Decentralised Energy – Power for the 21st Century

- The developed world's electricity is generated by an outdated, technologically obsolete, centralised system which wastes around 65% of the energy used to fuel it.
- An approach which makes use of the heat wasted by producing electricity close to where it is needed in tandem with local generated renewable energy, would be better for the climate, more secure and give better value for money.
- The nuclear industry is promoting nuclear power as a solution to climate change, energy security and other challenges. A DE energy strategy produces less carbon emissions, is cheaper and requires less dependency on imported fuel.
- DE democratises energy, and promotes a cultural change in our attitude to the use of energy and thus helps to stimulate energy-use efficiency.
- In global terms, decentralising energy could revolutionise the lives of billions of people who currently lack access to basic energy services.
- The share of new generation taken by decentralised power globally is on the increase. Savings could reach $2.7 trillion by 2030.
- DE has already eclipsed nuclear power. Subsidising nuclear is futile. A portfolio of energy efficiency and DE will always be the least cost investment.
- National governments around the world need to remove policy and regulatory barriers to promote DE in order to tackle climate change.

Introduction

Climate change has thrust energy production to the top of the political agenda. The developed world is currently dominated by a centralised electricity generating system, which is the embodiment of technological inertia, performing little better today than it did in the 1970s. This centralised system is hugely wasteful and environmentally damaging. Technological advances over the past 30 years suggest an optimum model of electricity supply and distribution, which is entirely different.

Within the (pre-2007) 25 European Union nations, for example, the electricity sector is responsible for releasing more than 1.2 billion tonnes of carbon dioxide (CO_2) and over 2600 tonnes of dangerous radioactive waste every year. What's more, only 0.6% of the oil, 2% of the gas, 7.3% of the coal and almost none of the world's uranium lie within EU, so there is limited security of supply. At the same time more than half of Europe's power plants are more than 20 years old, and will need to be replaced over the next decade or so, offering an opportunity to move towards a more sustainable system which protects the climate and provides future generations with secure energy. (1)

Big centralised electricity generating stations waste around two thirds of the energy in the fuels they use by throwing away waste heat in cooling water, up the cooling towers and then in the electricity transmission wires. So 65% of the energy is lost before it even reaches consumers. If we could make use of this waste heat it would make a very large contribution to tackling climate change and improving security of supply.

By seeing the energy system as a whole and locating energy production close to where it is used, it possible to use both the heat and electricity generated and more than double the efficiency of power stations. This system would work hand-in-hand with renewable energy sources and more efficient end use. This highly efficient, decentralised, approach is better for

the climate, more secure and gives better value for money than investment in a centralised system.

Decentralised Energy

A Decentralised Energy (DE) system produces heat as well as electricity at or near the point of consumption. It includes high efficiency co-generation or combined heat and power (CHP); on-site renewable energy systems and energy recycling systems. CHP plants, although often fuelled by fossil fuels, are much more efficiently than in large centralised plant, because the heat is used either as process heat in industry or distributed around buildings via a district heating system. The availability of district heating networks means the CHP plant can be converted to run on other fuels such as biomass, geothermal energy, or solar collectors.

The nuclear alternative

As energy prices escalate, several countries are exploring the opportunity for nuclear power. The nuclear industry continues to promote nuclear as a key part of the solution to climate change, energy security and other challenges. DE is cheaper, more secure and cleaner than nuclear power - and it's already working in many countries today.

