



E U R O P E A N
C O M M I S S I O N

T H E R M I E

The demonstration component of the JOULE-THERMIE Programme



Hydrocarbons

**Sectoral Report
1995-97**

Directorate General for Energy (DG XVII)

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HYDROCARBONS

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.

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 (the budget between 1995 and 1998 is 1030 MECU), 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, 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 hydrocarbons sources.

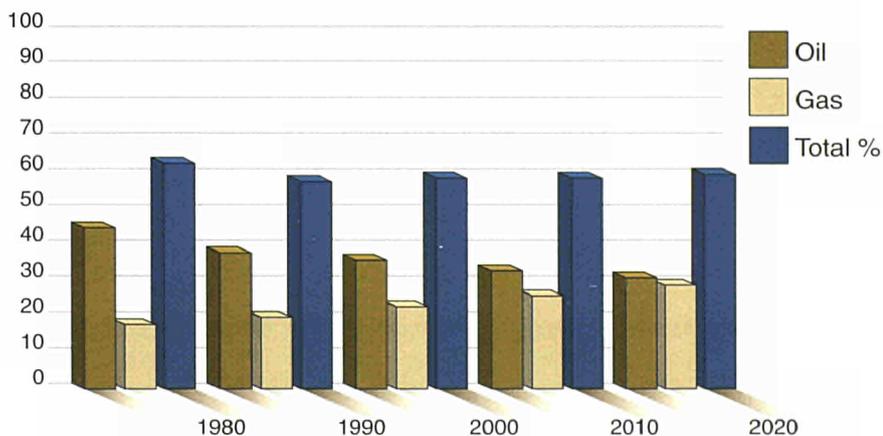


RATIONALE FOR THE SECTOR - HYDROCARBONS

The hydrocarbons sector under THERMIE provides support for demonstration projects in the major activities of the upstream oil and gas industry. Its aim is to provide innovative technological solutions to meet increased demand for oil and gas, while at the same time coping with the growing environmental concerns about the safe, clean, efficient and affordable exploitation of hydrocarbon resources.

During the twentieth century much of the world's economic development has been dependent on oil, and its derivatives and gas. Resource forecasts predict that these fuels will continue to supply the largest share of world energy requirements to 2020 and beyond. Despite efforts to diversify the energy supply base in the EU through the promotion of renewable energy sources, hydrocarbons will remain the primary energy source. Proportionally, demand for gas as a cleaner fuel will rise, but, in a time period where it is anticipated that world energy demand will almost double, hydrocarbons will maintain their dominance and will continue to play a crucial role in the world and European economy. This is illustrated in Figure 1 below.

Figure 1. Hydrocarbons Share in World Energy total primary production (in %)



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

In 1996 oil and gas accounted for just over 40% and just over 20% respectively of the EU's primary energy supply. Forecasts predict that by 2020 they will together supply almost 70% of all EU energy dependence. Unless appropriate steps are taken now, the EU's reliance on imported hydrocarbons will increase from the current 70% of total consumption, to nearly 90% by 2020. This will have a significant adverse effect on Europe's balance of payments and security of supply. This dependency could be limited to around 50% if Research and Technological Development (RTD) and demonstration is focused on improving the European supply situation by, for example, increasing the efficiency of recovery of North Sea oil reservoirs.

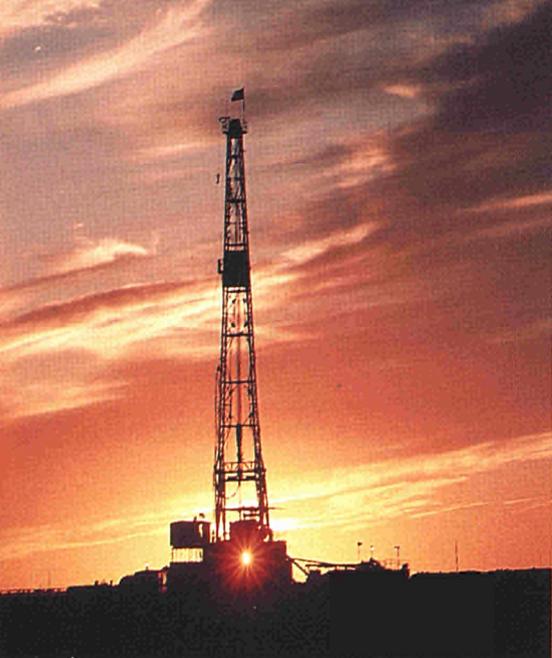
The 5,000 companies which make up the European hydrocarbons industry consist mainly of two types of organisation; the large private multinational oil and gas exploration and production (E&P) companies, and the service and supply industry which supplies equipment and services to the E&P companies. A large number of these service and supply companies are small and medium sized enterprises (SMEs). The large multinationals are increasingly concentrating on core business and are contracting out services to smaller, specialist companies. Responsibility for RTD and demonstration in the field has therefore also been passed down to these SMEs. The exploration and production sector is technologically highly complex and capital intensive. Any investments made are generally high risk, but offer the prospect of high rewards. Investment in RTD and demonstration therefore involves huge financial commitment and commercial risk, particularly for these small companies. The hydrocarbon industry is a truly global market as the oil companies will buy services and equipment from any part of the world. European companies are currently well placed in this market, but are facing sustained competition, in particular from the USA. If they are to develop innovative services and equipment and remain competitive in the global market, financial support is required which will assist in the mitigation of commercial risk associated with RTD and demonstration.



European equipment supply and service companies currently hold a strong position in the global hydrocarbon service and supply market. Europe's current share, of around 30% in this 115 billion ECU market, makes a significant contribution to European employment and the economy. Furthermore, market opportunities are on the increase as the major oil companies seek to reduce costs and maximise revenues from their hydrocarbon fields by contracting out of E&P activities to companies world-wide.

To maintain and strengthen its market position in the face of severe international competition, it is vital that Europe continues to provide financial assistance to the hydrocarbons sector. This is particularly important with regard to SMEs as this funding can provide the small amount of additional finance required alongside that from internal funds and other sponsors, that makes the company able to accept the degree of commercial risk which is associated with such activities. The development of a strong European market will provide a sound commercial base which will allow EU companies to successfully export equipment and services to both the traditional markets of North America, the Middle East and North Africa as well as those emerging in South East Asia and the Former Soviet Union.

European funded RTD and demonstration in oil and gas technologies has made a valuable contribution to reduce indigenous oil and gas production costs per unit volume in recent years. This is essential if European production is to compete with the cheap exploitation costs for hydrocarbons from the Middle East. Technological advances have allowed Europe to increase production from more marginal and difficult indigenous reserves and establish a globally competitive service and supply industry.



Minimising the potential environmental impact of oil and gas operations is becoming an increasingly important issue for this sector. Efforts are being made to minimise environmental impact and raise the environmental profile of the industry. European funding has contributed to the development and demonstration of successful novel technologies for decontamination equipment, the decommissioning of off-shore installations and the removal of harmful pollutants from emitted gases.

Without the significant technological advancement that has taken place in recent years the harsh, off-shore environment of the North Sea could not have progressed to current exploitation levels. Europe is now entering a new era in the exploitation of the indigenous European hydrocarbon resource. New technologies are required to exploit deeper reservoirs and marginal fields in areas of complex geology as this is where the majority of the remaining oil reserves lie. The private sector recognises the imperative of technology innovation and demonstration if it is to remain competitive in the global market and has committed considerable funds to this. The assistance provided by THERMIE during technology demonstration where costs and risks are high, has undoubtedly assisted in this process and has helped the industry to innovate and respond rapidly to market changes.

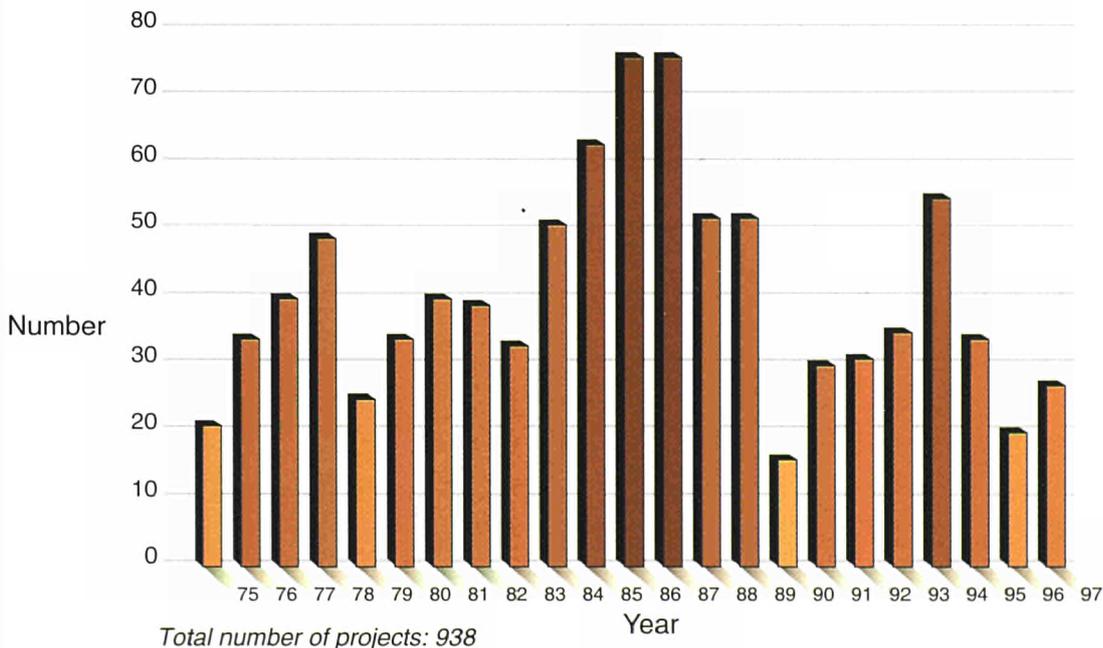
OVERVIEW OF THERMIE ACTIVITIES DURING 1995-1997

Innovation for hydrocarbon technologies has enjoyed a long history of support from the European Commission under a variety of programmes. Since 1975 financial assistance has been provided for research, development, demonstration and dissemination projects in the hydrocarbons sector.

In 1990, after a review of the successes of previous programmes, the European Commission established THERMIE which ran for 4 years and gave 122 MECU of support to 167 hydrocarbon projects. In 1995 the THERMIE programme was included into the Fourth Framework Programme and coupled with the JOULE programme which covers research and development projects. THERMIE is dedicated to projects which demonstrate new technologies and associated measures designed to accelerate the uptake of these innovative energy technologies in the marketplace.

The number of hydrocarbons projects supported to date and the level of support received can be seen in the Figures below.

