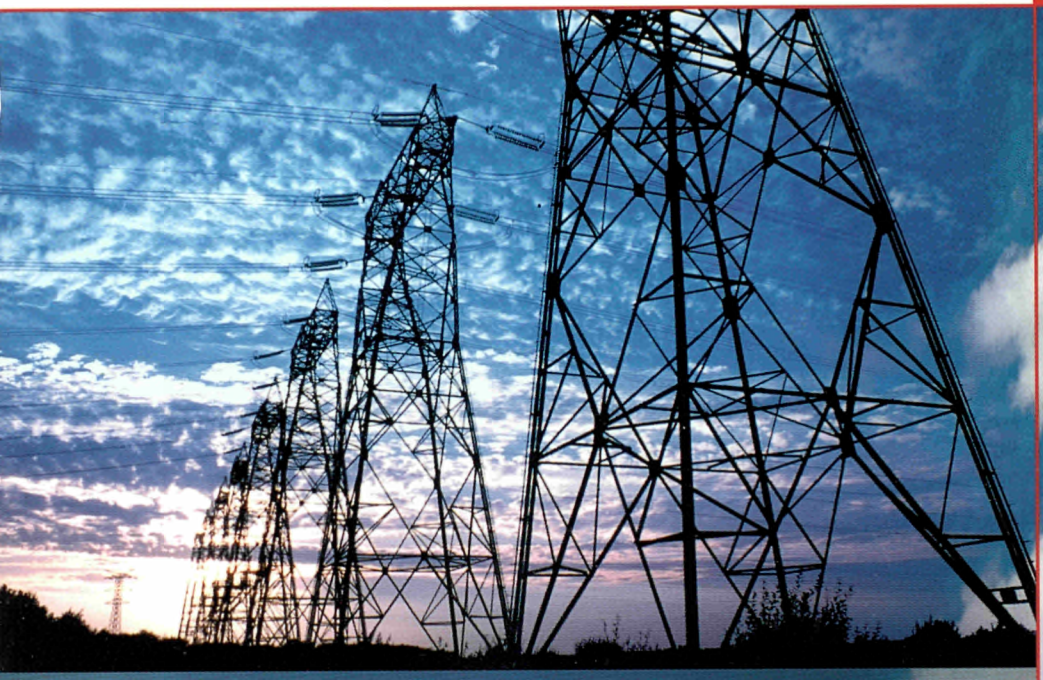
EUROPEAN COMMISSION

THERMIE

The demonstration component of the JOULE-THERMIE Programme



RUE in Industry and the Energy Industry

Sectoral Report 1995-97

Directorate General for Energy (DG XVII)

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RATIONAL USE OF ENERGY (RUE) IN INDUSTRY AND THE ENERGY INDUSTRY

THERMIE SECTORAL REPORT

Overview of THERMIE activities 1995-1997

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WHAT IS THERMIE?

JOULE-THERMIE was launched in 1995 as the European Union's first 'integrated' programme, bringing together the resources of the Directorates-General XII (Science, Research and Development) and XVII (Energy). The aim is to encourage the wider utilisation of non-nuclear energy technologies from research and development, through demonstration, towards the goal of the penetration of these systems into the marketplace. The programme runs until 1998 and has a total budget of 1,030 MECU.

Energy is fundamental to the existence of society, as without it industry, commerce and civil society cannot function. Fortunately, the earth is endowed with considerable energy-giving resources, mainly in the form of fossil fuels, such as oil, gas and coal. These are, however, unevenly distributed globally and are finite, so their use raises questions regarding security of supply and environmental sustainability. The JOULE-THERMIE programme supports research and technological development aimed at addressing these issues through the research, development and demonstration of technologies which enable us to reduce our energy demand, and to use what we need more cleanly and efficiently.

The THERMIE component of the programme focuses on the targeted demonstration of clean, efficient, cost-effective, and environmentally-friendly energy technologies. It participates in actions to prove the technological and economic viability of these technologies and promotes their wider replication and market penetration both within the EU and beyond, particularly in Central and Eastern Europe and the developing world. It promotes the application of a new energy infrastructure which fully utilises renewable energy sources, seeks to improve the efficiency of energy use and makes better use of fossil fuels. It also promotes improvements in the exploration, distribution and transport of hydrocarbons.

THERMIE aims to encourage the development and use of innovative energy technologies to meet EU aims and objectives across a wide spectrum of policy areas - energy, environment, economic, innovation, regional and social.

THERMIE promotes non-nuclear energy technologies through two types of actions. Demonstration projects help to prove the technical viability and economic advantages of new technologies by applying them on a sufficiently large scale for the first time. Associated measures help to prepare and implement the results of the programme by enhancing its impact on the market and its performance. These actions include activities related to strategy, dissemination and to encouraging and facilitating the participation of SMEs.

The final call for proposals under THERMIE was made at the end of 1997. The programme ends in 1998, after which a new programme will be developed as part of the Fifth Framework Programme.

Meeting the needs of the market

A key element of THERMIE today is that its activities must consider and respond to the real needs of market actors and the final consumer. It is not enough that technologies are developed and successfully demonstrated. A primary objective of the programme is to ensure that technological improvements are truly relevant to the needs of industrial, commercial and domestic society. This will help to ensure the availability of reliable, environmentally-acceptable and durable energy services (such as heating, lighting, transport or industrial processes) at affordable cost.

A sectoral approach

THERMIE is divided into three main sectors:

- Renewable Energy Sources
- Rational Use of Energy in Buildings, Energy Industry, Industry and Transport
- Fossil Fuels (solid fuels and hydrocarbons).

This sectoral report provides a comprehensive overview of the activities carried out under THERMIE during 1995-1997 to promote the development and deployment of rational use of energy technologies in industry and the energy industry.

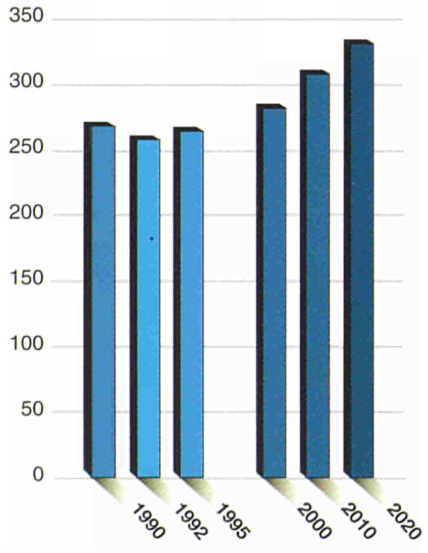
RATIONALE FOR THE SECTOR

A reliable supply of energy at a reasonable price is key to the functioning of European society today. Energy cannot, however, be regarded as an insatiable resource as its unrestrained consumption raises questions with regard to security of supply, the balance of trade and the environmental impacts of its generation. There are two sides to the energy equation, supply (generation) and demand (consumption) and efficiency improvements must be made in both if a rational use of energy is to be achieved in Europe. This report brings together both sides of this equation and considers the rational use of energy in both the energy industry and one of the major energy consuming sectors, industry.

Industry is a major energy user and in 1995 accounted for around 35% of EU primary energy demand. Some of the largest consumers include the petrochemicals, plastics, steel, oil products, paper, textile and bulk chemicals industries.

