MICRO-MAP

MINI AND MICRO CHP – MARKET ASSESSMENT AND DEVELOPMENT PLAN

Summary Report

PROJECT

A study supported by the European Commission SAVE programme, DGTREN

Project Partners

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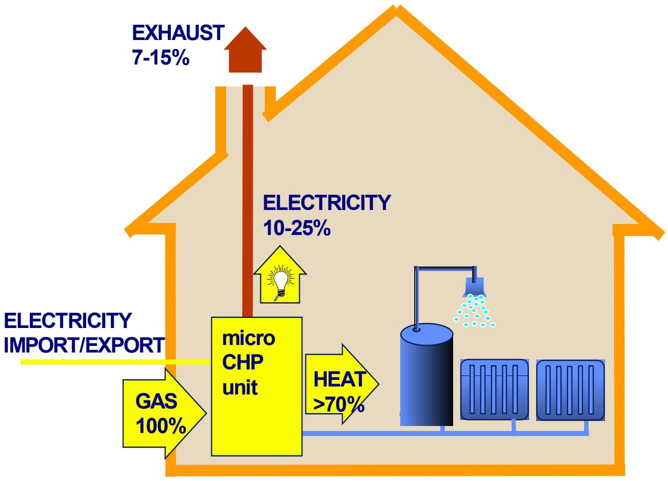
Introduction to the MICROMAP study.

This report summarises the results of a pan-European study, part funded by the European Commission SAVE programme, on the potential for micro and miniCHP in Europe. The study, which ran from April 2001 to April 2002, had the objectives:- to evaluate the technologies, markets and players; to assess grid connection and electricity payment issues; to estimate the possible system take-up in different countries up to 2020 ; to assess potential energy, CO_2 emission reductions and cost savings; and to propose possible routes by which the new technology could be exploited.

The project team brought together experts from the cogeneration, electricity, gas, housing, renewable energies and small generation industries, as well as experience in the coordination, planning and forecasting functions. The project was coordinated by FaberMaunsell Ltd (previously ECD Energy and Environment) with partners the European Association for the Promotion of Cogeneration (COGEN Europe), Energy for Sustainable Development Ltd (ESD), EA Technology Ltd, European Union of the Natural Gas Industry (EUROGAS-GERG), SIGMA Elektroteknisk AS, and Enervac- Flutec Ltd.

MicroCHP based on a stirling engine, internal combustion engine or fuel cell, will replace the conventional boiler in a dwelling and provide both electricity and heating to that dwelling, possibly with surplus electricity exported to the local grid. Several different systems are likely to become available in the near future and depending on the power output and ratio of power to heat, as well as the heat and power demands of the dwelling itself, different operational modes are possible and variable overall efficiencies of the systems will be achieved. The most efficient operation of microCHP systems will, as with conventional CHP, be heat demand lead and it is this that will lead to overall efficiencies exceeding those based on conventional generation and supply of electricity to a house.



MicroCHP may be important in the future for a number of reasons. First, it could provide significant savings in CO_2 emissions, assisting in meeting Kyoto targets. Second, it could change the operation of the local electricity distribution network by having a small feed of electricity into the grid, from a large number of houses at some times of the day, particularly peak hours. Third, it could have a significant effect on the traditional domestic boiler supply and replacement market, as microCHP is likely to be supplied, installed and maintained by completely new consortium arrangements. Fourth, it could provide new commercial opportunities for manufacturers, and for partnerships between manufacturers, energy suppliers, financiers and others.

MiniCHP was defined in the study as systems capable of supplying between 10 and 100kW of electricity and thus applicable to blocks or groups of dwellings, as well as small non-domestic buildings. The operation of miniCHP systems is very different from a microCHP system in an individual dwelling and was included in this study to provide an overall view of small CHP installations in housing. MiniCHP is becoming more important due to the development of commercially available small turbine systems as well as the more traditional internal combustion systems. MiniCHP analysis formed only a small part of this study.

The study covered the 15 EU countries plus Norway, with 11 Central and Eastern European (CEE) countries treated as a block in less detail. The work was broken down into workpackages, the results of which are summarised in the following sections.

