JULY 1995 ECN-C--94-113

STRATEGIES AND INSTRUMENTS TO PROMOTE ENERGY EFFICIENCY IN DEVELOPING COUNTRIES

Project working paper 5

Effectiveness of industrial energy conservation programmes in IEA countries

A.D. KANT

Framework of the study

The present paper is the fifth working paper in the framework of the collaborative research project of ECN, ENDA, IEI and TERI entitled: 'Strategies and Instruments to Promote Energy Efficiency in Developing Countries'. It has been partially financed by the Dutch National Research Programme on Global Air Pollution and Climate Change (NOP/MLK). The project makes a preliminary assessment of major implemented and ongoing policy initiatives to improve industrial energy efficiency in the developing world. In addition, it sets out to identify possibilities for transfer of appropriate technology from OECD member states to enhance energy efficiency and environmental performance of manufacturing industries in the developing world. This project is registered with ECN under project number 7128.

Abstract

In this working paper the energy conservation policy instruments have been treated from the wider perspective of government involvement in the energy sector in IEA countries. Although all IEA member countries have market oriented economies, the level of government involvement in the energy sector differs strongly from country to country and depends on the energy carrier. The involvement is strongest in nuclear energy and the grid-based energy carriers, and less so in the oil sector. The involvement results in the design and enforcement of legislation, planning, tarification and pricing of energy. Involvement has been very tight during the oil crises and decreased substantially afterwards, but the wave of environmental concern has put energy on the political agendas again, as the market mechanism is not expected to lead to quick and adequate responses concerning energy efficiency measures and the introduction of renewable energy sources.

In this working paper the focus is on IEA countries' industrial energy policy instruments, being information programmes, financial incentives and codes and regulations. The general idea is that the results of these policy instruments in IEA countries may yield indications for application in developing countries. With this purpose in mind it is not sufficient to review the instruments and evaluate them. The instruments are not applied in isolation but are embedded in a general energy policy environment: organization of states, ministerial bodies responsible for energy, energy legislation and the international energy context. The general energy policy environment sets out margins for policy design. Policy design is implemented with policy instruments among which energy pricing, tariff structure, and taxation are the most important ones.

Major conclusions for developing countries on energy market intervention instruments, as used in IEA countries, are:

- The application of *financial incentives* in industrial energy conservation is generally cost-effective, but relatively expensive from the state point of view. Grants, loans and tax incentives are easy to regionalize, but require control capacity at the regional administration level. Grant programmes

should be applied only in case of the few largest energy consuming industries.
- *Information programmes* constitute the cornerstone of all policy programmes and are valuable in ensuring the success of other types of policy measures. Demonstration projects, training and education are possibly the most effective ways to reach structural effects. A capable institutional basis for the establishment of information programmes, either run by the authorities or by the utilities, is a necessary condition.
- *Regulations and standards* can be supportive at achieving a minimum level of energy conservation, but do not guarantee that the optimal level will be attained. Regulations and standards can provide long-term continuity also during periods with relatively low energy prices. Standards and regulations need to be enforced which is rather expensive and which presupposes the availability of high-quality experts with control being exerted in industry and at the national borders.

The conclusions on effectiveness of energy conservation policy instruments are the basis for an expansion of the role these instruments can play in developing countries. The working paper is concluded with some policy priorities which can be derived from the IEA experiences and the experiences described in the regional papers, notably the Latin American and Asian papers. The final conclusion may be that the market should be allowed to play a major role, but within the boundaries set by governments usually confronted with other, even more compelling needs.

CONTENTS

1. INTRODUCTION

This working paper is part of a research project entitled: *Strategies and Instruments to Promote Energy Efficiency in Developing Countries.* The project falls into the theme called 'Sustainable Solutions' of the Dutch National Research Programme on Global Air Pollution and Climate Change (NOP/MLK). The project is financed by the NOP/MLK and by ECN and has been carried out jointly by ECN, ENDA in Senegal, IEI in Brazil, and TERI in India. The study sets out:

- to make an assessment of policy strategies and instruments implemented in developing countries to promote more efficient use of energy in the industrial sector;
- to put forward recommendations on effective external assistance to improve the institutional framework and to enhance local capabilities to design and implement measures and programmes to effectively stimulate efficient use of energy in the industrial sector of developing countries.

Although NOP/MLK is a national programme, the solution for global environmental problems is strongly dependent on the extent to which countries, especially but not only in the developing world, succeed in managing the crucial problems of:

- demographic developments
- eradication of poverty
- making economic development more environmentally compatible.

These problems are of global relevance, but solutions have to be found at regional and national level. The Rio summit showed that these problems should be treated in a framework of international cooperation as problems and resources to deal with these problems are distributed very unevenly across the world.

Sustainable solutions to the greenhouse effect necessarily have to address the energy issue. A growing energy demand results in a rapidly growing contribution to global CO_2 emissions [1]. The industrial energy demand in the developing world is already quite large and is bound to rise fast. In fact, the industrial sector is the most important energy end-use sector, accounting for almost one half of the final demand for commercial energy in the developing world. Typically, energy intensity of production in developing-country manufacturing plants is substantially higher than in their counterparts in OECD member states. It can be inferred that developing-country industry encompasses vast energy conservation potential. Besides, compared to other major final demand sectors - notably the residential and transportation sectors - actors in the industrial sector, if operating under competitive market conditions, tend to be more sensitive to market signals and government interventions.

In this working paper a policy maker perspective is adopted to describe energy efficiency policy instruments related to the general economy and the general energy policy environment. This perspective provides insight in the relevant conditions for successful energy conservation measures that have been applied in the IEA countries. Moreover, it is expected that the

emergence of some of the conditions are necessary preconditions for the development of an energy efficient industry at a national level.

Before giving the detailed objectives of this working paper it should be stressed that industrial energy efficiency improvement occurs as an effect of multiple processes which are usually very difficult to entangle. First there is the autonomous improvement which occurs anyway, with or without government policy. The autonomous share in the improvement is caused by good housekeeping measures which require no investment, retrofitting existing equipment and machinery, replacing old machinery and changing products and production processes. The latter two causes have by far the most important share in the industrial energy efficiency improvement. Secondly, and apart from the autonomous improvement, exists the energy efficiency improvement which may be attributed to measures coming forth of energy policy measures. It is expected that in IEA countries energy policy makes a difference, while in developing countries autonomous processes determine pace and extent of the improvements. What is relevant to policy makers is if the improvements go quickly enough and for what costs the process can be speeded up successfully in order to realize the existing potential. The referred to analysis is needed to be made in every individual case. If the conclusion is that the pace of the improvement should be increased the question of how this should be achieved becomes relevant. An analysis and evaluation of policy instruments applied in IEA countries may be useful to any policy maker confronted by the question to develop energy policy measures.

There exists a huge number of policy instruments which have been applied throughout the world with varying degrees of success. Especially in the IEA countries a variety of policy instruments has been applied in one common framework: instruments should contribute to improved market functioning. The objectives of this working paper are:

1. *Description of energy conservation policy instruments applied in IEA countries with a focus on the industrial sector.*
2. *A general, tentative evaluation of instruments will provide information about the efficiency of these instruments.*

The idea underlying this working paper is that energy conservation experiences in the IEA may yield lessons for developing countries. However, it should be taken into account that policy instruments are embedded in a general policy environment. Secondly, assessment of the efficiency of energy conservation policy instruments meets a number of difficulties, such as attribution of effects, assessment of incrementality (what would have happened without a dedicated programme?) and assessment of cost-effectiveness of measures. Indisputable measurement of the efficiency of a particular instrument is practically impossible. Thirdly, the efficiency of energy policy instruments is narrowly related to a large number of conditions, among which the general policy environment, closeness of investor's needs and potential supply, the general economic environment (market situation, market expectations, alternative investment objects, reliable government actions), the exact design of conditions, procedures, mode of supply and relative height of support. Some of these aspects are floating points, entirely driven by market movements, others can be influenced to a certain extent. It is concluded that these considerations make it plausible that a

working policy instrument in one country is not a guarantee for success in another.

In fact, it is necessary to describe not only the instruments and their efficiency, but equally important is an analysis of the conditions under which an instrument appeared to be successful. Without a thorough analysis of the conditions replicability of energy conservation policy instruments is deemed to be a failure. However, the last step of the analysis of conditions will not be provided here, as this would change the scope of this working paper beyond the limits set by the financial resources allocated to this part of the joint research project. Instead these conditions should be analyzed for a limited number of instruments in a follow-up effort.

Notwithstanding difficulties with assessment of the efficiency of energy conservation programmes and irrespective of the adoption of liberal economic principles or other economic paradigms, a coherent energy policy is required for most countries for many reasons:
- the essential role of energy in economic performance,
- energy has a place among other strategic policy issues,
- the endowment with or lack of energy resources,
- the allocation of financial resources over the myriad of tasks and responsibilities usually considered to be in the state's domain.

The design and implementation of a national energy policy requires institutional structures, such as legislation, institutions and a division of tasks and responsibilities. Formal, controllable procedures based on laws are to be carried out by a formal institution explicitly responsible for the energy issue. Establishment of an adequate institutional structure includes:
- definition of ministerial responsibilities,
- establishment of an energy unit in a ministry or the establishment of a more independent energy agency at arms' length of the authorities,
- design of adequate framework legislation,
- design of a coherent, integrated, long-term national energy policy.

A variety of institutional arrangements is realized throughout the world according to local social, political and resource endowment characteristics. The design and application of policy instruments appears to vary accordingly. The general policy environment determines for a large part way and scope of establishment of adequate institutions. Some of the major determinants of the general policy environment will be described first. As in the OECD energy supply and pricing is predominantly left to the market, important aspects of energy markets will be reviewed. The bulk of this working paper is drawn up around the description of policy instruments used as energy market interventions. The working paper is concluded with an evaluative summary of the major findings. Throughout the text four boxes contain examples of a subsidy instrument successfully applied in Dutch industry.

2. GENERAL ENERGY POLICY ENVIRONMENT

In most IEA countries and many developing countries the energy issue is often subsumed under a ministry of industry and trade, or it is under the responsibility of a ministry of energy and mining. In contrast, the remainder of developing countries has supra-ministerial policy groups coordinating national energy policies.

In virtually all democratic countries parliaments are involved in legitimizing energy policies proposed by governments. Parliaments have to ratify important key decisions on siting issues, large investments in energy sub sectors (nuclear energy, hydro schemes) and prospecting rights and licensing questions. This practice has its rationale in considerations such as:

- energy has a national strategic component,
- energy is often a major source of national income contributing significantly to GDP,
- energy policy is strongly interrelated with general economic policy,
- energy production and end use have strong environmental consequences.

Democratic principles also control the way and extent of involvement of society in energy policy issues. Policy preparation, design and implementation take place in various extent of cooperation with the actors involved, among which the utilities, industry, societal interest and pressure groups, research organizations and political parties. Consultation may be framed in official advisory committees (installed by government), at local or national level, informal consultations between ministries and ministers on the one hand and the possibly affected actors at the other. Some countries can be characterized to have collective bargaining economies precisely for this practice.

Energy policy making, the way it is prepared, accepted, made public, carried out, evaluated and controlled, is strongly depending on institutional arrangements in society. Institutional arrangements are prescribed procedures that define actions of the actors involved. Policy making is an action typically to be carried out by state officials and political parties. Energy policy making can be characterized as the design of a coherent set of principles guiding government in a situation in which limited energy resources have to be shared among a multitude of interest groups. Energy policy is usually based on framework energy legislation, taking into account interests of industry, agriculture and other economic sectors, the prevailing political orientation, historical and cultural peculiarities. Hereafter, dominant aspects impacting on energy policy making will be examined briefly.

2.1 Centrally or federally governed states

National states can be distinguished as centrally or federally governed. The distinction is important as management of the energy sector is affected accordingly. National policy issues, defined as such because their importance exceeds local or individual interests, are usually the domain of national governments. This is the case with:
- energy supply and demand,
- legislation on emergency situations in the energy supply,
- national energy taxation policy,
- drilling and exploitation rights,
- energy pricing issues
- expansion of power generation capacity.

Implementation of legislative rules is, on the other hand, usually under federal government responsibility. This allows the design of energy conservation programmes specifically tailored to fit regional and sectoral needs and possibilities.

2.2 Ministerial energy bodies

Institutional arrangements vary over time and place as they are strongly influenced by external events. Before the oil shocks of the seventies energy had not been a political issue in most IEA countries, apart from incidental siting or exploration decisions. Shortly after the first 1973 price increases perceived OPEC threats were followed by the establishment of Energy Ministries or Energy Departments, thus emphasizing the national strategic component. Policy goals focused on diminishing energy end-use, substitution of energy carriers and intensified exploration. However, falling oil prices in the early eighties resulted in diminished public attention for the issue and ministries were downgraded to General Directorates or Directorates in ministries with wider responsibilities. This shows that the institutional structure is floating, covarying with the importance given to issues covered by the ministry. If important actors in society are facing changing conditions (for instance energy prices affect industry's international competitive position) the institutional structure may change if the existing structure is not able to defend the national interest.

2.3 Specific energy legislation

In virtually all countries government involvement in energy policy matters is guided by sector specific energy legislation. Electricity laws regulate:
- utilities monopolising electricity generation,
- transport and distribution of electricity,
- consumers' right to be connected to the grid even in non-profitable situations,
- responsibility for the extension and maintenance of the national grid,
- expansion of power generation capacity.

Laws concerning oil and gas regulate prospecting, licensing, drilling and landing. Pricing is usually under the control of government, although in some countries, like the UK and Norway, price formation is left to the market. Also society's shares in revenues originating from national energy resources is secured in different sets of rules. Legislation is usually prepared in ministries or in supra ministerial committees directly controlled by the Head of State.

Political influence of interest groups is exerted in a variety of ways. Some political systems consult major parties in advance in one or more rounds of consultation (collective bargaining economy), while at the other end of the continuum new legislation is decreed according momentary needs. In the former case institutional arrangements are rather stable and changes can be anticipated long before, giving investors time to reallocate resources and to adapt to the new market conditions. The latter case may surprise interest groups, resulting in uncertain conditions for potential investors. However, it may be advantageous to governments to respond early to changing conditions, whereas in collective bargaining economies adequate action is often hampered because of institutional obligations. Nevertheless, cooperative consultation of industry and other sectors has proven to be very productive. In Brazil for instance labelling appeared to enhance energy savings significantly, because of intensive rounds of consultations between government, appliance producers and certifying laboratories. In Mexico, on the contrary, companies were not consulted which resulted in negligible action from the side of industry.

