An integrated approach necessary to improve energy efficiency

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1. SYNOPSIS

Integrating supply and demand side alternatives, as well as considering optimizing the energy sector as a whole will be advantageous and avoid resource misallocation.

2. ABSTRACT

In the Netherlands there is a distinct separation between generation and distribution of electricity. Both producers and distributors have a limited understanding of the activities of the 'other parties'. The distributors have taken initiatives in CO_2 reduction by introducing dispersed production, increased insulation and other demand-side activities. The producers have pursued emissions reduction through energy efficiency improvements in production, a world-wide afforestation programme and desulphurization programmes in Poland. The question that develops is whether this unbundling will lead to an optimal solution, concerning the environmental and energy efficiency challenges. Moreover will the introduction of increased competition in the utility industry enhance or detract from the attainment of the environmental targets?
To ascertain if a different way of planning is feasible and which conditions are of critical importance, IJsselmij (a distribution utility) and Sep (an association of producers) have launched a study of "Integrated Resource Planning". The targets of the study are to:

- Develop a methodology and techniques for integrated resource planning in the Netherlands, which will include demand, supply and dispersed production resources.
- Consider the role of electricity, as a component of the entire energy sector, by analyzing the advantages of substituting electricity for other primary fuels, especially in relation to environmental goals (such as Ecowatt strategies), overall energy efficiency and resource costs.

Preliminary results of the study indicate that considering supply and demand-side alternatives, as well as examining the entire energy situation is an appropriate resource planning strategy. Competition and separation of distribution and supply sectors without a mutual exchange of information ensures a less-than-optimal energy supply.

3. INTRODUCTION

3.1 Presentation of producers and distributors

This paper is presented by Sep and IJsselmij. Sep is the Dutch Electricity Generation Board, and is responsible for the Dutch central production. IJsselmij is one of 40 distributors in the Netherlands, with about 10 % of the nation's electricity sales. It also distributes gas and steamheat.

It should be stated that there will be producer's and distributor's viewpoints in this presentation. IJsselmij and Sep launched a study of "Integrated Resource Planning" to examine those view points and the advantages of exchanging information. Integrated Resource Planning represents a technique that evaluates all resources available - both on the demand and the supply-side - in a consistent and balanced way in order to achieve an operational set of objectives.

The targets of the study are to:

- Develop a methodology and techniques for integrated resource planning in the Netherlands, which will include demand, supply and dispersed production resources.

- Consider the role of electricity, as a component of the entire energy sector, by analyzing the advantages of substituting electricity for other primary fuels, especially in relation to environmental goals (such as Ecowatt strategies), overall energy efficiency and resource costs.

3.2 Organization structure

The Dutch electricity industry has gone through a period of reorganization, both in the generation and distribution sectors. The Electricity Act of 1989 separates the electricity industry into two sections; the electricity generating section and the electricity distributing section.

This law imposes on both sectors the duty to supply electricity in a secure and reliable way at the lowest cost possible while taking into account other considerations such as the Government's environmental policy, the general energy policy and others.

The Electricity Act of 1989 prevents the generating companies from delivering electricity to parties other than distribution companies. These distribution companies sell and deliver the electricity to other (smaller) distributing companies or directly to end consumers of all categories at differentiated tariffs. Distribution companies are in general allowed to build and operate their own power plants, especially for renewable energy or if the fuel efficiency of the plants exceeds 55%. The latter means in fact - which has been also the intention for the Dutch Government - that this freedom exists only for cogeneration plants.
Due to the separation, both producers and distributors have a limited understanding of the activities of the other, as will be described later in this presentation.

4. ENVIRONMENTAL ACTIVITIES

4.1 Distributors

4.1.1 "Looking behind the meter"

During past decades energy companies have focused primarily on the tasks to supply energy to consumers in a reliable and undisturbed manner and to send the bill to the correct address. The responsibility of the energy companies ended at the customers's meter.

Two facts have changed this view. First, in the second half of the 1980's the Dutch government made a National Environmental Plan in which among others targets for reducing CO_2-emissions of carbon dioxide were formulated. The distribution companies undertook an initiative designed to contribute to the realization of this national goal. The distributers hope to realize a reduction of almost 13 % over 1990 emission levels by 2000.

Second, at the same time the separation between production and distribution of electricity became a reality. As a result, the distribution companies have to buy the electricity from the producers. In response to the National Bulk Supply Tariff the distributors want to influence the demand for electricity by their customers in order to minimize the purchase costs from the producers.

