CAME GT

EC RTD Framework Programme FP7
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Thematic Domain -Energy

by

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Introduction

CAME-GT was a Thematic Network funded under the EC Framework 5 programme (Contract No. ENK5-CT-2000-20062) and ran from October 2000 to May 2004. The Network brought together gas turbine researchers across Europe (including the New Member States and the Accession States) to develop gas turbine technology and achieve the performance targets set by FP5. During its existence the Network held 9 Workshops and two Conferences. The first Conference was held with the co-operation of the US DOE and the second Conference with the support of the Gas Turbine Society of Japan. Thus there was input into the network from the most advanced gas turbine researchers worldwide. A list of the partners in the Network and the papers presented at the Workshops and Conference can be found on the web site www.came-gt.com. One of the most important tasks for the members of the Network was the publication of a gas turbine strategy for Europe. This Strategy was agreed by all the partners in the Network to be the definitive outcome of the activities of the Network members. The contribution to the Consultation exercise into FP7 contained in this note is distilled from the Strategy document agreed by the members of CAME-GT.

Future Energy Use

World Energy Outlook 2004, published by the International Energy Agency, predicts that the primary energy demand in the EU will increase by 0.7%/annum between 2002 and 2030. By that time, fossil fuels in total will still be used for over 80% of the energy requirements of the EU.
The use of natural gas will grow at a rate of 1.8%/annum and will reach nearly one third of energy use by 2030. The majority of this natural gas will be imported and used for electricity generation from gas turbine and combined cycle gas turbine power plant (CCGT). It is of vital importance therefore that the fuel is used in an optimum way to minimise waste and reduce the strategic dependence on imported fuels. The major saving in energy in a gas turbine plant comes from the increased efficiency of operation. The CAME-GT Strategy Document describes the targets for increased efficiency considered possible by the industry and outlines the RTD programme required to meet those targets. So long as fossil fuels continue to play such a large part in the energy mix of the EU, then CO_2 emissions will be an increasing problem and sadly, the World Energy Outlook predicts an increase in CO_2 emission by EU Member states and the EU in total will miss its Kyoto target for 2010. Of all fossil

fuel plant, gas turbine combined cycles produce the lowest CO_2/unit of electrical output and offer the lowest cost option for CO_2 sequestration. Increases in the efficiency of CCGT will reduce the amount of CO_2 produced, thereby reducing the cost of removal. For these reasons the Framework 7 Work Programme should include gas turbine technology as part of a Key Action into improved efficiency and CO_2 removal and disposal for all fossil fuel power plant.

CO_2 Emissions

CO_2 emissions from fossil fuel plant are approximately as follows:-

Power plant	Emissions CO2 g/kWh
Conventional coal	900
Supercritical coal	800
Ultra-supercritical coal	750
Natural gas CCGT	300

It can be seen that replacing conventional coal power plant with CCGT would dramatically reduce the output of CO_2 and the CAME-GT Strategy document projects that replacing the oldest 10% of coal plant in the EU with CCGT would enable the EU to meet its Kyoto targets. For a policy which includes CO_2 sequestration for fossil fuel power plant, the aim must continue to be the improvement in efficiency of plant to minimise the cost of the CO_2 removal. Current estimates are that a CO_2 trading scheme will double the cost of electricity production, so that efficiency improvements in plant are vital if European business and industry is to remain competitive but at the same time continue to reduce the effects on global warming. Existing CCGT plant operates at around 58% efficiency. A 2000MW CCGT power station will emit around 4Mt CO_2/annum. A 5% increase in efficiency will reduce those emissions by 200000t CO_2/annum

Thematic Domain in Energy Research

It is clear from the present energy scenario in the EU described above, that there will be a continuing use of fossil fuels in power generation, and along with the research activities in Framework 6 into energy conservation, renewable energies and CO2 sequestration, in Framework 7 there should be a renewed emphasis into research into fossil fuel plant. This should cover all power plants which use fossil fuel, including gas turbines, combined gas and steam cycles and steam turbines. The core areas are:-

- increased efficiency of components and systems
- carbon abatement technologies

Within the Domain of fossil fuel RTD, gas turbine technology is very important as Combined Cycle Gas Turbines are the power plant of choice when adequate supplies of natural gas are available, and research into gas turbine components and systems should be a Key Action within this Domain. Contributions to the consultation exercise in other fossil fuel powerplant areas of the Energy Domain have been provided by the Networks Powerclean and CO2NET.