Energy consumption per unit of industrial production, 'energy intensity', has been falling overall in most EU countries since 1973.

The table below shows the evolution of the final energy demand in industry between 1990 and 1995 with a projection to 2020.



Source: "European Energy to 2020" A scenario approach.

This is due to a combination of factors including energy efficiency improvements in industrial processes and the efficiency gains made in power generation through plant improvements. Other contributing factors have been the trend towards lighter industry and the change in fuel mix in favour of gas, electricity and heat. Despite this, on a 'business as usual' scenario, it is anticipated that industrial energy demand in the EU will grow by between 0.5 and 0.9% annually from 1990-2020, a total increase of 16-31% over the period.

Demand for electricity is predicted to increase most dramatically, with an anticipated annual growth rate of 1-1.5% to 2020, mainly due to increases in the automation of industrial processes and the use of electrical appliances in the home. The majority of this electricity is likely to be produced in centralised fossil fuel fired generation plant and distributed through a transmission network. Large investment is therefore anticipated for replacement and expansion in the energy industry. The adoption of innovative technologies is essential if power generation, transmission and distribution efficiencies are to maximised.

Decentralised generation is also predicted to grow in the liberalised EU energy market. It is anticipated that the use of district heating and cooling will increase at approximately 2-3% per annum and that Combined Heat and Power (CHP) could contribute 30% to energy supply in the medium term. Fuel cells are also likely to become more widely adopted if current technical and economic barriers can be overcome.

The EU recognises that, in order to comply with the 15% reduction of greenhouse gases from 1990 levels by 2010, levels of industrial energy intensity must be reduced by 20%. The potential for energy efficiency improvements in industry are considerable, with 60-70% of the anticipated reductions in energy use expected to come from the modernisation of industrial processes. It is thought that the remainder will come through technological innovation in energy consuming equipment.

The combined effects of efficient energy generation, transmission and distribution and rational energy use in industry, are highly significant for the European economy and the global environment. An energy industry which produces a reliable, clean, inexpensive supply of power is a pre-requisite to economic growth, industrial competitiveness, job creation and environmental protection. The efficient use of this energy further compounds these benefits, as generation requirements are reduced. Efficiency gains in supply and demand can only be achieved through the development, demonstration and widescale adoption of innovative energy technologies. THERMIE has an important role to play in supporting the demonstration of these technologies, bringing them into the marketplace and pushing the frontiers of rational energy use further forwards.

Unlike raw materials costs, which are outside a company's control, energy is a production input which offers cost saving opportunities to industry. Improving energy efficiency, either in production or the use of energy consuming equipment, will reduce production costs. This is particularly true for energy-intensive industries, such as chemicals, metals and cement where energy accounts for a higher proportion of production costs. Continuing low energy prices, however, means that the importance of energy alone as a significant cost factor is decreasing and a trend is developing which links energy efficiency to improvements in other process factors, such as waste minimisation, process efficiency, product quality and environmental impact. These can, in combination, contribute to economic growth by improving the competitiveness of European industry.

An increase in overall production efficiency is necessary if European manufacturers are to compete effectively in today's globalised market, against products manufactured at lower cost overseas, due to labour cost differentials, etc. The widescale adoption of innovative, energy efficient process and energy consuming technologies is vital if costs are to be reduced and industrial competitiveness maintained. Before this can take place, however, these technologies must have been fully demonstrated in a real, industrial environment. THERMIE has provided valuable assistance towards the market penetration of these technologies through its support for essential technology demonstration.

Increasing process efficiency is also important in terms of its impact on industrial employment in Europe, which has, in recent years, experienced a sharp decline. This has been partly displaced to the growing service sector, but employment has also been lost as result of intense foreign competition. The main challenge for European industry today is to remain competitive, in order to maintain current levels of employment, and achieve growth where possible. The market penetration of energy efficient technologies therefore offers significant opportunities for cost reduction in industry, improved competitiveness and job retention/creation.

The widescale implementation of RUE technologies offers significant opportunities for environmental protection, particularly with respect to the reduction of gaseous emissions. Table 1 below shows the anticipated long term potential savings in gaseous emissions which could result from a 40% saving in industries' primary energy consumption, brought about through increased uptake of energy efficient technologies. In the energy industry, the uptake of innovative technologies which utilise fuels more efficiently will, in addition, reduce emissions per unit of power produced.

Table 1. Potential savings in environmentally harmful emissions by increasing energy efficiency in industry.

Emission	Potential Savings in the Long Term (kt/yr)
CO_2	100,000
SOx	800
NOx	2,300

Source: Energy Technologies: The Next Steps, Summary Findings of the Atlas Project

For many RUE technologies, EU manufacturers hold a dominant position in the eu market, and many are also competing successfully globally. If this position is to be maintained, considerable investment in research and technological development (RTD) and demonstration is required. Many of the technologies which are already developed would benefit from further development, demonstration or dissemination in order to compete better in the global market. This is a particular issue for European power equipment suppliers who face fierce competition from the USA and Japan. Integrated and targeted assistance under THERMIE is therefore essential if Europe's leading market position in key technology areas is to be secured. Only in this way can a strong domestic and export industry in energy efficient technologies be developed and maintained.

OVERVIEW OF THERMIE ACTIVITIES DURING 1995-1997

THERMIE has made a significant contribution through its support of demonstration projects and associated measures, to the increased market penetration of cost-effective and environmentally-friendly energy and industrial process technologies.

With respect to demonstration projects, the main goals of THERMIE in these sectors have been to promote innovative technologies which not only have a clear impact upon energy consumption, but also significantly improve environmental impact. For industry this means the demonstration of new, energy efficient, less polluting process technologies which also consume less raw materials. Within the energy industry, support has mainly focused upon the demonstration of technologies which improve efficiency in the generation, transmission, distribution and storage of energy. Particular attention has also been given to the demonstration of innovative energy technologies, such as co-generation, district heating and cooling and fuel cells. Particular emphasis has been placed on achieving cost reductions in these currently expensive technologies.

With respect to associated measures, THERMIE's activities in the industry and energy industry sector have focused upon breaking down current barriers to the widescale uptake of high efficiency technologies. One of THERMIE's main objectives is to promote European technologies on the world-wide market, to enable them to develop and maintain, a strong market position and compete effectively with manufacturers from other nations. THERMIE has achieved this by supporting various dissemination activities which help to raise awareness amongst potential consumers of the benefits offered by these technologies. These activities have also provided market intelligence to technology manufacturers, particularly regarding opportunities outside the EU. These actions have actively encouraged European manufacturers to explore market opportunities in third countries, and have contributed to the establishment, and maintenance, of a strong domestic export industry.

THERMIE activities in the industry and energy industry sector between 1995 and 1997 have consisted of a wide variety of demonstration projects and associated measures, all of which have the same broad goal; to promote technologies which maximise the efficiency of power supply and ensure that this power is used rationally by both energy-intensive and less energy-intensive industries.

It must be noted that the focus of activities within this sector is no longer energy saving alone, rather the overall optimisation of energy generation and industrial processes. Demonstration activities which result in energy savings but also offer additional reductions in environmental impact, lower resource consumption and improvements to product quality, have therefore formed the backbone of projects supported under THERMIE. In the energy industry projects which demonstrate technologies which optimise the energy generation process and minimise

generation costs have been favoured. The reduction of technology costs, energy generation and industrial production costs are the greatest challenges faced by industry and the energy industry today. This therefore formed the focus of THERMIE activities in 1995-97.