2.4 International Energy Agency (IEA)

Energy is not entirely a national policy domain in IEA countries. The IEA, established in 1973 as an organization of oil importing countries, clearly as an OPEC counterpart organization, stresses the importance of economic energy pricing of all energy carriers. IEA energy ministers of member countries agreed on a number of principles for energy pricing practices [2]:

- consumer prices should reflect world market prices (as is the case for oil and oil products);
- without the existence of a world market, consumer prices should reflect costs for long term supply maintenance;
- subsidies of consumer energy prices should be abandoned;
- electricity tariffs should reflect costs for generation plus revenues to secure the provision of future demand;
- taxation of energy carriers should fit general energy policy objectives of a country;
- transparency of energy prices should be aimed for to enhance informed decision making for consumers and producers of energy.

These guidelines reflect a market based approach for energy pricing. As already discussed the desired situation barely exists in the IEA countries. Pricing is usually strongly influenced by national energy market peculiarities and other than energy policy domains, such as employment policy, economic growth prospects and balance of payments considerations.

Although very few countries comply these guidelines, and IEA cannot enforce its rules on member countries, the agency sets the agenda for political discussions.

2.5 Other international developments

As an outgrowth of political cooperation between EU countries, it can be observed that there is a tendency to internationalize the energy issue. In the EU, governments are increasingly ready to hand over responsibilities to the European Commission. The EU stands for a high degree of market mechanism regulating energy production and distribution, as is already the case with the oil sub sector. Objectives of current policy are:

- Energy pricing of gas and other energy carriers, now often bound with the spot market oil prices, should be liberalized.
- The third party access (TPA) issue concerns the natural monopolies of the owners of the transmission and distribution grids. Use of the grid to transport electricity can be denied to large energy consumers, who are able to obtain better energy delivery contracts elsewhere.
- Exclusive delivery rights for utilities in defined delivery zones prevent development towards high quality energy services for lower prices in these zones as the result of competition between utilities.

The EU policy, however, proceeds slowly as national governments are strongly pressed by national utilities not yet ready for open competition. The utilities in neighbouring countries are perceived as threats to national energy independence. For example the integration of the former East Germany opened the possibility to foreign electricity producing companies (Electricité de France) to obtain a 15% share in the electricity generation of East Germany, however with the condition that Rheinisch Westfalische Elektrizitäts Werke (RWE) should be admitted to the French market for a comparable share. High level bargaining between the heads of state was not successful and the European novelty of foreign-owned electricity generation capacity did not occur.

Another important development in Europe is the European Energy Charter. The Charter, signed by all European countries and the former Soviet Republics, describes a mechanism for cooperation between the countries involved. Western financial and economic support for the detrimented economies in the East will be returned with huge and secured deliveries of natural gas and oil to the relatively poorly energy endowed countries of western Europe.

The same trend of regional cooperation occurs in the economic partnership between the US, Canada and Mexico (NAFTA). Especially Mexico, with extremely low electricity prices, radically changed its energy policy under the pressure of the treaty. Since 1991 electricity prices went up sharply, currently reaching 87% of long term marginal costs. The US and Canada already celebrate a long standing cooperation in the energy field at their mutual border.

The World Bank is a global actor heavily involved in the energy sector. The Bank often relates structural economic support with energy infrastructure investments. The institute is increasingly criticized for its one-sided orientation towards large energy supply systems at the expense of energy efficiency improvement measures (Demand Side Management) and alternative energy sources. In spite of publicly confessed energy efficiency objectives, the World Bank continues with this biased large scale supply orientation.

3. ENERGY POLICY AND DIRECT CONTROL MECHANISMS

3.1 Government involvement in the energy sector

The main features of government involvement in the energy sector have been examined in a study carried out by the IEA [3]. In this study the rational, scope and effect of government involvement is examined. It is shown that in the seventies government involvement in the energy sector was quite strong as a result of world market instabilities. In the eighties the abundance of energy on the world market was reflected in a significant reduction of government intervention in the energy issue. The reduction of government intervention is evidenced in the lifting of price controls, reduced subsidies, the removal of barriers to energy trade and the (partial) transfer of state-owned energy industries to the private sector. However, energy is still not treated as other commodities in any of the IEA member states. There remains a government interest in energy matters in all market economies. Moreover, it is stated that '.. environmental concerns are giving rise to renewed government interest and a new, more interventionist approach to the energy sector than in the recent past' [3].

In the IEA report the level of state ownership in energy companies is distinguished. The level of state ownership is characterized by three variables: the ownership may be in the hands of the national authorities, the regional authorities (federal states), or the local authorities. The influence exerted in the parastatal may be classified as close to 100%, a majority holding, a minority holding, or non-existent (in that case a private sector company is concerned). The role in the energy sub sector in general can be classified as dominant, important, or minor. Because government involvement in the energy sector is strongly related to the various energy carriers, the latter are examined apart: coal, oil, gas and electricity. These modalities of State ownership in the energy sub sectors are listed in table 3.1 for the main activities in each sector: production, refining, transmission, distribution and generation.

Table 3.1 *State ownership in the energy industries in EC countries*

	Coal		Oil			Gas			Electricity	
Country	Production	Production	Refining	Distribution	Production	Transmission	Distribution	Generation	Transmission	Distribution
Austria	A.II(iii)	B.I.(i)	B.I.(i)	B.I.(i)	B.I.(ii)	B.I.(ii)	A.II.(i)	A.I.II.(i)	A.I.(i)	A.II.(i)
Belgium	A.I.(i)	-	P	P	-	B.I.(i)	B.II(i)	C.I.(i) A.I.(iii)	-[4]	B.III.(i)
Denmark	-	A.I.(ii)	P	P	A.I.(ii)	A.I.(i)	A.II(i)	[?]	[?]	A.II.(ii)
France	A.I.(i)	B.I.[?]	B.I.[?]	B.I.(ii)	B.I.(i)	A.I.(i)	A.I.(ii)	A.I.(i)	A.I.(i)	A.I.(i)
Germany[1]	P	P	P	P	P	P	A.II.[(ii)]?	C.II(ii)	C.II.(ii)	C.II.(ii)
Greece	A.I.(i)[2]	A.I.(ii)	A.I(i)	A.I.(iii)	-	A.I.(i)	A.III.(i)	A.I.(i)	A.I.(i)	A.I.(i)
Ireland	A.I.(i)[3]	-	A.I.(i)	P	P	A.I.(i)	A.I.(i)	A.I.(i)	A.I.(i)	A.I.(i)
Italy	A.I.(iii)	A.I.(ii)	A.I.(ii)	[?]	A.I.(i)	A.I.(i)	C.I.(ii) A.III.(ii)	A.I.(i)	A.I.(i)	A.I.(i)
Luxembourg	-	-	-	P	P	B.I.(i)	A.III.(ii)	P	C.I.(i)	C.I.(i) A.III.(iii)
Netherlands	-	C.I.(ii)[5]	P	P	B/C.I.(ii)[5]	B.I.(i)	A.III.(i)	A.III.(i)	-[4]	A.III.(i)
Portugal	A.I.(i)	A.I.(iii)	A.I.(i)	A.I.(ii)	A.I.(iii)	A.I.(iii)	A.I.(iii)	A.I.(i)	A.I.(i)	A.I.(i)
Spain	A.I.(ii)	B.I.(ii)	B.I.(ii)	B.I.(ii)	B.I.(ii)	A.I.(i)	C.I(ii)	C.I.(ii)	B.I.(i)	P
U.K.	A.I.(i)	P	P	P	P	P	P	A.I.(iii) C.I.(iii)	P	P
Poland[6]	A.I.(i)	A.I.(i)	A.I.(i)	B.I.(i)	A.I.(i)	A.I.(i)	A.I(i)	A.I.(i)	A.I.(i)	A.I.(i)

Source: Derived from [2].

Notes
[1] Former West Germany only.
[2] Lignite.
[3] Peat.
[4] Transmission grid is owned by the utilities.
[5] Modification of the original table.
[6] Poland is added.

Key
Level of State ownership in undertaking: A. Close to 100%. B. Majority holding. C. Minority holding. P. Private sector.
Public sector ownership held by: I. National Government. II. Regional government. III. Local government.
Role of public sector ownership in sector: (i) Dominant. (ii) Important. (iii) Minor.

Three main categories of state ownership can be derived from the table:

A.I.(i) Those where the energy sector is dominated by major state-owned industries; currently Austria, France, Greece, Ireland, Italy, Portugal and Spain.

B.x.(ii/iii) Those where there is either joint ownership of major energy and enterprises by the public and private sectors, or

C.x.(ii/iii) Arrangements for joint decision making which enables the government to influence the general strategies followed by the industries or a combination of the two: Belgium, Denmark and the Netherlands.

P Countries where the energy industries are mainly in the private sector and subject to specific regulatory controls which may be more or less strict: Germany and the United Kingdom.

The ownership identified in the table reflects government influence in the energy sub sectors. The actual influence is exerted with:

- control over investments
- division of markets
- exclusive delivery rights
- energy pricing based on other mechanisms than long term marginal costs
- replacement of old capacity
- non-market conform taxation etc.

The government involvement clearly also serves other goals than energy specific interests. The major policy goals related to the energy issue will be treated below.

3.1.1 Energy policy goals

Besides the already mentioned goals guiding current IEA energy policy, a large number of policy goals exists. In the IEA countries cross-subsidisation is often legitimated by an industrial policy framework: low natural gas prices protect greenhouse horticulture in the Netherlands. Low electricity prices are bargained by the energy intensive aluminium industry. It is concluded that energy pricing in the IEA, although generally in line with marginal cost pricing, sometimes generates economic signals unfavourable for energy conservation aims in specific sectors.

A last, more directly with energy related reason to reestablish national energy policies is the global environmental degradation. Global environmental concerns even brought together world leaders in the UNCED meetings in Rio de Janeiro. Developed and less developed countries appeared to have diverging interests and solutions.

In the IEA countries energy efficiency is back on the political agenda as environment and energy exploitation and use are strongly intertwined. Environmental concerns and a plethora of other reasons justify the renewed interest in energy e.g.:

- A sustainable future can only be reached if energy supply can be secured at the level necessary for economic growth without adversely affecting the global environment.

- Security of sufficient energy supply, at low, affordable costs is important for every country.
- Diversification of national fuel mix decreases vulnerability of import depending countries.
- World market prices for energy are likely to increase in the near future.
- Energy efficiency supports the creation of a sustainable environment.
- Investments in energy conservation often provide higher returns than investments in increased supply.
- Investments in energy conservation are flexible in uncertain energy markets.
- Energy conservation can support the development of new conservation-related industrial and service activities.

3.1.2 Energy policy control modes

Government involvement in the energy sector has many faces in IEA countries. Apart from the framework legislation also specific emergency legislation has been designed to guide situations of sudden energy supply disruptions. This is an anticipatory control instrument just in case of disruption. In most countries this legislation has been established after the first oil shock.

The instruments can be distinguished in direct control mechanisms, which allow a permanent control over energy prices and therewith indirectly over energy demand, and indirect mechanisms. Direct pricing (day-by-day establishment of prices), tariffication of energy prices (procedures for price changes usually related to the demand), taxation and the control over state-owned energy companies or parastatals are widely used in and outside the IEA. The direct pricing instrument is the most important. Pricing of energy carriers has to be evaluated per energy carrier as significant differences exist. Indirect policy instruments will be treated in section 4.

Energy pricing

In IEA/OECD countries energy prices for the various energy carriers come off differently. Prices for the grid-based energy carriers are strongly determined, or at least controlled by the authorities, while oil and oil product prices are largely left to the market. This practice assures society to obtain its share in the economic rent of national energy reserves. Apart from the economic aspects, environmental concerns easily lead to compelling support of the relevant technologies by subsidies and tax rebates. In many countries it is felt that introduction of renewable energy sources or the realization of energy efficiency improvements cannot be entirely left to the market. For these categories introduction and realization would not be realized quickly enough if purely economic criteria were applied. With price interventions the market can be influenced rather efficiently, as the market mechanism is expected to result in conservation and efficiency actions.

Consistent national energy pricing policies are difficult to realize, especially in federal states such as the US, Canada and Australia, where with respect to energy pricing responsibilities alternate between national and federal authorities.

Oil and oil product prices
Of all energy sub sectors the oil sector is most market driven. Oil prices are established on the international spot market in most IEA countries. So consumer prices are directly connected to the world oil market prices, thus giving relatively undisturbed market signals. Subsidies are lifted in virtually all IEA countries since the late eighties. Price controls only exist in a number of countries, notably Greece, Italy and Portugal. Prices for oil products are generally left to the market, though taxes on oil products, notably gasoline, are a substantial part of the price paid by consumers at the gasoline station, thus diminishing the market mechanism in price formation.

Electricity prices
Electricity prices are usually strongly controlled by governments. Although some form of marginal cost pricing is declared to be the principle, the IEA complains about the slow pace of the adoption of this economic principle by most of its member countries. With exception of the USA, Canada, United Kingdom and Norway electricity pricing is regulated by the authorities to a considerable extent. Transparency of tariff structures may be hampered sometimes, while the tariff scheme itself may contain cross subsidisation categories, thus limiting the market mechanism as well.

For electricity exist considerable price determination difficulties over IEA governments. In many IEA countries prices are more determined by historical trends than by marginal costs considerations. Even in the minority of IEA countries using long run marginal cost pricing, actual tariffs are adjusted for national fund raising needs, social equity reasons or anti inflation objectives for instance. As it is believed that only truly market based prices give correct long run signals to consumers, subsidized non-market prices are thus a barrier to energy conservation.

Gas prices
Gas prices are, though to a lesser extent than electricity prices, considered difficult to determine. In the majority of countries with domestic gas resources the shift to gas away from import oil is reinforced with adjusted gas prices. In the Netherlands and Denmark the gas prices have a connection with the spot market oil prices. Gas prices are fluctuating with oil prices though lagging behind somewhat. Both countries export gas on long term contract base. With large movements of the oil prices these contracts are adjusted after renewed negotiations between the governments concerned.