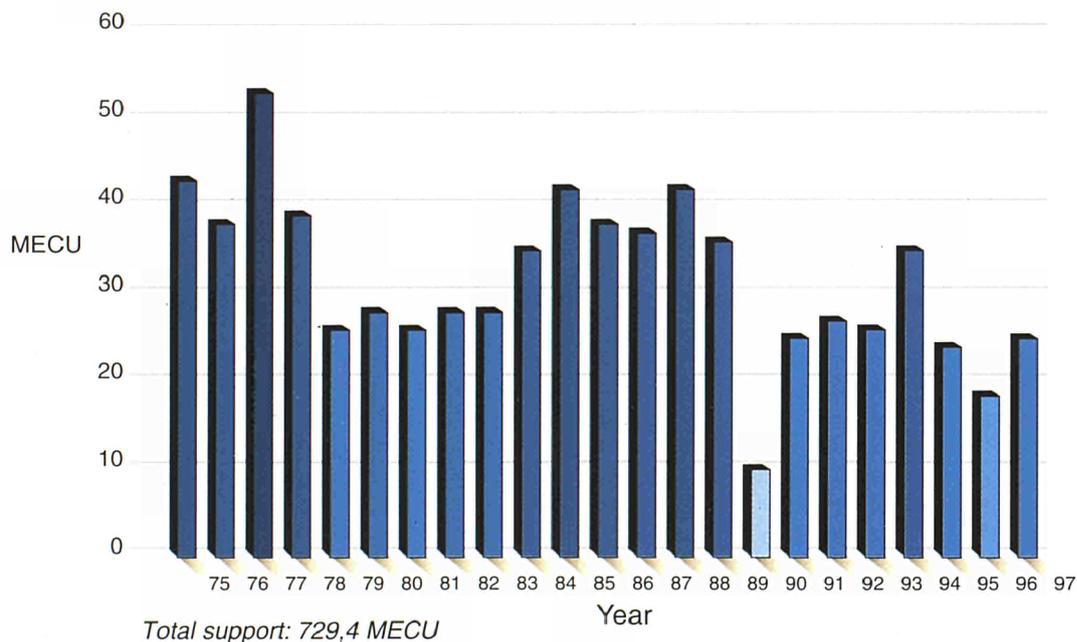
Figure 2. Number of Demonstration Projects supported by THERMIE per year



Considerable progress has made between 1995-1997 towards the demonstration and subsequent market penetration of hydrocarbon technologies which have made an effective contribution to a more efficient, cost-effective and environmentally-friendly exploitation of oil and gas.

During this time the hydrocarbons activities supported under THERMIE have focused upon the demonstration and market penetration of technologies which result in efficiency improvements in the exploration, production and transport of oil and natural gas. THERMIE's main intentions, with respect to demonstration projects, has been to encourage innovation in exploration and recovery technologies which lower production costs, particularly in marginal fields. In doing so it also aims to maintain Europe's strong position in the development of innovative oil and gas technologies. Through its associated measures THERMIE, in addition aims to promote the rapid uptake of European oil and gas technologies, by providing assistance to activities which help to market these technologies and encourage their widescale adoption world-wide. These activities have contributed to the development of a European hydrocarbons industry, strong in both the domestic and export market, which sustains stable economic growth and respects the environment.

Figure 3. THERMIE support for Demonstration Projects per year





THERMIE projects in the hydrocarbons sector represent a broad spread of activities, all of which are aiming towards the achievement of the same broad global goal; the safe, clean, efficient and affordable exploration, production and transport of oil and natural gas.

Considering that Europe will continue to rely heavily upon hydrocarbon fuels for energy supply in the foreseeable future, the main challenge for the sector is to secure an affordable internal energy supply so that reliance on imported fuels may be minimised. This can only be achieved through continuous technological development which will reduce costs and increase efficiency in exploration, production and transport and optimise returns from domestic reservoirs. Before they can be adopted widescale such innovative technologies must be effectively demonstrated to prove their applicability and cost-effectiveness. The results of these projects must then be spread as widely as possible. Products must be launched onto the global market through promotional activities, such as awareness-raising campaigns which promote market opportunities to industry and encourage European technology suppliers to approach new markets.

Demonstration activities supported have involved a wide variety of hydrocarbons technologies. These have ranged from improved seismic techniques which maximise discovery, to new reservoir monitoring equipment which allows better reservoir management and improved pipeline inspection, maintenance and repair equipment which increases the safety, and reduces the environmental impact, of hydrocarbons transport. Many projects also involve cost reduction against the use of existing technologies.

Associated measures supported during 1995-97 addressed the global challenge of encouraging the uptake of innovative European energy technologies in the global market place, maximising the exploitation of existing markets and developing new ones wherever possible. They have also addressed such issues as improving the image of hydrocarbons as an energy source. Activities selected for support have included a variety of market studies, the organisation of events including EU representation at international exhibitions and conferences, and several training courses. A number of projects have also involved awareness raising actions such as the preparation of dissemination material and publications.

Project selection for hydrocarbons proposals is based around the technical quality, cost-effectiveness, innovation, replication potential, relevance to the objectives of the programme in general and the publicised priorities for the sector. Specific priorities for the sector are presented annually in the call for proposals in order to meet the more detailed objectives for the year in view. Projects which are follow-on phases of existing activities or are associated measures to these projects have a high priority, in order that effective work can be built upon. Projects involving SMEs and the transfer of hydrocarbons technology to third countries also have a high priority within the programme.

SMEs

SMEs employ 97% of the European workforce and are particularly active in the energy and energy efficiency industries. The hydrocarbons sector is characterised by both large oil companies and a significant number of SMEs. SMEs make up a large proportion of the equipment supply and service sector and their contribution to technological innovation within the sector is considerable. Generally, however, these companies find it difficult to finance the demonstration of innovative technologies from internal resources as considerable amounts of capital are required. SMEs must generally identify sponsors who will share the cost, and also the risk, of these commercially sensitive activities. THERMIE has in many cases provided such financial assistance. During 1995-1997 a significant number of projects were carried out by consortia with a strong SME involvement. For example, a quarter of all demonstration projects in 1997 were led by SME organisations and their involvement in the majority of project consortia is strong, with 42% of projects supported in 1996 including SMEs. Most of the remaining projects are led by large oil companies, with a few being co-ordinated by universities and research organisations. In 1997 THERMIE made a concerted effort to encourage SME involvement, helping these organisations to access EC support schemes by assisting in their proposal preparations. As a result more SMEs than in previous years were involved in THERMIE supported activities in the hydrocarbon sector.

Cross-border Collaboration

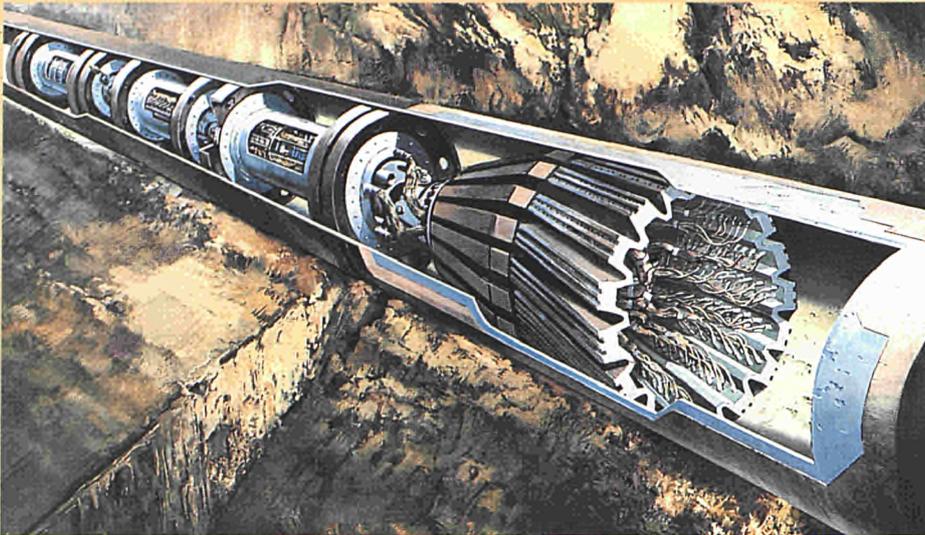
The level of cross-border collaboration in hydrocarbons projects is high. The majority of projects supported between 1995-97 involved consortia of organisations from across the countries of the EU. Collaboration within Europe is necessary if the currently strong position of EU industry in the global hydrocarbons market is to be maintained. Consortia also tend to be large to allow the significant financial and commercial risk associated with technology demonstration to be spread between organisations.

Third Countries

The hydrocarbons sector is becoming increasingly international. New markets in South East Asia, Central and Eastern Europe, Latin America, Africa and the Mediterranean are currently emerging alongside the traditional markets of North America, Europe and the Middle East. Projects which support technology transfer industrial co-operation, international partnerships and can assist the development of a strong European industry are actively encouraged under THERMIE. A number of associated measures devoted to actions within Third Countries have been supported between 1995-97. These have mainly involved projects facilitating the transfer of advanced EU technologies in the oil and gas fields to foreign markets.

The table below illustrates the number of projects in the Hydrocarbon sector and the financial support granted to the gas and oil projects which were approved in the period 1995-97.

	Demonstration projects	Associated measures
1995		
Number of Projects	34	33
Support received (MECU)	24	2.6
1996		
Number of Projects	20	30
Support received (MECU)	18	3.4
1997		
Number of Projects	27	17
Support received (MECU)	25	1.7



Highlights - Demonstration Project Success Stories

The demonstration projects supported during 1995/97 focused on the exploration, production and transport of hydrocarbons. Several projects are already completed or are close to completion and have produced promising results in their first operational reports. Projects which have made noteworthy progress to date are included. Particularly interesting projects which have received support during 1997 are also described below.

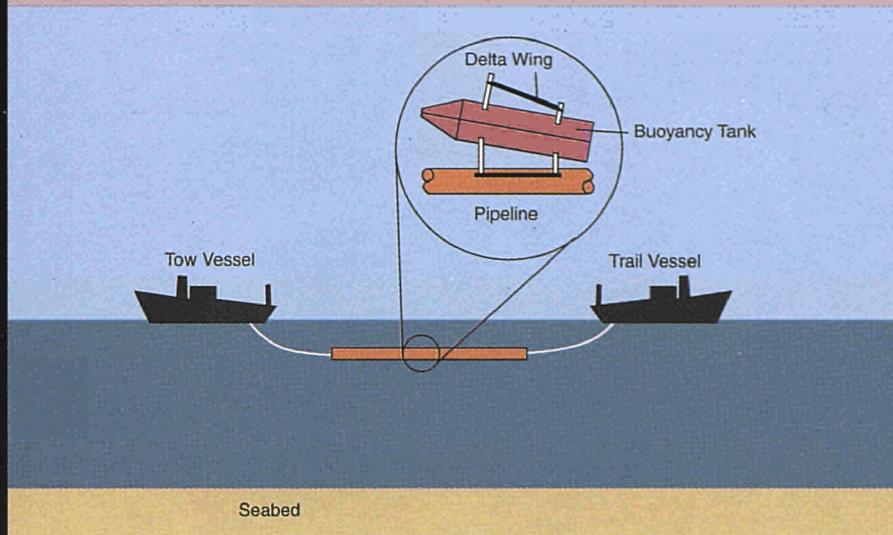
Demonstration Project - OG/00270/95/DE/NL Improved Inline Detection of Corrosion Damage in Pipelines - Ultrascan

The aim of this ongoing project is to demonstrate by field tests in an operating 36 inch crude oil pipeline, that corrosion inspection of pipelines can be improved using new ultrasound technology. This will contribute to the safety of pipeline operation and the prevention of environmental hazards due to pipeline failure.