Demonstration projects in the industry sector have, in recent years, shown a trend towards linking energy efficiency with other process factors. Projects which improve process integration, develop more compact equipment and increase the scope of industry to operate more competitive and flexible industrial processes, have been supported. In the main, priority has been granted to projects aiming at energy efficiency improvements, while at the same time reducing water consumption, and/or recycling waste/raw materials, thus pursuing the objective of better resource management. Pilot promotional campaigns in 1995-1997 targeted companies in the cement and textile sectors and significantly increased the number of projects receiving funding in these sectors.

In the energy industry demonstration projects have, in recent years, been dominated by fuel cell, district heating and cooling, and co-generation. In 1997 attention was focused upon the demonstration of molten carbonate and polymeric electrolyte technologies in real industrial environments to further improve component durability and reduce specific investment costs.

Associated measures supported in 1995-1997 had the same broad objective, to address current barriers to the adoption of innovative industrial process and energy industry technologies, and help them enter and maintain a strong position in the mainstream global market. A wide variety of actions have been undertaken by industry and the energy industry in support of these aims. With respect to industry, efforts have continued to promote the use of clean, efficient process technologies through awareness raising and information dissemination campaigns in both energy-intensive (cement, paper, pulp and brick) industries and less energy-intensive sectors (textiles, wood, etc.). Similar actions have taken place in the energy industry, particularly with respect to the promotion of co-generation, district heating and cooling and fuel cell technology.

Project selection in the industry and energy industry sector is based around their technical quality, cost-effectiveness, innovation replication potential, and also on their relevance to the objectives of the programme in general and the publicised priorities for the sector. In order that effective work can be built upon, projects which are follow-on phases of existing projects or are associated measures to these projects have a high priority within THERMIE. Projects involving small and medium sized enterprises (SMEs) and the transfer of technology between Member States also have a high priority within the programme.

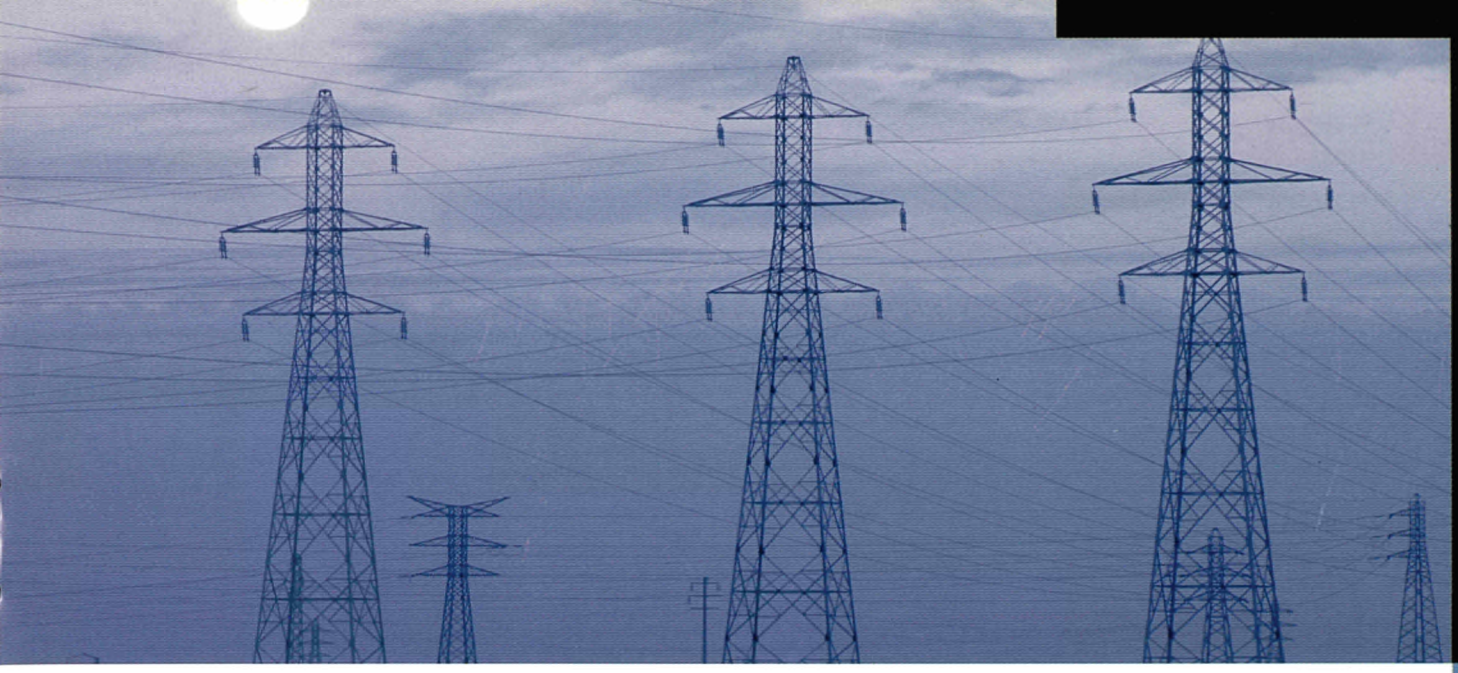
SMEs

SMEs employ 97% of the European work-force and are particularly active in the industry sector. The majority of projects supported by THERMIE in 1995-1997 in this sector were led by manufacturing companies, with some co-operation from other organisations such as universities and research establishments. The involvement of SMEs in demonstration projects and associated measures in the industry sector has been high between 1995-1997, with many projects being led by SMEs. This has been assisted by a particular emphasis on the promotion of technologies to SMEs operating within various targeted industrial sectors, such as cement and textiles.

For energy industry projects the large size and costly nature of RUE demonstration projects mean that these in the main involve the utilities and large manufacturing companies, the main players in the energy industry. There is usually some involvement from universities and research organisations, but only marginal participation from SMEs.

Cross-border Collaboration

In order to stimulate intra-EU co-operation and prevent duplication of effort, cross-border collaboration is an integral part of all THERMIE activities. Cross-border collaboration in industry and energy industry projects is strong, particularly with respect to demonstration projects in the energy industry sector. These projects tend to be large scale and costly and therefore carry a significant financial risk for the companies involved. The majority of these projects involve a large consortium of companies from across several Member States, who share the financial risk associated with technology demonstration to achieve an acceptable level of risk and reward. Within the industry sector, projects are often smaller scale and therefore involve smaller project consortia.



The table below illustrates the number of projects in the Industry and the Energy Industry sector and the financial support granted to these projects in the period 1995-1997.

	Demonstration projects	Associated measures
1995		
Number of Projects	17	22
Support received (MECU)	11.4	1.66
1996		
Number of Projects	14	12
Support received (MECU)	15.6	1.73
1997		
Number of Projects	19	10
Support received (MECU)	20.6	0.84

Highlights of Demonstration Project Success Stories

A wide variety of demonstration projects have been supported under THERMIE in 1995-1997 in the industry and energy industry sector. Many are already constructed and have produced promising results in their first operational reports. In industry demonstration effort has concentrated upon technologies which increase overall production efficiency, minimising resource use and waste generation, in conjunction with energy efficiency improvements. In the energy industry the focus of demonstration attention has been on technologies which improve the efficiency of energy generation, transmission and distribution, and utilise e.g. waste products as alternative fuels.

