Micro-CHP technologies have been said to be 'close to market' for some years, but now – led by very significant moves in Japan – they are finally showing signs of approaching commercial maturity. Sytze Dijkstra keeps an eye on technologies and markets worldwide, and reports that Europe will be next to adopt the leading technologies.

Micro-CHP

edging towards the mass market

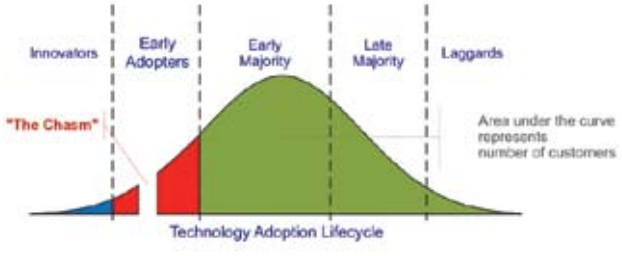
The anticipation of micro-CHP markets taking off is now higher than ever. Last year 22,700 units were sold worldwide and cumulative sales have passed the 100,000 mark. The vast majority of these micro-CHP units are the Honda ECOWILL in Japan.

Several product manufacturers have positioned themselves to start supplying European markets, predicting a step-change in sales in 2010. However, some fear that the expectations could herald another 'false dawn' and suppliers may not meet their sales predictions. So what is different this time?

At first sight, 2008 was much like 2007 – whereby global sales of micro-CHP actually levelled off. With the exception of the Honda ECOWILL, all products are still in the 'innovation' stage of the market, and still need to bridge the chasm to become a mass-market success (Figure 1).

The last few years of preparation have enabled the sector to create a sound basis for commercial launch. Two Stirling engine manufacturers, Microgen Engine Corporation (MEC) and Whispergen, are establishing volume production facilities. Large utilities and boiler companies are engaged, and some are putting their weight behind the commercialization of micro-CHP products. Governments in Germany, the Netherlands and UK have introduced or announced support. Customer attitudes to micro-CHP remain little understood, but the early signs are positive.

Micro-CHP could therefore finally push aside the harsh statement that it is always one or two years away from market. The market introduction in the next few years will undoubtedly show some hiccups, but it has plenty of potential to play an important role in the heating and electricity markets.



New technologies do not always succeed in reaching their mass-market potential. Some never move beyond the initial uptake by innovators – people who are willing to take a risk with new products for the thrill of being the first to try something out. Successful products, on the other hand, manage to bolster the support and interest, and cross the so-called 'chasm' when early adopters raise the profile of the product to the wider public, allowing it to achieve its mass-market potential.

Figure 1. Can micro-CHP cross the chasm and reach the mass-market?
Source: Wikimedia, Delta Energy & Environment, 2009

FLAVOURS OF MICRO-CHP – NEW TECHNOLOGIES

Near-term technologies

The micro-CHP systems that are entering European markets now are based on Stirling engine, Organic Rankine Cycle (ORC) or internal combustion engine (ICE) technology.

These technologies are characterized by relatively low electrical efficiencies, and high heat-to-power ratios (Figure 2). They are therefore most suited to applications in existing houses, which

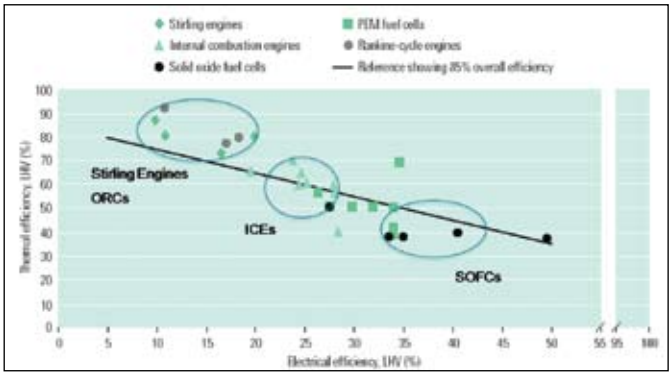


Figure 2. Efficiency performance of the five main micro-CHP technologies
Source: Delta Energy & Environment, 2009

The average heat demand of homes will therefore fall, creating the need for micro-CHP technologies with a higher power-to-heat ratio. Fuel cells are well positioned to meet this demand

have a high heat demand compared to the need for electricity. In these places, they can be installed as a direct replacement to a gas boiler, with the added benefit of generating some of the customer's electricity needs, as well as meeting the heat demand (Table 1).

Medium-term technologies

Residential buildings will become increasingly well-insulated over time, as new building regulations and energy efficiency measures spread. The UK government, for example, has announced that new buildings will have to be zero-carbon from 2016. The average heat demand of homes will therefore fall, creating the need for micro-CHP technologies with a higher power-to-heat ratio. Fuel cells are well positioned to meet this demand.