Existing ultrasound crack inspection technologies are being adapted for corrosion damage inspection. The existing algorithms have been adapted to use multiple echo sequences for the measurement of wall thickness and further algorithms have been developed which can distinguish corrosion, inclusions, laminations etc. In the early test phases, data collected during tests on corroded pipe segments and those with artificial defects was compared to data achieved using the existing technique. The performance of the system was then validated through a test run in an operating pipeline. All corrosion defects were correctly identified and sized. The data collected is currently being evaluated and will be used to assess the state of the damaged pipeline, including a Maximum Allowable Operating Pressure calculation and an estimation of the remaining lifetime.

This new technology can potentially make a significant contribution to the improved safety of pipeline operations.

Principal Contractor	Pipetronix GmbH
Partners	RRP
	Shell



**Demonstration Project - OG/00156/95/UK/NL/NO
Marginal Gas Field Development - The Re-use of Submarine Pipelines**

The aim of this ongoing project is to develop the necessary technologies and methods to locate, recover and re-route existing pipelines for the transport of gas from new marginal fields. As the pipeline can account for more than 50% of the total project cost, their re-use can make the exploitation of these fields economic. Re-use will also benefit the environment as materials will be recycled and unused pipelines removed from the marine environment.

The project involves the re-location of a pipeline close to the Dutch coast to develop other marginal gas discoveries within the same area. The pipeline will be located and uncovered using survey equipment fitted to the deployment vessel. It will then be fitted with 'Delta-Wings' and buoyancy elements which can be inflated and deflated via acoustic telemetry to lift the pipeline while towing. Intelligent acoustic transponders for positioning and monitoring will then be installed along with towing heads on each end of the pipeline. The pipeline will then be towed to a new location, installed in the seabed, connected to a new platform and commissioned for further use. The type of strain gauge, buoyancy units, pipeline clamps, towing heads and their method of attachment will be looked at in detail during the project and the individual elements will be tested in off-shore trials. The final phase of the project will conclude in the re-use of the repositioned pipeline.

To date, preliminary engineering has been carried out to assess the feasibility of the project and detailed drawings of the necessary equipment have been produced. Model tests of the 'Delta Wings' have also been carried out. In the final phase of the project an 8.3 km long 8 inch pipeline, at present used in the Netherlands Q8 block will be relocated to a marginal field. This will be done in mid -1998 when the pipeline is no longer used in its present location.

**Principal Contractor
Partners**

Clyde Petroleum Plc
Korndorffer Contracting International
Seateam Norge A/S

Demonstration Project - OG/00057/95/UK
New and Modified Technologies for Improved Drilling - Advanced Wells

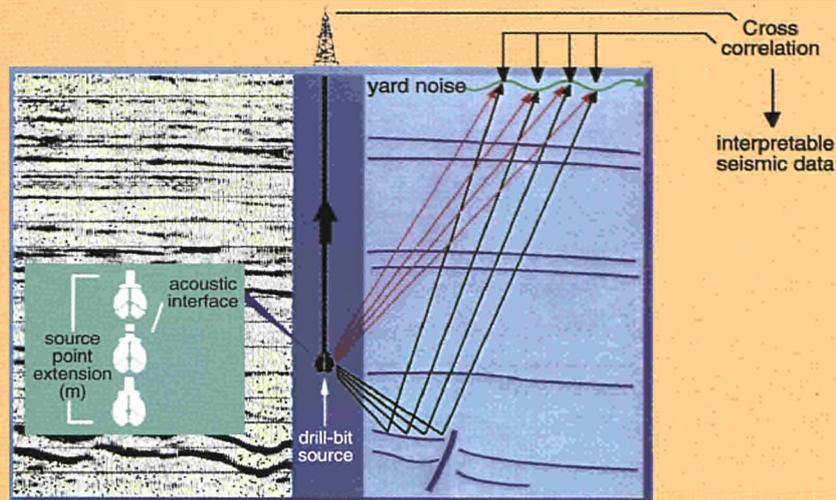
The purpose of this project is to demonstrate and bring to maturity new technologies for more cost-effective exploration, development and production of hydrocarbon resources. The project focuses on new and modified technologies for improved drilling completions, operation and evaluation of advanced wells, the aim being to reduce economic risk and uncertainty related to operational safety and technical performance. New technologies and modified existing technologies are continually being evaluated for testing within the Advanced Wells Project (AWP). In order to meet the objectives, sections in on-shore and off-shore test wells have been, and will continue to be, drilled using the technologies identified to demonstrate emerging technologies in a safe, low-risk environment.

The project also aims to improve the evaluation and prediction of advanced well performance through the development of new features for existing tools for the simulation of reservoir flow, flow through completions and flow in wells. These will also be integrated to enable simultaneous simulation of the entire fluid flow process from reservoir to surface.

The project is divided into two work packages: Reservoir, and Drilling and Completion. The former mainly involves activities to improve prediction of advanced well behaviour. These activities will provide a tool-set for the design, evaluation and ranking of the potential of alternative advanced well systems. One of the main objectives is to develop well technology related to multilateral/ branched wells, to enable the selection of optimal well trajectories. Technologies for optimal reservoir management including devices to control inflow profiles and reservoir simulation tools are also being developed. The main product will be an integrated computational tool-set for accurate simulation of the total multiphase flow production system including the reservoir, the near wellbore region, specific completions and the pipe network for advanced and multilateral wells.

The Drilling and Completion work package involves mainly the demonstration, at various sites, of drilling and completion equipment considered advantageous for advanced wells such as; hard rock drilling, drillstring dynamics, window milling and rotary steerable drilling. Possible weaknesses in methods and equipment will be disclosed and corrective measures undertaken to bring the technologies closer to commercialisation. Improved simulation tools for reservoir evaluation have been produced and demonstrated by testing and evaluation against real field data. Final products are soon to be commercialised. Many tests have been carried out on new and modified equipment, which indicate potential improvements in functionality and several are soon to be commercialised. The successful application of newly qualified technologies will contribute to the exploitation of new and existing hydrocarbon resources by reducing costs and increasing reserves and well productivity.

Principal Contractor	Norsk Hydro ASA	
Partners	Agip SA	Philips Petroleum Company
	Amoco	Saga Petroleum
	BP Exploration Operating Co	TOTAL Norge SA
	Den Norske Stats Oljeselskap AS	



**Demonstration Project - OG/00136/95/IT/UK
Geobit-EXT - New Applications of Drill Bit Seismics for Exploration
through Extension to Diamond Bit Drilling.**

This ongoing project aims to demonstrate the use of the new, innovative Seismic-While-Drilling (by using the drill noise) SWD Seisbit methodology, developed during previous projects. This new Seisbit project involves the large-scale application of the recently developed new Seisbit technology using Polycrystalline Diamond Compact (PDC) drill bits to a) position the bit in time, b) characterise the reflectivity of the strata in the well, c) predict the stratigraphy ahead of the bit and d) increase the availability of real-time geophysical information used for exploration. The project aims to demonstrate an improved performance/cost ratio due to the increased efficiency and applicability of the enhanced Seisbit system.

The already developed Seisbit methodology has produced high quality results using roller cone bits. These typically generate vibration wavelengths from which signal exploitation is robust enough to be immediately used in oil industry applications. PDC bits act as friction tools and the radiated vibration is quite different. The drill bit method generally gives less energetic seismic signals using PDC bits. These are, however, widely used and an increasing number of off-shore and on-shore wells are being drilled using PDC. In this project drill bit vibrations using PDC bits will be applied to the new Seisbit methodology. The main results of the project will be the ability to identify and use even the low level PDC signal to acquire and process it to enhance the signal content to give real-time seismic results useful to exploration and drilling. This will result in the enhancement of the performance/cost ratio due to the increased applicability of the MWD seismic.

To date, good quality PDC signals have been analysed and the results show that both direct and reflected PDC signals match with the roller cone data. The first stage of the project involved the revision of the system where the technical prototype was enhanced by adding the capability to better manage the low level PDC seismic signal in the presence of high environmental noise.

Principal Contractor	OGS
Partners	AGIP SpA Prosol



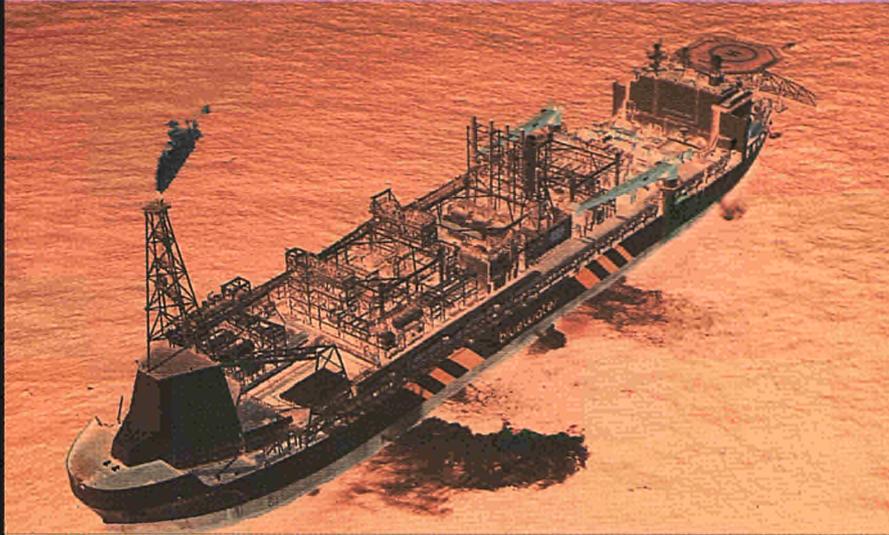
**Demonstration Project - OG/00024/96/FR/NL
SMART LEG - Installation and Decommissioning of Complete Deck Units
in the Open Sea**

Smart Leg is a method for installing and decommissioning complete deck units off-shore. Deck installation in the open sea is performed using the conventional transportation barge with specific equipment to cancel wave-induced movements. Surge movements are first neutralised using lateral shock absorbers. Jacks with non-return valves between the deck unit and the barge then block the deck unit at the peak heave position. The technique was validated with a 1/40 physical scale model within THERMIE project OG/00287/94 (Step 1). The method has recently been used to install a 4500 tonne six legged deck in the open sea. This occurred in June 1997 and was highly successful.