A recent study for Greenpeace UK by the World Alliance for Decentralised Energy (WADE) using their economic model clearly indicates that a strategy based on DE implementation rather than Centralised Generation (CG) to meet future electricity demand can:

- Reduce delivered costs by 1.01 UK pence/kWh in 2023, a 15% saving relative to CG
- Reduce capital costs by UK£19 billion to 2023, a 27% saving relative to CG
- Reduce CO_2 emissions by 2.83 million tonnes in 2023, an 8% saving relative to CG
- Reduce fossil fuel use by 140PJ in 2023, a saving of 6.1% relative to CG (2)

The Rocky Mountain Institute has undertaken some detailed analysis which demonstrates that alternatives to nuclear power can achieve similar objectives at lower cost. Amory Lovins, of RMI says:

"So the big question about nuclear "revival" isn't just who'd pay for such a turkey, but also...why bother? Why keep on distorting markets and biasing choices to divert scarce resources from the winners to the loser—a far slower, costlier, harder, and riskier niche product—and paying a premium to incur its many problems?"(3)

Advantages of DE

A DE system has advantages over a Centralised system because:-

- It avoids network losses and reduces transmission and distribution costs.
- Fuel efficiency is generally higher because localised generation allows the use of heat as well as generating electricity.
- DE requires less backup capacity than CG because, unlike a system consisting of a few large power plants, a system of many small generators cannot suffer a major impact from the outage of a single generator.
- Most importantly, DE offers the opportunity to cut greenhouse gas emissions dramatically, along with the other environmental benefits of a reduced reliance on fossil fuels and nuclear power.

Increasing energy efficiency at its point of use in the home, factory or business is the most cost effective way of tackling climate change, and dependency on fuel imports. A DE system gives people more active ownership of their energy sources. It democratises energy, providing

real opportunities for local political leadership on climate change, and curbing the influence of the centralised industry's powerful vested interest. By enabling local action and empowering individuals and communities as producers, decentralisation brings about a massive cultural change in our attitude to the use of energy and thus helps to stimulate energy-use efficiency.

In global terms, decentralising energy could revolutionise the lives of billions of people who currently lack access to basic energy services. DE is highly flexible, can be tailored to local conditions and installed much faster than a centralised system. According to Dominique Lallement of the World Bank:

"DE presents a unique opportunity to help developing countries progress towards the provision of clean, affordable, reliable energy, towards economic growth and poverty alleviation"(4)

Energy policies incorporating DE and energy efficiency measures could deliver global cost savings of the order of $2.7 trillion as against an estimated expenditure of £16 trillion by 2030. (5)

DE on the increase

The share of new generation taken by decentralised power in the world market has increased to 25% by 2006, up from 13% in 2002. A transition from a central power model to a 'hybrid' DE-central mix may possibly be underway, though slowly. However, there does seem to have been a surge in DE developments during 2005. High energy prices are likely to promote energy efficiency and moves towards more decentralised generation of energy. (6)

50% of Denmark's electricity and almost 40% of the Netherlands' is generated by DE systems. Its use is widespread and mainstream in many other European countries, including Sweden, Germany, Austria, Finland, Italy and Spain.

In Denmark a strategy of decentralised energy focused on district heating and improving efficiency in housing means that while final energy consumption for space heating has *fallen* by over 15%, the actual floor space heated has *increased* by over 20%. (7)

The Netherlands increased its use of CHP so successfully that in the period from 1985 to 1995 it grew to be the biggest single source of generation in Holland and will continue to grow. According to a review by the Dutch government, CHP also played the most significant role of any policy instrument in reducing CO2 emissions in the Netherlands in the period 1990-2000 and was also the most cost efficient policy instrument for reducing emissions (8).

In the United States the level of installed CHP continues to increase and is now more than 82GWe. A study by WADE shows that the optimum way to provide load growth in the USA would be by using DE, particularly CHP. This would save $291 billion by 2020 and reduce CO_2 emissions by 46% compared with centralised generation. (9)

The UK Government now has a Microgeneration Strategy (10) and its recent Energy Review report, although it sanctioned the construction of new, privately financed, nuclear stations, also devoted a whole chapter to DE. (11) The recently appointed Environment Minister, David Milliband, told local municipalities in July 2006 we could see the same transformation in energy production we have seen in computers over the past generation. (12)