Both developments changed the range of influence that now is desired by the distributors. To influence the behaviour of their customers the distributors were forced to look behind the meter. It became necessary to know 'for what purposes does the customers need energy', 'at what time do they use energy', 'with what energy efficiency do they use energy' and 'what are the instruments to influence the behaviour and the decision making process of the customers'.

4.1.2 Environmental Action Plan

For the realization of their contribution to the National Goal regarding the reduction of CO_2 emissions, the energy distribution section created the General Environmental Action Plan. Each distribution company committed itself to realize its part of the target based on its share of the national sales of electricity and gas. To pursue this goal, each distribution company made its own Company Environmental Action Plan.

The environmental plan of IJsselmij includes activities targeted on the production of electricity in a highly energy efficient way and targets a reduction of the growth in the demand for energy. IJsselmij expects that its Company Environmental Action Plan will realize a reduction of CO_2 emissions above its share of the Dutch target.

IJsselmij pursues its objective for highly energy efficient production of electricity by investing in cogeneration and waste incineration, district heating, wind and solar energy,and by stimulating customers to do the same. All of these activities should help to ensure that IJsselmij will realize its targeted contribution to the national CO_2 emission goal.

The activities directed towards influencing the demand for energy can be split up into activities directed towards changing the behaviour of customers concerning the use of energy and activities directed towards stimulating the more efficient use of energy.

There are programs for households as well as commercial and industrial customers for measures such as insulation, high efficient lighting, lower flow shower-heads, and highly efficient heating systems.

4.2 Producers

The producers have pursued emissions reduction by efficiency improvements in production, a world-wide afforestation program and a desulphurization program in both the Netherlands and Poland. Also a de-NOx program has been implemented.

The producers have made good progress with respect to further implementation of combined production of heat and power. It has now become clear that substantial sales of heating by the production sector will be possible. This enhances the construction of gas- fired combined heat-and-power capacity with its high levels of efficiency.

Reducing the impact on the environment has been an important policy objective for the electricity generating industry for a number of years. As a result of the efforts made in the Netherlands to reduce the emissions of environmentally harmful substances, the Dutch electricity generating industry has now become a world leader in this field.

The agreement between Sep and the government involves meeting the government's objectives to reduce total nation-wide emissions (recognizing a certain regional balance), and the electricity generating industries pursuing this reduction at the lowest possible cost.

Part of the agreement is that the electricity generating industry will bear the cost of building a flue gas sulphurization installation at a coal-fired plant in Poland. The willingness on the part of the electricity generating industry to bear these costs should be considered in view of the fact that further reductions of SO_2 emissions in the Netherlands would entail considerable costs and that we are dealing with emissions which are hardly restricted to this country alone.

When viewed in terms of quantity, carbon dioxide is one of the most important waste products released during the combustion of fossil fuels. A possibility of addressing the CO_2 problem, which is currently within reach, is sequestering CO_2 from the atmosphere in trees. Sep set up the FACE foundation (Forests Absorbing Carbon dioxide Emissions) as an instrument for financing the planting of new woods thereby compensating for the CO_2 emissions corresponding to those from a coal-fired plant.

5. COMPARISON OF DECISION-MAKING WITH AND WITHOUT AN IRP FRAMEWORK

In today's situation, actors in the energy field in The Netherlands make decisions in a setting in which no Integrated Resource Planning framework exists. To ascertain if a different way of planning is feasible and which conditions are of critical importance, IJsselmij and Sep have launched a study of Integrated Resource Planning.

This methodology is not yet applied in the Netherlands. The researchers profit from experiences in the USA and exchange information with e.g. the Danish researchers in this field. In the next paragraphs a comparison will be made between independently made planning decisions and the extent to which an IRP framework can prevent the described imperfections.

Six illustrative examples with their consequences will be given.

5.1 Contributions to the governmental environmental goals

Because there is no framework in which all the different energy options can be balanced in a coherent manner, one result is that the government concludes separate agreements with producers, distributors and consumers. There is no guarantee that all the agreements form a coherent program.

In this paragraph three examples of this imperfection are given.

The first example is that if the producers succeed in lowering the CO_2 emissions of the central generation, the distributors will have to raise their efforts to meet their targets for the reduction of CO_2 emissions through increased demand-side management.

A second example is that the regulations of the government with respect to the maximum allowed CO_2 emissions differ between cogeneration plants which are part of the central park and cogeneration plants which are being operated by distribution companies or by end users.

Third, the covenants between the national government and the industrial end users regarding energy efficiency are kept secret from the energy companies. The energy industry has to forecast the development of the demand for energy, yet it is unaware of the consequences of these covenants.