Coal prices
Coal industry in the IEA should be divided in countries with and without an economically viable coal production sector. In the former category Australia, Canada and the United States are found, with privatized companies. Government involvement in the sector is export oriented (Also working conditions and mining safety, as well as environmental aspects are under government control). The US for instance has agreements with a number of countries in which coal exports are fitting in bilateral R&D arrangements. In Australia the Commonwealth Government can reject coal export contracts.

In the majority of countries without a viable coal sector, coal mining is heavily subsidized. However, subsidies are used to retain domestic coal sectors for social, economic and regional (Belgium) reasons. The coal price

in a number of countries, notably the UK and Germany is above the world market prices. Utilities have contracts with the domestic mining corporations to buy minimum quantities of coal. These contracts are induced by governments to support their mining industry, which is often perceived as the traditional motor of national economy. The coal subsidies need large public funds. In 1989 support to the coal industry mounted to about 18 billion US$ in five IEA countries. In table 3.2 the historical trend is shown [3].

Table 3.2 *IEA estimates of total producer subsidy for coal production in selected countries (in million 1990 US$)*

Country	1986	1987	1988	1989
Belgium	429	387	286	217
Germany	4996	6945	7277	7088
Japan	1320	1375	1292	1008
Spain	447	768	704	693
United Kingdom	3311	3985	4062	9085
Total	10,503	13,460	13,621	18,091

It is clear that countries cannot afford a large scale coal industry because of high labour cost. In Germany revenues for subsidies are raised with a dedicated tax paid by all consumers and which is received in the monthly bills (the 'Kohlepfennig'). Only the UK is expected to maintain a future coal industry of some importance without having to rely on heavy subsidies. In the rest of these countries coal mining will gradually stop. Since 1990 policies are directed towards elimination of heavy subsidies. The above-world-market-level prices for coal paid by the utilities are usually transferred to consumers (e.g. the 'Kohlepfennig' in Germany). On the one hand this cross subsidization may enhance energy conservation actions, on the other energy prices should reflect real costs in order to profit most from the market mechanism.

Nuclear energy prices

Nuclear energy is another extreme on the market dimension as it is heavily bound to national safety. Exploration, extraction, transport, supply contracts, processing and reprocessing as well as guarding fuel are strictly regulated in most countries. Costs for nuclear electricity are difficult to obtain. In the Netherlands for instance exact figures are embargoed and known to a limited number of people. Privatization in the UK for instance showed that electricity generation and distribution can easily be effectuated, however, with exception of nuclear power. No buyer could be found who was willing to take the risk to be made responsible for the decommissioning of nuclear premises. Government involvement is also strong because in many countries the scale of nuclear programmes has been such that they could only have been carried out with government support for research and development and in some cases for investment.

Fixed energy prices

Fixed energy prices are an interesting phenomenon because stabilized energy prices are believed to enhance economic activities. Momentarily no countries can be mentioned in the IEA with this pricing mechanism. Fixed

price experiments were observed in a number of countries with little success though. Examples include Australian LPG policy, Denmark's natural gas policy, CNG policy in New Zealand and energy taxation in Sweden. However, prices based on arbitrary relatives can rarely be maintained in the face of unexpected and contrary movements in costs. Fixed prices did encourage substitution from oil to domestic energy sources, though for a limited period of time. In the long run energy market pricing is expected to be a superior mechanism for energy price establishment.

Tariff structure

The structure and the level of tariffs for electricity, gas and district heating is important for energy conservation. Multi-part tariffs reflect the capital costs and the fuel costs, making prices transparent to energy consumers. This type of tariff structure offers a rational base for full cost recovery. For large consumers of gas and electricity it is possible to use complex metering in order to recover real costs for the energy supply service. For small and medium size consumers average load characteristics can be applied for cost price calculation as complex metering is too expensive for large scale application. In most multi-part tariff schemes prices tend to fall as consumption rises since the capacity used is spread among a greater number of units consumed. This phenomenon is not carrying incentives for energy conservation. In some countries, notably Japan, progressive tariffs were introduced to stimulate conservation. This type of tarification indeed enhances energy conservation measures. Unfortunately it is difficult to show that pricing and energy conservation have a causal relationship, as many externalities obscure the relationship. However, Denmark having the highest price increases of the entire IEA and one of the most aggressive energy efficiency programmes shows the biggest decline over energy end use. Apart from these achievements Denmark managed to reduce its oil import dependency from 100% in 1976 to a current 10% [4].

Highly flexible tariffs are sometimes perceived to be necessary to accommodate changes in the share of fuels in the economy.

Transparency

With the transparency of prices usually is meant the clarity of justification provided by the utilities of the tarification (level and differences in pricing classes) of energy services supplied. The costs to be made by utilities for supplying energy services to meet the peak demand of domestic users are much higher than meeting the more or less stable demand by large energy consumers in industry. Despite relatively low capital costs, peak load is expensive per unit of generated electricity. Base load capacity is functioning most of the time, resulting in lower capital costs per energy unit supplied. Tariff structure should make clear these cost differences for the utilities.

Transparency of tariffs is important in those countries where utilities are obliged to publicize tariffs. The public is thus informed about different price levels, which puts barriers to cross subsidization schemes which are not stimulating energy conservation in the subsidized category of energy users. In most countries prices for the largest consumers are not published, giving rise to suspects of other consumer categories of heavy subsidies. In the EU subsidies to industrial companies are followed with great care as equal and

transparent market conditions for all competitors in the EU are highly valued.

Taxation

Taxation policies are affected by much wider concerns than energy alone. Particularly fiscal policy, macroeconomic, regional, and industrial considerations contribute to the taxation schemes. Government needs to raise revenues in a simple, convenient and socially acceptable way. Government revenues based on energy taxes are largely derived from the taxation of oil, oil products and gas. The justification for considerable taxes on automotive fuels is easy, as the use of private cars satisfying the fundamental need of free mobility is highly valued throughout the world. In contrast, electricity services are perceived as less voluntary and consequently high taxes are more difficult to justify.

As energy taxation is expected to affect energy demand, some countries explicitly used taxation as an energy conservation instrument. Sweden, Denmark, Australia, Ireland, Italy, Switzerland and the UK have used the energy taxation instrument. Portugal for example used the falling oil prices of the eighties to phase out subsidies on oil and oil products.

Coal is often not taxed or tax levied is rebated. Coal is often favoured for different kinds of inland political reasons. Contrary to the main practice in the IEA countries, Sweden shows special high taxes on coal to signal that coal use results in environmental damage. Taxation tariffs for coal are 50 to 75% above oil tax tariffs. The basis for the difference is found in the differential heat content of coal and oil.

Consistent energy tax policies are non-existent in IEA countries. Very often tax regimes do not give equal treatment to energy supply and conservation options. For example in the UK, insulation materials are under VAT regulations whereas electricity and natural gas were VAT exempted. In many countries users of company cars are favoured in the tax regime, while private car owners pay all kinds of taxes and levies. Even worse is the case of house owners in many countries. Mortgage interest payments can be deducted from income tax. In the US non-house owners are paying 31% of the house owners' mortgages, allowing the latter category to buy bigger houses needing more space heating in winter and more cooling in summer. This subsidy scheme is estimated to result in a 60 billion dollar transfer from non-house owners to owners [1]. The latter case shows that energy is involved in many other non-energy issues. Political and economical interest are barring consistent energy pricing policies in many ways.

Parastatal utilities

In many IEA countries the energy utilities are largely or completely state-owned companies. The national authorities define tasks (expansion as well as reduction), nominate managers, judge utility designed tariff schemes, judge national electricity generation planning, judge investment plans and replacement of obsolete equipment. These companies enjoy a monopolistic or oligopolistic position in the economy. Their market shares in exclusively defined supply regions are usually secured, no or limited competition occurs and long term fuel contracts are common. Private investment or partial ownership is unequivocally regulated. Often distribution utilities are

partially owned by local authorities, giving elected representatives influence over the utility. Utilities are more and more inclined to render energy services instead of supplying electricity, gas or water. The role of the utilities tends to broaden to other elementary services in many countries.

Authority control may force utilities to start up energy conservation programmes. The least cost principle now guides activities of a good deal of them. Not only information campaigns, but active investments, loans, grants and audits are provided at substantial costs for the utilities, but these costs are still lower than investment requirements for generation capacity expansion. In Canada for example utilities are investing in multibillion energy conservation programmes. The same counts for Italy, the Netherlands, Norway, the UK and the US.

3.2 Other actors in the energy field

Besides national and local authorities a great number of actors is usually involved in energy conservation activities: energy supply industry, line organizations, awareness groups and political parties.

With the strategic reorientation that marked the shift in policy orientation from energy supply to energy demand, the energy field rapidly became complicated. Because of the end-use character of these activities the actors outnumber the energy producers by far. The heterogeneity and diffusiveness of the end-use approach is a fundamental break with former practices, when energy supply industry easily handled energy saving approaches. This shift in attention from supply side to demand side urges new instruments and new ways of market approaches. Nor the governments neither the energy producers are easily adapting to this newly warranted approach shift. This type of barrier towards energy conservation can be characterized as institutional: organizations are not ready to respond to the needs emerging in society. Partly this is due to obsolete knowledge, partly to vested interests in the organizations.

Energy conservation urges a myriad of specialized activities. A wide variety of professionals is involved: energy auditing specialists, manufacturers of all kinds of devices, insulation manufacturers, consultants, construction engineers, architects, retrofit industries (boilers, cooling and heating), financial specialists. The older organizations such as the energy distribution companies have built a traditional relationship with energy consumers. The others have been involved only since the 1973 oil shock or even later. With varying extent of direct client contact these specialists have relevant knowledge on conservation possibilities and constraints.

Dutch industrial energy conservation programme TIEB

Project title: introduction of an energy management system in cement industry

Character of the proposed project	:	market introduction
Economic sector	:	building materials, ceramics and glass
Applicant Company	:	Cement factory Rozenburg
Application	:	Energy management
Project costs	:	95,000 US$
Subsidy	:	24,000 US$
Project's energy conservation	:	355,725 m^3 natural gas equivalents
Estimated potential in the Netherlands	:	3,557,250 m^3 natural gas equivalents

At the cement factory Rozenburg one is willing to get insight in the energy end-use pattern. Objective is to optimise energy use patterns resulting in significant energy savings. This is to be realised with a registration system for energy use for every single device. The system will also be connected to the national control system of the electricity generation utilities. The control system is managing electricity generation at a national level and electricity prices are charged based on peak load measurements. The connection with the national control system is used to carry out load management by closing down parts of the factory. This is advantageous for the factory and helps reducing national electricity use by shaving national peak loads. With the introduction of measurement devices for every single device a central computer manages the production process. A 5% reduction on electricity end-use is expected in this factory alone, while in the branch as a whole about 3.5 million cubic metres of natural gas potential is determined.

A great number of the involved specialists is organized branch-like or profession-like. Economists, electrical engineers, communication specialists have their regional and global networks. These networks are usually aimed at the provision of information, dissemination of experiences and financial schemes.

The energy supply industry, being the electricity generation utilities and distributing companies have another direct access to their clients, mainly by the grids entering the houses and billing arrangements at regular intervals. For the supply industry energy conservation is important in a number of respects. Firstly, a Megawatt installed is often more expensive than a Megawatt avoided, which makes their activities more cost-effective. Secondly, a Megawatt avoided during the peak is more cost-effective than one outside peak periods. Energy conservation is thus often seen as a means for peak shaving. Thirdly, utilities are in many cases under government pressure to save energy. Good energy saving records relieve government monitoring and render more freedom for own planning and capacity extension. In next section it is shown how utilities obtained the entire responsibility for energy conservation programmes in some countries.

In energy industry a number of alliances occur which act as service organizations to their members, being individual companies. At the same time the line organization acts as a pressure group towards government if legislation and regulation concerning their economic sub sector is proposed.

A great number of local energy awareness groups exists in many countries, involved in what might be called broader energy interest issues: the support of renewable energy systems, to provide cheap labour for the weatherization of houses for the elderly, to test appliances, to support consumer's

applications for government financial support, to stimulate the introduction of biomass energy etc. Often, these private personal initiatives are government supported. This is the case in Germany, the UK, Canada and many other countries.

Energy policy obtains a more central position on the policy agenda if political parties commit themselves to the issue. More political commitment results in stronger institutional framing of the issue.

3.3 Conclusion

Economic energy pricing is a prerequisite for effective energy conservation policies. Energy prices should reflect long term marginal costs, as consumers need correct and consistent signals about energy supply costs. This is perceived to be the best way to secure long run energy supply against lowest possible costs. There exists, however, considerable disagreement among countries on the methodological questions to calculate economic energy prices. As a myriad of non-energy considerations influence energy pricing policies, uniformity in pricing should not be strived for. However, irrespective of the national differences pricing and taxation policies should reflect energy conservation aspects.

4. ENERGY MARKET INTERVENTIONS

Today there are significant differences in the degree of government involvement both by sub sector and between countries. All IEA governments have a number of instruments which are used to implement energy policy. These include financial incentives (taxation, fiscal incentives - grants, loans on favourable terms and tax credits), regulations and standards and informative programmes. Governments can also directly influence the energy industries and the main energy consuming industries to varying degrees by energy pricing, formal persuasion in the board of directors of state-owned companies, and informal persuasion and pressures.

The grid based industries (gas, electricity and district heating), which tend to act as monopolies in some operations, are also marked by strong public involvement. In the case of countries with indigenous resources of oil and gas, the government is in most cases concerned to secure the national interest and to obtain its share of economic rent on production. Government involvement is least in downstream oil activities. The same applies to the economic chain of coal in those countries with a viable coal industry. On the other hand, government intervention is intense in those countries where the coal industry depends largely on public support. The need for government action to promote the efficient use of energy and to promote the introduction of new technology, is accepted in all IEA countries. However, the depth and effectiveness of that action varies. Hereafter the conservation programmes and measures will be treated in more detail.

4.1 Energy planning and energy conservation programmes

In the majority of IEA countries some kind of indicative energy planning guides policy making. Besides energy planning, environmental plans increasingly guard and align decisions with environmental implications, notably energy decisions. In a country like Portugal industrial target areas are taken up in regional plannings, with strong consequences for the energy key decisions.

