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Published by:
John Wiley & Sons, Ltd
The Atrium
Southern Gate
Chichester
West Sussex
PO19 8SQ
England
www.wiley.com

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Visit our homepage at www.customdummies.com.

ISBN: 978-1-118-75570-9 (pbk)

Printed in Great Britain by Page Bros

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Acknowledgements

Many people have contributed to this book and we'd like to take this opportunity of thanking them: Sandra Bain, Mark Bygraves, David Crossman, Jodie Eaton, David James, Jeremy Gann, David Leck, Tara McGeehan, Karen Beckett and Steve Westlake.

Publisher's Acknowledgements

We're proud of this book; please send us your comments at `http://dummies.custhelp.com`. For other comments, please contact our Customer Care Department within the U.S. at 877-762-2974, outside the U.S. at (001) 317-572-3993, or fax 317-572-4002.

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Contents at a Glance

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Introduction

Welcome to *GB Electricity Industry For Dummies*, the essential pocket guide to the British electricity sector.

About This Book

Every now and again, you come across someone who's new to the electricity industry. They're easy to spot. They're the ones with glazed expressions as waves of acronyms and jargon wash over them. Of course, those embroiled within the industry aren't immune. Lifting someone out of, say, distribution and dropping them into settlement can produce a similar expression. And just observe people from overseas trying to get to grips with the foibles of the British market. The likelihood is that they're equally confused.

This book is intended as a mild source of pain relief for such individuals. We explain what each bit of the industry is for, why it's ended up the way it is, the major players and the big issues. And, of course, we explain some of the jargon.

Foolish Assumptions

We made a few assumptions while writing this book. The first obvious one is that something as complex and diverse as the British electricity market can be condensed into a conveniently pocket-sized booklet – clearly a ludicrous undertaking! We also assume that:

- You're relatively new to the industry, or have worked only in one area, and are interested in a useful, light-hearted overview of how the British electricity industry fits together.

- You don't want opinions as to the rights and wrongs of the various twists and turns that the industry has been through (for those that do, we'd recommend Alex Henney's excellent *The British Electricity Industry 1990–2010*, published by EEE Limited).

How This Book Is Organised

We divide the book into ten concise and informative chapters:

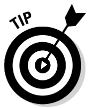
- **Chapter 1: Getting to Grips with the Basics:** We look at the structure of the British electricity industry and how it has changed over time. Read this chapter if you read nothing else.
- **Chapters 2 to 9:** We take a closer look at the individual bits of the industry: generation, transmission, distribution, the retail market, the wholesale market, settlement and regulation. And because it's a hot topic right now, we include a bonus chapter on Smart Metering Implementation Programme. Each chapter has a common layout – what the bit of the industry's for, how it's evolved to be as we see it today, who the major players are and the big issues that keep them awake at night. We include a useful 'jargon buster' sidebar to help you hold your own in coffee machine conversations. Plus we include the odd crystal-ball-gazing session with an industry expert.
- **Chapter 10: Ten Take-Away Points to Remember:** A few observations on the British electricity industry to keep in mind.

Finally, we include an appendix with a succinct summary of the key milestones in the development of the British electricity industry.

Icons Used in This Book

To make navigation to particular information even easier, we use icons to highlight key text:

Important points to keep in mind.



Pointers to help you deepen your understanding of a topic.

Drawing your attention to the Dark Side!

Where to Go from Here

As with all Dummies books, you can dip in and out or read from cover to cover – it won't take long! Like the electricity network itself, the various bits of the industry are interrelated so, in an attempt to minimise repetition, we give lots of useful references to other chapters. If you require any more information, feel free to visit us at `www.cgi-group.co.uk/utilities`.

Chapter 1

Getting to Grips with the Basics

In This Chapter

- Examining the key bits of the industry
- Taking a historical tour
- Reviewing the key challenges

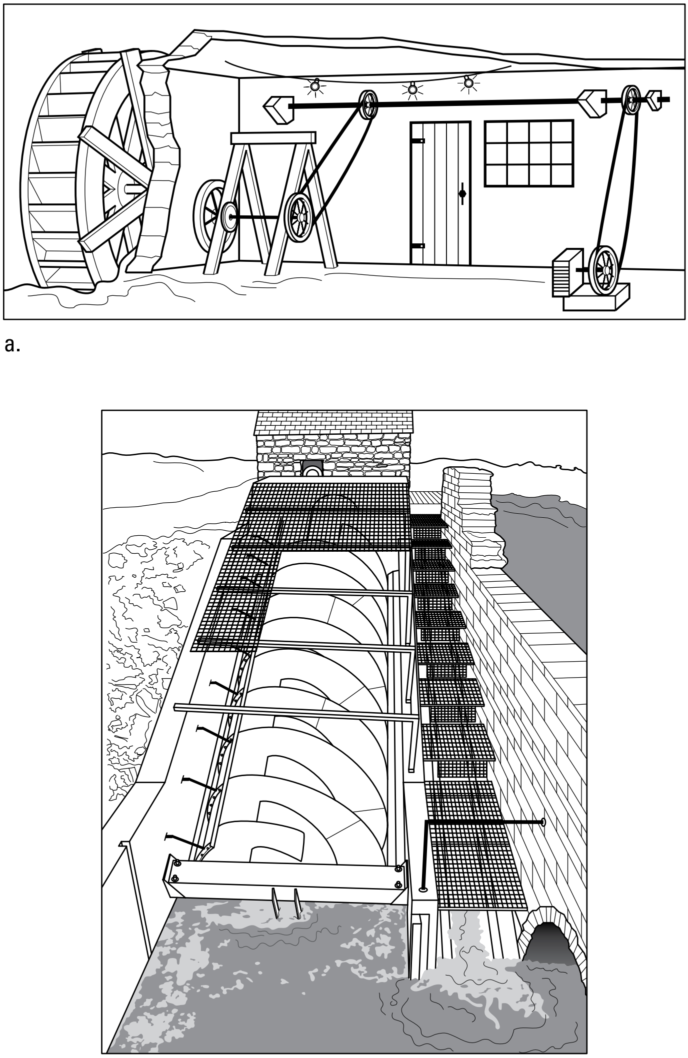
The British electricity industry has to be one of the most complex in the world. It certainly qualifies as the oldest. This chapter looks at how this industry came about and how it's changed over its 120-odd year lifespan.

Coming Full Circle

In 1881, Messrs Calder & Barnet installed a Siemens AC alternator and dynamo, powered by a waterwheel located at Westbrook Mill on the River Wey. It fed seven arc lights and 34 Swan incandescent lights that lit the streets of Godalming and was the first experimental public electricity supply.

In 2008, a 70-kilowatt (kW) Archimedes screw was installed in the River Goyt in Derbyshire. By February 2012, this community-owned hydro scheme (affectionately known as 'Archie') had generated over 500 megawatt hours (MWh).

Figure 1-1 illustrates the two schemes.



a.

b.

© Torrs Hydro New Mills plc, 2008

Figure 1-1: Coming full circle with two community electricity schemes.

REMEMBER

Looking at these two examples of small-scale community electricity schemes, it would be easy to think that not much has happened in the intervening 127 years. Not so. From its first tentative steps in the streets of Godalming, the British electricity industry has grown massively, has transformed beyond recognition, and continues to evolve. Which means that, by the time you read this, things will have moved on and there'll be a new set of issues, initiatives and acronyms. Such is life.

Understanding the Electricity Industry Structure

Electricity is something we take for granted. Recently, however, it's becoming eye-wateringly expensive. Total UK household expenditure on electricity is now over 20 times what it was in 1970, and the latest available government statistics show that over 3.5 million households were in fuel poverty (spending more than 10 per cent of household income on gas and electricity) by the end of 2010. The numbers came down a little in 2011 but this was partly due to the introduction of a new definition of fuel poverty. The depth of fuel poverty, however, has increased for those unfortunate enough to suffer from it.

TIP

The household electricity bill is a pretty good place to start to get an understanding of how the electricity industry works. Figure 1-2 shows the composition of an average electricity bill according to statistics published by the regulator Ofgem.

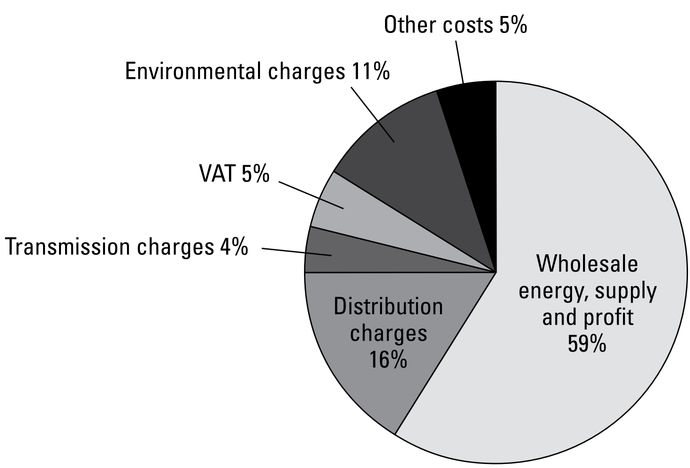


Figure 1-2: Breakdown of an average domestic electricity bill

The biggest portion is the cost of generating the electricity in the first place (we discuss generation in Chapter 2). The majority of electricity is generated in large power stations connected to a high-voltage transmission network that moves the electricity over large distances to where it's needed (we cover transmission in Chapter 3). The electricity leaves the transmission network and enters distribution networks to complete the last leg of its journey to the end consumer (Chapter 4 covers distribution). The end consumer buys the electricity from a supplier in a competitive retail market (we look at retail in Chapter 5), who, in turn, buys the electricity from a competitive wholesale market (the subject of Chapter 6). And after the kettles have boiled and the toast has burnt, the settlement process works out who used what so that all the participants can get paid accordingly (Chapter 7 looks at settlement).

As you can see from Figure 1-2, generators and suppliers receive a little over half of your bill payments, and moving the electricity around (transmission and distribution) accounts for another quarter. Because storing large quantities of electricity isn't easy, the System Operator (SO) is responsible for ensuring that exactly the right amount of electricity gets to where it's needed at a stable frequency and voltage (we cover balancing in Chapter 6). Some of the 5 per cent of the 'Other costs' in Figure 1-2 pays for this balancing (that is, keeping the lights on).

Another key challenge facing all of us is climate change. Through the Climate Change Act, the government has entered a legally binding target to reduce the UK's greenhouse gas emissions by at least 80 per cent below 1990 levels by 2050. Ten per cent of your electricity bill pays for the government's policies for achieving this (we discuss regulation in Chapter 8).

Reviewing How We Got Here

You can liken the evolution of the GB electricity market to continental drift: a constantly shifting scene, driven by the forces of nationalisation and privatisation, in which large chunks of the industry either split up or come together to form new entities. Bits of the industry, notably the wires that transport the electricity, are natural monopolies (the massive cost of transmission and distribution networks makes it impractical for a new entrant to compete). However, other bits, notably generation and supply, have the potential for competition.

Nationalisation

The electricity industry started life in the form of numerous individual, isolated ventures such as the water-powered street lighting of Messrs Calder & Barnet in Godalming. The discovery of alternating current (AC)-enabled transmission paved the way for bringing these ventures together and small islands of network started to coalesce. The advantages for doing so were economies of scale and an increased chance of keeping the lights on (security of supply) by having access to a larger mix of generation to meet uncertain demand.

Legislation in 1926 paved the way for the first national grid, a set of 132-kilovolt (kV) interconnected regional grids that became fully integrated in 1938.

The Electricity Act of 1947 saw nationalisation of the numerous municipal and privately owned electricity generation and supply utilities to form the British Electricity Authority and 15 Area Electricity Boards.

In 1955, the British Electricity Authority became the Central Electricity Authority, which, in turn, became the Central Electricity Generation Board (CEGB) in 1957.

Then, in 1990, the whole process started to reverse.

Privatisation

Privatisation saw the CEGB broken up into a monopoly transmission business (National Grid Company) and two competing generators (National Power and PowerGen, affectionately called ‘Big G’ and ‘Little G’). Later, the government decided not to include the nuclear stations (originally given to National Power) in the privatisation process, resulting in the formation of the publicly owned Nuclear Electric. The 12 Area Electricity Boards in England and Wales were renamed Regional Electricity Companies (RECs) and sold off. Sixty per cent of National Power and PowerGen followed in 1991, the remainder being sold in 1995.

The year 1991 also saw privatisation of the Scottish electricity industry, although the two organisations, renamed ScottishPower and Scottish Hydro-Electric, remained *vertically integrated* (they retained ownership and control of their transmission networks).

The introduction of retail competition during the 1990s culminated, in 2000, in the split of the competitive supply and monopoly distribution functions of the Regional Electricity Companies, leaving the distribution network operators picking up the monopoly distribution businesses. Metering competition accompanied retail competition and saw metering businesses separated from their corporate companies and snapped up by new independent meter operators.

By 1999, divestment of generation assets by National Power and PowerGen had resulted in 38 generators. But despite the apparent competition, the Office of Gas and Electricity Markets (Ofgem, the energy regulator), concluded that wholesale prices were still controlled by a dominant few. By 2000, a ‘dash for gas’ (largely by new market entrants) added 7.9 gigawatts (GW) of new Combined Cycle Gas Turbine (CCGT) plant and created a substantial surplus of generation. This, combined with a warm winter, saw a 10 to 20 per cent fall in wholesale prices, a process that was to continue with the replacement of the existing wholesale market (commonly known as the *Pool*) with the New Electricity Trading Arrangements (NETA) (more in Chapter 6).

Then, the process started to reverse again. . . .

Vertical integration

In the late ’90s, generators, foreseeing a collapse in wholesale prices, started buying up supply businesses as a natural hedge. If wholesale prices were high, the generation arm of the business made money. If low, the supply side of the business would bring in the cash. This vertical integration saw National Power and PowerGen buying Midlands Electricity and East Midlands Electricity, respectively. Replacement of the Pool with NETA in 2001 only increased this trend. Recently, the mandated rollout of smart meters to domestic and small non-domestic customers has seen the large supply businesses taking metering back in-house.

Throughout these privitisation and vertical integration phases, a number of major US energy companies invested in generation and supply, along with speculative trading in wholesale markets (remember Enron?). When prices collapsed, however, they had their fingers badly burned and rapidly withdrew, to be replaced by the emerging major European energy 'national champions'.

Outlining the Key Industry-Wide Challenges

We look at the key issues affecting each area of the industry in the following chapters, but here's a heads-up of some of the big issues occupying the industry as a whole today:

- **Decarbonisation of the electricity industry:** The threat of climate change is forcing the closure of fossil fuel generation plant in favour of low-carbon renewable and new nuclear generation (see CGI's *New Nuclear For Dummies*). However, renewable generation tends to be intermittent and uncontrollable (dependent on when the wind blows or the sun shines, for example) and nuclear's not very flexible (it's either on or off), which means we're looking at a radical change to the way we consume electricity. Today, we generate to meet demand. In the future, we may well have to use electricity when it's available (more on this in Chapter 2).
- **Decarbonisation of the economy:** Decarbonising electricity generation won't be sufficient on its own to manage climate change. We need to radically reduce our dependency on fossil fuels in general. The humble domestic electricity supply will have to replace the petrol pump and the domestic gas supply as we replace our gas-guzzlers with electric vehicles and central heating with heat pumps. This will mean a massive increase in the demand for (low-carbon) electricity.
- **Network investment:** Increased demand for electricity means more electricity to move around. Unfortunately, our existing transmission and distribution networks weren't designed with this in mind, and they'll need massive investment to support a future low-carbon economy.

This means not just bigger networks, but also smarter networks (more on this in Chapters 3 and 4; also, see CGI's *Smart Grids For Dummies*).

- **Smart metering:** One way of coping with the impending increase in electricity demand is to start using less of it. Improved home insulation can do a lot, but to really start cutting down, we need to become more energy-savvy. Smart meters are a way of helping us to not only better understand our energy consumption, but also actively manage and reduce it (more on this in Chapter 9; also, see CGI's *Smart Metering For Dummies*).
- **Innovation-based regulation:** The scale of investment required in our electricity infrastructure requires a new approach to designing and operating networks. But how do you incentivise regulated, monopoly network providers to challenge age-old ways of working and start thinking out of the box? Ofgem's response to this quandary has been a radical change to the regulatory regime that places greater emphasis on delivering innovation (more on this in Chapter 8).
- **Electricity Market Reform (EMR):** Ever-increasing electricity prices and growing fuel poverty have focused attention on the retail market and the dominance of the 'Big Six' suppliers. Despite Britain being in the vanguard of a European trend towards retail competition, dramatic headlines of large supplier profits have prompted Ofgem to conduct an Energy Probe (more in Chapter 5), which, in turn, has led to proposals for Electricity Market Reform (more in Chapter 6).
- **European Target Model:** Britain's reform of its electricity market is happening against the backdrop of a European initiative to implement a single European energy market. Recent draft European Union legislation requires tighter integration of member states' electricity networks as a step towards a fully liberalised internal electricity market by 2014, and the legislation is likely to impact everyone in the British electricity industry.

Chapter 2

Generation

In This Chapter

- Describing fuel types, scale and flexibility
- Examining how Britain generates
- Introducing the main generators
- Exploring issues, from new nuclear to Project TransmiT

Generation is the process of turning primary energy sources into electricity. Given the fact that this book's about the British electricity industry, it's fitting that it was a British scientist, Michael Faraday, who first generated electricity back in the early 1800s. And we still use his basic method of moving a wire through a magnetic field to generate electricity today.

This chapter looks at the different types of generation we rely on in Britain, who owns it and the challenges the owners face in the future.

Semi-interesting generation fact

The largest power station in the world is the Three Gorges Dam in China, which, at 22,500 MW, is more than six times larger than Britain's largest power station and could meet 60 per cent of Britain's 2011 average demand.

What's Generation All About?

In this section, we look at the major types of generation, categorised by fuel type, scale and flexibility.

Looking at fuel types

Different types of generation use different methods for moving the wire through a magnetic field to generate electricity, and each method has advantages and disadvantages in terms of the amount of electricity generated, the speed with which generation can start and stop, and its impact on the environment. Here are the main flavours of generation in Britain:

- **Fossil-fuel:** These power stations burn coal, gas or oil and convert the heat generated in combustion to electricity, usually via a steam or gas turbine. By-products are waste heat (a typical fossil-fuel generator is only 33 per cent efficient), hence the large, iconic cooling towers you see dotted across the countryside. The other key by-product is flue gas containing, amongst other things, carbon dioxide, making fossil-fuel generators major emitters of greenhouse gases. With a cumulative capacity of over 41,000 MW, Britain's 72 fossil fuel plants currently make up a little over 41 per cent of the country's generation capacity.
- **Combined Cycle Gas Turbine (CCGT):** Still a fossil-fuel power station that converts gas into electricity via a gas turbine. However, in a CCGT, the heat of the turbine's exhaust generates steam that drives a secondary generator, making the plant more efficient (typically more than 50 per cent). Currently, 41 CCGTs are operating in

Britain, providing just under 29,000 MW (29 per cent) of the country's generation capacity.

- **Nuclear:** Nuclear power stations are similar to fossil-fuel or CCGT power stations in that they use heat to generate steam that's in turn converted to electricity via a turbine. In a nuclear power station, however, the heat is generated by nuclear fission (the process in which the nucleus of an atom splits into smaller parts). This has the advantage that it doesn't generate carbon dioxide.

  Nuclear power stations do, however, generate spent nuclear fuel that remains deadly to living organisms for extremely long periods and requires careful management. Nuclear generation also has the disadvantage of being relatively inflexible (it's either on or off, making it good for delivering 'base load' demand but poor at meeting peak demand).

  Currently, nine nuclear plants are operating in Britain, accounting for 9,200 MW (9 per cent) of the country's generation capacity. Many of these are approaching the end of their lives; however, ten sites have been identified as candidates for new nuclear builds. For more information, have a read of CGI's *New Nuclear For Dummies*.

