Enabling the UK's smart-grid future: The wireless spectrum debate

A Greenbang strategy paper

Greenbang
thinking about planet management

Dan Ilett | Research Director
3rd Floor, Isis House, 74 New Oxford Street, London, WC1A 1EU
UK: +44 20 7193 7006 | dan@greenbang.com | Skype: danilett
Twitter: @greenbang, @danielilett
www.greenbang.com

About the research

Enabling the UK's smart grid future: The wireless spectrum debate is a Greenbang Research strategy report. Greenbang Research bears sole responsibility for the contents of this report. Our editorial team provided the analysis, conducted the interviews and wrote the report.

In preparing this report, we conducted intensive desk research and interviews with a wide range of executives and academics involved in smart metering and/or smart grid research, development or deployment.

We set out to answer the following questions regarding the use of wireless spectrum in the development of the UK's smart grid:

- Should dedicated wireless spectrum be allocated to UK utilities for smart-grid systems? If so, why?
- What, if any, cost factors would enter into a decision to allocate a dedicated spectrum for utilities?
- Is the lack of spectrum allocations slowing or hindering the development of smart-grid systems in the UK and the broader EU?
- What future drawbacks could the smart grid face without a dedicated spectrum for utilities?
- To what degree is an optimised smart grid dependent on a dedicated spectrum allocation? And is there an ideal range for spectrum allocation?
- Does the EU need to adopt a continent-wide spectrum allocation and, if so, what would be the benefits? Would there be any benefits to each country/market establishing its own spectrum allocation?

Executive Summary

With the UK on its way toward deploying smart electricity meters to all 27 million households by 2020 at the latest—an initiative announced in 2010—regulators, energy utilities and technology companies are already looking ahead to the next logical step: an end-to-end smart-grid infrastructure. Such a grid would enable utilities to not only monitor and manage energy demands and issues at the consumer level, but at every key point along their transmission and distribution networks.

Combined with the data generated by a new generation of smart meters, the information flowing back and forth from all these devices on the grid will lead to a huge surge in data that utilities will need to track and manage.

While this will create a major opportunity for new services, potentially from new market entrants, it will also present a substantial communications challenge for utilities faced with overseeing what will be, essentially, an "internet of things."[i]

Such a fully smart grid in the UK would connect, ultimately, not only 27 million smart electricity meters but more than 600,000 devices across the power transmission and distribution systems. Wiring so many elements together would be a daunting and costly task at best, suggesting wireless communications will prove the preferred solution.

In its 2009 report, *The Utility Spectrum Crisis: A Critical Need to Enable Smart Grids,* the Utilities Telecom Council (UTC)—a global trade group that advocates for power companies and other organizations with critical infrastructure communications needs—noted that wireless networks are "among the most critical components in a utility's communications arsenal."

Among the activities wireless networks enable for utilities are: voice communications, dispatch, crew-to-crew communications, emergency calls, interconnection with landlines, data messaging and reports, telemetry, supervisory control and data acquisition (SCADA), automated meter reading, remote device monitoring and remote video for security.

For the same reasons, many stakeholders involved in the planning and implementation of the UK's smart grid believe that wireless communications will be the best way to ensure the future infrastructure's reliability, resilience and security.

If a wireless approach is taken, the most robust and secure approach would be for UK regulators to dedicate a frequency range on the wireless spectrum specifically for smart-grid operations, rather than having utilities depend on existing public wireless networks or proprietary managed services, just as they have done for mobile phones and other devices.

An alternative approach could lie with lightly licensed spectrum, which would not be

[i] "The Internet of Important Things—Smart grid: an intelligent test case," a 2009 report from the ICT consultancy Helios, describes the internet of things (IoT) as a network enabling machine-to-machine communication without human intervention: "Some 'Internets' are also more easily implemented than others due to size and power availability: developments in 'smart grid' technology which interconnects utility meters are therefore a logical first step towards the growth of the IoT, given the availability of local power sources and of space within meters to accommodate a connecting device."

Executive Summary (continued)

exclusive but would also not incur the potentially high costs associated with commercial spectrum that is auctioned-off, although such an auction may be appealing to the Treasury precisely in order to raise additional revenue.

