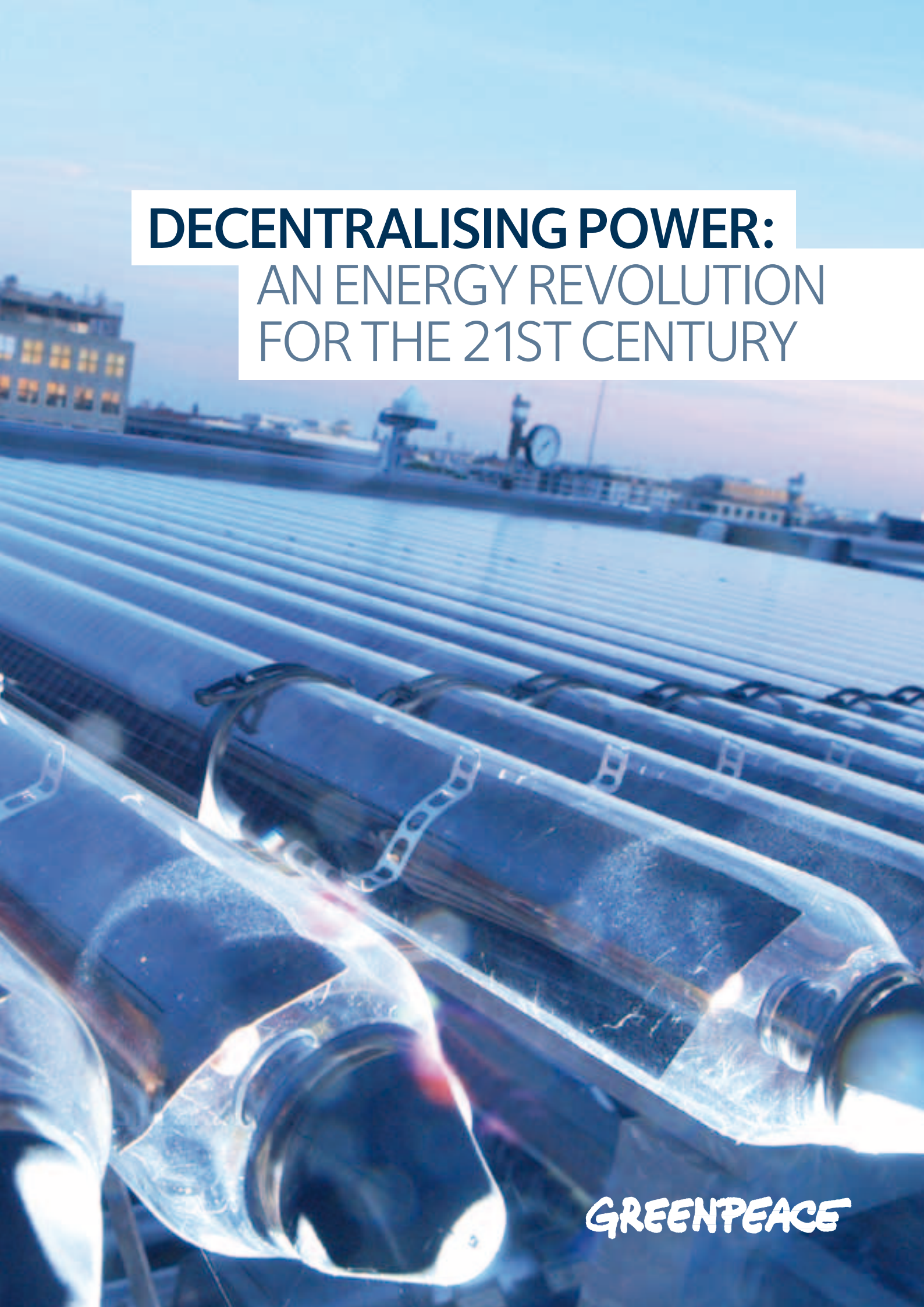
DECENTRALISING POWER:
AN ENERGY REVOLUTION FOR THE 21ST CENTURY



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To tackle climate change, renewable energy technologies, like wind, can be embraced by adopting a DE pathway.
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Cover: Solar thermal installation. ©Langrock/Zenit/Greenpeace.

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FOREWORD

KEN LIVINGSTONE, MAYOR OF LONDON

I am delighted to have been asked by Greenpeace to contribute a foreword to this timely report.

Climate change has now become the problem the world cannot ignore. Addressing future global warming, and adapting to it now, will require making fundamental changes to the way we live. How we produce, distribute and use energy is key to this.

My London Energy Strategy set out how decentralised electricity generation could deliver huge CO_2 reductions in London by enabling the convergence of heat and power generation, leading to massive growth in renewable energy production, and providing the cornerstone of a renewable hydrogen energy economy.

Decentralised energy allows the financial costs and energy losses associated with the long-distance national transmission system to be reduced and savings passed on to consumers. Bringing energy production closer to people's lives helps in our efforts to promote energy efficiency. Security of supply can be improved, with power blackouts reduced. The UK could take the opportunity to develop expertise and technologies, leading the developed world, and facilitating the developing world's path to a sustainable energy future.

In London the opportunities for decentralised energy supply range from solar panels on Londoners' homes, to adapting existing full-sized power stations to more efficient combined heat and power systems supplying thousands of businesses and residential buildings.

To achieve all this we need an energy revolution, overhauling the current regulatory and commercial framework of the electricity industry to incentivise the use of combined heat and power and renewable energy. And, as I know first-hand from the struggle I had in making my house a 'solar home', we need to strip away the bureaucracy and costs that currently dissuade all but the most determined individuals from taking action to reduce their own energy usage.

This is why on June 20th this year I launched the London Climate Change Agency, with a mission to deliver ground-breaking energy efficiency and renewable energy projects across London. I want London to lead Britain and even the world in tackling climate change.

Large, major-energy consuming cities like London have both a responsibility to reduce their carbon emissions, and, by virtue of a high density of population, the greatest opportunity to take advantage of new energy systems and renewable energy. In the Thames Gateway we have the single biggest development opportunity in Europe, and a chance to showcase sustainable building and energy supply.

'Decentralising power: An energy revolution for the 21st century' makes a vital contribution to the debate about how we can do this and I look forward to working with Greenpeace on implementing London's decentralised energy programme.

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FOREWORD

STEPHEN TINDALE, EXECUTIVE DIRECTOR GREENPEACE UK

Electricity production in the UK is responsible for a third of our carbon emissions. This is the UK's single greatest contribution to climate change. It need not be so. Our centralised model of production and transmission wastes an astonishing two-thirds of primary energy inputs, requiring us to burn far more fuel and emit far more carbon dioxide than necessary. It is hard to imagine a more wasteful and inefficient model than that which currently services the economies of the 'developed' world.

In our existing system, electricity is produced in a small number of large power stations, and then distributed to where it is needed. Because the power stations are generally far from centres of demand, much of the heat which is produced when fossil fuels are burnt is not used, but vented up chimneys or discharged to rivers. This heat loss alone represents a wastage of over sixty percent of the total energy released by burning the fossil fuels. Further losses occur as the electricity travels along the wires of the transmission and distribution systems.
In total, the energy wasted at the power station and on the wires is equal to the entire water and space heating demands of *all* buildings in the UK – industrial, commercial, public and domestic. This is a nonsensical way to run our economy and power our lives.

But there is an alternative. In a decentralised energy (DE) system, electricity would be generated close to or at the point of use. Buildings, instead of being passive consumers of energy, would become power stations, constituent parts of local energy networks. They would have solar photovoltaic panels, solar water heaters, micro wind turbines, heat pumps for extracting energy from the earth. They might also be linked to commercial or domestic operated combined heat and power systems.
The massive expansion in renewable capacity that this would represent, and the fact that when fossil fuels were burnt the heat would be captured and used, would lead to dramatic reductions in overall carbon emissions – at least half of all emissions from the power sector, or 15% of total UK emissions.

This radical transformation of our energy system sounds attractive but expensive. But in fact decentralising our energy sources, instead of replacing our current centralised system, may actually save money in the long run. A centralised network of cables is an old technology – and a phenomenally expensive one at that. New low-carbon technologies dictate a different infrastructure. According to the International Energy Agency, the European Union will spend $648 billion on modernising and replacing the transmission and distribution networks. The opportunity to avoid many of these costs means that decentralised energy makes economic as well as environmental sense.

DE also offers a way forward for developing nations and for the emerging economic giants like China and India. It is sometimes claimed, fatalistically, that efforts to stabilise the climate will be overwhelmed by China burning its coal reserves. But developing a decentralised energy system in response to its growth in demand for power would enable China to reduce associated

©Greenpeace/Rezac.

carbon emissions by 56% as compared to the centralised scenario – and costs would be reduced by 40% as well.

Unfortunately, the debate in the UK has focussed more on whether we need a new generation of nuclear power stations. Nuclear power is the epitome of centralised, outdated electricity generation. Replacing existing nuclear stations with new ones would perpetuate the centralised system, entrenching all the costs and inefficiencies that implies. Such inefficiencies currently waste three times as much energy as would be contributed by new nuclear power stations.[1] It is only because of technological apathy – failure by government and industry to invest in real innovative alternatives – that nuclear power is given any serious consideration.

Decentralising energy offers a compelling alternative vision, in which we can both combat climate change and roll back the nuclear threat. To give just one example of the potential, if half the houses in the UK were provided with domestic combined heat and power units, which is technically feasible, then the electricity generated would replace the entire nuclear capacity we have today.

This report sets out a series of reforms that are needed to make the vision a reality, including regulations to require all new buildings to double up as mini-power stations, and a ban on any new fossil-fuel power stations unless they are CHP. These may sound radical, or too dirigiste for some tastes. But as Tony Blair, Michael Howard and Charles Kennedy have all acknowledged in the past year, climate change is the greatest challenge we face. Already a hundred and fifty thousand people die each year from its effects, a figure that will spiral upward unless we curb emissions dramatically and quickly. In the face of such a challenge, radical measures are surely required.

Heat and cooling, as well as electricity, is provided to Woking's leisure centre by a hydrogen fuel cell. ©Greenpeace/Cobbing.

'In the early years of the new millennium, the electricity system, the bloodstream of industrial society, is going to change almost beyond recognition. It will have to.'
Walt Patterson, Royal Institute of International Affairs, UK[2]

EXECUTIVE SUMMARY

Climate change has thrust electricity generation under the political spotlight. Our current centralised electricity system dominates the developed world. Yet it is the embodiment of technological inertia, performing little better today than it did in the 1970s.

The debate over the UK's energy future routinely overlooks an issue that is key to our rising emissions – the huge wastage inherent in our centralised electricity system. Because we generate electricity in large power stations far from our cities, almost two-thirds of primary energy inputs to the system are wasted – partly from the wires that transmit the electricity around the country, but mostly in the form of waste heat from the power stations themselves. If this could only be used rather than lost into the sky, it would be more than enough to meet the entire space and water heating needs of every building in the country. In the face of climate change and mounting security concerns, such wastage is indefensible.

Reform of the centralised electricity system is urgently needed, to put an end to this environmentally destructive wastage. The scope for reducing electricity demand, and thus CO_2 emissions, through energy efficiency measures is widely accepted, if weakly pursued by government. Less well known, but at least as important, is the potential to reduce wastage and emissions by remodelling our electricity system around a decentralised pathway, where energy is produced close to where it is consumed.

A decentralised energy (DE) system has two key characteristics. Firstly, buildings (from terraced houses to industrial units) double up as power stations because they have within them one or more energy generating technologies such as solar panels, wind turbines or cogeneration units. Local impact is important, cumulative impact could be enormous.

Secondly, local energy networks will proliferate, distributing heat and power. These networks will be supplimented by community scale plants generating close to the point of demand. For example cogeneration plants with heat, the by product of combustion for electricity, being captured and distributed for nearby use. This radically improves efficiency and so reduces overall demand, increasing security of supply and cutting emissions.

Decentralised energy – the benefits

Decentralising the UK's electricity system represents our best chance of getting to grips with our greenhouse gas emissions. By enabling the effective use of heat and by establishing a more appropriate infrastructure and regulatory regime which encourages renewables and other low-emission technologies, a decentralised model could halve our electricity system's contribution to climate change within a few decades reducing UK emissions by at least 15%.

In the long run, a decentralised system may also prove cheaper, cutting the need for investment in hugely expensive high-voltage transmission networks. By boosting the market for renewable generation and related technologies, it would also stimulate innovation. It would deliver an electricity supply far less vulnerable to massive system failure as a result of sabotage or extreme weather.

Decentralising energy would also democratise energy, providing real opportunities for local political leadership on climate change, and curbing the influence of the centralised industry's powerful vested interests. By enabling local action and empowering individuals and communities as producers, decentralisation has the potential to bring about a massive cultural change in our attitude to and use of energy.

In global terms, decentralising energy could revolutionise the lives of the billions of people who currently lack access to basic energy services. Decentralised energy is highly flexible, allowing solutions to be tailored to local conditions and be installed much faster than a centralised system. Western governments must rise to the challenge of promoting globally a far more sustainable energy model than they themselves have achieved so far. They have a moral duty (backed up by legitimate self-interest) to incubate and disseminate technologies, skills and knowledge suitable to both international development and tackling global warming.

To summarise, overhauling our outdated electricity infrastructure and pursuing a decentralised pathway would enable the UK to:

- slash CO_2 emissions
- bring down energy consumption levels
- deliver enhanced energy security
- drive technological innovation and real competition in UK energy markets
- foster the inherent economic advantage of renewable technologies
- save consumers money in the longer term
- increase public involvement in tackling climate change
- increase opportunities for local political leadership in the energy sector
- reduce the influence of vested interests
- incubate and export technologies which are safe for global dissemination and urgently required for international development.

Solar thermal installation – an everyday element of a DE solution. ©Langrock/Zenit/Greenpeace.

Barriers to decentralised energy

Despite its many benefits, the barriers to DE in the UK remain immense. Because we have a choice of electricity providers it is perceived that the market is liberalised and competitive. But the reality is that the centralised system severely limits the way in which electricity is generated and delivered. The only real choice is who we buy our centralised electricity from. DE, however, offers a genuine alternative but is largely excluded from the market place due to protectionism, short-sighted and inappropriate regulations and failures in cost and benefit allocation.

This situation reflects the sharp misalignment between the energy regulator Ofgem's remit and the key policy goals set out in the Government's 2003 Energy White Paper. The Government's failure to correct this misalignment in turn illustrates its own fractured approach to energy policy reform, in which a rag-bag of decentralised and renewable energy initiatives are plastered over a fundamentally faulty system. Further obstacles to reform are posed by the centralised energy sector's huge influence in the corridors of power.

Climate change emissions: The centralised electricity system is a prime culprit. ©Greenpeace/Vielma.

Moving to decentralised energy in the UK

Despite all these barriers, there has been significant innovation in decentralised energy in the UK. Networks such as that set up by Woking Borough Council, alongside energy efficiency measures have slashed emissions by 77% and cut energy prices for low-income households, offering important lessons for UK policy-makers.

But much remains to be done to make decentralised energy commonplace. Bold government leadership is required. The time is ripe for change: key parts of the UK's networks and generation capacity are reaching the end of their natural life, and closures should be pursued as a strategic opportunity to remodel our electricity system.

While Ofgem has recently taken some small steps in support of decentralised energy, it should be given an explicit obligation to deliver a fully sustainable energy system within a few decades. The electricity market needs fundamental reform, to promote meaningful competition and to support and stimulate technological advances. At the same time the economic regulation of the electricity sector must be overhauled, abolishing the present system under which network operators are rewarded for continued investment in outdated grid assets, and instead incentivising them to connect decentralised generation and to become active managers of efficient local networks.

Removing the barriers to decentralised energy will facilitate the emergence of new enterprise models, particularly energy services companies (ESCOs) focused on the efficient delivery of local low-emission energy – offering a genuinely competitive and innovative alternative to business-as-usual in the electricity sector.

The UK's ambitious house-building programme presents an exceptional and immediate opportunity to pump-prime the ESCO and DE marketplace. At the same time, established householders and businesses need access to a user-friendly microgeneration package. The public sector, the farming community and industry must also be empowered and incentivised to drive the expansion of decentralised energy, and a range of measures are suggested in the report. In particular, the ceilings on the use of private electricity wires to supply domestic customers, and on electricity exports onto the grid from private wires, should be lifted. These measures should rapidly transform the economics of decentralised energy, strengthening the ESCO and DE marketplace further. Over time this will increasingly allow UK electricity consumers to choose local low-emission power over 'dirty' centralised power.

Electricity is the lifeblood of any modern society, but for too long politicians have allowed its importance to eclipse the wastage and lethargy inherent in our present system. The energy debate is heating up again. If the Government is to make the right choices about future electricity supply, it needs to consider not only better generation technologies, but also how it can revolutionise the entire electricity system.

Winds of change: DE technologies promise an energy revolution. ©Centre for Alternative Technology.

KEY STEPS TO DECENTRALISED ENERGY

Greenpeace calls for:

1. **The Government to use the tax system to reward householders and businesses that install DE technologies such as solar panels, micro-wind turbines or cogeneration systems.** Tax incentives could include reduced stamp duty, council tax or business rates for properties capable of generating their own electricity, and expanded capital allowances for businesses.
2. **All new buildings to be required to incorporate DE technologies.** This would steadily cut emissions from the building stock and enable the retirement of power stations, while also transforming the economics of DE by creating economies of scale and cutting installation costs.
3. **Local sustainable electricity systems to be encouraged through the removal of current limits on the development of private wires.** Limits on the export of power from these sustainable local systems should be raised. Together these measures would enable electricity consumers increasingly to choose clean local power over dirty centralised power.
4. **Local government to become a key player in moving to sustainable energy systems.** There should be area-based CO2 reduction targets, along with a statutory requirement for all councils to develop an energy strategy.
5. **All electricity suppliers to be required to purchase surplus electricity from domestic power generators,** at rates that will ensure the take-off of domestic generation.
6. **Inefficient, centralised power stations to be heavily penalised to reflect the damage they cause and to ensure that the most polluting are closed.** One way to do this would be to tighten up the European Emissions Trading Scheme. In addition, supplementary fiscal measures could be enacted at UK level, such as a tax on waste heat.
7. **No new fossil-fuel generation to be permitted unless it includes cogeneration.**
8. **A nationwide network of biomass or biogas cogeneration plants to be developed,** with Regional Development Agencies playing a leading role.
9. **Energy regulation to be completely overhauled.** Ofgem should be transformed into a sustainable energy regulator with its primary duty being to deliver substantial emissions reductions through the encouragement of DE. BETTA (British Electricity Trading & Transmission Arrangements) should be replaced with a more flexible and responsive system, which encourages genuine competition, and rewards rather than penalises cogeneration and renewables.
10. **The publication of a Decentralised Energy White Paper.** Instead of a new white paper on nuclear power, the Government should pull together all relevant parties to set out the necessary steps for a coherent and rapid transition to a decentralised energy system.