These examples show that although every organization tries to contribute to the national goal, it is possible that every actor executes its activities according to its own objectives.
The IRP concept arranges that all the actions will contribute to the overall objectives. Within an IRP framework every actor uses the same criteria to meet and verify results. It is less likely that activities can counteract each other because all aspects of the energy sector can be considered, in an integrated manner.

5.2 Responsibility versus influence

The government has given the responsibility for the electricity forecasting and for the secure supply of electricity to the generation sector, or in this case, to Sep.
However Sep has no formal relationship with the end users of electricity. Furthermore, Sep has no influence on the way in which the distribution companies and/or their customers operate dispersed generation nor about the reliability of these production units.

Without sufficient information about the market developments and without information about the reliability of the dispersed generation units it is difficult for Sep to carry out its responsibility for a reliable energy supply in the future at the lowest possible costs.

To properly execute Sep's responsibility it is clear that information exchanges are needed and that there should be possibilities to influence the process for which Sep is responsible. It is becoming clear, that there

has to be an exchange of information between and inside the distribution sector and the production sector to assure that future demand for electricity can be met AND that all objectives and constraints are being fulfilled.

5.3 Selection of load management activities

The costs of the central production are divided over four chargeable moments. These moments are determined by the four highest, monthly peak loads. It should be emphasized that this is a tariff system which does not reflect the marginal costs of central generation.

The load management activities of the electricity distribution companies are primarily targeted on the minimalization of the purchase costs. To minimize these costs a distributor and/or its customers try to minimize its share during the chargeable moments. Hence, if the costs of autogeneration or loss of production by customers is less than the avoided purchase costs the load management activity will be pursued.

In this paragraph three observations are presented.

First: There is a financial stimulus to use decentralized production during peak times. E.g. autogeneration with emergency generators, which has a relatively low energy efficiency, is profitable. This is clearly not in line with the environmental goals.

Second: The national maximum week peak loads hardly vary during the season because of load management. This results in a loadfactor on the system of about 70 % which means that there are no "valleys" left in the load curve to carry out the maintenance activities. A possible solution is to raise the reserve factor; however, this can be inconsistent with the goal of cost efficiency.

Third: Once, during a chargeable moment The Netherlands exported electricity. This implies that the end users have suffered production losses at a moment when there was no need to reduce demand from a supply viewpoint.

To overcome these inefficiencies it is necessary that players have information about the consequences of their actions on other players. Taking these consequences into account during the decision making process will lead to a different decision and may allow for the actors to share the benefits and costs associated with the new decision. It should be noted that if the rates reflect the long run marginal costs in which externalities are incorporated, rational actors in a perfect market do not need to exchange information to act according to the ideal IRP situation.

5.4 Selection of environmental projects

The generators have chosen environmental projects both inside and outside The Netherlands which either prevent or control emissions. Although the generating plants in The Netherlands are very efficient in terms of CO_2, NOx and SOx emissions, the generators invest in environmental projects so as to further diminish emissions.

They also finance projects abroad in order to upgrade very poor performing generation plants in Eastern Europe. These projects are more efficient because they realize a greater savings in terms of emissions per invested financial unit.

Plants -flora not factories- control emitted CO_2. The generators finance afforestation programs in tropical areas and these programs are probably the most efficient ones in terms of emissions saving per invested financial unit.

The producers have raised two interesting topics by their project choices.

The first point is that the global warming issue is a worldwide problem. There should be an evaluation of the efficiency of spending for both supply and demand-side resources within the Netherlands and outside the Netherlands.

The second point is that it could be more efficient to control the emissions in-stead of preventing them. In this case land use, as well as financial aid to developing countries in tropical areas, should be part of the evaluation.

Whether a framework which includes all these elements can be constructed and used in practice is questionable. This implies that an IRP frame-work also has limits which should be carefully described.

The distribution company IJsselmij has executed a multi- criteria analysis to select its environmental activities. Among others the costs to society and to the government per saved Mg of CO_2, the net costs of IJsselmij per saved Mg of CO_2 -(including revenue losses)- and the customers pay back period have been taken into account.

It turned out that from IJsselmij's perspective it is reasonable sound to focus on activities concerning high efficiency production of electricity. A decision made from IJsselmij's perspective is primarily based on a positive net present value for IJsselmij.

Not a single measure directed towards diminishing the demand for gas had a positive net present value for IJsselmij; however, these measures are being pursued as important contributors to the realization of the CO_2 targets.

Some activities in the environmental plans of IJsselmij and other distributors have been promoted nationally using television and radio, especially those that require customer action to receive a subsidy for investments in insulation, high efficiency lighting and so on. These activities often do not have a positive net present value for the distributor.