The key findings of this research include the following, each of which are reviewed in more detail within the report:

- Dedicated licensed—or at least lightly licensed—spectrum will be important for ensuring the effectiveness of the UK's future smart grid.
- A decision on spectrum allocation for the UK's smart grid will likely be needed within the next three to five years.
- Several technology trends—among them micro-generation and plug-in electric cars—are driving dramatic changes for energy utilities and could, if they accelerate, require an even earlier decision on spectrum allocation. These trends will also deepen the business case for dedicated spectrum. In the US, for example, a fully smart grid would be expected to cut losses from power outages by $49 billion per year, and save over $20 billion in energy costs between now and 2030.
- The smart grid is too critical a development to be guided by the standard, market-based approach toward spectrum allocation. Energy utilities are as much first responders as police, fire and medical personnel during severe weather and other disasters. In fact, other emergency personnel often *can't* respond fully until energy utility issues, such as downed power lines, are resolved.
- Tomorrow's smart-grid communications system will need to be able to accommodate a "tsunami" of data that is exponentially higher than today's levels. Experts believe that data traffic from smart metering and smart grid infrastructure could result in as much as 800 terabytes of information being sent over the network per year—roughly equal to how much raw web data is processed by Google.
- The lack of access to spectrum for smart-grid communications could raise significant reliability and scalability issues, as well as cost and market development concerns. ■

Introduction: The dawn of a smart grid

Wherever the main impetus for the deployment of smart-grid infrastructure is coming from—some believe the pressure is primarily political for now, while others emphasise that early-adopters have already established a solid business case for supporting a smart grid—development has now gotten under way with the UK mandate for 100 per cent smart metering, and will continue to move forward steadily, if not necessarily rapidly.

The pace of development will rely on a number of factors, including technology, adequate investment, and public support. However, a primary factor will be which platform ultimately wins out for smart-grid data communications. At the moment, the consensus is that radio-based communications will be the preferred method for sending and receiving data from meters and myriad other points on the electricity grid. What portion of the radio spectrum those communications will take part on, however, is as yet undecided.

A decision on that will need to come sooner rather than later, as a solution needs to be in place that can allow for competitive, robust, widely available and scalable communications that will not only work with the soon-to-be-rolled-out smart meters but with additional smart-grid features to be built upon that in years to come. Smart metering alone will considerably raise the amount of data flowing between end-users and utilities. Additional smart features will increase that data exponentially.

Because of the mission-critical nature of electricity service, the communications solution for handling that vast amount of data will also need to be secure, fast-responding (ie, low latency) and free from interference from less-vital communications. That suggests a dedicated portion of spectrum is the preferred option moving forward.

Support for such a dedicated and, preferably, licensed band of spectrum is growing. This report examines why this approach is important, and the implications it holds for the UK's fledgling smart-grid infrastructure. ■

Table 1: Advantages and disadvantages of different network solutions for smart-grid communications

Solution	**Advantages**	**Disadvantages**
Cellular networks	Straightforward deployment; adequate capacity for initial data traffic levels expected from smart meters	Difficult to upgrade on mass scale as old technology becomes obsolete; limited revenue incentives for cellular carriers; limited coverage in some areas
Wireless mesh networks	Resilient and self-healing, akin to a "wireless internet"; no need to upgrade unless underlying devices (ie, smart meters) also need replacing	Offers connectivity only between network nodes; as number of nodes grows, capacity of existing mesh access points can be exceeded
Hybrid cellular-mesh networks	Easily scalable as number of devices and data traffic grow; adaptable for different devices and types of data traffic; adequate coverage; no need to upgrade unless underlying devices (ie, smart meters) also need replacing; greater revenue incentives	

Understanding spectrum allocation

In the UK, the management, licensing and allocation of spectrum fall under the authority of the communications regulator Ofcom. Established in 2003, Ofcom takes a market-based approach toward spectrum management in which frequencies are put up for auction to "secure the optimal use of the radio spectrum," according to Ofcom's website.

As the UTC made clear in its spectrum report, wireless communications already support a wide range of critical activities for utilities today: from voice communications and dispatching to telemetry, SCADA and remote device monitoring. Add to that existing mix a new population of millions upon millions of smart meters and smart transmission and distribution devices, and other communications options fall short. For example, power line carrier, or PLC, systems can transmit data across transmission lines; however, they are known for their high levels of noise.

Public wireless networks, on the other hand, offer the best coverage in high-density areas; less sparsely populated regions can receive spotty or even non-existent coverage, which is not an option for utilities with a mandate to serve customers everywhere. Some wireless radio frequencies are also less effective than others at transmitting through walls or into basements, making them less than ideal for an infrastructure that includes indoor smart electricity meters and smart appliances such as hot-water heaters.