Trigeneration plants supply electricity, heat and cooling. ©Greenpeace/Cobbing

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INTRODUCTION

Climate change has thrust electricity generation technologies under the political spotlight – with the burning of fossil fuels highlighted as the major source of greenhouse gas emissions, and renewable energy sources in particular being proposed as emission-free alternatives that could still save us from the worst consequences of global warming. Yet animated debate over our energy future routinely overlooks the fact that the UK's reliance on large-scale centralised fossil-fuel power generation means that it currently wastes nearly two-thirds of primary energy inputs into the electricity system. This wasted energy corresponds to one fifth of total UK carbon dioxide (CO_2) emissions,[1] and is equivalent to two-thirds of the UK's entire North Sea gas output,[3] or to the combined thermal energy demand of every building in the country.[4] Clearly, business as usual in the electricity sector offers a very poor benchmark against which to debate the merits of future technology options. More fundamental questions need to be asked about the nature of our electricity system. Without an integrated critique, Greenpeace believes that the UK is in danger of sleepwalking into an energy future dominated by expensive and outdated technology that will not deliver the radical reductions in CO_2 emissions urgently needed to combat climate change.

67% of primary energy input is wasted in the current global centralised model of power generation

20% of the UK's CO_2 emissions results from energy wasted in the current centralised fossil fuel power generation

In response to this challenge, Greenpeace presents here the growing case for a decentralised electricity network. Technological advances over the past 30 years[8] suggest an optimum model of electricity supply and distribution entirely different to that which dominates today. Indeed, a centralised system, with centralised rules, now presents a major obstacle to capturing the benefits of technological progress, particularly in the fields of renewables and cogeneration (combined heat and power). Opportunities to implement a fresh approach are imminent, since key parts of the UK's energy infrastructure are reaching natural obsolescence.

While this report focuses on the potential for emissions reductions achievable (among other benefits) through a transformation of the existing electricity generation and supply model, the importance of demand reduction through energy efficiency measures at the point of use must not be forgotten. In the context of this report, which sets out the case for a more efficient and therefore environmentally sustainable electricity supply, it should be appreciated that the robust pursuit of demand reduction through strong fiscal instruments would serve to enhance further the already substantial benefits of decentralised energy (DE). The strong synergies between DE

'The technology exists to enable a radical overhaul of the way in which energy is generated, distributed and consumed – an overhaul whose impact on the energy industry could match the internet's impact on communications.'
The Economist Technology Quarterly[5]

DE technologies, such as micro wind turbines, can be incorporated into all new building designs. ©Greenpeace/Davison.

and energy efficiency are explored further in Part I. Ultimately what is needed is a whole-system approach to the future of the energy sector. Where electricity is concerned that means considering the cost not just of generation but of delivery infrastructure, energy efficiency (or the lack of it) and environmental and social externalities. It also means considering electricity in the wider energy context – particularly in relation to capturing the heat associated with electricity generation involving combustion processes.

'The current power infrastructure is as incompatible with the future as horse trails were to automobiles.'
Kurt Yeager, President, Electric Power Research Institute[6]

In Greenpeace's vision of a DE future the old energy sector has been shaken by a real competitive threat and is adapting to survive. Coal-fired power stations have been closed and their surrounding webs of pylons dismantled, restoring swathes of countryside – though a skeleton grid remains, to enable demand-balancing energy flows between regions mostly self-sufficient in energy from a diverse array of sources. A wide range of new energy actors has been empowered to exploit the competitive and environmental advantages of local generation. Vibrant markets have developed in low-carbon energy technologies at the local and community level. New and existing buildings make use of localised and/or on-site generation, owned by occupiers themselves or perhaps by a commercial energy services company (ESCO).[iii] Architects strive to minimise building energy demand to reduce outlay on generation plant and running costs. Heat and power networks run underground, some municipally owned, linking houses, hospitals and business parks. Thermal stores occupy the basements of public buildings, balancing heat loads, while local electricity flows are balanced by computer systems operated remotely by the thriving energy IT sector. Developers explore local renewable energy options as a preliminary to new housing schemes and consider whether to contract out the energy infrastructure implementation and maintenance to the fiercely competitive ESCO marketplace.

'Between the substation and the end-use consumer appliance is a business and technology no-man's-land ripe for innovation.'
Vernon L Smith, Nobel Prize-winning economist[7]

Regional and local government only approve planning applications which avoid the costs to consumers of centralised grid expansion and which meet stringent regional CO_2 emissions targets agreed with national government. Farmers routinely take their slurry and biomass crops to the local cogeneration plants serving rural towns and villages, while in urban centres biodegradable household and food industry waste powers local biogas plant. Energy demand has fallen, as people understand where their energy comes from and take care to conserve it – not least to reduce their own household bills or business overheads. The UK, having led the world in the centralised energy paradigm, is now leading the way out. UK businesses are striving to keep up with the demands of a huge international market for DE products and services, particularly in what was formerly known as the Third World.

77% of Woking Borough Council's CO_2 emissions were slashed by setting up DE networks and instigating energy efficiency measures.

Decentralising power in this way will require a strategic evolution in the existing physical, regulatory and institutional architecture of the energy sector. It will also require the urgent empowerment of new actors in energy generation, such as householders, local authorities, ESCOs and the construction sector, who can deliver early wins. Even if the existing electricity industry accepts the need for radical reform – and parts of it do – it is by releasing the genuinely competitive threat represented by DE technologies and DE enterprise models (particularly ESCOs) that overarching industry and regulatory reform will be made an urgent necessity. Climate change demands speedy action, and those willing to pursue an enterprise model fit for the challenges of the 21st century must be enabled to set the pace and shape of change.

Understanding energy: Locally supplied power at Woking's leisure centre raises awareness and drives energy efficiency. ©Greenpeace/Cobbing.

Incremental reforms negotiated with existing energy stakeholders will not get us far – particularly while no real alternative to centralised generation is allowed to exist. A DE future thus demands a highly proactive government stance towards energy policy. This year's Climate Change Strategy Review, the Microgeneration Strategy, the Sustainable Communities agenda, the Building Regulations revisions and the replacement of the Distributed Generation Co-ordinating Group with the new Electricity Networks Co-ordinating Group present current or imminent opportunities to develop the ambitious and strategic policy approach climate change demands. Most importantly, activities in all these areas should mutually reinforce and expedite the DE vision, as clearly set out in the enlightened 2003 Energy White Paper.

The energy generation and distribution model we advocate will not only tackle indefensible system wastage, but also deliver on much wider energy policy objectives – not least the four primary objectives of the 2003 Energy White Paper, namely to:

- put the UK on track to reduce CO_2 emissions by some 60% by 2050;
- maintain the reliability of energy supplies;
- promote competitive markets in the UK and beyond; and
- ensure that every home is adequately and affordably heated.

'The nationwide and local electricity grids, metering systems and regulatory arrangements that were created for a world of large-scale, centralised power stations will need restructuring over the next 20 years to support the emergence of far more renewables and small-scale, distributed electricity generation.'
Energy White Paper, 2003[8]

PART I: DECENTRALISED ENERGY AND ITS BENEFITS

WHAT IS DECENTRALISED ENERGY?

Decentralised energy[iv] (DE) is energy generated at or near the point of use. Britain's energy regulator, the Office of Gas and Electricity Markets (Ofgem), defines DE as energy produced by generating plant of under 50MW 'connected to a local distribution network system, rather than to a high voltage transmission system'.[9] However, DE can technically involve the use of generators with an output up to 100MW, which do not require use of the extensive high-voltage[v] electricity grid, but need only use the smaller low-voltage[vi] local networks supplying homes and offices. The proximity of electricity generating plant to energy consumers allows any waste heat from combustion processes to be piped to buildings nearby (a system known as cogeneration or combined heat and power) so that nearly all the input energy is put to use – not just a fraction as with traditional centralised fossil-fuel plant. DE also includes stand-alone systems entirely separate from the public networks. In industrial applications it can involve plant with a much larger output than 100MW – currently invariably cogeneration plant – where all the heat is consumed onsite by industrial processes and any surplus electricity is sold on.

Smaller-scale DE is referred to as 'microgeneration'.[vii] The term suggests a very small output, but the largest microgenerators can provide base load power sufficient for approximately 50 average UK homes. The efficiency of DE technology is often optimised at the community level. For example cogeneration technology can achieve greater efficiencies when scaled to meet the energy demands of a street, rather than an entire city or conversely a single household. Furthermore the performance of many DE technologies needs to be considered not in isolation, but in the context of wider DE energy systems deploying a mix of complementary technologies.

DE technologies supported by Greenpeace include the full array of renewable options suitable for deployment on local networks: photovoltaics, biogas and biomass cogeneration, and geothermal, wind, wave, tidal and small-scale hydroelectric power. Greenpeace also supports natural gas cogeneration as a bridging technology able to achieve input/output energy efficiencies of over 90%. While remaining firmly tied to the promotion of renewable sources of energy, Greenpeace appreciates that gas, used in an appropriately scaled cogeneration plant, is valuable as a transition fuel, able to drive cost-effective decentralisation of the energy infrastructure. With warmer summers trigeneration, which incorporates heat-fired absorption chillers to deliver cooling capacity in addition to heat and power, will become a particularly valuable means to achieve emissions reductions. DE technologies supported by Greenpeace also include dedicated heating technologies such as ground source and air source heat pumps, and solar thermal and biomass heating. These can all be commercialised at the domestic level to provide sustainable low-emission heating.

DE technologies are disruptive technologies because they do not fit the way the existing electricity market and system operate.[10] With appropriate changes in the system and the regulatory regime, they have the potential for exponential growth, promising 'creative destruction'[viii] of the existing energy sector. Once the advantages of DE are appreciated and the barriers to expansion overcome, the take-up of DE technologies will accelerate rapidly, revolutionising the way we generate and supply energy. By no means all DE technologies are in their infancy, although some are at the cutting edge. Many, including gas turbines and reciprocating engines, have a track record established over decades and are manufactured all over the world. Thus the technological basis for an affordable and rapid expansion of the DE sector is already in place.

Photovoltaic facility from inside Greenpeace offices in Hamburg. ©Greenpeace/Vielmo.

Air conditioning on the roof of Woking's leisure centre, powered by a trigeneration plant that offers cooling for extra emission savings. ©Greenpeace/Cobbing.

Global adoption of DE is needed to tackle climate change and support development. ©Gemmel/Shell.

Royal approval: two cogeneration plants power Buckingham Palace, and will save 19,000 tonnes of CO_2 emissions over their lifetime. ©Alisdair Macdonald/Rex Features†

DE is not simply a concept – despite substantial barriers to adoption it already provides significant amounts of electricity (contributing around 5% of the UK supply[11]) and heat. Well over 1,000 cogeneration plants power hospitals, leisure centres and households around the UK. Nearly half of all councils have taken steps to support local renewables development and 8% already have, or are establishing, municipal ESCOs (see Box 1).[12] Following the lead of Merton Council in London, over 40 local authorities are considering the introduction of a compulsory contribution from DE technologies to the energy needs of new commercial buildings.[13] However, DE is considerably more advanced among some of our European neighbours. Changes to energy sector rules over 20 years ago have allowed Finland, the Netherlands and Denmark to meet, respectively, 35%, 40% and 50% of national electricity demand through DE today.[14] For example, 98% of Greater Helsinki is supplied with locally generated heat through community heat networks.[15] The best example of municipal DE innovation in the UK is provided by the town of Woking (see Box 2) although notable schemes exist elsewhere, for example in Southampton.

30% of UK CO_2 emissions is from electricity production

40% of national electricity demand is met by DE in the Netherlands

5% of UK electricity is currently supplied by DE technologies

Box 1: Energy services companies (ESCOs)

Inefficient energy production and wasteful consumption patterns create room for improvement that translates into potential cost savings. ESCOs originally evolved to exploit that potential. Recognising that most consumers (whether companies, public bodies or private individuals) do not have energy management as their primary concern or competence, ESCOs contract with customers to realise these potential cost savings, sharing the benefits both ways. The customer pays less for energy services such as heating, lighting and power, while the ESCO makes a profit. However, today's market is driven, not just by cost savings, but increasingly by the demand for low-carbon energy, and ESCOs have developed their offer in response to this. The reduction of CO_2 emissions, rather than that of energy consumption per se, increasingly dictates the services ESCOs provide. Commercial customers in particular are keen to be seen to be 'green'.

There are two closely related approaches to ESCO contracting: **delivery contracting** which entails the installation and operation of an energy supply, and **energy performance contracting** which focuses on energy efficiency measures in the customer's building(s) to reduce demand. ESCOs have yet to take off in some key sectors in the UK, but have enormous competitive potential, given our antiquated supply models and inefficient utilisation of energy. Delivery contracting ESCOs sometimes work at the community scale, delivering and operating an appropriate infrastructure to service a large number of users. They can also work at an individual customer level, fitting and maintaining microgeneration plant in a house or office. While energy performance contracting has huge potential for demand (and therefore emissions) reduction, it is delivery contracting that is most relevant to DE expansion.

How might delivery contracting ESCOs work at the community level?

- An ESCO either agrees energy delivery partnerships with individual companies or housing developers, or seeks 'pools' of buildings such as the collective stock of a local authority or perhaps a street or village.
- Once it has assessed a potential client's needs, the ESCO offers an energy delivery contract with attractive terms for the delivery of low-emission heating, lighting, power, air conditioning and/or refrigeration, over a specified period of years. Once the terms have been agreed, the ESCO organises and oversees all necessary works to the building(s) (which may include energy efficiency measures) and the energy supply.
- The client pays for the energy services, while the ESCO focuses on how to deliver those services as efficiently as possible to maximise profits and/or environmental benefits.
- Energy costs to a property are thereby minimised, as are emissions to an extent depending on the technologies used.
- The cost of providing an energy service is guaranteed by the ESCO, so the client cannot lose out, and the financial risk to the ESCO ensures a focus on delivering energy by the most efficient and/or low-emission means, depending on the terms of the contract.
- When this approach is twinned with enforced zero-emission development standards for new buildings, they represent a powerful combination of drivers for incredibly high efficiencies and very low emissions.

How might delivery contracting ESCOs work at the individual level?

- The ESCO and the customer enter into a contract under which the customer undertakes to procure power and/or heat from the ESCO over a specified period of time.
- The ESCO installs a microgenerator in the customer's building, at no expense to the customer. The microgenerator remains the property of the ESCO.
- The ESCO maintains, and if necessary replaces, the microgenerator and all other equipment necessary to fulfil its obligations under the contract.
- The customer thus avoids any capital outlay and incurs no ongoing maintenance costs.
- By undertaking initial energy efficiency measures in the building – improving insulation, for example – the ESCO can minimise the required output capacity of the supplied microgenerator, thus increasing its own profits.

Box 2: The key lessons from Woking[16]

Woking Borough Council has pioneered a network of over 60 local generators, including cogeneration and trigeneration plant, 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 Woking energy model produces dramatic savings in energy use and greenhouse gas emissions. With further help from energy efficiency measures, the council has reduced CO_2 emissions associated with the operations of its own estate, including social housing, by a staggering 77% over just 15 years. Some sophisticated engineering solutions have been deployed, including large thermal stores in the town centre car park and at the leisure centre at Woking Park. The balancing of the system is performed entirely by computer, and the control system can be readily accessed by remote engineers or council officers.

The generators are connected to users via private electricity wires owned and operated by Thameswey Energy Ltd – a company set up and partly owned by Thameswey Ltd, a municipal energy and environmental services company itself wholly owned by Woking Borough Council. These private wires[ix] have points of connection to the local distribution networks (in turn connected to the national grid), but in 2003 the council's electricity infrastructure was 99.85% self-sufficient. In the event of a grid power cut the system can switch to island generation mode, meaning businesses and householders connected to the private wires continue to be supplied with electricity with only a short interruption while the system disconnects from the dead grid and restarts using a small black start generator (a generator which can start up with no external power input).

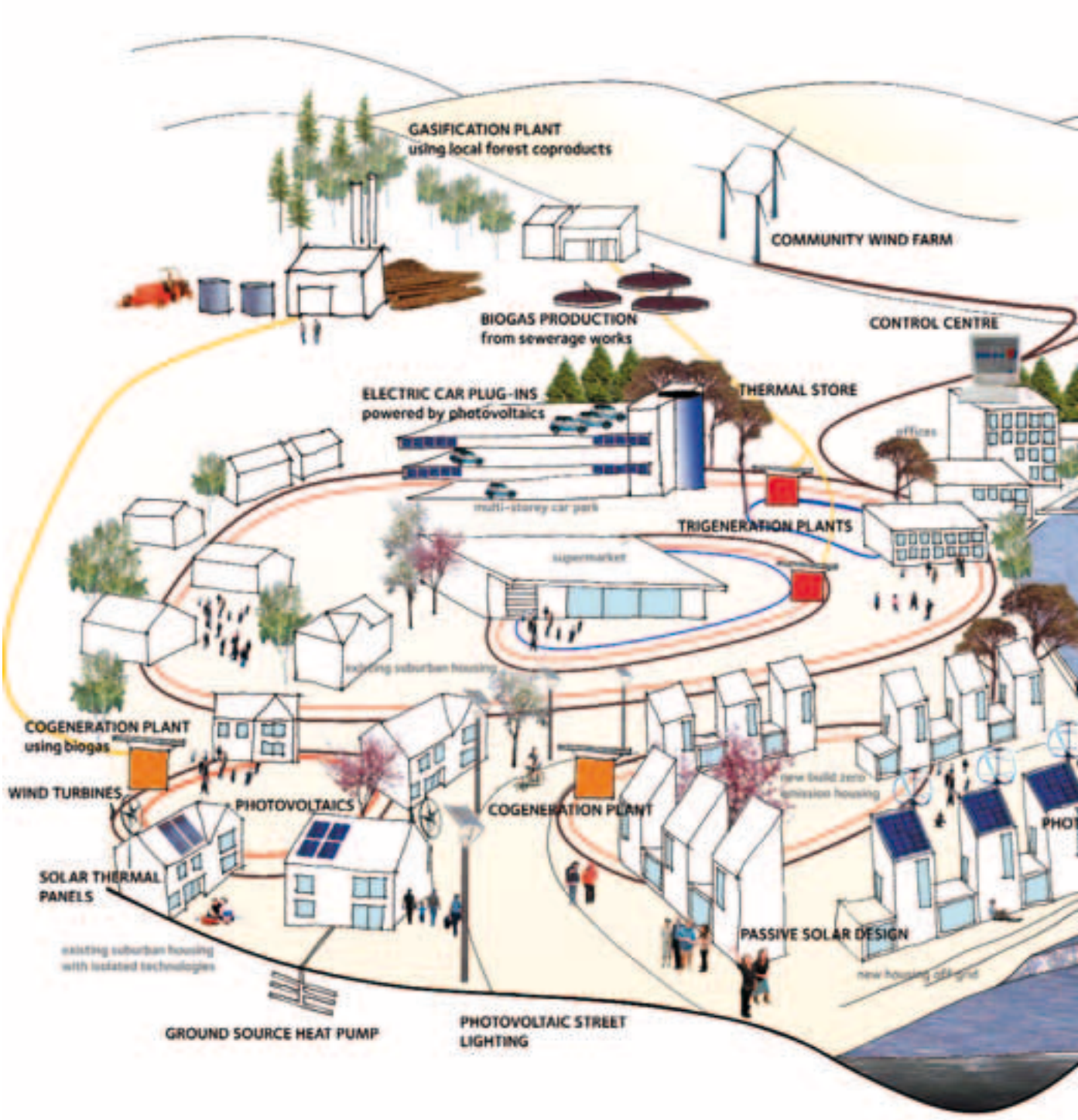
Woking was able to raise capital for energy infrastructure development initially through energy efficiency savings. A fund mechanism was established in a benchmark year for energy expenditure, against which savings accruing from energy efficiency measures were recycled, year on year, into further energy-saving initiatives. The substantial financial savings allowed the council to invest millions in energy supply innovation. Moreover, Thameswey Energy Ltd has attracted investment from Danish pension companies who recognise the steady low-risk return the initiative offers – energy systems like Woking's are a common component of investment portfolios for pension and insurance companies across Europe.