- **Hydro:** Conventional hydroelectric generation plants use dammed water to drive a water turbine to generate electricity. Other variants include pumped storage (see the next bullet), tidal and wave. Britain can claim to have the world's first hydroelectric power scheme, developed at Cragside in Northumberland in 1878. In Britain, we have 83 hydro plants with a combined generation capacity of 1,974 MW (less than 9 per cent of the capacity of the biggest power station in the world, the Three Gorges Dam)!

- **Pumped storage:** This is a form of hydroelectric generation in which the water used to generate electricity is pumped from a lower elevation to a higher elevation at a time when electricity demand is low and then released to generate electricity when demand is high. The losses incurred in pumping the water make these stations net consumers, rather than producers, of electricity, but their ability to meet peak demand at short notice makes them extremely useful for balancing the grid (see Chapter 3). In Britain, we have four pumped storage plants accounting for just over 2.5 per cent of the country's generation capacity. However, it's this 2.5 per cent that keeps the kettles of Britain boiling at the end of *EastEnders*.

- **Wind:** Wind turbines convert wind energy into electricity. On the plus side, they produce no greenhouse gases. However, wind farms typically comprise many individual wind turbines and they aren't always popular with the public. Offshore wind farms go some way to addressing public resistance, but are expensive to build and generate power a long way from where it's needed, which means high transmission costs. The major drawback with wind power, however, is its intermittency, which, in the absence of large-scale storage, requires alternative generation to be available to cope with days when there's too little or too much wind to generate (yes, it can be too windy to generate)! As of July 2012, Britain had 155 onshore and 19 offshore wind farms, accounting for around 5.2 per cent and 2.6 per cent of capacity, respectively.
- **Other renewables:** This category covers a range of generation including solar, biomass (crops, wood chip and so on), animal waste, landfill gas, solar and tidal, and provides a little over 4 per cent of Britain's generation capacity.
- **Interconnectors:** Britain is currently served by three interconnectors to France, the Netherlands and Northern Ireland. These have a combined capacity of 3,500 MW (3.5 per cent of the nation's capacity) and can be used to import or export electricity depending on market prices.

Sizing up scale

In addition to coming in an assortment of flavours, generation also comes in different sizes.

- **Grid-connected:** Most of the generation we describe in the preceding section is large scale and provides electricity at high voltage directly onto the transmission network (see Chapter 3) through Grid Entry Points (GEPs).
- **Embedded:** Smaller scale generation that connects directly to the distribution grid (see Chapter 4) at lower voltages. Some smaller scale renewable generation falls

into this category, along with Combined Heat and Power (CHP). CHP is effectively a mini power station designed to meet the electrical and heating needs of the site in which it's installed, but it's also capable of exporting electricity onto the distribution network.

- **Micro:** The government's Feed-In Tariff Scheme (FITS) has seen many households installing solar panels (also called photovoltaics, or PVs). This has given rise to the term *prosumer* (a consumer who also produces). Although a lot of PV generation is consumed by the household, PVs, like CHPs, are capable of exporting onto the distribution network. Micro-generation can also take the form of wind turbines or micro CHP.

Considering flexibility

Another useful categorisation of power plant is its flexibility. Given the current need to match uncertain demand with generation in real time, plant that can deliver large quantities of electricity at short notice (so called *peaking plant*) can command premium prices.

The clear winner in this race is pumped storage, which can achieve maximum output from a standing start in less than 16 seconds. By comparison, *base load plant*, such as nuclear and coal-fired, take appreciable notice to change output and can be considered more marathon runners than sprinters.

And finally you have *intermittent plant* such as wind and solar whose output depends on the forces of nature and that are virtually uncontrollable.

REMEMBER

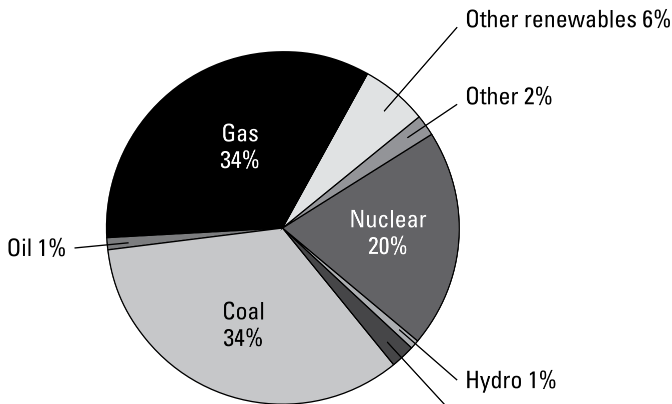
The current wholesale market arrangements (see Chapter 6) favour flexibility.

Assessing the Generation Mix

We've come a long way since the days of Big G and Little G in 1990 (the first two competing generators that we mention in Chapter 1). As of end of May 2011, there were well over 50 power producers, operating almost 400 power stations in Britain, with a combined capacity of a little under 96,000 MW.

In addition, we also have some 3,500 MW of interconnector capacity to draw on.

However, moving to a low-carbon economy requires us to increase overall generation capacity while at the same time de-carbonising it. The scale of this task becomes clearer if we look at the types of generation plant we actually use to generate our electricity (see Figure 2-1).



Based on figures contained in DUKES, July 2012.

Figure 2-1: Fuel used in British generation in 2011.

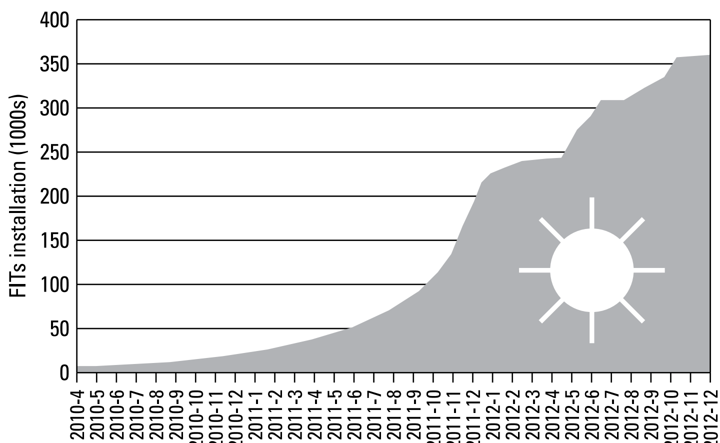
The majority of the generation capacity we currently use is provided by fossil fuels and an aging fleet of nuclear plant, much of which will close in the near future. In its Carbon Plan published in December 2011, the government predicted that we need to build around 60 to 80 GW of new electricity capacity by 2030, and that 40 to 70 GW of this needs to come from low-carbon technologies, such as nuclear, renewables and fossil fuel stations with Carbon Capture and Storage (see the later section 'What are the Big Issues?').

Who Are the Major Players?

Although we have over 50 generators in Britain today, over half of the 390-odd power stations are owned by only four players (EDF, RWE, E.ON and SSE). RWE tops the list, closely followed by EDF (having acquired British Energy in 2009).

These two companies alone account for almost 30 per cent of our generation capacity. The trend towards vertical integration means that the six largest electricity suppliers (commonly referred to as 'the Big Six') also feature in the top seven biggest British generators. The impact of this vertical integration on market liquidity is one of the drivers for the Electricity Market Reform, led by the Office of Gas and Electricity Markets (Ofgem) (we discuss this in Chapter 8).

However, homeowners may be set to become major players in Britain's generation industry too (well, perhaps not individually, but collectively). The government's Feed-In Tariff scheme (in which consumers with micro-generation get paid for the electricity they generate) has encouraged many households to install micro-generation, predominantly in the form of solar panels. By the end of 2012, the Feed-In Tariff scheme (or FITS, as it's more commonly known) had resulted in an estimated 350,000 homes with solar panel installations, totalling over 709,698 kilowatts of capacity. Although still less than 2 per cent of Britain's average demand, this represents a 19-fold increase since 2010, as illustrated in Figure 2-2. Mid-Devon leads the way with almost 1 in 13 households having installed solar panels.



Based on Ofgem's Feed-In Tariff Installation Report, January 2013.

Figure 2-2: Feed-In Tariff installations

What Are the Big Issues?

Here are some of talking points in the world of generation.

New nuclear

Those of you who have read CGI's *New Nuclear For Dummies* will be aware that the government is considering ten sites in Britain for development of new nuclear plant. National Grid is assuming that new nuclear will feature prominently in the future British generation mix.

Carbon Capture and Storage

Carbon Capture and Storage (CCS) is a technology for preventing the release of large amounts of carbon dioxide into the atmosphere as a result of burning fossil fuels. It's the great white hope for extending the life of fossil fuel electricity generation and it comes in three forms:

- **Pre-combustion:** The fuel is converted into a clean-burning gas by stripping out the carbon dioxide before it's burnt.
- **Post-combustion:** Carbon dioxide is captured from the power station's flue gases.
- **Oxy-fuel combustion:** The fossil fuel is burnt in oxygen rather than air, resulting in a pure carbon dioxide emission that can be captured.

The upside of CCS is that it could reduce carbon dioxide output from fossil fuel power stations by 80 to 90 per cent. The downside is that it could take between 25 to 40 per cent of the power station's output to drive the technology, dramatically increasing the cost of the power generated. The government has been looking for a CCS demonstration project on a large coal-fired power station, but progress has been difficult.

Renewable Obligation

The *Renewable Obligation* (RO) is an obligation on UK electricity suppliers to source an increasing proportion of electricity they supply to customers from renewable sources. It's one of the government's key instruments in meeting its commitment to generate 15 per cent of energy from renewable sources by 2020.

Ofgem issues Renewable Obligation Certificates (ROCs) to renewable generators for every megawatt hour (MWh) they generate and suppliers collect these as evidence of renewable generation purchases. At the end of the year, suppliers must hold sufficient Renewable Obligation Certificates to cover the agreed proportion of their demand, and any shortfall incurs a fixed penalty (the *buy-out price*). The buy-out price for the 2013–14 Obligation is £42.02 per MWh, setting a minimum price for renewable generation.

The government is considering replacing Renewable Obligation with Feed-In Tariffs with Contracts for Differences (FITCfD) as part of the Electricity Market Reform (see the later section on this).

Feed-In Tariff Scheme

The *Feed-In Tariff Scheme* (FITS) is a similar subsidy scheme to the Renewable Obligations, but aimed at smaller scale (less than 5 MW) renewable generation. FITS guarantees payments for each kWh generated, and also pays for electricity deemed to have been exported onto the distribution network.

REMEMBER

FITS is responsible for the proliferation of PVs on rooftops around Britain, but a larger-than-expected uptake caused the government to cut the guaranteed payments from 43.3 p/kWh to a tiered tariff ranging from between 7 p/kWh to 16 p/kWh, attracting much press coverage.

Electricity Market Reform

We cover *Electricity Market Reform* (EMR) in Chapter 8 on regulation, but suffice to say it will have a major impact on generators (along with many other participants). The key elements affecting generators are:

- The proposed replacement of Renewable Obligations with Feed-In Tariffs with Contracts for Differences (FITCfDs)
- The Emissions Performance Standard (EPS) designed to prevent new coal-fired generation that doesn't have CCS
- The Capacity Market designed to encourage new and existing generation capacity to ensure security of supply (see Chapter 6 for more details)

Project TransmiT

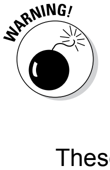
Project TransmiT is Ofgem's independent review of the charging arrangements for gas and electricity transmission networks and, as such, it gets a mention in Chapter 3 on transmission. However, Project TransmiT impacts generators too in that it will affect the Transmission Network Use of System (TNUoS) charging arrangements – that is, what generators pay, or are paid, for using the transmission network.

European Target Model

We cover the European Target Model (ETM) in Chapter 8 on regulation, but we mention it here because the tighter integration between European transmission networks that the European Target Model is looking to put in place may provide generators with an expanded market for their product.

Large Combustion Plant Directive

The *Large Combustion Plant Directive* (LCPD) is European legislation aimed at controlling emissions of sulphur dioxide, nitrogen oxides and particulate matter. Combustion plants, including power stations, have a choice as to whether they opt in or opt out of the scheme. If they opt in, they must invest in technology to meet defined emission limit values (or ELVs, as they're often referred to). Those opting out can operate for a maximum of 20,000 hours prior to a 'must close date' of the end of 2015.



A lot of opted-out Britain's power stations have used up their hours more quickly, due to high market prices, and are being shut down imminently.

Industrial Emissions Directive

Not to be confused with improvised explosive devices, the *Industrial Emissions Directive* (IED) is a further tightening of the emission limit values for fossil-fuelled plants. Opting in will require fitting of Selective Catalytic Reduction (SCR) or similar nitrogen oxide-reducing technology. Opting out will restrict plant to 17,000 hours of operation between 2016 and 2023.

Jargon buster

Here's a smattering of terminology to try out on your generator friends:

- **Black start:** A power station capable of providing black start is one that can start itself without using power from the transmission network. Only some types of plant are capable of doing this, an example being pumped storage.
- **Frequency response:** As the GB System Operator (see Chapter 3), National Grid is required to keep the frequency of the network to 50 Hertz (give or take 1 per cent). Frequency response is a service National Grid procures from generators to help do this.
- **Registered Capacity (RC), Transmission Entry Capacity (TEC), Connection Entry Capacity (CEC), Declared Net Capability (DNC):** All subtly different ways of measuring how big a power station or generating unit is.
- **Maximum Export Limit (MEL):** A dynamic version of RC, TEC, CEC and DNC, allowing generators to declare their available generation capacity in real time.
- **Spinning and non-spinning reserve:** *Spinning reserve* is extra generation capacity available from generators that are up and running and, therefore, delivered quickly. *Non-spinning reserve* is additional generation capacity that isn't up and running and therefore requires more notice to bring online.
- **Short-Term Operating Reserve (STOR):** A service that National Grid procures from generators to provide additional generation when needed to balance the system.

Chapter 3

Transmission

In This Chapter

- Getting a feel for the transmission network
- Charting the history of transmission
- Introducing the Transmission Owners
- Examining the big issues in transmission

Thomas Edison's system for electricity distribution, patented in 1880, used direct current (DC). Then, in the late 1800s, Nikola Tesla worked out that doubling the voltage (thus halving the current) reduced the amount of electricity lost when moving it around by three quarters. However, changing voltages efficiently requires alternating current (AC). Thus followed the 'War of the Currents' (DC versus AC), from which AC emerged victorious. Electricity could now be moved efficiently at high voltages while still being available for use at lower, relatively safe voltages. This principle underpins most of our transmission and distribution networks today.

This chapter takes a closer look at the transmission network, how it's come about and what's likely to happen to it in the future.

Semi-interesting transmission fact

The largest ever drop in UK demand occurred during the three-minute silence in memory of victims of the 9/11 attacks in the US.

What's Transmission All About?

In this section, we take a look at what makes up the transmission network and how it differs from the distribution network (which we describe in Chapter 4). We also examine the role of the GB System Operator in balancing, planning and charging for use of the transmission network.

The transmission network

The *transmission network* is a bunch of wires that connect large power stations, where electricity is generated, to distribution networks, where it's distributed for use. It operates at high voltages to reduce losses.

In Britain, we have a fully integrated national transmission network comprising networks owned by three different Transmission Owners (TOs), two in Scotland and one in England and Wales. The England and Wales transmission network mainly operates at 400 kilovolts (kV) and 275 kV. Anything operating at less than 275 kV belongs to distribution (the subject of Chapter 4). In Scotland, things are slightly different because the transmission network operates down to the 132 kV network (the 132 kV network is part of the distribution network in England and Wales).

REMEMBER

Most of the transmission wires (96 per cent, in fact) are overhead lines, accounting for the more than 21,000 kilometres of connected pylons we see crisscrossing the landscape. Buried transmission cables have advantages (aesthetics, less prone to weather damage) but can cost up to ten times as much to build and are expensive to maintain.

Because people generally consider overhead cables an eyesore and they're unpopular with the public, several attempts have been made to make them more acceptable. The traditional pylon was a product of a 1931 competition won by Sir Reginald Bloomfield, a prolific British architect and member of the Royal Academy. In 2011, National Grid held another competition and selected Bystrup's 'T Pylon' as the winning design from over 250 entries. Figure 3-1 shows the differing designs.

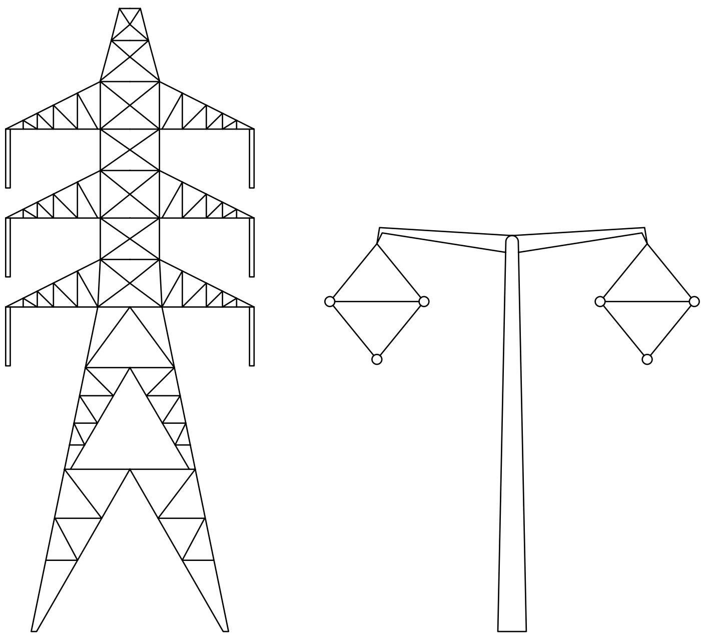


Figure 3-1: Sir Reginald Bloomfield's 1931 design and Bystrup's 'T Pylon', winner of the RIBA's 2011 pylon design competition.

Electricity generated at the power stations enters the transmission network at Grid Entry Points (GEPs) and leaves the transmission network at Grid Supply Points (GSPs) where it enters the distribution networks. A typical distribution network is fed by a little over 30 GSPs. Very large 'grid-connected' customers (for example, aluminum smelters) can connect directly to the transmission network via their own

GSP. Network Rail has 13 GSPs supplying its electrified track, and there are more than 60 GSPs supplying electricity to the power stations themselves, to meet station demand.

Balancing the transmission network

Electricity isn't easy to store in large quantities, so the transmission network needs to be constantly balanced to ensure that enough electricity is present in the right place at the right time to meet demand. In Britain, this role is performed by National Grid in its role as GB System Operator (GBSO). The GB System Operator has three main tools for keeping the national system in balance:

- Ancillary services (such as the Short-Term Operating Reserve, procured by National Grid from generators to provide additional generation when needed to balance the system).
- Wholesale trades (bilateral contracts ahead of gate closure – see Chapter 6 on the wholesale market).
- Bid/offer acceptances in the Balancing Mechanism, a market put in place under the British Electricity and Trading Arrangements (BETTA – covered in Chapter 6).

Planning investment

In addition to balancing the network and moving electricity around the country, National Grid provides the industry's crystal ball. The Seven Year Statement (affectionately known as SYS), published annually, sets out the National Grid's forecast of future demand and generation, and its subsequent plans for the transmission network. National Grid also produces the Offshore Development Information Statement (ODIS), which aims to help the long-term development of the transmission system in the offshore waters around Britain (to support offshore generation). With the move to a new regulatory framework (see 'How is transmission regulated'?) later in this chapter, National Grid is consulting on how best to align these two publications.

Charging for transmission

Users of the electricity network must sign up to the Connection Use of System Code (CUSC; more in Chapter 8). The Connection Use of System Code includes a charging statement that sets out what charges network users are liable for. Charges include:

- **Connection charges** that recover the costs of connecting the user to the network.
- **Transmission Network Use of System (TNUoS)** charges that cover the annual £1.6 billion cost of installing and maintaining transmission network assets. Suppliers pick up the bulk of TNUoS charges (73 per cent, to be exact). TNUoS charges are currently calculated annually using two models:
  - A *transport* model (the 'DC load flow investment cost-related pricing model', to give it its full title) that calculates the 20 per cent locational element of the charge.
  - A *tariff* model that calculates the 80 per cent residual component of the charge.
- **Balancing System Use of System (BSUoS)** charges that recover the costs of balancing the network. The charges cover the cost of the ancillary services, wholesale trades and bid/offer acceptances required to keep the national system in balance. They're paid by suppliers and generators based on the energy they take or supply to/from the transmission grid on a half-hourly basis.