Product and technology review

The project evaluated the range of potential micro and miniCHP technologies and specific products that are emerging. Market intelligence on these technologies and products has been collected and, in addition, estimates of future cost and performance characteristics have been provided.

As the microCHP unit is intended to replace the conventional gas boiler in a central heating system, the performance requirements and constraints are particularly onerous and are significantly different from those of conventional CHP. MicroCHP systems must be able to operate reliably with service intervals equivalent to an annual gas boiler maintenance. At the same time, economic considerations require in excess of 2500 operating hours per year. Conventional technologies such as IC (internal combustion) engines can only achieve this by incorporating expensive and bulky components that are compounded by the need to meet emissions and noise limits.

Technologies most likely to be successful long term are Stirling engines within the next 2-3 years, followed by fuel cells within a 10-year timeframe. Quite apart from the prime mover technology, the status and market approach of the product developers is of key significance; the following summarises the key players and relevant features of their products.

There are three Stirling engine developers producing 1kWe units aimed at the individual homes market. WhisperTech of New Zealand utilise a novel "wobble-yoke" kinematic engine with relatively low electrical conversion efficiency, but with heat to power ratio and other physical characteristics making it suitable for typical family homes as a floor-mounted unit. Both BG Group and ENATEC have produced wall-mounted units with a combi-boiler function based on linear free piston technology with low vibration and high efficiency generators. However, it is believed that their relative sophistication may require a somewhat longer time to market than the WhisperTech unit which is planned for commercial availability in 2003. Sigma are developing a 3kWe engine, with high electrical efficiency (>25%) and expect to have a commercial product by 2005.

The two leading fuel cell developers are Vaillant using the PlugPower stack as the basis of a modulating 5kWe unit suitable for multi-residential applications, and Sulzer Hexis using a SOFC (Solid Oxide Fuel Cell) to produce 1kWe with the facility to add 35kWt to enhance thermal performance. Both companies are involved in field trials in collaboration with energy companies, but do not expect to have truly commercial units for at least 5 years.

The only commercially available IC engine based unit is produced by Senertec in Germany with an electrical output of 5.5kWe and 10kWt thermal. However, at this scale it is a multi-residential unit with relatively high noise level making it suitable only for plant room applications. The need for catalytic emissions control, acoustic attenuation and extended service intervals impose severe cost and size constraints on the unit. It is understood that Honda are developing a 1kWe unit suitable for individual homes, but the limited reports in the public domain indicate that acceptable performance has yet to be demonstrated.

MiniCHP systems for multi-residential groups use conventional internal combustion engines or the newly available micro-turbine technologies, which are being developed with fairly good performance.

Issues such as integration with the electricity distribution network and the home energy system are in the process of being addressed. In particular, network connection standards are being developed at EU level (CEN Workshop Agreement) and in the UK (by the Electricity Association) to facilitate the simple, safe and cost effective connection of microCHP units.

Market characteristics and analysis

A specific database of the housing stock in Europe was generated to provide the basis of the modelling work to be carried out where the market potential for microCHP was calculated. The database comprised 27 Excel housing spreadsheets, one produced for each of the countries included in the study. They provide detailed information on the housing profile for all the European countries, plus Norway and for the Central and Eastern European countries, including numbers of different dwelling types, energy usage and heating systems.

The main source of data was Eurostats, with additional data provided through a wide variety of sources, including a past SAVE project, SOLGAIN, for which ECD were contractors. The source year for much of these data varied from 1996 to 1999. In order to bring data to 2001, the base year for the project, the data were projected based on new construction rates.

The database provides a substantial amount of data from which trends and patterns can be drawn. The database of EU countries and Norway demonstrates as expected, that larger dwellings have a greater thermal demand than smaller dwellings and that older dwellings have a higher thermal demand than newer dwellings due to the enhanced thermal requirements of new properties. The information shows that Greece, Portugal, Ireland, Norway and Sweden have little or no gas networks compared to the UK, Netherlands and others, where gas is the main heating fuel. Denmark, Finland and Sweden are the countries that have the highest proportion of housing stock linked to a district heating system, about 50%. In Central and Eastern European countries it can be seen that Albania, Estonia, Latvia and Bulgaria have little or no gas supplies, while the Czech Republic, Hungary and the Slovak Republic have gas supplied to approximately half the housing stock. District heating systems are most prominent in Estonia with 45% of housing stock linked to a system.