The Smart Leg method extends the limit for deck installation, allowing heavier weight decks to be installed in shallower water in more severe environmental conditions. It should also drastically reduce deck installation costs and contribute to safer off-shore operations. Savings will be realised in installation costs as Heavy Lift Vessels (HLVs) are no longer required. Installation can be carried out by a conventional cargo barge and tugs, which are cheaper to mobilise and operate than HLVs. Using the Smart Leg method decks can be installed fully assembled. This saves considerable time and money against the traditional methods which require long and costly hook-up operations, often carried out under unsafe conditions at the installation site. Reduced installation time means that production can start earlier, reducing the financial impact of investment without production and lowering oil and gas exploitation costs overall.

The potential market for Smart Leg is the oil and gas companies operating off-shore.

Principal Contractor ETPM S.A
Partners Hydraudyne Cylinders BV

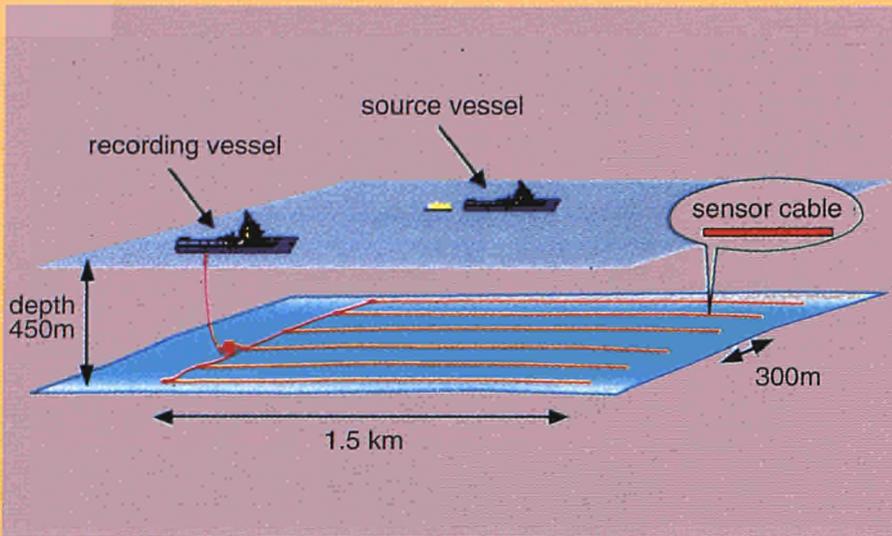


**Demonstration Project - OG/0062/96/NL/FR
Demonstrating the Structural Integrity of Floating Production, Storage &
Offloading Units**

This ongoing project is aiming at the validation and demonstration of structural integrity assessment for Floating Production, Storage & Offloading (FPSO) units operating in harsh conditions in the Northern North Sea.

Turret moored FPSOs have been adopted by many oil companies as they offer important benefits over alternative exploitation technologies. They can be moved from one field to another, are able to operate in deep water and have a large tank storage capacity giving solutions for marginal, remote and deep-water fields where pipeline infrastructures are lacking and fixed structures too expensive. This concept is, however, relatively new and data on the structural integrity of these vessels is currently unavailable. The structural integrity of FPSOs is crucial to the economics, safety and environmental impact of exploitation and its assessment, both before and during operation. Much research has recently been carried out in this area, but an integral validation and demonstration of the techniques is not yet available. This project involves a two and a half year assessment of the new build FPSO - 'Glass Dowl'. An extensive programme measuring hull stresses, motions, turret loads, anchor line loads and sea climate will provide benchmark data to be used for extensive comparison with existing computational models. Measurement began on 1/10/97. Each of the participating companies will run their fatigue analysis models for this vessel and the results will be compared. The results will be summarised in the form of recommendations and guidelines on how to incorporate structural integrity assessment into design, engineering and inspection of FPSOs.

Principal Contractor	Maritime Research Institute
Partners	Bluewater Engineering BV Bureau Veritas



**Demonstration Project - OG/00243/96/GB/NO
Enhanced Oil Recovery through Efficient Permanent Instrumentation for
Reservoir Characterisation and Monitoring.**

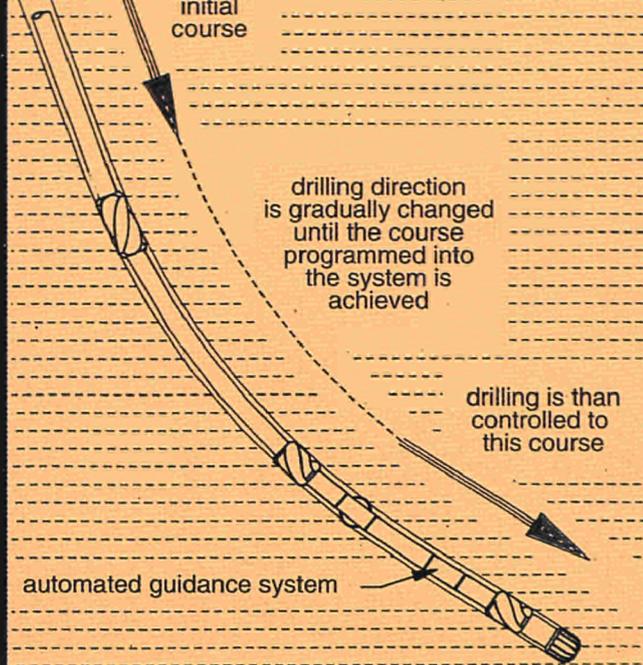
During the last decade 3D seismic technologies have dramatically reduced the cost of finding oil. Increasingly sophisticated techniques have been developed and applied to the reservoir production phases as a cost-effective means of improving reservoir description. To take this a step further 4D seismics have been developed to monitor how a reservoir is being drained. The aim of this project is to demonstrate that 4D seismic reservoir monitoring can be done efficiently and reliably over any size oil field and over the whole life of the field, using the world's first permanently embedded deep-water seismic acquisition system. Such a system, using embedded hydrophone cables, is more accurate than the use of conventional towed marine streamer acquisition and will allow oil companies to improve reservoir development and control, enhance recovery and reduce production cost and risk.

The three main objectives of this project are to reduce the cost of the system, making it attractive to install in all reservoirs to monitor fluid movement, to demonstrate that the technology works in deep water and is reliable for a full 10 years. This demonstration will help in the implementation of reservoir monitoring by making it technically and economically feasible to install in a large number of both new and old oil fields.

In this project the hydrophone cables are to be permanently embedded in 480 metres of water depth and data is acquired by towing a source above these cables, which are connected to a static recording vessel. These permanently installed seismic receivers ensure repeatable data acquisition over the lifetime of the reservoir, which is crucial to obtain subsurface images clear enough to detect unswept hydrocarbon pools. They can also receive data from all angles and distances and will handle subsurface differences associated with azimuth and offset better than marine towed streamers. The electronics and receivers are to a large extent integrated into the cable system, which provides for protection, hence reliability and operational lifetime.

The cost of cable and electronics manufacturing and installation will be demonstrated to be comparable with 5-10 towed streamer data acquisition surveys over a standard sized reservoir. The technology will offer an optimal solution to reservoir monitoring considering the 10-20 year life of a typical reservoir. The resultant increase in recoverable European hydrocarbon reserves is estimated to be 528 million toe over 20 years.

Principal Contractor Geco-Prakla, UK
Partners Norsk Hydro, Norway



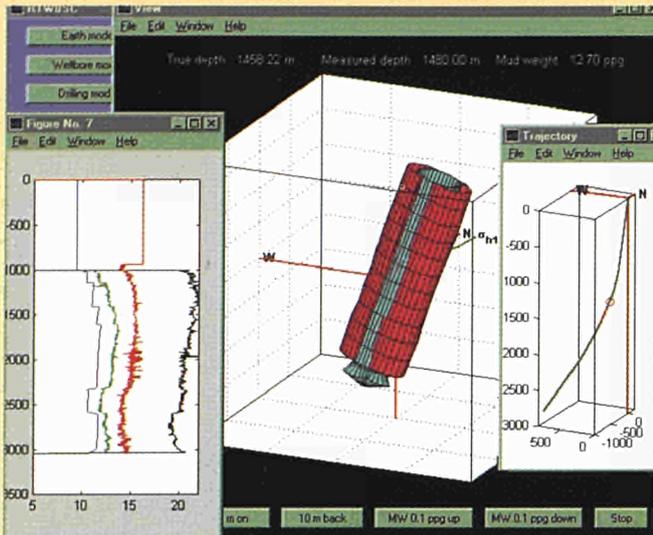
**Demonstration Project - OG/0229/95/UK
 Demonstration of Automated Guidance System for Drilling Extended
 Reach 8.5 inch Boreholes**

The aim of the project is to construct and test an Automated Guidance System (AGS) for directional drilling for use in 8.5 inch boreholes. Three units of the system will be tested.

AGSs provides automatic control of the drilling course in oil and gas production. Present methods involve monitoring the drilling course by means of directional sensors. The information thus obtained is transmitted to the surface as digital data by inducing pressure pulses (mud pulsing) in the circulating drilling fluid. Correction of drilling course is achieved by mechanical operations performed at the surface. The unique feature of this is that control is achieved locally and automatically. Information from a directional sensor is processed within the system by means of an on-board computer which operates an electronic servo-system in order to control the drilling course. The system is autonomous and eliminates the need for surface intervention. This offers a wide range of benefits especially greatly increased drilling range. This arises by minimisation of wellbore tortuosity and the elimination of static friction by allowing automated steering with rotary drilling. A 12.25 inch AGS is already commercially available, but the commercial potential for an 8.5 inch version is enormous.

This AGS will allow additional oil to be recovered from each well drilled due to its ability to drill further into hydrocarbon deposits. One unit has been constructed and field testing is currently taking place.

Principal Contractor Cambridge Drilling Automation Ltd.

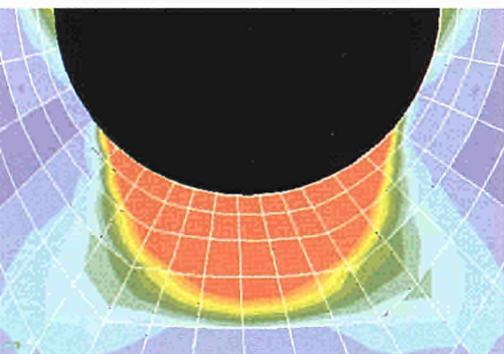


Demonstration Project - OG/0199/95/UK/NL Monitoring Wellbore Instability

The aim of this ongoing project is to demonstrate that a real-time product for monitoring wellbore instability will reduce drilling costs by providing information on the wellbore during the drilling process. It will also provide a recommendation on mud weight, mud property, mud circulation casing point and well direction. This product, which involves measurements acquired by drilling, must be robust and easy to use. It is an extension to an existing commercial simulator, IMPACT, incorporating the results of research recently completed. The demonstration will take place in a North Sea field where drilling problems are significant.