How Has Transmission Changed?

It was the creation of the Central Electricity Board in 1926 that paved the way for the transmission network we have today. The first electricity pylon was built in 1928 near Edinburgh and the first part of the national grid was opened in 1930 when a 132 kilovolt (kV) line was energised from Portobello power station. Commercial operation of the integrated national 132 kV grid, the first in the world, began in 1935, with full integration achieved in 1937.

By 1950, realisation dawned that the existing grid could not meet the future demands of customers and work started on a 12-year project to create a 275 kV 'super grid' with lines designed to carry 400 kV in the future. In 1953, a rural electrification programme started that would see 85 per cent of farms supplied by 1962.

The Electricity Act of 1957 saw the demise of the Central Electricity Authority, and its generation and transmission duties passed to the Central Electricity Generating Board (CEGB). The Electricity Act of 1989 paved the way for privatisation of the industry, and in 1990 the National Grid Company was formed, taking ownership and control of the transmission network in England and Wales (the transmission network in Scotland remained with the two vertically integrated companies). A single Electricity National Control Centre at Wokingham became operational in 1996, replacing seven regional control centres.

In 2001, the New Electricity Trading Arrangements (NETA; see Chapter 6) were introduced, and National Grid started balancing the England and Wales transmission network using the Balancing Mechanism. Then, in 2005, NETA was replaced with the British Electricity Trading and Transmission Arrangements (BETTA), and National Grid became the GB System Operator, taking control of the Scottish transmission networks in addition to the England and Wales network.

The introduction of BETTA saw the Anglo–Scottish Interconnector (also known as the Cheviot boundary) absorbed into the national network and Scottish generation gain access to British transmission rights. The Cheviot boundary had long been a bottleneck in moving Scotland's excess generation down south. This constraint didn't magically disappear overnight with BETTA, and the relevant transmission companies embarked on the Transmission Investment for Renewable Generation (TIRG) works to address this bottleneck.

REMEMBER

The growth in renewable generation and the move towards a 'connect and manage' regime has focused attention on constraint costs and how these can be minimised. It's also prompted a re-think of the way the transmission companies are incentivised. The focus is shifting from short-term incentives aimed at minimising operational and investment costs towards long-term incentives to speed up connections and minimise constraint costs. Transmission Owners and the GB System Operator have different roles and, therefore, different incentive schemes, but the Office of Gas and Electricity Markets (Ofgem) recognises the interdependencies between the two and is looking to align incentives as much as possible.

Who Are the Major Players?

The Transmission Owners, of which there are three. National Grid Electricity Transmission (NGET) owns the transmission network in England and Wales, and ownership of the Scottish transmission network is split between Scottish Hydro-Electric Transmission Limited (SHETL), owned by SSE, and SP Transmission Limited (SPTL), owned by Iberdrola.

Prior to 2005, the three Transmission Owners operated their own networks. However, following the introduction of BETTA, the three networks are now managed as a single national network by NGET, acting as the GB System Operator.

The growth in generation off the coast of Britain has seen a new kind of transmission owner, namely the Offshore Transmission Owner (OFTO).

Given the growing influence of Europe on the British transmission system, it's probably worth mentioning the European Network of Transmission System Operators for Electricity (ENTSO-E). Established in late 2008 as part of the Third Package (EU legislation looking at creating a European Internal Energy Market), ENTSO-E represents the electricity Transmission System Operators in 34 European countries. ENTSO-E will play a key role in the implementation of European initiatives such as the European Target Model (see Chapter 8).

How Is Transmission Regulated?

Because of the huge investment in transmission infrastructure, transmission is a natural monopoly, and as such, it's heavily regulated. For the past 20-odd years, the transmission companies have been regulated by an RPI-X price control introduced by Professor Stephen Littlechild (we talk about this more in Chapter 8). More recently, they're moving to a new incentive-based price control mechanism called RIIO (Revenue = Incentives + Innovation + Outputs). RIIO – TD1, the transmission flavour of RIIO, replaced RPI-X from April 2013 (see Chapter 8 if you're interested).

What Are the Big Issues?

Here are some of talking points in the world of transmission.

Growth in renewables

As we discuss in Chapter 2, the mix of generation in Britain is set to change over the coming decades with an increasing reliance on intermittent generation. This means a move from conventional generation with high load factors (generating most of the time) to less predictable renewable generation with lower load factors, which will have a significant impact on the way the transmission network is managed. For the GB System Operator, that means a need for greater reserve capacity (when renewable generation output is low) and more congestion management (when it's high).

Deep or shallow connections?

There's been much debate on whether connections should be *deep* (the new user pays not only for the connection assets but also for any reinforcement of the network that's required) or *shallow* (the new user pays only for the connection assets, and the cost of the reinforcement is socialised across all users). The deeper the connection charges, the greater the need for generation subsidies to encourage renewable generation investors.

'Invest and connect' or 'connect and manage'?

Should new users have to wait for any network reinforcement to complete before being able to use the network (so called 'invest then connect') or should a 'connect and manage' policy exist in which users can start using the network as soon as they're connected, with the GB System Operator managing any resulting constraints? The large amount of renewable and other low-carbon generation queuing up to join the network has brought this issue into the spotlight, and the government's tending towards a shallow 'connect and manage' policy.

Greater European integration

TIP

Interconnection capacity is expected to increase from 2.5 gigawatts (GW) at the end of 2010 to 4 GW at the end of 2012, and potentially rising to 8 GW in 2020. This, combined with European legislation aimed at implementing a single European Internal Energy Market (see Chapter 8), will impact the British transmission network and the way that it's balanced.

RIIO – TD1

For a regulated monopoly, the price control mechanism by which it's regulated is fundamental to the business. In the case of the transmission companies, the price control mechanism is set to change for the first time in over 20 years. The move from RPI-X to RIIO – TD1 is occupying a lot of Transmission Owners' time (see Chapter 8 for more details).

Project TransmiT

Project TransmiT is an Ofgem review of the charging regime and associated connection arrangements for Britain's electricity and gas transmission networks. It's tasked with ensuring that the right incentives are in place to deliver the estimated £200 billion investment required in our transmission networks over the next ten years in transitioning to a low-carbon economy.

In terms of electricity transmission, Project TransmiT is predominantly looking at reforming the Transmission Network Use of System charging regime. The Project is considering three broad options:

- Some minor tweaks to the current charging model.
- An improved charging model that takes into account changes to the system (for example, more intermittent wind generation).
- A non-locational 'postalised' model in which all transmission costs are socialised.

At the time of writing, the government seems to be favouring the improved charging model approach.

Offshore wind farms

There was a time when, other than the odd interconnector or two, transmission networks were confined to land. However, the government, seeing potential for over 32 GW of offshore wind generation and other marine technologies, has extended National Grid's onshore System Operator responsibilities offshore.

To date, existing offshore wind farms (or those under construction) have required dedicated transmission infrastructure to connect to the onshore transmission network. Ofgem has run competitive tenders to select an Offshore Transmission Owner (OFTO) to own and manage the transmission assets for 20 years. The assets themselves were either built by the OFTO or inherited from the generator if generator-built. As offshore wind farms proliferate, there's increased scope for sharing of transmission assets and, therefore, an increased need for co-ordination, a role that National Grid is expected to perform.

Jargon buster

Here are a few transmission terms that may come in useful:

- **Average Cold Spell (ACS):** A correction applied to annual peak demands to remove weather variations from one year to the next.
- **Bilateral Connection Agreements (BCAs), Bilateral Embedded Generation Agreements (BEGAs) and Bilateral Embedded Licence Exemptible Large Power Station Agreements (BELLAs):** Different forms of agreement between generators and the GB Operator, setting out terms for connection to the transmission network.
- **Balancing System Use of System (BSUoS):** The element of transmission charges that pays for balancing the transmission network.
- **DC load flow (DCLF):** A model used by National Grid when setting TNUoS charges.
- **Grid Entry Point (GEP):** The point at which electricity enters the transmission network.
- **Grid Supply Point (GSP):** The point at which electricity leaves the transmission network and enters a distribution network or grid-connected customer.
- **High voltage DC (HVDC):** A long-distance direct-current power transmission system that uses direct-current voltages up to about 1 megavolt (MV). In some cases, it's a more efficient means of transmitting large quantities of power over large distances, particularly in the case of undersea cables.
- **Investment Cost-Related Pricing (ICRP):** A methodology currently used for calculating the locational component of TNUoS charges.
- **Retail Price Index (RPI):** First calculated in 1947, it's a measure of inflation published monthly by the Office of National Statistics based on the change in the cost of a basket of retail goods and services.
- **System Operator (SO):** The party responsible for balancing the transmission network.
- **Supergrid:** The part of the transmission network that operates at 275 kV or above.

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- **Seven Year Statement (SYS):** A document produced each year by National Grid in its role as the GB Operator that sets out forecasts of how supply, demand and the transmission network will change over the next seven years.
- **Transmission Owner (TO):** The organisation that owns and maintains the transmission assets.
- **Transmission Owner Reinforcement Instructions (TORIs) and Transmission Owner Construction Agreements (TOCAs):** Forms of agreement between the Transmission Owner and generators wanting to connect to the TO's transmission network.
- **Transmission Network Use of System (TNUoS):** The element of transmission charges that pays for the installation and maintenance of transmission assets.

Chapter 4

Distribution

In This Chapter

- Charting changes in the distribution network
- Inspecting the records that distributors keep
- Identifying the network operator licensees
- Thinking about challenges, from innovation to theft

Distribution is the means by which electricity travels the 'last mile' from the transmission network to the end consumer. In many ways, it's similar to the process of transmission (see Chapter 3), but at lower voltages and with more connections. And like transmission, the scale of investment in distribution assets makes it a natural monopoly.

In this chapter, we examine what makes up a distribution network, what distribution network operators currently do and what they'll need to do in the future.

Semi-interesting distribution fact

From a distributor's perspective, home-charging an electric vehicle (EV) is the equivalent of adding eight houses to your street.

What's Distribution All About?

So let's take a look at what happens to electricity when it leaves the transmission network.

The distribution network

Figure 4-1 shows the various bits of a typical distribution network topology. Distribution starts at the Grid Supply Point (GSP), where electricity leaves the transmission network and enters the extra-high voltage (EHV) distribution network, reducing its voltage to 132 kilowatts (kV) (as we mention in Chapter 3, in Scotland, the 132 kV network is considered part of the transmission grid). Each GSP typically feeds half a dozen Bulk Supply Points (BSPs), where the voltage is further reduced to 33 kV. Each BSP typically supplies half a dozen primary substations, where it enters the high-voltage distribution network, reducing the voltage yet again to 11 kV. Finally, each primary substation typically feeds 20-odd secondary substations, where the electricity enters the low voltage distribution network at 400/230 volts, ready to boil kettles and charge iPhones.

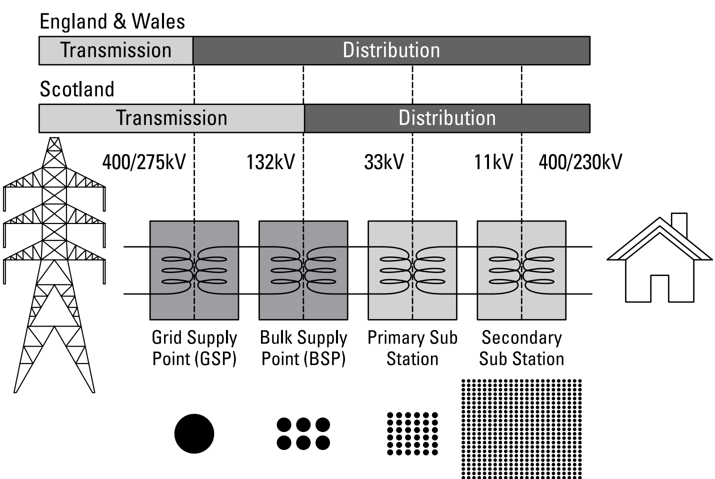


Figure 4-1: Typical distribution network topology.

Charging for distribution

In the same way that Transmission Network Use of System charges recover the cost of maintaining and operating transmission assets (see Chapter 3), Distribution Use of System (DUoS) charges recover the cost of maintaining and operating the distribution network.

Until recently, each of the 14 distribution companies had their own DUoS charging mechanism. However, in April 2010, the distributors implemented the Common Distribution Charging Methodology (CDCM) for customers connected at the low-and high-voltage levels. Similarly, in October 2010, the *distribution network operators* (the holders of a distribution licence) implemented a largely common connection charging methodology.

Keeping records

Distributors are responsible for getting electricity to your door or, more precisely, to your meter (the meter, itself, being the responsibility of your supplier – more on this in Chapter 5). Distributors are, however, also responsible for keeping a record of every electricity supply point on their network (every point at which electricity leaves or enters the distribution network).

Electricity supply points are identified by something called a *Meter Point Administration Number* (MPAN). A common misapprehension is that an MPAN is the 13-digit number you read off your electricity bill when changing supplier, but the pedants would point out that this is, in fact, the MPAN core. The first two digits of the MPAN core identify the distributor and the last digit is a *checksum* (a number calculated from the other 12 numbers using a special algorithm that allows you to verify that the MPAN core is valid). The full MPAN (also sometimes referred to as the *S number*) is a 20-digit number that, in addition to its core, also contains the Profile Class, Meter Timeswitch Code and Line Loss Factor (more on these terms in Chapter 7 on Settlement).

It's the distributor's job to maintain a record of which suppliers are registered to which supply points and which agents the suppliers have appointed. The distributor does this by providing a *Supplier Meter Registration Service* (SMRS) using a *Meter Point Administration System* (MPAS), a large database that holds information about all the supply points connected to the distributor's network. This role is set to expand to include maintaining details of 'Green Deals' – see Chapter 5.

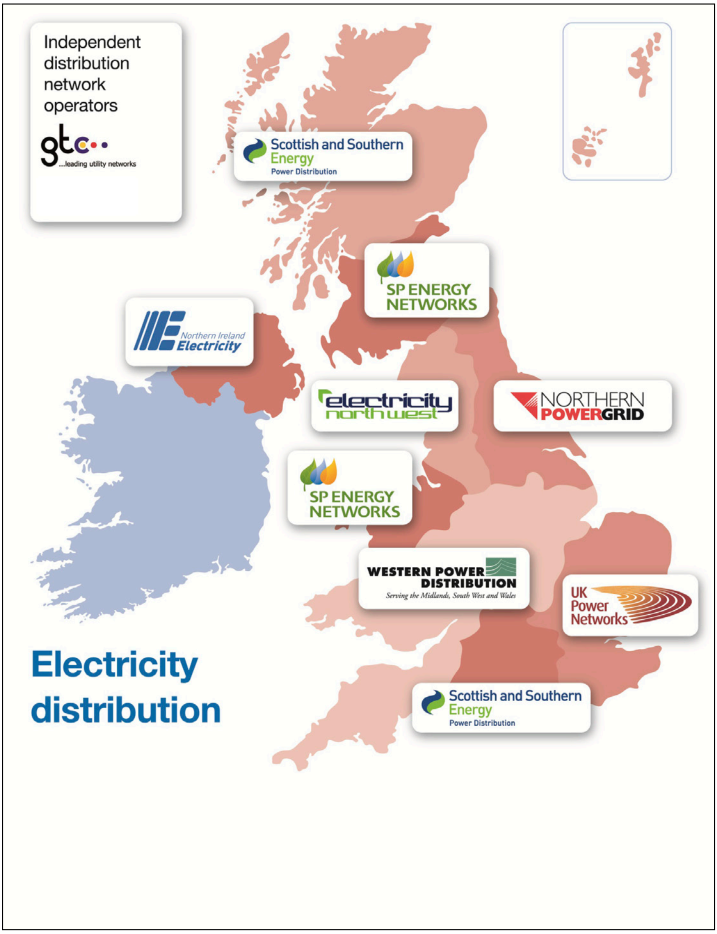
How Has Distribution Changed?

The distribution networks as we know them today first came into being with the Electricity Act of 1947, which saw the establishment of 15 Area Electricity Boards. When privatisation hit in 1990, these became Regional Electricity Companies and were sold off. The same year saw the introduction of retail competition. As this expanded to more and more customers, the franchise supply function of the Regional Electricity Companies diminished until, under the Utility Act 2000, the Regional Electricity Companies lost their supply function and were left with looking after the distribution networks run by licensed distribution network operators (or DNOs, for short).

Who Are the Major Players?

In Britain, there are 14 distribution network operator licences. However, a series of mergers and acquisitions means that these licences are currently held by six organisations (Electricity North West, Northern Powergrid, ScottishPower, SSE Power Distribution, UK Power Networks and Western Power Distribution). Figure 4-2 shows the 14 licences and their current holders. It also shows some of the independent DNOs (more in a minute) and Northern Ireland Electricity (beyond the scope of this book). But given the penchant for mergers and acquisitions in the distribution sector, the situation may well have changed by the time you read this.

Of the six distribution companies, UK Power Networks tops the list in terms of number of customers served (28 per cent), closely followed by Western Power Distribution (26 per cent), following their acquisition of Central Networks. The smallest, Electricity North West, serves 8 per cent.



Source: Energy Network Association (ENA) http://www.energynetworks.org/info/faqs/electricity-distribution-map.html

Figure 4-2: British electricity distribution networks.

In addition to the 14 distribution network operator licences, seven other independent distribution network operators (or iDNOs) are signed up to the Balancing and Settlement Code. iDNOs own and operate electricity distribution networks that are mostly network extensions connected to the existing distribution network (serving new housing developments or shopping centres, for example).

How Is Distribution Regulated?

Distribution companies have been regulated by the same Littlechild RPI-X price control mechanism applied to the transmission companies (see Chapter 3). And, just like the transmission companies, the RPI-X mechanism is being replaced with RIIO (Revenue = Incentives + Innovation + Outputs). RIIO – ED1 (the electricity distribution variant of RIIO) will take over from RPI-X at the next electricity distribution review in April 2015. For a full explanation of RPX-I and RIIO – ED1, take a look at Chapter 8.

What Are the Big Issues?

Here are some of hot topics in the world of distribution.

More consumption

Distribution network operators are at the front line of the government's campaign for a low-carbon economy. Replacing fossil fuels with renewable electricity means that we're all set to use far more electricity than we do today. This means that our distribution networks will need to carry far more electricity than they were ever designed to do.

TIP

One option is traditional reinforcement (dig up the roads and lay more cables, for example). However, apart from being hideously expensive and disruptive, this approach isn't fleet-of-foot enough to accommodate an uncertain uptake of low-carbon technology. Electric vehicles come and go as people change car and/or move house, making it hard to plan reinforcement. Truth is, our distribution networks need to get smarter (for more information, see CGI's *Smart Grids For Dummies*).

More generation . . . everywhere!

An early indicator of our transition to a low-carbon economy is the uptake in solar panels prompted by the government's Feed-In Tariff scheme (FITS). Over 300,000 households now have solar panels installed and are now capable of exporting electricity onto the distribution network.

Traditionally, electricity flow was one-way: from generator to customer via the transmission and distribution network. Now flows can be two-way, as *prosumers* (those capable of exporting power onto the distribution network), proliferate. This is a major change for distribution network operators, particularly when it comes to maintenance, not least because it's now harder to isolate sections of network to make them safe to work on.

More innovation

In 2010, the Office of Gas and Electricity Markets (Ofgem) established the Low Carbon Network Fund (LCNF), £500 million for the distribution network operators to work out how they'll cope with the massive increase in demand and generation expected to accompany the transition to a low-carbon economy. Established as part of the last distribution network operators' price review (Distribution Price Control Review 5, or DPCR5, for short), the learning generated from the fund will inform the next price control starting in 2015. What's more, LCNF is the vanguard of Ofgem's new innovation-based regulatory model, RIIO (Revenue = Incentives + Innovation + Outputs). We talk about RIIO a bit more in Chapter 8.

