MOTT MACDONALD

Current affairs

A new world for electricity transmission and distribution

The changing business of power

The day-to-day business of balancing power supply and demand is becoming much more complicated, but with this challenge comes opportunity

The world's first coal-fired power plant started generating electricity in London in 1882. One-hundred and thirty-five years later, in April 2017, Great Britain had its first coal-free power generation weekday. The milestone was a stark illustration of how the business of energy is changing.

Around the world, records for electricity from renewable sources are being continually set and broken. Wind now produces almost half of Denmark's annual power production, while India has completed construction of the world's largest solar farm, a 648MW plant covering 10km² in Tamil Nadu.

Complex challenge

The accelerating move to cleaner energy is rightly applauded, but it heralds a complex challenge: with many ways of generating power now in the mix, the day-to-day business of balancing supply and demand is becoming more complicated.

Network operators are having to adapt to the intermittent nature of power from renewables and more widely distributed generation than the traditional centralised grid model.

The UK's National Grid expects that, as the country moves from big power plants to many smaller generators, it will have 'visibility' (ie: control) of only 30–50% of power generated.

Operators everywhere face the same challenge: how to balance supply and demand second by second, hour by hour. To keep up with this challenge, energy policy is shifting rapidly too. In the UK, the government is aiming to manage the grid via a three-pronged approach involving storage, interconnectors and demand-side response – essentially an inducement to businesses to become more flexible about when and how much electricity they consume.

A big step

It's a very big step from what has been done before, but it is a global trend. The new power transmission and the distribution networks to support the universal objective of clean, secure and affordable energy require a greater range of skills and knowledge. Gone are the days when power engineering design consultancies were concerned solely with overhead lines, substations and transformers. Their focus must now also include:

- grid-scale battery storage schemes;
- technologies to maximise the amount of power generated by existing infrastructure;
- high-voltage direct current interconnectors; and
- a workable demand-side response programme.

We have the technical expertise as well as the advisory skills and behind-the-scenes real-world economists to help power businesses – generators, suppliers, distribution companies and network operators – through the transition.

Lightening the load

Grids look to store energy

Large-scale battery storage is set to become an integral part of power grids around the world. This is partly because diversification of power generation from traditional thermal plants to newer and more varied forms, such as renewables and continental interconnectors, makes managing the grid more complex.

Using batteries to manage renewables is important, but the need to apply the technology to balance out the daily load cycle is arguably greater. If you look at the UK's load curve through the day, there is a peak in the late afternoon between 4pm and 7pm. A consistent daily peak is a pattern repeated around the world (although the time varies). Currently, the variation in load up to peak is about four times greater than the variation in the supply from renewables. It matters because the peak evening load dictates how many generators are needed on the network, which dictates the size of both the transmission and distribution systems.

Effectively, the sector is using capital expenditure to provide for this three-hour peak, says Douglas Ramsay, an electrical engineer in Mott MacDonald's transmission and distribution team. "Frequency control is the need to balance supply and demand on a second-by-second basis," he explains. "When the load in the network goes down, you have to pull back the generation, and when the load goes up, you have to add some extra generation."

Big batteries, delivering tens of megawatts of power, could increase the network's capability to deal with a large and sudden variation in generation and load, while also storing enough power to serve peak demand periods. This has huge potential benefits for the network.

The economics of battery storage are beginning to stack up. The price of batteries has been falling by around 15% a year, and has halved over the past five years. And it seems that a tipping point has been reached in the past 12 months. As projects become economic, the move to battery storage is accelerating. As Douglas puts it: "We are starting to see things happening now that were considered science fiction five years ago." He believes that using battery storage to help manage supply and demand is about to become a huge market.

There is already strong evidence the supply stream is ramping up to meet the expected demand. Tesla's Gigafactory, a lithium-ion battery factory in the Nevada desert near Reno, opened in July 2016 and will reach full output in 2022. Battery producing factories are planned around the world by other manufacturers.

The case for battery storage

It's not only the world's grid operators that can benefit from battery storage. Take a water company that requiries more power. It would likely be charged a significant amount by the local distribution network operator to install an extra connection. Installing a battery would not only potentially remove the need for a new connection, it would save the company money by enabling it to avoid drawing power from the grid when the highest tariffs apply. "That's a real motivation," says Douglas. "Lopping off your peak load means you pay less for your current electricity, but you can also earn money because batteries help match generation and load across the grid and there are big incentives in place to do that."