Ofcom had its first consultation on the future use of two specific bands in the potential range for smart-grid communications in 2006: 872-876 MHz and 917-921 MHz. As technology development continued apace in the ensuing years, it issued a second consultation in 2009. Among those responding to the consultation was the smart grid firm Silver Spring Networks, which noted:

"The Smart Grid will depend on a highly capable communications platform. This Smart Grid communications platform must meet a demanding set of requirements, principally Coverage, Capacity, Responsiveness, Reliability, Longevity, Security and Affordability.

"While each may well play an important role, none of the communications technologies currently available in the UK … can fully meet these requirements ... This lack of viable communications options is holding back deployment of Smart Grid in the UK, while other countries move ahead aggressively.

"The 872-876 MHz and 917-921 MHz frequency bands, at reasonable power levels and channel widths, are ideally suited for Smart Grid, in terms of range and penetration. The proximity of these bands to the ISM (Industrial, Scientific and Medical) band used in the Americas and Australia offers the potential for the UK to benefit from substantial economies of scale, since it should be possible to use the same radios across all markets."

While a firm like Silver Spring Networks admittedly has a vested interest in seeing a dedicated spectrum allocation for the smart grid, others also support such a solution. Canada, for example, has already allocated 30 MHz of spectrum in the 1.8 GHz range for utilities nationwide. UK officials have also acknowledged the need for more bandwidth for utilities. In a House of Commons report on "The future of Britain's electricity networks" released in early 2010, the Energy and Climate Change Committee stated, "(T)here is a lack of suitable spectrum currently available in the UK, which

Understanding spectrum allocation (continued)

is preventing companies wishing to deploy the 'wireless mesh' approach from entering the market here." The report went on to note:

"Creating smarter distribution poses significant challenges. Although many of the technical aspects are well-understood there is relatively little experience of their application to the smart grid. Furthermore, the regulatory framework does not at present provide a level playing field for the adoption of smart grid solutions, such as active demand management.

Ofgem [the energy regulator] must address these issues in the coming years. One area in which we believe it could make an immediate difference is to work with Ofcom to ensure the allocation of suitable spectrum for smart grid use as soon as possible, thus enabling the full range of smart grid technologies to be considered for deployment in Britain."

While current solutions might be adequate for today's level of smart-grid deployment in the UK—mostly automated meter reading with some smart metering pilots—the amount of data generated in a fully smart grid would be beyond the capacity of existing systems. S. Massoud Amin, a professor of electrical engineering and director of the Technological Leadership Institute at the University of Minnesota, estimated a full-scale smart-grid deployment would increase today's utilities data management demands more than ten-fold.

Since that most recent Ofcom consultation, the UK's energy regulator Ofgem and the Department of Energy and Climate Change (DECC) have published their long-awaited consultation on smart metering standards and technologies. Among the questions they are seeking input on is whether a radio frequency mesh topology will be an option for the UK's smart metering network.

Whatever the selected approach, the pressure is on for Ofcom to resolve the issue of whether to allocate dedicated spectrum for the smart grid in the first half of 2011, when Ofgem plans to release a package of smart-metering measures based on the responses it receives to its prospectus. Even if this time-frame is achieved, the smart-grid community faces a long road ahead until the spectrum is made available—and uncertainty about what it will cost.

Key findings in detail

- **Dedicated licensed—or at least lightly licensed—spectrum is important for the smart grid infrastructure, but not all stakeholders are as yet up to speed on its importance.**

Technology vendors, particularly those in the automated meter infrastructure (AMI) space, are realising that an adequate range of dedicated or, at minimum, lightly licensed spectrum to support smart-grid communications will enable them to develop more effective product lines that will help them tap entire markets, rather than just certain segments.

Utilities, too, are beginning to appreciate that such an approach would allow them to be able to shop around with a variety of vendors all supporting the same range for data communications, rather than being locked into a proprietary system of some sort.

Furthermore, faced with a host of emerging issues that will change the way they operate—an expanding base of renewable energy sources, micro-generation, a shift from gas heat to ground-source heat pumps and an increasing number of electric cars, among others—utilities are beginning to think hard about all the elements needed to build a smarter grid infrastructure that can meet the challenge.

That challenge, as wireless products and services vendor Airspan puts it, is to “maintain grid reliability while also vastly increasing the communications complexity by upgrading the grid to support real-time two-way broadband communications from the utility operations centre all the way to the consumer’s meter.”

Ultimately, a dedicated or lightly licensed spectrum that could support reliable smart-grid data communications is important for every sector involved, from regulators to vendors to utilities. However, not all stakeholders fully grasp the importance of a specific spectrum allocation for smarter energy distribution and management—and its associated implications.