External influences

The external factors affecting the development of microCHP vary from country to country, but in general they fall into three categories:

- Energy markets: in terms of the regulatory framework of energy markets, the important market actors, the degree of competition and the regulatory framework;
- Electricity and fuel prices: including tax regimes, incentives and exemptions; and
- Institutional factors: the policy context for CHP either enabling or restricting its deployment.

An overview of the external influences in EU and CEE countries was assembled from ten countries selected on the basis of their market potential (Austria, France, Germany, Italy, the Netherlands and the United Kingdom), and to provide an illustrative demonstration of the range of external factors (Bulgaria, Greece, Norway and Poland).

Gas and electricity markets are in the process of transition to full competition across the EU and, to a certain extent, in the CEE countries. However there is great variation even within the EU: the UK has full competition for electricity and gas supply to the domestic sector, whereas in other countries the process is just beginning. Others, such as the Netherlands and Germany, have embraced competition in electricity and gas supply but this has yet to have an impact in the residential sector. In others, such as France, Italy and Greece, control of electricity and gas supply is still largely in the hands of state-owned monopolies.

The high transaction costs of third party access, which allows independent power producers to export self-generated electricity, can prove a barrier to small scale CHP even where the regulations allow it – in the UK, for instance. The UK also provides an example of how liberalised markets can act against small embedded generators. For example, electricity exported from a residential CHP unit, which is neither firm nor predictable, but instead is simply ‘spilled’ to the distribution network when the household cannot make use of all the CHP output, typically achieves a very poor price per kWh.

Energy prices vary widely across Europe and similarly the ratio between household electricity and gas prices varies widely between countries. For example, the ratio appears to be relatively high in the Netherlands and the UK; conversely, expensive imported gas in Italy creates a less favourable ratio. In general, the difference between electricity prices between countries is less dramatic than the difference between gas prices.

Over the long-term it appears that gas prices are set to increase at a faster rate than electricity prices, worsening the financial case for gas-fired CHP. However, extreme caution must be exercised in drawing such conclusions, given the inherent uncertainties of fuel price projections and also because micro and miniCHP may be able to benefit from the time-varying value of electricity exports (during the day, and during the year) and other embedded generation benefits such as avoided transmission costs, or the provision of ancillary services.

None of the countries examined have a coherent regulatory framework that specifically supports micro or miniCHP, or even CHP generally. For example, there is commonly a lack of grid connection procedures and simple market mechanisms to enable electricity generated from CHP to be sold, either to local electricity supply companies or to third parties. But the underlying conditions for the deployment of micro and miniCHP are improving, in particular through the continued liberalisation of European energy markets and the strengthening of climate change policy. And while most national CHP policy is aimed at large and medium scale applications, special provisions for micro and miniCHP and other embedded generators are beginning to emerge.

In Germany, for example, subsidies are offered for CHP installations of less than 2 MW_e capacity and CHP below 100 kW_e benefits from special metering rules. In the UK, policy work is underway to create standardised network connection procedures for domestic CHP. These examples are the exception rather than the rule.

Finally, even though conditions for the development of micro and miniCHP markets in the CEEC countries are currently poor, this situation will improve as the accession states link their policies and energy markets to those of the EU.

Market mechanisms and delivery options

It is generally accepted that microCHP will enter the domestic market as a direct replacement for gas boilers in wet heating systems. In order to understand how microCHP may compete effectively in that market, the project considered the fate of other products which have been introduced either as direct competitors to the conventional gas boiler or as complementary products.

The introduction of condensing boilers to the domestic sector was taken as an illustrative example. Although initially available in the early 1980’s, the market in the UK, even with substantial subsidies, is less than 10%. On the other hand, in other EU markets such as NL, DE, substantial market share has been achieved by regulatory measures. Initial technical problems have been overcome, but have left many specifiers reluctant to risk high service and maintenance costs. The marginal investment cost is now relatively small and paybacks are only a few years, but householders remain reluctant to make any investment when they may move home before savings are realized.

