Decentralised Energy - Going local

December 2008

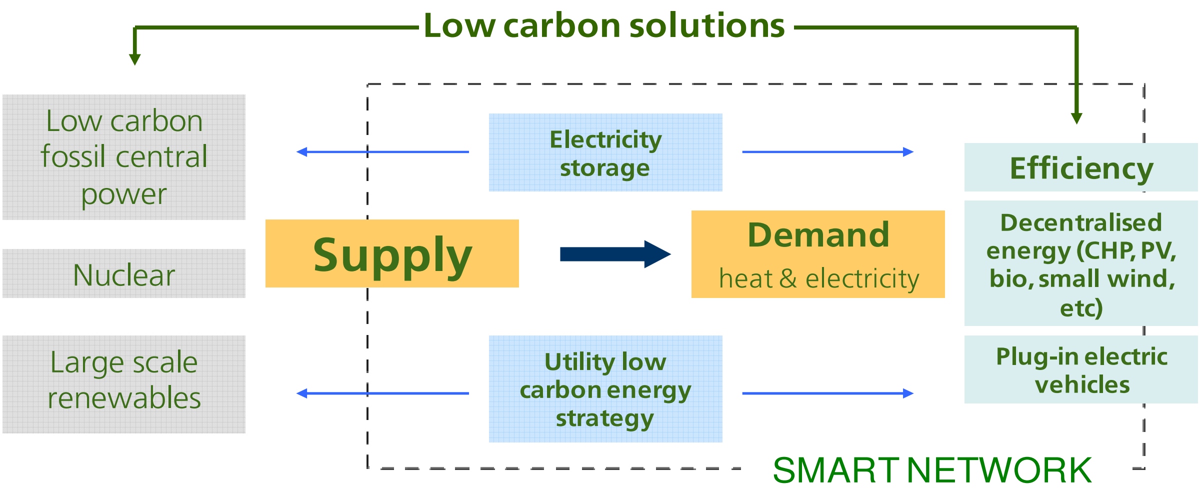
The big utilities are beginning to grasp the potential of decentralised energy technologies – promising huge opportunities for investors.

The city is London; the year is 2020. The energy supply system has undergone a remarkable 'reverse evolution' towards its original form of local, or decentralised, energy.

Electric vehicles whizz around the city, charging during the night and providing power to the grid during peak times. Combined heat and power (CHP) units are commonplace in suburban homes and commercial and industrial buildings. Heat networks fed by biomass CHP are the default option for new housing developments. Micro-grids operate autonomously from the main grid, trading against it. Smart meters allow homeowners to benefit from tariffs that control when their appliances run. Wind turbines are commonplace on exposed rooftops and rising above light industrial buildings. New types of battery are widely deployed at substations, flattening demand and smoothing the output of local generation.

Of course, a combination of nuclear, large wind, gas and clean coal generation still command a considerable base-load presence – but the balance has shifted much more towards local and on-site production and distribution of power (Figure 1).

Figure 1 – Combining large low carbon generation with decentralised generation



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This scenario is not wild speculation or fantasy, but is already emerging. And there will be rich pickings for investors that can pick the decentralised energy (DE) winners.

The shift in how energy is generated, transported and supplied can be seen around the globe:

- President-elect Obama plans to develop and promote “smart metering, demand response, distributed generation and electricity storage systems” and to “deploy the cheapest, cleanest, fastest energy source: energy efficiency”;
- The UK has just proposed a feed-in tariff to guarantee a minimum price for power from microgeneration systems (up to 3 MWe), encouraging the installation of low-carbon generation;
- The Netherlands – which already generates over 35% of its electricity from CHP systems – has set a target to have 10,000 micro-CHP units in homes by 2011;
- Governments across the US and Europe are driving the development of electric cars, perhaps the ultimate form of distributed generation and storage; and
- China is looking to roll out smart grid technology on its huge new transmission systems.

Driven by the challenges of climate change and energy supply security, we are embarking on the most dynamic period ever for the electricity and heat supply sectors.

Energy utilities - at the forefront of the transition

It is the energy companies – the utilities – that are the key influencers and shapers of how the electricity system operates. For years, they have had a preference for the status quo of the centralised system – the easiest and most profitable way for them to do business. However, regulation, unbundling of generation and supply and environmental obligations are forcing them to fundamentally change the way their businesses work. Some are already beginning to see the competitive advantage that DE or energy efficiency can deliver and are looking to embrace the opportunity of new technologies, products and systems, investing time and money and acting as a key catalyst to market development.