Demonstration Project - IN/00008/95/ES/NL
A fully integrated energy system for higher efficiency waste utilisation at a chipboard factory

The main aim of this project is to increase energy efficiency in the chipboard production process by enhancing the useful value of the wood waste through its conversion to electricity. An integrated energy system has been designed in such a way that in combination with a new combined heat and power application, an annual primary energy saving of 19.6 toe can be achieved. This will lead to a 100% reduction in energy costs and a net income (excluding operation and maintenance costs) of 3.8 MECU, mainly from exported power. Along with these economic benefits, product quality and energy supply reliability are improved and environmental benefits, CO_2 reductions of 82,100 tonnes per year, are also realised. The system is now being fully demonstrated.

The project consists of an Integrated Energy System which embraces a top and bottom co-generation cycle in one plant to optimise energy generation within the plant and maximise flexibility in the chipboard manufacturing process. The system is based on the waste incinerator from the existing process which has been modified to the requirements of the new plant to include an 18 MW gas turbine. Heat from the incinerator meets the process demand for hot water and the needs of the dryers are covered by the exhaust gases from the gas turbine. Waste heat is converted to steam in a heat recovery boiler, which is then used for the generation of additional (6 MW) electricity in a steam condensing turbine, maximising the energy efficiency of the system. The gas turbine uses natural gas as a fuel.

The design, manufacture, assembly, installation, erection and commissioning phase of the project have been fully completed and the project is now in its monitoring phase.

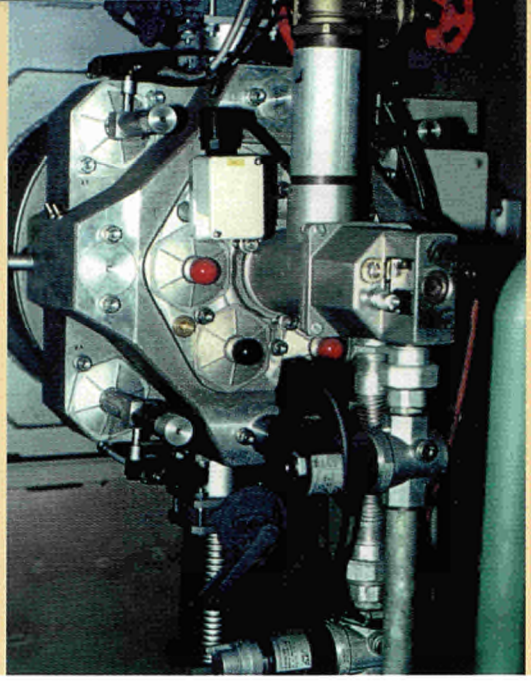
Principal Contractor	Ute Alabe-Moinsa
Partners	Turolense de Tableros S.A.
	Alabe Sociedad de Cogeneracion S.A.
	NEM-Mecapeña

Demonstration Project - IN/0343/95/IT/GR
Reduction of energy consumption in a brick and tile dryer through innovative regulation and control

The aim of this on-going project is to achieve an energy saving of approximately 20% in the heat and electricity consumption required by the drying process and obtain an efficient quality control of the product with a significant reduction in the generation of waste products.

All modern dryers are equipped with a regulation system which allows the control of hot feed air and the extraction of humid air, taking the duration of the drying cycle into consideration and avoiding damage to the material. To date, this has been based upon the continuous monitoring of the temperature and humidity of the drying environment. The new regulation system will improve this situation by measuring the evaporation speed directly, allowing the drying curve to be directly controlled and regulated. This is possible due to the installation of a continuous weighing system in the chamber immediately below the supports of the drying material. The system is so precise that it will allow the evaluation of the humidity of the product over time to within 0.2% of the dried weight. It is possible to install these units at various points in the drying chamber to evaluate the drying speed of products in the most and least favourable positions in the dryer.

Principal Contractor	Laterforni SRL
Partners	Keramopiia
	Kothalis S.A
	ENEA



Demonstration Project - IN/00015/95/IT/DE
Reduced fuel consumption through the use of compact regenerative burners in energy-intensive furnaces

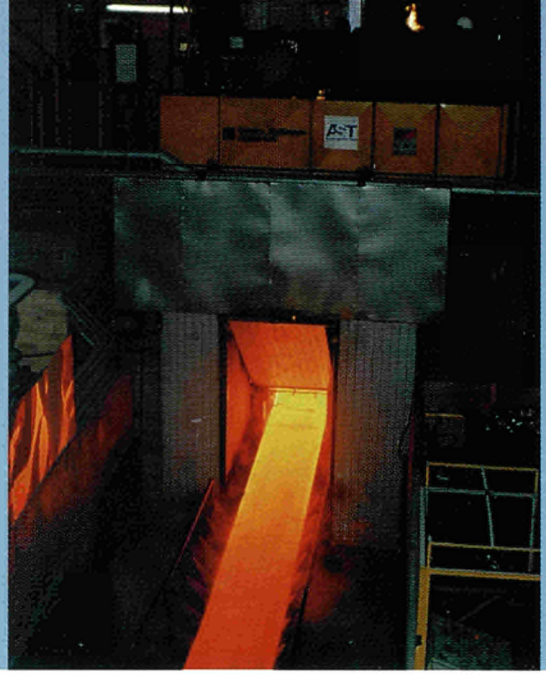
The aim of the project was to prove that advanced firing techniques, based on combustion equipment specifically conceived for high temperature applications, are a viable and effective design solution in energy-intensive continuous furnaces.

The project involved a new regenerative technique for firing natural gas at very high thermal efficiency, possible as a result of a very efficient air pre-heater with a very short inversion cycle time. Nitric oxide (NOx) emissions were also abated well below current and anticipated limits. The new firing technology developed can be systematically applied above self-ignition temperature (around 800°C for natural gas) and is based upon a novel, flameless process (FLOX) which reduces local peak temperatures. The main system component is a compact burner, the REGEMAT, which has twice the thermal output of a conventional furnace.

The technology has been applied to a continuous annealing furnace in an annealing and pickling line for cold rolling of stainless steel strips. This allowed the natural gas consumption to be reduced by more than half, and the maximum production rate to increase quite substantially. NOx emissions have been abated by a factor of 8.

This project is now complete and the technique has proved to be reliable and no significant maintenance problems have been identified in a year of continuous operation. The technique is suitable for further application in energy-intensive continuous furnaces at high temperatures and is fully competitive for processes requiring high plant availability.

Principal Contractor Centro Sviluppo Materiali SpA



Demonstration Project - IN/124/96/IT/AT
Reduced energy consumption in steel hot strip production

The objective of this project is to reduce energy consumption in the fabrication of steel hot strips by eliminating some of the steps in the current production process. A new technology, 'Twin Roll Strip Casting' will be used to achieve this. This technology is already developed to pilot stage, but must be scaled up to cast strips of 1000-1300 mm wide, to prove the technical and economic viability of the new process at commercial production conditions.

