

## Organisations of the Future

### Brief 1: What will be the impact of micro/local power generation?

*Microgeneration (or local generation) is the production of zero or low-carbon heat and power by households, communities, businesses and government. It is the production of energy by or near the consumers of it.*

A Ci briefing paper for stars 09

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**Introduction**

This briefing paper is one of three written specially for the next-generation international leaders taking part in **stars**’09. The papers were designed as input to a structured workshop process, to stimulate thinking on emerging issues that will impact organisations in future. The topics have been selected as examples of developments in the fields of environment/resources, politics/economics and technology.

The 2009 papers address:

1. Micro/local power generation
2. Transnational crime
3. Distributed manufacturing

Each theme is presented in the same way:

- The story so far
- What will influence the next 20 years?
- What might be the implications?

The papers are based on a review of literature and fresh interviews with selected experts, further edited to include outputs from the symposium itself. They are not designed to make precise projections, but to identify the factors that will influence developments in these fields.

Participants are welcome to use this **stars** briefing paper in their own organisations, with or without support from Ci.

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## What will be the impact of micro/local power generation?

Microgeneration (or local generation) is the production of zero or low-carbon heat and power by households, communities, businesses and government. It is the production of energy by or near the consumers of it.

### *The story so far*

Local generation is very different to the centralised production of energy, based on large power plants, that dominates the industry today. The current model has clear economies of scale, but also contains some diseconomies.

Power plants are generally located away from energy users, meaning that electricity is delivered over long distances. Around 7% of energy is lost in transmission along the miles of cables that supply homes and industry.<sup>1</sup>

A benefit of microgeneration is that the production of electricity can be close to demand. Various technologies can be used (see box).

### Some microgeneration technologies:

<p><i>Electricity generation</i></p> <p>Solar PV (photo voltaic) panels Small hydro Wind turbines</p>	<p><i>Heat generation</i></p> <p>Solar water heating Heat pumps (ground source or air source) Biomass</p>	<p><i>Cogeneration (electricity &amp; heat)</i></p> <p>Combined Heat and Power (CHP) Hydrogen energy and fuel cells</p>
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Combined Heat and Power (CHP) technologies are the holy grail of microgeneration. They capture the waste heat generated during the production of electricity and use it for domestic or industrial purposes.

*'Approximately two-thirds of the energy used to produce electricity by standard power plants is lost as waste heat. CHP can raise the overall efficiency of power generation to as high as 70 per cent.'*<sup>2</sup>

Germany (where users are paid a premium for feeding power back into the grid) seems to be in the lead in encouraging local

<sup>1</sup> *Lost in Transmission? The role of Ofgem in a changing climate*, Sustainable Development Commission, 2007, p. 7. The loss varies from country to country, depending on the distances involved. This is a UK figure.

<sup>2</sup> *Technology Futures*, Shell International BV, 2007, p. 93.

generation, with Japan and Sweden close behind.<sup>3</sup> Between the 1970s and 2006, Swedish government programmes led to the installation of heat pumps in roughly 10% of homes.<sup>4</sup>

### *What will influence the next 20 years?*

Five sets of drivers will largely determine the speed and extent to which microgeneration develops.

### Technology

The first will be technology. Micro wind turbines can be effective in rural areas but are unlikely to generate sufficient power in cities, where wind speeds and patterns make them less effective. Among other approaches, solar energy is especially promising.

Developments are likely to include:

- *thin-film solar systems.* These are PV systems based on nanotechnologies that use extremely thin layers of solar-conversion materials. The materials are applied to a thin sheet of flexible backing, usually some type of metal.



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They are cheaper to make than conventional solar panels, use fewer scarce materials, are far easier to install and are much thinner. They can cost 20% of conventional panels.<sup>5</sup>

- *converting energy from windows.* An MIT team led by engineer Marc Baldo has developed 'solar concentrators' that move usable sunlight to the edges of windows, where conversion materials create electricity from it.

He believes that this collector system will be on the market within 3 years, and will be particularly effective in office blocks with numerous large windows.<sup>6</sup>

<sup>3</sup> Guy Copans, "Microgeneration holds much promise, but demands new way of thinking," *Engineering News*, 16 May 2008.

<sup>4</sup> *Our Energy Challenge. Power from the people*, London: DTI, 2006, p. 11.

<sup>5</sup> 'Your solar-powered future', *The Futurist*, May-June 2009, p. 26.

<sup>6</sup> *Ibid*, p. 27.

- *solar and fuel cell combinations.* MIT scientists Daniel Nocera and Matthew Kanan are developing a process that would enable solar panels to provide heat and light during the day, while also using the energy to split water into hydrogen and oxygen for storage.