Developing a private network enabled Thameswey Energy Ltd to avoid charges usually associated with the use of the grid (see the pie chart on page 31). By circumventing these costs, it has been able to fund wires and generation to deliver low-emission electricity in competition with conventional suppliers. For domestic customers in social housing, Thameswey provides electricity below the rate of other electricity suppliers as part of Woking Borough Council's fuel poverty programme. The council estimates that it supplies heat and power to potentially fuel-poor households for 6–7% of the state pension – well below the 10% threshold of all household income spent on heating that the Government uses to define fuel poverty.

While the Woking model is widely celebrated in energy circles, its significance for UK energy policy has yet to be fully appreciated. It shows that renewable technologies and cogeneration are highly complementary and lend themselves flexibly to a piecemeal engineering approach as finances allow. The key lesson from Woking is that, liberated from the constraints of centralised rules and infrastructure, cogeneration and renewables can assert their own competitive potential.

'[Woking] has been able to extract the true economic benefits of combined heat and power and renewable energy technologies.'
Allan Jones MBE, London Climate Change Agency (former Energy Services Manager, Woking Borough Council)[17]

Housed under a car park Woking's cogeneration and trigeneration plants heat, power and cool businesses and shops in the town centre. ©Greenpeace/Cobbing.



DECENTRALISED ENERGY FUTURE – TODAY'S TECHNOLOGIES

Existing technologies, applied in a decentralised way and combined with efficiency measures and zero emission developments, can deliver low carbon communities as illustrated here. Power is generated using efficient cogeneration or trigeneration technologies with the heat (and sometimes cooling) plus electricity distributed via local networks. This supplements the energy produced from building integrated generation. Energy solutions come from local opportunities at both the small and community scale with this town making use of – amongst others – wind, biomass and hydro resources. Natural gas, where needed, can be deployed in a highly efficient manner. Private wire electricity networks deliver power in the town but are connected to neighbouring networks and the national system to allow for export and import and to assist in security. This town's decentralised system is flexible and able to adapt to future circumstances. More importantly it can be constructed relatively swiftly using technologies available today. ©Greenpeace/breeze.

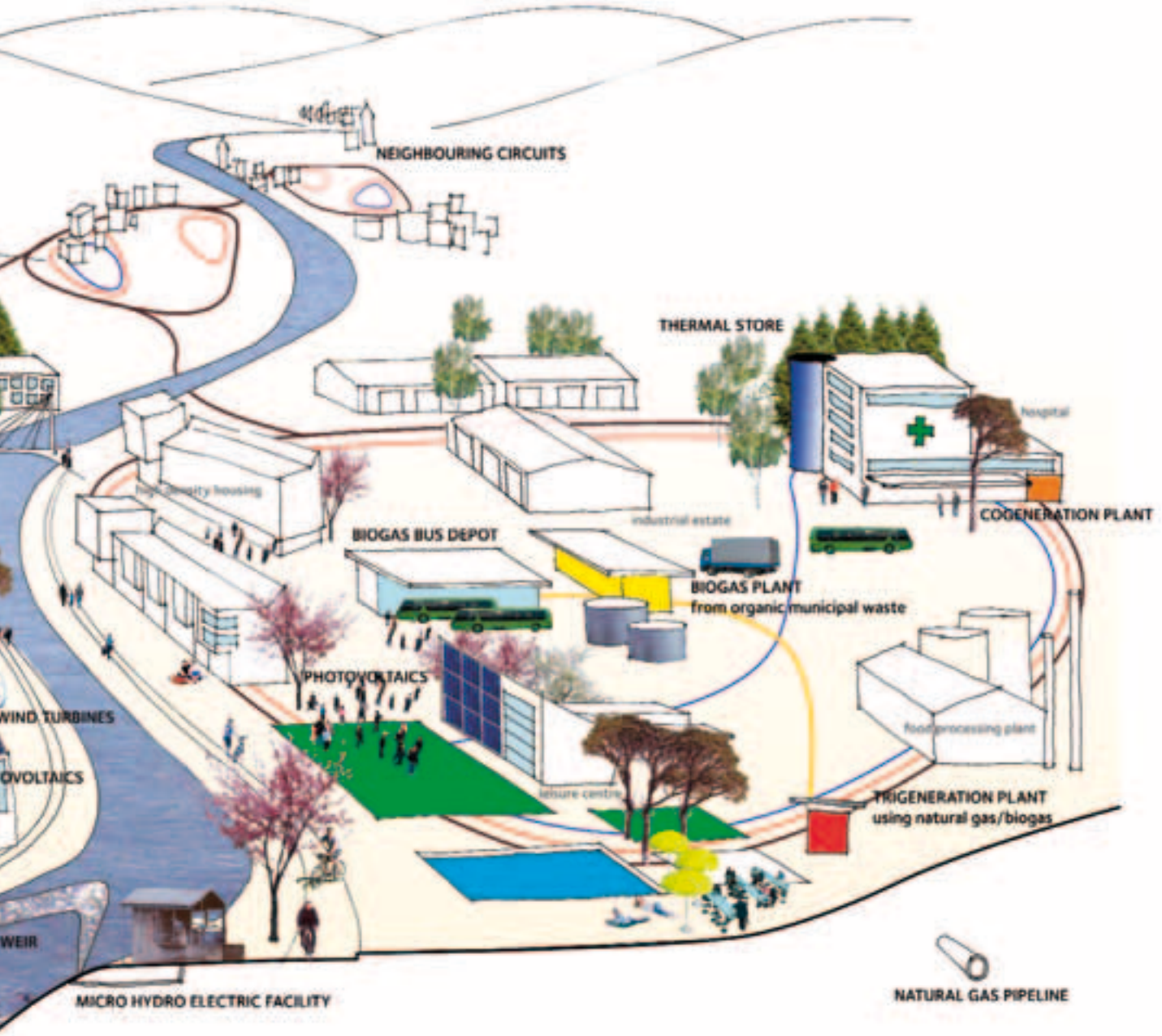


illustration: breeze | www.breeze-scape.co.uk

CENTRALISED GENERATION: WHY IT IS OUTDATED

Current electricity generation relies on burning fossil fuels such as coal, oil and natural gas, with associated CO_2 emissions, in power stations which lose a great deal of primary input energy in waste heat – as can be seen by the steam plumes that emerge from their cooling towers. These very large power stations (typically rated at 1GW), along with nuclear power plants, supply electricity into the high-voltage grid, for transmission around the country and distribution, via 12 lower-voltage distribution networks,[x] to homes, offices and industry.

However, this system, developed in the 1940s around remotely situated coal mines, relies on a lot of cables and expensive infrastructure (pylons, sub-stations, etc) to transmit and distribute the electricity. In addition to the huge amount of energy wasted in the power stations themselves, more is lost in the cables which move the power around and the transformers which convert it from the high transmission voltage to intermediate distribution voltages, and ultimately to one suitable for domestic or commercial consumers. The system is also innately vulnerable to disruption: localised technical, weather-related or even deliberately caused faults can quickly cascade, resulting in widespread blackouts. Whichever technology is used to generate electricity within this old-fashioned configuration, it will inevitably be subject to some, or all, of these problems.

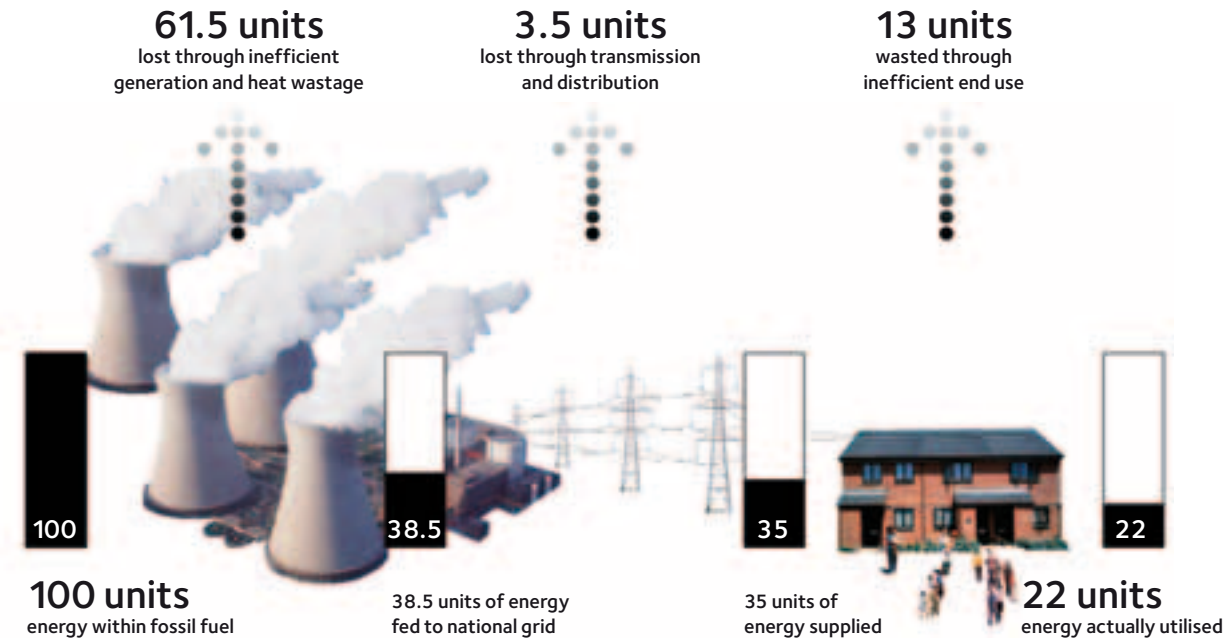
The centralised grid model, first pioneered in the UK, has been duplicated around the world. As a result, 93% of electricity worldwide is supplied through centralised generation and distribution, resulting in wastage of 67% of primary energy inputs into electricity systems around the globe[18] – energy which, if deployed efficiently, could supply existing world electricity demand nearly twice over.

22% of primary energy input is eventually used in the home – the rest is lost in the centralised system and wasted through domestic energy inefficiency

Moreover, in the UK the electricity system contributes around a third[xi] of total national CO_2 emissions.[19] As well as massively reducing the wastage of energy and resources, a move to a decentralised system presents the opportunity to halve associated CO_2 emissions through improving the efficiency with which we power our homes and economy. Add to that the well-rehearsed potential for reductions in energy consumption from efficiency measures at the point of use, such as energy-efficient light bulbs, and it becomes clear that a 'super-efficiency' approach could deliver staggering cuts in emissions – as Woking has demonstrated.

1930s based technologies are clearly unfit for the challenges of the 21st century. ©Langrock/Zenit/Greenpeace.

'We can be pretty certain what unsustainable electricity looks like – it looks like most of the world's present-day electricity systems.'
Walt Patterson, Royal Institute of International Affairs, UK[20]



Centralised energy – yesterday's technologies: Centralised energy infrastructures waste more than two thirds of the energy available from fossil fuels. Inefficient end use makes this situation worse. ©Greenpeace/breeze.

'The US power industry achieves the same 1960 level of 33% delivered efficiency. The same picture largely describes the worldwide power industry. What could better define stagnation?'
Tom Casten,
US DE entrepreneur
and campaigner[21]

82% of UK domestic energy use is for space and water heating

3 times more energy is put in to the centralised model than is demanded by consumers.

93% of electricity worldwide is supplied through centralised generation, with just 7% through DE

The rewards to be reaped under a centralised model through increasing the size and thermal efficiency of power stations peaked in the 1970s. Combined Cycle Gas Turbine (CCGT) power stations offer some scope for further improvement – they now achieve average efficiencies of 45%[22] (with efficiencies of up to 55% being theoretically possible). But the relatively good threatens to be the enemy of the best: CCGT power stations still fall far short of the efficiencies and other benefits achievable under a decentralised system. The average efficiency of UK power stations in 2004 stood at 38.5%,[23] negligibly better than in the 1970s, with a further 8.5%[24] of the electricity loaded onto the grid lost in transmission and distribution to consumers, giving a total wastage of 64.8% of the original input energy. By the time power reaches UK homes, barely more than a third of the initial primary input energy is delivered as potentially useful energy (see diagram opposite). At this point further energy is wasted through the use of inefficient domestic appliances. Using UK domestic energy efficiency averages[25], just over one fifth of the original primary energy will be turned into useful energy in the home.

Todays DE technnologies offer a real potential for the future. Moving from a wasteful centralised system along a decentralised pathway requires an energy revolution. ©Nimtsch/Greenpeace.

'It is this inefficient provision of heat that lies at the heart of Britain's energy problems.'
Chris Hewett, IPPR[26]

'Each new announcement of an investment in a CCGT [combined cycle gas turbine] with no heat recovery tells us that the electricity industry is not yet on a least-cost path – it's an expensive lost opportunity that will be with us for the next 30 years.'
Michael Brown,
Director, World Alliance for Decentralised Energy[27]

Most primary input energy into the centralised system is wasted through heat loss at the point of generation – yet 82% of domestic energy use and 64% of commercial energy use in the UK is for space and water heating.[28] It would clearly be desirable to meet as much as possible of this demand by capturing and distributing the heat that is currently wasted in the generation and transmission processes. However, heat capture demands more localised generation, since it is expensive and inefficient to transport heat over significant distances – heat networks are more expensive to deliver than gas networks.[xii] Nevertheless, there are already over 600 community heating schemes in the UK, and it has been demonstrated that there are millions of homes and public buildings[29] in areas of high-density heat (and heat-to-cooling) demand for which heat networks would be cost-effective, cutting heating bills and CO_2 emissions.

The environmental benefits DE offers are urgently needed. Most important of all is the opportunity DE presents to cut greenhouse gas emissions. Renewables and cogeneration offer the potential for dramatic overall emission cuts and are best exploited through a decentralised model. Biomass and biogas plant can have short supply chains, provided they procure local fuel sources to further reduce their environmental impact; while other renewable power generators such as wind and photovoltaic systems dispense with the need to procure any energy feedstock, making these technologies highly appropriate for local applications.

Open cast coal mining: DE would reduce the devastation of landscapes by reducing fossil fuel extraction. ©Arnold/Visum/Greenpeace.

DECENTRALISED ENERGY: ENVIRONMENTAL BENEFITS

The World Alliance for Decentralised Energy (WADE)[xiii] has calculated that if the world were, henceforth, to pursue a decentralised approach to the replacement of ageing infrastructure and growth in demand, the projected increase in associated emissions could be almost halved by 2020 as compared to a business-as-usual trajectory.[30] The Tyndall Centre, in an exploration of microgrid engineering and economics,[31] has concluded that it would be both technically feasible and cost-effective to meet the present energy needs of UK households through a combination of battery storage, cogeneration and photovoltaics linked through local microgrids. A ballpark calculation of associated emission reductions done for Greenpeace by Cambridge applied economist Jonathan Kohler, one of the authors of the Tyndall Centre's report, suggests that emissions associated with household energy demand would be cut by two-thirds.[32] DE offers other environmental benefits. Some are associated with reduced fuel use, including reduced emissions of sulphur and nitrogen oxides and particulates.[33] DE could ease pressures on rural landscapes, including the harmful environmental impacts associated with extracting fossil fuels and uranium around the world. DE technologies also require little or no water for their operations,[xiv] thus enabling precious supplies to be conserved – another important consideration given anticipated climate change impacts. All centralised fossil-fuel and nuclear power stations require vast volumes of water for their operations – indeed nearly half the fresh water used in the UK is used by power stations,[34] and although most of this water is returned to rivers for example (rather than being dissipated as steam) there are still supply implications for regions with declining rainfall. Such regions include London and the South-East where water shortages are already a concern.[35]

'There is a growing consensus among experts in the field that, in the longer run, hydrogen powered fuel cells will eventually assume dominance and become the energy leader in the distributed generation market.'
Jeremy Rifkin, President of the Foundation of Economic Trends, Washington[36]

While DE offers considerable immediate environmental benefits, in the longer term a DE pathway has particular strategic value because it is the most efficient model for supporting the growth of the renewable hydrogen economy, with all that this promises in terms of revolutionising the generation, storage and transportation of energy. Hydrogen is already produced in quantities approximately equivalent (in energy terms) to 10% of world oil production.[37] However, in order to reap its environmental (and economic) potential, hydrogen must be manufactured using renewable sources of power and deployed in fuel cell technologies suitable for domestic, business and transport applications. The inherently decentralised nature of renewables means that hydrogen produced using renewable energy could potentially render obsolete the expensive centralised infrastructure required by fossil fuels, a fact not lost on car industry analysts in relation to its transport potential. Indeed a study for the Ford Motor Company and the US Department of Energy illustrates the lower cost of localised as opposed to centralised hydrogen generation[38] – hardly surprising when one considers the likely expense of a national dedicated pipeline infrastructure (considered in the study) or the specialist road transport and storage costs associated with a bulky gas.

Fuel cells come in flexible modules which can be scaled to meet power demand. They are currently expensive, but are already acknowledged to be highly reliable.[39] Experts believe hydrogen fuel cells will come to dominate the DE market.