However, the role of the installer who effectively specifies the product is seen by most to be the biggest single obstacle to establishing condensing boilers in the market, and may well constitute a similar obstacle to microCHP. Installers are both reluctant to acquire the necessary skills and to expose themselves to potential after sales service effort for little perceived benefit. The key lessons are therefore to ensure product reliability from the outset, to create an appropriate economic environment and to develop adequate installation and service support mechanisms.

The liberalised UK market appears to be leading the way in terms of market introduction and formed the focus of the study. A number of companies are expected to launch commercial products within the next two years, the majority of which plan to use the Energy Service Company (ESCo) route, however one has stated that they additionally hope to sell significant numbers direct to house builders and the social housing sector. It is possible that different solutions will be sought for other countries and UK niche markets.

The economics of microCHP depend substantially on the actual cost of electricity and, to the householder, the avoided cost of electricity purchase. However, the energy supply company gains further benefits due to the modified cost of supply and can benefit still further from the sale of aggregated export power from a large number of units. It is for this reason that the ESCo route to market is seen as a means of capturing the full economic value of microCHP, which the individual householder is unable to do. The ESCo route also appears capable of resolving the quality, service and economic challenges of introducing a radical new product to the market and appears to avoid many of the potential obstacles to successful commercialisation.

The study concluded that the benefits of the ESCo route to market, make it likely that the initial market entrants and the principle long term players will be ESCo. The combination of high profitability in a highly competitive (but currently unprofitable) energy supply market could attract a number of major players already in the market as well as those outside who see the opportunity to “leapfrog” the market. Potential players include vertically integrated energy companies such as Scottish Power, EdF etc., as well as established ESCo in the commercial sector.

In addition, significant niche markets such as new-build housing, may be served by specified manufacturers, although even these may ultimately succumb to the benefits of the ESCo route.

Market potential, the modelling

An econometric model was developed to estimate the potential size of the microCHP market in Europe under various scenarios for the period from 2001 and 2020. The scenarios chosen were: a) the ‘business as usual’ approach where current conditions are assumed, b) the “medium effort” scenario where reasonable efforts are made with regard to legislation, policy and financial incentives and c) the “maximum effort” scenario whereby considerable initiatives are taken to promote microCHP systems. A model was also developed to estimate the potential of miniCHP, based on the assumption that it is most likely to be used in existing district heating schemes where these exist across Europe, and where district heating is commonly installed.

Three microCHP systems were the focus of the study, a “small (1kW) Stirling engine”, a “large (3kW) Stirling engine” and a “small (1kW) efficient fuel cell”. For each system, a “business case model” developed in a previous project stage, was interrogated to provide feedback on the parameters affecting the economic viability of that particular system under the arrangements of an Energy Services Company (ESCo), as this was considered as the most likely route to the large scale market. Calculations have included the marginal cost of the systems over that of a new traditional boiler, the export value of electricity, the operation and maintenance implications of microCHP, the leasing arrangements of the system by the ESCo to the householder, the overall cost to the customer, and the overall profit to the ESCo. Information obtained from the business case model was then used to calculate the overall payback period and consequent market share for each system. Scenario modelling was based on variations in the buy-back price of the exported electricity, used as the mechanism most likely to be implemented, and to cover the changes in legislation, policy and financial incentives built into the scenario assumptions.

The model also calculates the penetration rate of each of the three systems, in each scenario, to illustrate the diffusion of microCHP into the market. This was calculated using a classic or "S-curve" formula. The curve was used to estimate the rate of adoption of the microCHP technology based on implicit assumptions on a slow initial growth, subsequent rapid growth, followed by declining growth as saturation levels are achieved. Housing data collected from a previous project stage were used to estimate the maximum potential for microCHP in each country, based on heat demand, the number of dwellings with central heating and boiler replacement rates.

Modelling was initially carried out for the 15 European Union countries plus Norway and then for 11 Central and Eastern European countries. Results were calculated for individual countries and summed as overall results for all European countries, for both market potential and CO_2 emissions reductions.

