A least-cost planning strategy for the European Community

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1. SYNOPSIS

The paper analyses least-cost planning (LCP) experiences in the USA to draw conclusions on the advantages of LCP for the European Community countries.

2. ABSTRACT

The paper analyses least-cost planning experiences in the USA to draw suitable conclusions for the European Community countries. A comprehensive variety of conservation programmes were developed by USA utilities, which coupled with innovative regulatory frameworks, are saving utilities and consumers billions of dollars. Due to its success, in most of USA least-cost planning is either compulsory or is under consideration. Traditionally European electric utilities have essentially invested in supply-side options, although normally the most cost-effective combination of those options is chosen, in order to meet the growing electricity demand in a reliable way. However, in plenty of situations, the investment in high efficiency equipment to reduce electricity consumption is more cost-effective than investing in new power plants. A combination of inertia and market imperfections has prevented the most cost-effective solutions from being systematically implemented. Least-cost planning has not been implemented in the Community due the lack of a suitable regulatory framework. Therefore there is an urgent need to define a regulatory framework which overcomes the traditional barriers to least-cost planning implementation. The european electric utilities face substantial challenges in the next decades. They will be faced with increased competition due to the Internal Energy Market (IEM) and probably stricter environmental regulations. The USA experience has shown that least-cost planning works well in a competitive environment and thus it seems compatible with the Internal Energy Market. Additionally least-cost planning appears as an essential strategy to contribute of the achievement of the energy objectives for 1995 of the European Community.

3. INTRODUCTION

Least-cost planning (LCP) also called least-cost utility planning (LCUP) is a planning methodology with the aim of meeting in a reliable way the demand for energy services with minimum societal costs by optimizing the mix of supply-side and demand-side options taking into account externalities, such as environmental impacts. In LCP the demand appears as a variable which can be influenced by the use of suitable demand-side options. Additionally, demand-side options are considered on an equal level with supply-side options not only in terms of kWh costs, but also in terms of reliability, controllability and external impacts. Because traditional planning has neglected demand-side measures, the introduction of least-cost planning may produce more emphasis to conservation measures.

In a perfect market economy with proper price signals, the consumers would make the proper decisions in choosing the least-cost demand-side options. Therefore the critics of LCP point out that if LCP is really cost-effective, consumers should need no help from the utility in making cost-effective investments in conservation measures. However a combination of consumer inertia and market imperfections (such as the information gap, the payback gap, capital availability, split incentives, realistic utility rates, initial high cost of new technologies) have prevented a stronger penetration of conservation options.

4. USA EXPERIENCE IN LEAST COST PLANNING

4.1. The Introduction of LCP in USA

The LCP movement was started in the mid seventies in the USA, due to a combination of factors including:

- Shortages and substantial price increase of oil and gas. The shortages were specially severe in states like California.
- Siting of large power plants became increasingly difficult due to public pressure and regulation. First the Three Mile Island accident and later the Chernobyll disaster stopped the expansion of nuclear power in USA.
- Fast escalating costs of power plants due to the need to include more safety and pollution control equipment, as well as due to longer commissioning delays.
- Regulated utility prices quickly deteriorated to well below avoided costs. This situation was not only unfair for utilities, but made conservation investments less attractive for individual consumers.

In these conditions it became attractive for utilities to invest in conservation measures to avoid the construction of costly power plants. Initially most demand-side measures were targeted at reducing the consumption of loads which contributed to peak demand.

California had a leading role in promoting LCP not only due the occurrence of the conditions mentioned above but also due to having regulators open to innovation in utility operation.

In general the conservation investments followed the rule:

Conservation Investment + Lost Utility Revenue < Avoided Costs

If this rule is followed, there are no losers. The reduction in utility costs is used to finance the conservation measures and there is no need to increase the rates. Participants in the programme see their bills reduced whereas non-participants have neither gains nor losses.

4.2. The New Regulatory Environment for LCP in USA

From the utilities' point of view, the fundamental change in the economics of LCP came when the regulatory commissions allowed the conservation investments to be recovered from the rates, in a similar way to supply-side investments. Investing in conservation became cost-effective if the costs of conserved electricity were below avoided costs.