At night, the stored hydrogen and oxygen would be combined using a fuel cell to generate power while the solar panels are inactive. Nocera believes that products based on this technology could hit the market within 10 years.<sup>7</sup>

These and other developments will combine with advances in energy saving to allow a growing number of users to produce more energy than they need.

The surplus will be sold back to the grid, which – using ‘smart’ meters – will be adapted to channel electricity to and from consumers.

#### Tight energy supplies

The higher the price of oil, the sooner these new technologies will be economic. Growing demand is set to push up oil prices in the long term.

In 2008 the US Department of Energy expected world energy consumption to expand by 50% between 2005 and 2030.<sup>8</sup> Despite the recession, something approaching that figure is still likely as the world’s population keeps expanding, China and India continue to industrialise and demand starts growing again in the rest of the world.

Bumping up supplies will not be easy. With international companies facing dwindling opportunities, companies owned by oil-producing countries are expected to account for about 80% of the increase in oil and gas production by 2030.



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But in November 2008 the International Energy Agency warned that these companies might well be unwilling or not able to attract sufficient capital to keep up the necessary pace of investment.<sup>9</sup>

<sup>7</sup> Ibid, pp. 26-27.

<sup>8</sup> US Department of Energy, Energy Information Administration, “International Energy Outlook 2008: Chapter 1 - World Energy Demand and Economic Outlook,” June 2008 <http://www.eia.doe.gov/oiarf/ieo/world.html>

The scale of operations is huge. Total's head of exploration, Christophe de Margerie, claimed that sheer logistics would be one factor stopping companies meeting the predicted demand for oil by 2030.

*'Take Qatar. How many projects can you have at the same time? You have more than 100,000 people working on sites. It's a big city of contractors.'*<sup>10</sup>

Then of course there is the role of OPEC. From the price increases after 2004, might OPEC conclude that the world can absorb a steady climb in energy prices relatively easily?<sup>11</sup> Producers would limit supplies to ensure strong prices.

### Political pressures

Governments will be under pressure to drive up prices further to cut energy consumption and encourage alternatives to oil.

The world's top five countries with oil reserves are all in the Middle East. They have two thirds of the planet's proven reserves and their oil tends to be of high quality.<sup>12</sup> Russia, Iran and Qatar have 55% of the world's known gas reserves.<sup>13</sup>

Though the US has long paid lip-service to reducing its dependence on imported oil, energy security has shot up the agenda in the wake of the second Iraq war, the potential for al-Qaeda to destabilise the Middle East, the risk that Iran goes nuclear and growing competition for supplies with China.

On top of this is the urgent need to avert dangerous climate change.<sup>14</sup> Even if all greenhouse gas emissions were halted today, past emissions would warm the world over several decades by enough to bring temperatures close to dangerous levels.

On the other hand, public resistance to higher energy prices is deeply entrenched. Rich-world consumers are reluctant to change lifestyles to accommodate more costly energy – look at the anxiety when fuel prices jump!

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<sup>9</sup> 'New Energy Realities. WEO Calls for Global Energy Revolution Despite Economic Crisis', International Energy Agency press release, 12 November 2008.

<sup>10</sup> *The Times*, 8 April 2006.

<sup>11</sup> *Shell energy scenarios to 2050*, Shell International BV, 2008, pp. 14-15.

<sup>12</sup> Chris Abbott, Paul Rogers & John Sloboda, *Beyond Terror*, London: Rider, 2006, pp. 28-33.

<sup>13</sup> *Shell Global Scenarios to 2025*, London: Shell, 2005, p. 194.

<sup>14</sup> IPCC, 'A Report of Working Group 1 of the Intergovernmental Panel on Climate Change: Summary for Policymakers', 2007.

Buying white goods, a motorbike and then a car, all of which gobble up energy, are strong aspirations among Asia's emerging, vast middle class.

So forcing up energy prices to provide incentives for politically secure and green technologies, including microgeneration, will be a difficult strategy for politicians. There will be some steps in this direction, but not as many as environmentalists would like.

The behaviour of green-aware consumers is unlikely on its own to change the pattern of energy consumption substantially.

### Centralised vs decentralised energy

A fourth influence on the spread of microgeneration will be the balance of advantage between centralised and decentralised production. All sorts of developments in the pipeline could favour the current centralised model.

It is widely hoped that carbon capture and sequestration technologies (CCS) will make it possible to clean carbon dioxide from coal and gas-fired power stations and store it under ground. The climate change objections to this source of electricity would be sharply reduced.

But if CCS proves too expensive and impractical, as some experts believe, local generation (along with other approaches) will become a matter of urgency. Much may hinge on the success of CCS.



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Many of the new green technologies will take a centralised form, such as large wind farms, wave power (to capture the energy of ocean surface waves) and concentrations of large solar panels, perhaps in deserts. If these solutions take off, microgeneration will face tough competition.