A study by PB Power for the Mayor of London and Greenpeace UK concludes that a DE strategy could reduce CO2 emissions from London by 27.6% by 2025. Despite the increased

use of gas for CHP, gas consumption could be 15% lower under a high DE scenario compared with a high nuclear scenario. The Mayor of London has now set out his intention to move London towards a DE future and has established the London Climate Change Agency to achieve this. (13) A similar report by PB Power for the City of Edinburgh Council, Greenpeace and WWF, concluded that the most cost effective way for Edinburgh to reduce its carbon emissions and increase energy security is by following a DE pathway. (14)

Micro-generation

Residential-level microgeneration systems are becoming increasingly commercial. The first handful of products is emerging in Japan, in some European countries and, to a lesser extent, in the US. This includes micro-CHP (domestic central heating boilers which provide hot water and electricity) and building-mounted micro-wind systems that could become mass-market products within the next decade or so which will have dramatic impacts on the way electricity is supplied to households. In the UK, electrical retailer, Currys is to stock solar (PV) panels (15), and DIY retailer B&Q is stocking rooftop wind turbines. (16)

Amory Lovins compares this growth in DE with nuclear power:-

"Nuclear power worldwide has less installed capacity and generates less electricity than its decentralized no- and low-carbon competitors—one-third renewables (excluding big hydroelectric dams), two-thirds fossil-fueled combined-heat-and power. In 2004, these rivals added nearly three times as much output and six times as much capacity as nuclear power added; by 2010, industry forecasts this sixfold ratio to widen to 177 as nuclear orders fade, then installed capacity begins to disappear gradually as aging reactors retire."(17)

Lovins says efforts to make nuclear power appear competitive with centralised fossil-fuelled plant by subsidizing nuclear or taxing carbon are futile because renewables and CHP are winning in the market place. A portfolio of least-cost investments in efficient use and in decentralised generation will beat nuclear power in cost, speed *and* size by a large and rising margin. This isn't hypothetical; it's what today's market is proving decisively.

Woking Borough Council, UK, DE Pioneer

In the UK, a small municipality – Woking Borough Council – in Surrey, with a population of less than 90,000 has reduced its CO_2 emissions by 77% since 1990 by decentralising its energy at no extra cost in the long term. Woking has over 60 local generators, including cogeneration and tri-generation plant (heating, cooling and electricity), photovoltaic arrays and a hydrogen fuel cell station, to power, heat and cool municipal buildings and social housing. Many town centre businesses are also connected to this local energy supply.

The generators are connected to users via private electricity wires owned and operated by a company set up by the Council. Although ultimately connected to the National Grid the council's electricity infrastructure is 99% self-sufficient. Woking was able to raise capital for energy infrastructure development initially through energy efficiency savings. The substantial financial savings made by reinvesting money saved through energy efficiency measures allowed the council to invest millions in energy supply innovation. The Woking model shows that renewable technologies and cogeneration are highly complementary and lend themselves flexibly to a piecemeal engineering approach as finances allow. (18)

DE goes global

In the same way that mobile phones have allowed many people in developing countries to leapfrog centralised phone networks, DE could allow developing countries to avoid large

expenditure on national electricity grids. The five most important emerging markets for DE are Brazil, China, India, Mexico and Russia. (19)

Brazil has one of the most centralised power infrastructures in the world. In 2005 92% of Brazilian power was generated by remote hydro plants and brought to users by vast transmission networks. However, DE applications are becoming more common in grid connected applications, especially in São Paulo state, partly due to the discovery of natural gas and the increasing use of waste biomass (bagasse) for cogeneration in the sugar industry. [It has been estimated that 11.5% of Brazil's and 25% of Cuba's electricity demand could be met through bagasse cogeneration. (20)] An innovative auction system used in 2005 resulted in 1,099MW of successful bids from CHP and DE plants (845MW natural gas, 157MW diesel and 99MW biomass). Further development of hydro-electricity will be contentious, expensive and have long lead times, so the prospects for DE are good. The share of DE capacity in the Brazilian power sector increased from 3.9% in 2004 to 4.4% in 2005. Abundant biomass reserves and recent offshore natural gas discoveries mean that fuels for CHP are abundant.