Adrian Grilli, managing director of the UK’s Joint Radio Company (JRC) and Special Spectrum Advisor to the European Utilities Telecom Council (EUTC), notes that politics is also colouring the smart-grid and spectrum debate. With the UK government pushing for rapid deployment of smart meters and, ultimately, a smart grid, utilities publicly acknowledge their support for such technologies, he believes. Behind the scenes, however, many utilities are less eager to leap in as they don’t yet see a strong business case for the transition. While a smart infrastructure will be put in place eventually, it is the government—rather than utilities—setting the time-frame, which could be likely to slip.

Compared to the response advocates of dedicated spectrum for the smart grid would have received just a few years ago, however, decision-makers at businesses and government alike appear more receptive to the need for dedicated spectrum today. But whether that receptiveness can be translated quickly enough into meaningful action remains highly uncertain.

There would certainly be benefits to doing so: a unified range of spectrum would help today’s vendors with their product development processes and, over the longer term, ensure that utilities could benefit from a market in which vendors could compete against one another on a level playing field. For utility companies, that could mean lower-cost solutions going forward.

“It is not just smart grid that is being thwarted, but Wimax and other technologies,” says Steve Boultwood, a senior executive at RAD Data Communications, a vendor partner of the EUTC.

Key findings in detail (continued)

- **Developing a secure and reliable smart grid infrastructure will require a shift away from the traditional market-based approach to spectrum management and allocation. The smart grid is too critical a development to be guided by the market alone.**

While market-based thinking has worked for the traditional energy industry, the transition to a smart grid will require a different approach. That's because one of the ideas behind a smart-grid infrastructure is to encourage customers to consume *less* of what utilities are selling—whether electricity, gas or water—rather than more.

"Ultimately, a smart grid must lead to a fundamental transformation of the power sector beyond a technical re-design," notes Rahul Tongia, principal research scientist at the Center for Study of Science, Technology, and Policy (CSTEP), a non-profit research organization based in India. In a white paper on smart grids last year, Tongia writes, "Most distribution utilities world-wide are regulated, and many operate on a costs-plus mechanism. Thus, the more they sell, the more money they make. Such profit mechanisms must be re-engineered to incentivize saving energy. What fraction of investment costs can be passed through to consumers must also be clarified."

Utilities are also in a different position from commercial network providers as they must provide service—and, hence, communications support—across an entire region, not just in areas where population density makes investment a worthwhile business proposition. Furthermore, their services are required around the clock with 99.999 per cent reliability, even—or more accurately, especially—when extreme weather or other events interrupt commercial communications.

As the UTC noted in its utility spectrum report, "Critical infrastructure entities can no longer be viewed, as they have been in recent years by the (US) Federal Communications Commission, as 'commercial' enterprises with the same resources as the nation's public communications carriers to purchase spectrum. These entities are not in the commercial communications business, and they do not build for-profit systems designed to serve high-density populations with consumer-oriented features. Moreover, most utilities are prohibited by either regulation or statute, not to mention insufficient capital, from participating in high-dollar auctions. As a matter of national economic and security policy, spectrum and wireless infrastructure used to support the availability of basic necessities like water, gas and electricity must be available at a reasonable cost."

As in the US, the attitude toward spectrum management in the UK and throughout Europe has long been essentially to let the highest bidder prevail: governments have focused their roles primarily on deciding when and which slices of the spectrum to offer up for auction, and for how long those deals should last. Once the appropriate agency had collected its revenues from the auction, it was done until that allocation had expired, setting in motion the next round of auctions. "The frequencies have been bought and sold like gold futures without regard to national imperatives," notes RAD Data Communications' Boultwood. This is especially the case in the UK, where the government takes a particularly market-oriented approach toward decision-making.

There's been considerable talk of the smart-grid infrastructure benefiting from the "digital dividend" created by the recent switch from analogue to digital television. However, utilities

Key findings in detail (continued)

aren't the only ones eyeing that portion of the spectrum that is opened up: television broadcasters are trying to retain as much as possible, advocates of greater broadband access view those frequencies as a resource for disadvantaged communities and mobile broadband players also want a piece.

There is a possibility that certain, older frequency ranges on the spectrum that have fallen into disuse could be allocated for the smart grid, but such an outcome is by no means certain at the moment. As with the digital dividend from television, there is also the concern that other sectors, such as mobile carriers, might want to grab such frequencies for themselves.