By contrast, under-investment in electricity generation could make centralised supplies insecure in some parts of the world.

This is already true of many developing countries, where factories often have their own generators. It may affect some rich-world countries too.

In Britain for example, inadequate investment could cause temporary power shortages after 2015, and this would stimulate local generation.

If we look at the big picture, the global energy challenge is so great that centralised solutions alone are unlikely to be enough.

As costs of microgen technology fall and energy conservation improves (through insulation and smart metering for instance), the generation of power for local use and sale back to the grid will become an increasing part of the world's energy mix.

An official study suggests that 30-40% of the UK's electricity demands could be met through microgeneration technologies by 2050, with Combined Heat and Power leading the way.<sup>15</sup>

### Major barriers

For this to happen, a number of barriers will have to be overcome. They are not insuperable, but are a considerable challenge. They include:

- costs, which should fall rapidly once the technologies reach mass production;
- lack of consumer awareness of the potential savings from microgeneration;
- technical issues surrounding metering, connection to the grid, and managing fluctuations in supply and demand on the grid;
- regulatory constraints, such as planning permission.

### Summary

We can be confident about some developments, such as technologies that cut the cost of local generation, the long-term rise in energy prices that will help to make these technologies economic, and the need for local energy solutions to complement centralised ones.

But there are also uncertainties about the pace of these developments and the extent to which microgeneration will be developed in different countries. Some organisations will want to develop scenarios for the possible outcomes.

### *What might be the implications?*

*Microgeneration will expand at different paces* in different parts of the world. As solar panel technology advances, take-up will be fastest in countries that have plenty of sun!

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<sup>15</sup> *Our Energy Challenge. Power from the people*, London: DTI, 2006, p. 15.

Local generation will be especially widespread in areas that are not linked to the grid. 400 million people in India still have no access to electricity.<sup>16</sup>

They – and others – will find microgeneration an affordable way to obtain energy. They will leapfrog centralised approaches in the same way they are doing with mobile phones.

*Microgeneration will be a growing priority for businesses and other organisations. After personnel, energy is the second largest expense for Wal-Mart.<sup>17</sup> Imagine the commercial benefits for a retailer from meeting all its energy needs itself.*

There are clear reputational advantages as well. Customers and workers like the idea of green buildings. Subway unveiled its first 'eco store' – in Florida – in 2007 and a year later had opened 4 more. Other retailers (not only in the US) are headed in the same direction.

Even now retailers and others are leveraging the PR opportunities, developing story lines about sustainability, social responsibility, employer of choice and innovation. Should companies take advantage of these opportunities quickly before being green is no longer newsworthy?

*Assets with no value will become valuable.* CleanStar, for example, works with landowners in India to help them produce biofuels on land that is unsuitable for food cultivation.

Farmers can run their diesel tractors entirely by using jatropha or pongamia oils that they have grown themselves. CleanStar provides the technology that allows diesel engines to run directly on such oils.<sup>18</sup>

As solar power takes off, roofs and windows that were once just a cost will become a source of value. Might cruise ships paint solar panels on all exposed surfaces? Might waste land at the side of railways become an asset on which to grow biofuels? Managers will look across their activities with a fresh eye.

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<sup>16</sup> *World Energy Outlook 2007: China and India Insights*, International Energy Agency, 2007, p. 3.

<sup>17</sup> Andrew Martin, "Green Plans in Blueprints of Retailers," *The New York Times*, 7 November 2008.

<sup>18</sup> Shashank Verma of CleanStar on 8 April 2009  
<http://www.cleanstar.in/index.htm>.

*Power companies will develop new business models.* Southern California Edison plans to install solar panels, which it will own, on otherwise unused large commercial rooftops across southern California. The aim is to create hundreds of neighbourhood solar power plants.

Some companies may create incentives for neighbours, residents in apartment blocks and even entire communities to come together to arrange the local production of power. Local generation would be a new force for community cooperation.

Others may secure a competitive advantage by developing easy-to-install power generation kits, or establishing high-quality call centres to give customers and engineers advice on local generation.

Power companies will increasingly be in the business not of supplying energy, but of helping their customers to save energy and become energy producers themselves.

Might this speed up the development of electric cars? If cars could be recharged at home (or work) using locally generated power, running costs would fall dramatically.

*Will there be an energy internet?* Environmentalist Jeremy Rifkin and others envisage that an 'energy internet' will eventually emerge. Consumers will trade power that they have generated rather than buying from centrally organised plants.<sup>19</sup>

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<sup>19</sup> EurActiv.com, "Microgeneration: Power to the people?" 25 July 2008  
<http://www.euractiv.com/en/energy/microgeneration-power-people/article-172519>