He believes this could have a big impact on the types of projects the Mott MacDonald transmission and distribution team gets involved with in the future. Traditionally clients have operated on a national scale and the work tended to be "huge chunky projects in the power sector."

Although large-scale battery storage will be associated with big power projects, Douglas says the technology also has clear benefits for other development schemes that require large power loads. "In the future we will need to get involved with companies working on airports and waterworks, and designing datacentres, and help them build large batteries into their projects," he says.

The resurgence of direct current

The proponents of alternating and direct current power supply battled for supremacy in the US in the late 19th century. It was known as the War of the Currents.

The two main protagonists were Thomas Edison and Nikola Tesla. Alternating current (AC), which was backed by Tesla, emerged the winner. A key factor in why it won, and why all cities today are powered by AC-based infrastructure, is that transformers do not work well with direct current (DC).

But today DC is enjoying something of a resurgence, especially when it comes to the transmission of large amounts of power over long distances.

Reduced power losses

Transmitting power over distance is essentially a balancing act. A high voltage is required to send power a long way, but AC transmission is inefficient over distances, with typically between 35% and 40% lost. By contrast, power losses in DC transmission are about one tenth of that.

However, DC transmission infrastructure is relatively expensive to build, not least because it requires large and complicated boxes of electronics at either end to convert it to or from AC and to step the voltage up and down. But DC transmission towers are smaller and carry fewer wires than AC equivalents, so are cheaper, require less right of way and have a smaller visual impact. Broadly speaking, DC is the better option to transmit more power over a long distance.

High-voltage direct current (HVDC) transmission has been around for almost 100 years, but its use until recently has been limited. Advances in the electronics that underpin the converters at either end are increasingly making HVDC a solution of choice.

Advances in power electronic converters makes high-voltage direct current feasible for long-distance transmission

AC to DC conversion
DolWin alpha platform in the North Sea converts alternating current from three wind farms into direct current so electricity can be distributed with minimal losses and without disrupting the grid.

ABB valves installed in the Skagerrak HVDC convertor station enabling DC power transmission system between Norway and Denmark

Offshore windfarms and subsea cable are key drivers

The key innovation underpinning the resurgence of HVDC over the past 20 years is insulated gate bipolar transistors (IGBTs), which are being used for voltage source converters (VSC). Converting AC to DC and back again requires semiconductor switches, and the introduction of IGBT transistors has made converters more controllable.

The offshore windfarm market is driving the market for VSC technology. Germany has been a pioneer in this area – initially in a bid to reduce carbon emissions and more recently in response to the 2011 Fukushima nuclear disaster, which prompted the government to pledge to shut the country's 17 nuclear reactors by the end of 2022. An historical problem, particularly for offshore windfarms, had been the size of the valve halls needed at either end of subsea cables, which made the connection expensive. Swedish technology company ABB developed a system called HVDC Lite. It incorporates the latest VSC/IGBT switching equipment, providing faster and more efficient conversion with fewer losses. It is also a more compact HVDC convertor and can be installed more easily on an offshore platform. Other manufacturers are now producing similar systems.

For subsea cables, DC typically becomes financially viable over transmission lengths of more than 70km. For overhead power lines, the tipping point in favour of DC is around 150km.

Increasing market share

As the power electronic and DC cable technology develops, both VSC and line commutated converter (LCC) systems will find a growing market.

HVDC is well suited to the rising trend for electricity to be traded across international borders, particularly in Europe. A 2GW HVDC link using the traditional thyristor type LCC system was installed between England and France in 1986, mainly to deliver French nuclear power. A 1GW project to run a DC cable through the Channel Tunnel is currently under design and construction.

More long-distance interconnectors from Europe to the UK are under development, including to Scandinavia to exploit surplus hydropower. A link to Iceland to tap into its geothermal energy resource is also on the cards. It's more than 1600km but advances in HVDC converter and cable technology make it technically viable to transmit energy.

HVDC offers other advantages. It improves power system stability and can be used to create a hybrid approach also using AC. Embedded HVDC offers opportunities to strengthen grids with reduced environmental impact compared with upgrading AC transmission lines. And asynchronous HVDC connections are often the only practical way to join systems operating at different frequencies or where it is not possible to make a direct link.

Around the world

In the Middle East, an oil and gas company is assessing the feasibility of constructing "energy islands" from which it will drill for previously untapped offshore oil. A key challenge is how to get the power needed to the new islands. Rather than embed generation on the islands, Mott MacDonald has recommended transferring nuclear power from the mainland using a 3GW HVDC converter and subsea cables.