Current hot strip production technology includes scrap melting and refining, continuous casting, cooling, conditioning and reheating of slabs and rolling. The reheating and rolling stages are the most energy-intensive. The new technology will reduce energy consumption and therefore CO_2 emissions against traditional techniques. The project covers the design, construction and operation of the plant to demonstrate the commercial viability of the strip casting technology. The plant is predicted to reach an annual capacity of 400 kt/yr of stainless steel strips. Besides energy savings, the commercial adoption of this process will allow a significant cut in operation and maintenance costs.

Testing has been carried out on the pilot plant to support design and the basic design of the industrial scale unit has been outlined. Data has been collecting regarding casting rolls and mould covering during casting tests are being utilised in the design of the scaled up technology.

Principal Contractor	Acciai Speciali Terni
Partners	Voest Alpine Industrieanlagenbau
	Centro Sviluppo Materiali

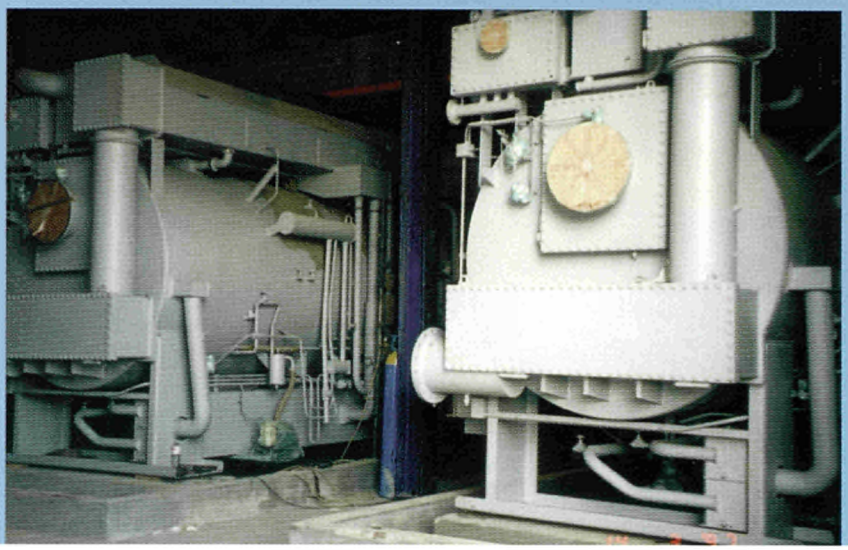
Demonstration Project - EI/238/96/FI/DE
Improved electrical efficiency in a diesel powered combined cycle power plant

The aim of this project is to present significantly improved electrical efficiency (target 55%) of a diesel combined cycle power plant capable of running purely on low grade heavy fuel oils.

This is to be achieved through the utilisation of new Hot Combustion and Low NOx combustion technologies in a diesel engine. Hot Combustion technology means a redistribution of heat flows in the diesel engine to raise exhaust gas and cooling medium temperatures in order to improve the conversion of waste heat into electricity. The low NOx technology reduces emissions by up to 50%, at the same time improving efficiency. New, efficient DeNOx and DeSOx technologies integrating the DeNOx into the exhaust gas boiler and utilising the Newly Integrated Desulphurifisation DeSOx system will also be implemented to reduce investment costs, emissions and energy and water consumption. Finally a fully optimised rankine cycle diesel engine will be utilised to achieve the highest overall efficiency and minimise emissions. These technologies are installed at a demonstration plant in Finland which has a net electrical output of 38 MW and a total efficiency of 70%.

It is anticipated that the project will result in a 16% reduction in fuel consumption through efficiency improvements and better emissions control, with increased economy.

Principal Contractor	Wasa Pilot Power Plant Oy
Partners	Wärtsilä NSD Finland Oy
	Nutech GmbH



Demonstration Project - IN/00100/96/PT/FR
Production and distribution of thermal energy on EXPO'98 exhibition site, Lisbon

The purpose of this project is to satisfy the needs for thermal comfort of the building inhabitants and other consumers at the EXPO'98 exhibition in Lisbon, Portugal. The project aims to prove the feasibility of a centralised management system for providing adequate comfort levels, while achieving a reduction in primary energy consumption and minimising environmental impact. The ability to transfer this system to other European cities is an important advantage of this project.

The project will initially satisfy the needs of two buildings, but eventually all of the EXPO'98 exhibition area. Heat will be provided by a centralised thermal energy production unit with a local pipe network. This will consist of a gas turbine coupled with an alternator to produce electrical energy. It will also provide heating and cooling through innovative use of the exhaust gases. A refrigerated water production and storage system will also be developed. The heating and cooling systems will be controlled by a centralised management and control system to optimise the functioning of the system.

After the event, an advanced business district will be built around the site as a showcase of technologies which give examples of the rational use of energy in industry and buildings. This will contribute to the renovation of East Lisbon and the development of Portugal.

Principal Contractor	Climaespaco SA
Partners	Parque EXPO' 98, SA
	ELYO

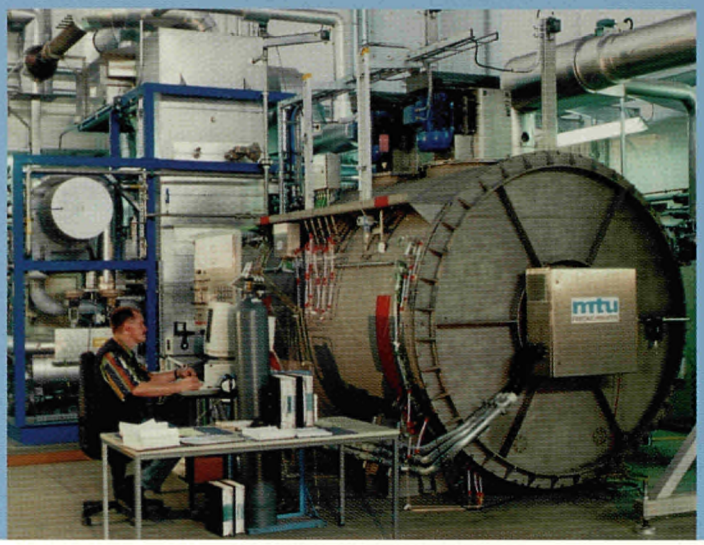
Demonstration Project- EI/0117/97/ES/IT/UK
Minimising transmission losses in regional power systems

To date, transmission losses in the power system are controlled manually by system operators. The objective of this project is to give, for the first time, a practical demonstration of the possibility to reduce transmission losses by installing an automatic multi-level voltage control system. Two areas of the electric power network of REE, (Spain) and ENEL, (Italy) will be used to demonstrate this system, which allows continuous reactive power and voltage optimisation. Power losses in the high voltage transmission system of any industrialised country account for 2-4% of electrical power consumption. This is equivalent to generating capacity of 500-1,000 MW for Spain and 800-1,600 MW for Italy.

This innovative system is a hierarchical voltage control system with four control levels. The three lowest levels (the generator, power plant and regional voltage control systems) will work in a closed loop mode, following their voltage setpoints. The generator and power plant levels are local controls, while the regional system will mean that all power plants in a region control the voltage of a set of remote pilot buses. The fourth system is for national system optimisation. It computes the optimal voltage values of the pilot buses and sets them as references for the regional system controllers.