With significantly less unlicensed spectrum available to the commons in the UK versus the US, other options for the British smart grid might include:

- Ofcom encouraging the government, in particular, the military, to release a portion of its spectrum for smart-grid communications;
- Adopting, at least for the near term, a solution being offered by communications infrastructure company Arqiva, smart grid specialist Sensus, IT services provider BT and intelligence/security firm Detica, which proposes to implement a purpose-built platform that would let utilities communicate with their smart meters over a licensed and dedicated band of radio spectrum.

Sensus, in fact, already has purchased dedicated spectrum that it leases to its customers, and expects ongoing developments in the smart grid will require additional future purchases. "The acquisition of additional spectrum is something we'll look at moving forward," says Randolph Wheatley, a vice president at the company. "We fully expect there are going to be some substantial new demands."

- **Securing a dedicated or lightly licensed spectrum allocation for the smart-grid infrastructure is something that needs to occur in the short term, rather than the medium- or long-term. This will be especially necessarily as utilities start looking beyond smart meters to a fully smart grid.**

While Italy and the Nordic region have beat the UK to the punch in terms of widespread deployment of smart electricity meters, Britain has announced plans to have the country fully smart-meter-enabled by 2020 or sooner. Other countries in the EU—in particular, Ireland, France and Spain—also have large-scale smart-meter deployments in the works in the near future.

With such smart metering initiatives under way, if not yet completed or universally deployed, many companies are now looking ahead to the next phase: a comprehensive smart-grid infrastructure. And organisations such as the global UTC have recognised that the next level of development will require a robust system for wireless communications.

Although the focus for now remains on smart metering, early-stage plans and procedures for moving on to deploying a smart-grid infrastructure will probably need to start being put in place within the next three to five years, if not sooner. That means the issue of spectrum allocation for smart-grid communications should be resolved as early as possible. "The next 18 months will be critical," predicts Peter D. Moray, director of the EUTC.

Accordingly, simply waiting for another portion of spectrum to become available through normal processes isn't an option, as spectrum

Key findings in detail (continued)

is typically allocated in 15- to 20-year cycles. Given the targeted rollout for the UK's smart grid, that is simply an impossible time-frame for the necessary planning and deployment.

The UTC is one of the agencies at the forefront of addressing that concern. It is making a concerted push to get its European members to speak with the regulators responsible for spectrum decisions in their respective countries and urge for action soon on spectrum allocations for the smart grid.

While the ideal solution might be for the European Commission to specify a continent-wide frequency and nationalise it, that appears highly unlikely to occur at this time. That means individual countries must either work together to reach an agreement on a common spectrum or establish their own national frequencies to support development of the smart grid.

Another option would be for utilities themselves to take the lead and buy a portion of spectrum together. However, even that remains a tall order for the near future. "It would seem very hard to get all the companies aligned to anything, let alone take a long-term investment view," says Boultwood. "Commercial considerations make this an expensive direction and the tax payer cannot subsidise a concept."

- **A solid business case exists for dedicated spectrum for the smart grid, although this is not widely understood. Various factors, including micro-generation, use of ground-source heat pumps and electric cars, are making the technology viable—and if uptake is more rapid than expected, energy utilities' could find their communications systems exposed.**

Building tomorrow's smart grid involves more than simply tacking on "smart" features and devices to today's energy infrastructure. The very nature of electricity generation and distribution itself is changing dramatically, which will put entirely new pressures on utilities. Those pressures will require energy companies to manage vastly more sources of electricity and significantly boost today's levels of generation to accommodate technologies that currently rely on fossil fuels.

The recent introduction of feed-in tariffs in the UK, for example, is expected to spur a new population of home-based energy generators: small-scale solar and wind installations that will be able to send surplus electricity back into the grid. That will create a whole new network of energy nodes that will need to communicate with utilities for efficient management of supply and demand.

With the Department of Energy and Climate change making an £850-million-plus investment in the Renewable Heat Incentive starting in 2011-12, the UK can expect a trend toward ground-source heat pumps and away from gas heating, which will also pose a growing challenge for energy companies. While such heat pumps promise an effective means of reducing the country's dependence on domestic and imported natural gas, they also create an increased need for domestically generated electricity for their operation. Any large-scale deployment of ground-source heat pumps will bring with it a proportionately large increase in demand for energy from utility companies.