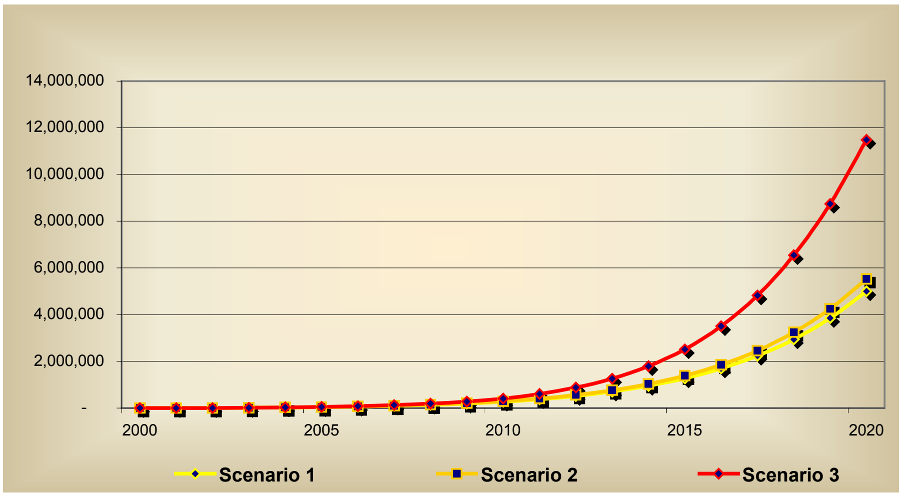


Figure 1: Cumulative microCHP sales in the EU

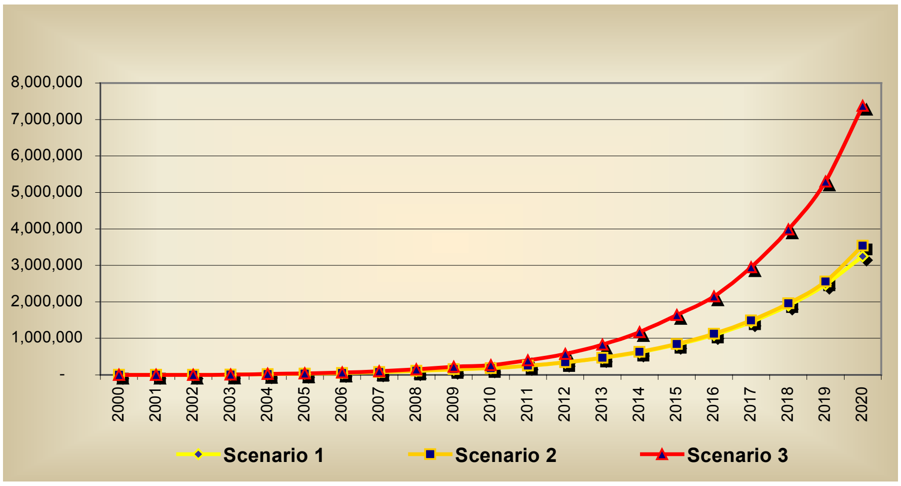


Figure 2: Carbon dioxide reduction by all microCHP sales in the EU

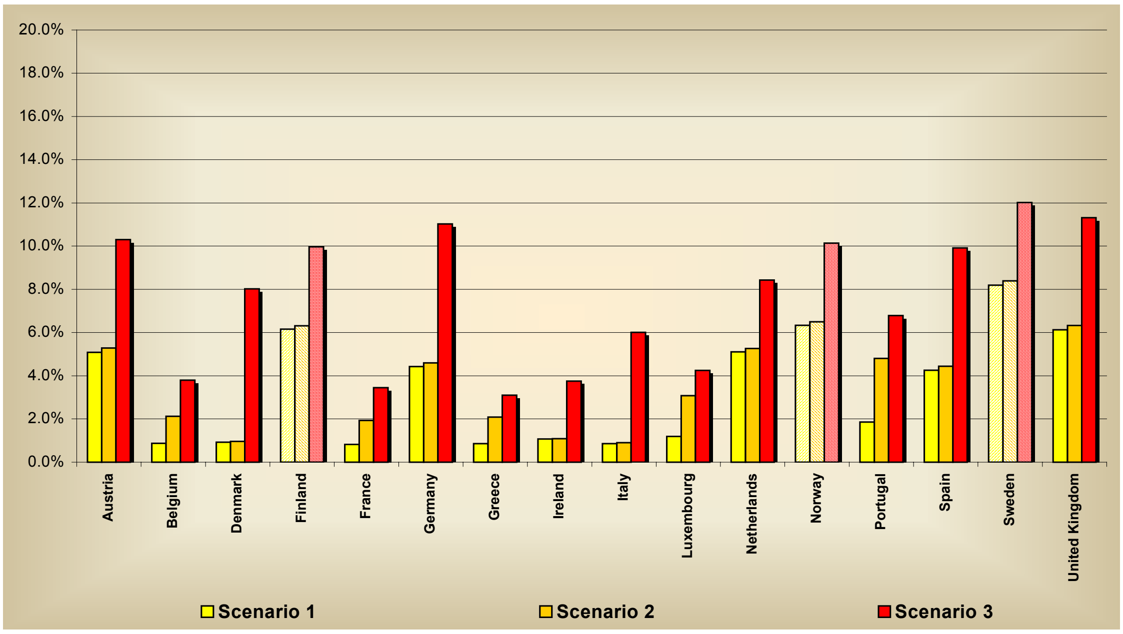


Figure 3: Percentage of maximum potential of each EU country taken up by microCHP under the three scenarios

For the EU as a whole, the modelling indicates that under the optimum scenario a total of 11.5 million microCHP units could be sold by 2020, equating to a CO_2 emissions saving of 7.3 million tons of carbon dioxide per year in 2020 and beyond. For the European Union countries, two countries stand out as having the greatest market potential in 2002 under the optimal scenari0, the United Kingdom and Germany. Other countries that currently have a high market potential are the Netherlands, Spain and Austria.

For Central and Eastern European countries, the modelling indicated that by 2020, around 670,000 microCHP units could be sold, with an equivalent saving of 1 million tons of CO_2 per year.

The model has shown that of the three microCHP systems, it is the small Stirling engine system that is likely to have the highest quantity of sales. This is due to the assumptions that this system has the lowest marginal costs, shortest payback period and can be utilised efficiently in most dwellings, varying from apartments to houses.

The model for the potential of miniCHP indicates that Austria, Germany and Sweden have the greatest potential and throughout all European countries (including Central and Eastern Europe) a total of nearly 3 million homes could be connected to miniCHP by 2020, leading to an equivalent saving of over half a million tonnes of CO_2 per year.

The completed model is a tool that can be reused with ease since inputs are only required on one page and macros automatically calculate the market potential and resulting CO_2 emissions savings.

Market development process and recommendations

Actions in seven key areas were identified as key to enabling a mass market for microCHP to develop:

- *Further technical development of microCHP products and systems*. Important issues are: minimising noise, size, weight and cost; maximising reliability, efficiency, ease of installation; and developing product appearance and user interfaces.
- *Product standards safety and performance*. Safety standards will be addressed by manufacturers obtaining the CE marking for their products. Performance standards are

necessary for consumer information and to facilitate the integration of microCHP into energy policy, e.g. building regulations and energy efficiency initiatives.

- *Network connection (technical issues).* Simple, safe and cheap grid connection standards and procedures to allow import and export of electricity power. A European Committee for Standardisation (CEN) Working Agreement is due to be finalised in May 2002, which can act as a template for Member States and is the first step towards creating a European Norm. Provisions for equitable cost recovery by the microCHP and the distribution company is also important. The connection with gas networks does not pose any problems as it is no more complicated than for conventional boilers.
- *Network connection (commercial issues).* Commercial arrangements to obtain value from microCHP electricity exports, including metering, settlement and trading mechanisms.
- *Physical supply chain issues.* Cost-effective delivery of products and the correct installation and servicing. Personnel are required with a combination of gas, electrical and plumbing skills. It may be appropriate to establish microCHP accreditation and training schemes.
- *Marketing.* MicroCHP is a new concept to most policy makers and consumers, needing authoritative and independent information about products and systems.
- *Integration with energy policy.* Compliance with existing and proposed EC directives and member state legislation and integration with energy efficiency/saving and climate change legislation and programs. Removal of perverse incentives acting against microCHP.