4.2 Government conservation programmes

The 1973 oil shock caused immediate political action, such as the design of emergency plans and all kinds of instant legislation aiming to secure vital functions in the economy. After the first shock governments obtained a more structural stand adopting a cost-effectiveness approach. The focus shifted gradually from energy *conservation* to energy *efficiency* and energy intensity of various economic sectors and products. This shift reflected structural considerations of the complexity of the energy issue, whereas initially energy import reduction was the predominant focus.

The following years the entire array of government regulation was scrutinized on energy relevant consequences. For example building codes, regulations for car performance and waste disposal were reviewed and adjusted accordingly. Until 1982 most IEA countries had subsidy schemes and broad based information programmes expressing energy conservation efforts. Since 1982 more specific programmes were launched.

Three major categories of energy conservation instruments can be distinguished: information programmes, financial incentives and regulation and standards.

4.2.1 Information programmes

Information programmes usually serve a number of goals among which influencing consumer behaviour, education of target groups, handling of potential conflicts and implementing decision making can be distinguished. Apart from these intrinsic goals information dissemination is a necessary prerequisite when regulations and codes are at stake, as people have to receive the information. These goals are usually defined by national authorities, though local authorities, industry, utilities and oppositional groups also may launch major information campaigns. Especially in the federal states and in national states with a high degree of decentralization local authorities have a role for example in the execution of energy related legislation. In Canada the utilities manage multi billion dollar energy conservation programmes aiming at various target groups in the economic sectors. A widely known information campaign from the side of oppositional groups is from the anti nuclear movement in Europe (The well known symbol with 'No Thanks' to nuclear energy has unified oppositional groups throughout the European continent, Japan and the US).

The functions and objectives of communication efforts are rarely explicitly stated and made clear to the target groups, causing considerable suspicion among the audience. In fact, information campaigns are often designed to influence human conduct. However, the psychological mechanism is rarely explicit in the campaign design. The lack of clear ideas about the relation between information and behavioural consequences reflects the simple opinion that just giving information is sufficient and automatically leads to behavioural change. As results of information campaigns have been rather disappointing so far, this is clearly not the case. It is only recently that communication attempts are firmly based in communication psychology, basing communication models on cerebral information processing principles.

When evaluating communication efforts, information campaigns can be described according to the extent of participation from the target group and the orientation of the communication. The orientation of the communication can be described by four different approaches: the technical, market, justice and participation approach [5]:

- The technical orientation aims at passing information to a group of receivers, which are merely passive recipients.
- The justice approach is mainly concerned in the establishment of proper procedures for handling the communication. Participation of receivers

may be low. Basic idea is that decision making is expected to be optimized as procedures are transparent and known to all involved.
- The market approach is based on the idea of compensation. Decisions may have negative outcomes, but target groups may be compensated with jobs for the acceptance of a waste disposal. The target group is a market party and some price has to be established taking into account the advantages and disadvantages of all involved. The market approach is a very pragmatic one, not taking into account that ethical stands are usually not negotiable.
- The participation approach is based on the fundamental belief that decision become better if all parties involved have the opportunity to communicate their points of view and a final decision should be discussed until agreement is reached. The selection of one or a mix of these approaches should be made explicit as well, as the relationship with the audience is guided by these orientations. The choice for one or the other orientation also guides selection of the medium for the information. Public hearings are typically part of a participation approach.

Information campaigns have been focused on specific segments of economic sectors. The shift towards energy efficiency improvement has framed information campaigns in a more general framework than the initial import reduction objectives. The general information campaigns have been replaced gradually by more specific actions resulting in practical behavioral suggestions. The actors of information campaigns are more and more locally focused, as direct contact with the target group is of decisive importance for success. The shift to local information activities is reflected in the utility based information programmes, which momentarily are the main communicating agents in most IEA countries. A great number of information programme activities can be distinguished: general information campaigns, information campaigns through utilities, demonstration projects, energy audits, residential audits (energy teams), labels, guides and handbooks, technical handbooks, energy management, advisory services, training and education.

General information campaigns

Experiences in OECD countries reveal that benefits of improved availability of information through an information centre are difficult to determine, because more factors influence the willingness of company managers to improve housekeeping or to invest in energy efficient equipment. Most positive experiences were obtained when information programmes are combined with energy audits.

The effectiveness of information programmes is rarely measured for many reasons. As objectives and target groups are not explicitly described, it is not clear what effects were to be expected. Besides this more formal problem there are very few examples of information campaigns based on psychologic knowledge on information processing and sociological knowledge on information dissemination in social systems. Consequently, information is usually just handed over without a clear cut idea whether information should impact on attitudes (general awareness) or on behaviour. Both aims are quite different and urge different approaches. If it is intended to change behaviour than financial incentives (tax and levies, or subsidies) are a

much stronger instrument than general information campaigns alone, which, if carried out professionally, impact on attitudes.

General publicity campaigns are not very effective as far as behaviour is concerned, but may impact on attitudes. Virtually all EU countries have witnessed general information campaigns. Only a minority of these programmes has been evaluated scientifically. Apart from the intrinsic evaluation problems of these campaigns, some external factors can be identified that further complicate evaluation. Firstly, energy awareness campaigns may impact on energy behaviour together with price setting and regulations. In many instances price changes occurred during the campaign, thus concealing effects. Another complication is that the actors (and receivers) of information campaigns usually have a record. For instance national authorities launch other information campaigns or even repeat energy saving campaigns. For instance, in the Netherlands energy saving campaigns were aimed to impact on residential insulation investments in the late seventies. The explicit rationale was that energy bills should decline afterwards. In fact energy bills even increased for residential consumers as taxes on fuels were increased. For this false expectation a second national energy conservation campaign, though mainly supported with environmental arguments, met a lot of suspicion in the late eighties.

Even if post campaign evaluation reveals higher insulation percentages it remains unclear to what extent the information campaign caused the consumer's insulation activities. Having read leaflets indicates higher levels of interest among the readers, which also may have caused the activities. However, without the campaign un unknown proportion of the readers might have realized insulation anyway. This example again shows the necessity of an information processing model on the individual level, with clear pretest-posttest measurement with control groups. This is all the more important as these campaigns are very expensive.

Specific campaigns aiming at well defined target groups are sometimes undertaken. In the UK breakfast meetings for senior executives were organized. About 20,000 executives attended the sessions. About three quarters of them monitored their energy use, 44% arranged energy surveys of their premises and 34% appointed energy managers. The target approach shows a high success rate. The success of the campaign is attributed to the Secretary of State which was personally involved in the action.

Information campaigns through utilities

Through direct contacts with their clients, utilities can be in an advantageous position to inform their clients about conservation possibilities. They have considerable in-house experience with energy using equipment which can be important especially for smaller consumers. Furthermore, information from a utility is generally perceived to be more reliable than from most other sources. Utilities are probably the most crucial actors in the successful implementation of certain conservation programmes. However, although peak shaving may be in the direct, short-term interest of utilities, campaigns aiming at reducing overall energy demand are often conceived as contrary to their financial interests.

A precondition for a credible role for the utilities in energy conservation information dissemination is that they first transform to companies aiming at supplying energy services instead of selling energy carriers.

Some of the basic preconditions which need to be met before utilities become genuinely interested in demand side management are: existence of a regulatory framework to prevent misuse of monopoly situations; formulation and enforcement of environmental regulations; a tariff structure that stimulates consumers to prevent inefficient use and an overall tariff level that generates enough funding for maintaining and if necessary expanding the system.

Demonstration projects

Often, the introduction of new technologies or improved practices only start spreading rapidly after one or a few examples of implementation exist. For the majority of the people, just being aware of conservation possibilities is not sufficient. What is needed are successful examples in comparable situations.

A major disadvantage to participate in a demonstration project lies in the need for openness in spreading information to outsiders, especially competitors. Participators should therefore be selected very carefully.

The high costs of demonstration projects require a very careful selection from the extensive range of possible projects to limit the programme to those projects with the highest expected impact. The technologies selected should be new and not yet implemented in the country. The programme should be limited to proven technologies with a relatively short pay-back period under local circumstances. Another requirement is that there need to be a considerable potential for replication. Finally, the organizations selected need to state their willingness to share their experiences with outsiders.

Dutch industrial energy conservation programme TIEB

Project title: electricity and process heat from waste of anode plant

Character of the proposed project	:	market introduction
Economic sector	:	aluminium
Applicant Company	:	Aluchemie Rotterdam
Application	:	process renovation
Project costs	:	17,500,000 US$
Subsidy	:	3,400,000 US$
Project's energy conservation	:	13,600,000 m^3 natural gas equivalents
Estimated potential in the Netherlands	:	54,400,000 m^3 natural gas equivalents

At Aluchemie an annual 18,500 tonnes of rest material has to be convoyed. Of the rest material 96% is filter particles with a high carbon contents and 4% tar. It is considered to burn this material in the own plant to produce electricity and process heat. A feasibility study showed that 2350 kW process heat and around 4 MW electricity can be generated for own use. The remaining electricity can be delivered to the national grid.

The market introduction aims at showing the viability of designing, constructing and exploiting of this equipment meeting new environmental regulations. It is expected that the installation will make 8100 hours of full capacity, resulting in 13.6 million m^3 saved natural gas annually. Moreover the costs to be made for transportation of the rest materials will lapse.

A boiler has to be installed with a heat intake of 19.3 MW, with which 25 tonnes of high-pressure steam can be generated, resulting in an overall efficiency of 35.5%.

A problem is optimum incineration of the very fine filter particles. This is solved with a newly developed boiler, integrating fluidized bed combustion technology. The filter particles together with the cryogen (-70°C) moulded tar products are palletised for application in the boiler's incineration process.

A successful example of an industrial energy conservation measure is the combined financial and information TIEB in the Netherlands. Based on the National Environmental Plan (NMP and NMP+) the Ministry of Economic Affairs issued the Energy Conservation Guidelines. In these guidelines policy is developed to influence sectoral energy use in the Netherlands. The core idea is that the industrial sector has its own responsibility for taking energy conservation measures to contribute to the national environmental priorities. In the framework of the national environmental policy national objectives for the reduction of CO_2 emissions have been established. The objective for the industrial sector is formulated as a 20% improvement of energy efficiency in the year 2000 compared with the 1989 base year [6]. This objective is supported by the Tender Industrial Energy Saving (TIEB). The subsidy measure is designed as a tender, which permits companies during a limited time period to apply for energy relevant projects. At the end of the application period the applications are judged and ordered according their perspective on energy savings and the extent of reproduction of the project. After three years tenders were focusing on process innovation, electricity savings in processes, energy saving plans and energy management.

The programme has been evaluated in 1993 with the following conclusions:
- Energy saving projects have been started earlier (52% of the applicants).
- The subsidy results in the formulation of actual energy saving projects (54%).

- Three out of ten projects should not have materialized without TIEB; however four out of ten would have realized the project anyway, although at a lower speed (32%) and with less quality (38%).
- One out of seven of the accepted projects does not materialize.
- Tender procedures, the management and execution of the programme are positively evaluated by the applicants.
- However, the extent of knowledge transfer from projects in one company to others in the sector has been insufficient, as a strategy for transfer is lacking.
- The Netherlands Agency for Energy and Environment (Novem), an intermediary between the Ministry of Economic Affairs and the research institutes is responsible for the execution of the tender.
- The projects are covering three categories, being demonstration projects, market introduction projects and studies. Over all categories 87% of the projects match the estimated savings. Process innovation is technically possible in 63% of the cases, however, substantial economic improvements cannot be expected of the innovations in 59% of the cases. Applicants are mainly the big companies (over 200 employees). The small and medium sized industries do not yet apply. For about 75% of the applicants energy costs are a substantial part of total costs.
- Some figures: Of a total of about 45,000 companies, 15% is responsible for 95% of the entire sector. TIEB resulted in energy savings of over 25 PJ in the 1990-1993 period. Savings are realized through the execution of more than two hundred projects [7]. In this report four examples of TIEB projects are given in boxes throughout the text.

Energy audits

As the energy field is complex and an analysis requires highly specialized knowledge, the economic actors often lack this knowledge, especially in case when their products do not involve large quantities of energy. Energy audits provide detailed on-the-spot analysis of a company's energy demand, sometimes at process level. Extended energy flow monitoring can be done by the company's own personnel. However, identification of conservation options, can generally be best conducted by external experts. The costs for these audits can be partly funded through financial support of the government. Experiences in the IEA show that audits are most effective if combined with other instruments, such as information campaigns, investment support or interest subsidies.

Interest to participate in an energy auditing programme will be highest if the companies involved expect to have a considerable chance to obtain external funding for the proposed conservation measures. It is of limited use to make available government support for energy audits, when users do not have access to sufficient funding. From that view-point, this would mean that without government investment support an arrangement to finance (partly) the costs for energy audits should have a low priority. However, even without proposals for investments, energy audits can render suggestions for improved operating practices (good housekeeping).

With energy audits kilowatts can be saved on the one hand and awareness of the energy end-use can be heightened.

Big companies usually can afford these audits themselves, but the small and medium scale industries cannot. In many countries these services were provided to the latter companies, in the framework of an auditing programme financed by government. In some countries the Ministry of Energy provided the specialists, while in others private auditors were subsidized by special government programmes. In the UK 50% grants were provided to cover these costs. In the US a massive residential energy audit programme has been launched: the Residential Conservation Programme. Utilities were allowed to provide Class A audits, in which a highly qualified utility expert conducted an on-site inspection of the premises, performed most of the calculations for the resident and recommended conservation measures. The Class B audits were partly carried out by the resident himself, as far as data collection and data transfer to the specialist is concerned.
In Denmark energy audits are obligatory when existing buildings are purchased. New buildings already are under building regulations and codes.

Energy audits in small and medium sized companies in Europe during the early eighties were rather successful. In Italy energy saving potentials per audit are reported to be 10 to 20% on average in the industrial and energy service sector. However, no follow-up visits were made and consequently effectiveness remains unclear. In the second half of the eighties energy audits in the EU were extended to the high energy intensity industries. A comprehensive evaluation has not been carried out. It seems that the audits lacked adequacy in a number of respects. The audits were not focused on process energy as the teams lacked measurement equipment. The audits did not analyze the entire energy flow in a company. Energy use involved in the vehicle fleets was not considered. The focus on mere energy savings did not take into account sufficiently the economic cost-benefit ratio for the company concerned.