The tool will be a system running at, or in close contact with, an active drilling rig, accepting data concerning drilling conditions, diagnosing problems of hole stability, and recommending the best method to overcome them. The diagnosis will be used to update a mathematical model of the wellbore to improve drilling performance in subsequent wells. The source of the data and the demonstration site is in a North Sea field where drilling problems are significant.

The project is taking place in six phases. Phase 1 involves the collection and assembly of data including seismic, drilling and logging data, allowing a picture to be built up of the drilling and hole stability problems encountered in the field and generates datasets against which the software can be tested. Phases II and III generate 2D and 3D petrophysical and geomechanical problems of the field onto which real well trajectories can be superimposed for stability assessment. Phase IV examines the stability of deviated wellbores using a finite element model in order to generate correction factors for the effects of deviation in the relatively simpler models to be used in the real-time algorithm. Phase V is the generation of the algorithms and prototype software for the product and Phase VI is the demonstration, evaluation and monitoring of the product during the drilling of a new well.

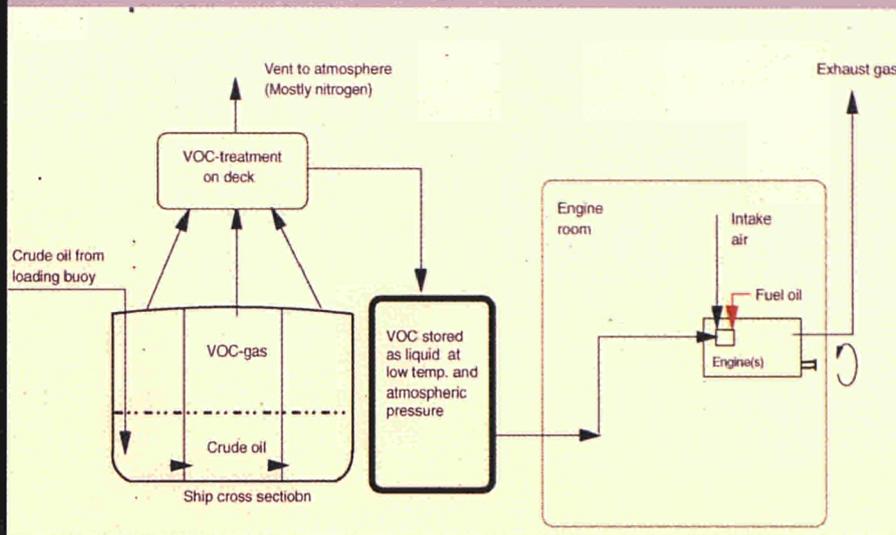


The product will use advanced visualisation techniques to display the results of the analysis to the drilling team as visual presentations of hole conditions have been found to be vital in promoting the acceptance of such analysis.

A first version of the software is now complete, but modifications and development are continuing. The field demonstration of the system is planned for mid-1998.

Principal Contractor Partners

Schlumberger Cambridge Research
Schlumberger Evaluation and Production services
Netherlands Institute of Applied Geoscience
Amoco (UK) Exploration Company



*Principle for VOC-Fuel
VOC-gas is trapped,
processed stored and
fed into diesel engines
as fuel.
Courtesy of Statoil*

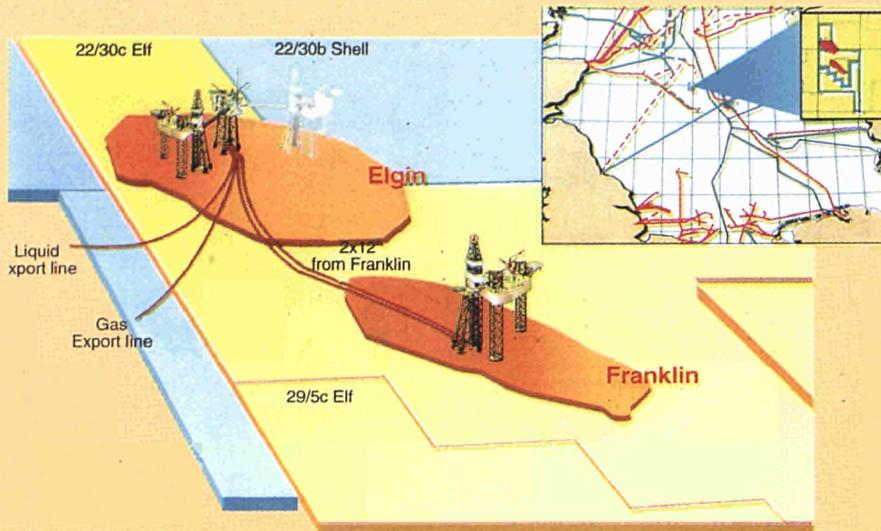
Demonstration Project - OG/00147/97/NO/DK Utilisation of Hydrocarbon Gas as a Ship Propulsion Fuel

This project will allow the utilisation of volatile organic compounds (VOCs), currently released to the atmosphere, causing severe environmental problems, as a fuel in ship propulsion engines.

It is aiming to produce an operable prototype system for trapping and condensing hydrocarbon gas (VOC) which is currently 'flushed off' from oil cargo during loading and transport and to use this as fuel in the ships engine. The VOC fuel will be used in dual fuel combustion, with up to 95% of the ships energy demand being supplied through VOC, the remainder through heavy fuel oil or diesel which is required to ignite the VOC. It is anticipated that a first generation commercial system can be used on crude oil carriers in the North Sea. The project has a strong environmental objective and will calculate the potential for a reduction in VOC emission, heavy fuel oil consumption and a corresponding reduction in related exhaust gas emissions as VOC contains no sulphur and 30% less oxides of nitrogen. The system's performance during operation will be monitored and this data will give a firm basis for deciding on broader implementation on crude oil carriers.

The project is currently in its design phase and preparations are currently being made for large-scale engine testing.

Principal Contractor Den Norske Stats Oljeselskap A/S R & D centre.
Partners MAN B&W Diesel A/S



Development scenario

**Demonstration Project - OG/00017/97/FR/GB
Realization and Utilisation of an Innovative Ball Valve for Deep Gas Fields
at High Pressure and High Temperature.**

The aim of this project is the manufacture, testing and installation of a 12 inch 15,000 PSI ball valve, able to operate under high temperature and pressure conditions.

This new valve, designed, developed and manufactured by the lead contractor, has several revolutionary features including a new body shape and a tungsten carbide coating on the ball and seats which allows excellent resistance to abrasion, corrosion and high temperatures. It will be tested by conformity with the usual standard (API 6A) and a special test procedure for high temperature and pressure. The valve is to be installed on a platform allowing the exploitation of deep gas fields at high pressure and high temperature. These fields are currently unexploitable due to lack of technology. The valve will act as an isolation valve, an emergency shut-down valve, between the gas reserve and exploitation pipe. On the platform the equipment is designed to process the gas to commercial specifications in order to deliver it into the grid. This will simplify the process on platforms and will considerably reduce equipment costs, maintenance costs and production losses.

The engineering phase is now complete, and the valve is currently being validated through testing of its behaviour under severe conditions. Installation of the valve on the ELF UK Central Graben platform for gas exploitation is planned.

Principal Contractor	Flow Control Technologies
Partners	ELF UK

**Demonstration Project - OG/00141/97/IT/FR
Advanced Liquid Paraffin Synthesis**

The objective of this innovative slurry process project is the demonstration of the suitability of a Fischer-Tropsch technology for the economical chemical conversion of natural gas into liquid paraffin, a cleaner and more easily transportable fuel with higher energy density.

Syngas generation technology (natural gas to carbon monoxide (CO) and hydrogen (H₂) mixtures) and heavy paraffin upgrading technology is already commercially available. On an experimental basis, this project will build and run a demonstration plant for Fischer-Tropsch synthesis, which converts syngas to heavy paraffins and hydrocarbon products. Heavy linear paraffins can be produced by a reaction of CO and H₂ on a catalyst, at high temperature and pressure, giving water and oxygenated hydrocarbon compounds as by-products. This project aims to use a new catalyst which minimises the generation of oxygenated molecules and maximises the molecular weight of paraffins produced. A new design of slurry bubble column reactor to maximise yield and productivity using accurate temperature control to ensure high wax quality, has been patented through the project. A separation system to remove the catalyst from the waxes has also been designed.

The energy cost savings expected compared to the use of a conventional fixed bed technology are considerable.

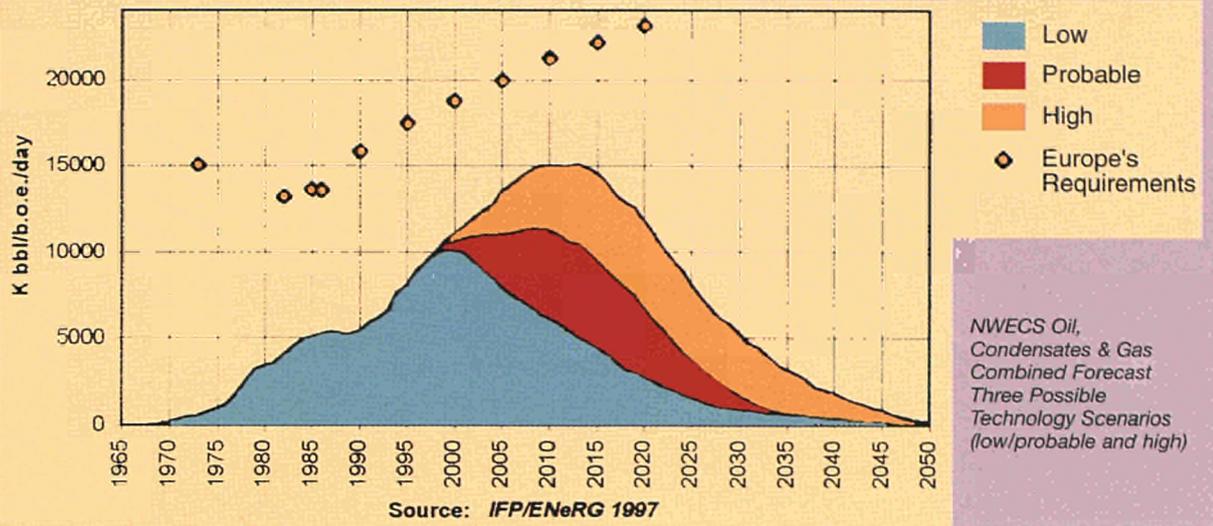
Principal Contractor Agipetroli SpA
Partners Institut Français du Pétrole

**Demonstration Project - OG/182/97/DE/FR
CBM COALMET (Coal Bed Methane)**

This project aims to demonstrate a complex technology for the production of gas from hard coal seams (coal bed methane, (CBM)). This demonstration will benefit from the use of advanced 3D gas reservoir simulators and of the contractors specific knowledge of coal basins and their associated petrophysical characteristics.