Traditionally the utilities make a profit on sales and had an incentive to increase the sales to achieve higher profits. The implementation of large-scale demand-side programmes requires decoupling profits from sales. For this purpose, several states in USA have implemented the Electric Revenue Adjustment Mechanism (ERAM).

ERAM is a rate adjustment mechanism that accounts for the over- or undercollection of revenues that occurs when actual electric sales differ from sales forecasts used to set the rates. ERAM eliminates impacts on utility earnings due to sales fluctuations resulting from conservation and load management programmes, weather, and other forecast conditions.

Most regulatory commissions allowed utilities to consider investments in conservation measures as operating expenses and thus suitable to be deducted from current revenues. This treatment of demand-side investments, called expensing, was the most common during the mid and late eighties. Under expensing the utilities can recover conservation investments but do not make a return on each unit of electricity saved. However more recent approaches provide more incentives to utilities than expensing. The profits can be

linked to the demand-side investments by two mechanisms (CEC 1990):

- Rate of return, also called rate basing, which creates demand-side assets that are eligible to earn a rate-of-return like traditional supply-side investments. This approach is sound when the investment is socially optimal, but the marketplace does not provide a fair return to the utility due to market imperfections.

- Shared savings, defined as a percentage of the difference between the costs of conservation and load management programmes and the costs of avoided supply evaluated over the life of the resource. The higher the net savings of the conservation measure, the higher the utility's profit. Although recently introduced, the shared savings approach is gaining wide acceptance due to its market-oriented approach.

On the other way the utilities must also agree to pay penalties, when the performance results of the demand-side investments do not meet the required minimum levels. Both for the determination of the shared savings and of the performance penalties, there is a need for measuring and evaluation of the conservation programmes.

With the above conditions, LCP gained momentum during the eighties and in some states LCP was made compulsory, with the following consequences:

- Supply-side investments were only approved if all more cost-effective demand-side options had been tapped.

- The increase in the rates was only approved if the least-cost options had been chosen.

4.3. The Status of LCP in USA

In 1990 LCP was already used in 23 states, whereas 19 other states were implementing , developing , or considering the introduction of LCP framework (EPRI 1990). Only one state in the survey (New Mexico) has considered that LCP is not applicable, due to a capacity surplus expected to last five to ten years.

In most states, regulatory commissions or legislative bodies lead the development of LCP procedures through mandate or or active encouragement. In seven states LCP is carried without forced regulatory framework. The enforcement of LCP is normally carried at the time of plant licensing or of rate change.

New general trends gaining wide acceptance in the LCP framework are the collaborative process (utilities making profit out of net savings of conservation investments), integrated demand-side and supply-side resource bidding, and the consideration of environmental externalities. In some states the consideration environmental externalities in LCP is not compulsory, due to the uncertainties in quantifying environmental effects.

A recent survey (Schweitzer et al 1991) of 24 USA large utilities shows that the impact of DSM programmes has produced an average reduction in electricity generation of 0.8%/year and an average capacity savings of 1.7%/year. The planned contribution of demand-side options of 16% as incremental energy resource and of 28% as incremental capacity resource, in the period 1990 to 2000.

The Electric Power Research Institute has also found out that demand-side options can save 24-44% of the electricity use in USA by the year 2000 in addition to the 9% already included in utility forecasts.

5. LCP IN THE EUROPEAN CONTEXT

5.1. LCP and Energy Strategic Objectives of the Community

Since the 1973 energy crisis the EC has been adopting coordinated policies to ensure energy supply security and diversity, to improve energy efficiency, and to minimize environmental impacts, without impairing economic efficiency. Some of the current policy objectives defined in 1986 to be achieved in 1995 include:

- To improve the efficiency of final demand by 20%
- To reduce the proportion of electricity generated by hydrocarbons to less than 15%.
- To ensure more secure conditions of supply and reduce the risks of energy price fluctuations.
- To apply Community price formation principles to all sectors.
- To balance energy and environmental concerns through the use of the best technologies.
- To develop a single energy market.

After the collapse of the energy prices in the mid eighties, there was a decrease in the european energy conservation effort and the 20% efficiency increase by 1995 seems difficult to achieve. The large-scale implementation of least-cost planning in Europe seems to be an essential strategy to achieve the above goals in the electricity sector. This is particularly true regarding the efficiency improvement and the reduction of the environmental impacts.