So too will the shift away from petrol-based transport to plug-in electric cars, a transition that is viewed as critical both for curbing greenhouse gas emissions and for reducing dependence on imported oil. More electric cars not only raises

Key findings in detail (continued)

the challenge of greater electricity demands, often at peak charging times, but also creates an opportunity for utilities as a potential new source of energy storage that can be tapped at times when other sources are unavailable or inadequate.

As with small-scale renewable sources of energy, plug-in cars will bring with them a much greater need for utilities to communicate with and manage many new nodes on the electricity grid. In any form of mass deployment, electric cars will prove “a huge problem for the network,” Moray notes.

While the challenges of integrating such new elements into today’s grid are daunting, the costs of not doing would be even steeper, according to Amin. In the US, for example, Amin says a fully smart grid would be expected to reduce losses due to power outages by about $49 billion a year, cut carbon emissions by 12 to 18 per cent annually, save $20.4 billion in energy costs over the next 20 years and significantly reduce the need for infrastructure expansion (ie, new power plants, transmission lines, etc.) to accommodate growing peak demand.

- **The exponential growth rate of data transfer that will be brought by smart meter and smart grid deployment adds to the need for dedicated spectrum. Connecting the tens of thousands of connection points that exist on each distribution network will generate a “tsunami” of data for utilities across the UK.**

Start adding up the numbers of devices that exist on today’s electricity grid, or will soon be added to it, and the scale of the data management issue quickly becomes apparent.

First, there are all the technology assets—transformers, circuit breakers, switches and substations—on the existing grid that will require a means of sending and receiving data to help utilities gain better intelligence and improve management as part of any smart-grid deployment.

There are an estimated 600,000 such assets across the UK’s electricity networks today. If even half of them require data communications, that is more than a quarter-million devices with data flowing back and forth from utilities.

However, many believe the need for communications will more likely extend to *all* such devices, increasing the potential data management demands across the wireless networks even more.

The government’s plan to equip every household in the UK with a smart electricity meter by 2020 or before brings on another 27 million devices that will need to communicate with utilities on a frequent basis.

The amount of data likely to be generated in a smart-grid deployment is exponentially higher than that being carried by wireless networks today, adds the University of Minnesota’s Amin. He terms the increase a “tsunami” of incoming data.

With both smart metering and a smart-grid infrastructure in place, that wave of data traffic could quickly reach Google-like proportions, Amin expects.

Key findings in detail (continued)

- **Security and reliability concerns also support the need for dedicated spectrum. Electricity, gas and water distribution are all society-critical services that need to be both safely managed and available at all times.**

While utilities could certainly use existing public wireless networks to handle their data communications needs, that approach raises valid concerns about both congestion and reliability. A stressed wireless network supporting mobile phone and internet services alone might cause inconvenience for customers in the form of intermittent outages or poor reception, but an overloaded wireless system that is also helping to drive a smart electricity grid creates the potential for brownouts and blackouts that could affect countless critical services.

As such, any smart grid communications technologies that are deployed should not have to rely on, say, the same spectrum used by a wireless carrier to keep their mobile customers' Blackberries connected. "Mobile might serve smart metering but it will not suit smart infrastructure," Moray says.

Unlicensed spectrum, on the other hand, while freely available, raises too many reliability concerns as there is much greater potential for interference from other devices uses the same bandwidths (see Table 2). ■

Table 2: Advantages and disadvantages of unlicensed versus licensed spectrum for smart-grid communications

Spectrum type	Advantages	Disadvantages
Unlicensed spectrum	Free and available to all users	Liable to interference from numerous other devices using the same bandwidth; slower communications; greater infrastructure and bandwidth requirements
Licensed spectrum	Higher signal power; less interference and better signal-to-noise ratio	Costly; difficult to obtain with adequate bandwidth

Conclusion: Five key lessons for policymakers

- A wide-ranging review of spectrum allocation should be conducted, to consider where limited spectrum may be freed up, or reallocated.
- Avoiding the temptation to go down a solely market-based route to spectrum allocation will help ensure a safer and more robust long-term solution to smart-grid communications.
- Given increased pressures on the UK's grid infrastructure, as well as the widespread rollout of smart meters over the coming decade, making a decision sooner rather than later will enable better takeup and faster rollout of related smart-grid services, as well as a more level playing field for competitors.
- Dedicating specific spectrum for wireless smart grid communications will help ensure takeup of other key initiatives, such as the network for electric cars in the UK or the surge in micro-generation following the introduction of the UK's feed-in tariff.
- Developing a stronger grid will also help ensure the UK's competitiveness in the coming decade, by boosting protection against the risk of power shortages, as well as allowing energy-related innovation to blossom. ■