Each distributor has made its own decision mainly from its own perspective. The financial effects for the producers, the consumers and the government -a public body not the society- are secondary elements in the decision-making process. In an IRP world all these elements would be considered simultaneously and effect the decisions each participant makes.

5.5 Financial consequences of environmental projects

The Ministry of Economic Affairs sets the maximum bill a customer has to pay. This ministry and the distribution sector reached an agreement regarding the financial side of the environmental plans. The content of this agreement is that projects which have a negative net present value for the distributor can result in an increase of tariffs with a maximum -for the total plan- of about 2 % of the kWh price to end- users.

Regarding the financial consequences of environmental plans for the producers, no agreements have been made nor have there been any efforts to start negotiations between producers and distributors. Therefore the producers can raise their tariffs towards the distributors with no formal limit. If an increase in the purchase costs of the distributors arises they will have to pass on this raise in the tariffs charged to the end users.
A raise in purchase costs for the distributors will be viewed as just a raise in purchase costs by the Ministry of Economic Affairs. It will lead to a raise in the maximum bill and is not considered a part of the 2 % for environmental projects.

In an IRP framework the activities of the government, the producers, the distributors and the customers would have been considered along with the value of saved emissions.
The appropriate cost increase would then be based on the most efficient course of action for the chain of actors.

5.6 Selection of substitution between gas and electricity

Water heating can be provided by gas or electric boilers. The efficiency of a gas boiler has a maximum efficiency of about 90 % which is less than the efficiency of an electric boiler (close to 100 %). The efficiency of a modern gas fired electricity generation plant is about 55 %. From the perspective of wanting to "use as little energy as possible" and consequently to release less CO_2 one of the environmental activities in progress is the stimulation of the substitution of electric boilers by gas boilers. But this is only one side of the story as will be shown later on.

Although substitution of an electric boiler by a gas boiler is defendable from an end-use viewpoint, the substitution could be very cost inefficient from an integrated energy perspective.
Electric boilers are coupled to a differentiated electricity tariff for the end-user. The distributor switches the boiler on at eleven o'clock in the evening and blocks them at seven o'clock in the morning. The electric boilers fill the night time "valley". This example shows that the role of electricity in the whole energy market should be analyzed.

5.7 Competition in the heat market

There is a triple competition in the heat market. In The Netherlands gas is nearly always used to meet the demand for heat. A very small part is met by electricity and a larger part is met by cogeneration or district heating.

First: There is competition between the gas supplier and the gas distributor. If a customer demands more than 2 Mm^3 per year, the gas supplier is allowed to serve this customer directly. If the demand of a customer of the gas distributor exceeds this amount the distributor looses revenues.

Second: There is competition between the gas distributors and the electricity distributors with regard to district heating. If an electricity distributor and its customers' agree to use a big combined heat and power plant to meet the customers heat demand, the gas distributor per saldo loses revenues. For the gas distributor there are no incentives to exploit district heating. It has happened that district heating options have not been realized, due to a of mechanisms for (and/or a lack of willingness to) sharing benefits and costs between gas and electricity companies.

Third: There is competition between the electricity distributors and the electricity generators. Both parties are allowed to operate cogeneration plants. If the producer can build a large plant, the costs will be part of the national bulk supply tariff. If the distributor succeeds in constructing a number of smaller plants this distributor avoids the purchase costs from the production sector.

6. CONCLUSION

It has been observed that in a competitive business environment it is necessary to share costs and benefits in order to pursue societally beneficial activities when judged on the basis of energy efficiency and cost efficiency.

A prerequisite for the development of such mechanisms is that the societal viewpoint is acknowledged as the basis on which parties should act. Furthermore, public bodies have to create business environments in which such mechanisms will be developed.

If there is one bundled gas and electricity company, the government can easily delegate the responsibility to this one company. The only task left to the government is to verify to what extent this company acts according to efficiency objectives.

If there are numerous supply and distribution companies of gas as well as electricity the government has to make sure that the necessary exchange of information and the necessary mechanisms to share costs and

benefits are in place. Furthermore, the government has to verify the actions of each actor and to communicate to these "relatively very short-sighted" companies, the appropriate societal objectives.

This indicates that the more independent the actors, the more difficult it is to apply Integrated Resource Planning. It seems that IRP can be applied most easily in a situation in which one body has the responsibility for the resource playing field and has the intervention possibilities in that resource playing field.

The in this paper presented examples show that all actors in the energy field primarily make decisions based on their limited view and mostly to enhance their own profits. Judged from the perspective of energy efficiency, cost efficiency and environmental targets, different forms of frictions and suboptimalizations occur in an environment without IRP. IRP is a framework that shows some promise to help overcome these suboptimalizations.

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