LCNF money comes in three forms:

- £16 million per year funds small, so-called Tier 1 projects that the distribution network operators can self-certify against a set of criteria laid out by Ofgem.
- £64 million per year funds a small number of flagship Tier 2 projects through a tender process that sees distribution network operators competing with each other to come up with the most innovative and cost-effective solutions to the challenges they face.
- £100 million is a discretionary fund to be awarded by Ofgem to the most successful Tier 2 projects.

REMEMBER

So what makes a good LCNF Tier 2 project? Well, it must:

- Make innovative use of new technologies, operating practices or commercial arrangements.
- Be trialled in the field, ideally addressing a real, existing problem.
- Generate learning that's applicable to all distribution networks, and have a clear strategy for disseminating that learning as quickly as possible.
- Break new ground: building on previous Tier 1 and Tier 2 projects but never replicating them.

Tier 2 projects to date have looked at how distribution network operators can make smarter investment decisions, make better use of smart meters, use technology to 'connect and manage' intermittent renewable generation, and apply innovative interventions as alternatives to traditional network reinforcement.

As of March 2013, there were 34 Tier 1 projects up and running with SSE leading the pack with 9 of them. In 2010, the Tier 2 pot was three times over-subscribed and that resulted in four projects receiving a little over £62 million between them. In 2011, the fund was marginally under-subscribed and all six competing projects received funding totalling just under £57 million. In 2012, the fund was once again over-subscribed with seven projects asking for £81.5 million. Five of these received funding of £51 million.

As of the end of year three, UKPN had received the most Tier 2 funding (£46 million) while WPD had won the most projects (five).

Skills shortage

A report by Energy & Utility Skills in July 2009 highlighted the growing skills shortage in both the distribution and transmission industries. The report put this down to:

- An aging workforce (45 per cent of the current distribution workforce was due to retire within the next 15 years).
- A growing need to cater for the massive planned investment in our networks.

- A lack of suitably qualified school leavers.
- A poor sector image.

The report recommended putting 13 occupations on the UK Government's Shortage Occupation List to attract skills from overseas (although given the fact that this is an international problem, it remains to be seen how effective this will be).

Metal theft

It's estimated that metal theft costs the UK economy £770 million per year. With over 88,000 pylons and 430,000 substations in the UK, it's not surprising that we can attribute £60 million of the theft to the energy networks, which spend an estimated £12 million a year trying to prevent it. Most of the effort to address this problem has been targeted at reforming the scrap metal laws to make selling the stuff a lot harder.

Jargon buster

The distribution business has its fair share of jargon. Here's a taster:

- **Common Distribution Charging Methodology (CDCM):** A standard methodology for calculating DUoS charges now adopted by all distribution network operators.
- **Distribution network operator (DNO):** The holder of a distribution licence.
- **Distribution system operator (DSO):** What a distribution network operator needs to become in order to actively manage smart grids.
- **Distribution Use of System (DUoS):** The charges levied on users of the distribution network.
- **Electricity Central Online Enquire Service (ECOES):** A website at `www.ecoes.co.uk` that allows authorised parties to access electricity supply point data held by all the distribution network operators' MPAS systems.
- **Embedded generation:** Also called 'distributed' or 'dispersed', this is small-scale generation connected directly to the distribution network.

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- **Grid Supply Point (GSP):** The point at which electricity leaves the transmission network and enters the distribution network.
- **GSP Group:** A collection of GSPs that, together, feed a licensed distribution area.
- **Meter Point Administration Service (MPAS):** A service provided by distribution network operators that holds information on electricity supply points on their network, such as the registered supplier, appointed agents and site address.
- **Smart grid:** An electricity distribution network that can monitor electricity flowing within itself and, based on this self-awareness, adjust to changing conditions by automatically reconfiguring the network and/or exerting a level of control over connected demand and generation (see CGI's *Smart Grids For Dummies* for a more detailed explanation).

Chapter 5

The Retail Market

In This Chapter

- Getting to know the retail market
- Thinking about competition and switching suppliers
- Identifying the key players in the retail market
- Discovering the hot topics in retail

It's primarily our retail market that differentiates Britain from other electricity industries around the world. It's not just the fact that we completed our journey to full retail competition in 1998, where other countries have only just started making the sandwiches; it's also the way that we've gone about it. Others have looked closely at the workings of our liberalised retail market when embarking on their own liberalisation, but none have copied it. For those involved in the industry, this is understandable. Let's face it, the British are unique.

This chapter looks at some of the characteristics that make the British retail market unique, introduces the major players in the sector and touches on some of the key issues being discussed.

Semi-interesting retail fact

You're over three times more likely to have changed supplier if you're a prepayment customer living in the North East than if you're a credit customer living in Northern Scotland.

What's the Retail Market All About?

Put simply, suppliers buy electricity in bulk on the wholesale market (see Chapter 6) and sell it on to customers in the retail market.

REMEMBER

Both wholesale and retail markets in Britain are now fully competitive, which means suppliers get to choose who they buy their electricity from in the wholesale market, and likewise customers get to choose which supplier they buy from in the retail market.

Being a supplier

However, there's a bit more to being a supplier than simply buying in bulk and selling on. You need to:

- Win customers.
- Forecast your customers' consumption and buy this on the wholesale market.
- Bill your customers, which generally implies being able to read their meters.
- Respond to queries when things don't go quite to plan.

And if things go really wrong, you need to be able to lose your customers to another supplier.

What suppliers do is of great interest to the regulator, the Office of Gas and Electricity Markets (Ofgem), given its mission to protect the interests of customers. Therefore, to be a supplier, you need a licence from Ofgem, and with the licence comes a set of obligations called Supply Licence Conditions (SLCs). These cover a wide range of areas such as compliance with industry codes (see Chapter 8), marketing, metering, prepayment, arrangements for site access, financial reporting, Feed-In Tariffs and, more recently, Green Deal obligations. And in the not-too-distant future, there'll be an obligation to provide all domestic customers with smart electricity meters (see Chapter 9).

Collecting the cash

When it comes to paying their electricity bills, domestic customers generally have the choice of three different payment methods:

- **Direct debit:** Suppliers like direct debit customers because their payments are reliable and cheap to process, and this is often reflected in a direct debit discount.
- **Credit:** Those who pay quarterly by cash or cheque are less attractive to suppliers because payments don't always arrive on time, and when they do they're more expensive to process.
- **Prepayment:** Customers pay for their electricity in advance, usually at corner shops, and then load the credit onto their electricity meters, usually using a smart card or token. In theory, suppliers should love prepayment because customers are paying for their electricity in advance.

However, prepayment meters are expensive to install and operate and they've been plagued with problems (see the later section 'Prepayment problems'). As such, prepayment tariffs tend to be higher than other forms of payment. And although some customers like prepayment meters because they help with budgeting, 17 per cent of prepayment customers have them as a means of recovering debt (the average debt per customer was £364 in 2012).

Back in March 2008, almost half of people paid for electricity by direct debit, a third by quarterly cash or cheque, and around 14 per cent via prepayment meters.

How Has the Retail Market Changed?

Here's what's been going on in the retail market over the last few decades.

Competition

Until 1990, electricity supply was a monopoly activity, like transmission and distribution. Electricity was supplied by Regional Electricity Companies (RECs), and which supplier you bought your electricity from depended only on where you lived. However, the Electricity Act 1989 split the electricity supply licence into two types:

- **Public** Electricity Supply (PES) licences, under which RECs continued to supply their franchise customers.
- **Private** Electricity Supply (or second tier) licences, which allow others to supply electricity within the REC's authorised area.

This paved the way for the introduction of retail competition in 1990. However, choice of supply was initially restricted to very large customers (those with demands greater than 1 megawatt – MW). Although accounting for 30 per cent of consumption, customers of this size numbered only 5,000.

In 1994, the threshold dropped to demands of more than 100 kilowatts (kW), adding 50,000 more sites and another 20 per cent of consumption. Then, in 1998, choice of supply extended to everyone, adding the remaining 50 per cent of consumption and some 28 million customers.

Change of supplier

By 2008, three quarters of people had changed electricity supplier at least once and only 4 per cent of customers were unaware that it was possible. In 2010, 17 per cent of customers switched electricity supplier (down on the 19 per cent who had switched in 2008). In the same year, a European Commission report on progress in creating a competitive retail energy market had Britain as fourth in a table of 28 European countries (a table which, interestingly, was topped by Slovenia).

Who Are the Major Players?

Let's take a look at the big cheeses in the world of retail.

Suppliers

At the time of writing, 118 organisations hold supply licences (69 for the domestic and non-domestic customers and 49 for non-domestic customers only). However, the market is dominated by the Big Six (British Gas, EDF Energy, E.ON, RWE npower, ScottishPower and SSE), which between them supply 99 per cent of domestic customers. In European terms, having six suppliers with more than 5 per cent of the retail market is pretty good going. As of 2009, only Denmark could manage better (they have the Big Seven).

Supplier Hub

To meet their Supply Licence Conditions, suppliers need help. In this case, the cavalry takes the form of the *Supplier Hub*, a collection of agents appointed by the supplier to help them meet their licence obligations.

Core to the Supplier Hub are the:

- **Meter operator,** responsible for installing and maintaining meters.
- **Data collector,** responsible for validating meter readings and calculating consumption.
- **Data aggregator,** responsible for aggregating consumption and submitting it into the settlement process – see Chapter 7.

Other agents that a supplier might appoint include:

- **Meter asset provider (MAP),** who owns meters and charges the supplier rental.
- **Data retriever,** who's responsible for visiting customers' homes and obtaining meter readings.

Energy Service Companies

Energy Service Company (ESCO) as a term covers a multitude of things, but essentially it's a commercial business that offers energy solutions to customers to reduce their energy bills, the idea being that the cost of the ESCO's service is less than the savings made in energy bills. ESCOs can be seen as a threat or an opportunity to traditional suppliers, and most are trying to re-invent themselves as ESCOs. ESCOs are likely to play a key role in delivering the government's Green Deal (see the following section).

What Are the Big Issues?

So let's take a look at what's hot in retail.

Retail Market Review

In 2008, an Energy Supply Probe conducted by Ofgem concluded that competition wasn't fully effective in all sectors of the retail market. As a consequence, Ofgem conducted a Retail Market Review (RMR) in November 2010 and concluded that this lack of competition was mainly due to:

- **Complex pricing:** The number of tariffs on offer has grown in recent years from just under 200 in January 2008 to more than 300 at the beginning of 2011. Some contain standing charges, whereas others operate a *two-tier structure* (charge one price for up to a set level of consumption and then another, typically cheaper, price for additional consumption). In short, you need a PhD in mathematics to compare tariffs and pick the cheapest.

  Ofgem's solution is to limit suppliers to one standard tariff per payment method (*standard* in this context meaning a tariff with no set end date, as used by three-quarters of people today). Ofgem also proposes setting certain standardised elements of this tariff (distribution and transmission elements), leaving suppliers to compete only the basis of a single unit rate. Non-standard tariffs must have an end date.

  Ironically, this trend towards tariff simplification is happening at the same time that we're trying to roll out smart meters (see Chapter 9), one benefit of which is the ability to support more complex Time of Use (ToU) tariffs designed to encourage changes in consumption behaviour aligned to a low-carbon economy.

- **Poor liquidity:** Despite having one of the most competitive electricity retail markets in the world, the British market is still dominated by the Big Six which account for 99 per cent of customers. Vertical integration (the tendency for companies to become both suppliers and generators) means that the Big Six also dominate British generation, featuring in the list of top seven British generators (see Chapter 2). With so much generation and supply in the hands of the same organisations, Ofgem has concerns as to the liquidity of the electricity wholesale market (see Chapter 6), particularly the ability for small, independent suppliers to buy the wholesale products they need to meet their customers' demand. Ofgem's proposed solution is a mandatory monthly auction of between 10 per cent and 25 per cent of the Big Six's generation capacity.
- **Lack of transparency:** Ofgem's Energy Probe in 2008 highlighted the difficulty in assessing the profit margins of the Big Six due to their vertical integration and wholesale hedging strategies. As a result, Ofgem now requires the Big Six to publish separate regulatory accounts for their supply and generation businesses. As part of the Retail Market Review, Ofgem appointed the accountancy firm BDO to review the transfer pricing and hedging practices of the vertically integrated firms and recommend how reporting could be improved.

Smart metering

Smart metering is such a hot topic right now that we've devoted an entire chapter to it (see Chapter 9).

Green Deal

In simple terms, the idea behind the Green Deal is to get people to spend money in order to save money. The *Green Deal* allows homeowners to borrow money to implement efficiency improvements on their homes (loft insulation, cavity insulation, double glazing and so on) and pay for these improvements using the resulting savings from their energy bill.

The Green Deal is a government initiative that establishes the framework necessary to enable private firms to offer consumers energy efficiency improvements to their homes, community spaces and businesses at no upfront cost. The firms recoup the costs of the improvements through an increment to the customer's energy bill.

Under the Green Deal's Golden Rule, the expected financial savings must be equal to or greater than the costs attached to the energy bill, and the repayment period must be less than or equal to the lifetime of the energy efficiency measures.

The impact on suppliers is that they will be required to collect Green Deal payments as part of the customer's energy bill.

The Green Deal was launched on 28 January 2013 in England and Wales and 25 February in Scotland. According to the Department of Energy and Climate Change (DECC)'s statistics, as of the end of February 2013, 1,803 Green Deal assessments had been lodged and £26.9 million in contracts had been let.

Mis-selling

When the domestic market first opened to competition, mis-selling was seen as a serious problem. Doorstep selling was one of the most cost-effective ways of acquiring new customers, but it resulted in many customers being signed up without their consent. In 2002, Ofgem imposed a £2 million fine on London Electricity, now part of EDF Energy, for breaching their licence obligations regarding customer sales. This prompted the industry to introduce a self-regulatory code, which, in turn, resulted in a sharp fall in mis-selling-related complaints.

However, mis-selling hasn't disappeared. In March 2012, EDF Energy was found to have breached its marketing licence conditions and the company agreed to pay £4.5 million to help vulnerable customers. In April 2012, Ofgem launched an investigation into energy sales by E.ON and, more recently, Ofgem fined SSE £10.5 million for what it called "numerous breaches of its obligations relating to telephone, in-store and doorstep sales activities".

Prepayment problems

Prepayment has always been a problem child to suppliers. Up until now, prepayment meters have cost more than credit meters – both to buy and operate – and this additional cost has often been reflected in prepayment tariffs that are higher than for other payment methods (direct debit or quarterly cash/cheque, for example). Perversely, this often resulted in the highest electricity tariffs being levied on those least able to pay.

Companies have tried various prepayment technologies (cash, token, smartcard) but all have their problems. Misdirected payments are a multi-million pound problem in which payments made at the corner shop end up with the wrong supplier. Recently, a widespread multi-million pound prepayment fraud came to light in which organised criminal gangs sold ‘cut-price’ electricity to over 150,000 prepayment customers using cloned meter keys.

Smart meters (see Chapter 9) are set to solve many, if not all, of these problems. Smart meters can operate in either credit or prepayment mode and can be remotely switched between the two. With no smart cards, misdirected payments become a thing of the past, and with remote top-ups replacing top-up keys, prepayment fraud is set to disappear as well.

However, smart prepayment is seen as complex and difficult, with many suppliers putting it on the back burner – somewhat ironic given the benefits that smart metering will bring.

Price increases

Up until 2011, suppliers increasing their prices had 65 working days to inform customers of the price increase *after* it had taken place. In early 2011, Ofgem decided this wasn’t in the customer’s best interest and changed Supply Licence Condition 23 so that suppliers must now provide customers with 30 working days *advance* notice of a price increase.

The Renewable Obligation and the Carbon Emissions Reduction Target

As we touch on in Chapter 2, suppliers are currently required to source an agreed percentage of their customers' electricity requirements from renewable sources. This means either trading with certified renewable generators and receiving Renewable Obligation Certificates (ROCs) in return, or paying a cash-out price (effectively buying the certificates from Ofgem without the generation). The cash-out price in 2013/14 was £42.02 per MWh.

The Carbon Emissions Reduction Target (CERT) has been around since 2002 (although it was called the Energy Efficiency Target back then). It sets a target megawatt hour (MWh) target by which large suppliers (those with 250,000 customers or more) must reduce the consumption of their customers. Typically, suppliers do this by providing free or subsidised energy efficiency measures such as energy-efficient light bulbs or loft insulation.

Collective purchasing and switching

A recent development in the retail market is the emergence of collective purchasing and switching initiatives. The idea's simple: rather than individuals searching around for the best available tariff, a group of like-minded customers band together and invite suppliers to bid against each other for the right to supply them, in a so-called *reverse auction*.

The Big Switch campaign run by Which? and 38 Degrees is probably the most high-profile example of this kind of initiative. It saw interest from over 280,000 people and resulted in over 37,000 customers switching supplier. Which? claims that the average savings for these customers was £223 per year.

Jargon buster

Here's a taster of some of the more common jargon you might hear in retail businesses:

- **Energy Efficiency Commitment (EEC):** The precursor to the Carbon Emissions Reduction Target.
- **Energy Supply Ombudsmen:** An independent body established by Energy UK (the trade association for the energy industry) that resolves disputes between customers and their energy suppliers associated with billing and transfer issues (a name always worth dropping into the conversation if ever you have need to complain to your energy supplier).
- **Energy UK:** A trade association for the gas and electricity sector. It includes small, medium and large companies working in electricity generation, energy networks, and gas and electricity supply, as well as a number of businesses that provide equipment and services to the industry.
- **Meter Asset Manager (MAM):** A company that works on behalf of a supplier to install and maintain customers' electricity meters.
- **Meter Asset Provider (MAP):** A company that owns a meter and rents it to the supplier.
- **Prepayment meter (PPM):** A meter that requires customers to purchase energy in advance of consumption.
- **Prepayment Meter Infrastructure Provision (PPMIP):** The specialised back office administration systems that allocate payments from prepayment customers to suppliers.
- **Supply Licence Condition (SLC):** A regulatory obligation placed on the holder of a supply licence.
- **Supplier of Last Resort (SoLR):** A supplier, appointed under a Supply Licence Condition, to take on the role of supplier should the previous supplier have had its licence revoked due to insolvency.
- **Super complaint:** A really, really good complaint (only kidding). A complaint made by a designated consumer body such as Energy Watch.

A supplier's view

David Crossman, Supplier Management Director, Haven Power, says:

'The recent trend of increasing regulation of the retail sector is likely to continue and even accelerate, driven principally by the environmental agenda. The effect on suppliers is to add complexity and to increase costs to serve. Customers see the bottom-line impact of such policies and the effect of the upward trend in distribution and transmission charges (which is likely to continue) to fund network development for distributed generation and large-scale renewables'.

'Greater transparency of these cost elements may help improve customers' trust in suppliers, and the current 'bundled' approach to billing small business customers could be replaced by a fully itemised 'pass-through' approach, currently used only for the largest buyers. Other product innovations would allow the customer to trade off headline cost against the risk of future price movements of specific or all third party charges'.

'The introduction of smart metering, while improving the provision of energy usage information for customers and increasing billing accuracy, will initially drive up suppliers' costs to provide the equipment, organise installation and operate the new Data Communications Company-based registration process in parallel with the existing registration process. In the longer term, supplier costs should fall as billing accuracy improves and settlement processes are simplified'.

'The challenge here is to make sure that the approach to the introduction of registration and half-hourly settlement for smart metering does genuinely simplify the processes, as the industry's track record when managing major change has, in the main, led to increased complexity and costs.'

Chapter 6

The Wholesale Market

In This Chapter

- Getting to grips with the wholesale market
- Reminiscing about the Pool
- Considering the New Electricity Trading Arrangements and the British Electricity Trading and Transmission Arrangements
- Examining the Electricity Market Reform

The *wholesale market* is where generators sell the electricity they generate to suppliers so that suppliers can satisfy their customers' demand in the retail market (which we explored in Chapter 5). As with any wholesale market, you also have *speculators* – those that buy and sell but never take delivery of the product (so called *non-physical traders*). The British wholesale market is competitive, meaning that suppliers, generators and non-physical traders can choose who they trade with. Most trading takes place bilaterally: either directly, through brokers or via a power exchange.

In this chapter, we look at why we need a wholesale market, how it's come about and what changes it's likely to experience in the coming years.