50% of global CO_2 emissions from power generation could be cut by adopting a DE pathway

Centralised power stations consume vast amounts of water – DE would reduce water consumption.
©Langrock/Zenit/Greenpeace.

For Greenpeace the environmental and climate security benefits of DE are paramount. Yet these represent just one element of the substantial benefits DE can deliver. Set out below are the further advantages of the DE pathway: economic, security-related, political, cultural and social.

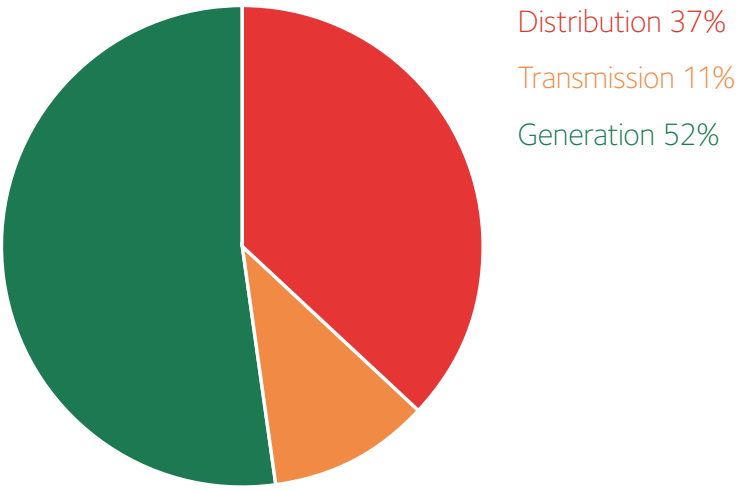
DECENTRALISED ENERGY: ECONOMIC BENEFITS

Interest in the economics of a DE model now has global momentum, with establishment bodies such as the Organisation for Economic Cooperation and Development (OECD)'s International Energy Agency (IEA) appreciating the economic benefits of DE.[40] So what is it that makes the DE pathway potentially cheaper? One of the major costs within the centralised electricity system is that represented by the high-voltage transmission and distribution networks. While the capital costs of generators under a DE system may be higher per unit output depending on the technologies used, generation costs can be offset by reducing the need for repeated investment in hugely expensive transmission networks. Investment in parts of the distribution networks can also be reduced (although other parts will require substantial investment if they are to be adapted to handle locally generated power). Transformation of the networks towards the DE model would in turn transform the economics of renewables in particular, revealing their inherent economic advantages: the wide geographical distribution and abundance of renewable energy sources means many renewable generation technologies can offer relatively minimal dependency on the expensive infrastructure that fossil fuels require to generate and distribute energy.

Such infrastructure is inherently wasteful, as it is scaled to meet short periods of peak demand. Billions of pounds worth of network assets are specified around the electricity demands of that Cup Final half-time moment when kettle switches are flicked in their millions. This overspecification is exacerbated by the fact that centralised network losses increase greatly (to as much as 20%) as a result of cable overheating at times of peak demand – meaning that centralised generation assets have to be further overspecified to compensate. A DE model offers a more flexible, efficient, and cost-effective alternative: back-up local generation capacity can simply be brought onto local networks in response to moments of peak demand. As a result, under the DE solution, while extra generation capacity still needs to be specified to meet the demand peaks, the overall assets required and costs involved are considerably smaller, not least because the problem of 'hot wires' is avoided. Furthermore, some DE technologies, most clearly cogeneration,[xv] have the potential to 'shave' demand peaks, reducing the need for local back-up (or over-specified grid assets) because their energy profile closely matches energy use patterns.

IEA's analysis of the $1.35 trillion investment sum which it estimates will be required by the EU electricity sector to 2030 demonstrates that nearly half of that sum – $648 billion – will be absorbed by transmission and distribution.[41] In the UK, Ofgem has approved nearly £6 billion of expenditure over the next five years by distribution network operators (DNOs – the managers of local grids) alone, ultimately to be recouped through electricity bills.

Another IEA analysis,[42] considering an alternative global energy scenario with 'considerable' potential for world-wide emissions reduction, shows that energy policies incorporating decentralised cogeneration, renewables and energy efficiency measures could deliver global cost savings of the order of $2.7 trillion as against an estimated expenditure of $16 trillion to 2030 under the business-as-usual model. While this scenario predicts that generation costs would be higher given higher proportions of renewable generation, it also anticipates savings of 40% in transmission costs and 36% in distribution costs – potentially cutting overall costs by as much as 20% compared to the business-as-usual scenario, depending on the technologies used. In the USA, the energy sector has woken up to the fact that half of its $30 billion annual investment spend is associated with transmission and distribution[43] – and as a result DE scenarios undertaken by industry players in the USA are now kept confidential on account of their commercial potential.



Europe's electricity sector investment: Transmission and distribution will absorb nearly half of total EU electricity sector investment to 2030.
SOURCE: International Energy Agency, World Energy Investment Outlook, 2003

Photovoltaic installation at an inner city playground, London. ©Greenpeace/Davison.

'Intermittency is not a "flaw" or a shortcoming as traditional "reliability" concepts imply. On the contrary, requiring a system to always deliver generation that matches a fleeting peak load gives rise to a set of generation and network assets that are invariably drastically overspecified and underemployed, a situation long overdue for frontal attack by innovative policy.'
Dr Shimon Awerbuch, economist, Tyndall Centre, Decentralisation, mass-customisation and intermittent renewables in the 21st century[44]

'As long as they remain embedded in a conventional framework for energy generation, providers and consumers of energy from renewable sources will continue to pay the costs of fossil fuel supply and distribution networks.'
Herman Scheer, President, EUROSOLAR[45]

$80 billion of power failures costs the US economy dearly each year

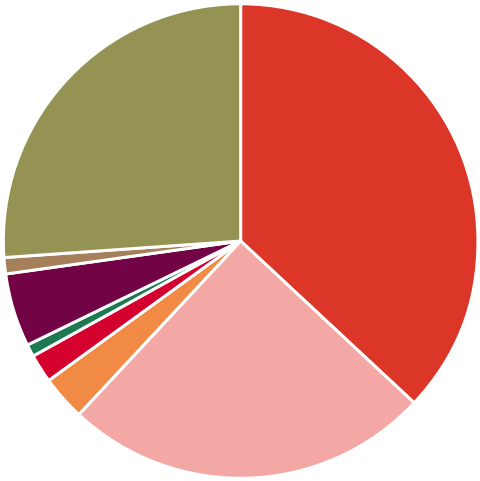
$2.7 trillion could be saved globally to 2030 through energy policies incorporating DE and energy efficiency measures

In Australia, too, the potential of alternative energy strategies to reduce the need for centralised grid expansion is being taken seriously. The Australian Competition and Consumer Commission (ACCC) has ruled that the owner of a high-voltage transmission system in New South Wales, TransGrid, would not be allowed to recover the full costs of grid augmentation via increased charges to customers. The ACCC's consultants concluded that TransGrid had acted imprudently by ignoring the potential of demand management projects – which could have reduced demand by at least 130MW, and so might have made it possible to defer grid expansion.[46]

Transmission and distribution may offer the most pronounced and obvious savings, but over 200 other economic benefits of DE have been identified.[47] Researchers from the US Department of Energy have recently calculated that power failures cost the US economy $80 billion annually[48] – a devastating economic impact that is set to grow further as society becomes more and more reliant on electronic technologies. This colossal cost could be radically reduced under a more decentralised system (see Decentralised energy: security of supply benefits below). Many further benefits have a direct economic value, for example shorter lead-in times for plant construction, reductions in workforce overheads due to reduced specialist training needs, and minimal or zero land remediation costs.[49] Other benefits remain resistant to specific valuation but are clearly of high economic importance. These include wider issues of system security (see Decentralised energy: security of supply benefits below) and enhanced social equity – under a decentralised model the benefits and costs of generation would not be felt so unequally by richer and poorer regions, with a consequent easing of urban-rural conflict and environmental injustice (see also The decentralised globe: closing the North-South divide below).

WADE's economic model explores different DE scenarios for meeting future growth in electricity demand. Applied globally on behalf of the UN in 2000, the model concluded that the pursuit of decentralised energy to 2020 in a world with increasing electricity demand, as well as reducing greenhouse gas emissions associated with the additional electricity use by nearly 50%, could result in 25% reductions[xvi] in retail energy prices.[50] WADE's analysis of China's energy development, funded by the UK Foreign and Commonwealth Office, showed that over the next 20 years a full commitment to meeting growth through DE rather than centralised generation, while delivering a 56% reduction in associated CO_2 emissions, could produce savings of $400 billion.[51] WADE's economic model, which has been used further in studies on the USA, Brazil and Ontario, does not propose a radical scenario, but assumes a decentralised, rather than centralised, response to the natural replacement of ageing infrastructure and to future growth in energy demand over the coming decades.[xvii]

Economic analyses focusing on the UK have yielded the same conclusions as studies in other countries. Most recently, Mott MacDonald's independent analysis for Ofgem of the cost of embedding DE capacity in local low-voltage electricity networks concluded that the cost of substantially increasing DE capacity would be 'considerably outweighed by the benefits directly associated with networks – in particular the ability to defer reinforcement costs and reductions in distribution losses'.[52] The study estimates that embedding approximately one-quarter of UK peak demand capacity on local grids would deliver economic benefits of around £1.3 billion per year.



Only 37% of the average UK domestic electricity bill pays for the electricity product. The rest supports the centralised infrastructure.
SOURCE: Ofgem Renewables Obligation Consultation 2005, Breakdown of domestic direct debit electricity bill.

The pie chart above illustrates how UK energy consumers currently find themselves paying for expensive and wasteful centralised infrastructure. Only a fraction of the domestic customer's electricity bill pays for the energy component – the bulk of it supports centralised infrastructure and its administration. Furthermore, unless challenged, upgrading and replacement of this centralised system will continue to load unnecessary costs onto consumers as a matter of course. Conversely, as the pie chart also shows, DE technologies may produce their low-emission electricity more expensively than centralised fossil-fuel plant, but nevertheless have the potential to deliver a lower price per kWh by avoiding or reducing the other components of the electricity bill.

'In a recent study National Grid Company found that of incremental investment in transmission assets, ~90% is driven by system peak demand or peak generation capacity.'
Ofgem[53]

In the long run, therefore, a move away from centralised generation and distribution towards the development of DE systems fit for 21st-century challenges and technologies presents not only an opportunity to cut emissions but also, based on conventional economic analyses, the possibility of reducing the retail price of electricity for consumers. However, it must be emphasised that reductions in the retail price of electricity should only be welcomed if the reduced price internalises all the environmental and social costs associated with the production of the electricity. Internalising of the environmental and social costs of gas-fired DE generation (which Greenpeace supports as a transitional DE technology) might well mean that future retail prices of DE electricity would initially be higher than today's centralised electricity prices which fail to take account of these external costs.

'The ripple effect of a blackout of even a few minutes in duration is now far more serious than it was in the past when computers and software connections played a smaller role in day-to-day life.'
Jeremy Rifkin, President of the Foundation of Economic Trends, Washington[54]

However, if more sophisticated economic analyses are used such that the environmental and social costs of electricity generation are fully internalised, the economic advantage of a DE pathway becomes dramatic – and indeed renewable-based DE would compare even more favourably with gas-fired DE.

A sustainable electricity and wider energy system – rather than energy which is only 'cheap' because it avoids paying for its own externalities – must be the primary objective.

DECENTRALISED ENERGY: SECURITY OF SUPPLY BENEFITS

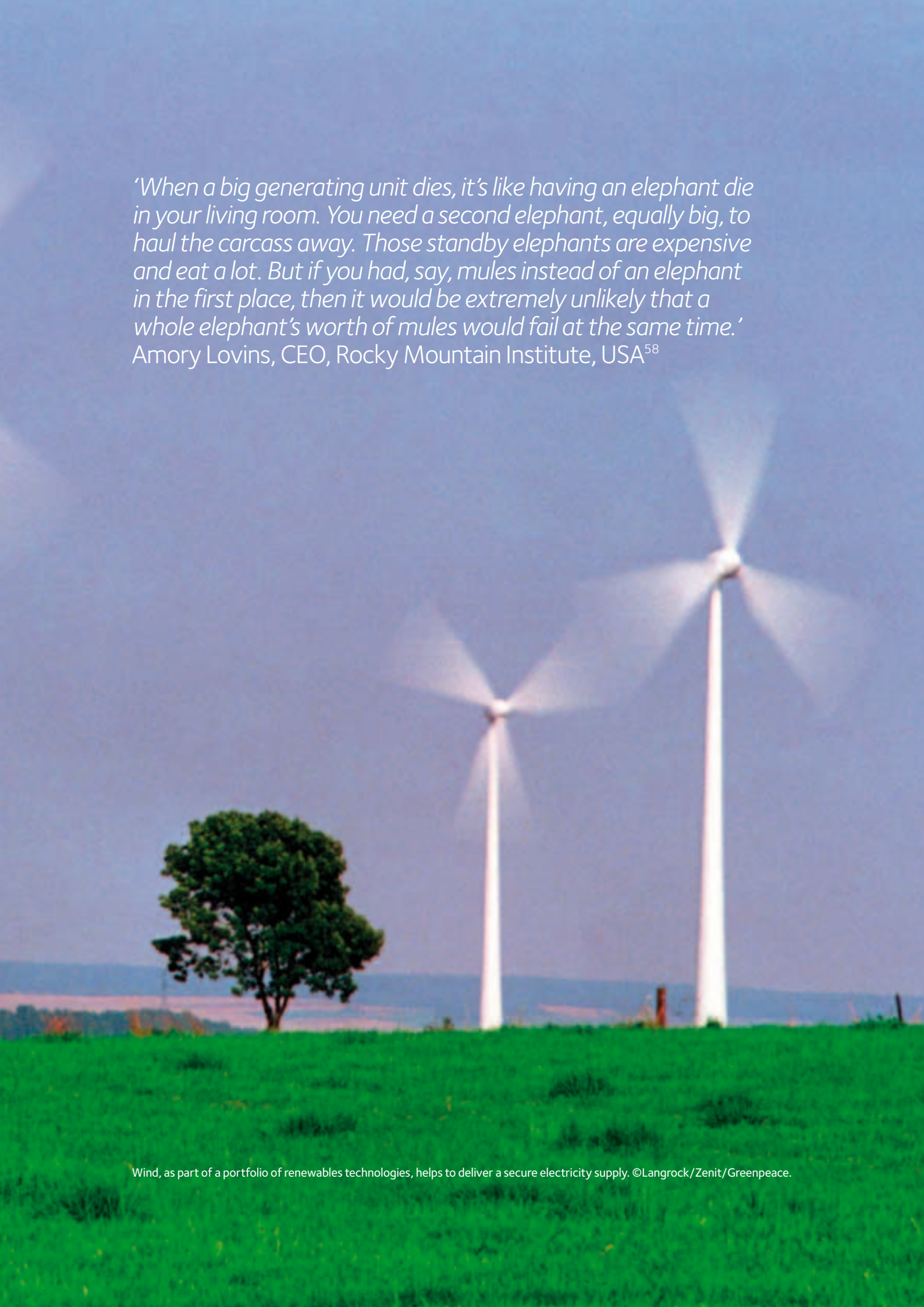
Electricity supply presents three key security dimensions: the reliability of the supply of energy feedstock (ie fuel or other primary energy input); economic or regulatory failures; and the vulnerability of the generation and transmission systems to failure from technical causes, 'acts of god' or sabotage. DE systems are superior to centralised ones on all counts. Indeed, a recent report by Deutsche Bank on the global oil supply cites DE as one of the key long-term strategies for ensuring future energy security.[55]

Generation and distribution efficiencies achievable under a DE model could dramatically cut overall primary energy demand. This is the best way to ensure security of energy supply. Primary energy demand would be further reduced because a DE model requires relatively little back-up power, owing to the low probability of a large number of small generators failing simultaneously – in stark contrast to the enormous back-up requirements of the present-day grid with its few large power stations. While wind power is often mistakenly attacked for its supposedly unique back-up requirements within the grid system, the UK's largest back-up capacity is in fact currently reserved in case of failure of the country's biggest nuclear power station, Sizewell B.[56]

Decentralisation of the energy system would also enable communities to identify and make use of optimum local solutions, increasing the diversity of energy sources in use and reducing dependence on any one source, along with the vulnerability that that entails. Different DE technologies will present the best option at different locations, and for different applications. The Woking network has shown that intermittent renewable technologies can provide highly reliable sources of energy when embedded in networks alongside technologies with complementary energy profiles, such as cogeneration. Advances in energy storage technology, and development of predictable renewable sources such as tidal energy, will expand still further the possibilities for local generator configurations and offer enhanced energy security benefits.

'The options and possibilities are expanding so fast that even specialists have trouble keeping track.'
Walt Patterson, Royal Institute of International Affairs[57]

'When a big generating unit dies, it's like having an elephant die in your living room. You need a second elephant, equally big, to haul the carcass away. Those standby elephants are expensive and eat a lot. But if you had, say, mules instead of an elephant in the first place, then it would be extremely unlikely that a whole elephant's worth of mules would fail at the same time.'
Amory Lovins, CEO, Rocky Mountain Institute, USA[58]



Wind, as part of a portfolio of renewables technologies, helps to deliver a secure electricity supply. ©Langrock/Zenit/Greenpeace.

The UK's largest back-up capacity is reserved in case Sizewell B nuclear power station fails. Greenpeace has also highlighted its vulnerability to terrorist attack. ©Greenpeace/Cobbing.

An emergency increase in French nuclear reactor water pollution limits was granted during the 2003 heatwave. ©Langrock/Zenit/Greenpeace.

London Underground closed its dedicated power station. Months later, the 2003 London power cut left passengers stranded underground in darkness. ©Evans/Rex Features.

Under a decentralised model, moreover, financial risks are constrained by the reduced capital requirements of smaller-scale generators – an increasingly important factor in a liberalised market where large investment mistakes can seriously weaken a company's position. Security of supply could be gravely compromised if one or more large generation companies were to fall into financial crisis, as happened recently to British Energy. The infamous electricity crisis in California, which began in 2001 and which threatened to wreck the Californian economy, came about partly as a result of faulty regulation and was also compounded by the threat of insolvencies among the utilities. The regulator froze retail prices, in mistaken anticipation of low wholesale prices. In fact wholesale prices soared – partly as a result of strategic behaviour by generators – and utilities were unable to make a profit sufficient to balance deficits resulting from earlier faulty investments.[59] In contrast to these crises, the likelihood of millions of DE generators going bankrupt simultaneously is negligible. Furthermore, as renewable DE technologies are increasingly deployed, so exposure to the volatility of fossil fuel energy markets will reduce, avoiding sudden energy price rises and enhancing energy security at the household level.