National governments wishing to promote mini and microCHP should establish suitable electricity network connection standards and procedures. Government can use the European Committee for Standardisation (CEN) Working Agreement as a template and introduce simplified metering, settlement and trading procedures to allow operators to obtain the maximum value of generation and hence extend the market and economic viability of the technology. This may require the use of demand profiles to value any electricity exported from the dwelling, as a low cost alternative to installing a separate export or two-way meter. National government should integrate micro CHP into national legislation and energy regulations. This is likely to require ‘product type’ performance standards, as is common with other household products. Where necessary, government should fund laboratory testing and field trials to establish these standards. Government action is also needed to prepare the physical delivery chain. Mini and microCHP require additional skills compared to heat only boilers; therefore support is needed to build the capacity of the workforce. This can be done by supporting installer trade associations build capacity in this area and supporting the integration of installer qualifications (as appropriate) into the educational sector.

European Union policy makers can help drive the creation of appropriate network connection standards and procedures by including a mandate for monitoring the provision of fair and transparent network connection for mini and microCHP in the proposed CHP directive. In the medium term, a European Norm on the connection of mini and microCHP should be established, building on the CEN Working Agreement. It may also be appropriate to establish a European installer qualification. The EU should also continue to push for full competition in electricity and gas supply in all European markets. EU the support for small stationary applications of fuels cells should be extended to other prime mover technologies, such as Stirling engines, I/C engines and micro-turbines. These activities could be incorporated in the 6th Framework Research programmes. The EU should also support field trials of products in a wide range of possible home heating situations to help develop product performance standards and facilitate the integration of microCHP into national policy. This will also help the technical development of microCHP systems and provide information for consumer advice.

Private sector action will require market actors to bring microCHP to market in large numbers, including: technology providers, manufactures, energy supply companies, electricity distribution companies, product installers and maintenance engineers. These actors are likely to form consortia to share the risks and benefits of microCHP commercialisation. The following generation recommendations are made:

- Developers should focus on the key initial markets of Germany, the Netherlands and the UK, using the ‘service provider’ route to market, ideally with the participation of an electricity and gas supply company to form a utility-led ESCO

- Developers should target specifiers (local authorities, housing associations and developers) and the customer bases of energy utilities as a means to achieve early market volume.
- Gas and electricity trade associations should work together to define installation and servicing skills, and technology providers and manufactures should aim to 'de-skill' installation and servicing as much as possible.

Initial markets are likely to be Germany, the Netherlands and the UK, due to a combination of factors, including suitable heating loads, extensive natural gas distribution networks, tightening climate change commitments and suitable energy market conditions. Germany and the UK already have retail gas and electricity competition. Germany has recently introduced fixed bonus payments for power exports for small-scale CHP, which is likely to create a significant boom in mini and microCHP. In the UK, the government has recently reaffirmed its commitment to CHP and regulatory changes are in train to facilitate the connection of embedded generation to the electricity grid. Furthermore, mini and microCHP is set to benefit from UK government energy efficiency initiatives. Full market opening in the Netherlands is scheduled for 2004. It has a long history of embedded generation and an 'energy service' approach to energy supply, which should facilitate the development of the Dutch mini and microCHP market.

Dissemination.

The dissemination of the results and findings of the MicroMap are important activities for the project. The interest in the market for micro and miniCHP systems is high at the moment and there has been widespread interest for this project in Europe. Dissemination has focused on presenting initial results of the work to the press and at conferences. A dedicated workshop was held at the COGEN Europe Annual Conference in March 2002. Initial information on the project has been available on COGEN Europe's web site since September 2001. In addition to these activities a report has been presented to the UK's Energy Saving Trust (EST) on the potential for Micro CHP in the UK. The EST is one of the principal agencies that will support the market introduction of Micro CHP in the UK.