Semi-interesting wholesale market fact

Almost four times as much electricity is traded in the British wholesale market as is generated (the so-called *churn ratio*). This may sound a lot, but it's actually an indication of a lack of market liquidity. In the German power market, for example, the churn ratio is 8 times, and the UK gas market manages nearer 15 times. The British electricity wholesale market has some way to go to reach the churn ratio of ten that's considered typical of a liquid market.

What's the Wholesale Market All About?

Because we can't store electricity in large quantities, we generate, transport, deliver and consume in real-time. As we discuss in Chapter 3, it's the job of the GB System Operator to ensure that supply constantly matches demand and that the lights stay on. Although this is a continuous process, electricity is traded and settled in half-hour chunks called *Settlement Periods*.

REMEMBER

For each Settlement Period, suppliers need to forecast how much electricity their customers will use and then buy this in the wholesale market. Similarly, generators need to find buyers for their intended output in each Settlement Period. Not surprisingly, this is a bit more complex than it sounds. Trading strategies must span from real-time delivery to years in advance. Suppliers' trading strategies need to consider future customer gains or losses, and generators' trading strategies need to take account of the purchase and delivery of the primary fuels (coal, gas) required to generate the electricity in the first place.

The British wholesale electricity market currently operates under the British Electricity Trading and Transmission Arrangements (BETTA). BETTA came into effect in 2005, when the New Electricity Trading Arrangements (NETA) that were operating in England and Wales extended into Scotland. Under BETTA, wholesale trading has three components:

- A **bilateral market** in which generators, suppliers and others trade a variety of contract types, either directly or via brokers or power exchanges.
- A voluntary **Balancing Mechanism** in which generators with flexible generation and suppliers with flexible demand can make firm bids and offers to vary output/consumption to the GB System Operator to help balance the system.
- An **imbalance settlement process** that pays for the balancing actions taken by the GB System Operator.

The majority of electricity (98 per cent) is traded in the bilateral market. This continues until *gate closure* (currently set at one hour before time of delivery). From this time until delivery, all further trading (the remaining 2 per cent) is with the GB System Operator in the Balancing Mechanism. The GB System Operator decides what actions are needed to balance the grid and selects the most cost effective of the bids and offers accordingly. The Balancing and Settlement Code (BSC) governs operation of the Balancing Mechanism and the processes for recovering system balancing costs (refer to Chapter 7 for details of the BSC).

TIP

If it all sounds deceptively simple, it isn't, but this is a Dummies guide. For a bit more detail, ELEXON's insightful 'Beginners Guide to the Electricity Arrangements' (available on its website, `www.elexon.co.uk`) is well worth a read.

How Has the Wholesale Market Changed?

We've had several stabs at getting wholesale trading right in Britain. Let's take a look at how things have changed over the past few decades.

The Pool

The wholesale market began life in 1990 as the *Pool*, a compulsory day-ahead market for bulk physical trading between generators and purchasers. Prior to this, the Central Electricity

Generating Board (CEGB) decided who should generate. The Pool was designed in six months and ran for 11 years. The whole process was managed by a computer program called GOAL (later to become SUPERGOAL) and it worked something like this. . . .

Every day, National Grid would forecast what the demand for electricity would be for the following day and generators would submit non-binding offers to generate for the next day. These offers were stacked in ascending price order and the most expensive offer required to meet the expected demand set the System Marginal Price (SMP). GOAL added a *capacity payment*, based on the probability and cost of a loss of supply, to the SMP to give the Pool Purchase Price (PPP), and paid this price to all dispatched generators, regardless of their offer price. This meant that *peaking plant* (generators that could respond to sudden changes in demand) were price setters and less flexible *base-load plant* (nuclear) became price takers (nuclear plant, for example, would frequently bid in at zero cost, safe in the knowledge that they would receive the Pool Purchase Price).

The stack of offers was called the *unconstrained schedule* because it didn't take into account the complexity of balancing an electricity grid (ensuring that the power could get to where it was needed at a stable frequency and voltage). In reality, some generators had to be 'constrained off' due to constraints on the network, meaning that others had to be 'constrained on'. Similarly, the National Grid didn't always get its forecast right, meaning GOAL had to make further changes to the schedule. GOAL added these additional costs to the Pool Purchase Price in the form of an 'Uplift' to give the Pool Selling Price (PSP), the price paid by all power purchasers.

Back in the days of the Pool, the retail market was open only to large customers that tended to enter into annual contracts at fixed prices. This gave suppliers a predominantly fixed income, which meant they weren't able to cope with a volatile Pool Selling Price. This led to the development of a separate financial contracts market in which Contracts for Differences (CfDs) were traded to hedge the price of electricity. In simple terms, a generator and a supplier would agree a strike price for electricity. In a two-way Contracts for Difference, the generator would pay the supplier if the PSP was above the agreed strike price, and the supplier would pay the generator if the Pool Selling Price fell below the strike price. This fixed the price of electricity for both parties. In a one-way Contracts for Difference, only one party paid out: effectively capping, rather than fixing, the price. In 1999, it was estimated that 90 per cent of demand was hedged using Contracts for Differences.

However, the Pool had its problems. For one thing, for the majority of the life of the Pool, only two competing generators existed (PowerGen and National Power) and a report produced by the Director General of Electricity Supply (DGES) in 1991 uncovered *gaming* (manipulating the Pool Selling Price through the way PowerGen and National Power offered into the Pool). Offers were non-binding, so could be withdrawn on the day without penalty, resulting in the dispatch of more expensive plant at a higher System Marginal Price.

In 1994, a consultation on Pool reform ended up making some radical recommendations, including adding a complimentary on-the-day spot market, incentives on National Grid to reduce Uplift and a pay-as-offered rather than uniform Pool Purchase Price. Although ignored at the time, these recommendations formed the basis of the New Electricity Trading Arrangements (NETA) introduced in 2001.

Ironically, while Britain was replacing the Pool, other countries that were de-regulating started implementing theirs, many of which have survived.

New Electricity Trading Arrangements

The New Electricity Trading Arrangements (NETA) started life in 1998 as the Review of Electricity Trading Arrangements (RETA), a series of consultations and proposals. The review concluded that:

- The two dominant generators had too much market power.
- The System Marginal Price calculation was too complex.

- No one was incentivised to reduce Uplift (for those with short memories, that's the bit added to the Pool Purchase Price to allow for necessary changes to the unconstrained schedule).
- Governance of the Pool rules (see the last section) was too inflexible.

(Apart from that, it was fine)!

RETA proposed replacing the Pool with an electricity market more like other commodity markets, with bilateral trading, pay-as-bid, firm offers that were simple and transparent. RETA also proposed allowing suppliers to participate by offering to move their customers' demand up or down as an alternative to generators offering to generate more or less.

The New Electricity Trading Arrangements (NETA) came into effect on 27 March 2001, replacing the Pool, which had served the industry for 11 years. This 'big bang' change to bilateral trading against a rolling gate closure was a radical one for companies that had been used to day-ahead trading in the Pool. In particular, generators suddenly found themselves responsible for dispatching their own plant – a bit of a shock when you've been used to being told what to do. The trading functions within energy companies began to resemble commodity trading desks as they recruited traders from other markets. Wide red braces made an appearance on the trading floor.

The trading desks of the energy companies typically split into two functions:

- A long-term trading desk that balanced the company's position up to a week or so before delivery.
- An operational trading desk that fine-tuned the position that they inherited and traded any remaining flexibility in the Balancing Mechanism (see the earlier section 'What's the Wholesale Market All About?').

Typically, the latter was populated with station engineers who'd spent their life dispatching power plant, and the former wore the wide red braces.

British Electricity Trading and Transmission Arrangements

As with the Pool, NETA (see the preceding section) applied only in England and Wales. From an electricity trading perspective, Scotland was quite literally another country, linked to the NETA market via an interconnector just like France. North of the border, the Scottish Trading Arrangements (STA) held sway and allowed the two vertically integrated companies, ScottishPower and Scottish Hydro-Electric, to dispatch their own generation to meet demand in their own area – trading with each other when necessary and selling surplus generation into England and Wales via the Anglo–Scottish interconnector.

REMEMBER

In April 2005, NETA invaded Scotland in the form of the British Electricity Trading and Transmission Arrangements (BETTA). Not only did BETTA extend NETA into Scotland, but it also had a profound effect on the transmission system. ScottishPower and Scottish Hydro Electric retained ownership of their respective transmission networks (becoming Transmission Owners), but operation of their networks was given to National Grid, acting as the new GB System Operator. The System Operator – Transmission Owner Code (STC) came into effect and the role of Settlement Agent passed from Scottish Electricity Settlement Limited (SESL) to ELEXON. Overnight, the Anglo–Scottish interconnector disappeared, becoming just another piece of network within the British transmission system (see Chapter 3 for more information).

Who Are the Major Players?

To trade electricity, you must be a *BSC Party*, which means signing-up to the Balancing and Settlement Code (BSC). This code defines the British wholesale electricity trading arrangements, and it replaced the Pooling and Settlement Agreement (PSA) that did the same thing for the Pool. It's administered by the Balancing and Settlement Code Company (BSCCo), a role performed by ELEXON.

As of March 2013, 262 BSC Parties existed, of which just over 209 were trading parties. *Trading parties* come in different flavours: namely, suppliers, generators, interconnector users and non-physical traders. A vertically integrated company typically has a single trading operation that satisfies the needs of its generation and retail arms. *Non-physical traders* are financial organisations that have no physical assets (no generation plant or customers) but speculate on changes over time in the wholesale market price through trading future positions that are closed out prior to delivery. As of March 2013, there were 68 non-physical traders.

What Are the Big Issues?

Things haven't stopped changing since the NETA/BETTA changes (see the preceding section). Vertical integration of generators and suppliers, declining indigenous fuels (particularly offshore gas), phasing out of obsolete power stations (particularly nuclear), increased intermittent generation and legal obligations to reduce the amount of carbon dioxide emitted are all instigating further reform of the wholesale market.

Electricity Market Reform

The British electricity industry faces some significant challenges. The government predicts that electricity consumption is set to double by 2050 as we wean ourselves off fossil fuels. We touch on what this means for our networks in Chapters 2 and 3.

A quarter of our generation plant is set to close over the next ten years, leaving a massive energy gap that threatens blackouts and brownouts. Recognising this, in July 2011, the government published a white paper, the Electricity Market Reform (EMR), outlining a package of reforms for changing the British electricity market to encourage much-needed generation of the right type.

REMEMBER

Here are the key elements of the reform that the government is proposing:

- **Carbon floor price** to reduce uncertainty and strengthen incentives to invest in low-carbon generation.
- **New long-term contracts** (Feed-In Tariff with Contracts for Differences) to encourage investments in much-needed low-carbon generation by fixing the price of electricity paid to generators (a replacement for the existing Renewable Obligations arrangements).
- **Emissions Performance Standard (EPS)** limiting the amount of emissions new fossil-fuel plants can emit to ensure that no new coal stations are built without Carbon Capture and Storage (see Chapter 2).
- **Capacity Market,** run as an auction, to contract for long-term generation and/or demand reduction to address the need for spare generation capacity when intermittent renewable generation isn't available.

The government favours the GB System Operator administering both the Feed-In Tariff with Contracts for Differences and Capacity Market, and intends to have the legislation necessary to implement the reform on the statue book by spring 2013.

Retail Market Review

Our semi-interesting fact at the start of this chapter points out that the British wholesale market has poor liquidity, as shown by its low churn ratio. A major contributor to this is the fact that the Big Six suppliers are also generators, and a lot of electricity passes directly between their generation and retail arms. Why does this matter? Well, it makes it harder for independent generators and retailers to find long-term electricity contracts, which, in turn, limits their business options.

In March 2011, the Office of Gas and Electricity Markets (Ofgem) released a Retail Market Review in which it concluded that a lack of wholesale electricity market liquidity resulting from vertical integration of suppliers and generators was creating a barrier to new entrants and inhibiting competition. Ofgem has since proposed introducing a monthly Mandatory Auction (MA) in which the Big Six will be required to sell between 10 per cent and 25 per cent of their generation capacity via long-term traded products.

Regulation of Wholesale Energy Markets Integrity and Transparency

Regulation of Wholesale Energy Markets Integrity and Transparency (REMIT) is a new EU regulation aimed at preventing wholesale market abuse and market manipulation by large vertically integrated suppliers/generators. It came into force at the end of 2011 and, when reflected in British legislation, will give Ofgem investigatory and enforcement powers.

Jargon buster

As you would expect, the wholesale market comes with its own peculiar set of acronyms and jargon. Here's a taster:

- **Balancing Mechanism Reporting Agent (BMRA):** A service that publicises near real-time information relating to the Balancing Mechanism.
- **Balancing Mechanism Unit (BMU):** In simple terms, things that either generate or consume electricity and whose generation/consumption can be measured or calculated for settlement purposes (see Chapter 7).
- **Balancing Services Adjustment Data (BSAD):** Data relating to actions taken outside of the Balancing Mechanism by the GB System Operator to balance the system.
- **Balancing System Use of System (BSUoS):** Charges levied on Balancing and Settlement Code parties to recover the costs of balancing the transmission network.
- **Contract Notifications:** What traders have to submit to the settlement process for their trades to be taken into account when calculating imbalance. A Contract Notification only specifies the amount of electricity that's been traded (the prices struck being confidential). Contract Notifications are notified via Energy Contract Volume Notification Agents (ECVNAs) to the Energy Contract Volume Aggregation Agent (EVCAA).
- **Energy Contract Volume Notification Agent (ECNVA):** An agent appointed by a trading

party to submit contract notifications to ELEXON on their behalf.

- **Energy Contract Volume Aggregation Agent (ECVAA):** The central function that aggregates contract volume notifications received from Energy Contract Volume Notification Agents.
- **Physical Notifications (PNs):** Notifications to the GB System Operator of what a Balancing Mechanism Unit is going to do in terms of consuming or generating electricity. The first to be submitted for a given day is the Initial PN (IPN) and the last to be submitted before gate closure is the Final PN (FPN).
- **System Buy Price/System Sell Price (SBP/SSP):** The prices applied to imbalance volumes to calculate imbalance charges.
- **System balancing and energy balancing:** Functions performed by the GB System Operator – *energy balancing* ensures that sufficient generation exists to meet demand, and *system balancing* is ensuring the electricity gets to where it's needed at a stable frequency and voltage.

The British wholesale market in 2020

Jodie Eaton, Director of Industrial & Commercial at RWE npower, says:

'An energy revolution will have changed the face of the wholesale market by 2020. The rollout of smart meters will result in a change of consumption profiles, providing our society can get used to putting dishwashers on after supper instead of after breakfast. We are already exploring much greener alternatives for our transport to reduce emissions, and increasing numbers of electric vehicles charging at home overnight will add to this change of profile. The alternative of reverting to donkey travel may prove impractical for urban flat dwellers! Talking of donkeys and emissions, new renewable micro-generation is set to change the way we consume electricity. Solar panels may be joined by garden turbines'.

'The technology revolution is still having a huge influence on the way we live, and predicting our energy use in 2020 is a challenge of imagination and innovation. What we do know is that, with greater customer choice, the wholesale marketplace will be very different from today.'

Chapter 7
Settlement

In This Chapter

- Working out who owes whom what
- Getting to grips with meters and profiling
- Understanding the settlement timetable
- Finding out about the Balancing and Settlement Code
- Examining the issues for settlement

Put simply, *settlement* is about working out how much electricity a generator has generated and how much electricity a supplier's customers have consumed, and then comparing the generation/consumption to what the supplier and generator have traded in order to calculate imbalance charges.

The settlement process we use in Britain epitomises what makes our market different from everyone else's. It's essential to our fully competitive retail and wholesale markets (see Chapters 5 and 6). It's also horrendously complex, takes over a year to complete and has been studiously ignored by other countries when implementing their own settlement processes. That said, it works pretty well (most of the time).

This chapter attempts to shed some light on one of the complexities that makes the British electricity industry unique. We explain what settlement's for and the weird and wonderful way it goes about fulfilling its function.

Semi-interesting settlement fact

British settlement handles almost £1.5 billion of funds from over 200 trading organisations every year.

What's Settlement All About?

Settlement is horrendously complicated, but in this section we try to give you a basic understanding of how it works.

Working out the numbers

As we discuss in Chapter 6, suppliers and generators trade electricity on the wholesale market, but given the nature of electricity, suppliers don't end up taking delivery of lorry-loads of electrons from their trading counterparties. Although the trades are for firm physical delivery of electricity, they may or may not reflect what actually happens.

Say a generator sells 100 megawatt hours (MWh) in a given half hour but has some problem at its plant that means it fails to generate it. If all the other generators manage to generate precisely what they've sold and the suppliers have purchased exactly what their customers need, a 100-MWh shortfall exists, which the GB System Operator needs to purchase to keep the lights on. Under the New Electricity Trading Arrangements (NETA; see Chapter 6), the cost of doing so – be it through ancillary services, forward trades or the Balancing Mechanism (also in Chapter 6) – should be levied on the generator that failed to generate. This is the so-called 'polluter pays' concept.

REMEMBER

So, to calculate imbalance, you need a comparison of how much generators generated and how much suppliers' customers consumed with how much generators and suppliers have traded physically with each other.

First, the easy bit: you can measure the output of *generators* by insisting that they install metering capable of recording export on a half-hourly basis. *Suppliers* are a little more difficult because you need to measure the consumption of their individual customers, and there are a lot more of these.

When retail competition started in 1990, the market opened only for customers with consumptions of more than 1 MW, and given the size of their electricity bills, it was a no-brainer to insist that installing a half-hourly meter was a pre-requisite for being able to change supplier. Even in 1994, when the threshold for market entry dropped to 100 kW, the average size of an eligible customer's bills justified installation of half-hourly metering. Grid Supply Points (the points at which electricity leaves the transmission network and enters the distribution network) are also half-hourly metered. Deducting the half-hourly metered consumption of those customers who had changed supplier from that measured at the Grid Supply Points gave the consumption for everyone else, which was allocated to the Public Electricity Supplier (PES), the default supplier for customers with no choice or those electing not to use their choice.

However, when the market opened to every household in 1998, settlement faced a problem. The high cost of half-hourly meters made it unacceptable to insist that domestic customers wanting to switch supplier should be metered half-hourly. But without a half-hourly meter, consumption couldn't be allocated to a gaining supplier on a half-hourly basis. The solution was profiling.

Before we get into profiling, it's probably worth covering a few basics about metering.

Meters

Metering, like settlement, probably deserves a whole Dummies guide to itself. However, here's a primer on some of the more noteworthy points:

- **Half-hourly versus non-half-hourly:** Meters come in two different types: half-hourly (also referred to as *interval*) and non-half-hourly (also referred to as *non-interval*). Half-hourly meters, as their name suggests, record energy flows every half hour, whereas non-half-hourly meters record continuously and are read occasionally (usually, when a meter reader is lucky enough to find you at home).

- **Registers:** A meter has one or more registers that can measure different properties over different timescales. They can measure *import* (how much you're using) and *export* (how much your solar panels are generating), active and re-active power, voltage sags and swells, maximum demand and many other attributes that get the electrical engineer's heart racing.
- **Settlement registers:** Registers used for settlement; those measuring imports and exports of active power. Other registers (maximum demand registers, reactive power registers and so on) are called non-settlement registers.
- **Restricted versus unrestricted:** Meter registers can record continuously or during pre-defined periods (for example, during peak or off-peak times). A meter with a continuously recording register is called an *unrestricted* meter and those with registers recording at pre-defined periods are called *restricted*. Restricted meters are used for *Time of Use tariffs* (where the price of electricity varies according to the time of day; for example, Economy 7). Around 20 per cent of domestic customers have restricted meters.
- **Codes of Practice:** Meters come in different sizes depending on the amount of power that needs to be measured. Ten meter codes of practice define the rules for the type of meter you need.
- **Supplier Volume Allocation versus Central Volume Allocation meters:** Large generators, whose output is highly significant to settlement, require half-hourly metering, as do Grid Supply Points. These meters, referred to as Central Volume Allocation (CVA) meters, are registered with the Central Registration Agent (CRA). Customers' meters, referred to as Supplier Volume Allocation (SVA) meters, are registered in the Supplier Meter Registration Service (SMRS). The Central Registration Agent is a central Balancing and Settlement Code Agent, whereas the Supplier Meter Registration Service is provided by the distributors as part of their licence obligation (see Chapter 4).