Current energy audits, though more sensitive to customer's needs, are still generating limited success. Diversity in the target group, decision making structures in large companies, and the minor share of energy costs in the total company's costs are the main inhibiting factors. Low world market energy prices suppress the need for energy efficiency measures for industry.

Residential audits: Energy teams

The majority of audits is carried out in the commercial and service sectors. However, some countries, such as the Netherlands, Sweden and Denmark established energy audits for residential customers. The E-teams are a utility effort in which they offer their service to customers in need of an energy conservation analysis in target areas (a village or region). results are promising as a high percentage of the advises results in actual insulation measures and behavioural changes.

Residential home audits are successful if the utility involved shows an aggressive approach. If the audit is targeted to both electricity and gas use efficiency, utilities have an interest in good results. However, if audits result in a switch in fuel use, as was the case in the US when customers saved oil for space heating which is not of interest to the utility, little incentives remain for the utility. Energy audits, however, remain a very costly affair. Good targeting and high flexibility, combined with financial incentives are

most promising. Especially middle income groups participate in the audits in the US. Their savings reached 9%, with a high participation rate. Cost-effectiveness of the energy audits is low in most countries.

Labels, guides and handbooks

Energy labelling provides a useful tool to customers to compare products on the energy demand dimension. This is particularly important to heighten market transparency and to induce production of energy efficient appliances. It provides an upstream policy instrument, which can be highly effective and which is easy to implement. For instance energy wasting in cooling in the OECD countries is highly reduced as the result of labelling of the appliances. Producers were encouraged to find the best alternatives. On the waves of environmental concerns one can perceive that producers are stressing the environmental qualities of their products in advertising campaigns. Another aspect of energy labelling that has to be considered is that it opens up the possibility of trade barriers among countries. In the EU for instance, European labelling was introduced in order to avoid artificial trade barriers. This sometimes causes heavy political tension among countries as the highly technologically developed countries have to slow down, in favour of the less developed ones.

In the transportation sector almost all IEA member states have fuel consumption programmes. Information is provided on fuel use of the new vehicles, proper vehicle maintenance schemes and proper driving conduct. The information consists of labels, state publicized lists, booklets, workshop guidelines, and television and radio advertisements. The governments have specialized units providing testing under specified circumstances (procedures are laid down in handbooks) in city use and road performance. In many countries older vehicles have to be controlled in specialized auto workshops at regular intervals. Motor performance is checked with analysis of various exhaust gases. After adjusting the motor the vehicle obtains a certificate being valuable for one year. Without a certificate the vehicle cannot be purchased.

Consistent, comparative information to consumers has dual influence on consumer's decisions on purchases of appliances and on enhancing competition among manufacturers. Consumers save energy but a significant effect to date is the economic competitiveness of the manufacturers in face of the import of products in their inland market.

In transportation credible information on fuel consumption is believed to be fundamental for consumer's decisions on buying vehicles. Awareness as a result of the labelling programmes is highly enlarged. In the US about half of the customers were found to take into account fuel economy figures.

Technical handbooks

Technical handbooks are designed for various target groups. For the residential energy consumer simple handbooks contain details on how to save energy: high cost insulation measures as well as low cost weatherization measures and energy friendly behavioural changes. Energy managers are supported with manuals detailing on combustion process control and heat recovery schemes. Besides this general information, technical handbooks support the establishment of energy management systems, usually

applicable in specific economic sub sectors with high energy end-use characteristics or with products with a high product energy cost rate.

Energy management

In many countries energy managers are installed in larger industries and service sector companies. The energy manager is responsible for the energy components of the entire production process or, even more fundamental, the complete energy flow entering the premises. Usually the energy manager advises general management on energy aspects of good housekeeping, retrofitting existing installations, replacement of obsolete devices and changing production processes and new products. The energy manager should be approached with industrial energy saving instruments (subsidies, grants, information) in the framework of industrial energy efficiency programmes.

Dutch industrial energy conservation programme TIEB

Project title: energy saving through low NO_x-liners in a gas turbine in paper industry

Character of the proposed project	: market introduction
Economic sector	: pulp and paper
Applicant Company	: Parenco
Application	: process renovation
Project costs	: 130,000 US$
Subsidy	: 55,000 US$
Project's energy conservation	: 950,913 m^3 natural gas equivalents
Estimated potential in the Netherlands	: 7,600,000 m^3 natural gas equivalents

Parenco is specialised in the production of newsprint. Parenco operates a General electric frame 5 machine, for which a lowered, national NO_x emission norm of 65 g/GJ has to be applicated since January 1993. The norm can be met with application of steam injection in the turbine.

Now Parenco wants to replace the current steam injection units with low NO_x-liners. Low NO_x-liners permit replacement without reducing gas turbine power and efficiency. However reduced steam injection results in lower energy process demand. Low NO_x-liners consist of a covering with holes allowing a better burning process thus lowering NO_x emissions (-15 to 20%). Measurement show that 1 to 1.2 tonnes per hour high pressure steam is saved.

The combination of steam injection and low NO_x-liners is not tried before in the Netherlands. Technical risk of the application of low NO_x-liners is that the process hot path, including the burners, will wear more quickly, demanding for rapid replacement. Also performance of the liners is uncertain. As a result losses can be significant, partially because of costs incurred by taking the installation out of process.

Reconstruction of the gas turbine, including cooling down, test runs and starting, takes about a week. Application of the new process combination is possible in industry with the same make and type of gasturbine.

Advisory services

Advisory services are provided by different actors. Governments established units inside energy ministries or in institutes at arm's length which provide energy relevant information to target groups. Regional advisory centres can be found in Canada, Switzerland and the Netherlands. In the latter case these centres also have a task in implementing national energy conservation policies concerning energy R&D and subsidy arrangements. Advisory services use the complete communication array ranging from offices, telephone services (Ireland and Canada) to videotext

(Belgium). Advisory services are increasingly provided by utilities, especially when electricity generation is separated from distribution. The latter have some interest in energy conservation, whereas the former are usually willing to increase energy sales. In some countries energy service industry plays a role in energy conservation measures, such as the central heating industry and central heating appliance retailers in the Netherlands. Strong line organizations in the Netherlands, unifying virtually all producers in the insulation, cooling and heating sub sectors, also provide specific product and process information. In the EU the IEA sponsored institution CADDET is aiming at the dissemination of energy conservation measures, both at the technical and informational level.

Training and education

As a lack of adequate information and technical skills have hindered realization of the existing energy conservation potentials, a vast amount of resources has been dedicated to improve levels of knowledge and skills. For instance Switzerland considers training as the major industrial energy conservation component of its policy programme. Government is providing funds to private companies specialising in rendering energy conservation consultancy services. Japan has an extensive training programme for energy managers. Other countries have special courses for truck drivers. The Canadian government started residential energy consumers programmes to overcome the lack of knowledge concerning energy conservation measures. Many governments have special energy programmes for buildings owned and used by national, regional and local authorities.

The energy service industry is subject to special attention in many countries. Construction companies have to get acquainted with new materials and building concepts. Information alone is insufficient to break through barriers of building customs. In the Netherlands high efficiency residential heating appliances did not reach the market as the technology was new and required special skills not available at the time of introduction. A special subsidy programme was set up by Dutch government, although an infrastructural lack of information and skills caused delay to the introduction. Workshops and seminars would have been much more effective probably.

4.2.2 Financial incentive programmes

Financial incentive programmes can be distinguished for industry and other economic sectors, but notably the residential sector.

Financial incentives are an important tool for influencing consumer behaviour. Energy conservation behaviour emerged as a consequence of the first oil shock. Investment in residential insulation measures or company measures to reduce energy costs were inspired by the high market prices. However, during the late seventies and the early eighties price incentives disappeared and energy efficiency measures in industry and other economic sectors slowed down.

There are three main types of financial incentives: grants, tax incentives and low interest loans and guarantees. Actual execution of these instru-

ments varies considerably with respect to domain, application procedures, returns and government control over the instrument.

Grant programmes

Grants are usually intended to stimulate conservation investments in energy end-use sectors by partially covering total investment costs. In 1984 grants represented about 60% of all financial incentive programmes in the IEA. Grants are specifically dedicated to improve the rate of return. Grants are instrumental for the provision of capital to poor segments in society. Grants have been employed to develop energy service industry and to demonstrate confidence in new products, such as the High Efficiency Heater in the Netherlands. Grant programmes require extensive paper work for an adequate administration. Bureaucratic procedures can hamper the effectiveness of programmes, especially in small and medium sized businesses. Grant programmes can be designed as a selective tool, but usually execution becomes rather complex.

The attractiveness of grant programmes is narrowly related to the tax regime in a country. Sometimes grant programmes are more attractive to non-tax paying and tax-exempt companies than to tax-paying companies. The quality of a programme can be expressed with the incrementality index, which is defined as actual activity minus predicted activity, the latter based on a comparison group not receiving the grant. A high incrementality indicates a successful programme, whereas for instance energy intensive industry has a strong drive towards motivation anyway, which results in the prediction that activities will occur. This decreases the incrementality index. The incrementality index depends on the eligibility criteria and the percentage of the investment provided. Narrowly defined programmes show better results. Effectiveness is highest when grants are dedicated to specific sectors, or, when the grant was made dependent on the ratio of investment cost and energy savings.

However, a Swedish evaluation of grants revealed that no systematic correlation existed between subsidies and improved energy efficiency. Due to the high turnover rate of capital stock in Swedish industry total grants provided were only a small fraction of total industrial investments. Most of the grants were given to industries with high energy intensity in which strong motives for energy conservation already existed. Moreover, some indications existed that industry did not invest in the highest economically profitable projects (which were not eligible for financial support), but in granted projects.

In the Netherlands the grant programme for CHP has been very effective. The grant funds were exhausted for several consecutive years. The electricity generation organization even signalled the difficulty of further dissemination of CHP for their planning: planning electricity supply becomes increasingly difficult if many small and larger CHP owners offer electricity to the grid.

Tax incentives

Tax rules, such as the allowed rate of depreciation, affect investment behaviour. Favouring investments in (energy) efficient equipment by allowing faster depreciation than with ordinary equipment, can be politically more

easily acceptable for the state budget than the application of subsidy programmes. Shorter periods of depreciation reduce the unfavourable effects to the company of inflation. For the state, total tax proceeds over a longer period will not be affected, but current tax proceeds will be shifted further into the future. This could result in a strong incentive, especially for relatively small firms, because for large investments the constraint of limited access to capital is expected to be dominant. A disadvantage is that relaxed taxes would not constitute an incentive for loss-making companies, as the latter are exempted from tax paying. Only profitable companies, generally having a larger chance to make investments profitable over the lifetime, would benefit from this type of support. However, at the same time this is an important advantage compared to subsidies, because it reduces market distortions.

Tax incentives are about 20% of financial incentive programmes. Tax reductions and exemptions are quite common, apart from tax credits. Reductions in tax rates and accelerated depreciation are widely used tools. Tax incentives for energy conservation are usually integrated in general tax incentives available to the consumer. Another feature of tax incentives is that they are often applied in combination with other energy conservation measures. Tax credits and allowances are easy instruments to administer, but harder to control in financial terms as accounting is complex. Residential tax incentives are mainly beneficial to higher income strata, which again proves that these instruments are difficult to be made selective.

The experience with tax incentives is widely diverging. In the US and Canada the instrument has not been effective. On the contrary, in Japan and the Netherlands this instrument has proven to be very effective with cost-benefit ratios around 1 to 5. In Japan two-thirds of all industrial investors took the tax credits, expanding and accelerating investments considerably (cost-benefit ratio estimated to be 1 to 3).

Soft loans

Soft loans make financial resources available at interest rates some percentage points below market level. Favourable loan instruments have been applied in Sweden (construction of buildings), the Netherlands (CHP) and Austria. As with grants, financial means are made available with soft loans at the beginning of an investment. The grant element of soft loans is small compared with market conditions for loans. However, the beneficial effect of the soft loan is spread over the entire term. It is important to take into account that companies usually have an interest in 'quick money', which may be a good reason for limited success of the loan instrument. On the other hand with the same volume of financial resources, government reaches a greater number of energy users than with grants.

In the industrial sector the effectiveness of loan programmes has not been examined. Loans are applied in combination with tax credits, the latter often being a larger part of the total financial support.

Loans on favourable terms in the Swedish residential sector appeared to be a very powerful instrument to induce energy saving measures. Thermal insulation of buildings improved strongly as the conditions for the loans were very attractive: Interest rates below the inflation level reach market

levels after 10 to 40 years. Efficiency measures in both new buildings as well as retrofit in old buildings, were enhanced. In the Dutch electricity transformation sector subsidies and risk-sharing loans amounted to 15% of total costs for DH projects. Government guaranteed commercial loans give in to risk-sharing needs felt by the sector. In general, in Germany and in the Netherlands favourable loans have been effective.

The transformation sector is encouraged to introduce Combined Heat and Power (CHP) cycles. The heat is often used in a local District Heating (DH) projects or in greenhouse agriculture. CHP is stimulated with financial incentives in Austria, Denmark, Germany, the Netherlands and Sweden. In Germany CHP has generally proven to be cost-effective: the cost-benefit ratio was 1 to 3 in the mid eighties. Later on this ratio declined as a consequence of decreasing world market oil prices. Subsidies in Denmark and Sweden for DH (10% for DH grids) accelerated DH considerably for a variety of favourable marginal conditions: no gas in the heating market, high levies on oil products, and circumstances with cooperative utilities. In Denmark the Heat Supply Act established the legal framework for the DH promotion, as price controls for grid-based energy were designed such that DH was promoted. Over time, however energy savings were reduced and even reversed. In response to the new situation Denmark further enhanced its supportive measures with improving investment conditions by reducing the initial outlay through an indexation system. The system allowed fixed yearly payments in 1986 currency and a spread of the pay-back period over twenty years.

4.2.3 Regulations and standards

Regulations and standards are an upstream policy instrument. Producers of consumer goods are facing normative standards to which their products are judged. Virtually all IEA countries use these policy instruments, as implementation is relatively easy and effects can be substantial for certain products. The standards can be mandatory or voluntary. In both cases market responses are likely as products not meeting the standard will disappear from the market, either by government control or by negative publicity from the side of consumer organizations. Especially in the markets of household appliances (refrigerators, washing machines) standards have encouraged impressive energy efficiency improvements. Regulations and standards are applied in household appliances, buildings and vehicles.