Fuel cells for residential micro-CHP generally come in two types – proton exchange membrane fuel cells (PEMFCs) and solid oxide fuel cells (SOFCs). Their power-to-heat ratio is close to 1:1, so a larger share of their output is electricity, compared to the near-term technologies (Table 2). PEMFCs are technically proven in lab settings, and initial field applications have been promising, but costs still need to come down before they can be considered truly commercial.

The companies developing SOFC systems have proved that electrical efficiencies of over 50% are possible, but need to improve understanding of the degradation process to ensure viable lifetimes – before costs can even become an issue.

MARKET POSITION AROUND THE WORLD

Commercially available – nothing new under the sun in 2008

The commercial availability of micro-CHP products changed little in 2008, despite previous announcements of intentions to launch products. Japan remains the only market where micro-CHP can be considered commercial, with annual sales of Honda's ECOWILL levelling at around 20,000. Yanmar has achieved steady sales of its 5 kWe ICE system, and has recently set up a European office to widen its market.

Sales in Germany, representing around 90% of Europe's micro-CHP market, fell somewhat – affected by a poor boiler market and people postponing purchase decisions in anticipation of the 2009 CHP Law. The 5 kWe Senertec Dachs remains the leading product, having sold just under 2000 units, with OTAG, PowerPlus Technologies and Sunmachine having each sold several hundred units.

Developers in Europe – anticipating market launch in 2009/10

Europe is now full of anticipation that new micro-CHP products will enter the market towards the end of 2009 or early 2010, as the main manufacturers have used the last few years to ready themselves for market launch.

Whispergen has established a partnership with Mondragon to mass manufacture and supply its Stirling engines to the European market through Efficient Home Energy (EHE). MEC, meanwhile, has moved its manufacturing plant from Japan to China and is

Table 1. Stirling Engines, ORC and ICE systems dominate the near-term micro-CHP market

Source: Delta Energy & Environment, 2009

	Stirling Engine	ORC	ICE
Description	External combustion engine, using a heat source to expand a working fluid driving piston engine	External combustion engine, using a heat source to expand a working fluid through a turbine	Vehicle or long-life engines
Electrical efficiency	10%–20%	~10%	20%–30%
Pros	Generally quiet, Little maintenance required	Components already mass-produced, Potentially low cost	Mature technology, Relatively high efficiency
Cons	High cost (today), Heavy	High heat-to-power ratio	Period oil changes required, Can cause vibrations
Example products	Whispergen, Microgen Engine Corporation, ENATEC	Energetix Genlec	Honda ECOWILL

Table 2. PEMFC and SOFC are promising future micro-CHP technologies

Source: Delta Energy & Environment, 2009

	PEMFC	SOFC
Description	Chemical cells consisting of an anode and cathode separated by a proton-exchange membrane	Chemical cells consisting of an anode and cathode in a solid oxide medium
Electrical efficiency	30%–35%	30%–50%
Pros	Technology understood and proven in laboratory, Operates at lower temperature than SOFC Proven in the field in Japan	High electrical efficiency, High temperature allows for internal reforming
Cons	Uses (expensive) platinum catalyst, Needs complete reforming of natural gas	Lifetime still unproven, Degradation process not well understood
Main producers	Ebara-Ballard, Toshiba, Eneos Celltech, Panasonic, Baxi	Hexis, Topsoe, Ceres Power, Kyocera

Figure 3. Four elements need to be in place for micro-CHP to move from innovation to the mass-market stage

building the expertise to start churning out its products in large numbers. Both expect to produce several hundreds of units in 2009, rising to thousands of sales next year. Other players are scaling up as well, careful not to be left behind.

PEM/PEFC products launched in Japan

Japan remains a step ahead of developments in Europe, seeing the market launch of PEMFC in April 2009. Gas companies (Osaka Gas, Tokyo Gas and others) are driving these products to market, aiming to win ground on the electricity companies over the domestic heating market.

Ebara-Ballard, Panasonic (previously Matsushita) and Eneos Celltech (joint venture between Sanyo and Nippon Oil) provide the products, and are convinced that the technology is ready for the customer. They aim to manufacture thousands of units this year, and tens of thousands in 2010. Costs are still an issue – systems cost around ¥3.2 million (€23,000) – but the government has stepped in with a ¥1.4 million (€10,000) subsidy.

SOFC developers achieving promising progress

Commercial SOFC products are still a prospect for the future, but developers have made promising progress in 2008. Ceramic Fuel Cells Ltd. (CFCL) has broken the 50% efficiency barrier, while Topsoe has shown 13,000 hours of reliable performance.

The Japanese SOFC Roadmap, a government-sponsored R&D programme, is seeing the first field trials in 2009 in Japanese homes – essential to make the transition from the lab to commercial products. Lifetimes and system operation remain to be proven before commercial systems can be introduced to the market; planned for 2011 at the earliest.