- **Meter reading:** Central Volume Allocation meters (of which there are around 800) are read remotely by the Central Data Collection Agent (CDCA), an agent appointed by the Balancing Settlement Code Company (the Central Registration Agent being another one). Supplier Volume Allocation meters are read by suppler-appointed agents. Half-hourly meters are read by half-hourly data collectors (HHDCs), usually remotely. Unless it's a smart meter (see Chapter 9), a non-half-hourly meter has to visited by a meter reader to be read.

Profiling

If anyone tells you that he understands how profiling works, he's almost certainly lying. You could probably count on one hand the number of people who truly understand the complexities of regression coefficients, algorithmic profiling, Group Average Annual Consumptions, Basic Period Profile Coefficients and chunking. So please treat the following explanation in the spirit intended – a stratospheric overview of the basic principles.

Profiling is the mechanism by which we turn non-half hourly meter readings into the half-hourly consumptions required for settlement.

That's probably enough information for most people, so feel free to skip on to the next bit on the Settlement Timetable at this point.

Want to know a bit more? Well, profiling uses a pattern of consumption (a *load profile*) appropriate to the type of customer. We use eight different patterns (or Profile Classes) in the British market:

- Profile Classes 1 and 2 are for unrestricted and restricted domestic customers, respectively.
- Profile Classes 3 and 4 are for unrestricted and restricted non-domestic customers, respectively.
- Profile Classes 5 to 8 are for *maximum demand customers* (customers whose tariff depends on their peak consumption, which is measured by a non-half-hourly meter that has a maximum demand register).

Profiles are updated annually based on samples taken from around 2,500 volunteer households who have agreed to have a half-hourly meter fitted. Using this data, the Profile Administrator (one of the BSC Agents appointed by the BSCCo) defines an algorithm that's used to calculate a set of profile coefficients, one for every half hour. The *profile coefficient* is essentially the proportion of a customer's annual consumption that you expect the customer to consume in that specific half hour. The algorithm used to calculate profile coefficients takes in a number of variables including time of sunset (we use more electricity when it's dark), effective noon-day temperature (we use more electricity when it's cold), season (we use more electricity in winter) and day of week (we use more electricity during the week compared to the weekends).

Knowing the fraction of a customer's annual consumption for every half hour, combined with the customer's actual consumption over a defined period (the *meter advance* between meter readings), allows you to estimate the customer's half-hourly consumption.

For example, on 21 May 2012, the noon-day temperature in London was 15.5 degrees Celsius and the sun set at 20:55. Putting these parameters into the regression algorithm produces a profile coefficient for Settlement Period 28 (13:30 to 14:00) of 0.0000432566838. If a London customer's annual consumption is 3,300 kilowatt hours (kWh), his consumption for that half-hour period would be calculated as 3,300 × 0.0000432566838 = 0.143 kWh. Nothing to it. . . . Well, there's obviously a little more to it than that, but you get the gist.

TIP

For more information on load profiles and their use in non-half-hourly settlement, take a look at ELEXON's comprehensive overview on load profiles (`www.elexon.co.uk/wp-content/uploads/2012/01/load_profiles.pdf`).

Time Pattern Regimes and Standard Settlement Configurations

No discussion around settlement would be complete without mentioning Standard Settlement Configurations (SSCs) and Time Pattern Regimes (TPRs), which form the language that separates settlement folk from the rest of us. Given constraints on space, any attempt at making you fluent in 'settlement' would be pointless, but here's the equivalent of '*dos cervezas, por favor*'.

Let's start with **Time Pattern Regimes** (TPRs). A TPR tells you when a settlement register is active. For example, a register mapped to TPR 00043 is active for the 17-hour period from 07:30 to 00:30 the next day, every day of the year. Similarly, a register mapped to TPR 00210 is active for the seven-hour period from 00:30 to 07:30, every day of the year.

Now for **Standard Settlement Configurations** (SSCs). An SSC is a combination of TPRs that covers every half-hour of the year. To continue our previous example, SSC 0151 is the combination of TPRs 00043 and 00210. Different SSCs are typically used for different tariffs, with each register having a different pence/kWh rate. For example, SSC 0151 is used for an Economy 7 tariff. The simplest and most common SSC is 0393, which has only one TPR (00001) that is constantly active. SSC 0393 is, therefore, associated with unrestricted meters (which have only one settlement register that records continuously).

Estimated Annual Consumptions and Annualised Advances

Estimated Annual Consumptions (EACs) and Annualised Advances (AAs) are actually the same thing. They're both estimates of annual electricity consumption to which you apply profile coefficients to calculate half-hourly consumption. The difference between the two is how you calculate them and use them. Figure 7-1 illustrates an example to show how EACs are calculated and how they grow up to become AAs.

Suppose a meter reader turns up at your door on 5 April and, miraculously, you happen to be in. The meter reader takes a meter reading and submits it into the settlement process, which uses it to calculate an EAC. It then uses the EAC to estimate your half-hourly consumption from 5 April onwards. Every day, the regression algorithm is run with the appropriate effective noon-day temperature, time of sunset, day type and so on, and a set of profile coefficients is produced. The EAC is multiplied by these to work out your half-hourly consumption.

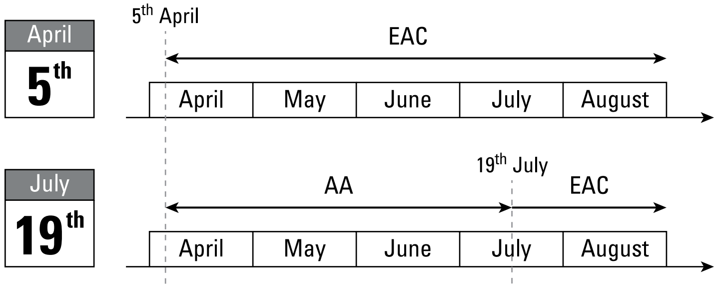

Figure 7-1: Estimated Annual Consumptions and Annualised Advances.

Now suppose that the meter reader returns on the 19 July and, miracle upon miracle, finds you home again. The meter reader takes another meter reading and submits this into the settlement process, which uses it to calculate an Annualised Advance (AA) for the period between the meter readings taken on 5 April and 19 July and an EAC for the period from 19 July. Being bounded by two meter readings means that the AA is more accurate than the EAC that's been used to date, and so the AA replaces the EAC for settlement purposes. Meanwhile, the EAC calculated from the 19 July meter reading is used in settling days after 19 July (until such times as another meter reading is taken). And so it goes on. . . .

Settlement timetable

Millions of pounds of electricity are traded on the British wholesale market every day. With so much cash at stake, settlement needs to be both timely and accurate. However, a natural tension between these two aspirations exists. Ideally, we would only use Annualised Advances to settle because these are more accurate than Estimated Annual Consumptions. However, whereas half hourly meters tend to be read daily, non-half hourly meters don't get read that often and it takes time to convert EACs into AAs. For this reason, every day (termed a *settlement day*) is settled not once but five times or more over a period of at least 14 months.

The *settlement timetable* determines the days on which settlement occurs for each settlement day. The first settlement run (the II run) occurs around eight calendar days after the settlement date. This is followed by the SF run (approximately 23 days), R1 run (approximately 52 days), R2 run (approximately 115 days), R3 run (approximately 216 days) and RF run (approximately 420 days). There's also the option of a dispute run (DF) should irregularities come to light. We illustrate the settlement timetable in Figure 7-2.

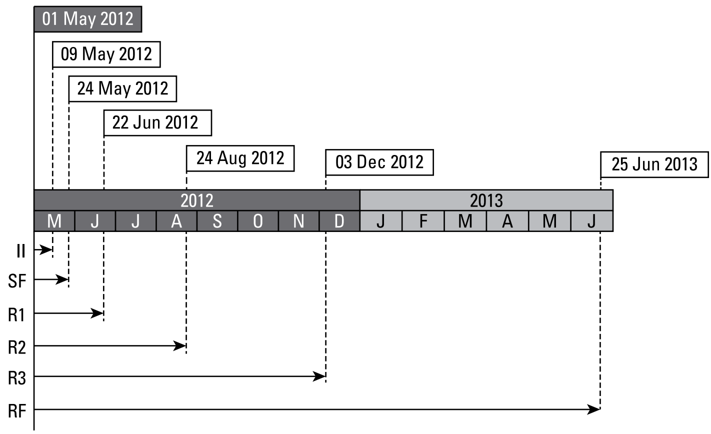

Figure 7-2: Settlement timetable.

After each settlement run, money changes hands as customers' consumption is re-calculated in the light of new Annualised Advances. However, with each successive settlement run, the money transfers should become smaller and smaller until the RF run, when the settlement day is deemed to be settled (unless, of course, there's a dispute).

Settling imbalance

We touch on the Balancing Mechanism in Chapter 6. It's a market that operates between gate closure and time of delivery in which the generators and suppliers can voluntarily offer flexible output/consumption to the GB System Operator to help balance the system.

The GB System Operator's actions, both within and outside of the Balancing Mechanism, need to be paid for, and this cost is borne by those participants that are found to be *out-of-balance*; that is, suppliers who've purchased too little or too much power for their customers and generators who've generated more or less than they sold. The settlement process charges those parties found to be out-of-balance for shortfalls or pays them for surpluses at the System Buy Price (SBP) and System Sell Price (SSP), respectively. These prices tend to be penal compared with market prices (you get paid less than market rate for your surpluses and are charged more than market rate for shortfalls), thus encouraging participants to balance.

The settlement process calculates a participant's imbalance after the event by comparing their contracted position (what they bought/sold) with what they actually did (what a supplier's customers consumed or what a generator's plant generated). The former comes from contract notifications submitted by participants prior to gate closure. The latter comes from the settlement process we describe earlier in this section.

How Has Settlement Changed?

From a settlement perspective, not much has changed since profiling came along with the introduction of retail competition in 1998. We still have the same eight Profile Classes that were introduced. Eight-five Standard Settlement Configurations have been added to the 647 we started with, and we've lost six. The big change is likely to come with the rollout of smart metering (see Chapter 9).

Who Are the Major Players?

Let's have a look at who's who in the settlement space.

Balancing and Settlement Code Company

ELEXON performs the role of the Balancing and Settlement Code Company (BSSCo). ELEXON is a non-profit making organisation owned solely by National Grid and set up under the Balancing and Settlement Code (BSC) to administer the code and provide and procure the services required to implement it.

Balancing and Settlement Code Agents

As the Balancing and Settlement Code Company, ELEXON is responsible for contracting with and managing Balancing and Settlement Code Agents, parties that help it to implement the Balancing and Settlement Code. Here's a list of the agents and what they do.

- **Settlement Administration Agent (SAA):** Calculates payments resulting from trades in the Balancing Mechanism and from imbalance.
- **Funds Administration Agent (FAA):** Transfers funds between Balancing and Settlement Code Parties for trades made in the Balancing Mechanism and for imbalance.
- **Balancing Mechanism Reporting Agent (BMRA):** Provides near real-time reporting of market information relating to individual Balancing Mechanism Units (BMUs), the Balancing Mechanism and the system as a whole.
- **Energy Contract Volume Aggregation Agent (ECVAA):** Collates and submits energy contract volume notifications to the Settlement Administration Agent (SAA).
- **Central Data Collection Agent (CDCA):** Collects, processes and aggregates metered data associated with Metering Systems registered with the Central Registration Agent.
- **Technical Assurance Agent (TAA):** Monitors meter compliance with requirements set out in the Balancing and Settlement Code and its subsidiary documents through sampled and targeted meter inspections.
- **Central Registration Agent (CRA):** Maintains a master registry of information such as the registered participants, trading units, physical plant, boundary points and interconnectors.

- **Supplier Volume Administration Agent (SVAA):** Allocates initial electricity volumes to suppliers and performs subsequent reconciliations as meter data becomes available.
- **Teleswitch Agent:** Monitors and provides details of transmitted teleswitch regimes to the Supplier Volume Administration Agent (for those interested, *teleswitching* is the process of remotely switching the pricing on restricted meters – for example, peak to off-peak).
- **BSC Auditor:** Performs an annual audit of settlement data and processes.
- **Profile Administrator:** Creates and maintains the profiles used to settle non-half-hourly metered consumption.

Other agents

In addition to the centrally procured agents, other agents are also required to make settlement work. Here's a list of some of the key ones.

- **Half-Hourly and Non-Half-Hourly Data Collectors (HHDCs and NHHDCs):** Supplier-appointed agents who collect and validate half-hourly and non-half-hourly meter readings, respectively. Non-Half-Hourly Data Collectors are also responsible for calculating Estimated Annual Consumptions and Annualised Advances.
- **Half-Hourly and Non-Half-Hourly Data Aggregators (HHDA and NHHDAs):** Supplier-appointed agents who aggregate consumption by supplier and submit it to the Supplier Volume Administration Agent.
- **Meter Operator (MOP):** A supplier-appointed agent responsible for installing and maintaining meters (they come in both half-hourly and non-half-hourly forms).
- **Meter Asset Provider (MAP):** An organisation that owns meters. Can be the supplier or a third party from which the supplier leases the meter.
- **Energy Contract Volume Notification Agent (ECVNA):** A Balancing and Settlement Code trading party-appointed agent responsible for notifying the Energy Contract Volume Aggregation Agent of traded volumes.

- **Meter Volume Reallocation Notification Agent (MVRNA):** A Balancing and Settlement Code trading party-appointed agent responsible for notifying the Energy Contract Volume Aggregation Agent of reallocations of metered volumes between trading parties.

Customers

For settlement purposes, customers are defined as either half-hourly or non-half-hourly. The half-hourly market comprises a little over 117,000 customers and accounts for 44 per cent of annual consumption. The remaining 56 per cent of annual consumption comes from the non-half-hourly market comprising a tad over 29.5 million customers.

What Are the Big Issues?

The prospect of mandatory rollouts of Automated Meter Read (AMR) and smart meters capable of recording half-hourly consumption for all customers has sounded the death knell for profiling. ELEXON's Profiling and Settlement Review Group has been looking at the possibility of mandating half-hourly settlement for customers in Profile Classes 5–8 (medium to large commercial customers) and Profile Classes 1–4 (domestic and smaller commercial customers). This has resulted in a number of consultations, two cost–benefit analysis reports and two Balancing and Settlement Code Modifications:

- **P272** proposes mandating half-hourly settlement for Profile Classes 5–8 customers (those who, by 2014, will have received an AMR meter that's capable of recording half-hourly consumption). At the time of writing, this modification is still pending.
- **P280** proposed new optional measurement classes to allow suppliers to settle domestic and small business customers half-hourly if they wanted to do so. Although approved by the Balancing and Settlement Code Panel, this modification was rejected by the Office of Gas and Electricity Markets (Ofgem) because it required changes to the Distribution and Use of System (DUoS) charging methodology to take effect, something that Ofgem wasn't in a position to decide on.

REMEMBER

Given the government's mandated rollout of smart meters, the eventual demise of non-half-hourly settlement is both inevitable and problematic. If and when smart meters are settled half-hourly, a gradually diminishing pool of non-half-hourly meters is likely to amplify settlement errors, potentially penalising (or benefiting) those suppliers at the rear of the smart-meter rollout. However, using actual half-hourly data would improve settlement accuracy, provide greater revenue certainty and incentivise suppliers to improve their forecasting of customer demand. Watch this space.

Jargon buster

We've covered our fair share of jargon in this chapter already. However, when it comes to settlement, there's never a shortage of acronyms. Here are a few more you may come across:

- **Estimated Annual Consumption Annualised Advance (EACAA):** A system used by Non-Half-Hourly Data Collectors to turn meter advances into Estimated Annual Consumptions and Annualised Advances.
- **GSP Group Average Estimated Annual Consumptions:** A default Estimated Annual Consumption that's used in settlement for customers in a given *GSP Group* (a collection of Grid Supply Points used for settlement purposes) when there's no data to calculate a meter-specific Estimated Annual Consumption (for example, for a newly built site).
- **GSP Group Correction Scaling Factor:** Profiling is an estimate and estimates are never 100 per cent accurate. The GSP Group Scaling Factor is a fiddle factor applied to the profile-estimated consumption within a group of Grid Supply Points (a GSP Group) so that it balances the actual half-hourly consumption measured at the GSPs.
- **Line Loss Factor Class (LLFC):** A grouping that determines what line loss factors are applied to metered consumption to allow for losses over the distribution network.
- **Measurement Class:** Categorises supply points as being metered/unmetered, half-hourly/non-half-hourly.
- **Measurement Requirement:** A mapping of Standard Settlement Configurations to Time Pattern Regimes.
- **Meter Point Administration Number (MPAN):** A 21-digit code containing information relating

to an electricity supply point. It comprises the MPAN Core, Profile Type, Meter Time Switch Code and Line Loss Factor Class.

- **Meter Timeswitch Class (MTC):** A three-digit code that reflects the various registers a meter may have (for example, single rate, day/night or seasonal time of day).
- **MPAN Core:** A 13-digit code that uniquely identifies an electricity supply point. It comprises a 2-digit code identifying the Distribution Network Operator, a 10-digit unique identifier and a single *checksum* (a number calculated by applying a special algorithm to the other 12 digits that's used to validate the MPAN).

British settlement in 2020

Mark Bygraves, Director of Strategy and Development at ELEXON, predicts:

'We will be part of pan-European settlement but may still have local imbalance prices for parts of Britain (Europe allows this where power flows between areas are restricted). The current gate closure of one hour may shorten and the existing Balancing Mechanism may split into two: a pre-gate closure Balancing Mechanism handling differences between aggregated scheduled generation and forecast demand (as notified by parties) and a 'real-time' Balancing Mechanism handling short-term, sudden differences (for example, a generator tripping or kettles at half time in a football match)'.

'Smart meters may be helping to speed up settlement and there may be localised settlement of demand response to support smart grids. There will be more wind generation, so imbalance prices may change rapidly in response to fluctuations in the wind'.

'Oh, and the price of electricity may not have come down.'

Chapter 8
Regulation

In This Chapter

- Examining the regulation hierarchy
- Perusing industry codes
- Introducing a new kind of regulation: RIIO
- Assessing what's happening in the world of regulation

Generating, transmitting, distributing and selling electricity is an expensive business that requires massive investment. Great chunks of the industry are natural monopolies, by which we mean that it's not financially viable for anyone to enter the market and compete with the incumbent infrastructure provider. As a result, customers in Britain can choose which supplier to buy their electricity from, but they have no choice over who delivers it to their home. The need for regulation to protect customers increases in the absence of effective competition. And the need to keep the lights on without killing anyone means that even competitive areas of the industry require some regulation to ensure that electricity is supplied safely.

This chapter skims the surface of British electricity industry regulation. We examine the regulatory framework and the key industry codes that underpin it. We also discuss the changes that are likely to happen over the next decade.

Semi-interesting regulation fact

The Distribution Connection and Use of System Agreement (DCUSA) is the most modified British electricity industry code, averaging 25 changes per year. Okay, let's face it, there's nothing very interesting about regulation. . . .

What's Regulation All About?

Let's take a look at the exciting world of regulation.

Understanding the regulatory framework

The British electricity sector is subject to a hierarchy of regulation, as illustrated in Figure 8-1. The levels are as follows:

- **Primary legislation:** Such as the Electricity Act 1989, which has been changed over the years to reflect changes in government policy. For example, the government's decision to mandate energy suppliers to rollout smart meters required changes to primary legislation.
- **Secondary legislation:** Provides the essential building blocks to deliver the high-level policy. An example of secondary legislation is the Prohibition Order required to establish the new Data Communication Company (DCC) licence that's central to the smart meter rollout (see Chapter 9).

  REMEMBER

  Both primary and secondary legislation require Parliamentary scrutiny and approval, which takes time.
- **Licences:** If you want to generate, sell, transmit, distribute or even move electricity over an interconnector, you need a licence from the regulator, the Office of Gas and Electricity Markets (Ofgem). Licences come with licence conditions that stipulate what the licensee can and can't do. A common licence condition is the requirement for

the licensee to sign up to one or more industry codes (see the next bullet).