How to spot the winners

Where should investors place their bets when it comes to low carbon products and technologies? While there has been a strong focus on large-scale renewables and carbon capture and storage (CCS), DE options have also been a target, most notably soloar photovoltaics (PV). But there are many other opportunities across the DE range and we believe that some of these have been overlooked.

A good place to start is to look at some the DE technologies themselves. In addition to PV, we see micro-CHP, small wind turbines, heat pumps and electric vehicles as front-runner opportunities. Some already have an emerging market foothold (e.g. small wind in the UK), in part driven by the energy industry. Such technologies are all potentially disruptive to the core business of these companies (generating electricity from large, remote, centralised power plants and supplying as many kWh as possible). There is also a need for complementary technologies that enable utilities to take fuller advantage of this new DE, including electricity storage, smart meters and demand side management.

Let's take a closer look at two of these: micro-CHP and electricity storage.

Micro-CHP - targeting mass residential markets

Micro-CHP is a potentially game-changing technology for the heating and utility industries. It represents a new means to meet all the heating requirements of a household and at least half of its electricity requirements. If it succeeds in penetrating the mass markets for domestic heating (over 5 million boilers are sold every year across Europe), it could provide gigawatts of low-carbon power generation.

Micro-CHP units are typically powered by fossil fuels (although biomass powered units are being developed), and are generally sized in the 1-5 kWe range for use in the residential sector. To the householder, these units appear very much like an average high-efficiency boiler but offer some significant carbon savings – 10-20%+ – compared to separate centralised electricity generation and conventional boilers.

There are five main micro-CHP technology types – the internal combustion engine (ICE), Stirling engine, Rankine cycle engine, fuel cells and pico-turbines (a gas turbine that sits in the palm of your hand!). The ICE is at a more advanced stage of commercialisation than Stirling and Rankine cycle engines. Fuel-cell micro-CHP offers higher electrical efficiency than these three technologies but we believe is unlikely to reach the European market by 2012 (see Table 1).

Table 1 – Major manufacturers/developers of micro-CHP technology and their market status

Internal Combustion Engine	Rankine Cycle Engine	Stirling Engine	Proton Exchange Membrane Fuel Cell	Solid Oxide Fuel Cells
Available now – approx 25,000 sales per year	**Ready for market by 2009/2010 – Final demonstration and field trials, set up for commercialization**		**Expected by 2012 or later in Europe – Starting demonstration and field trials***	
Aisin Seiki	Energetix	Baxi	Ballard	Acumentrics
Honda	OTAG	Bosch	Baxi Innotech	Ceres Power
SenerTec		Disenco	Matsushita Electric Industrial	Ceramic Full Cells
Vaillant		ENATEC	Toshiba FC Systems	Hexis
Yanmar		Hoval	Toyota	Kyocera
		Remeha	Plug Power and Vaillant	Topsoe Fuel Cells
		Stirling Power Module	Viessmann	Nippon Oil Corporation
		Stirling Systems		TOTO
		Sunmachine		Versa Power
		Vaillant		Webasto/Vaillant
		Viessmann		
		WhisperGen / Efficient Home Energy		

*Delta Energy and Environment, 2008. * Japan is a step ahead with fuel cells – with commercialisation likely in 2009*

Micro-CHP markets are emerging in Europe and Japan, bringing both opportunities and threats to utilities and heating equipment manufacturers. In Japan, Honda has sold 60,000 of its 1 kWe Ecowill unit – showing that Japanese energy efficiency efforts are a step ahead of those in Europe. The

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drivers of this market are clear: government incentives during operation and demonstration; support from energy utilities; growing customer interest and a good product.

In Europe, Stirling engine and Rankine Cycle manufacturers are also ramping up in expectation of a mass market for their products. Utilities such as Centrica, E.ON, Nuon and Gaz de France are involved in demonstration projects and most of the major boiler manufacturers are engaged with product developers.

At a summit Delta organised earlier this year, 15 major utilities, three boiler manufacturers and 13 micro-CHP developers predicted annual European sales of around 260,000 units per year by 2015. While there remain risks and uncertainties, we believe it likely that micro-CHP will penetrate the boiler market in the next five years to a significant level, with the potential for major international mass markets by 2020.