In general, standards and regulations are most useful in case energy consumers have high implicit discount rates (i.e. require very short pay-back times), in combination with having a large freedom of choice. Main disadvantages of standards and regulations are their inflexibility and the fact that they are hard to change once being formulated. Furthermore, they do not constitute a least-cost method in the decision process to invest in energy efficient equipment. Advantages of standards and regulations are their conceptual simplicity and the fact that they are generally easy to implement.

For industry, imposing standards and regulations is not thought to be practical because of the diversity of end-uses and the inflexibility of the measures. Accordingly, in most IEA countries the industrial sector is not con-

fronted with energy efficiency standards, as most governments expect the market mechanism to function in this respect. The variety of products and processes in industry make regulations very difficult to implement. In Japan and the Netherlands industrial companies are hold to produce a plan in which energy flows and waste flows have to be described before a permit to establish a business is granted. In most countries regulations and standards are mandatory. Mandatory measures in Japan include the appointment of energy managers and the design of energy plans for buildings with a floor space of over 2000 square meters. In Portugal large companies (annual energy consumption of over 1000 toe) are required to establish energy management services and to design energy efficiency plans to be approved by the General Directorate for Energy every five years. In the US the same goes for companies with an annual energy consumption of over 25000 toe.

In the residential sector regulations and standards are applied in many countries. The long life-span of buildings lead to considerable long term energy savings. Applied measures during construction are usually very cost-effective, easy to implement and require minor additional investments. Measures applied in buildings are: minimum thermal efficiencies (prescriptive standards) or levels of performance (performance standards), heating system efficiencies, individual metering, boiler maintenance requirements and air condition regulations. Also the retrofit of residential housing and office buildings is extensively prescribed in terms of materials and applications. However, costs are usually much higher for retrofitting than for the same measures applied in the construction phase.

Appliance labelling is increasingly regulated in the IEA. The EU publishes guidelines for member countries detailing on performance standards and control of servicing of heating systems. Denmark requires a heat inspection report when the building is sold.

In the transportation sector, the US and Canada have mandatory programmes for automobile manufacturing industry detailing on fuel efficiency standards. Germany, the Netherlands and Austria require regular inspections of passenger cars when vehicles pass a certain age. Emissions and fuel efficiency maintenance are mandatory in these countries. Speed limits on highways exist in most IEA countries, although the limits differ substantially. However, both regulations in transportation are induced by environmental concerns rather than energy saving considerations. Standards require additional information programmes focusing on target groups. Besides that, manufacturers and car importers are to be signalled that their products should be redesigned, which requires the design of special information e.g. handbooks and manuals for these target groups.

Building codes and standards

Building standards ensure lower limits for energy efficiency performance at the construction of houses and office buildings. The construction sector is rather conservative as new technologies are concerned. New technologies require adjustments of efficient routines, causing difficulties in the design phase, delaying actual construction and increasing after-sales efforts. In the construction sector a myriad of interests is involved, which ends in laborious procedures when building codes are to be revised. The time-lag bet-

ween the new codes and actual building practice is often more following practice than normatively leading building practices. In Sweden building practices were altered about two years before these changes were enacted. It is concluded that if the institutional infrastructure delays the acceptance of new codes, it might be more worthwhile to influence basic material industry, construction companies and customers with information to support the autonomous building market processes. Only in specific cases, such as with wall insulation in the Netherlands, building codes can overcome initial consumer objections. As may be the general principle, government involvement in economy should be considered especially in these cases where the market does not result in the desired actions of the market parties, such as is often the case with energy efficiency activities.

In the EU most countries could have more stringent building codes from a cost-benefit perspective, since buildings have a long expected lifetime. During the lifetime energy costs should be predicted based on the probable energy price level in the medium term. Additional costs to be made at the construction are minor compared to the expected costs to be made for space heating. An IEA commission.. 'believes that building codes for new buildings are very important because 20% of the buildings still standing in 2000 have not been built yet and insulation is two to four times less expensive during construction than during retrofit.'[2]

Appliance standards

Standards for appliances are an extremely effective tool because the instrument has an impact on the consumer as well as the producer side of the market, without affecting the market mechanism itself. In the US the Department of Energy issued the first appliance rule making under the 1987 National Appliance Energy Conservation Act. Minimum efficiency standards were established for 11 categories of appliances: refrigerators, freezers, small gas furnaces, dishwashers, clothes washers and dryers, water heaters, room air-conditioners. It takes some years before testing procedures are accepted by the industries involved. Procedures in the US are aiming at maximum energy improvement being technologically and economically feasible. Seven factors are considered [8]:

- the economic impact of the standard on the manufacturers and on the consumers of the products;
- savings in operating costs throughout the estimated average life of the product compared to the increase in product price, including installation and maintenance;
- total amount of projected energy savings;
- any decrease of the utility of the product;
- impact of any decrease of competition;
- the need for national energy conservation;
- other factors considered to be relevant by the DOE.

The pay-back time of three years is taken as point of departure for economically beneficial consumer investments. Appliance standard development procedures include a public comment period, and after incorporation of criticisms another oral public comment opportunity at the standardization commission's premises. Finally, all comments are taken into account in the final rule-making.

Adequate appliance standards require permanent research and development from the side of universities, manufacturers and the authorities. The standards are best supported by utility rebate programmes for consumer's purchases of appliances, and the support of R&D. In the US several utilities are reported to gain money with this approach through delayed investments in electricity generation capacity.

A high level of cooperation between authorities and manufacturers is a necessary precondition for any standardization programme. An important side effect of standardization programmes is the increased competitiveness of consumer products in the international marketplace.

Automobile fuel efficiency standards

Attribution of fuel savings to fuel efficiency standards in transport has been attempted in Australia, Canada and the US. Standards were difficult to evaluate and no relationship could be made plausible. Efficiency standards can be defined in terms of individual car performance, which is verifiable. However, targets can also be defined in terms of fleet sales. The latter is not the preference of car manufacturing industry. Nevertheless, industry did improve energy efficiency standards rapidly, surpassing existing standards, as soon as gasoline prices rose sharply in the 1978-1980 period. After this period, which was characterized by decreasing gasoline prices, major car producers were not able to meet the fleet average of 27.5 miles per gallon in the US. Notably, efficiency improvement in car performance is strongly supported by rising gasoline prices.

5. EVALUATION OF EFFECTIVENESS OF ENERGY POLICY INSTRUMENTS

5.1 General conclusions on information programmes

Any intervention in the market from the side of the authorities will make use of information programmes, as other intervention instruments (financial incentives, and regulations and standards) have to be communicated to the target groups.

General information campaigns have been launched regularly by most IEA countries. It is only recently that evaluation procedures are integrated in these programmes. The definition of target groups, the actor and his goals, communication channels, psychological impact of the communication and the focus on attitudes or behaviour have long been neglected. Recent insights are that information transfer should be undertaken based on a sound theory of information processing in the individual. Only than it becomes clear why more information not necessarily leads to better understanding and higher information levels in the target group.

Some general principles of information programmes can be derived at:
- Information programmes form the cornerstone of all policy programmes and are valuable in ensuring the success of other types of policy measures.
- Energy audits, particularly in the residential sector, can be more effective if combined with financial incentives.
- Information programmes help ensure continuity of energy conservation activities, even in rapidly changing market conditions.
- Information programmes have higher success rates if made flexible and responsive to the target group's needs.
- Awareness and motivation need to be reinforced periodically.
- Specific programmes targeting at narrowly defined groups are more effective than general information campaigns.
- General campaigns make sense only in case other energy efficiency measures (grants, loans, standardization) need to be communicated to the broader public; behavioural shifts are not to be expected from general information campaigns.

In table 5.1 the various energy policy instruments that have been used by IEA governments are presented, together with the instrument's objectives, and occurrence. In the next columns the market limitations which are addressed by the instrument are mentioned followed by the most important conditions for application of the instrument. Finally, the instrument's efficiency, as estimated by IEA experts or measured in a minor number of cases is given. As can be derived from the table utility-based information programmes, demonstration projects and labels and guides have proven to be effective inducing industrial energy conservation.

Table 5.1 *Summary of information programmes*

Policies/programmes	Objectives	Occurrence	Limitations addressed	Implementation conditions	Estimated effectiveness
General information campaigns	• inform on policy • support decision making • education • handle conflicts	IEA	• knowledge gaps • communicate government policies • political stalemates	• highly educated and involved population • high penetration of media • trust, acceptance	• hardly assessed • sometimes discouraging results • unfavourable cost-benefit rate
Information through utilities	• peak shaving • delay capital investments	most of IEA	• unknown possibilities • practical advises	• image of trustworthiness and expertise • regulatory framework • adequate tariff structure	• highly effective • easy target group selection
Demonstration projects	showing implementability	most of IEA	reluctance to innovation	• proven technology • short pay-back times • careful selection of participants	highly effective
Industrial energy audits	• Demand Side Management • showing implementability • show cost effectiveness	most of IEA	• reluctance to innovation • fear for negative effect on operational security	• proven technology • short pay-back times • embedment in regulatory structure • high level of experience of auditors	• mixed results • high costs
Residential energy audits	• showing implementability and cost effectiveness	Canada, the Netherlands, Sweden, Denmark	• relieve ignorance • improvement of knowledge	• unfamiliarity • non-acceptance • applicability • combination with financial incentives	• high costs • highly effective in middle income classes
Labels and guides	• comparison of products • increasing market transparency • inducement of efficient products	IEA	• lack of market transparency • lack of knowledge	• awareness for artificial trade barriers • intensive interaction authorities - companies	• highly effective with adequately functioning authorities

Source: Energy Conservation in IEA Countries, IEA, 1987 (adapted table)

Table 5.1 *(continued)*

Policies/programmes	Objectives	Occurrence	Limitations addressed	Implementation conditions	Estimated effectiveness
technical handbooks	• support to do-it-yourself • stimulate energy analysis capacity	most IEA	• lack of knowledge • availability of practical support	selection of target group critical	• effects unknown • effects not only dependent on handbook
energy management	• making energy an issue in company • add energy analysis to other operational considerations	most IEA	low priority of energy aspects in company decisions	• high energy intensity industry • energy proportion of product price large	• mixed effects • highly dependent on high level management participation
government based advisory services	permanent dissemination of products and processes	Switzerland, Canada, the Netherlands	barriers to innovation	• specific economic sectors • high degree of cooperation in economic subsectors	effects are unknown
training and education	improving analytical and technical skills	most IEA	lacking skills	• specific economic sub sectors • adequate analysis of actual needs	structural effects existent but difficult to quantify

Source: Energy Conservation in IEA Countries, IEA, 1987 (adapted table)

Dutch industrial energy conservation programme TIEB

Project title: oxy gas use in basic iron industry

Character of the proposed project	: market introduction
Economic sector	: iron and steel
Applicant Company	: Hoogovens
Application	: process renovation
Project costs	: 3,000,000 US$
Subsidy	: 750,000 US$
Project's energy conservation	: 5,930,000 m^3 natural gas equivalents

Hoogovens produces warm and hot rolling mill steel products, coated as well as uncoated. With realisation of a system of suppressed burning the total quantity of oxygas (final process gas with 70% CO content) has strongly increased. This gas was burned off before, although the gas is applicable in the process, replacing natural gas as prime fuel. The project aims at redesign and reconstruction of the infrastructure for this replacement.

Important components of the project are:
- instalment of a second oxy gas ventilator for increased transport capacity to target users in and outside the plant;
- oxy gas pipeline to new clients;
- a management system to ensure optimal distribution to clients as well as enrichment of furnace gas to be transported to the extern electricity generation plant, controlling for a constant caloric value of the gas mix;
- filtering of the oxy gas to be distributed to the gas motors.

5.2 General conclusions on financial incentive programmes

Financial incentive programmes are rarely evaluated. Partially this is due to pragmatic and opportunistic reasons: show that you do something in view of pressing national, environmental or economic needs (e.g. to save on the national energy bill). Paying attention to the effects seems to be less attractive to politicians. On the other hand these instruments are very difficult to evaluate as structural economic developments and the investor's price perception are difficult to separate from programme effects.

Fundamental issues for effectiveness of programmes include:
- ability to overcome market limitations,
- ability to encourage incremental conservation investment,
- extent of energy efficiency improvement induced,
- cost-effectiveness.

Cost-effectiveness of the financial incentives requires explicitness of a number of preconditions. The IEA uses the present value of the total accumulated energy cost saving during the whole life-cycle of the equipment. Incrementality is assumed to be 50% as the shares of free-riders and genuine incremental investors is small with a large grey zone in between.

Up to the early eighties governments tried to maintain action momentum by providing financial incentives to overcome market and technological barriers of energy efficiency improvement. Incentives in industry have been used for a variety of activities: energy audits, feasibility studies, CHP and district heating, heat recovery systems, refuse incineration plants, insulating

materials, improved heating systems, heat pumps, control systems, and R&D. The costs covered by the incentives are estimated to be 7 to 30% of total investment costs [2]. The programmes are sometimes specific on pay back times, ratios of investment costs and energy savings, or an energy saving threshold expressed in minimum percentages to be achieved.

The evaluation of the various financial incentive instruments is shown in table 5.2.

- Financial incentive programmes are widely used throughout the IEA, and have shown different levels of incremental effect. The effect is contingent with the specificity of eligibility criteria, carefully chosen percentages of total investment costs provided by the programme and the definition of the target groups.
- Grant programmes usually show positive cost-benefit ratios, particularly in industry.
- Grant programmes are likely to be more cost-effective than any other financial incentive programme on an average.
- Financial incentives can be valuable to introduce new energy technologies in situations where costs are just above a competitive level or where new technology is not penetrating for other reasons.
- Grant programmes are expensive and difficult to implement; implementation often needs involvement of local authorities.
- Grant programmes in the owner segment of the residential sector have been very popular, resulting in energy savings of around 12% for retrofits. The rent segment has not yet responded to these instruments.
- Financial incentives need complementary instruments such as information dissemination programmes for target groups, as well as for selection of the investments with highest expected incremental effects.
- In the transformation sector risk-sharing through guaranteed loans seems to be effective in case risks for utilities in expansion of grid-based energy systems are felt to be high.