Germany is becoming the main European hub for SOFC development. The government, energy companies and technology developers, have joined forces in the Callux programme, aiming to test 800 fuel cells up until 2012. CFCL and Ceres Power aim for product launch on a similar timescale.

SHORT-TERM PROSPECTS – READY FOR TAKE-OFF?

Critical factors determining the future of micro-CHP

Micro-CHP developers are convinced that the time for micro-CHP has finally come, but critics remain sceptical after several years of unfulfilled promises. Delta believes four critical factors will shape the fate of micro-CHP in the next few years (also see Figure 3):

1. market-ready, mass-market products at the right price
2. a route to market
3. government push
4. customer demand.

Market-ready products – manufacturers ready to deliver

The manufacturers planning market launch in 2009 and 2010 are better placed to deliver than previously, as they have addressed technical teething problems, overcome organizational shake-ups and established mass-manufacturing facilities. This suggests that they are able to start supplying their systems as planned, although some of the more bullish projections may remain optimistic.

Prices are still high, so micro-CHP will rely on subsidies initially, but costs can be brought down if volumes of around 30,000 units per year are achieved.

Route-to-market – engagement from utilities/boiler companies

Electricity and gas suppliers will be critical for bringing micro-CHP to market, as seen from the success of the ECOWILL in Japan. Their commercial weight, customer relationships and heating service networks make them much-desired partners for product developers.

Promisingly, many European utilities see opportunities to generate value from micro-CHP, and have become actively involved in driving the market. All three major utilities in the Netherlands (ENECO, Essent and NUON) are conducting advanced field tests and are planning to start selling micro-CHP systems to customers. Centrica and E.ON are investing heavily in the technology and market preparation in the UK, while MVV (a Mannheim-based utility) and GASAG (a Berlin-based gas supplier) are supporting the Callux fuel cell trials in Germany.

Boiler companies are the other obvious route to market for micro-CHP. Here too, all major players have directly engaged with micro-CHP. Remeha, BAXI and Daalderop have made bullish announcements of selling tens of thousands of units in the next few years, while Vaillant has revealed it is partnering Honda to bring the ECOWILL to Europe.

Governments stepping up to the plate

Cost will remain an issue for micro-CHP when the first products become available later this year, so their success will initially depend on subsidies to bridge the price-gap with condensing boilers. The governments of the leading markets have all realized this, and have introduced or announced support.

The Japanese government has already been offering installation subsidies for the ECOWILL product and is now doing the same for PEMFCs. Its R&D support through the fuel cell roadmap also continues, supporting on-going development of SOFCs into commercial products. The new German CHP Law continues the €0.0511/kWh ($0.07/kWh) feed-in tariff for micro-CHP that allowed for the success of the Senertec Dachs, and introduces an additional installation subsidy.

Support in the Netherlands and UK is less secure, but micro-CHP will be included in Britain's incoming micro-generation feed-in tariff, while the Dutch micro-CHP sector is lobbying for an extension of the existing subsidy after September 2009.

Customer demand – will people buy?

Until now, micro-CHP has not yet moved beyond the innovation

stage of the market, so its appeal to the mass market is as yet untested. This year the main manufacturers are likely to target innovators, but mass-market success requires wider appeal in subsequent years. This will reveal which companies have best anticipated demand and offer the best customer proposition.

Early signs of interest from innovators are good. Sales of Senertech Dachs units in single-family houses in Germany exceeded 1000 last year, even though it is technically too large at 5 kWe. This suggests a gap in the market that can be filled by the new 1 kWe systems which are available in 2009/10. Japanese customers have already been sensitized to micro-CHP by the ECOWILL, paving the way for PEMFCs now. Interest from the wider public is still uncertain, and could be affected by the high product cost; but the strong engagement from utilities and boiler manufacturers allows for good customer communication and support.

CONCLUSIONS

Micro-CHP is better placed than ever to move beyond the innovation stage and reach the mass market. Manufacturers are ready to start mass-producing their units; major companies are backing them to reach customers; governments are stepping up to provide financial support; and initial feedback from customers is positive.

The process will not be plain sailing though. If the industry has learned anything over the last few years, it is that the commercialization process always takes longer than planned. Field trials have been successful, but the early experiences of installation and operation in a true customer environment will be vital for the development of the market. If the lessons are learned successfully, production can be scaled up and the necessary cost-reduction achieved – as governments will not maintain support indefinitely.

The manufacturers planning market launch in 2009 and 2010 are better placed to deliver than previously, as they have addressed technical teething problems, overcome organizational shake-ups and established mass-manufacturing facilities

The set-up for commercial micro-CHP launch is good though, so it is likely the market will develop beyond the current 22,700 units. However, commercial launch in Europe may slip into early 2010 and the bullish forecasts of some suppliers of tens of thousands of sales in a few years may prove optimistic.

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