'When the power stops, it does so throughout the system. That's why critical services and activities increasingly rely on emergency generators located on site.'
Jeremy Rifkin, President of the Foundation of Economic Trends, Washington[60]

'Distributed generation at many locations around the grid increases power reliability and quality while reducing the strain on the electricity system. It also makes our electricity infrastructure less vulnerable to terrorist attack, both by distributing the generation and by diversifying the generation fuels.'
David Garman, US Assistant Secretary of Energy[61]

In a variety of ways, therefore, DE offers substantially enhanced reliability of the energy feedstock supply and reduced vulnerability to economic shocks. Critically, it also offers an innately more stable network configuration able to contain the spread of costly and potentially dangerous disruption to normal services. The catalogue of recent high-profile failures of centralised energy systems is instructive. In 2003 half a million Londoners were plunged into darkness when a single transformer in South London became faulty and efforts to isolate it caused automatic protection equipment to shut the Wimbledon to New Cross circuit. In the same year, the whole of Italy blacked out when a single tree fell on a power line, triggering a cascade of failures. The North American blackout, also in 2003, affected 50 million people and cost billions of dollars: it was attributed by official investigators to inadequate tree trimming in the vicinity of power lines. High temperatures as well as storms can cause major disruption: long-distance power lines can sag under unusual summer heat, triggering blackouts, as experienced by five million Californians in 1996 when temperatures hit 45 °C – a temperature reached in Europe during the 2003 heatwaves.

Nuclear power plants are particularly vulnerable to climate change impacts, since their huge water cooling needs require them to be sited on large water bodies. France's 2003 heatwave reduced and warmed river flows, prompting the Fessenheim nuclear plant to call in the fire brigade to hose down its reactor. Coastal storms in 1999 led to the shutdown of the Blayais reactor, also in France, when it was flooded with seawater; while storms early in 2005 caused two Swedish reactors to be turned off.
But it is not only faulty equipment and extreme weather events that could lead to massive system failures. A 1997 report by the US President's Commission on Critical Infrastructure Protection calculated that by 2001 more than 19 million people globally would have sufficient computer acumen to create minor disruptions to the US electricity network, while 1.3 million would have the expertise to cause significant damage.[62] US Nobel Prize-winning economist Vernon Smith, an advocate of DE on economic grounds, has observed that it would be difficult to design an electricity system more vulnerable to attack than the one which currently dominates world economies.[63]Post-September 2001, it is not surprising that security considerations are now the main driver of decentralised energy investment in the USA.

It is increasingly clear that centralised systems are susceptible to rapid and breathtaking disruption, whatever the cause, and that they are ill-equipped to contain that disruption when it happens. Moreover, their vulnerability will only increase over time – not only through the threat of terrorism in an unequal world, but also through the ever more extreme weather patterns brought about by the climate change which humankind has set in motion and to which traditional fossil-fuel power generation is such a major contributor.

From many perspectives DE equates to better security. At the household level, it is the security benefits that are driving over a million US households every year to install some form of back-up power system.[64] In the UK, too, DE entrepreneurs cite security concerns as a key factor in householders' investments in DE technologies.[65] Better energy security at a national level contributes to fairer international security. Reducing our own vested interests in imported fuel resources by adopting a decentralised energy model assists us in achieving that energy security.

DECENTRALISED ENERGY: POLITICAL, SOCIAL AND CULTURAL BENEFITS

DE technologies, particularly those at the cutting edge, are exciting to encounter and attract immense public interest. Energy efficiency purists bemoan the politicians' fixation with 'sexy' renewables, but there is no denying their appeal. Developments incorporating renewables, such as BedZED in Sutton and the Hockerton Housing Project in Nottingham, among many, run regular tours to satisfy sustained public interest.

'Once the consumer, the end-user, becomes the producer and supplier of energy, power companies around the world will be forced to redefine their mission if they are to survive.'
Jeremy Rifkin, President of the Foundation of Economic Trends, Washington[66]

7,000 people could be employed by the sustainable energy industry in London alone by 2010

When energy generation is devolved either to the householder or the community, and energy consumers become their own producers, then these consumers are incentivised to pursue significant reductions in energy demand in order to minimise the capital and running costs of their plant. This interaction between production and consumption at a local level has the potential to drive down emissions and energy bills radically. Thus the lure of DE technologies can be harnessed to promote energy efficiency at the same time as bringing local economic gains. Under the correct framework, local generation can result in direct local economic benefit through reduced consumption, the export of surplus power and, depending on the technology, a cheaper energy supply. DE simultaneously offers formidable opportunities to innovative local businesses. The London Development Agency has estimated that the sustainable energy market in London alone could potentially be worth £3.35 billion by 2010 and employ up to 7,000 people.[67]

'Government ministers and ministries should use their speeches and their budgets to make people aware not only that they can switch electricity based on a price decision, but that they can also make an environmental choice, whether that is just switching to a greener tariff or going a step further and implementing their own generation.'
Juliet Davenport, Director, Good Energy[68]

Stimulated by such a tangible economic and environmental opportunity, the cultural change that climate change demands of many professions can begin in earnest – from architects and civil engineers to plumbers and building services managers. Hearts and minds are won more widely as people increasingly encounter local generation on their doorsteps, understand energy better and develop a sense of responsibility for their own energy footprints. Local generation thus acts as a catalyst for cultural change in the way people regard their own energy use. DE can promote a virtuous circle, with increased awareness of local networks and renewables stimulating their uptake – for example, Woking Borough Council is now being pressed by its own residents to pursue local wind power.
DE promises to transform the drivers which dictate patterns of energy production and consumption: instead of remote large-scale energy producers seeking to sell yet more unsustainable energy to passive consumers, demand will fall and what energy is required is increasingly likely to be derived from renewable sources.

'A decentralised future will be an interacting future.'
Walt Patterson, Royal Institute of International Affairs[69]

'Microgeneration meets the barbecue test: if you've got the neighbours over you're not going to show them your old boiler or your loft lagging, are you? But you might if your boiler's also a power generator saving 1.5 tonnes of CO_2 per year or if you have a small turbine on the roof. Microgeneration is a real talking point.'
Dave Sowden, Director, Micropower Council[70]

Photovoltaics can already offer the most cost effective solution for stand-alone applications like this parking meter in Woking. ©Greenpeace/Cobbing.

Making a meaningful urban statement: a micro wind turbine in London. ©Greenpeace/Morris.

Enabling DE at the local level would in turn increase local and regional empowerment in energy planning. Where high levels of DE penetration are achievable in practice, individuals, communities, councils and regional governments have meaningful opportunities to take responsibility for their energy footprints. The value of local leadership on climate change is frequently endorsed in principle, but in practice opportunities for such leadership are severely limited. After all, climate solutions are intimately linked to energy policy. Framing political debate on the future of energy in terms of choices between vast centralised technologies not only misinforms but also alienates and disempowers the growing number of people concerned about climate change. The public, increasingly familiar with government calls for urgent action, lacks real agency on the doorstep, risking further political disenfranchisement. DE offers the opportunity for local democratic renewal – the shared sense of pride and purpose in Woking is evident.

Vested interests would be less likely and less able to wield their formidable influence if decisions on energy were increasingly democratised via the devolution of decision-making and the creation of practical opportunities at the local level. The UK's ongoing legal battle with the EU over the National Allocation Plans for the EU's Emissions Trading Scheme (ETS)[xviii] provides a clear reminder of the influence of the business lobby over central government's energy and climate policies. Local and regional government, with their relative proximity to everyday people – many anxious about the world their children will inherit – offer a more wholesome set of parameters for decision-making, all the more so because they are well placed to recognise the local economic benefit of DE innovation. The conventional energy sector in the UK – indeed in Europe – is dominated by a handful of companies, all with huge global interests and turnovers.[71] Localised energy decision-making in the UK, whatever the outcome, is unlikely to register on such vast corporate radars.

The opening up of practical local opportunities should draw local and regional government towards the strategic management and spatial planning of local energy solutions. Over time both regional and local government may have a valuable role to play in developing alternatives to centralised capacity development. The Mayor of London voluntarily produced an Energy Strategy in 2004 and is firmly behind the policy of developing DE networks: a dedicated delivery agency to transform energy supply and use in London has been launched, with engineer Allan Jones (responsible for the Woking scheme) headhunted to front it.

THE DECENTRALISED GLOBE: CLOSING THE NORTH–SOUTH DIVIDE

Between one-third and one-quarter of people around the world lack access to electricity.[xix] The IEA has recently demonstrated the exceptionally intimate correlation between access to electricity and the Human Development Index.[72]
The great energy challenge of the 21st century is to meet the needs of international development while promoting the evolution of a far more sustainable energy model than Western countries have achieved thus far.

The benefits DE offers developing countries are of a completely different order to the benefits that countries such as the UK can anticipate. Applied globally, DE would work for both practical and political reasons, promising a social transformation as profound as the industrial revolution itself. It must not be forgotten that the oil crisis of the 1970s played an important role in plunging developing countries into the desperate and deepening cycle of debt that continues to this day.

In developing countries, tight budgets under intense and competing pressures cannot stretch to grand centralised infrastructure projects – nor should they aspire to, given the arguments for a DE pathway set out above. Instead, decentralised solutions lend themselves to an incremental engineering approach, allowing networks to develop as finances, energy options and skills allow. Solutions can be uniquely tailored to local opportunities. For example, the world's major sugar-producing countries suffer low levels of electricity access. It has been estimated that cogeneration plants fuelled by bagasse – the dry residue of sugar cane after the juice has been extracted – could make a major contribution to meeting electricity demand in many of these countries: some 11.5% of Brazil's and 25% of Cuba's electricity demand could be met through bagasse cogeneration.[73] 400MW of bagasse-fuelled DE capacity are under construction in India. India has already woken up to the DE opportunity – in 2004 it passed new laws opening up the grid to DE.

Climate change impacts the developing world first and hardest. Villagers in Mauritania secure sand dunes at the edge of the advancing Sahara desert.
©Shirley/Signum/Greenpeace.

'DE presents a unique opportunity to help developing countries progress towards the provision of clean, affordable, reliable energy, towards economic growth and poverty alleviation.'
Dominique Lallement, World Bank[74]

Illustrating just how far rich nations are from taking responsibility for the global environmental and social impacts of their energy policies, in 2005 OECD countries will spend 170 times more subsidising fossil fuel worldwide than they have pledged to assist developing countries in adapting to climate change impacts.[75] Calculations by the New Economics Foundation illustrate how different Western assistance could be: a one-off investment of less than 70% of the annual amount spent by OECD countries subsidising their own dirty energy supplies could provide all of non-electrified sub-Saharan Africa with local renewable power.[76] International financial institutions likewise need to understand the value of DE in cutting infrastructure costs, and must commit to prioritising cogeneration and other DE technologies. Recent research reveals that such institutions spend less than 1.5% of their total energy portfolio funding on cogeneration and less than 9% on renewables or energy efficiency measures.[77]

Cogeneration plants fuelled by bagasse could make a major contribution to meeting electricity demand in sugar-producing countries. ©Henley/Panos Pictures.

Batteries charged by solar power during the day make possible this night school in Rajasthan, India. ©Greenpeace/Franken.

Western governments need to recognise both a moral duty and a constructive economic interest in incubating technologies appropriate for international deployment and local ownership in a warming world. Global leadership on climate change can best be offered through bold domestic action – namely reforming our outdated and shamefully wasteful electricity system to one that can be safely replicated around the world. The international context firmly underlines the case for a prioritisation of R&D and market development of low-emission DE technologies, and for bold domestic leadership aimed at transforming our energy system.

'The existing global energy systems are among the key causes of the misalignment of the socio-political structures between North and South.'
Herman Scheer, President, EUROSOLAR[78]

Woking Borough Council worked hard to overcome the barriers to DE.
The town centre now receives power from a trigeneration plant housed in a multistorey carpark. ©Greenpeace/Cobbing.

PART II: BARRIERS TO DECENTRALISED ENERGY

REGULATORY BARRIERS TO DECENTRALISED ENERGY

Regulation of the electricity market

Great Britain's model of market 'liberalisation' constrains both competition and technological progress. Britain has what is nominally one of the most liberalised electricity markets in the world, but closer inspection reveals its permitted form of competition – at the wholesale level – is a narrow one. Under the New Electricity Trading Arrangements (NETA), introduced in 2001 across England and Wales, and their Great Britain-wide successor the British Electricity Transmission and Trading Arrangements (BETTA – see below), conventional energy producers compete merely to inject into the national grid the cheapest possible wholesale electricity, produced by generating plant long since amortised, for obligatory and expensive distribution as a homogeneous product. This wholesale model of liberalisation takes the centralised electricity model as a given and in doing so consolidates it, creating immense barriers to DE.

The fast-moving wholesale marketplace, with its complex forward bidding, may have reduced wholesale prices, but it has produced some perverse outcomes for broader energy policy goals. Output from small generators fell by 44% at the introduction of NETA[79] and recovered only slightly over the first year of its operation.[xx] Centralised generators can play the market by keeping power stations on standby in anticipation of profitable wholesale price spikes. This practice may well have contributed to a 20% rise in emissions from the electricity sector[80] within a year of NETA's introduction.

'From the environmental perspective of a major shift to non-fossil-fuel sources, what NETA delivers is the right answer for a sub-optimal system; and, worse, by doing so it slows down, or even prevents, the transition from a large-scale centralised network to a more local and embedded one.'
Dieter Helm, energy economist, Oxera[81]

20% was the rise in CO_2 emissions from the electricity sector within a year of the introduction of New Electricity Trading Arrangements

BETTA for who? The Scottish renewables industry is concerned about the new market arrangements.

'When a new process technology – wind – is "shoe-horned" into an existing system that evolved to support a previous vintage technology, things do not work correctly. To the network operator it may seem as plain as day that the new technology needs to morph so it takes on the characteristics resembling the old technology. This is wasteful and foolish. Quite the opposite must happen. If we are to effectively exploit technological progress, it is the underlying system that needs to metamorphose and adjust to accommodate the innovation.'
Dr Shimon Awerbuch, Economist, Tyndall Centre[82]

Furthermore, at the outset of NETA, large generation plant operators competed to establish contracts with major consumers so as to ensure a market for their base-load output – a level essential to guarantee their operation. These consumers were thereby able to obtain electricity at or near cost price. Thus the largest power consumers in the UK paid fractionally over 3p per kWh in 2004 while small commercial consumers paid just over 6p and domestic customers just under 8p.[83] The very cheap electricity offered to the major power consumers acts as a disincentive to invest in onsite power in a sector where the environmental benefits of doing so could be huge.

The cogeneration industry in England and Wales was devastated by the introduction of NETA. Under NETA (and now BETTA), generators are rewarded solely for putting cheap power on to the national grid, while the colossal loss of associated thermal energy invites no financial penalty, providing no incentive for a switch to more efficient cogeneration. Instead the cost of this inefficient production, in terms of the unnecessary greenhouse gas emissions associated with it, is externalised onto societies and ecosystems around the world that are vulnerable to climate change impacts. In theory these costs might be internalised by the EU's ETS, but unless the scheme is revised so as to operate within a science-based and globally equitable cap,[xxi] it will continue to make only a negligible contribution to correcting climate injustices. Unhelpfully, the scheme makes no distinction between emissions from cogeneration and those from conventional plant, meaning that the much greater efficiencies associated with the former go unrewarded.[xxii] In the next round of national emission allocations it is vital that stringent targets are set and that cogeneration receives distinct treatment, accurately reflecting its climate benefits.

Renewable energies have also been penalised by NETA and BETTA. While the Renewables Obligation was intended to mitigate the effects of NETA, the main thrust of the regulatory regime is indisputably hostile to renewable technologies. The financial penalties attracted by intermittency reduce the wholesale value of power supplied by many renewable technologies to below that of centralised fossil-fuel production. Furthermore, these penalties are greater than the real cost of grid balancing.[84] Rather than penalising renewables for differing from centralised fossil fuel technologies, a progressive regulatory regime would embrace their characteristics and allow them to dictate and direct system and market development, stimulating innovation and supporting technological progress.

In April of 2005 NETA was extended to the Scottish market and became the British Electricity Transmission and Trading Arrangements (BETTA), creating a single wholesale market for Great Britain. BETTA has introduced locational pricing, whereby charges for use of the transmission network vary depending on the distance of generation plant from consumers. At first glance such a development may appear favourable to DE – but this is not the case. Locational pricing will merely reward the relocation of centralised generation closer to large population centres – principally from North to South. It has not been conceived in such a way as to reward the very close proximity of generation to consumers that is characteristic of the DE model. Moreover, it is widely feared that locational pricing will penalise renewables development in remote areas abundant in renewable energy resources, such as parts of Scotland.[xxiii] BETTA therefore falls far short of the regulatory reforms needed to promote a sustainable energy system.

One of the most trenchant criticisms levelled at the centralised wholesale market model is that it isolates sellers from users, stifling market innovation and ultimately economic efficiency.[85] Under BETTA, indeed, there can be no price differentiation of different quality energy products – yet the quality of electricity supply required, for example, by an aluminium smelter is very different from that required by a manufacturer of electronic parts. Another failure of the current electricity market is that many consumers are unable to adjust their behaviour according to the fluctuating price of electricity around demand peaks. The more 'intelligent' networks of the future advocated by DE visionaries such as Jeremy Rifkin will correct this market failure by providing real-time pricing information – for example through smart metering.

'Could a modern telephony operate in such a fashion? Would we have access to the mind-boggling range of products, price and service menus if customers had to buy each and every call from a government-run dispatcher?'
Dr Shimon Awerbuch, economist, Tyndall Centre[86]

Crucially for DE, the electricity sector does not currently compete in the most meaningful way at the point of retail. The pie chart on page 31 shows the supply cost and profit margin as a proportion of retail price. It is clear that the current electricity market is constrained with the potential for retail competition between conventional suppliers under a centralised wholesale model severely restricted. Far greater competitive potential could exist between centralised and local generation and supply, where nearly all components of the electricity bill illustrated in the pie chart could be open to competition. Yet there are no incentives for conventional energy producers to explore the cheaper, more reliable and less environmentally damaging ways of meeting consumer needs for light, heat and power that localised generation can offer. Worse, the whole system throws up immense barriers to new entrants seeking to adopt a genuinely competitive stance at the retail level by doing just that (see below).