The following reports have been delivered as outputs from the project:

- Full study report
- Summary report, 5000 printed
- Conference and proceedings
- Report on distribution of summary report
- Information on COGEN web site.

Due to the nature of the project, the dissemination of the results will continue after the completion of the contract. This dissemination will include the distribution of the publishable summary report, updating the web-site with the final results of the project, further press liaison with specialist journals and discussions with the National Member network of COGEN Europe. It is also expected that the project team will be active in presenting the project and its results at conferences in Europe over the next year.

Overall conclusions.

The study has shown that between 6 million and 11.5 million microCHP systems could be installed and operating commercially in European Union Countries by the year 2020. This would result in CO_2 emissions savings of between 3.5 and 7.5 million tonnes per year. The number installed will depend on many factors and these are discussed briefly below. In addition there exists the potential to install 700 000 units in Central and Eastern European Countries, assuming that Countries become a part the Union to the anticipated timetable.

The small stirling engine microCHP systems producing around 1kW of electricity are likely to dominate the market due to their widespread application, current state of development and anticipated lower cost, compared with the alternatives.

The reasonable potential for miniCHP as part of existing and new district heating systems, is seen as supplying up to 3 million dwellings for the whole of Europe, with around half of the maximum figure being in Central and Eastern European countries. The CO_2 emission savings are estimated at half a million tonnes per year.

Institutional, regulatory and financial issues will play a dominant role in the development of miniCHP in the different countries, though if current progress is maintained and deadlines for complete liberalisation of the European energy markets are met, there is no blockage to development of microCHP in most countries after 2010. However regulatory frameworks need to be developed and agreed in several areas, including for the microCHP systems themselves and for connection to the local grid. Due to the additional capital costs of installing microCHP compared with conventional boiler systems, financial incentives to stimulate the market are proposed by the study team and can be expected to be effective.

Commercial development of microCHP systems and ownership and management arrangements, are starting to take place and these are likely to be very different from the conventional boiler equivalents. Further technological developments are required in the component products to improve efficiency, reliability and generally to provide a suitable replacement to the conventional domestic boiler. Stirling engine systems are likely to be the first to be ready for the mass market, with fuel cell systems maybe coming into the market around 2010.. Mass production facilities need to be developed and marketing, sales, installation and maintenance teams need to be trained to adapt to the new and relatively complex microCHP systems. Whilst microCHP systems could be sold via the conventional boiler manufacturing and installation chain, the study concluded that if microCHP is to be a significant replacement for the conventional domestic boiler a mass market is essential and other routes to market are necessary. The favoured route is via “service providers” or ESCo, comprising consortia of organisations including manufacturers, financiers, installers and energy supply companies. This route is seen as the way to minimise the installed cost of microCHP systems by reducing the costs associated with conventional supply chain “middlemen” and optimising the financial flows of the energy suppliers and the householder, whilst ensuring a reliable service for the householder. However it was recognised that few successful “service providers” of this type exist and that concerted private sector action will be required if this route is to be developed. A negative aspect of this route to market was seen as the possible backlash from existing boiler manufacturers and all those involved in the conventional supply chain, who could see a reducing market for their services over time.

Initial Markets for the new microCHP systems are thought to be the UK, the Netherlands and Germany due principally to the liberalisation of the energy markets in these countries but also to other factors such as high house heating demands, existing gas supply networks and social factors. In these countries there are opportunities for “specifier sales”, where owners or developers of housing areas or groups of housing, such as local authorities and private house builders of new estates, to negotiate directly with microCHP supplying consortia for mass installation and maintenance in one area. In Germany, it was also though possible that there could be an early demand from individual house owners for microCHP systems

The householder will need to be convinced that changing his or her boiler for a microCHP system brings benefits which outweigh any disadvantages. The main benefits should be in reduced fuel costs, though if the system is installed through an ESCo, the whole package of finance, maintenance and gas and electricity costs will be what convinces the householder to change. It will thus be important that early installations work efficiently and reliably and are seen to do so. Marketing of systems and the benefits to householders is likely to form an important part of all early attempt to start the market for microCHP.