Table 5.2 *Summary of financial incentive programmes*

Policies/programmes	Objectives	Occurrence	Limitations addressed	Implementation conditions	Estimated effectiveness
Industry					
Grants	selective stimulation energy conservation investments	most of IEA	• financial attractiveness and access • confidence • lack of information	• relatively high energy prices • relatively long pay- back times	• expansion and acceleration of investment • facilitation of introduction new technologies • favourable cost- benefit ratio • created awareness • administratively complex and expensive • highly selective instrument
Tax incentives	selective stimulation energy conservation investments	US, Canada, some European countries, Japan	• financial attractiveness • confidence	• relatively high energy prices • relatively long pay- back times	• simple implementation • created awareness • easy application • not applicable to non-tax-payers
Favourable loans	selective stimulation energy conservation investments	Japan, Germany, Austria	• access to capital • confidence	• relatively high energy prices • relatively long pay- back times	• moderate market interference • facilitating access to capital • incrementality difficult to assess

Source: Energy Conservation in IEA Countries, IEA, 1987 (adapted table)

Table 5.2 *(continued)*

Policies/programmes	Objectives	Occurrence	Limitations addressed	Implementation conditions	Estimated effectiveness
Residential and commercial sectors					
Grants	• selective stimulation energy conservation investments	half of IEA member countries	• financial attractiveness and access • confidence • lack of information • separation of expenditures and benefits	• relatively high energy prices • relatively long pay- back times	• information provided to consumers • improved financial attractiveness • favourable to development of energy service industry • poorer cost-benefit ratio • created awareness • administratively complex and expensive • highly selective instrument
Tax incentives	• selective stimulation of energy conservation investments	US, UK, Austria, Belgium, Denmark, Germany, Japan, Switzerland	• financial attractiveness • confidence • lack of information • separation of expenditures and benefits	• relatively high energy prices • relatively long pay- back times	• lower government involvement • mainly used by higher income groups
Favourable loans	• selective stimulation of energy conservation investment	Japan, Germany, Denmark and Sweden	• access to capital • confidence	• relatively high energy prices • relatively long pay- back times or high initial outlays	• incrementality difficult to assess • easing retrofit in buildings
Energy transformation sectors					
Grants	stimulation investment in CHP/DH	half of European IEA countries	financial attractiveness and access	• relatively high energy prices • high implementation costs	• reduced investment risks • high incrementality • favourable cost-benefit ratio similar to industrial programmes
Tax incentives	• selective stimulation energy conservation investments	Austria	financial attractiveness	relatively high energy prices	effectiveness not measured
Favourable loans	• selective stimulation energy conservation investments	Austria, the Netherlands, New Zealand	financial attractiveness	relatively high energy prices	effectiveness not measured

Source: Energy Conservation in IEA Countries, IEA, 1987 (adapted table)

Table 5.3 *Summary of regulation and standard programmes*

Policies/programmes	Objectives	Occurrence	Limitations addressed	Implementation conditions	Estimated effectiveness
Building codes	upgrade efficiency new building stock	IEA	• invisibility of energy consumption • lack of information • separation of expenditure and benefits	• major energy price increases • consultation with energy service industry	• very effective in overcoming market limitations • energy efficiency improvement in periods of low energy prices • cost-effective for new building stock • provision of long term signals • easy to regionalize
Appliance efficiency standards	upgrade efficiency of new appliances	Japan, US, Germany	• invisibility of energy consumption • high discount rates • lack of information • separation of expenditure and benefits	• major price increases • consultation of energy service industry	• effective though difficult to measure • appliance labelling more preferred than standardization
Fuel economy standards for new cars	upgrade efficiency of new cars	• most of IEA • US has slightly relaxed mandatory programme	• weak drive to innovation • lack of information	• major price increases • consultation of manufacturers and importers • careful timing of target periods	• directed towards manufacturers and importers • energy efficiency improvement in periods of low energy prices • possible artificial trade barrier

Source: Energy Conservation in IEA Countries, IEA, 1987 (adapted table)

5.3 General conclusions on regulations and standards

Regulations and standards have an enormous potential for energy efficiency improvement. Introduction of these instruments is a laborious and time consuming effort. Because these instruments affect the production of houses, cars and appliances, strong barriers may exist among the supplying companies, especially in traditional markets with stable shares for the competitors. In newly emerging markets the introduction of standards and regulations provides opportunities to expand market shares with high quality products at the expense of competitors who do not adjust quickly enough. A high degree of consultation is necessary to give time to industries and construction companies to adjust to the expected situation.

The regulations and standards are summarized in table 5.3.

- Standards and regulations have been most successful in residential, commercial and transportation sectors. However, the volume of appliances and equipment affected is comparatively small from a macro-economic point of view.
- Building codes and standards are applied to new constructions mainly; the existing stock of buildings with very low efficiency compared to technological possibilities is unaffected yet in most countries.
- Vehicle standards have resulted in energy performance improvement, although the results cannot be attributed easily, nor can be determined whether mandatory or voluntary programmes are more effective.
- Regulations and standards can be supportive at achieving a minimum level of energy conservation, but do not guarantee that the maximum level will be attained.
- Energy price fluctuations resulting in limited market incentives for energy conservation measures threaten continuity of energy conservation efforts. Regulations and standards provide long-term continuity also during periods with relatively low energy prices.
- Standards and regulations need to be enforced which is rather expensive: intensive consultation in long procedures for the establishment of rules, testing facilities for materials and equipment have to be installed and maintained, control has to be exerted in industry and at the national borders.

6. CONCLUSIONS ON GOVERNMENT INDUSTRIAL ENERGY CONSERVATION POLICIES

6.1 Why national energy policies

Traditionally, IEA governments, as most other governments in the world, have been heavily involved in the national energy market. Sometimes this involvement was not energy-driven, but resulted as an outcome of policy making in adjacent policy domains, such as: General economic policy, general taxation and general law making, national import regulations and trade policy. Some of the activities in the energy sector, such as with nuclear energy, are perceived to be of a dangerous nature, which urges regulation and control from the side of a government. Increasingly, policy making in the environmental and transport domains affects the energy sector as well. Ecotaxes, carbon taxes, special levies on automotive fuels, and siting legislation regarding gasoline stations and electricity generation plants are examples of policy instruments also serving goals outside the energy sector.

The typical arguments brought forward to establish an energy policy are:
- supply security
- generating national income in countries with significant energy endowments (energy trade)
- competitive energy prices
- energy emergency law-making
- foreign ownership of energy enterprises (investment, taxation of revenues)
- introduction of new energy technology
- environmental concerns (mainly emissions, local production and siting)
- safety
- establishment and maintenance of energy R&D infrastructure.

In this paper the focus has been on industrial energy conservation. The reason is that industry consumes a significant part of primary energy in most countries. Moreover, because there is usually a limited number of actors involved, government policy concerning energy conservation may have rather quick and significant results, this in contrast to the energy consumption in other economic sectors, which is more difficult to influence without taking draconic measures.

The strategic importance of an energy supply security justifies government involvement, especially for the situation that the market is not able to respond adequately, or for situations in which market parties do not show interest in aspects of general concern (e.g. the environment). Nevertheless, in all IEA countries increasing reliance on the market mechanism can be observed. The privatisation tendency in the electricity sub sector is the manifestation of giving way to the market in the formerly state controlled sub sector. This provides the rationale to organize this concluding chapter

around the emergence and maintenance of the market mechanism, with a marginal control of governments over the outcomes of market processes.

6.2 Conditions for energy conservation policies

Since the oil shocks it is clear that the major condition for energy conservation actions is the establishment of realistic energy prices. With low energy prices energy conservation policy is doomed to fail. Only with realistic prices the market may be expected to function. Apart from the energy prices there is a number of other impediments preventing the market to function. Hereafter, these conditions for successful energy conservation policies are summarized.

Energy pricing

The prime mover of energy conservation has proven to be increasing world market energy prices. Consequently, in periods of declining prices, the market usually reacts with slowing down the rate of energy efficiency innovations. The latter is typically a situation where governments should maintain momentum through the design of adequate measures, however, without disturbing the market too much. On the other hand, in many cases prolonged energy conservation policies are not only supportive from the energy efficiency perspective, but they also improve the competitive position of national industry in international markets.

In many countries energy conservation programmes were in effect when the second oil price shock occurred in the late seventies. Political support for these programmes disappeared in the following years. Political support revived when energy again entered the agenda, but than as an emission problem mounting to environmental concerns. Since the late eighties energy has been integrated in a myriad of environmental plans in the majority of IEA countries, partially because of acidifying precipitation but mainly because of the greenhouse gas issue. In either case, in energy and environmental programmes, energy policy initiatives are usually not considered in isolation.

Reliance on market mechanism

IEA governments heavily rely on the market mechanism in their efforts to address national energy conservation. The applied policy instruments basically provide market signals in situations where the market is not expected to respond adequately or in which the market function is impeded. Moreover, the energy sub sectors are too divers to expect the market mechanism to function in the same way. The market is strongest in oil and oil products, with many market parties, transparent market conditions and almost perfect flows of information. This is not the case in the grid-based energy carriers, notably electricity, district heating and gas. These energy carriers are usually supplied by parastatal companies enjoying quasi monopolistic market conditions. Nuclear energy may be qualified as the least market-driven energy sub sector. Safety reasons (uranium extraction, transport, use, radioactive waste, proliferation), high investment costs, extremely long spatial planning procedures and strong societal opposition are the main reasons for maintaining a strong government role in the sub

sector. Hard coal is more market-driven than these energy carriers, but less so than oil and oil products. Safety, increasing economic costs, emissions, and historical (motor of economy) and social concerns (employment) are some of the more important issues justifying the allocation of large financial means to the coal sub sector.

Market impediments

Energy investment decisions meet a variety of impediments which can be classified in a limited number of categories:

- Energy conservation investment decisions are based on other dimensions than decisions concerning energy supply investments.
- The benefits of energy conservation measures are experienced by others than those investing in these measures.
- The obstacles to economic pricing of energy are widespread and vary for the energy sub sectors.
- Finally, imperfect information among market parties prevents energy conservation policy measures to be effective.

Typical market limitations for the introduction of energy conservation actions are high upfront investment costs, introduction of relatively unknown technologies, long pay-back times, and establishment of a costly energy R&D infrastructure. The primary goal of many of the government actions is to overcome one or more of these market impediments.

Legislative framework

For authorities it is important to have legislative frameworks to give energy efficiency policies a firm base. The development of legislative frameworks is a delicate and time-consuming labour, involving extended consultations with a great number of affected industries and interest groups. In the IEA countries legislative frameworks exist for the electricity sub sector, for the energy endowments abundantly available at national territory, or for the energy issue in general. As most IEA countries are confronted with privatization tendencies these laws have to be revised regularly, alternatingly accelerating and blocking the privatization process which reflects fluctuating political support. Especially in the EU countries, with increasing influence from the European Commission, energy laws are anticipated to change in the coming decade.

The legislative framing of energy conservation policy instruments needs to be considered with great care. Flexibility of instruments is extremely important as responses on fundamental changes in the application environment must be enabled. Especially the effectiveness of financial instruments is difficult to predict, which often results in subsequent adjustments of percentages, thresholds and secondary conditions for applicants. The executive conditions of these policy instruments should not be formulated in laws, but some freedom to the executive agency should be given to adjust the conditions. Parliamentary control can be institutionalized as a post hoc control.

General policy environment

A final consideration on government involvement in the energy sector concerns institutional impediments for energy efficiency improvements. 'Institu-

tional impediments' not only refers to regulations and procedures inhibiting wide-spread application of adequate measures, but also to prevailing perspectives on energy efficiency which sometimes hamper efficiency improvements. For instance the predominant supply oriented analysis does not shed light on alternatives for energy services, which do enter if an energy demand analysis approach is selected. Supply oriented analysis, being the most common practice, embedded the analysis of the energy issue for a long time. Other impediments stem from adjacent policy domains, such as general taxation policy or national import regulations. Clearly this type of barrier to energy efficiency improvement can be lifted only through a joint effort by authorities surpassing strict energy mandates. A state with a federal structure may encounter more difficulties with the design and application of transparent procedures and with the perception of responsibilities than a unified state.

6.3 Effectiveness of market intervention instruments

Three main categories of energy conservation policy instruments can be distinguished: financial incentive instruments, regulations and standards, and information programmes. The efficiency of these instruments is often difficult to determine, as the dimensions for comparison are hard to define. Important dimensions to date are:

- the estimated effectiveness (in terms of energy savings in units (Joules) per invested dollar),
- extent of energy efficiency improvement induced,
- incurred instrumental costs,
- flexibility of the instrument,
- adequacy in relation to the impediment concerned.

The application of *financial incentives* in industrial energy conservation is cost-effective, but relatively expensive from the state point of view. Tax incentives are easiest to put into effect as the control mechanism and procedures already exist. Grants and loans need a complex, expensive and high-quality administration. Grants, loans and tax incentives are easy to regionalize, but require control capacity at the regional administration level. In developing countries grant programmes should be applied only in target sectors, maybe restricted to few of the largest energy consuming industries, with clear definition of specific eligibility criteria, and carefully chosen percentages of total investment costs. Often involvement of local authorities is necessary for implementation.

Realistic energy prices reflecting world market prices are the strongest incentive. Tariffs for energy carriers, notably electricity, should be transparent and transmit market signals.

Information programmes constitute the cornerstone of all policy programmes and are valuable in ensuring the success of other types of policy measures. Demonstration projects, training and education are possibly the most effective ways to reach structural effects. This may be difficult to asses, but certainly contributes to the build-up of an energy service sector. The creation of an energy service sector is thought to be crucial for prolonged energy conservation activities. In industry energy audits have

shown to be rather effective. The audits are even more effective if combined with financial support programmes. Information programmes help ensure continuity of energy conservation activities, even in rapidly changing market conditions. This lesson can be drawn from the experiences in IEA countries after the first and second oil shocks. The auditing capacity is lacking in a great number of the poorest countries, notably on the African continent [1]. Some institutional basis for the establishment of information programmes, either run by the authorities or by the utilities, is a necessary condition. Specific programmes targeting at narrowly defined groups are more effective than general information campaigns.