To summarise, the wholesale market model rewards and at the same time fossilises an already obsolescent system, with predictable results. Indeed, the dire stagnation of innovation in the electricity sector was recently reported in the Financial Times, citing the industry's position at the very bottom of technology consultancy Arthur D. Little's 2005 study of innovation in 13 key industry sectors.[87] The old public model of ownership may have had an inertia of its own, but it did at least allow for long-term planning. Unfortunately the sheer intensity of the privatised electricity market results in a very short-term and incremental approach to regulatory development, with little impetus to change existing arrangements which suit the business models of powerful vested interests, on whom the lights depend. Injecting the much-needed long-term signals into the market promises to be a difficult exercise.

"Liberalisation is sometimes called "deregulation". The reality, however, is at best "reregulation".'
Walt Patterson, RIIA[88]

Regulation of the transmission and distribution networks

Barriers to DE run deep. The wholesale marketplace operates at the centre of a web of transmission and distribution networks. The system by which the operators of those networks are remunerated serves to perpetuate the dominance of centralised generation models. To a large extent, the networks are governed by rate-of-return regulations. These enable National Grid Company (which operates the high-voltage transmission network) and the DNOs to recover their operating costs, future investment costs and depreciation through a level of user charges agreed with Ofgem. They also receive an additional return based on the value of their investments in infrastructure. Together these guaranteed returns provide a strong incentive to make the transmission and distribution networks asset-heavy and to seek capital-intensive solutions such as feeder and substation upgrades, perpetuating the existing centralised model and epitomising the culture of acceptance rather than management of growth in electricity demand.[89]

'The structure of electricity distribution charges has not changed significantly since the 1980s.'
Ofgem[90]

DNOs are regulated by the Distribution Price Control, which sets a price formula that not only allows for a rate-of-return charge, but is directly linked to the volume of electricity passing through their wires from the national grid. Connecting DE to local networks is therefore potentially perceived by DNOs not only as an inconvenience, but in the longer term as offsetting centralised grid power and therefore actually diminishing the core revenue which flows to them from centralised power distribution. This system of economic regulation means there is no natural incentive for DNOs either to connect DE to local networks or to pursue any form of demand management, even if this would reduce costs to consumers.

Western 'liberalised' electricity markets are anything but cheap. Extreme drought dried up this irrigation canal, impoverishing farming communities, Cambodia 2005
©Greenpeace/Thongma.

Laying a ground source heat pump means that warmth from the earth can be used to heat buildings.
©Marches Energy Agency.

A plant in Germany uses agricultural waste to generate biogas that can be used to fuel cogeneration plants.
©Greenpeace/Cobbing.

'The New Electricity Trading Arrangements – initially intended to favour renewable energy and combined heat and power – ended up doing exactly the opposite.'
ENDS Report[91]

There have been recent moves by Ofgem to tackle this inherent system apathy towards DE and in 2005 three incentives for the connection of DE on local networks have been introduced. Firstly, the costs of connection for DE generators have been reduced by 20% – offering what is termed a 'shallowish' connection charge for individual DE generators. This is by the introduction of a new use-of-system fee (GDUoS) for utilising of the local networks, to enable DNOs to recoup their initial higher capital outlay.[xxiv] Secondly, Ofgem is promoting the concept of Registered Power Zones (RPZs). Each year DNOs will be able to register one or two geographical or network areas in which they will be able to levy an extra charge[xxv] on DE connectees in return for demonstrating and trialling new products and 'significant innovation'.[92] Finally a new Innovation Finance Incentive has been introduced to stimulate technological development of the local networks.

Overall, Ofgem estimates that it has introduced a package of measures valued at up to £500 million over the next five years to promote DE connection to distribution networks. The measures were introduced in clear recognition that as a result of market liberalisation and short-term competitive pressures, innovation by DNOs has been dormant for a decade or more.[93]

'Transforming today's centralised, dumb power grid into something closer to a smart distributed network will be necessary to provide a reliable power supply – and to make possible innovative new energy services.'
The Economist Technology Quarterly[94]

While these developments are welcome, it remains to be seen if they stimulate sufficient progress. Worryingly they do not allow for the cost benefits of DE (see Decentralised energy: economic benefits in Part I) to be fully reflected back to DE generators – rather they establish a mechanism for charging DE providers. Indeed much of the £500 million will come in the form of distributed generator's payments to the DNOs rather than direct expenditure from DNOs in new network infrastructure. Furthermore in some circumstances, such as for private wires (see Grid licensing exemption regulations below) the new framework could lead to significantly higher costs to DE.[xxvi] The £500 million attached to the three Ofgem measures to encourage DE pales beside the £5.7 billion that Ofgem has allowed operators to spend on general network asset investments over the same period, which represents an increase of 48% on current levels. Crucially, new energy actors have not been empowered to provide a genuine competitive threat to DNOs, spurring innovation through direct competition via private wires – as opposed to the present bureaucratic and prescriptive model of incentives under which the electricity industry is rewarded for incurring risks of a kind that any other industry would accept as part and parcel of real-world business.

'The majority of [EU] countries levy a shallow connection charge and recognise that Distributed Generation [DE] brings the benefit of reduced losses and reduced reinforcement costs.'
Ofgem[95]

The fact remains that DE entrepreneurs, eager to compete at the retail level, find themselves precluded from doing so by a regulatory and economic regime aligned to a bygone era. A DE pathway demands that DNOs in particular must be radically transformed from passive purveyors of a one-way flow of electricity to active managers of complex local networks, where energy may flow in different directions from many different sources. There is therefore a formidable job to be done in reforming the revenue drivers of DNOs so that their business model naturally strives to realise the many benefits of DE and demand reduction.

'The problems caused by NETA are merely a symptom of a much larger malaise in the regulatory system.'
Chris Hewett, IPPR[96]

Downstream regulatory barriers

The very clear distinction between generation and supply breaks down under a DE model as the relationship between consumers and suppliers blurs. A million potential customers are also a million potential power producers. In response, an entirely new regulatory framework alive to the practical and technical needs of small local generators is needed. Ways must be found to bridge the yawning gap between an electricity sector governed by outdated rules and the huge opportunities offered by a decentralised future.

Until that happens, DE's competitive advantage will remain squashed by the system and disproportionately burdened with a maze of inappropriate and insensitive regulation, which creates bureaucratic barriers and imposes extra costs. Indeed, just as the big picture is dictated by the demands of big centralised generators, so is the detail. For example, there is inconsistency in the thresholds at which the rules governing metering, connection standards and Renewables Obligation Certificates (ROCs) apply to small generators, loading further costs onto DE.[xxvii] A consistent, simple approach to all these issues for all installations up to 100kW in size would greatly assist the development of the DE sector.

Taking care of the future: India is dismantling the regulatory barriers to DE. ©Greenpeace/Franken.

Microgeneration under 3kW, which has huge market potential at the household level, is currently impeded by complex issues of cost and benefit allocation. As a result there is at present no guaranteed remuneration for any surplus energy generated; while even the modest reward that renewable microgenerators can claim through ROCs[xxviii] involves completing a 19-page application form. Today, most surplus from microgeneration spills onto the local networks without recompense for the householder or other producer, but to the benefit of both licensed electricity suppliers and DNOs (see Decentralised energy: economic benefits in Part I).[xxix]

To overcome the current bias against small-scale microgeneration, the Distributed Generation Co-ordinating Group has recommended[97] that licensed suppliers should be obliged to publish terms for the purchase of excess electricity exported over local networks from microgenerators – and to purchase that electricity under those terms. However, this recommendation has not met with the approval of Ofgem in its current consultation on the regulatory implications of domestic-scale microgeneration. With a predictably short-term perspective, it counters: 'A secure supply of electricity is a social necessity, exporting electricity from domestic premises is not.'[98] Clearly, were it to take a longer-term perspective it would appreciate that, for all the reasons cited in Part I, facilitating the export of electricity from microgenerators has an important part to play in the vital goal of ensuring a far more secure electricity system for the future.

Finally, Ofgem's '28-day rule', which stipulates that any domestic customer who decides to switch electricity supplier must be enabled to do so within 28 days, is potentially a major barrier to delivery contracting ESCOs seeking to operate at the individual level (see Box 1, page 19). Such ESCOs will not take off as long as the 28-day rule can override any contract for services that will need to be agreed with potential customers.[99] In any event the basic premise of the rule is flawed. While regulation is undoubtedly needed to ensure contractual clarity, customers for services that can entail more significant household expenditure than electricity (such as mortgages or telecommunications services) are not treated as incapable of pursuing competitive contracts, as they are at present for electricity supply.

With changes to the rules community-scaled low-carbon energy networks could proliferate. ©Greenpeace/Cobbing.

Simple technologies are incorporated into the design of housing in East London. ©Greenpeace/Davison.

The 28-day rule has recently been relaxed for a modest percentage of customers of existing electricity suppliers as part of a pilot on the development of energy services. This should enable the offering of energy service contracts by existing suppliers at advantageous rates in return for a commitment to a longer-term contract. However, at the moment the relaxation of the rule is temporary, and will therefore do only a limited amount to encourage companies to implement capital-intensive measures. Furthermore, given their overriding interest in increasing electricity demand, it remains to be seen how vigorous these suppliers will be in promoting energy services and demand management. Regardless of the outcome of the pilot, the 28-day rule should be dropped to enable the wider development of a new ESCO sector – which is needed to deliver DE capacity at the same time as presenting a competitive threat to existing suppliers. With the 28-day rule barrier removed, entirely new players (including established brands with large customer bases, such as supermarkets and DIY stores) could be drawn into the delivery contracting ESCO marketplace.

Grid licensing exemption regulations

For Allan Jones, the mastermind behind Woking, it is the regulations governing private wires and grid licensing exemptions that must be changed.[100] Such a step is critical, for example, to the Greater London Authority's ambitions to promote DE and to tackle fuel poverty. Private wires present an opportunity to engender real competition in the electricity markets – not least because they offer the possibility of exemption from expensive grid licensing with its complex rules, fees and charges. Without grid licensing exemption an ESCO is forced to participate in the UK's wholesale electricity markets, regularly forward bidding into the central marketplace, making its energy product indistinguishable from standard supply and squashing the competitive advantage that proximity to consumers should provide. However, current grid licensing exemption rules stipulate that an ESCO seeking to provide and bill for energy directly to householders can only supply power up to 1MW (sufficient to base-load about 1,000 households) on each private wire. By contrast, for non-domestic purposes[xxx] grid licensing exemption is available for generation and supply capacity of up to 50MW, or up to 100MW over private wires with the approval of the Secretary of State. There are no limits to onsite generation for non-domestic purposes.

Private wires are further constrained in that each operator, however many wires it has, can only export an aggregate maximum of 5MW of power onto public networks from exempt generation and supply – of which a mere 2.5MW can be supplied to domestic customers. Since export power onto public wires is important for balancing between private wire island generation networks, the 5MW/2.5MW aggregate limit has the effect of inhibiting local generation, distribution and supply. Export power exceeding the 5MW/2.5MW limits has to be sold to licensed suppliers at a low price. Even if the surpluses and deficits over all an operator's private wires balance out, whenever those surpluses exceed these limits then the excess must be sold cheaply, while the deficits must be made up by purchasing grid electricity at full cost. In short, an operator's various wires are not able to balance each other out across the public network above the 5MW limit.

'It is time for the protection of the current grid generation/ supply system to cease if we are to move forward to local sustainable energy communities and to rewire the grid for distributed generation technologies.'
Allan Jones MBE, London Climate Change Agency (former Energy Services Manager, Woking Borough Council)[101]

Private wires already have competitive value, which would be enhanced if they could be liberated from the above constraints. The cost of laying electrical cables and ancillary electrical equipment is relatively small compared to the overall cost of installing a community heat and power network – yet it is the electricity product, rather than heat or cooling, that can yield the greatest economic return. Furthermore private wires offer added value when compared to the public electricity supply, since although they cost the same as, or less than, conventional distribution network cables laid in new developments, they are future-proofed, being designed as active networks able to allow electricity to flow in both directions from dispersed DE plant, unlike the grid, which is designed for the passive one-way flow of current.

'Electricity systems deliver not only physical power but institutional power: political, social and economic.'
Walt Patterson, RIIA[102]

Enabling the proliferation of larger exempt local energy networks on private wires, and lifting export limits over public wires, will increasingly give UK electricity customers the opportunity to choose local low-emission power over dirty centralised power. Moreover, if the UK is to attract the investment community, and indeed the existing electricity sector, behind new enterprise models for DE technologies and infrastructure, grid licensing exemption limits will need to be raised substantially. The arguments against doing so are unclear and need to be challenged robustly by politicians. The House of Lords Science and Technology Committee could see no justification for what they agreed was a suppression of competition through the exemption limits imposed on private wire supply to domestic customers. The Committee recommended that these limits be relaxed.[103] As Jones argues,[104] why should what is permitted for 1,000 households not be allowed for many more? Householders are already amply protected against financial risk. Where a private wire connection is in addition to a public wire connection the householder can revert back to the public wire at any time. Where a private wire is laid in a new development as the sole source of electricity, existing regulation ensures that the electricity supplied is priced below grid electricity and index-linked to the grid price for the term of any contract.[xxxi]

Regulatory barriers to decentralised energy – conclusion

Greenpeace frequently hears the DE industry bemoan the 'mindset' of Ofgem. The unquestioning alignment of the regulator with the centralised model certainly betrays an institutional misconception that renewables and DE present a rather awkward way of generating power, and that the onus is on them to adapt to the existing technology and infrastructure. This is, sadly, a predictable state of affairs for a 'liberalised' electricity market under a regulator whose core objective is short-term price reduction – rather than demand management, long-term system efficiency and stability, and environmental responsibility. Ofgem appears overly focused on minimising the price per kWh of electricity on the national grid, but that is the wrong goal. What matters ultimately to users is not the price per kWh on the grid, but the size of their electricity bill – a fundamentally different matter given the potential of DE technologies and infrastructure alongside demand reduction through energy efficiency measures.

Clearly far-reaching and fundamental changes are required to the regulation of the electricity sector in order to enable DE. The needs of DE must be addressed systematically and sensitively, as a core function of a committed regulator. Until that happens the regulatory regime will continue to be one of the key forces which keeps the current unsustainable energy model firmly on track – ultimately to disaster.

POLITICS, POLICY LAG AND IDEOLOGY

DE is not technologically constrained. The technologies that would enable the practical implementation of a DE model have been available for years – decades in many instances. The reasons why its merits are not given due attention are complex and highly political. Partly the centralised energy model is so pervasive in the UK that its domination of the employment market for energy professionals has the effect of reproducing its own skills set and perpetuating its own assumptions. Partly DE's potential has yet to be fully grasped in policy circles. The integrating nature of DE has not been appreciated, with government departments separately pursuing disjointed energy initiatives in the domestic energy efficiency, green electricity, community renewables and construction spheres (although, bizarrely, no department has taken any interest in the UK's dominant use of non-transport energy – heating). These fractured initiatives are layered over a fundamentally faulty system, incurring additional costs to the taxpayer. This is not a serious, sustainable or transformative approach, since initiatives may only prosper as long as their funding continues while the perverse underlying causes within the electricity system remain unaltered.

The desperate plight of cogeneration is stark evidence of the UK Government's failure to join up the basics of energy policy, considering both heat and power markets in tandem. At best, just 3.5 staff members at the Department for Environment, Food and Rural Affairs (Defra) work on cogeneration, compared to an army of 30 working on nuclear power at the Department of Trade and Industry (DTI).[105] Not always involving renewable fuels, nor purely an energy-saving device, cogeneration appears to have slipped into a gap between both definitions and departments. Yet it has been explicitly identified by Defra as the 'most cost-effective single non-transport measure in the Climate Change Programme'.[106] No wonder the energy and environmental policies of Western governments have been described by an energy expert at the Royal Institute of International Affairs as 'at best incoherent, if not flatly contradictory'.[107]

The limitations of this disjointed approach are underlined by the European SUSTELNET[xxxii] project, set up with the support of the European Commission to make recommendations on DE regulatory policy. The project's final report observes that 'governments still use support schemes to ensure that DG [decentralised generation] and RES [renewable energy sources] are employed and environmental benefits are achieved and thus mitigate the often complex barriers to incorporating DG and RES within economic regulation of the electricity networks. **In the long run DG and RES should become fully part of the electricity market, since continuation of market protection could result in much higher infrastructure costs'** (our emphasis).[108]

The 19 light towers at Sydney's Olympic stadium are powered by solar energy. ©Greenpeace/Ziegler.

'The policy changes required are many and varied. There is no silver bullet and a great deal of the changes will be highly technical. They would also ruffle feathers in parts of the industry that wish to resist change.'
Chris Hewett, IPPR[109]

One barrier to such fundamental regulatory acceptance of DE is the technical complexity of electricity and the electricity market, which results in incomprehension in government and wider political circles and thereby acts as a brake on criticism and the development of better solutions. In the course of researching this report Greenpeace has discovered that even energy sector professionals sometimes do not understand the content or significance of Ofgem's consultations. Will the political heat which Greenpeace would like to see directed at the centralised electricity sector be dampened down by an incomprehensibly technical defence of business-as-usual?

In part, the poor advocacy of the DE model by its own proponents reflects the relative weakness of the DE industry compared to the staggering resources and political influence of the fossil fuel, nuclear and grid network industries. The blame for this can in part be laid at the door of government. Over the coming year, the DTI will provide a paltry £280,000 of direct support to trade associations to enable representation on various industry forums dealing with DE-related issues, including renewables and cogeneration; while during 2004–05 it expected to spend just £1.7 million on specific projects aimed at the removal of barriers to the development of DE, or research into its impact on the electricity networks.[110] This level of support pales besides the £19 million of Coal Investment Aid offered to the UK coal mining industry last year[111] and is overshadowed by a recent £38 million investment[xxxiii] made over one year by the DTI to support nuclear fusion research.[112] And of course it is utterly derisory in comparison to the minimum of £3.5–4 billion[xxxiv] that the Government will spend on bailing out British Energy for its nuclear decommissioning and waste liabilities over coming decades.[113]

'The power plant and grid network industry is one of the top three global business sectors. They are close to policy-makers, regulators and utilities in every country and they are formidably well resourced and professional in their promotion and marketing efforts. I like to think that we are similarly professional, but our resources are a pinprick in comparison.'
Michael Brown, World Alliance for Decentralised Energy[114]

Cleaning up: A solar facility on the roof of the Reichstag, Berlin. ©Langrock/Zenit/Greenpeace.

