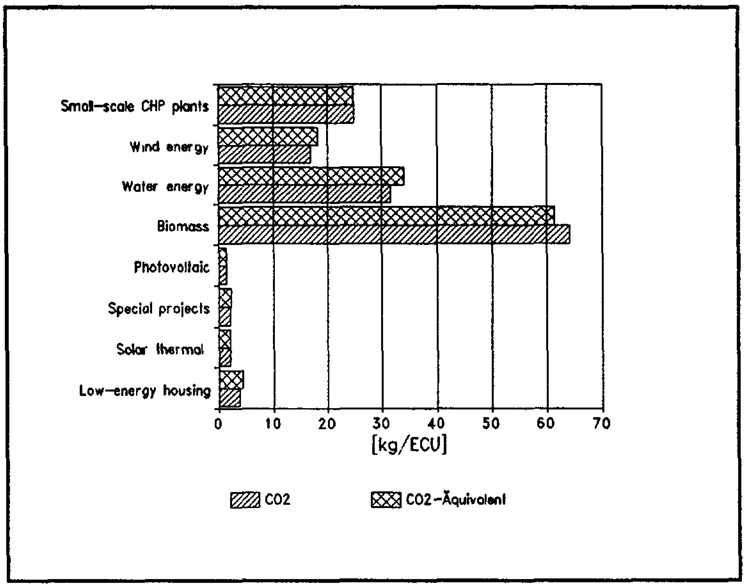

Figure 6. ***Reduction of the greenhouse gas emissions per financial subsidy unit***

Compared with the best value the efficiency of subsidy and investment costs for the small-scale CHP plants is smaller by factor 3. Compared with the wind energy programme the efficiency of CHP-plants is evidently higher. The efficiency of investment costs is twice as high. The reason is, that heat from CHP-plants substitute mainly fossil energy carriers.

All kinds of solar energy use show a remarkable low efficiency of subsidy and investment. Efficiency is one order of magnitude smaller than those of small-scale CHP plants and wind turbines. Considering the energy consumption for producing photovoltaic cells which is ten times higher than for all the other technologies, the efficiency of photovoltaics becomes even worse than presented. Low efficiency of solar technologies results from high investment costs (not expected for solar collectors which are not so expensive) on the one hand and from the disadvantageous site for using solar energy on the other hand,

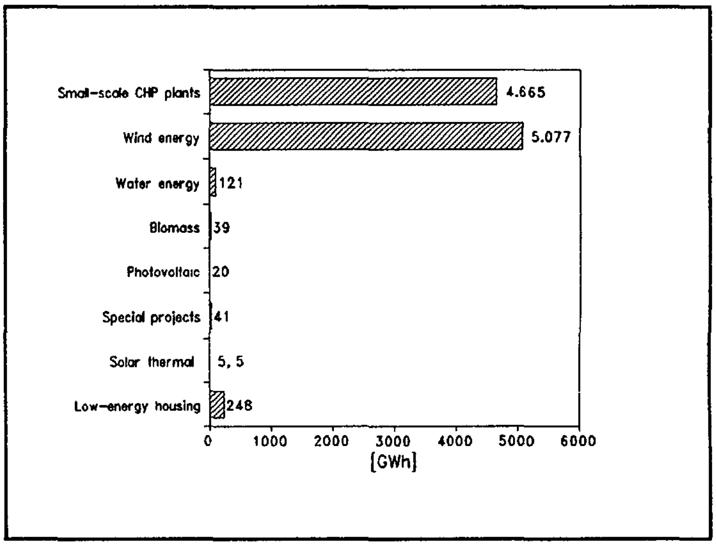

Figure 7. . *Total energy savings*

While in all the above analysed programmes technologies for conversion of energy were supported, the low-energy-house programme is the only energy conservation programme. Although life time of insulation is long, the efficiency of subsidy is by factor 4 lower than the wind energy programme. One reason for this result could be that in addition to insulation in 50 % of the dwellings controlled ventilation combined with heat recovery systems were installed additionally, which increases the specific additional costs from approximately 20 ECU/m² to 50 ECU/m² floor area.

The findings of the evaluation presented answer the question, to what extent objectives like energy saving and reduction of greenhouse gas emissions are achievable. Further they can provide a guide line in designing future energy policy programmes since they include empirical data of the cost effectiveness for each measure which has been evaluated.

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