5.2. LCP and the Environment

In Western Europe during the eighties there was a rapidly escalating interest and awareness about environmental problems, both at regional and global level. It is not surprising that environment is one of the strongest arguments to implement least-cost planning in Western Europe. End-use efficiency and fuel switching are key strategies to minimize environmental impacts.

Although pollutants such as SO_2 and NO_x can be removed at a cost, there is no technology for the large-scale removal of CO_2. The reduction of CO_2 emissions can be achieved by the following means:

- Reducing the fossil fuel used by improving the efficiency of the supply side (e.g. combined heat and power[CHP], combined cycle gas turbines [CCGTs])
- Reducing the fossil fuel used by using non-fossil supply sources, such as renewables and nuclear.
- Replacing high carbon fuels such as coal with low carbon fuels such as natural gas.
- Last but not the least , reducing energy demand by improving end-use efficiency.

The Toronto Conference "The changing atmosphere" held in Toronto in 1988, recognized risks of global climate change and recommended the stabilization of global CO_2 emissions by the year 2000 at the latest and 20% reduction by 2005 as the international target. The Energy and Environment Ministers meeting in Luxembourg, in October 1990 decided to keep the CO_2 emissions in the year 2000 at the 1990 level. In order to achieve that goal the Commission has proposed a strategy based in improving energy efficiency and taxation. The European Community is recommending several actions, namely:

- reconsider EC policies and orientations to counteract the greenhouse effect.
- take urgent action to increase energy savings, to improve energy efficiency, to promote the use of non-fossil fuels, as well as the development and the introduction of technologies in these fields.

- help developing countries to reconcile development requirements with prevention of global warning.

Many studies, such as (Gusbin 1991), have shown that electricity conservation can play a key role in the reduction of CO_2 emissions. The introduction of cost-effective high efficiency appliances just in the domestic sector would lead to CO_2 reductions in the range of 3-24% of the present emissions of the electricity sector (or 1-24% of the total country emissions). These numbers show a large variation from country to country due to the different generation mix.

In a similar way least-cost utility planning, the planning of the reduction of CO_2 emissions can be analyzed with least cost planning techniques (Jackson 1991). For each type of technical option (improving efficiency of different loads, nuclear, renewables, CHP, CCGTs, etc.) there is an associated cost (both capital and operating costs) and CO_2 savings potential.

Taxation of pollutants, such as CO_2 is under consideration and increasingly strict emission regulations are being set. The EC has set regulations on the emissions of regional pollutants (SO_2, NO_x and particulates) for newly licensed plants. Existing plants will have reduce gradually the emissions until 2000.

In Europe there is little experience in the evaluation of environmental externalities, but as population density is substantially higher than in the USA, external costs should also be higher. In Germany a preliminary estimate points to external costs in the region of 20-50% of the electricity price in that country in 1982. The burden of pollutant removal, and eventually the taxation of pollutants, will make supply options more expensive and hence conservation measures will appear increasingly attractive.

5.3. LCP and the Internal Energy Market

The European Community (EC) is moving to a Single European Market which will dismantle existing barriers to free trade. In this context the energy sector will move in similar directions, giving place to the appearance of the Internal Energy Market (IEM) which implies getting rid of state monopolies, restrictive measures to free trade, different taxation, energy subsidies, as well as implies the need common regulations. A common energy policy will enable price transparency, increased competition and finish with market distortions. The objectives of Internal Energy Market are compatible with the strategic energy objectives defined for 1992, although there is now a greater emphasis in cost-effectiveness and economic efficiency. The main objectives of the Internal Energy Market for 1992 are:

- To break national procurement links.
- To harmonize taxes and standards.
- To scrutinize vertical links between primary fuel suppliers and the electricity supply industry.
- To ensure transparency of prices.
- To consider terms of access to main networks for private suppliers and large industrial consumers, breaking organization links between suppliers and distributors.
- To increase trade in energy products in order to achieve economies of scale and utilize lowest cost supplies.
- To remove financial, planning and other distortions from energy investment and trade.

LCP fits also with these objectives, and in particular the last objective points clearly to remove distortions which allow the optimization of the balance mix of supply-side and demand-side options.