Of all the barriers to DE in the political sphere, the most striking of all is the fundamental disjuncture in the relationship between Ofgem and central government. The Government's energy policy, explicitly set out in the 2003 Energy White Paper, aims to pursue policy objectives simultaneously in four areas: environmental, social, economic and security-related. Yet Ofgem's legal remit[xxxv] is predominantly that of protecting the interests of the electricity consumer, to which it applies a curiously narrow and short-term interpretation. As such the regulator increasingly clashes with government ambitions to meet emissions reduction targets. (For example, the Government was obliged to cap transmission prices proposed by Ofgem under BETTA, so as to protect the renewables industry in northern Scotland and the Scottish islands.[115]) Yet the Government does not seek to undertake the overhaul of Ofgem that is so essential if the electricity system is to play its part in emissions reduction – as it must given its staggering contribution to CO_2 emissions. Perhaps such inaction is simply a consequence of the essential nature of electricity to the functioning of modern society, which intimidates our politicians and continues to deflect them from the urgent task of casting a critical eye over the massive wastage and lethargy inherent in the UK's electricity system.

'As the true economic value of CHP and renewable energy is lost in the grid, taxpayers' money has to be used to grant-aid these technologies to make them economically viable.'
Allan Jones MBE, London Climate Change Agency (former Energy Services Manager, Woking Borough Council)[116]

DE technologies can be readily fitted to existing buildings to reduce their environmental impact. ©Greenpeace/Beere.

'At a time when fossil fuels are disappearing and nuclear power stations are being closed down, the EU is expanding national grid networks across boundaries. So now we get whole countries, like Italy, going out on power cuts; whole cities like London going out on power cuts. That is not the way forward. I do not think either politicians or the research people are looking sufficiently far forward to the systems that we will need in place in the future, and fairly soon.'
Allan Jones MBE, London Climate Change Agency (former Energy Services Manager, Woking Borough Council)[117]

A nuclear facility was abandoned during the bombing of Iraq in 2004 resulting in life-threatening contamination in surrounding communities. ©Greenpeace/Reynaers.

Up against it: DE must compete with the highly subsidised and politically influential centralised power industry. ©Lohmeyer/Joker/Greenpeace.

Inaction is also explained by the ideological fashion for 'liberalised' markets, which appears to have led politicians to embrace wholeheartedly a market that in reality is far from competitive and which actually stifles innovation. Our model of liberalisation has fundamentally failed to get to grips with the role of the network. After all, electricity is not a tangible commodity,[xxxvi] but the result of a process requiring real-time balancing of electrical inputs and outputs across delivery infrastructure. Choice of delivery infrastructures, in particular localised infrastructure, would therefore provide real competitive potential. 'Liberalisation', if it is to deliver on its own promise, needs to go much further – but the market also needs to be made to operate within the economic and political realities of mounting and globally inequitable environmental costs.

'It is difficult to see why the Government's [renewables] objectives should be prejudiced by the higher authority of a regulator with a totally different agenda... After all, nobody voted for Ofgem.'
Brian Wilson, former Energy Minister[118]

Wind power: the UK has the greatest wind resource in Europe. ©Greenpeace/Cunningham.

PART III: MOVING TO A DECENTRALISED NETWORK IN THE UK

EMPOWERING THE NEW ENERGY ACTORS: CREATING REAL COMPETITION

A robust DE strategy would stimulate local action and innovation by opening the door for new actors to participate in the energy generation and supply sector. These might include householders; community, municipal and commercial ESCOs; developers of housing and commercial buildings; the farming community; industry and commerce; and the public sector, including regional and local government. Indeed, all current users of electricity could be systematically empowered to become active stakeholders, not just in their own energy supply, but in the UK's energy future. Collectively these new actors could drive the expansion of decentralised capacity and offer a competitive challenge to the consolidated electricity sector and its outdated business model.

The potential of new developments

New-build developments present an exceptional and immediate opportunity for progressing DE (and containing growth in electricity demand), but one which government policy has so far failed to seize – notably in the new Part L Building Regulations proposals and the £38 billion Sustainable Communities Plan. A sustainable future requires many buildings to be not merely dwellings, schools or offices, but power stations with the potential to offset centralised grid expansion. Factoring this function into cost-benefit analyses would radically transform the economics of compulsory incorporation of low-emission energy technologies into new build – currently dismissed as prohibitively expensive. Furthermore, it has been calculated that zero-emission housing could be delivered at a cost comparable to that of existing standard housing beyond a threshold of just 2,500 to 5,000 dwellings (not necessarily in a single locality),[119] due to economies of series production of component parts and enhanced supply chain efficiency.

Zero-emission developments – power stations of the future and no more expensive than conventional housing at a scale of just 5,000 units. ©BedZed.

Thames Gateway will be the biggest regeneration zone in Europe and could be a hotbed for DE technologies and infrastructure.

Greenpeace therefore believes that the UK's ambitious Sustainable Communities building programme has huge potential to pump-prime the DE and delivery contracting ESCO marketplace. In order to realise this potential, for all building projects – commercial and domestic – developers (including housing associations) should be required either to incorporate low-emission DE technologies into individual units or to invite delivery contracting ESCOs to tender for infrastructure delivery and operation at the community scale. Such a requirement on developers, while allowing them financial flexibility, would provide a real stimulus to the development of the delivery contracting ESCO marketplace. Over time and through the use of private wires (see below) this approach would also provide a competitive spur to DNOs and increase pressure on RPZ schemes to innovate successfully.

Microgeneration for existing buildings

The domestic sector currently consumes one-third of electricity produced in the UK.[120] In order to empower this important sector to become an active driver of DE capacity, the growth of microgeneration needs to be stimulated in existing households, not just in new build. At present microgeneration is impeded by unresolved issues of cost and benefit allocation between microgenerators and the electricity system (see Downstream regulatory barriers in Part II). Householders (and small businesses too) urgently need access to a user-friendly retail package comprising microgenerator, installation, metering arrangements and a contract with an energy company to reward surplus production. Electricity supply companies should be obligated, as a matter of routine, to publish terms for the buying of excess generation from microgenerators, and actually to purchase surplus electricity under those terms – as recommended by the Distributed Generation Coordinating Group.[121] Once suppliers are obliged to engage with the microgeneration industry, they will gain a commercial interest and expertise in actively resolving outstanding obstacles to the growth of microgeneration.

'Concentrations of microgeneration may have an impact on distribution networks. However, a recent study has indicated that such impact is, for the foreseeable future, likely to be small. ... However, detailed issues of microgeneration and supply have yet to be systematically addressed.'
Ofgem[122]

It is therefore important that the regulations drawn up in the wake of the current Ofgem consultation on domestic-scale microgeneration oblige licensed electricity supply companies to buy excess generation. If this does not happen the Government must take decisive steps and offer microgenerators an interim feed-in tariff – a publicly funded reward for every kWh of electricity fed into the networks. In these circumstances the Government should also counter Ofgem's anxiety over the reverse running meters[xxxvii] found in millions of homes around the UK which could potentially over-reward exported power – at least until the regulator produces a fair and satisfactory framework to support the expansion of microgeneration.

At the same time, fiscal incentives are needed to stimulate take-up of microgeneration in existing households and small businesses.[xxxviii] Measures advocated by Greenpeace include rebates on stamp duty and/or council tax or business rates based on building energy performance; and encouragement to lenders to develop green mortgage products which incentivise energy efficiency and onsite power. Enhanced Capital Allowances (ECAs) should be extended to cover all DE technologies,[xxxix] and the opportunities for cheaper DE investments currently enjoyed by the business sector through ECAs at 100% should be extended to individual taxpayers through personal tax allowances.[123] Such incentives would also help drive demand reduction while establishing the market for delivery contracting ESCOs operating at the individual household or office level (see Box 1, page 19 and Box 3 below). With respect to enabling ESCOs to thrive at the household level, it is also critical to abandon the 28-day rule.

Box 3: Encouraging the growth of ESCOs

ESCOs are relatively well established across Europe. In the UK, however, they are restricted to medium- and large-scale electricity users and have yet to take off in the domestic, public, or smaller-scale commercial sectors. A range of cultural barriers to ESCOs exists, including a general lack of awareness and experience of this enterprise model. These barriers are reinforced here in the UK by a lack of genuine liberalisation in the electricity market, where a small number of energy suppliers dominate a marketplace which offers potentially huge opportunities to ESCOs.

Greenpeace calls for a true liberalisation of the marketplace, addressing regulatory barriers such as the 28-day rule and grid licensing exemption limits. In such a liberalised marketplace ESCOs would be able to proliferate. However, one further barrier would remain in this new marketplace – that of finance, since lenders also lack familiarity with the ESCO model. Confidence in financing this enterprise model needs to be built through example, so Greenpeace is calling on the Treasury to commit to a £100 million revolving loan fund. Dedicated to the installation of equipment, the fund would allow rapid expansion of the ESCO sector. As a loan fund it would be repaid and become available for reinvestment.

The result of this extension of liberalisation, coupled with the judicious application of financial assistance, would be to ensure that the benefits of ESCOs could begin to be more widely realised across the UK.

The public sector

The public sector, including public lighting, accounts for 6.8% of all electricity consumed in the UK.[124] The government estate comprises over 50,000[125] public buildings, illustrating the scale of the potential for the public sector to drive DE forward via innovation and sheer market power. Nor is this potential restricted to existing buildings. The Government should require PFI contracts drawn up to deliver new public buildings to stipulate zero emission standards. Given that PFI contracts usually cover both the construction and services of a building or scheme, an obligation to include DE would bring benefits to both public sector customers and private shareholders.

6.8% of UK electricity is consumed by the public sector

Why are cooperatively owned wind farms like this one in Cumbria so rare in the UK? ©J.Oakes.

South Somerset District Council plans to install a 50kw wind turbine at this school to reduce the school's energy bill by £7,000 per year. ©SWNS.

Local public institutions represent a key potential driver for local network and ESCO market development, in terms not only of meeting their own substantial heat and power requirements, but also potentially of exporting energy to the surrounding community and/or acting as a stimulus to wider take-up of DE. Local and regional government in particular, along with some other public-sector bodies such as schools and universities, are well placed to precipitate cultural change with inspirational and highly visible DE projects. There are, for example, approximately 25,000[126] schools in England, which could not only save precious resources by adopting DE but could also act as a focus for wider community involvement in sustainable energy.

The potential exists for councils and other public-sector bodies to achieve radical energy efficiency targets.[127] When all demand-side energy efficiency measures have been implemented, the financial savings released can then be hypothecated to procure alternative forms of energy supply, as has happened in Woking. This approach could provide valuable resources to drive DE and ESCO development at the community scale. Local government can also prioritise innovation for the benefit of fuel-poor households, as the example of Woking again demonstrates.

Research for the Energy Savings Trust and the Carbon Trust has shown that community heat networks could be cost-effectively installed by the public sector to service some 5 million households and hundreds of public buildings under a Treasury discount rate of 6% for public-sector investment.[128] At this discount rate, the research demonstrated that one in four UK households could save on heating bills through connection to a community heating scheme. The more favourable economics of local private wire networks (see Regulation of the electricity market, page 43) suggest that public sector enterprise delivering combined community heat and electricity networks could be even more cost-effective than the delivery of straightforward heat networks. Along with the fact that the discount rate was reduced to a mere 3.5% after the research had been conducted, this implies that many more homes than the 5 million originally identified by the research could be cost-effectively connected to local heat and electricity networks.

Biomass and farm wastes can power rural communities, while benefiting the local economy. ©Langrock/Zenit/Greenpeace.

London's Mayor and Deputy Mayor are backing DE for London through a dedicated agency and turning down major planning applications on grounds of energy performance. ©Frank Sutton/Rex Features.

'Time is short and we have to act strategically. We have to go for the big CO_2 hits: in new developments where we can get the energy infrastructure in at the beginning; in clusters of large commercial and public buildings that use a lot of energy.'
Nicky Gavron,
Deputy Mayor of London[129]

In recognition of its leadership potential, and to spur action, the public sector – including local and regional government – needs to be made responsible for stringent CO_2 emissions reductions across its own estates and to be held meaningfully to account for performance. Local and regional government and/or Regional Development Agencies (RDAs) should also be given responsibility for reducing wider CO_2 emissions in their areas and should work closely with central government to achieve this. Central government's contribution should include revision of planning guidelines, to ensure that decisions on planning consent are more strongly informed by anticipated energy performance and that planning rules help rather than hinder the uptake of DE technologies. For their part, local and regional authorities should be under a statutory duty to produce energy strategies, and spatial development plans should be required to identify both renewable energy opportunities and areas of high-density heat demand suitable for community heating.

The rural scene

A key question for the UK is why the rural energy cooperatives that have been so successful on the continent, notably in Germany and Denmark, have failed to catch on here. Reasons may be partly cultural,[130] but local enterprise has not been aided by (for instance) the Government's stop-start approach to the biomass sector.[131] Biomass and biogas are potentially particularly important to rural communities, offering the additional benefit to the local economy of local feedstock procurement. In England, grant funding is available under the Energy Crops Scheme for biomass growers to form producer groups, and applicants quite rightly need to demonstrate proximity to cogeneration plant.[132] Unfortunately, take-up of the grant scheme has been undermined by a shortage of existing cogeneration plant located close to suitable growing areas.[133] The situation is exacerbated by the lack of both guidance on appropriate locations for cogeneration plant[134] and wider political and community advocacy for interested local entrepreneurs, who are already thin on the ground.

Action is desperately needed to break this stalemate. Similarly, the strong potential linkages between organic farm wastes and energy need to be made, as biogas produced from such wastes offers the double virtue of reducing emissions of methane (a more potent greenhouse gas than CO_2) while producing heat and power. Rural communities and farmers need greater assistance to pursue energy options related to biomass and organic farm wastes. RDAs and other regional authorities should take particular care to identify appropriate sites for biomass or biogas plant in their spatial plans. A grant regime to assist feasibility studies and planning applications for rural cogeneration plant may also be required.

Industry and business

Like the domestic sector, industry is responsible for a third of UK electricity consumption. There is huge scope for industry to benefit from the economic advantages of DE – indeed more than 80% of existing cogeneration capacity in OECD countries is in large industrial applications, particularly in the paper, chemicals, petroleum refining and food processing industries.[135] Industry can already make use of the grid licensing exemptions provisions for on-site generation. Further incentives include ECAs at 100% for many DE technologies, and the exemption of both cogeneration and renewables from the Climate Change Levy (CCL). However, the cheap electricity provided to major energy consumers (see Regulation of the electricity market in Part II) is currently a major disincentive to DE investment for this important sector. Over time, though, the take-up of DE by the household and small business sector should increasingly drive the centralised generation sector to seek its profits from industry, raising prices for this sector and making DE investment look increasingly attractive. Moreover, DE uptake in industry would be greater if the EU ETS were to operate under a robust science-based and globally equitable cap.

The commercial sector also offers huge potential; there are around 300,000 offices in England and Wales and over 300,000 retail outlets across the UK.[136] The commercial sector is responsible for just under a quarter of UK electricity consumption. Greenpeace would like to see the Government provide a strong incentive for the sector to address energy use, through the alignment of business rates to the energy performance of business and retail premises. This would stimulate demand for ESCO services and DE technologies from the commercial sector. The obligatory certification of buildings' energy performance whenever they are sold or rented out, to be introduced under EU legislation,[xl] promises to make such a rate adjustment a wholly workable and effective policy mechanism. The Government should therefore embrace this aspect of the EU legislation and not seek to delay its introduction in the UK. Moreover it should increase the CCL to stimulate DE take-up further.[xli]

CHANGING MARKET AND ECONOMIC REGULATION

Transforming market and economic regulation to facilitate rather than disable DE presents a substantial challenge that will not be achieved overnight. While comprehensive reform is commencing, early action towards DE should be facilitated by raising the limits on grid licensing exemptions for private wires. This would enable new-build developments, including the largest, to incorporate 21st-century energy infrastructure from the outset, rather than delivering a suboptimal built environment that will present a climate burden for decades to come.

New build incorporating generation on private wires, delivered and operated by ESCOs, provides an unparalleled opportunity to pump-prime a strong ESCO and renewable power sector, since it enables the current complex regulatory barriers to DE to be avoided and the cost of laying heat and power infrastructure to be reduced by coordination with other civil works. Moreover, the larger enterprise opportunities available under a more liberal regime for private wires would better attract the interest of the investment community in backing delivery contracting ESCOs (as is common elsewhere in Europe), creating a truly competitive alternative to existing licensed suppliers dependent on centralised electricity generation. Accordingly, the 1MW limit on single private wires supplying domestic customers should be removed and no distinction made between domestic and non-domestic customers within the 50MW limit (or 100MW with the Secretary of State's approval). The 5MW non-domestic and 2.5MW domestic exemption limits for aggregated overspill onto public networks should also be removed. Exempt generators should be permitted to export as much surplus energy onto public networks as they need from each private wire. Over time, the expansion of DE networks and the relaxation on export limits will mean that UK electricity customers will be increasingly able to choose clean local power over dirty centralised power.

Beyond this first step, Ofgem should be given a fresh primary statutory remit explicitly aligned to the Government's four energy policy objectives set out in the 2003 Energy White Paper (see page 15). It would be absurd to allow a market framed by the technologies of the past to dictate future investments and system development. Instead, Ofgem should be charged with establishing a framework able to deliver a sustainable electricity system by 2050, and ensuring that the UK electricity sector meets interim CO_2 reduction targets through a diverse array of DE, renewables, system efficiency improvements and coordinated action with other government agencies on demand reduction programmes. Such a remit would enforce a long-term perspective and a more enlightened approach to technological innovation and climate security, sweeping away the regulator's present culture of shoring up business-as-usual. The huge emissions savings which must be realised from the UK's electricity sector can only be achieved by a purposeful and deliberate strategy of system reform. This should focus on delivering a regulatory regime and electricity marketplace that works for DE technologies and their many potential operators, delivering enhanced energy security as well as emissions reductions.

'Energy investments are generally long-term. Energy companies, industry and business and domestic customers need us to set clear goals and a strategy that supports them in making the long-term investments they need to make in energy efficiency and supply.'
Energy White Paper, 2003[137]

Instead of closing Lots Road power station, a trigeneration plant should have been installed to provide power and cooling on the London underground. ©Jonathan Evans/Rex Features.

Jeremy Leggett of Solar Century was one of the first to fit his home with building integrated photovoltaics. © Still Pictures/Bond.

British industry has the potential to benefit from adopting a long term DE pathway. ©Wavegen.

Early regulatory reforms Greenpeace would welcome include abandonment of the 28-day rule, the raising of grid licensing exemption limits for private wires, an attractive reward mechanism for surplus power from microgeneration (whether through a feed-in tariff or supplier buy-back), and the simplification and standardisation of rules on connection standards, ROC eligibility and metering for all DE installations up to 100kW in size. In addition, 'shallowish' connection charges combined with the new use-of-system (GDUoS) charges for use of local networks may lead to higher net costs for DE in some circumstances (see Regulation of the transmission and distribution networks in Part II). The option to forgo this combination and pay the full costs of connection should be retained. These steps would empower new energy actors to gain the expertise and capacity needed to make increasingly loud and informed demands for further regulatory reforms over time. For too long the regulatory regime has worked in favour of dirty centralised generation. In the short term at least, to correct this historic bias, the pendulum should swing decisively to support DE. A more level playing field can then be pursued over time.