- **Industry codes:** These establish detailed rules that govern market operation. Continuing with the smart metering example, a new Smart Energy Code (SEC) is being written to define the roles and obligations of the Data Communication Company (DCC) and those using it. Each code has its own governance arrangements that allow signatories to modify it, subject to the approval of the regulator.
- **Industry working practices:** Often accompany industry codes, they define how parties should go about meeting the obligations set out in the codes. An example is the Balancing and Settlement Code Procedures (BSCPs) that accompany the Balancing and Settlement Code (BSC).

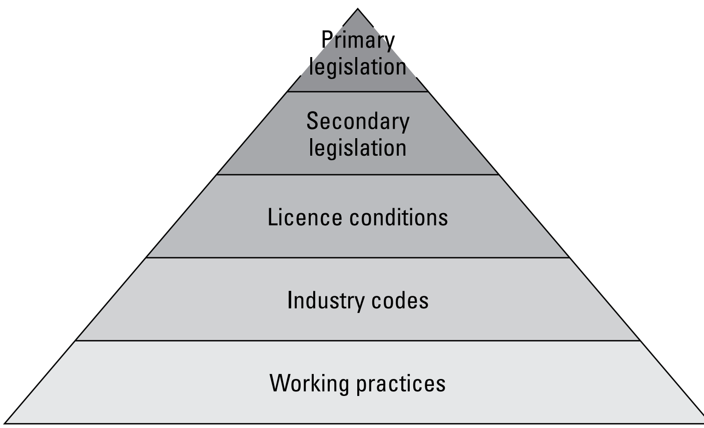

Figure 8-1: British regulatory structure.

Policing the regulatory framework

Ofgem is the industry's regulator. It's Ofgem's job to protect customers by promoting competition, wherever appropriate, and regulating the monopoly companies that run the gas and electricity networks. Ofgem enforces, rather than sets, regulation, although it often has the final say as to whether changes to industry codes go ahead.

Industry codes

Licences come with licence conditions (the supplier's licence currently has 42). A common licence condition is to comply with one or more industry codes that set out the rules for operating in the industry. The codes can be heavy-going and are subject to change.

Here's a crammer of those codes that you should probably be aware of:

- **Balancing and Settlement Code (BSC):** Sets out the arrangements for electricity balancing and settlement in Britain and is supported by a number of procedures (BSCPs). Originating in 2001, it weighs in at 858 pages, is administered by ELEXON and, at time of writing, has had 292 proposed changes, a quarter of which have concerned governance of the code itself. Around 60 per cent of modifications end up getting implemented (others are withdrawn or rejected). For more information, see www.elexon.co.uk.
- **Distribution Connection and Use of System Agreement (DCUSA):** A youngster in comparison to the Balancing and Settlement Code but a comparable read (753 pages). Coming into existence in October 2006, it's a multi-party contract between suppliers, generators and distributors concerned with the use of the distribution network. To date, it has had 168 proposed changes, making it one of the most shifting industry codes. It's administered by DCUSA Ltd, owned and funded by Distribution Connection and Use of System Agreement signatories. For more information, see www.dcusa.co.uk.
- **Connection Use of System Code (CUSC):** Sets out the legal framework governing the interactions between National Grid (NGET) and users of the transmission system, and is administered by National Grid. Arriving on the scene in September 2001, it's not an easy read, at 654 pages. At time of writing, it has received 218 proposed changes, making it a veritable rock compared to its Distribution Connection and Use of System Agreement cousin. For more information, see www.nationalgrid.com/uk/Electricity/Codes/systemcode.

- **Grid Code:** Whereas the CUSC provides a legal framework, the Grid Code provides a technical framework for connections and use of the transmission network. At 614 pages, it's a similar length to its sibling, the Connection Use of System Code, and has been in existence for as long. However, it's had less than half as many change proposals. For more information, see `www.nationalgrid.com/uk/Electricity/Codes/gridcode`.
- **Master Registration Agreement (MRA):** Governs the processes used by suppliers and distribution companies to enable customer switching, or *Change of Supply*, as it's known (often shortened to CoS). It's administered by the MRA Service Company (MRASCo), a joint-venture company established in 1998 and maintained by all Master Registration Agreement parties. At the time of writing, it has seen 190-odd change proposals. At 237 pages, it's a relatively light read. For more information, see `www.mrasco.com`.
- **System Operator – Transmission Owner Code (STC):** Came into existence with the British Electricity Trading and Transmission Arrangements (BETTA) in 2005. It defines the high-level relationship between the GB System Operator and the Transmission Owners and, as with the Balancing and Settlement Code, it's supported by a number of procedures (STCPs). Only just making 200 pages, it's a light read and one of the most stable codes with only 49 proposed changes. For more information, see `www.nationalgrid.com/uk/Electricity/Codes/sotocode`.
- **Distribution Code:** Sets out the technical framework for connecting and using the distribution network and does for distribution what the Grid Code does for transmission. At 189 pages, it's the lightest read of the codes listed. For more information, see `www.dcode.org.uk`.

How Has Regulation Changed?

Regulatory change has been a key driver in sculpting the electricity industry we have today. Similarly, the behaviour of industry participants has driven changes to the regulatory framework. Let's take a look at some of the key regulatory changes over the past few decades.

RPI-X

In 1989, Professor Stephen Littlechild came up with a pricing-control model that has been applied to gas and electricity transmission and distribution companies. It takes the *Retail Price Index* (a measure of inflation based on the cost of a basket of retail goods and services first calculated in 1947) and applies an expected efficiency saving (the '-X' bit). The value of X is based on overall performance of the industry. Any savings above X that the regulated company makes are pocketed by its shareholders. RPI-X is, therefore, intended as a proxy for a competitive market in a set of industries that are natural monopolies.

The price-control period is typically five years (we're now in the fourth and fifth price control periods for electricity transmission and distribution, respectively). The end of a price-control period represents a busy time for regulated and regulator alike as companies set out their plans for the next price-control period and Ofgem challenges their requests for cash in the interests of consumers. However, things are about to change, with RIIO (see the next section).

RIIO

Ofgem estimates that over the next decade network companies need to invest over £30 billion in their networks to keep the lights on. This investment is necessary to replace ageing assets and build new infrastructure to support the increase of renewable forms of energy and power demands of a low-carbon economy. This unprecedented need for investment prompted a re-think in how transmission and distribution companies should be regulated, and in March 2008, Ofgem announced it was going to conduct a review of the RPI-X regime. The RPI-X@20 review ended in 2010 and came up with the RIIO model as a replacement.

REMEMBER

RIIO stands for 'Revenue using Incentives to deliver Innovation and Outputs', and it attempts to build on the elements of RPI-X that worked well but also add new elements that focus on delivery of a sustainable energy sector, give long-term value for money, and encourage innovation and timely delivery.

RIIO comprises three elements:

- An upfront eight-year ex-ante (by that, we mean set in advance) price control that sets the network operator's expected outputs and their allowed revenue for delivering them (similar to the existing RPI-X regime but without the '-X').
- The option to give third parties a greater role in delivery of large and separable projects.
- A time-limited innovation stimulus.

RIIO comes in three types: T1, governing electricity and gas transmission, and ED1 and GD1, governing electricity and gas distribution, respectively. RIIO replaced RPI-X for electricity transmission and gas distribution in April 2013 and will come into effect for electricity distribution in April 2015.

REMEMBER

Ofgem has high hopes that RIIO will provide the regulatory framework needed to encourage network companies to deliver a sustainable energy sector and provide value for money. Ofgem estimates that RIIO could mean customers paying up to £1 billion less in the next ten years than would have been the case under RPI-X.

Who Are the Major Players?

So who's involved in the world of regulation?

- **Ofgem:** The British electricity industry's regulator. It's primarily tasked with protecting the interests of customers. Towards the end of 2009, Ofgem re-structured, creating a new business unit called Ofgem E-Serve. E-Serve is focused on environmental programmes and sustainability projects.
- **Gas and Electricity Markets Authority:** Referred to as GEMA or, rather more imposingly, the Authority. It's Ofgem's governing body, determining strategy and setting policy priorities. The Authority's powers come from the Gas Act 1986, the Electricity Act 1989, the Utilities Act 2000, the Competition Act 1998 and the Enterprise Act 2002.

- **Energy Supply Ombudsman:** An independent body, funded by the industry that helps consumers to resolve outstanding complaints with energy suppliers. Energy suppliers have eight weeks to resolve a complaint before the consumer can be refer it to the Ombudsman.
- **Just about everyone:** There isn't any participant in the British electricity market that isn't in some way impacted by regulation. Table 8-1 illustrates this, showing the mapping between industry participants and the numerous industry codes that we touched on in the earlier section 'Industry codes'.

Industry Code Impact

Participant	*BSC*	*DCUSA*	*CUSC*	*Grid Code*	*MRA*	*STC*	*Distribution Code*	*SEC*[1]
Generators	✓	✓	✓	✓			✓[2]	
Distributors	✓	✓	✓	✓	✓		✓	✓
GB System Operator	✓		✓	✓		✓		
Transmission Owners						✓		
Suppliers	✓	✓	✓	✓	✓		✓	✓

[1] *In the process of being drafted.*

[2] *Embedded generators*

What Are the Big Issues?

Let's have a look at what's happening in regulation right now.

Impending Armageddon

The government's Carbon Plan (published December 2011) identifies two key energy-related risks to consumers:

- Climate change due to greenhouse gas emissions.
- Security of supply due to aging power stations and an increasing reliance on imported fossil fuels with volatile prices (a fifth of generation capacity is due to close in the next decade, and by 2020 Britain could be importing more than half its oil and gas).

In simple terms, the challenge for the government is to keep the lights on using local, renewable generation. From a regulatory perspective, this means putting in place the right regulatory framework to encourage investment in low-carbon generation and the refurbishment of the energy infrastructure (see Chapter 6 on the Electricity Market Reform).

Climate Challenge Act

It's estimated that almost 40 per cent more carbon dioxide is in the atmosphere now than there was before the industrial revolution, with the UK accounting for 1.5 per cent of global greenhouse gas emissions. The Climate Change Act, which became law in November 2008, sets the greenhouse gas emission challenge by establishing a legally binding target to reduce the UK's greenhouse gas emissions by at least 80 per cent below base-year levels by 2050.

REMEMBER

The government has published four carbon budgets covering 2008 to 2027, calling for:

- Twenty-three per cent reduction in 1990 levels by 2012.
- Twenty-nine per cent reduction in 1990 levels by 2017.
- Thirty-five per cent reduction in 1990 levels by 2022.
- Fifty per cent reduction in 1990 levels by 2027.

This act is at the heart of what's driving many of the changes in British regulation today.

Electricity Market Reform

We cover the Electricity Market Reform, the government's package of reforms for changing the British electricity market to encourage much-needed generation of the right type, in Chapter 6 on the wholesale market.

EU Emissions Trading System

The EU Emissions Trading System (EU ETS) is an EU-wide carbon 'cap and trade' system that started life in 2005. It covers electricity generation and the main energy-intensive industries (in the UK, these industries account for about 40 per cent of national emissions). It sets a declining limit on emissions and allows participants to trade the right to emit with each other.

Scarcity of the EU Emissions Trading System allowances is supposed to set a carbon price. However, the UK government has decided that the carbon price set by the EU ETS is neither high enough nor stable enough to encourage the necessary investment in the UK, and as such the government plans to introduce a Carbon Floor Price (see Chapter 6's section on the Electricity Market Reform).

European Target Model

On 3 September 2009, the 'Third Package' came into force. This is EU legislation on European electricity and gas markets that includes the *European Target Model*, a regulatory vehicle for achieving a single European energy market.

The European Target Model establishes a common set of pan-European rules aimed at facilitating efficient use of cross-border capacity and encouraging harmonisation of European wholesale market arrangements. Specifically, the European Target Model advocates:

- **Day-ahead market coupling:** The British day-ahead market price will be calculated at the same time and in the same way as those in neighbouring countries.
- **Continuous intra-day trading:** Allowing cross-border trading in near to real time.
- **Electricity balancing:** Following gate closure, transmission system operators will be required to balance between themselves using any remaining available capacity, initially bilaterally but ultimately, multilaterally.

- **Long-term transmission rights:** Development of cross-border markets based on increasingly harmonised long-term rights to access capacity on interconnectors.

The European Target Model may require changes to the regulatory framework here in Britain, a framework that is already in a state of flux through home-grown initiatives such as the Electricity Market Reform (see Chapter 6).

Code Governance Review

In November 2007, Ofgem launched the Code Governance Review, an attempt to reduce complexity and fragmentation of industry codes and make them more accessible and understandable. The review resulted in a set of licence modifications in July 2010.

Smart Energy Code

The mandated rollout of smart meters requires a fair few changes to the regulatory framework, including a new licence (Data Communications Company, or DCC for short) and a new code (the Smart Energy Code, or SEC for short). For more details, head to Chapter 9.

Jargon buster

If you've made it this far, you've probably had enough jargon to last a lifetime, so we'll let you off this time.

Chapter 9

The Smart Metering Implementation Programme

In This Chapter

- Getting to know the programme
- Identifying who'll be responsible for delivering smart meters
- Knowing when you'll get a smart meter
- Weighing up privacy issues

Part of the government's strategy for achieving its carbon-reduction commitments is to make us all more energy savvy. Currently, we find out about our energy consumption sporadically with the arrival of an eye-watering bill, charging us for electricity and gas used months ago and, more often than not, based on what the energy company *thinks* we've used rather than our *actual* consumption.

Smart meters provide timely, accurate and detailed information on energy usage, the theory being that understanding our energy usage is the first step to managing it. Think in terms of a wood pile: if you could physically see the electricity and gas you were using, you'd use less of it. Smart meters provide you with the electronic wood pile.

Semi-interesting smart metering fact

The Data and Communication Company is expected to be handling over a million smart-metering transactions per minute by 2020.

The government is mandating suppliers to provide all their domestic customers with both gas and electricity smart meters by 2020 and has kicked off the Smart Metering Implementation Programme to make this happen. We've had some major industry changes in the past, but they've largely gone unnoticed by the consumer. The smart metering rollout, however, is a massive undertaking that involves visits to 30 million premises and the replacement of almost 50 million meters. Like the 2012 Olympics, it will be highly visible to the public and a prime candidate for spectacular failure. From an industry perspective, the stakes have rarely been higher.

In this chapter, we take a closer look at the programme charged with delivering smart meters in every home. We identify the organisations and systems that will need to be put in place and some of the major issues that will need to be addressed.

What's the Programme All About?

An Ipsos MORI poll conducted for the Department of Energy and Climate Change (DECC) and published in February 2013 claimed that around half of us had heard of smart meters, but less than a quarter were able to articulate any benefits of having a smart meter. However, given that this book is primarily aimed at those involved in the industry, we'll make the foolish assumption that you know what a smart meter is and what it does (for more about the benefits of smart meters and smart metering in general, take a look at CGI's *Smart Metering For Dummies*). So in this chapter we dive straight into the government's programme for rolling out smart meters – the Smart Metering Implementation Programme (SMIP).

The Centralised Communication Model

A national rollout of smart metering has been bubbling away in the background for many years now. After considering several market models, we've ended up with a Centralised Communication Model that places responsibility for installing smart meters on the suppliers and establishes a new licensed body called the Data and Communication Company (DCC) to provide the central infrastructure required to communicate with the smart meters. The licence grants the DCC a franchise for this service for all domestic electricity and gas smart meters (so suppliers are obliged to use the service whether they want to or not). In addition, suppliers can elect to enroll non-domestic smart meters into the DCC service. Oh, and unlike virtually any other industry licence, the DCC licensee is being procured competitively.

REMEMBER

The smart metering rollout also requires the introduction of a new industry code – the Smart Energy Code (SEC). The Smart Energy Code will govern the relationship between the DCC and its users (or DCC Service Users, to give them their full title). Establishing the Smart Energy Code and the DCC licence has required changes to primary legislation, giving the programme political prominence.

The DCC will use a number of service providers to provide the DCC service of two different types:

- **Data Service Provider (DSP):** A single national provider that provides the central DCC Data Systems used to communicate with the smart meters.
- **Communication Service Providers (CSPs):** Providing the network over which the communication happens. Three regional Communication Service Provider contracts are being let (for Scotland and Northern England, Central England and Wales, and Southern England).

In the future, the DCC will get to appoint its own service providers. However, to speed things up, the Department of Energy and Climate Change (DECC) is procuring the DCC, DSP and CSPs in parallel. The successful DCC will, therefore, inherit its first set of service providers, but will be responsible for re-procuring at the end of the service providers' contracts (the DCC's contract is expected to be 10 years with the option of a 5-year extension; the Data Service Provider's contract is for 8 years with three optional 1-year extensions; and the Communication Service Providers' contracts are for 15 years with an optional 5-year extension).

The Smart Metering Implementation Programme came into existence in late 2009 and was initially jointly managed by DECC and Ofgem. By 2011, the government had taken control and a major procurement exercise had begun to appoint the DCC, DSP and CSPs (an exercise that's drawing towards its conclusion at the time of writing).

Getting to grips with the terminology

Before we talk about how the DCC Service works, let's get some terminology straight. Firstly, smart meters. From a DCC perspective, there are two types: electricity and gas (with subtle variations of electricity meter including import, export and so-called 'variants').

In addition, smart meters can come with a range of optional smart devices, including

- **In-Home Display units (IHDs):** Display, amongst other things, real-time consumption information.
- **Customer Access Devices (CADs):** Enable consumers to locally extract data from smart meters (for example, consumption history).
- **Prepayment Meter Interface Devices (PPMIDs):** Allow consumers to display and manually apply credit to a smart meter in prepayment mode.
- **Hand-Held Terminals (HHTs):** Meter operators use these when installing or replacing smart meters.

All these smart devices within the home communicate via the Home Area Network (or HAN). Another device on the Home

Area Network is the *Communications Hub* (often abbreviated to Comms Hub), which provides the bridge between the Home Area Network and the CSP's Wide Area Network (WAN). The supplier gets to choose which smart devices to use, but the Comms Hub is the responsibility of the CSP. Comms Hubs may also come in different types if the CSP is using more than one WAN technology.

Smart meters, the optional additional smart devices and the Comms Hub are collectively referred to as *Smart Metering Equipment* (SME). Smart Metering Equipment forms the root of a term you'll hear a lot in smart metering discussions: SMETS, which stands for Smart Metering Equipment Technical Specification (see the later section, 'Standards', for more information).

Good, glad we've got all that straight.

Dissecting the anatomy of the DCC

Figure 9-1 shows the major parts of the DCC service.

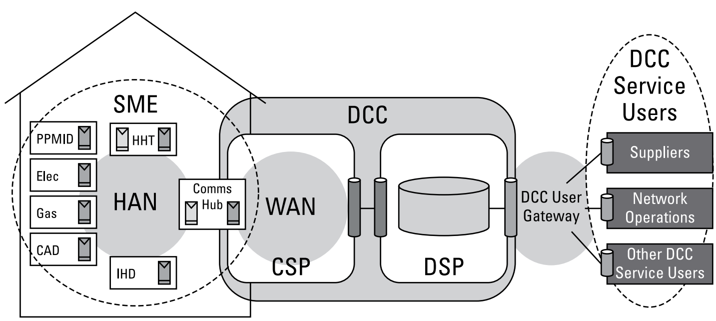

Figure 9-1: The anatomy of the DCC.

DCC Service Users (suppliers, network operators and others who need to talk to smart meters) send instructions (called *Service Requests*) to the DCC over a network called the *DCC User Gateway*. These are received and validated by the DCC Data Systems (the central IT solution provided by the DSP).

The DCC Data Systems are also responsible for transforming the Service Request from the DCC User Catalogue format, in which it's received, to the GB Companion Specification format that smart meters understand, and then sending the transformed message to the appropriate CSP, depending on the location of the smart device to which the Service Request is targeted.

The CSP is responsible for sending the transformed message over its Wide Area Network (WAN) to the smart device via the Comms Hub. The CSP is also responsible for sending back any device-initiated messages to the DCC Data Systems, which, in turn, forwards these to the appropriate DCC Service User.

It's all a bit more complicated than that, but you get the gist.