This complete system is proposed as the best possible and practical way to implement a real-time loss minimisation system for high voltage transmission systems. Its potential important impact upon power system control, security and stability is significant. Field tests are to be carried out once the system in installed, to verify the expected results, which are loss reductions of between 4% and 6% of actual transmission losses.

Principal Contractor	Red Electrica España, S.A
Partners	ENEL SpA
	ENDESA
	University of Strathclyde



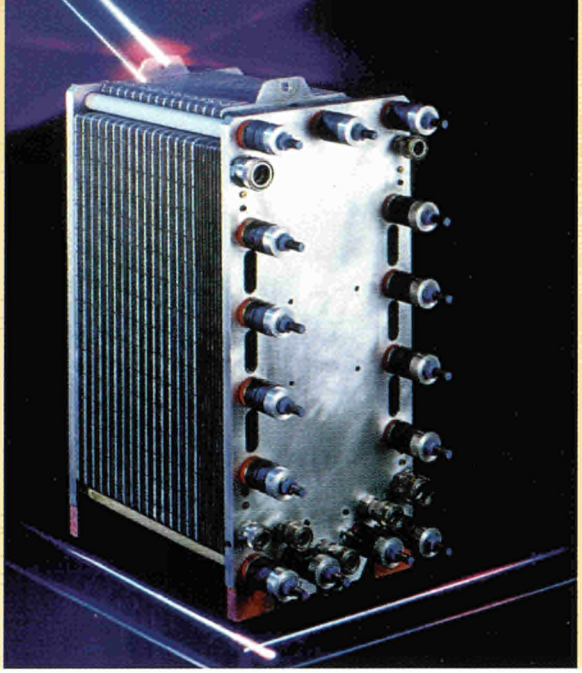
Demonstration Project - EI/001/1997/DE/DK
Design, construction and demonstration of a DFC Hot Module Pilot plant for co-generation.

The aim of this project is the design, component manufacture, construction and installation of a highly innovative Balance of Plant (BoP) for a DFC Hot Module Plant for co-generation.

The Hot Module comprises a new, integrated ancillary sub-system for the operation of a Molten Carbonate Fuel Cell (MCFC) in a real industrial and utility environment. This will be tested and demonstrated within this project for the first time world-wide. The Hot Module design and the relevant engineering was carried during a previous THERMIE project. The innovation in the Hot Module design is a radical simplification of the BoP for the MCFC, with a minimum number of interfaces between subsystems as well as a minimum number of interfaces at the battery limits. All subsystems operating at similar hot temperatures are integrated into the Hot Module Vessel representing a repeating building block for larger MCFC plant.

The target of the project is to develop a small marketable DFC co-generation unit which requires a compact, integrated, innovative design for the fuel processor. The complete DFC co-generation unit will also comprise three further innovative BoP subsystems, the modular inverter and the grid connection, the control system and the visualisation system for operational process control.

Principal Contractor	MTU Motoren und Turbinen Union Friedrichshafen GmbH
Partners	Ruhrgas AG Holder Topsoe A/S



Demonstration Project - EI/00174/1997/FR/IT
Stationary application of a PEM fuel cell fed with waste hydrogen

The objective of this new project is to demonstrate the feasibility of a polymer electrolyte membrane fuel cell (PEMFC) for generating electricity from waste gases from an industrial process by developing a prototype. The target for power production by the unit is 200 kW of net power and is based on a 240 kW PEM stack. The consumption of auxiliaries for operating the power unit have an estimated power of 40 kW. Reliability, safety and the economics of the system, particularly the air compression system and hydrogen feeder, are emphasised in order to provide the complete system with low operation and maintenance costs.

Hydrogen to the value of approximately 10% of the total plant production capacity is wasted annually when liquefied nitrogen tankers return to the industrial plant for refilling. This project consists of a power generating unit which recovers this waste hydrogen, contributing to the energy savings of the plant. A hydrogen feeder recovers the cold hydrogen from the tankers and converts the erratic flow to a steady low pressure flow required to feed the 200 kW PEMFC. The voltage supplied by the stacks is then converted to the current features of the plant using an AC/DC static converter and is used to supply selected plant equipment. The unit is to be operated automatically by a computer and remotely controlled via a modem link.

Principal Contractor	Air Liquide DTA
Partners	De Nora, Schneider Electrica
	CEA

Highlights - Associated measures success stories

Between 1995 and 1997 the associated measures supported by THERMIE have, in industry, focused upon promoting the uptake of technologies which optimise production process efficiencies world-wide. In the energy industry these measures have concentrated on increasing the market penetration of innovative European energy generation, transmission and distribution technologies.

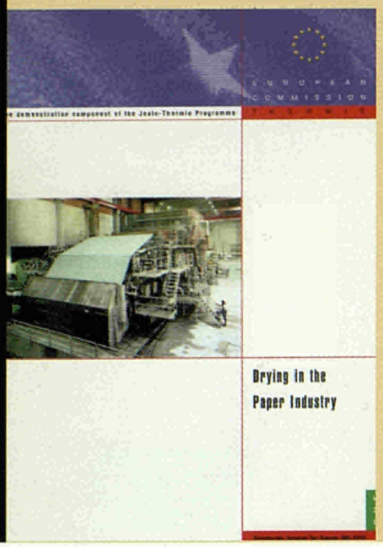
Associated Measure - STR-0193-1995-DK/BE/FR
Strategy for the extended use of district heating and cooling in Europe

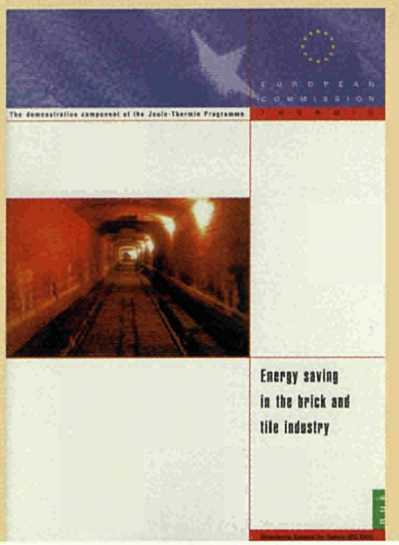
The potential for the extended application of district heating and cooling in Europe is significant, but effective promotion of the technology is required before uptake will be increased. The aim of this project was to explore the best strategic approach to the dissemination of knowledge on district heating and cooling technology, through the continuation of the EU marketing group on district heating and cooling.

The initial task of this group was to identify emerging technologies and produce a strategy report for the promotion of district heating and cooling. From this starting point the group then met on five occasions during the course of the project to plan promotional activities. These meetings provided events at which information and dissemination material was exchanged and also permitted discussions which dealt with identifying strategic approaches towards the opening up of new markets inside the EU.

The promotional activities undertaken during this project included; a Handbook on District Cooling, participation at the Euroheating'97 event at Arnhem and the creation of a district heating and cooling Internet Homepage (http://energi/dti.dk/ecd/dhe.htm).