The R&D phase of the project involving exploration and gas testing in the drilled coal bed methane (CBM) well - Aspenhübel 1 - has already taken place. Low permeability, hard coal seams are to be exploited from surface drilled CBM wells. The permeability of the coal seam is increased by fracs to extract the gas with good productivity. Relevant data will be collected in order to run the reservoir models and to determine the design parameters of the subsurface and surface equipment and facilities required for CBM exploitation. A comprehensive logging and well testing will take place on a suitable test well. The drilling phase will be followed by a 12 month production period when associated production data will be recorded. The final assessment report will consist of the comparisons of numerical 3D model prognosis and the actual production profiles.

Principal Contractor	Saarbergwerke Akinienengesellschaft
Partners	GDF DBI



Highlights - Associated Measures Success Stories

Activities supported in the first three years of the programme in the hydrocarbons sector have involved dissemination activities which address the market needs of actors within the hydrocarbons industry. Activities have included organisation of exhibitions and conferences, training courses, workshops/seminars and publications.

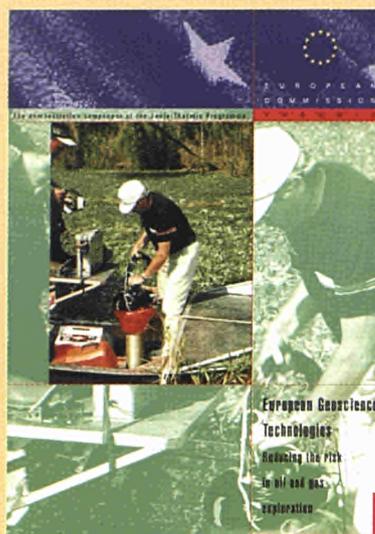
Associated Measure - STR-0640-1995-FR North Sea Oil and Gas Production Outlook

The majority of Europe's remaining oil and gas reserves lie within the North Sea region. To ensure that the economic potential of these reserves is maximised and they are exploited to their fullest potential, it is imperative that exploration and production takes place at optimum efficiency.

This project therefore aimed to clearly assess the potential of hydrocarbon reserves and production within the North Sea, with or without the implementation of innovative technologies. It has made an assessment of undiscovered and recoverable reserves and has translated these into production estimates and expense forecasts, with or without the implementation of innovative technology. Based on these forecasts the impact of these scenarios upon the economy of the EU, its Member States and regions, in terms of revenue, investment and employment, has been assessed.

The overall aim of the project is to give the European Commission, the governments of Member States and the oil and gas industry an objective perception of the potential economic contribution of North Sea Oil through aggressive technology innovation. This will provide a common basis for the development of a strong Research and Technological Development (RTD) Programme and help consolidate a European energy strategy in this sector.

Principal Contractor Institut Français Du Pétrole



**Associated Measure - SME -0800-1996-NL
Arabian Gulf Conference on European Oil and Gas Technologies 13-14
October 1997 Bahrain**

The potential market for European oil and gas technologies in the Middle East is significant. They must, however, market themselves strongly in the region in view of the strong competition they face, particularly from North American companies.

This project involved the organisation and follow-up of a large conference on European Oil and Gas Technologies in Bahrain. The conference, held in October 1997, within the framework of the Gulf Co-operation Council (GCC) - EU co-operation agreement, was the first GCC-EU Conference on Advanced Oil and Gas Technologies. During the conference, speakers and attendees from all around the Arabian Gulf and the EU took part in technical sessions where presentations on a variety of relevant themes were made. This successful event provided significant export opportunities for European technologies and products in this important hydrocarbon province and cemented relations between the EU and the states of the GCC.

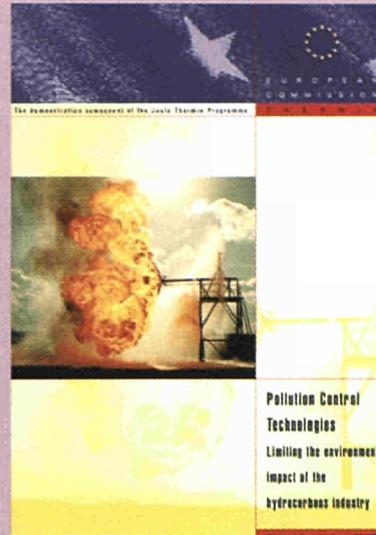
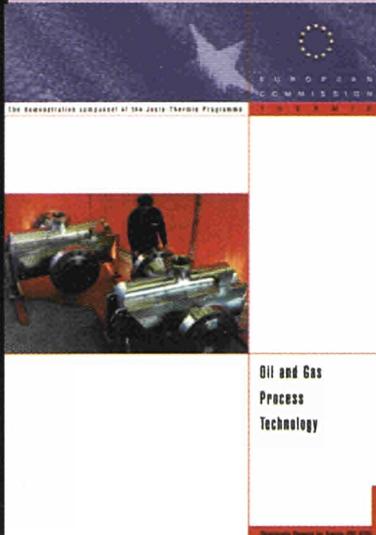
Principal Contractor Association of Dutch Suppliers in the Oil and Gas Industry (IRO)
Partner CMPT

**Associated Measure - DIS-1087-1996-GB
Offshore Technology Conference, 6-9 May 1996, Houston, USA**

European oil and gas technology suppliers and service companies are constantly seeking to enter new, and expand existing markets. One of the most effective methods for marketing technologies is through attending conferences and exhibitions overseas where direct contact can be made with potential customers.

This project involved the organisation and management of an EU stand at the Offshore Technology Conference and Exhibition, the premier oil and gas trade show in the world. The latest upstream European hydrocarbons technologies were demonstrated at the event and successful THERMIE funded projects were promoted. This event raised the profile of many European oil and gas technologies in the international market.

Principal Contractor The Petroleum Science and Technology Institute, UK

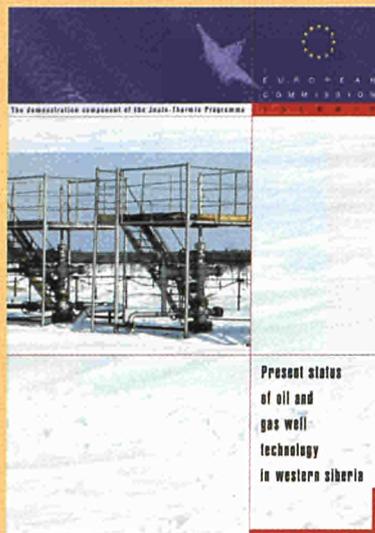
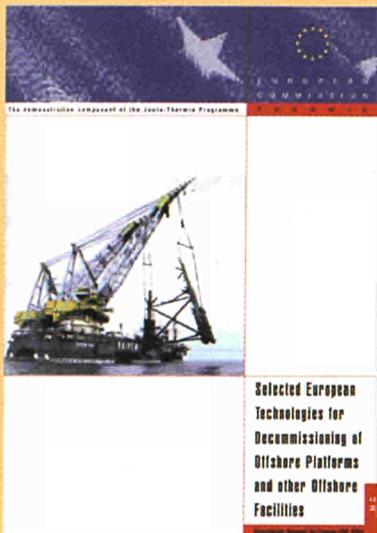


**Associated Measure - SME-1486-97-IT
Gate 2020 - Gas Advanced Technology for Europe 2020**

In recent years, natural gas has come to play an increasingly important role in the European energy supply situation and demand for this energy source is continuing to increase. Its supply must therefore be increased wherever possible and technological innovation is one means through which this can be achieved.

This project aims to assess the technology needs required for the accelerated supply and utilisation of natural gas in Europe through identification of the RTD needs and critical technologies. This will involve state-of-the-art review of existing natural gas technologies followed by the identification of future demonstration requirements to meet the technological and socio-economic needs of the EU in 2010 and 2020.

Principal Contractor ENI SPA
Partner Institut Français Du Petrole



**Associated Measure - DIS-1256-97-FR
Workshop on Pipeline Safety and Spills Remediation, Russia -
OUFA, October 1997**

Reducing the environmental impact of the oil and gas industry is a priority area for the sector. Improving the safety of hydrocarbon transport and the ability of the industry to effectively remediate accidental spillages is one important way through which this can be achieved. The transfer of innovative technologies in this field to third countries is therefore an important mechanism to ensure widescale environmental improvement in the operations of the industry.

The Russian oil transportation system is one of the largest in the world and Russian oil company representatives have requested assistance in improving this system through technology transfer from Europe in the field of pipeline safety and spill remediation. A workshop was therefore conducted for the reciprocal exchange of experiences in this field. This workshop provided European technology suppliers with significant opportunities to develop new contacts and business opportunities within the Russian market.

Principal Contractor Groupement des entreprises parapétrolières
Partners Association of Dutch Suppliers in the Oil and Gas
 Industry
 GOPA-Consultants

Details of all projects supported under THERMIE are available to the general public. These are recorded on a database, 'SESAME', which contains information on all research and development and demonstration projects funded through EC programmes managed by the Directorate-General for Research & Development (DG XII) and Energy (DG XVII). Details of projects supported during 1995-1997 are available on the internet at <http://europa.eu.int/en/comm/dg17/thproj.htm>.

Further dissemination is available from DG XVII including a selection of 'Flag Brochures' which give a full description of completed THERMIE projects in the hydrocarbons sector.



CONCLUSIONS AND RECOMMENDATIONS FOR A FUTURE STRATEGY

Despite efforts to diversify the energy supply base in recent years, oil and gas will continue to be the dominant source of primary energy and their direct and indirect impact upon the European economy will continue to be significant. Today two thirds of Europe's hydrocarbons are imported and this could increase to 90% by 2020 unless innovative technologies are developed and applied to increase indigenous resources. Europe has therefore reached a turning point with regard to the North Sea reservoirs. Efforts must now be made to secure supplies for the future through improving the yield of currently active oil and gas fields and locating and developing new fields, which will be marginal and more difficult to exploit. This depends primarily upon the development of new, innovative exploration, production and transportation technologies.

In addition to increasing security of energy supply, technological innovation offers multiple benefits to Europe. These include employment creation, economic growth, industrial development, and a healthy export market. European Research and Technology Organisations and SMEs have made considerable progress in hydrocarbon E&P technologies and techniques, including geosciences, directional drilling, underwater production, floating production platforms, gas development, LNG carriers and long distance gas pipelines. Many companies already derive over 50% of their turnover from the export of specialised technologies and services.

The majority (95%) of the world's remaining, unexplored hydrocarbon fields are expected to be in deep-water, offshore locations. Innovation in E&P technologies is therefore required to find solutions which move back the frontier for the economic exploitation of these reserves. Since 40% of world off-shore production is currently in the North Sea, European companies have already developed skills specific to off-shore production. Considerable opportunities exist for them to exploit this competitive lead and hence expand their market share, which is currently 30% compared to USA's 43%. This will require sustained investment in RTD and demonstration for the commercialisation of novel technologies at a European level.