Electricity storage – diverse technologies and applications

Meanwhile, diverse opportunities exist in electricity storage. Our centralised electricity system is built around the fact that electricity cannot easily be stored, but generated when it is needed, creating a myriad of supply and environmental challenges. The introduction of non-dispatchable generation such as wind, solar and CHP (which typically generates electricity when the host site requires heat) goes against the grain of this tradition.

Today, a range of emerging electricity storage technologies offer a means for utilities and network operators to manage these new decentralised assets. Its applications include:

- Storing power from intermittent peaks from wind and solar generation, rather than resorting to costly and time-consuming investment in grid reinforcement;
- Smoothing the most severe supply peaks as peak load on a network increases, allowing the network operator to defer upgrading the network until it is economically viable to do so;
- Reliable power storage for areas at risk of outage, while damaged transmission lines are repaired.
- Night storage of cheaper off-peak power for energy-intensive industrial customers to use during the day.

Significantly, the challenges that storage addresses are all exacerbated by increasing amounts of DE and renewable generation on an aging grid – an increasingly pressing issue for many North American and European systems.

There are now several technologies for storing electricity. Some have been around for many years, but the applications for these are limited, making them unsuitable for most grid applications. For example, water can be pumped into reservoirs and released to drive turbines, but the technology is capital intensive and dependent on specific geological sites. Compressed air energy storage suffers from similar problems, while standard battery technologies, while cheap and reliable, cannot readily be cycled.

The sector is now looking to emerging technologies to overcome the limitations of conventional storage (see Table 2).

Table 2 – Electricity Storage Technologies

Technology	Description	Examples
Flow batteries	Very flexible – can be scaled to provide a wide range of power (kW to MW) from minutes to hours Good cycling capability	VRB Power Systems has installed several MW globally in a wide range of applications Premium Power is emerging as a highly cost-competitive solution but has no units on the ground yet
High-temperature batteries	The only commercially available emerging storage solution. High costs and inflexible specifications (MWs for hours only)	NGK Insulator's NAS (sodium-sulphur) battery is the sole product and also the market leader with over 270 MW installed globally, mostly at customer sites in Japan.
Flywheels	Store electricity by converting it to mechanical energy. Good for high power, short-term storage – "MWs for minutes"	Beacon Power is developing 20 MW flywheel plants to provide frequency regulation in the US electricity market
Adiabatic CAES (compressed air energy storage)	Recycles the heat released during compression to make the re-electrification much more efficient	No projects yet on the ground

Delta Energy and Environment, 2008.

Micro-CHP, storage and other DE technologies – including building-integrated PV, small wind and fuel cell CHP – are at various stages on the road to full commercialisation. And, based on this, we believe that there are good opportunities to be found for investors with both short-term and long-term time horizons. The former will be interested in the emerging products and technologies, and will need to understand in depth the sharply changing market environment that awaits them since this will determine which technologies will succeed and which will fail. The latter will want to understand how the larger energy companies – generators, network operators, and suppliers – are adapting their business models to respond to the opportunities.

And there will be winners and losers in both groups.

Among the energy companies, there are already examples of innovative players:

- In the UK, E.ON and Centrica have both established dedicated divisions to provide low-carbon energy services to customers. The Dutch utility Nuon is aiming to provide a similar service;
- Tokyo Electric Power Company got in at a very early stage in the development of the high-temperature NAS (Sodium-Sulphur) battery. It has now sold over 200 MW of the technology;
- American Electric Power has installed several storage projects on its networks and plans to have 1GW of storage capacity installed by 2020;
- EDF has surged forward with the introduction of Toyota's plug-in hybrid vehicles to the French and UK markets. In the UK, EDF is looking at building a network of 250 recharging stations with Elektromotive;
- Scottish and Southern Energy has acquired a minority stake in up-and-coming flow battery developer Premium Power; and
- RWE Innogy has invested £6 million ($7.6 million) in small wind developer Quiet Revolution.

These energy companies and many investors have woken up to the prospect of the vision set out at the beginning of this article – and are already spotting some of the opportunities. For those that do their homework properly and understand these growing DE markets, there will be many more to be found.

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