Critical/Sensitive Service Requests

We'd be remiss if we didn't touch on a couple of the complications. Different kinds of Service Requests exist, and two of the most important are as follows:

- **Critical** Service Requests that, if compromised, could result in loss of power and/or financial fraud.
- **Sensitive** Service Requests that contain data that's private to the consumer (for example, consumption data).

To prevent bogus Critical Service Requests being sent to devices, the DCC Service User 'signs' the Service Request to verify to the smart device that it is, indeed, from the DCC Service User. In brief, this involves the DCC Service User sending the Service Request to the DCC, who transforms it into the format that the device understands before sending it back. The DCC Service User then checks whether the DCC's done its job correctly and, assuming it has, signs the transformed message, before sending it back to the DCC again. The DCC then sends the signed transformed message via the CSP to the device, which checks the signature to verify that it did, indeed, come from the DCC Service User and, assuming it did, it actions the command.

Simples.

Checking that the transformed message matches the original is done using a ‘Parse and Correlate’ function developed centrally and distributed to all DCC Service Users.

In the case of Sensitive Service Requests, no one other than the sender and receiver must be able to see the payload. This means that the payload must be encrypted by the originator (DCC Service User or device) before it’s sent via the DCC. The DCC Service User and device use what’s called a ‘shared secret’ to do the (de)encryption.

How Has the Programme Changed?

It’s taken many years of discussion and debate to arrive at the rollout model that we’re currently following. So why has it been so difficult?

In most other countries, smart metering rollouts tend to be much more straightforward. A vertically integrated electricity company decides to replace all its dumb meters with smart meters and sets about it on a methodical, street-by-street basis. The company, as owner of the wires, tends to focus on smart grid benefits. Retail competition, if it exists at all, has little, if any, impact.

In Britain, we’ve spent the last decade carving up the industry into component parts and introducing competition wherever possible. A consequence of this is the fact that responsibility for metering now falls to suppliers battling it out in a competitive retail market. Although some suppliers have used smart meters to differentiate themselves in this market, competition was never likely to deliver large-scale rollout, hence the necessity for the government’s mandate on suppliers to rollout smart meters.

Various rollout models were considered. Those of you who recognise terms such as ‘Supplier Hub’ and ‘Regional Franchise’ have clearly been involved in smart metering far too long and shouldn’t be reading this chapter. However, the spectrum of models considered ranged from supplier-led smart meter deployment based on statutory meter replacement (replacement of meters after they'd reached the end of their natural life) to an accelerated, regional, street-by-street replacement of meters managed by an appointed central body (more like the overseas model). The compromise arrived at was an accelerated supplier-led replacement of meters supported by a Central Communications Model (the DCC). The accelerated rollout is supposed to complete by 2020 and is mandated by changes to the suppliers' licences.

Who Are the Major Players?

Here's a who's who of the programme:

- **Consumers:** First and foremost. They're expected to realise almost a third of the benefits identified in the government's impact assessment (see the later section 'Impact assessment'). It's consumers who need to grant access to their homes in order for smart meters to be installed. And ultimately, it's consumers who'll pay for the rollout through their energy bills.
- **DCC:** Central to success of the programme is the DCC's ability to provide ready access to smart data and functionality. This, in turn, depends on the DCC's service providers, the Data Service Provider (DSP) and Communication Service Providers (CSP).
- **Suppliers:** Much falls to the suppliers and their agents to achieve a supplier-led accelerated rollout. In addition to needing more meter operators, suppliers have to consider the supply chain, customer engagement and education, and the changes required to the suppliers' back-office systems to enable them to benefit from the additional smart data and functionality that comes with a smart meter. And all this has to be done in a competitive retail market where a mistake can lose customers.
- **Network operators:** It's estimated that a significant number of smart meter installations will require some on-site intervention by the network operator. In addition, they're expected to be heavy users of the DCC in the future as smart grids come into existence (see CGI's *Smart Grids For Dummies*).

- **Other DCC Service Users:** These include Energy Service Companies (ESCos) that will use the DCC to offer consumers value-added energy services based on smart data. To be a DCC Service User, you must have signed up to the Smart Energy Code and undergone 'accreditation' (the equivalent of a driving test).
- **SEC Panel:** Governs the Smart Energy Code. The SEC Panel is an independently chaired body comprising 16 members including representatives of the DCC Service User community (large suppliers, small suppliers, network operators, others). It's proposed that day-to-day administration of the Smart Energy Code should be performed by a Secretariat and Code Administrator, appointed by the Smart Energy Code Panel and contracted either through the DCC or a special purpose corporate vehicle (the SECCo).
- **Central Delivery Body (CDB):** A central body charged with building customer awareness and support for the rollout and helping customers to use their smart meters, especially vulnerable, low income and pre-payment customers.

REMEMBER

A key factor in determining whether the government's impact assessment benefits are realised is the DCC Service Users' appetite for using smart meter data and functionality. Smart meters enable new and innovative retail offerings, providing a rich and level playing field for retail competition. Smart metering also offers network operators with an essential tool for implementing smart grids. However, you can lead a horse to water. . . .

What Are the Big Issues?

When attempting to describe the major issues impacting the Smart Meter Implementation Programme, it's difficult to know where to start. Here's a selection of things keeping smart metering implementation managers up at night.

Rollout

The smart metering rollout represents a major challenge to suppliers. Although this isn't the first smart meter rollout (Italy and Sweden got there first), this is the first supplier-led rollout ever to be attempted. Replacing every customer's meter within a five-year period will require at least four times as many meter replacements as currently happen through the statutory meter change process (the replacement of meters that have reached the end of their certifiable life). And, according to MORI, half of consumers won't have any idea what's going on.

And there's also the question of when it all needs to happen. At time of writing, the programme had just announced a year's slippage (completion of the rollout moving from December 2019 to December 2020).

Opt-out

With nearly a third of anticipated benefits falling to consumers, the government's view is that most people will want a smart meter.

However, scare stories abound and other rollouts (most notably in the Netherlands) have fallen foul of organised protests. So the government has stopped short of mandating smart meters and consumers will have the right to opt out.

In addition to the anticipated benefits, there are likely to be strong financial incentives for opting in because suppliers will almost certainly want to pass on the cost of maintaining manual data retrieval for a dwindling group of 'smart refusniks'.

Data access and privacy

Concerns have been raised in many countries regarding who has access to smart metering data and what they can use it for. For example, half-hourly consumption data says a lot about a household's lifestyle, including how often people are at home. With this in mind, the Department of Energy and Climate Change ran a public consultation between April and June 2012, and reported its findings in December of that year.

At the time of writing, the government is minded to allow suppliers to read smart meters monthly without having to seek the consumer's permission. Suppliers wishing to access half-hourly consumption will require explicit consent from the consumer. Network operators will be allowed to access energy consumption data, including half-hourly energy consumption data, for regulated purposes without consent if they have approved plans for addressing potential privacy concerns (for example, through aggregation or anonymisation of data). With the new security model (see the next section), it's difficult to see how this aggregation/anonymisation will be achieved because it's not something the DCC will be able to provide.

Security

'Security by Design' has been the mantra of the programme since the start. Unfortunately, CESG (the government's security experts), took a while to engage, resulting in a significant change to the security model halfway through the procurement.

CESG is a branch of the more famous Government Communications Headquarters (GCHQ). It used to stand for Communications Electronics Security Group, but it now stands for The National Technical Authority for Information Assurance (no doubt a change designed to confuse the enemy).

Until CESG's involvement, Britain had a largely centralised security model in which a lot of faith was placed in the DSP (access control, device keys and so on). CESG's intervention moved Britain to a more decentralised model in which keys and access control migrated away from the centre to devices and DCC Service Users. The security model probably warrants a Dummies guide of its own, but suffice to say this new model lessens the threat of compromise to the end-to-end service.

Impact assessment

Back in May 2009, the government published an impact assessment that looked at the costs and benefits of a national smart metering rollout. Since then, the impact assessment has been re-issued five times as more information has become available on costs and benefits.

The most favourable impact assessment was back in March 2011. That assessment returned a Net Present Value (NPV – a measure of the difference between costs and benefits) of just over £5 billion over a 20-year period. Since then, this has dropped back to just under £4.4 billion in January 2013.

Assessments of costs and benefits continue to change as the procurements proceed, and keeping a healthy positive NPV is an essential requirement for the smart metering rollout to happen.

Standards

Agreeing smart metering standards and delivering equipment that conforms to these standards is highly likely to be the determining factor in when you get a smart meter.

Under the proposed rollout model, suppliers are responsible for choosing the smart devices that they install. However, these devices must be of a type that has been approved for use by the DCC. So what constitutes an approved device?

This is where the Smart Metering Equipment Technical Specification (SMETS) comes in. It defines a standardised set of functional requirements to which Smart Metering Equipment must comply in order to be eligible for enrolment within the DCC Service. The government needs to notify SMETS to the European Commission, under the Technical Standards and Regulations Directive 98/34 (a requirement when any government introduces rules or guidance that regulate products or services provided over the Internet or by other electronic means).

REMEMBER

Two kinds of SMETS exist:

- **SMETS1:** Designed to deliver functional interoperability in smart metering equipment installed during the Foundation stage (*Foundation* is the period before the DCC goes live). It was published by the government in April 2012, notified to the European Commission and designated on 18 December 2012.
- **SMETS2:** Builds on SMETS1 by adding communication standards to support smart metering within the home

and additional smart functionality. It also includes the new security model (see the earlier section on security), which arrived too late for SMETS1. The first iteration of SMETS2 was notified to the European Commission in January 2013.

As you've probably guessed, further iterations of SMETS2 are likely, and of course nothing's stopping SMETS3, 4 and 5 in the future as more smart functionality is added to the DCC Service.

A key difference between SMETS1 and SMETS2 is the inclusion of communication standards that define how different Smart Metering Equipment components should communicate with each other and with the DCC. Two so-called *application layer protocols* have been chosen:

- **Device Language Message Specification/Companion Specification for Energy Metering (thankfully shortened to DLMS/COSEM):** Mandated for electricity meters (although the DLMS/COSEM commands are 'tunneled' over ZigBee Smart Energy Protocol – placed in a Smart Energy Protocol envelope).
- **ZigBee Smart Energy Protocol v1.2 (ZigBee SEP v1.2):** Mandated as the Home Area Network standard for the gas meter, In-Home Display units, Customer Access Devices and Prepayment Meter Interface Devices.

So why have we ended up with two application layer protocols rather than one? Well, DLMS/COSEM is more verbose than ZigBee, and this presents a problem for gas meters, which have limited battery power. Conversely, few electricity meters use ZigBee SEP – hence the dual protocol approach.

Unfortunately, neither ZigBee SEP nor DLMS/COSEM currently support the new security model (see the earlier section) and so modifications to these standards are required for the British market. A GB Companion Specification is being drafted that will set out how these application protocols should be used with SMETS in Britain.

To complete this enthralling tale of standards, we really should mention the *Communication Hub Technical*

Specification, which sets out the minimum physical, functional, interface and data requirements that apply to a Communications Hub.

The government intends to formally notify both the GB Companion Specification and the Communication Hub Technical Specification to the European Commission in Autumn 2013 (but, as a wise old project manager once said, never trust a project plan based on seasons . . .).

Volumes

The number of Service Requests that the DCC will be required to handle is very difficult to predict, but rest assured that we're talking *big* numbers! When the rollout is complete, the DCC will be supporting in excess of 50 million devices located in over 30 million premises. CGI's Foundation Smart Data Service suggests that your average smart meter today receives 44 Service Requests per month. Industry predictions suggest this could increase to over 370 per month by 2031.

Foundation

Foundation is the name given to the period prior to the DCC going live. The government's been keen to encourage suppliers to start installing smart meters during Foundation to gain the necessary real-life experience needed to make the mass rollout a success and to start delivering smart benefits earlier. As encouragement, the government has stated that Foundation meters will count against suppliers' mandated rollout targets and will be eligible for enrolment in the DCC once it goes live.

However, for a Foundation meter to be eligible for enrolment, it must be SMETS1-compliant, and SMETS1 was only designated at the end of 2012. Suppliers have been reluctant to install meters until they have assurance that the meters they install will be eligible for enrolment, and so Foundation meter volumes are likely to be significantly lower than was first envisaged.

Jargon buster

As with all major industry change programmes, the Smart Metering Implementation Programme has more than its fair share of acronyms designed to confuse outsiders. Here are a few of the more essential ones:

- **Accreditation:** The process that new parties must go through to become DCC Service Users.
- **Adoption:** The process by which the communications contract for an enrolled Foundation meter is transferred to the DCC.
- **Certification:** The process by which a device is approved for enrolment within the DCC.
- **Communications Hub:** A device installed in the home that provides connectivity between the Wide Area Network and devices on the Home Area Network.
- **Communication Hub Technical Specification (CHTS):** Sets out the minimum physical, functional, interface and data requirements that apply to a Communications Hub.
- **Communication Service Provider (CSP):** An agent of the DCC responsible for providing the communications network over which the DSP can communicate with smart meters.
- **Critical Service Requests:** A Service Request that could result in loss of power or in financial fraud.
- **Data Communications Company (DCC):** A new licensee established to procure and manage the central services required to support the national rollout of smart meters.
- **DCC Data Systems:** The central IT system, provided by the Data Service Provider, through which DCC Service Users communicate with smart meters.
- **DCC Service User:** A party that uses the DCC to communicate with smart meters. There are five kinds: electricity suppliers, gas suppliers, electricity network operators, gas network operators and 'others'. All DCC Service Users must be signatories to the Smart Energy Code.
- **DCC User Gateway:** The network over which DCC Service Users communicate with the DCC.
- **Device Language Message Specification/Companion Specification for Energy Metering (DLMS/COSEM):** One of the two application layer protocols proposed for British smart meters.

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- **Data Service Provider (DSP):** An agent of the DCC responsible for providing the DCC Data Systems.
- **Enrolment:** The process by which a certified meter is included within the DCC.
- **Foundation:** Relating to the period before the DCC goes live and to smart meters installed during this period.
- **Home Area Network (HAN):** The network within the home over which smart metering devices communicate.
- **Hand Held Terminal (HHT):** A device used by a meter operator when installing or maintaining smart meters.
- **Sensitive Service Request:** A Service Request (or response) that contains consumer information deemed to be of a personal nature (for example, consumption data).
- **Service Request:** A command issued by a DCC Service User to the DCC.
- **Smart Energy Code (SEC):** A new industry code governing the relationship between the DCC and DCC Service Users.
- **Smart Metering Equipment Technical Specification (SMETS):** A standard that sets out what a smart meter must be able to do to become certified.
- **Wide Area Network (WAN):** The network over which a Communication Service Provider communicates with Communications Hubs within the home.
- **ZigBee Smart Energy Protocol v1.2:** The application layer protocol proposed for use over the Home Area Network.

Chapter 10

Ten Take-Away Points to Remember

In This Chapter

- Considering the pace of change
- Realising that the industry is complicated
- Using that effective word *ombudsman*

Here's a collection of observations on the British electricity industry based on years of bitter experience:

- **Britain is bleeding edge.** We're frequently at the sharp end of major industry change (for example, the introduction of retail competition), but that doesn't mean we always get it right. Other countries often take a great interest in what we've done in Britain – but they don't always choose to follow.
- **This book is already out-of-date.** The British electricity market has changed dramatically over the past two decades, and continues to do so. It's part of what makes it such an interesting place to work. However, the fast pace of change in some areas does make it particularly hard to write this sort of book because it's invariably dated before it even leaves the printers.
- **Change isn't always quick.** Don't hold your breath – dynamic though the British electricity industry is, with so many different parties involved, implementing change can take a long time, as those of us involved in the smart metering rollout will testify. Some change can seem glacial!

- **What comes around, goes around.** Just because something's been tried before, doesn't mean that we won't return to it later. The return to community generation schemes that we describe in Chapter 1 is a good example, as is the likely return to Contracts for Differences as part of the Energy Market Reform.
- **Don't expect consensus.** Getting industry stakeholders to agree on industry change is like herding cats. With so many different roles within the industry, it's not surprising that not everyone shares the same goals.
- **If you think the British electricity industry is complicated, you're right!** Britain has the most competitive and fragmented electricity market in Europe with more roles and more players than anywhere else. It's been going a long time and evolution often increases complexity.
- **Start thinking energy, not electricity, and service, not commodity.** Despite focusing on electricity, today's energy companies shouldn't be differentiating between gas and electricity and should be looking to sell more than just kilowatt hours and therms. Smart metering is helping to make this happen (the Smart Energy Code being the first dual-fuel industry code) and newly emerging Energy Service companies are showing the way.
- **If you think you've got a good idea, it probably is a good idea.** The utilities sector tends to occupy the bottom quartile of service industries with notoriously high levels of customer complaints. If you're new to the industry and have seen something being done better in another sector, it's well worth trying to apply that experience in the utilities space. But keep in mind the point in the next bullet. . . .
- **If something seems simple, you probably haven't understood it.** The British electricity industry is complicated, often unnecessarily so. Things that, on the face of it, seem simple usually aren't.
- **Get your voice heard.** Always remember to mention the word *ombudsman* when complaining to your energy supplier!

Appendix: Timeline

Here's a handy summary of some of the key milestones in the development of the British electricity market.

1878: World's first hydroelectric power scheme developed at Cragside in Northumberland.

1881: Calder & Barnet install the first public experimental electricity supply in which the streets of Godalming are lit electrically using water power.

1891: Deptford power station commences operation supplying high-voltage AC power that's 'stepped down' for consumer use on each street.

1926: Electricity (Supply) Act passed, paving the way for a national grid. The Central Electricity Board is created (the BBC follows a year later).

1935: Commercial operation of the national 132-kV electric power transmission grid begins in the UK, the first integrated national grid in the world.

1937: National grid becomes fully integrated.

1947: Electricity Act passed and the Central Electricity Board makes way for the British Electricity Authority and 15 Area Electricity Boards, nationalising numerous municipal and privately owned electricity generation and supply utilities.

1952: First Economy 7 tariffs introduced to flatten load.

1955: British Electricity Authority becomes the Central Electricity Authority.

Scottish Area Boards merge into the South of Scotland Electricity Board.

1956: World's first large-scale nuclear power station is opened at Calder Hall (Sellafield).

1957: Central Electricity Authority is replaced by the Electricity Council and the Central Electricity Generation Board (CEGB).

1961: First Anglo–French interconnector commences operation.

1982: First wind farm commissioned at Camarthen Bay, South Wales.

1986: British Gas privatised.

1989: Electricity Act 1989 paves way for retail competition, creating Public Electricity Supply licences and 'second tier' Private Electricity Supply (PES) licences. Professor Stephen Littlechild recommends an RPI-X price control for gas and electricity transmission and distribution companies.

1990: CEGB is broken up into National Grid Company (NGC), National Power, PowerGen and, later, Nuclear Electric. Area Electricity Boards become Regional Electricity Companies (RECs) and are privatised. Retail competition introduced for 5,000 customers with demands of less than 1 MW (30 per cent of national consumption). Wholesale trading commences in the Pool of England and Wales.

1991: 60 per cent of National Power and PowerGen are privatised. Scottish electricity industry is privatised.

1994: Retail competition extends to 50,000 customers with demands of less than 100 kW (20 per cent of national consumption).

1995: Remainder of National Power and PowerGen privatised. NGC is listed on the London Stock Exchange.

1998/1999: Retail competition extends to all customers (50 per cent of national consumption). PES licences disappear. RECs become Distribution Network Operators (DNOs).

2001: The New Electricity Trading Arrangements (NETA) replaces the Pool.

2002–4: British Energy is financially restructured.

2005: NETA becomes the British Electricity Trading and Transmission Arrangements (BETTA).

2010: Ofgem launches the Low Carbon Network Fund.

2015: The Data Communication Company (DCC) is due to go live.

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Chris Beard is one of CGI's leading Subject Matter Experts in energy markets. Author of *Smart Metering For Dummies* and *Smart Grids For Dummies*, Chris has spent the last 17 years working across all parts of the energy industry, helping companies to adapt and thrive within the ever-increasingly de-regulated market.

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ISBN: 978-1-118-75570-9
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