The IEM will also bring increased competition. The USA experience has shown that LCP performs well under competition, provided that a suitable regulatory framework has been implemented. LCP may not work under a monopoly because lack of incentives. LCP is a good way for coming from a highly regulated

market to a more free competition. In this way LCP implementation will benefit from the existence of the IEM.

The electricity sector is already being influenced by the IEM. A directive about easy transit has been approved and there are no borders limits to where capacity planning can be done. Electricity is already being traded in increasing quantities between EC countries to take advantages of surplus and cheaper generation of some countries. Furthermore, competition leads to trend of a growing uncoupling between production and distribution. This increased competition will also be between different forms of energy. In many european countries there is direct competition between gas and electric utilities, especially for the home heating market.

5.4. The Need for a Regulatory Framework

Least-Cost utility planning, has not been systematically implemented in EC. This is mainly due to the lack of a suitable regulatory framework. Regulation was a key factor in the introduction of LCP in USA.

There are significant differences in the structure and operating environments of european utilities. In principle utilities which are vertically integrated and have monopoly control over supply areas, have more incentives to implement LCP, as it is clear who assumes the costs and the benefits of the investments in conservation measures.

In the cases where the utilities are not vertically integrated or do not have the monopoly control over the supply, the regulation has to ensure that:

- LCP is carried on a state or on a regional level, to meet the projected demand of energy services of consumers in the area, considering the investments in conservation and supply measures on an equal level.

- The projected demand for energy services should then be fulfilled by competitive biding of supply resources and of conservation resources. The bidders can be electricity supply companies, energy services companies from any country in the community, large consumers and the electricity distributor. Bids should specify capacity, energy, timeframe, reliability and costs.

- The prices charged must be set to give a net profit to cost-effective investments.

These regulatory principles seem the most suitable even for integrated utilities. The Internal Energy Market points to a situation of increasing competition when electricity supply companies in any location can sell to a customer in a different region or country. The main limiting factor to this competition are the transportation prices of electricity. Therefore to achieve competition, it may be necessary to uncouple the generation and distribution in vertically integrated utilities. In these conditions the above methodology could also be applied.

Given the potential advantages of LCP for Europe and its fully compatibility with the IEM objectives, the CEC is considering the setting up of regulation to make LCP compulsory.

6. EUROPEAN COMMUNITY SPONSORED LCP PILOT PROJECTS

The European Community has sponsored two LCP pilot projects, one with the local government of Schleswig-Holstein in Germany and the other with a spanish utility (Iberduero).

Furthermore within the context of the SAVE programme, in mid 1991 the EC launched a call for proposals for utilities wishing to carry out LCP studies. Forty eight proposals were received, which shows awareness of the potential benefits of LCP for a wide range of different utilities. About fifteen proposals will be financed during 1992-1993.

6.1. The Schleswig-Holstein LCP Project

The State Government of Schleswig-Holstein is interested in LCP in order to reduce the energy cost for most consumer groups, to reduce the need for new power plants, to divert capital resources to other sectors of the economy and to limit environmental impacts.

The conservation supply-curves were built considering the possible conservation measures (InnoTec 1991). A main difficulty of the project was the estimation of the specific saving costs associated with each conservation measure. The determination of the savings potential did not pose special problems.

In the optimization of the supply-demand mix, the conservation measures were chosen if they were efficient from a technically-economic point of view, i.e. the additional cost of selecting the more efficient technology was compared with the tariff (marginal cost at ECU 0.11/kWh) and the tariff with external costs (environmental costs plus a penalty for the use of non-renewable energy resources at ECU 0.16/kWh). The following estimated savings were achieved:

- Residential sector. 32%
- Small scale consumers 21%
- Industry 18%
- Overall 20%

If all the cost-effective potential is used this translates into a profit of DM 300 million /year.

It was found that it would have been desirable to have guidelines on how to apply external costs, for the different types of externalities associated with the several supply and demand options to LCP. During the project it was verified the LCP does not pose legal conflicts with national and regional law, namely being compatible with energy supervision and competition.

The experience of this project showed that the american experience and methodology in least-cost planning is transferable under european conditions by taking into account the regional differences.

6.2. The Iberduero LCP Project

Iberduero is on the largest spanish utilities and is interested in LCP to be more competitive in the energy market and to improve profitability.

