(from Facing The Challenge: of global climate change,
International Emissions Trading Association, 2009)

Decarbonizing Electricity

By Walt Patterson

Of all the ways we use energy, electricity should be the easiest to decarbonize. An extraordinary assortment of electrical technologies provide us with comfort, illumination, motive power, refrigeration, and information in endless variety. We can get the electricity to run these user-technologies from a rapidly lengthening catalogue of generating technologies. Some use fuel more efficiently; others need no fuel. If we wish we can already get our electricity services with low carbon or no carbon. Moreover, the traditional model of electricity in society is now evolving at a hectic pace. Options and opportunities for beneficial change, including decarbonization, abound. So, however, do obstacles.

Traditional electricity is based on a model more than a century old, replicated worldwide. It presumes that we generate electricity in very large power stations a long way off, and deliver it over vast networks to user-technology such as lamps, motors and electronics, almost all much smaller than the generators. This arrangement arose because generators used to depend on water power or steam power, for which bigger meant cheaper. But the configuration is inelegant and inefficient. A large steam-cycle power plant wastes more than half the fuel-energy it uses even before it leaves the plant. Most lights, motors and other user-technologies operate only part of the time; but large steam-cycle plants ought to operate continuously - a challenge to system managers, imposing costs and wasting assets. Networks are vulnerable to disruption, by mishap or malice. Even in rich countries keeping the lights on gets steadily more difficult. Elsewhere, traditional electricity has left some two billion people - almost one-third of humanity - with no electric light at all.

We do not have to accept the shortcomings of traditional electricity. We can do much better. If we were starting anew to establish electricity systems, with what we now know about technology, finance, business and environment, twenty-first century electricity would look utterly different from traditional - more reliable, more efficient and cleaner. We are not, however, starting anew. Those of us who do have electric light rely on what in the US are called 'legacy' assets - existing traditional facilities - to keep our lights on. We cannot upgrade or replace them overnight. With legacy assets come legacy institutions and legacy mindsets - the way we think about electricity in society. That, too, must change; and the change will take time.

Unfortunately, another major change, set in motion two decades ago, has complicated matters. The UK and other countries 'liberalized' electricity, breaking up monopoly franchises and introducing competition between generators: an 'electricity market' selling kilowatt-hours as a commodity - as

though electricity were equivalent, for instance, to natural gas. It is not. Electricity is not a substance; it is a process in infrastructure. Electricity as we now use it cannot be stored, or withheld from a market until the price is right. In the past two decades the consequences for electricity business have been traumatic. Without captive customers to bear the risks, and with the key financial determinant the ephemeral price of a kilowatt-hour, liberalization has made investment in electricity supply assets a hair-raising adventure. Many players have lost their shirts, their jobs or their companies. Instead of a thriving free market in electricity, with many participants, easy access and minimal regulation, liberalization has created an international electricity oligopoly and a regulatory minefield, with rules perpetually in flux.

This ferment of uncertainty, however, opens the way for more coherent, innovative policies and plans. One key is to recognize that we can now generate electricity close to where we want to use it, on the same site or even in the same building, reducing vulnerability to the power cuts and price rises endemic in traditional electricity. Small-scale modern generating technologies now available include gas engines, Stirling engines, microturbines and fuel cells, all able to produce not only electricity but also heat, steam or hot water, more than doubling the useful energy obtained from fuel, and hence cutting carbon dioxide emissions in half. Solar photovoltaics, using no fuel at all, can become part of the building fabric. Moreover, if you are generating your own electricity and heat on site, you will want to make sure you do not waste it. On-site generation and cogeneration will also prompt you to upgrade the thermal and electrical performance of your buildings, lighting, motors, refrigeration, electronics and other user-technology.

This whole-system approach will be a key to the electric future, with integrated optimized local systems in buildings, neighbourhoods and villages. It will be dramatically enhanced by information technology, allowing generators and user-technologies to communicate with each other continuously in real time, matching loads and generation instant by instant. Such systems can be self-stabilizing and autonomous, with no need for human dispatchers. Local systems will not, however, be isolated. They will be loosely connected with larger-scale renewable generating technologies, including wind turbines, concentrating solar generators, and marine generators using waves and tides, using no fuel and creating no carbon dioxide. Hydroelectricity with large dams is renewable but problematic. On the other hand, small-scale hydroelectric generators that do not require dams may be especially valuable in many rural areas, particularly for village systems. So may generators based on modern combustion or gasification of local biomass.

Decarbonizing electricity may thus go hand in hand with decentralizing electricity. In some parts of the world the process is already under way. As yet, however, it meets with stubborn opposition from traditional large-scale centralized electricity, and from those now doing well out of traditional electricity. They warn us that unless they are allowed to build new traditional coal-fired power stations, unless governments and taxpayers help them to build new nuclear power stations, the lights will go out. They insist that innovative smaller-scale generation, cogeneration and renewable generation are too costly and unproven. Traditional networks, meanwhile, are essentially one-way and radial, set up to deliver electricity from remote large-scale generation. Innovative electricity, especially local systems, need two-way meshed networks interconnecting large numbers of small generators and loads of broadly similar size. In some places, network configurations are evolving appropriately. In too many others, however, traditional networks pose major impediments to innovative electricity, both technical and regulatory, and are proving obstinately resistant to change.

Change, however, is coming. Traditional electricity people declare that costs determine policy; in fact policy determines costs. Effective electricity policy will make reliable, clean electricity the cheapest. As governments confront the global financial crisis, US President Barack Obama and other leaders have recognized an opportunity to be seized. They can invest to upgrade government facilities, improve the performance of energy technologies, and foster innovative generation and smart networks, making electricity fit for the twenty-first century. Decentralizing and decarbonizing electricity will deliver not just better services but healthier economies around the world. What are we waiting for?

Walt Patterson is an associate fellow of Chatham House, London. His latest book is Keeping The Lights On: Towards Sustainable Electricity. *Walt Patterson On Energy, <www.waltpatterson.org>, is an online archive of his work for four decades.*