Principal Contractor	Energy Centre Denmark
Partners	Euroheat
	European District Heating Pipe Manufacturers Association
	Reseau des Agences Regionals de l'energie





Associated Measure - STR-1072-96-DE/ES/HE/UK
Creation of an energy technology dissemination network for brewing

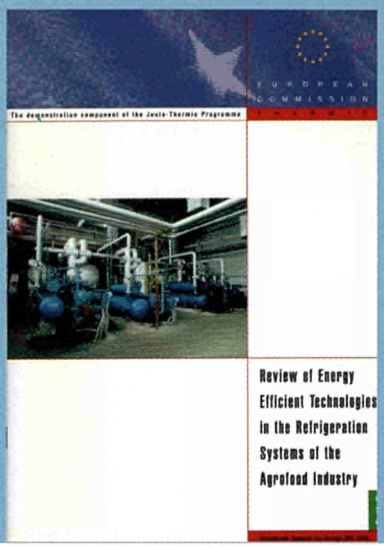
Significant energy saving potential exists within the brewing industry, but many companies are currently unaware of this potential.

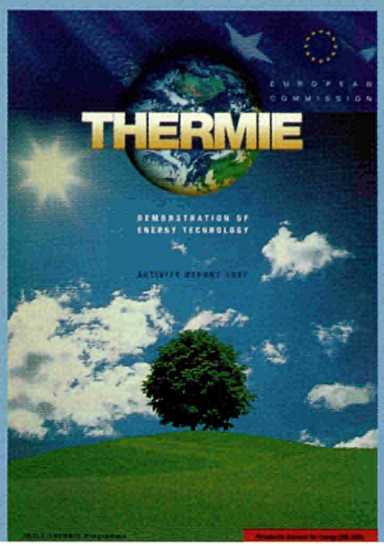
The aim of this project was to establish a European network for the dissemination and implementation of efficient energy technologies in the brewing sector, in association with the European and national brewing associations. It also aimed to launch a set of dissemination activities within the European regions with most demand for technology transfer. Special attention was given to the dissemination of energy technologies to small and medium sized breweries. A study carried out for the sector, discussions at marketing group meetings and additional meetings with experts from industry, research, the associations and the project participants, have identified the most important technology developments, as well as future demand for technological development in the brewing sector. A strategy for the wider implementation and replication of these technologies has therefore been developed.

The project has involved the following activities:
The establishment of Brewnet, three workshops for employees in the sector on brewing technologies and financing schemes and a site visit to see innovative technologies in a Bavarian brewery. In addition, a regular newsletter and an information and advice service have also been set up.

It is anticipated that this will lead to a higher replication of new and innovative energy technologies in small and medium sized breweries in Europe and a strengthening of the competitiveness of these businesses.

Principal Contractor	Zentrum für Rationelle Energieanwendung und Umwelt
Partners	Instituto para la Diversificacion y ahorro de la Energia
	LDK
	March Consulting Group





Associated Measure - DIS-0887-96-DE/IT
Data collection on fuel cell applications

Fuel cell technology is not as yet widely applied in the energy supply sector. The aim of this project is to promote fuel cell technology for such applications.

For this purpose, quantitative information on practical fuel cell applications, for example, performance data, operating hours, necessary investment, operation and maintenance costs, electricity costs etc., will be collected and distributed to interested parties. The information system created will allow an interactive calculation for the simulation of performance and economics for a virtual power unit to be made.

The information is available in several formats: e-mail, newsletter and Internet Web Page (http://www.ds.leipzig.de/fuelcell.html). Promotion of this new information system by speakers at seminars, workshops and conferences, such as PowerGen'98 in Milan, will allow its further development.

Principal Contractor	ICEU
Partner	CESEN SpA

Associated Measure - SME-1172-97-IT/ES/PT/HE
Liaison Offices - Textile Industry Network (LOTIN)

Considerable opportunities exist for energy saving in the textiles sector, but their participation in THERMIE has been limited. The aim of the LOTIN project is to promote the participation of textile clothing and textile machine manufacturers in THERMIE by providing assistance, particularly to SMEs, in the preparation of proposals to ensure that these are of high quality.

LOTIN will create a network of associations in the textiles sector and technical institutes operating in the energy field. The main objectives of this network are to favour co-operation amongst textile manufacturers and machinery manufacturers after the identification of their needs, and to stimulate textile enterprises to work at a European scale, from both a technical and market point of view. It also aims to optimise textile sector industrial processes by saving energy, water and raw materials, thus reducing costs. Finally it aims to increase the competitiveness of the textiles industry in terms of cost, product quality and environmental impact.

Principal Contractor	CESVIT
Partners	AITPA
	CITEVE
	HCIA

Associated Measure - STR-1194-97-BE/ES/FR/NL
Waste and by-product recycling in the cement industry: Technical Issues

The cement industry is highly energy-intensive and could potentially derive significant benefit in waste management and cost terms, if wastes could be valorised in the cement kiln as an alternative to conventional fuels. This project consists of a technical evaluation of the issues associated with waste valorisation in cement kilns. The feasibility and environmental impact of waste valorisation in existing cement kilns will be compared with other waste disposal routes, e.g. incinerators, blast furnaces, power plants. Waste material is to be considered as a fuel. Emerging technologies for cement kilns will also be analysed, and new patents and products proposed by the project participants will be analysed to assess their impact upon health, safety and the environment.

Overall, the study will lead to a better knowledge of the market actors in the field by identifying and promoting emerging technologies. It will lead to a better understanding of the environmental impact of waste valorisation in cement kilns compared with other alternative disposal options.

Principal Contractor	Ciments d'Orborg
Partners	EMIGRISA
	ISE
	TERIS
	TNO MEP

Associated Measure - STR-1195-97-BE/ES/FR/NL
Waste and by-product recycling in the cement industry: Non-Technical Issues

This project is directly related to project STR-1194-97-BE and consists of the evaluation of the non-technical issues associated with the valorisation of wastes in cement kilns. The legal, administrative and strategic issues related to emissions from cement kilns, product norms and waste management will be reviewed. A database describing the waste streams of value to the cement industry, their origin, quantity and present rate of use will be set up. The socio-economic and techno-economic aspect of the problem will be analysed in detail as well as its impact upon the competitiveness of the EU cement industry. Interactions with the building industry will also be analysed.

Principal Contractor	Ciments d'Orborg
Partners	EMIGRISA
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A VIEW TO THE FUTURE

The energy market is characterised by a slow but steady growth in demand, particularly for electricity. Even on a 'business as usual' scenario, industrial energy demand in the EU is expected to grow by 0.5-0.9% per year from 1990-2000, with serious implications for the environment. If this impact is to be minimised, then the development of innovative energy technologies which generate power in the most efficient manner, and utilise that power as rationally as possible, are required. The role of THERMIE in providing a co-ordinated, targeted approach to the development of a long term, sustainable energy scenario for Europe is important as without public sector financial assistance for demonstration, these technologies would certainly take longer to reach the marketplace.

The Energy Industry

Reliable, cost-effective and environmentally sustainable energy supply is a pre-requisite for economic growth, industrial competitiveness, environmental protection and job creation in Europe. Several key energy technologies have been identified as offering particular opportunities for achieving this, but they must be effectively demonstrated, to prove their real-life applicability, if they are to be widely adopted. The support provided by THERMIE for such activities has been of significant value in stimulating the increased uptake of these technologies. This has not only helped the energy industry improve supply efficiency and reduce environmental impact, but has also assisted the development of a strong indigenous and export industry for European technologies, meaning that manufacturers are able to compete effectively in the global market with foreign companies, particularly those from the USA and Japan.