The recent restructuring of the industry has transferred much of the responsibility for innovation from the large oil companies to the service and supply sector. Financial assistance for technology demonstration should therefore target SMEs, as these make up the majority of the service and supply sector. SMEs, although technically capable of being highly innovative, are often not financially able to develop and particularly demonstrate novel technologies without some form of financial assistance as this stage of technology development is the most expensive and commercially risky.

The demonstration of emerging technologies is particularly crucial in the hydrocarbons sector. Despite the fact that the oil and gas industry is heavily reliant on technology and is innovation based, the major oil and gas companies remain a highly traditional and conservative industry. This is primarily due to the high costs and risks involved in the exploration and development of hydrocarbon resources. The service and equipment supply companies often find themselves in the difficult position where their customers require innovative solutions, but are unwilling to accept the risk of being the first to apply them. The SMEs are highly innovative, but often lack the financial resources to undertake the most risky and expensive stage of technology development - demonstration. Public sector financial assistance is therefore vital in this area.

The funding available through THERMIE makes an important contribution to pre-commercial activities, helping to turn innovative concepts into real technologies.

The impact of technology innovation on direct and indirect employment in the European oil and gas industry is potentially significant. Around 750,000 people are currently employed in the European service and supply sector and technological innovation provides the opportunity for the industry to grow significantly, gaining market share and increasing European employment opportunities. If Europe falls behind its competitors in technology innovation then market share will quickly be lost, along with a significant number of jobs. Continued investment in RTD and demonstration is vital if European industry is to remain competitive in the world-wide market and extend its market share.



It is anticipated that for the future the EU will continue to rely upon hydrocarbons for energy generation. For energy security and balance of payment reasons, it is important that as much of this as possible is indigenously produced and not imported from third countries. Technological innovation has already started to close the gap between production costs in Europe and the Middle East. In the early 1970s the production cost per barrel of oil was USD 0.1 in the Middle East and USD 2.0 in the North Sea. Today this gap has decreased to USD 1.0-2.0 in the Middle East and USD 4.0-5.0 in the North Sea.. One of the reasons for this is the reduced risk and cost of exploration achieved. Twenty years ago in Europe only one exploration drilling in ten yielded a commercially productive well; today this is one in five. With innovation in exploration technologies it is anticipated that this can be reduced to one in three in the next 10 years, further reducing production costs. Optimisation of field exploitation and increased recovery rate is extremely important for reducing hydrocarbon production costs. Increasing recovery from existing production fields by just 1% is equivalent to one whole year of world hydrocarbon consumption. Much has already been achieved with recovery rates on the Norwegian continental shelf increasing by 17% between 1991 and 1996. For this to continue significant efforts in technology demonstration must be maintained. The target for Europe should be to increase production efficiency and reduce costs to equivalence with the Middle East, through technology innovation.

Technology-driven solutions will increasingly be required in Europe to address the growing demand for a cleaner and safer oil and gas production system. European companies have been particularly successful in the development of technologies which increase the safety and efficiency, and reduce the environmental impact of producing energy from hydrocarbons. European environmental policy continues to be in advance of the rest of the world and may well be in anticipating a world-wide trend for the near future. European industry will gain a world-wide competitive advantage if they seek to address these issues through RTD and demonstration now.

If the most cost-effective and suitable technologies are to be developed then extensive collaboration between oil companies, service and supply companies, research institutions and academia is required. This already exists, but needs to be further strengthened if the long term needs of the EU in terms of hydrocarbon production are to be met and a commercially competitive industry established and maintained. Cross border collaboration should be encouraged wherever possible in order that scientific and technical experience be shared between Member States to develop a strong European industry.

Pre-commercial support initiatives, such as THERMIE, therefore have an important role to play in helping organisations to develop real, cost-effective technological solutions by providing financial assistance for technology demonstration. The market penetration of proven technologies can only take place once they have been fully demonstrated under commercial conditions. THERMIE has provided valuable financial assistance for focused and targeted demonstration and associated actions which has contributed to the replication of new, efficient, environmentally-sustainable energy systems. These will in future provide Europe with a reliable, efficient, safe and economic supply of energy services which are essential to the functioning of society and the competitiveness of its industry, while taking account of environmental protection.

The OPETs

ADEME

27, rue Louis Vicat
F-75737 Paris
France
Manager: Mr Yves Lambert
Contact: Ms Florence Clement
Telephone: +33 1 47 65 20 41
Facsimile: +33 1 46 45 52 36
E-mail:
florence.clement@ademe.fr

ASTER-CESEN

Via Morgagni 4
I-40122 Bologna
Italy
Manager: Ms Leda Bogni
Contact: Ms Verdiana Bandini
Telephone: +39 51 236242
Facsimile: +39 51 227803
E-mail: opet@aster.it

BEO

c/o Projektträger Biologie, Energie,
Ökologie
Forschungszentrum Jülich GmbH
D-52425 Jülich
Germany
Manager: Mr Norbert Schacht
Contact: Mrs Gillian Glaze
Telephone: +49 2461 615928
Facsimile: +49 2461 61 2880
E-mail: g.glaze@fz-juelich.de

BRECSU

Bucknalls Lane, Garston
WD2 7JR Watford
United Kingdom
Manager: Mr Mike Trim
Contact: Mr Mike Trim
Telephone: +44 1923 664540
Facsimile: +44 1923 664097
E-mail: trimm@bre.co.uk

CCE

Estrada de Alfragide, Praceta 1
P-2720 Alfragide
Portugal
Manager: Mr Luis Silva
Contact: Mr Diogo Beirao
Telephone: +351 1 4718210
Facsimile: +351 1 4711316
E-mail: dmre.cce@mail.telepac.pt

CLER

28 rue Basfroi
F-75011 Paris
France
Manager: Ms Liliane Battais
Contact: Mr Richard Loyer
Telephone: +33 1 46590444
Facsimile: +33 1 46590392
E-mail: cler@worldnet.fr

CMPT

Offshore Technology Park,
Exploration Drive
AB23 8GX Aberdeen
United Kingdom
Manager: Mr Jonathan Shackleton
Contact: Ms Jane Kennedy
Telephone: +44 1224 853440
Facsimile: +44 1224 706601
E-mail: j.kennedy@cmpt.co.uk

CORA

Altenkesslerstrasse 17
D-66115 Saarbrücken
Germany
Manager: Mr Michael Brand
Contact: Mr Nicola Sacca
Telephone: +49 681 9762 174
Facsimile: +49 681 9762 175
E-mail: sacca@sea.sb.eunet.de

CRES

19 km Marathonos Ave
GR-190 09 Pikermi
Greece
Manager: Ms Maria Kontoni
Contact: Ms Maria Kontoni
Telephone: +30 1 60 39 900
Facsimile: +30 1 60 39 911
E-mail:
mkkontoni@cresdb.cress.ariadne-t.gr

Cross Border OPET- Bavaria- Austria

Wieshuberstr. 3
D-93059 Regensburg
Germany
Manager: Mr Johann Fenzl
Contact: Mr Toni Lautenschlaeger
Telephone: +49 941 46419-0
Facsimile: +49 941 46419-10
E-mail: fenzl.zreu@t-online.de

ENEA

CR Casaccia
S Maria di Galeria
I-00060 Roma
Italy
Manager: Mr Francesco Ciampa
Contact: Ms Simona Fumagalli
Telephone: +39 6 3048 4118
Facsimile: +39 6 3048 4447
E-mail:
enea_opet@casaccia.enea.it

Energy Centre Denmark

DTI
P.O. Box 141
DK-2630 Taastrup
Denmark
Manager: Mr Poul Kristensen
Contact: Mr Nils Daugaard
Telephone: +45 43 50 70 80
Facsimile: +45 43 50 70 88
E-mail: nda@dti.dk

ETSU

Harwell
Didcot
OX11 0RA Oxfordshire
United Kingdom
Manager: Ms Cathy Durston
Contact: Ms Lorraine Watling
Telephone: +44 1235 432014
Facsimile: +44 1235 432050
E-mail:
lorraine.watling@aeat.co.uk

EVE

Edificio Albia I planta 14,
C. San Vicente, 8
E-48001 Bilbao
Spain
Manager: Mr Jesus Mari Giori
Contact: Mr Juan Reig Giner
Telephone: +34 94 423 50 50
Facsimile: +34 94 424 97 33
E-mail: jreig@eve.es

FAST

2, P. le R. Morandi
I-20121 Milan
Italy
Manager: Ms Paola Gabaldi
Contact: Ms Paola Gabaldi
Telephone: +39 2 76 01 56 72
Facsimile: +39 2 78 24 85
E-mail: paola.gabaldi@fast.mi.it

GEP

45, rue Louis Blanc
F-92038 Paris, La Defense Cedex
France
Manager: Mr Michel Ningler
Contact: Ms Nadine Monpert
Telephone: +33 1 47 17 68 65
Facsimile: +33 1 47 17 67 47
E-mail: gep@gep-france.com

ICAEN

Avinguda Diagonal, 453 bis, atic
E-08036 Barcelona
Spain
Manager: Mr Joan Josep Escobar
Contact: Mr Joan Josep Escobar
Telephone: +34 93 4392800
Facsimile: +34 93 4197253
E-mail: edificis@icaen.es

ICEU

Auenstrasse 25
D-04105 Leipzig
Germany
Manager: Mr Albrecht Krause
Contact: Mr Alexander Schmidt
Telephone: +49 341 9804969
Facsimile: +49 341 9803486
E-mail: krause@iceu.manner.de

ICIE

Via Velletri, 35
I-00198 ROMA
Italy
Manager: Mrs Rosella Cicarelli
Contact: Ms Mariella Melchiorri
Telephone: +39 6 8549141-8543467
Facsimile: +39 6 8550250
E-mail: icie.rm@rm.icie.it

IDAE

Paseo de la Castellana 95, planta 21
E-28046 Madrid
Spain
Manager: Mr José Donoso Alonso
Contact: Ms Virginia Vivanco Cohn
Telephone: +34 91 456 5024
Facsimile: +34 91 555 1389
E-mail: vvivanco@idae.es

IMPIVA

Plaza Ayuntamiento, 6
E-46002 Valencia
Spain
Manager: Mr José-Carlos Garcia
Contact: Mr Joaquin Ortola
Telephone: +34 96 398 6336
Facsimile: +34 96 398 6322
E-mail:
ximo.ortola@impiva.m400.gva.es

Institut Wallon

Boulevard Frère Orban 4
B-5000 Namur
Belgium
Manager: Mr Francis Ghigny
Contact: Mr Xavier Dubuisson
Telephone: +32 81 25 04 80
Facsimile: +32 81 25 04 90
E-mail: iwallon@skypro.be