Because of the lack of end-use data, large surveys and studies of electricity using equipment had to be carried out to characterize demand-side potential and the associated costs (Iberduero 1991). In the LCP methodology used, the electricity supply costs were calculated with and without the promotion of conservation measures. The criteria for investing in demand-side measures was based on the relation between avoided cost and the price of electricity.

To assess which demand-side options should be implemented, the net benefits of the different options were evaluated from different perspectives: the net social perspective, the net utility benefit, the net consumer benefit and the total distributable benefits.

The conservation measures which look more profitable are variable speed drives, high-efficiency motors, industrial heat pumps, cogeneration, commercial heat pumps and storage water heating. The technical savings potential in these measures is over 15% of present consumption, although the economic potential is only around 9%.

Avoided costs are projected to rise until 1996, then stabilize until 2002, and then increase again. Avoided costs are smaller than the average prices for all consumers, with the exception of very large industrial consumers. In the mid nineties the peak period avoided costs will be larger than the peak period rates for most consumers. In the absence of a new regulatory framework, conservation is only cost-effective for the large industrial consumers and winter peak demand control will be an attractive option from the mid-nineties

onwards.

There are uncertainties concerning spanish regulatory reform, namely in relation to pricing of electricity, which will influence decisively the application potential of LCP. These uncertainties do not advise the large-scale application of LCP at this stage. Iberduero thinks that the policies from the European Community will influence future regulation.

7. THE POTENTIAL IMPACT OF LCP IN THE EUROPEAN COMMUNITY

Europe utilities have been, and still are, supply-oriented focusing their activities in generation, transmission and distribution of electricity. Their main interest in demand-side management has been the improvement of the load factor and in particular to decrease the peak demand.

For this purpose demand-side management has been applied by Western European utilities during the past three decades. Attractive and sophisticated tariff structures (the main tool), controls and end-use technologies have been used, in some cases with considerable success, to smooth the load diagram. A good example is former West Germany, where the average load in the peak day increased from 80% (during the mid-sixties) to 90% (in the mid-eighties). A similar figure is found in France where efficient pricing has led to a capacity savings of 3000 MW.

Some effort has also been made in several european countries to improve electricity efficiency. A good example is France where a residential programme to improve insulation and heating systems in dwellings led to 18% savings in the period 1983-1989, with expected savings reaching 32% in the year 2000. However the electricity conservation resource remains essentially unexploited. Although in European Community countries, the average electricity consumption per capita is only about half of the USA equivalent, there are significant cost-effective potential savings.

Although the existing LCP projects in Europe have in general produced promising results, there is still little experience in Europe regarding LCP, namely regarding large-scale LCP implementation. USA experience can be used, namely to take advantages the methodology, models, software packages and tools, developed for LCP. However, differences in the market structure and the per capita consumption will require a evolutionary experimentation and tuning process in Europe. The customer acceptance and market penetration of conservation measures seem particularly difficult to estimate.

Due to the short european experience in LCP, the estimates of the cost-effective savings potential in the European Community differ significantly and are in the range of 10-20% . These savings translate into impressive impacts by the year 2000:

- The primary energy requirements of the Community would drop by 45-90 MTOE (a reduction of 4-8% of present consumption). This means mainly a reduction of the fossil fuel imports, with an equivalent value in the range of 8-16 billion ECUs.

- The avoided capacity would be in the range 40,000-80,000 MW, which leads to a capital investment savings of 60-120 billion ECUs (assuming an average capital cost of 1500 ECUs/kW for generation, transmission and distribution).

- A substantial reduction in the quantity of pollutant emissions, namely with a reduction of over 100 million tons of CO_2. The CO_2 savings are strongly dependent upon the avoided generation mix.

Just the investments in the residential sector can save 22-72% of the electricity used in that sector (this means 3-12% of the total electricity consumption) in the different countries. In France these savings would translate into 8,000 GW of saved capacity (Gusbin 1991).

The impact in the different Community countries would vary according to the expansion requirements. In the countries where there is the need to increase substantially the supply side, such as Greece, Italy and

Portugal, the introduction of LCP could provide substantial savings in the short term. Other countries with excess capacity, such as France, would only gain substantial benefits in the medium and long term.

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