Regulations and standards can be supportive at achieving a minimum level of energy conservation, but do not guarantee that the maximum level will be attained. The instrument is especially relevant in case of relatively high information costs for an expected low incrementality. Also the split-incentives situation, in which the benefits of energy efficient behaviour go to another person than the actor, can be overcome with this instrument. Energy price fluctuations resulting in limited market incentives for energy conservation measures threaten continuity of energy conservation efforts. Regulations and standards provide long-term continuity also during periods with relatively low energy prices. However, a crucial condition is trust-building from the side of the authorities, as may be illustrated with the experiences in Brazil [9] and India [10]. Apart from intensive consultations, the authorities should provide testing facilities and testing equipment. Standards and regulations need to be enforced which is rather expensive and which presupposes the availability of high-quality experts with control being exerted in industry and at the national borders. Standards and regulations have been most successful in residential, commercial and transportation sectors. However, the volume of appliances and equipment affected is comparatively small from a macro-economic point of view. Vehicle standards in the IEA countries have resulted in considerable energy performance improvement, but a negative consequence is that the old fleet not meeting the standard is often exported to developing countries.

Although the above evaluation is supported by a great number of expert views [2], it should be kept in mind that several methodological questions can be raised. The cost effectiveness of an instrument is difficult to assess. Usually the difference between the gross energy savings and the government costs is taken, expressed as proportion of the costs. The effects attributed to a programme cannot be separated from the general policy environment, especially not from fluctuating energy prices. A final consideration is the incrementality problem: the difference between what happened and what would have happened in the absence of the programme. Control groups and different scenarios are used to get a reliable estimate of the programme's cost effectiveness. However, this is rarely done and subsequently hard conclusions on effectiveness should be avoided.

Another aspect important for government involvement in energy efficiency is the potential for energy efficiency improvement in the various economic sub sectors. The need for good data is evident for a valid estimation of the energy conservation potential. Governments are bound to weigh energy efficiency policy against other policy domains on the one hand, and to consider a proper choice from the array of policy instruments on the other.

Costs, potential and expected results of actions vary considerably among different types of measurements. Only reliable databases allow selection of the most profitable energy efficiency targets.

It may be concluded that a mix of programmes is necessary to obtain the best results, with emphasis on financial incentives if financial impediments are dominant. An in-depth analysis of the barriers hindering the market is needed for the selection and design of a supportive, market conform energy policy instrument.

Execution of energy conservation programmes

In many countries governments are aiming at privatization of the tasks implied in the implementation of energy policies. Special institutes are mandated to execute tangible energy efficiency measures. A second alternative is mandating local authorities with the execution of measures, especially of importance for large countries with heterogenous development characteristics. Moreover, local authorities are better informed on specific needs of the target groups affected by the measures. A third alternative is gaining support throughout the IEA as utilities are designing and running their own energy efficiency programmes, mostly with their own financial resources. This is the case in the US, Canada, the Netherlands, and Denmark among others.

6.4 Priorities of energy efficiency policy

Energy efficiency measures should be of particular interest to developing countries. Scarce financial resources are necessary for a myriad of other, even more compelling needs. Any possibility to save financial resources by better management of the energy sector should be welcomed. Fundamental question is if and how energy efficiency measures applied in the IEA countries can be applied in developing countries. There is no unambiguous answer to this question. However, a number of conditions can be identified for the design and implementation of a successful programme.

First the general policy environment is of importance. The energy issue should be firmly based in legislation and responsibility for the design, implementation and control of energy policy should be clearly institutionalized: either in the national and regional administration, in an energy agency at arm's length of the administration or at the utilities.

In the field of industrial energy efficiency a national energy agency (NEA) can perform, among others, the following functions:

- training target groups: energy service companies (ESCOs), E-cells, DSM agencies, industrial bodies, ministries;
- initiating, monitoring and evaluating industrial audits, using ESCOs and DSM agencies;
- demonstration programmes to disseminate feasible energy-efficient options and technologies with a large replication potential;
- gather data and identify plants with best energy-efficiency performance that may be widely replicated;

- encourage private-public partnerships to achieve efficiency goals set at branch and plant levels, based on information from abroad and national 'best practices programmes';
- standards setting and equipment labelling in close consultation with industry;
- information campaigns (in cooperation with branch associations and ESCOs);
- educational campaigns, in cooperation with the education ministry;
- technical management of special credit line programmes (in cooperation with appropriate financial institutions).

NEAs have to be government-sponsored as many activities cannot be completely commercialized. On the other hand, complete or partial cost recovery for activities with a commercial character should be given serious consideration, as the willingness to pay of clients gives important feedback information on the societal usefulness of the institute's activities. In Peru for example the industrial energy conservation institute, established as a government institute, succeeded in gaining industrialist's confidence within a couple of years. It developed as an independent institute as paid industry audits generated an economic base allowing to gain independence.

A regional focus is of special importance in countries with highly heterogenous development characteristics: unequally distributed industrial activities, high population concentrations and varying quality of communication channels. With the very common figure of one or two large industrial centres in a country, energy efficiency measures can be carried out efficiently, i.e. with relatively low costs and high benefits, by local authorities or utilities. In that case, local authorities and utilities should be empowered with a mandate to control the energy issue.

Government involvement in economy should be stable and being characterized by a high degree of predictability. Only with consistent and lasting government policy investors may be expected to show their confidence by investing money in economy. Stable authorities are a necessary condition for the application of standardization and regulation instruments, as high quality consultation between authorities and market parties is decisive for success. As in the case of Brazil, government agencies acting as mediators between parties succeeded in the establishment of networks between firms and laboratories. Energy efficiency policy, in line with general economic policy, should be perceived as sound, consistent and durable to gain credibility and effectiveness. Credibility is not an easy condition to achieve, but its absence has underlain several programme failures.

Even when the condition of consistent, lasting policy lines is met, investors are usually more interested in capacity expansion than in rationalisation of production processes, simply because profits from expansion are higher than from measures resulting in reduced energy use. If less stable governing structures are prevailing in a country, price instruments are the most promising option, as higher energy prices make the market functioning. In these cases some type of government intervention is indispensable. However, industry should not be allowed to pass on higher energy costs to the customers completely, in order to generate the drive towards industrial energy conservation measures.

A long term energy planning integrating energy, environment and economy may be helpful to realize secured energy supply at affordable costs from the macro-economic point of view. National energy policy making should see upon a reasonable distribution of costs implied in taking energy conservation measures and upon an equally reasonable share of benefits over the economic categories.

It may be concluded that the application of energy efficiency policy instruments is strongly dependent on institutional ripening, the availability of technical capacity, the availability of financial resources and communication skills from the side of the authorities. The market price of energy carriers is, however, the number one incentive for the occurrence of energy conservation activities.

Next scheme categorizes the elements treated before in a coherent way.

Plant	Industry	Policy maker	National state	International environment
hardware	products	NEA	energy legislation	provision of financial resources
services	services	financial incentives	energy organization	establishment international energy institute
financial resources		information incentives	general economic policy	products
		standards & regulations	energy efficiency policy	services
			lasting & consistent policy	
			energy planning	

Industrial energy efficiency has to be realized at the plant level (column 1). Apart from good housekeeping measures the highest gains are from changing products and processes. At that level hardware, services and financial resources have to be available. The hardware may be derived from the international market, but often there is ample scope for development of a national energy service industry (column 2). Than the policy maker point of view is adopted where the array of policy instruments comes into the picture (column 3). If responsibility for industrial energy efficiency policy is laid by the utilities, this level should be depicted next to the policy maker. The policy maker functions in a national political climate in which a number of important aspects should be taken into account (column 4). Finally, the international level can be discerned as an important actor in the energy field in terms of financial support, and the delivery of services and products by multinational companies (column 5).

The policy maker, confronted with the need to improve energy efficiency, has to convince actors in all categories. From this scheme it is clear that one person can hardly survey all elements needed for the design and deployment of successful energy efficiency policy instruments. Specialists

employed in a national energy agency are indispensable to support the required tasks implied in adequate policy making.

The needs at plant level meet a similar supply at the international level at the other extreme in the scheme. Politics at a national (and regional) level aims at matching both needs and supplies within the framework of national legislation. On the one hand this requires excellent knowledge of the market (company's needs and possibilities) on the other access to international actors, notably the international development cooperation, multilateral development banks and multinational companies.

Taking the IEA experiences as a base line several opportunities exist for international cooperation. However, government commitment to sound, consistent policies to improve energy as well as economic efficiency, is a necessary condition for success, but may be insufficient without external help. This is particularly the case in poorer countries, or those with an incipient industrial basis, but in most or all cases cooperation will be beneficial. The following opportunities for useful international cooperation exist:

- *Strengthening the capabilities of energy policy agencies, particularly at the national level*
  In most developing countries, energy policy is poorly coordinated. Programmes for the rational use of energy are often ad-hoc and lacking continuity; agencies have to use a staff that has little formation in the required analytical skills. Furthermore, information gathering on energy use is most often insufficient to design and target specific actions. The situation is particularly critical in Africa, but in many Asian and Latin American countries there is ample scope to improve technical capabilities of agency staff to design, implement, monitor and evaluate integrated energy strategies. Assistance could take the form of training the technical staff of such agencies, either on the job or through traineeships abroad; interchange of experiences with well-developed institutes would be another mode of cooperation. Support for this could come through well-designed bilateral arrangements or through multilateral organizations like regional development banks or regional energy organizations.
- *Strengthening national regulatory organs*
  Globally, important new developments are taking place in the energy supply industry, with consequences on energy regulation. Several aspects of the rational use of energy also have implications for energy regulation: demand-side management, stimulus to co-generation and to independent generation are socially rational, but require important and delicate changes in the way industry is regulated. Here, cooperation might be more effective through experience interchange, given the wide variation in national contexts.
- *Strengthening other national agents, such as research institutions, E-cells and energy service companies*
  These agents have important functions in a consistent policy promoting efficient energy use. The former are important components of training programmes and the development of technological capability. The second are crucial for a vigorous programme of auditing and technical assistance to industries. Cooperation could be done through participation in national training programmes, and assistance to national networks. Energy service companies are needed to provide the hardware of energy

conservation actions. In eastern Africa, for example, the almost complete lack of service companies made energy efficiency improvements virtually impossible [1].

- *Facilitating the access to information on energy-efficient technology*
  This is an important component of several other lines of cooperation. Up to date knowledge of efficient options requires systematic access to information not readily available in developing countries (and perhaps elsewhere as well). This line of action might take e.g. the form of a multilaterally managed data base on existing technologies. Also establishment of an international energy institute may be instrumental for developing countries to gain access to information on the issue, in line with the wishes of many developing countries expressed at the Rio conference [11].
- *Assistance to design and fund adequate credit lines to foster industrial energy efficiency*
  Financial incentives may fail for poor design or lack of funds. Cooperation should aim at a three-pronged goal: to identify viable projects in need of funding, to design effective financial stimuli and to devise ways to fund the actions. A source for government funding could be an indirect tax on energy, notably on fossil fuels. Such a tax should be moderate, so that competitiveness of national industry in energy intensive branches vis-a-vis foreign producers will not be seriously affected. With such a tax small and medium scale industries could be supported to finance energy conservation measures. Consideration of such an indirect tax is all the more pregnant as energy intensive industries tend to leave the OECD to settle in developing countries.

6.5 Market or government involvement?

In the developed countries of the OECD institutional ripening resulted in stable political economies, allowing the energy issue to be largely regulated by the market. In developing countries market conditions are far off from the salient market conditions in the North. Without salient conditions, a transparent grip of the authorities on the energy sector is often indispensable. Consultation of target groups and communication of policy goals and policy instruments has proven to be an effective way of IEA government involvement in the energy sector. It is hard to see how effective energy policy making in developing countries can do without.

REFERENCES

[1] Energy for Sustainable Development: Post-Rio Challenges and Dutch Responses, in: *Resources, Conservation and Recycling*, Vol. 12, No's 1-2, Elsevier, Amsterdam, October 1994.

[2] *Energy Conservation in IEA countries.* OECD/IEA, Paris, 1987.

[3] *The Role of IEA Governments in Energy: A survey* (Draft). International Energy Agency, Standing group of long term cooperation, IEA/SLT/CRD(92)25, 1992.

[4] A.D. Kant, H.M. Verhagen: *Government institutions of the energy sector in the EU countries.* Working Paper II, Netherlands Energy Research Foundation, Petten, July 1993.

[5] H.M. de Loor, C.J.H. Midden, M. Hisschemöller: *Publieksoordelen over nieuwe technologie.* Werkgroep Energie- en Milieuonderzoek, Rijksuniversiteit Leiden, E&M/r-91/22, 1991.

[6] Tenders Industriële Energiebesparing, Subsidieregeling 'Tenders Industriële Energiebesparing', Samenvatting, derde ronde, Novem, Apeldoorn, 1993.

Evaluatie Subsidieregeling Tenders Industriële Energiebesparing (TIEB), Eindrapportage, Den Haag, augustus 1993.

[7] Vervolgnota Energiebesparing, Ministerie van Economische Zaken, 23561, nrs. 1-2, SDU uitgeverij, 's Gravenhage, 1993.

[8] E. Vine, D. Crawley: *State of the Art of Efficiency: Future directions.* American Council for Energy-Efficient Economy, Washington D.C., 1992.

[9] J.L. de Araújo, A. de Oliveira, E.A. Guimaraes, R. Tolipan, *Regional Project Study on Latin America, final report*, IEI, Rio de Janeiro, Brazil.

[10] S. Barathan, P. Bhandari, P. Dadhich, *Regional Project Study on Asia, final report*, TERI, New Delhi, India.

[11] UN Earth Summit: Agenda 21 (1993) United Nations Programme of Action from Rio. United Nations, New York.

LITERATURE

D.R. Khatkhate: *The Regulatory Impediments to the Private Industrial Sector Development in Asia.* A comparative study, World Bank Discussion Papers 177, World Bank Washington D.C., 1992.

B. Krier, I. Goodman: *Energy Efficiency: Opportunities for Employment.* Prepared for Greenpeace UK/International, Boston, 1992.

P. Guislain: *Divesture of State Enterprises.* World Bank Technical Paper 186, World Bank Washington D.C., 1992.