Irish Energy Centre

Glasnevin
IE-Dublin 9
Ireland
Manager: Ms Rita Ward
Contact: Ms Rita Ward
Telephone: +353 1 8082073
Facsimile: +353 1 8372848
E-mail: opetiec@irish-energy.ie

IRO

P.O. Box 7261
NL-2701 AG Zoetermeer
Netherlands
Manager: Mr Rosen Jacobson
Contact: Mr Rosen Jacobson
Telephone: +31 79 3411981
Facsimile: +31 79 3419764
E-mail: iro@xs4all.nl

LDK

7, Sp. Triantafyllou St.
GR-113 61 Athens
Greece
Manager: Mr Leonidas Damianidis
Contact: Ms Marianna Kondilidou
Telephone: +30 1 8563181
Facsimile: +30 1 8563180
E-mail: ldkopet@mail.hol.gr

NIFES

8 Woodside Terrace
G3 7UY Glasgow
United Kingdom
Manager: Mr Andrew Hannah
Contact: Mr Graham Howes
Telephone: +44 141 332 4140
Facsimile: +44 141 332 4255
E-mail: glasgow@nifes.co.uk

Novem

Swentiboldstraat 21, P.O. Box 17
NL-6163 AA Sittard
Netherlands
Manager: Mr Theo Haanen
Contact: Mrs Antoinette Deckers
Telephone: +31 46 42 02 326
Facsimile: +31 46 45 28 260
E-mail: A.Deckers@Novem.nl

NVE

P.O. Box 5091, Majorstua
N-0301 Oslo
Norway
Manager: Mr Roar W Fjeld
Contact: Mrs Marianne Kramer
Telephone: +47 22 95 93 23
Facsimile: +47 22 95 90 99
E-mail: rwf@nve.no

OPET Austria

Linke Wienzeile 18
A-1060 Vienna
Austria
Manager: Mr Guenter Simader
Contact: Mr Guenter Simader
Telephone: +43 1 586 15 24 ext 21
Facsimile: +43 1 586 94 88
E-mail: simader@eva.wsr.at

OPET EM

Swedish National Energy
Administration
S-117 86 Stockholm
Sweden
Manager: Ms Sonja Ewerstein
Contact: Mr Anders Haaker
Telephone: +46 8 681 6554/9514
Facsimile: +46 8 681 9328
E-mail: sonja.ewerstein@stem.se

OPET Finland

Technology Development Centre
Tekes
P.O. Box 69,
Malminkatu 34
FIN-0101 Helsinki
Finland
Manager: Ms Marjatta Aarniala
Contact: Ms Marjatta Aarniala
Telephone: +358 105215736
Facsimile: +358 105215908
E-mail: marjatta.aarniala@tek.es.fi

OPET Israel

Tel-Aviv University
IL-69978 Tel Aviv
Israel
Manager: Mr Yair Sharan
Contact: Mr Yair Sharan
Telephone: +972 3 6407573
Facsimile: +972 3 6410193
E-mail: sharany@post.tau.ac.il

OPET Luxembourg

Avenue des Terres Rouges 1
L-4004 Esch-sur-Alzette
Luxembourg
Manager: Mr Jean Offermann
(Agence de l'Energie)
Contact: Mr Ralf Goldmann
(Luxcontrol)
Telephone: +352 547 711 282
Facsimile: +352 547 711 266
E-mail: goldmann@luxcontrol.com

OPET Norrland

Norrlandsgatan 13, Box 443
S-901 09 Umea
Sweden
Manager: Ms France Goulet
Contact: Mr Anders Lidholm
Telephone: +46 90 77 69 06
Facsimile: +46 90 16 37 19
E-mail: opet.venet@swipnet.se

Orkustofnun

Grensasvegi 9
IS-108 Reykjavik
Iceland
Manager: Mr Einar Tjörvi Eliasson
Contact: Mr Einar Tjörvi Eliasson
Telephone: +354 569 6105
Facsimile: +354 568 8896
E-mail: ete@os.is

PARTEX-CEEETA

Rua Gustavo de Matos
Sequeira, 28 - 1 . Dt .
P-1200 Lisboa
Portugal
Manager: Mr Aníbal Fernandes
Contact: Mr Aníbal Fernandes
Telephone: +351 1 395 6019
Facsimile: +351 1 395 2490
E-mail: ceeeta@mail.telepac.pt

RARE

50 rue Gustave Delory
F-59800 Lille
France
Manager: Mr Pierre Sachse
Contact: Mr Jean-Michel Poupard
Telephone: +33 3 20 88 64 30
Facsimile: +33 3 20 88 64 40
E-mail: are@nordnet.fr

SODEAN

Isaac Newton s/n
Pabellón de Portugal - Edificio
SODEAN
E-41012 Sevilla
Spain
Manager: Mr J.Antonio Barragán
Rico
Contact: Ms Maria Luisa Borra
Marcos
Telephone: +34 95 4460966
Facsimile: +34 95 4460628
E-mail: mborra.sodean@sadiel.es

SOGES

Corso Turati 49
I-10128 Turin
Italy
Manager: Mr Antonio Maria Barbero
Contact: Mr Fernando Garzello
Telephone: +39 11 3190833/3186492
Facsimile: +39 11 3190292
E-mail: sogint@tin.it

VTC

Boeretang 200
B-2400 Mol
Belgium
Manager: Mr Hubert van den Bergh
Contact: Ms Greet Vanuytsel
Telephone: +32 14 335822
Facsimile: +32 14 321185
E-mail: opetvto@vito.be

Wales OPET Cymru

Dyfi Eci Parc
Machynlleth
SY20 8AX Powys
United Kingdom
Manager: Ms Catherine Peasley
Contact: Mr Rod Edwards
Telephone: +44 1654 705000
Facsimile: +44 1654 703000
E-mail: opetdulas@gn.apc.org

The FEMOPETs**Black Sea Regional Energy Centre - BSREC**

8, Triaditza Str.
BG-1040 Sofia
Bulgaria
Manager: Dr L. Radulov
Contact: Dr L. Radulov
Telephone: +359 2 980 6854
Facsimile: +359 2 980 6855
E-mail: ecsynkk@bsrec.bg

EC BREC - LEI FEMOPET

c/o EC BREC/IBMER
Warsaw Office
ul. Rakowiecka 32
PL-02-532 Warsaw
Poland
Manager: Mr Krzysztof Gierulski
Contact: Mr Krzysztof Gierulski
Telephone: +48 22 484832
Facsimile: +48 22 484832
E-mail: grewis@ibmer.waw.pl

Energy Centre Bratislava

c/o SEI-EA
Bajkalská 27
SK-82799 Bratislava
Slovakia
Manager: Mr Michael Wild
Contact: Mr Michael Wild
Telephone: +421 7 52 48 472
Facsimile: +421 7 52 48 470
E-mail: ececwild@mbox.bts.sk

Energy Centre Hungary

Könyves Kálmán Körút 76
HU-1087 Budapest
Hungary
Manager: Mr Andras Szalóki
Contact: Mr Doris Keszthelyi
Telephone: +36 1 313 4824
+36 1 313 7837
Facsimile: +36 1 303 9065
E-mail: doris.keszthelyi@energycentre.hu

Estonia FEMOPET

Estonian Energy Research Institute
Paldiski mnt.1
EE-0001 Tallinn
Estonia
Manager: Mr Villu Vares
Contact: Mr Rene Tonnisson
Telephone: +372 2 45 0303
Facsimile: +372 631 1570
E-mail: femopet@femopet.ee

FEMOPET Hungary OMIKK

c/o National Technical Information
Centre and Library OMIKK
Muzeum Utca 17
HU-1088 Budapest
Hungary
Manager: Mr Gyula Nyerges
Contact: Mr Gyula Nyerges
Telephone: +36 1 338 4803
Facsimile: +36 1 3382232
E-mail: nyerges@omk.omikk.hu

FEMOPET Romania ENERO

8, Energeticienilor Blvd.
RO-79619 Bucharest 3
Romania
Manager: Mr Alexandru Florescu
Contact: Mr Christian Tintareanu
Telephone: +401 322 0917
Facsimile: +401 321 2790
E-mail: crit@mail.gsci.vsat.ro

FEMOPET LEI - Lithuania

c/o Lithuanian Energy Institute
3 Breslaujos Str.
LT-3035 Kaunas
Lithuania
Manager: Mr Romualdas
Contact: Mr Sigitas Bartkus
Telephone: +370 7 35 14 03
Facsimile: +370 7 35 12 71
E-mail: felix@isag.lei.lt

FEMOPET Poland KAPE-BAPE-GRAPE

c/o KAPE
ul. Nowogrodzka 35/41 XII p.
PL-00-950 Warsaw
Poland
Manager: Ms Marina Coey
Contact: Ms Marina Coey
Telephone: +48 22 62 22 794/
795/797
Facsimile: +48 22 62 22 796
E-mail: kape4@pol.pl

FEMOPET Slovenia

c/o Jozef Stefan Institute
Energy Efficiency Centre
Jamova 39
SL-1000 Ljubljana
Slovenia
Manager: Mr Boris Selan
Contact: Mr Tomaz Fatur
Telephone: +386 61 1885 210
Facsimile: +386 61 1612 335
E-mail: tomaz.fatur@ijs.si

Latvia FEMOPET

c/o B.V. EKODOMA Ltd
Zentesenes Street 12-49
LV-1069 Riga
Latvia
Manager: Ms Dagnija Blumberga
Contact: Ms Dagnija Blumberga
Telephone: +371 721 05 97/
+371 241 98 53
Facsimile: +371 721 05 97/
+371 241 98 53
E-mail: ekodoma@mail.bkc.lv

Sofia Energy Centre Ltd

51, James Boucher Blvd.
BG-1407 Sofia
Bulgaria
Manager: Ms Violetta Groseva
Contact: Ms Violetta Groseva
Telephone: +359 2 96 25158
Facsimile: +359 2 681 461
E-mail: ecencentre@enpro.bg

FEMOPET Czech Republic

c/o Technology Centre AS CR
Rozvojova 135
CZ-165 02 Prague 6
Czech Republic
Manager: Mr Karel Klusacek
Contact: Mr Radan Panacek
Telephone: +420 2 203 90203
Facsimile: +420 2 325 630
E-mail: klusacek@tc.cas.cz

For further details about the OPET Network please contact:**OPET-CU**

13b Avenue de Tervuren
B-1040 Brussels
Belgium
Manager: Mr John Butson
Contact: Ms Jana Hainsworth
Telephone: +32 2 7438930
Facsimile: +32 2 7438931
E-mail: OPET_CU@ecotec.com

or visit the OPET Web site:
<http://www.cordis.lu/opet/home.html>

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The European Commission
Directorate-General for Energy DG XVII
200 rue de la Loi
B-1049 Brussels
Belgium

Fax: +32 2 2950577

Internet: <http://europa.eu.int/en/comm/dg17/dg17homepage.htm>



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