China The predominant forms of DE in China are (a) coal-fired cogeneration which provides heat to municipal district heating systems and industrial sites and (b) small-scale hydro electric power. Chinese energy policy is slowly opening up to the opportunity of DE, and the National Development and Reform Commission (NDRC) is considering the introduction of new incentive frameworks for CCHP (combined cooling, heating and power) in 2006 or 2007. Almost 50% of Chinese cities have centralized steam or hot water distribution systems ideal for cogeneration. The World Bank is financing rapid renewable energy development and the Government has a solar energy development plan.

China's level of cogeneration and DE development is above the global average but could be greatly increased as power demand continues to surge. WADE carried out an analysis of China's energy development funded by the UK Foreign and Commonwealth Office. This showed that over the next 20 years a full commitment to meeting growth through DE rather than centralised generation would reduce CO_2 emissions by 56% and save $400 billion. (21)

India The Indian electricity system is notorious for its high losses and much of the existing generation system needs upgrading. Rapid increases in demand for power are exacerbating the problem. Power is under state jurisdiction so developments differ from state to state, but a new Electricity Law passed in 2004, has opened up the grid to decentralised generation, and the potential, especially the use of agricultural wastes, remains high. Cogen India, for example, is working with local distilleries to promote cogeneration. 400MW of bagasse-fuelled DE capacity are under construction in India, and there is increasing investment in small-scale solar and wind power. Increased gas supply means there is competition between centralised Combined Cycle Gas Turbine plants and more efficient cogeneration. Only government policy can shift investment to the more efficient CHP.

Mexico The Mexican power sector remains dominated by the two state-owned utilities, CFE and LYFC, which together generate around 75% of Mexico's electricity, mostly from fuel oil. An additional 316 MW of CHP capacity was installed in 2005 bringing the total to 1,743 MW. In 2004, out of a total of 7000 MW of permits allocated for self-supply projects only 1,500-2,000 MW were issued. Mexico's treasury building installed microturbines in CCHP mode in 3 of its downtown buildings, which could inspire more such investment.

Russia Russia's weak and disconnected power system is providing buoyant conditions for DE systems, with and without heat recovery. There is great demand for district heating and electricity demand is growing rapidly. Most of the current capital stock is old and desperately needs replacement or retrofitting. Around 20-30% of electricity generation is from cogeneration, mostly in association with municipal district heating, with great potential for smaller industrial and commercial DE as a whole. Electricity reforms should promote

competition in the wholesale and retail markets. If successful, reforms of both electricity and gas markets should help provide finance for much needed investment in cogeneration and raise awareness of the potential for other decentralized, on-site options.

Barriers to Decentralised Energy

Despite it many benefits there are still some significant barriers to DE, which vary depending on national circumstances. The centralised system is still dominant and severely limits the way in which electricity is generated and delivered. National governments around the world need to act to promote DE in order to tackle climate change. As the use of the WADE economic model for the UK has shown, implementing a DE energy strategy produces less carbon emissions than the promotion of nuclear power, it is cheaper and requires less dependency on imported fuel. Governments need to remove policy and regulatory barriers to the introduction of DE. In addition they should:-

- Prevent the construction of any new fossil fuel generating plant unless it makes use of heat as well as generating electricity.
- Promote the incorporation of decentralised energy technologies in all new buildings, linked wherever possible to district heating schemes.
- Require utilities to purchase surplus power from DE generators at rates that ensure the development of DE systems.
- Use the tax system to reward DE generators whether it is CHP systems or small-scale renewables.
- Use local and regional government to promote local energy plans which encourage the development of the most appropriate DE systems for each area, such as plans to develop biomass.

Removing the barriers to DE should also involve facilitating the emergence of a new enterprise model – the energy service company (ESCO) which focuses on the delivery of energy services, warmth, light and electric power, rather than trying to sell consumers more electricity and gas. Such a company would be able to offer consumers energy efficiency measures in exchange for a share of the savings, or install a microgeneration package which can be paid for over a number of years, as well as supply electricity and gas.

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