Great potential still exists within the energy industry for improvements in the efficiency of energy conversion, transmission and distribution. Future innovation in large scale, centralised, electricity technologies should focus on the demonstration of technologies using materials and manufacturing processes which improve supply efficiency, facilitate the use of various fuels and lead to a reduction in overall generation costs. Future technology demonstration should focus on improving plant performance and reducing equipment costs, through, for example, the demonstration of high efficiency gas turbines, especially for mixed, unconventional or low heating value fuel applications, the development of dry low NOx burners for mixed fuel applications and the use of the super critical steam water cycle for power production. Improved monitoring and control systems should also be demonstrated. This is of particular importance in view of the severe competition that EU manufacturers in this field currently face from the USA and Japan,. If European manufacturers are to maintain their competitive advantage, then their technologies must enter the market ahead of their competitors.

The fuel cell concept should also be a focus for future demonstration attention, as this could be developed to reach economic viability in the medium to long term. Innovations which will reduce investment costs, and increase technology lifetime, are particularly necessary as these factors currently mean that fuel cells are uneconomic. Costs related to the ancillary equipment such as air compressors and fuel gas clean up technology are too high at present for fuel cell technology to be adopted widescale, therefore further development and demonstration is necessary. The use of low temperature fuel cells in small scale CHP applications would appear to be their most promising application, but further demonstration is also necessary here. Emphasis should not only be placed on technology demonstration, but also on promoting these new energy concepts to gain their widespread acceptance.

With regard to electricity transmission and distribution, future demonstration should focus on measures which reduce costs and losses from power lines. It is anticipated that with demonstration support, super conducting high voltage power lines for underground installation can be developed before 2010. Improvements in the distribution network should concentrate upon improving reliability of supply and the demonstration of high voltage direct current techniques for cross border exchange of electricity. The wider use of power electrons in transmissions networks must also now take place. A further important demonstration target is that of technologies which, in the light of the expected increase in small decentralised power production, ensure the frequency stability of the network.

The EU market for district heating technologies is very strong, and on this basis EU manufacturers have become world leaders in the supply of low cost, efficient heat generation and distribution equipment. If this market position is to be maintained in the face of growing competition, then innovation and technology demonstration in this field must continue, with the aim of reducing installation cost for transmission and distribution networks, and heat losses. Other future priorities should include the demonstration of improved control and monitoring equipment for performance optimisation, and new cost-effective ways of retrofitting existing networks.

District cooling is still at an early market penetration stage, but its acceptance is gaining speed, particularly in the EU and the USA. EU equipment manufacturers are already facing severe competition from the USA and Japan and the development and demonstration of low cost absorption chillers should be given priority to enable EU companies to compete effectively in this emerging market.

It is widely recognised that CHP is one of the most efficient ways of reducing total EU energy consumption and therefore CO_2 emissions. Energy technology demonstration should seek to maximise these benefits by promoting the widescale application of CHP systems.

The widescale adoption of these technologies in the EU should be encouraged, as they can generate multiple economic benefits for Europe and environmental benefits world-wide. A strong EU market for innovative energy technologies can result in the development of a strong European manufacturing industry, and a globally competitive industry. This generates employment in Europe and makes a significant contribution to economic growth. Widescale uptake will only take place, however, after technologies have been successfully demonstrated in a real, commercial environment, to prove their cost-effectiveness and applicability. Demonstration is one of the most important stages in the technology development process as, once technologies have been commercially proven, the market will take over.

Rational Use of Energy in Industry

European manufacturing industry has lost ground in recent years as a result of international free market conditions and the globalisation of the economy. This has introduced world-wide competition based on comparative cost advantage, for example lower wage rates. This has resulted in the relocation of some industries outside the EU border. The goal of EU industry is to sell its products, maintain its competitive position in established markets and participate, where possible, in new market opportunities. This would lead to the creation, or at least retention, of manufacturing jobs in Europe. In recent years EU manufacturers have failed to achieve these goals in several sectors, such as textiles, mechanical engineering and automotive equipment, where a significant market share has been lost to strong competition from outside Europe.

In view of intense global competition, reducing costs has become a fundamental aim within EU manufacturing industry and demand is strong for technologies which can help to achieve this. Reducing expenditure on energy inputs can make a significant contribution to cost saving , particularly for energy-intensive industries. Significant opportunities exist for increasing the efficiency of energy use in manufacturing, through the adoption of efficient energy consuming equipment and the installation of energy efficient processes. Energy saving alone, however, will not achieve the optimisation of EU industry and innovative technologies should, wherever possible, also accommodate other objectives such as increasing product quality and the re-use or valorisation of by-products. Continuous innovation and demonstration of such technologies is vital if they are to be widely adopted.

The establishment of a strong domestic market for energy efficient technologies will lead to the simultaneous development of a strong EU manufacturing industry. EU manufacturers are capable of taking the lead in the development of many energy technologies and the sector has the potential to make an important contribution to economic growth, industrial development and employment creation in Europe. Innovative technologies will not, however, be adopted until they have been commercially proven under full scale operation in real working industrial conditions. THERMIE, by providing financial assistance for the demonstration of innovative technologies at the pre-commercial stage, therefore helps to address this market penetration barrier. Effective demonstration can thus help to reinforce EU technology leadership in some key areas.

Reductions in industrial energy consumption can make a positive contribution to global environmental protection objectives as reduced energy demand will feed back to the energy industry, reducing power generation requirements. This can contribute significantly to the reduction of emissions necessary to meet CO_2 reduction targets.

Several technologies have been identified as being of key importance in terms of their potential to contribute to improved energy efficiency and therefore cost

reductions in industry. Attention should be focused on the demonstration of technologies in these key areas in the future.

- Process heating, including advanced combustion and burners
- Separation processes
- Refrigeration and cooling
- Milling, forming and casting
- Recovery of wastes as raw material and/or fuel
- Process control and sensors
- Process integration and intensification.

Technology benchmarking should be stimulated within specific sectors, especially for SME's in traditional industry sectors. Targeted initiatives should also be undertaken in specific technology areas to achieve consensus targets.

If EU industry is to maintain its position in the global market innovation in the technologies of energy generation and use are essential to ensure that products can be manufactured at competitive cost and with minimal environmental impact. This can only be achieved through the development and deployment of fully-demonstrated innovative energy technologies for the energy industry and for the rational use of energy in manufacturing. The globalisation of the economy not only provides a threat to EU industry, but also opens opportunities for the development of export-orientated industries in the supply of energy efficient technologies. THERMIE has played an important part in bringing these technologies to the marketplace and in the achievement of the environmental, economic growth and industrial development objectives of the EU.

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The overall objective of the Community's Energy Policy is to help ensure the security of energy supplies for European citizens and businesses at competitive prices and in an environmental compatible way. DG XVII initiates, coordinates and manages energy policy actions at European level in the fields of solid fuels, oil and gas, electricity, nuclear energy, renewable energy sources and the rational use of energy. The most important actions concern the security of energy supply and international cooperation, the integrity of energy markets, the promotion of sustainable development in the energy field and finally the promotion of energy research and technological development through demonstration projects. DG XVII manages several programmes such as SYNERGY, SAVE, ALTENER and THERMIE. More information is available on DG XVII's pages on EUROPE, the Commission's server on the World Wide Web.

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