'Ofgem should have a clear remit to promote innovation and remove any regulatory barriers to emerging technologies as a matter of priority.'
Joanna Collins, Green Alliance[138]

'We believe that the Regulator's interpretation of its primary duty to protect the interests of customers is too limited and short-termist. We recommend that the Government ensures that Ofgem's guidance underlines the importance of long-term planning for the provision of secure electricity supplies.'
House of Lords Science and Technology Committee, 2004[139]

With Ofgem's remit aligned to wider energy policy goals, the regulator would be committed to revising the current perverse economic regulation of the electricity sector. The overhaul of the DNO business model could be expedited to facilitate the growth of DE on low-voltage networks. Rather than enjoying financial rewards related to the volume of electricity passively conducted through their cables and the extent of investment in physical assets, DNOs could instead be transformed into active managers of local networks, rewarded for their performance in reducing energy wastage and incentivised to enable the efficient connection of new embedded generators and the buying and selling of electricity products across their cables.

Similarly, rather than expanding its centralised asset base, National Grid Company should be made to earn its keep balancing an increasing load of intermittent sources, as fossil-fuel and nuclear plant closure events allow greater and greater volumes of large-scale renewable capacity onto existing grid assets. In the longer term, the national grid may serve, not to transmit power from remote generators to users, but to enable demand-balancing energy flows between the largely self-sufficient regional power networks of the future. The company should be allowed to invest in local network development to allow it to redevelop its business model in the UK and to move on from its interest in centralised generation.

'The problem is that there is no single reform required but a tangle of old regulations designed for a bygone era which have to be modernised to encourage innovation.'
Chris Hewett, IPPR[140]

The cost comparisons of DE and centralised grid electricity cited in Part I (economic benefits) are based on orthodox economic analyses. But the escalating environmental and social costs of energy are increasingly hard to deny, and expose how crude today's energy markets are. In order better to reflect the true costs of different energy options, and to expedite the transition to a sustainable energy system, the environmental and social costs of electricity production must be internalised. Options for doing this include (as already mentioned) a more robust EU Emissions Trading Scheme, set within a science-based and globally equitable cap under which cogeneration receives distinct treatment reflecting its better environmental performance. However, such an approach would largely surrender responsibility for the urgent restructuring of the UK electricity sector to the machinations of EU politics. Supplementary fiscal measures at a UK level to penalise wasteful centralised generation – such as a plant efficiency tax – should therefore also be considered. In any event, regulation should be introduced immediately to ensure that no new combustion plant project proceeds unless it includes measures for the effective capture and use of its waste thermal energy output.

Cost comparisons between centralised and decentralised energy provision in the UK should be made as a matter of routine by the regulator and monitored by the Competition Commission. When network operators propose to recoup large planned investment expenditure through system charges, it should become obligatory to explore the decentralised option (including aggregated local generation and demand reduction from energy efficiency measures) as an alternative. This may represent a very meaningful future role for regional and local government in climate change mitigation.

Building integrated DE technologies – like these photovoltaics – increase energy production and reduce energy costs.
©Greenpeace/Weckenmann.

GOVERNMENT LEADERSHIP

The 2003 Energy White Paper clearly sets out a substantially decentralised vision for 2020 that should be further developed alongside a bold and coherent set of policy instruments to hasten the currently imperceptible rate of progress. Tackling the indefensibly poor emissions and efficiency performance of our electricity system must be at the heart of the revised UK Climate Change Programme. Similarly, the early opportunities represented by the forthcoming Microgeneration Strategy and current Sustainable Communities Agenda must be seized. Another priority for the new Labour Government should be the overdue reform of Ofgem and its remit. This should be supplemented by a new Decentralised Energy White Paper setting out a comprehensive strategy towards electricity decentralisation over the coming decades, taking into account cogeneration's potential to meet thermal energy needs. While the huge emissions associated with centralised electricity production mean that decentralised electricity production should be a priority for expansion, the value of DE technologies which deliver heat alone also needs to be recognised. For example, it has been estimated that across Europe, solar thermal applications alone could offset energy requirements equivalent to nearly a third of oil imports from the Middle East.[141]

To drive forward progress towards all these goals, a cabinet minister should be appointed with special responsibility for UK emissions reductions and the delivery of the new White Paper. Meanwhile, on the European stage, the UK should argue for an alternative model of EU electricity market liberalisation prioritising climate security, a level playing field for DE and renewables, and massive increases in DE.

Large parts of the UK's ageing grid and much of the country's large-scale generation plant, including nuclear plant, are nearing the end of their expected life. Detailed and comprehensive information is difficult to obtain due to commercial confidentiality. Nevertheless, this anticipated obsolescence of parts of the existing infrastructure presents a timely opportunity to reconsider and alter the pattern of system development. It is vital that closure events be made the basis of a long-term strategic plan for grid redevelopment and the prioritisation of remaining transmission capacity for large-scale renewables.

At the same time, as local capacity grows, demand on the higher-voltage transmission and distribution networks will decline. It is critical that this be anticipated. Rather than adopting a passive business-as-usual approach and allowing grid expansion in anticipation of new demand, thereby consolidating the centralised model and its technological inertia, the Government must now drive a coordinated programme of network redevelopment for DE, alongside a serious programme of fiscal incentives for demand reduction.

The photovoltaics facility on the roof of Berlin's Federal Chancellery shows leadership on climate change.

'The changes introduced by Ofgem may ease the burden on distributed generation, but fall far short of effecting any fundamental reorientation of the regulatory framework that penalises distributed generation. If the Government wish to encourage distributed renewable generation, they must therefore fundamentally review their strategy.'
House of Lords Science and Technology Committee, 2004[142]

CONCLUSIONS

Decentralising our electricity network offers the opportunity to join up and deliver on the UK's primary energy policy objectives – and more besides. The UK's energy discourse currently misses the real challenges that must be confronted and opportunities that must be seized in the face of climate change. It must change track. Politicians must debate and explore the merits not just of new generation technologies, but of a very different electricity (and wider energy) system – designed to unleash, rather than hinder, technological progress. The urgent threats posed by climate change demand that policy intervention move from peripheral tinkering to the mainstream of the energy system and in particular the electricity system where the scale of wastage, and thus of unnecessary emissions, is appalling.

The bizarre misalignment between Ofgem's remit and the Government's stated energy policy goals must be corrected and the regulator must work under an explicit primary obligation to develop a framework able to deliver a fully sustainable electricity system by 2050. A bold, strategic approach to future power generation and network reconfiguration is needed to drive the profound physical, institutional, professional and cultural change that climate change demands. Electricity is critical to the functioning of any modern society – but for too long our politicians have allowed that fact, alongside a misplaced faith in the UK's 'liberalised' electricity market, to blind them to the massive wastage and inertia inherent in the system.

New energy actors must urgently be enabled and incentivised to provide a genuinely competitive and sustainable alternative to business-as-usual and to offer increasingly informed input to the development of the rules and regulations needed to nurture a technological revolution in a sector where innovation has atrophied for decades. Private wire networks in new-build developments present an exceptional and immediate opportunity to pioneer a new electricity model, and growth of the delivery contracting ESCO sector should be encouraged in order to take this forward.

A complete review of energy policies leading to robust support for DE is required as part of a fresh Decentralised Energy White Paper, and analysis needs to be undertaken to identify the most effective ways to promote DE across all sectors and to establish real competition between sustainable energy and the centralised markets. Greenpeace believes that a comprehensive package of policy measures should include all the steps laid out below.

'There is a need for a step change in energy efficiency and for a radical shift from use of fossil fuels to low carbon energy generation. To achieve these ends, determined action is required at both Member State and EU level, as well as globally.'
Professor Sir David King, Chief Scientific Adviser to the Government[143]

'How did world electricity come to this? And where might it go from here? The question is too important to leave to insiders. How it is answered will affect everyone on earth.'
Walt Patterson, Royal Institute of International Affairs, UK[144]

KEY STEPS TO DECENTRALISED ENERGY
Greenpeace calls for:

1. **The Government to use the tax system to reward householders and businesses that install DE technologies such as solar panels, micro-wind turbines or cogeneration systems.** Tax incentives could include reduced stamp duty, council tax or business rates for properties capable of generating their own electricity, and expanded capital allowances for businesses.

2. **All new buildings to be required to incorporate DE technologies.** This would steadily cut emissions from the building stock and enable the retirement of power stations, while also transforming the economics of DE by creating economies of scale and cutting installation costs.

3. **Local sustainable energy systems to be encouraged through the removal of current limits on the development of private wires.** Limits on the export of power from these sustainable local systems should be raised. Together these measures would enable electricity consumers increasingly to choose clean local power over dirty centralised power.

4. **Local government to become a key player in moving to sustainable energy systems.** There should be area-based CO2 reduction targets, along with a statutory requirement for all councils to develop an energy strategy.

5. **All electricity suppliers to be required to purchase surplus electricity from domestic power generators,** at rates that will ensure the take-off of domestic generation.

6. **Inefficient, centralised power stations to be heavily penalised to reflect the damage they cause and to ensure that the most polluting are closed.** One way to do this would be to tighten up the European Emissions Trading Scheme. In addition, supplementary fiscal measures could be enacted at UK level, such as a tax on waste heat.

7. **No new fossil-fuel generation to be permitted unless it includes cogeneration.**

8. **A nationwide network of biomass or biogas cogeneration plants to be developed,** with Regional Development Agencies playing a leading role.

9. **Energy regulation to be completely overhauled.** Ofgem should be transformed into a sustainable energy regulator with its primary duty being to deliver substantial emissions reductions through the encouragement of DE. BETTA (British Electricity Trading & Transmission Arrangements) should be replaced with a more flexible and responsive system, which encourages genuine competition, and rewards rather than penalises cogeneration and renewables.

10. **The publication of a Decentralised Energy White Paper.** Instead of a new white paper on nuclear power, the Government should pull together all relevant parties to set out the necessary steps for a coherent and rapid transition to a decentralised energy system.

ENDNOTES

i Since the electricity sector is responsible for a third of UK CO_2 emissions and just under two-thirds (64.8%) of the energy inputs into the electricity system are wasted (see figures on p.26), the wasted energy can be estimated to account for a fifth of total UK CO_2 emissions.

ii Namely in Stirling engines, reciprocating engines, micro-turbines, renewables and fuel cells.

iii See Box 1 (p.19) on ESCOs and how they work.

iv A confusing array of terms are used to denote decentralised energy systems: 'embedded generation', 'distributed generation' and 'decentralised generation' or 'decentralised energy'. Embedded generation and distributed generation both refer to systems in which generators are connected to local distribution networks. Decentralised generation or decentralised energy means generation at or near the point of use – this does not necessarily entail connection to a network.

v 400kV or 275kV.

vi 11kV to 132kV.

vii According to the EU's definition, microgeneration refers to generation plant with an output of less than 50kW.

viii The economist Joseph Schumpeter championed 'creative destruction' as a critical component of a healthy capitalist economy.

ix 'Private wires' are supply cables owned by an ESCO or other private body and not by a distribution network operator (company managing a local public network).

x Plus the two regions making up the Scottish networks where transmission networks are at a lower voltage.

xi CO_2 emissions on an IPCC basis allocate 30% to power stations for 2003. By UNECE source the figure is 30.98%. However the figure is considered to be above those stated as they omit emissions from extraction and distribution of fossil fuels and fugitive emissions from solid fuels and gas. While emissions had fallen in 2002 they had risen in the two preceding years and were considered to be rising again throughout 2003. A figure of around one third is used within this report.

xii The Cabinet Office's Policy and Innovation Unit originally estimated heat networks to be 20 times as expensive as gas networks in its Energy Review (The Energy Review, PIU, 2002), but retracted this estimate when challenged by the Combined Heat and Power Association (CHPA). Greenpeace is informed by the CHPA that the costs of heat networks depend on a number of site-specific factors, eg whether they are being installed in new build and whether sewerage is being installed at the same time. Generally, 75% of the cost is for civil engineering (excavation and back-filling), while the cost of heat pipes themselves is coming down.

xiii An international alliance of decentralised energy companies that also includes national government members.

xiv With the obvious exception of small-scale hydroelectric schemes.

xv It is worth also noting the very close annual correlation between wind strength and peak electricity demand (see Figure 2.29 'Correlation of wind and electricity demand in England' in Lovins, A. Small is profitable: The hidden economics benefits of making electrical resources the right size, Rocky Mountain Institute, 2002).

xvi It is important to recognise that this figure is not an overall figure for retail price reduction, but is in relation to meeting new demand.

xvii The WADE scenarios run to date anticipate demand growth. Greenpeace is working with WADE on a set of scenarios for demand reduction.

xviii After pressure from industry, the UK added 19 million allowances to its earlier agreed quota of 736 million allowances for the first phase of the EU ETS, which runs from 2005 to 2007 (one allowance equals one tonne of CO2). However, the EU refused to accept this increase. In 2005, both sides launched legal actions against the other (see Defra press release EU Emissions Trading Scheme, 24 May 2005).

xix Estimates vary.

xx According to Ofgem, The review of the first year of NETA, 2002, available at www.ofgem.gov.uk/temp/ofgem/ cache/cmsattach/1984_48neta_year_review.pdf. No evaluation of the impact of NETA/BETTA on small generators has been carried out since then and this is overdue.

xxi To minimise the danger of global temperature rises exceeding 2°C, a level considered dangerous, a concentration of no more than 400ppm of CO_2 in the atmosphere is recommended, for example by the International Climate Change Taskforce. The EU's burden of responsibility to meet this science-based cap should be apportioned on the basis of equal global rights to carbon consumption.

xxii Under the EU ETS emissions are allocated on a site basis, not a net emissions basis (one which would reflect the capturing of heat and the consequent saving in emissions as a result of the reduced need to obtain heat from elsewhere). This means that the environmental benefits of cogeneration are not recognised by the scheme – the emissions from a cogeneration plant producing heat and power offset the need for the much greater emissions associated with the separate supply of heat and power, yet cogeneration plant operators are expected to buy equivalent amounts of carbon certificates to their wasteful centralised counterparts. The DTI's own figures show that cogeneration already delivers total emission reductions of between 3.3 and 4.6 million tonnes of carbon each year in the UK. This benefit needs to be reflected by requiring the ETS to reward cogeneration emission offsets.

xxiii Ofgem claims that this is not the case and that Scottish renewables will benefit from access to the wider GB electricity market. This is strongly disputed by the Scottish Renewables Forum and Scottish Nationalist Party, who argue that under BETTA the option to sell to local markets has been removed, increasing transmission costs for renewables substantially. The Government was sufficiently concerned about the impact of BETTA on remote renewables that it stepped in and capped transmission prices proposed by Ofgem for renewable generators in the north of Scotland and the Scottish islands.

xxiv This means that DE plant seeking network connection now pays for the local costs of connection to the network, but not for any more distant changes to the network that may be necessary as a result of that connection. In return, DNOs can impose the Generation Distribution Use of System (GDUoS) charge on new DE plant. In theory these arrangements should reduce the upfront costs for DE connectees.

xxv £3 per kW of connected assets per year.

xxvi 'Shallowish' connection charges combined with GDUoS could lead to higher net costs for DE in some circumstances.

xxvii Above 16 amps per phase (roughly 3kW) connection standards are at the discretion of the DNO and, even if most DNOs are reasonable in their demands, all contracts are different, complicating the implementation of DE. A requirement for expensive half-hourly metering is applied to generators over 30kW for central electricity settlement purposes under NETA. Generators under 50kW are currently only eligible for ROC payments annually, as opposed to monthly, which can cause cash flow problems for smaller operators.

xxviii For their contribution to meeting the Government's renewable energy targets.

xxix See also Collins, J., A microgeneration manifesto, Green Alliance, 2004 for further information on barriers to microgeneration.

xxx Exemptions from grid licensing were originally envisaged for use by large-scale industry.

xxxi In the interests of householder protection, it is illegal under the Electricity (Class Exemptions from the Requirement for a License) Order 2001 to lock domestic customers into a long-term contract for energy services on a private wire, unless the terms are more competitive than services provided through local public wires and the savings are index-linked to grid electricity prices for the duration of the contract.

xxxii Its full name is Policy and Regulatory Roadmaps for the Integration of Distributed Generation and the Development of Sustainable Electricity Networks.

xxxiii £38 million was provided for nuclear fusion research by the DTI in 2000–01 – the most up-to-date figures we could find. Of this, £14.3 million supported UK research and £23.5 million went to EURATOM. Nuclear fusion research is not expected to deliver any practical benefits for 30 years.

xxxiv This is not the final figure and only covers liabilities up to March 2005. The Government may have to contribute more if British Energy can not fully fund future liabilities.

xxxv Under the Energy Act 2004 (Section 83) Ofgem is required as a secondary duty to contribute to 'the achievement of sustainable development'. However, in a written answer of December 2004 – months after the Energy Act came into force – Energy Minister Mike O'Brien stated that it was for Ofgem to interpret its own statutory duties and that the most recent guidance provided by the Government on sustainable development to Ofgem had been supplied prior to the passing of the Energy Act in February 2004. (Written answer by DTI to Simon Thomas MP, 21 December 2004). The lack of fresh guidance following the Energy Act does not inspire confidence in the status of Ofgem's new sustainable development obligation.

xxxvi Although it may be treated more like one in future when viable storage technologies are available.

xxxvii It is estimated that 10 million meters in the UK have reverse running – this means that the meter will run backwards when energy generated onsite is exported, effectively rewarding onsite microgeneration with the same price as is paid for domestic supply. The prevalence of reverse-running meters is of great concern to Ofgem in its current consultation. In any case, Greenpeace believes that current take-up of microgeneration is too small for these concerns to warrant serious attention at this stage.

xxxviii See Collins, J., A microgeneration manifesto, Green Alliance, 2004 for a wider range of fiscal instruments.

xxxix ECAs currently cover some DE technologies, such as cogeneration and solar thermal systems. They also cover energy efficiency technologies such as pipe insulation and heat pumps for space heating.

xl The Energy Performance of Buildings Directive.

xli There is a good case for increasing the CCL, since business has made more money from the reduction of National Insurance Contributions (introduced to compensate for the CCL) than it has expended on the CCL. In 2003 receipts were £831 million from the CCL while the NIC reduction was worth around £1.5 billion (data supplied to Greenpeace by Dr Bridget Woodman, Warwick Business School, 2005).

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A solar dish captures enough solar energy to generate heat to cook for 2,000 people each day in Auroville, India. ©Greenpeace/Novis.

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