Contribution of Gas Turbine Technology to EU Policy Objectives

EUnited Turbines, the trade association of the turbine industry in the EU has estimated that the turbine sector employs over 70 000 people in the EU and has a turnover of around 20bn euro, 6bn euro of which goes to companies, mainly SMEs, carrying out sub-contract work for the major companies. Advanced gas turbine plant is among the most high tech equipment in the world with components operating at the very limits of temperature and stress of very sophisticated materials. Development is on-going with equipment being pushed to provide higher and higher efficiencies and at the same time having to reduce emissions of e.g. NOx and CO_2 to the lowest levels possible. International competition is very fierce, particularly from the US and Japan and without governmental and EU support commensurate with that given to its competitors by their governments, European Companies will have difficulty continuing at the forefront of the technology and thus remaining internationally competitive. It is clear that although gas turbine power plant has been around for over 50 years, the technology is still very much part of the European dynamic and knowledge based economy, and future advances will lead to sustainable economic growth. The Energy Thematic Domain which includes gas turbine technology is thus of current importance is likely to remain important into the foreseeable future where fuels from renewable sources (such as biomass) and hydrogen will be used in high efficiency combined cycle plant with perhaps fuel cells.

Contribution of Gas Turbine Technology to European Research Potential

The European gas turbine industry continues to carry out very high-level RTD in order to remain competitive with US and Japanese manufacturers. The results arising from research programmes are incorporated into products, which are cleaner and more cost effective and are sold on the worldwide market. For instance the efficiency of combined cycle plant has increased from around 45% to 58% over the last 30 years and the strategy document produced by the CAME-GT Thematic Network had indicated the potential to reach 75% efficiency by year 2020 (see the targets below). Also emission of the acid rain gases NOx from land-based gas turbines has reduce more than an order of magnitude over the same timescale. Future developments if supported in FP7 offer the potential to reduce CO_2 emissions by the same or greater amounts.
Continued competitiveness of European gas turbine plant in the world market will produce lasting economic benefits to the EU and the increased efficiency of plant and reduction of emissions will bring social and environmental benefits in the form of reduced global warming and a significant reduction in dependence on imported fossil fuels.

Contribution of Gas Turbine Technology to European Added Value

The work carried out by the Thematic Network CAME-GT brought together gas turbine researchers from across the EU and Accession Countries. Of the 25 member states and the two accession countries only 5 countries were not involved in one or more of the Network's Workshops and Conferences (see the web site www.came-gt.com). A major success of the Network was to bring together researchers from National Programmes and researchers working on Framework Programmes to produce an active European Research Area in gas turbine technology. This is leading to a critical mass of scale and scope and bringing together National and European programmes in gas turbine technology. The visibility of European research was enhanced by including US participants in the first Gas Turbine Technology Conference held by the network and researchers from Japan in the second Conference. It is clear from the integrated and co-ordinated structure that has come out of CAME-GT that the funding for gas turbine RTD in Framework 5 had the desired effect of enhancing the European Research Area in gas turbine technology, giving added value to the individual research projects supported in FP5. Now there is the need to build on the ERA by extending the funding in FP7 to continue research into gas turbines and combined cycles. A major threat to the European gas turbine industry is the funding given to competitors through their government agencies and this should be matched by the EU for the sector to remain competitive.

Advanced Gas Turbine Technology Targets

Gas turbines cover a wide range of applications and sizes and the development strategy must take account of the driving forces that determine technical need. A Work Programme in FP7 for gas turbine technology should have ambitions technology targets. The targets suggested by the CAME-GT Strategy document are set out in the following table:-

Type of gas turbine	Combined cycle	Small gas turbine
Medium term efficiency (2012)	65%	40%
Long term efficiency (2020)	75%	45%
Availability (2006)	92%	
Availability (2020)	96%	
Reliability (2006)	97%	
Reliability (2020)	99%	
NOx emissions (2006)	9 ppmv	
NOx emissions (2020)	1ppmv	
CO_2 removal (2020)	95%	
Fuels LHV	< 20% natural gas	

Gas turbine technologies

The basic combined cycle gas turbine consists of the following components:-

- inlet compressor
- combustor
- turbine
- heat exchanger
- steam turbine
- electrical generator

the core technologies associated with these components are:-

- aerodynamics
- heat transfer
- combustion
- materials
- system performance
    - gas turbine/steam turbine combined cycles
    - fuel cell/gas turbine combined cycles
    - novel cycles

CO_2 abatement technologies applicable to gas turbines will include

- upstream removal of carbon in fuel
    - use of biomass gas
    - use of hydrogen gas
- downstream sequestration of CO_2

The future design and optimisation of the combined cycle gas turbine plant will take into account CO_2 sequestration, either on installation or in retrofit

Research instruments

It has been demonstrated above that there is an urgent strategic need for a Key Action in FP7 in gas turbine technology, to both reduce the use of valuable, imported natural gas and reduce the high costs associated with the sequestration of CO_2 to reduce the impact on global warming. An RTD Work Programme in Framework 7 should be aimed at strengthening the European Research Area in gas turbine technology built up through the CAME-GT Network, which included almost all of the member states as well as the Accession Countries. The programme should make use of all available instruments for research and demonstration, namely:-

- technology platforms
- integrated projects
- specific targeted research projects
- co-ordination actions
- specific support actions