Closer to home, our transmission and distribution team has been appointed technical engineer on ElecLink, a transmission system interconnector via DC cable through the Channel Tunnel, with converter systems at either end. The 1GW, 51km, HDVC interconnector will meet the growing need for energy in the UK as well as help both countries balance their energy mix.

"Mott MacDonald has a large, growing HVDC function containing staff with vast experience in the computer modelling, design, installation and commissioning oversight of power electronic HVDC systems," says David Cross, practice leader for HVDC. "Our HVDC experts, as well as colleagues from other disciplines, have supported the ElecLink team as it grew in size with engineering, geotechnical and risk management staff."

Withstanding the heat

Advances in high-temperature conductors are increasing the benefits of refurbishing transmission lines

When changing circumstances create the need to transfer more power through an existing transmission network the simplest solution is to “turn up the juice”.

But the scope to do so is very limited. Increasing the power raises the operating temperature of the conductors, the thick wires between the pylons. This causes them to sag and could infringe clearances – the statutory regulations that dictate the distances from live cables to physical things below, such as motorways, woodlands and moorland. Turn up the power too much and the conductor will anneal and weaken, and corrode at a faster rate. Eventually it will fail.

Increasing capacity

In most circumstances, capacity cannot be increased by simply adding more cables because that will overload the pylons. However, high-temperature conductors that expand less and can run at double the operating temperature of conventional ones without compromising electrical clearances are now available. They transmit about twice the amount of power.

Jason Rowan, manager of Mott MacDonald’s energy transmission division, says that, although there are many different types of high-temperature conductors, they basically all use a material that deals better with heat.

Early conductors were made of copper, which is hugely expensive. Aluminum replaced copper in the mid-20th century, with alloy blends coming in during the 1970s and 1980s. Some relied on a steel core for strength. The technology remained reasonably static until the early 2000s when carbon fibre core cables were developed and improved the business case for renewing overhead power transmission lines.

Fraction of the cost

The basic process, which is a common activity for many Mott MacDonald transmission and distribution teams around the world, is to undertake a full condition survey of the existing assets. This involves inspecting the condition of structures to identify corroded or missing members. Pylons are then refurbished, electrical clearances checked and new conductors installed, increasing the transmission capacity for a fraction of the cost of installing a new line.

Live-line working in South Africa

In exceptional circumstances, new conductors can be installed under live-line conditions. It is not the preferred course of action, but where a critical element of the network needs upgrading, and it is difficult to suspend supplies, there may be no alternative.

This approach was adopted in Johannesburg, South Africa, by power distribution business City Power. It wanted to increase the power transfer of its 50-year old, 88kV network and ruled out installing new transmission lines as impractical.

Mott MacDonald teamed up with US contractor Quanta Services, a world leading specialist in the field, to develop a solution. We were ideally placed to help because our southern African power business grew out of Merz & McLellan, which had designed the original transmission infrastructure and retained the design drawings for the towers in its archive.

Faraday cages

The project started with a complete condition assessment of the lines, tower insulators and footings, access roads and facilities. This was followed by line design, conductor selection and general engineering studies. Most of the tower and footing re-conditioning took place before the line work commenced.

The project, the first of its type in Africa, involved replacing some 400km of conductor under energised conditions. The main principle of live-line working, says Claudio Pierini, Mott MacDonald's account leader in South Africa for transmission and distrubution, is to protect the engineers from the 88,000 volts passing through the line: "You do that by using what are called 'live-line buckets'. The operatives are in suits that have stainless steel woven into the material, effectively providing each with their own Faraday cages."

The bucket boom arm acts as an insulator up to 500kV. Operatives use a wand to bond to the live conductor before attaching a clamp from the bucket to the conductor. They are then at the same potential as the wire and can work on it safely. It is the same principle that prevents birds from frying when they land on power cables.

Zambia's power bypass

Maintaining electricity supplies during the upgrade of a major power transmission line in Zambia

For a country that has been enjoying the benefits of hydroelectric power for almost 80 years and is currently generating 96% of its electricity from the Zambezi river basin, Zambia is an unlikely contender to be in the final stages of commissioning its first coal-fired thermal generating plant.

But the Zambian economy has been growing in recent years, leading to the expansion of energy-intensive industries. This has increased base-load requirements to the point where demand for electricity is outstripping the available hydroelectric resources. The situation is compounded by climate change, which is making the country's hydroelectric power less reliable.

Improving the network

The new 300MW coal-fired power plant is at Maamba in the Zambezi basin, in the south of the land-locked country. But the additional power is needed hundreds of kilometres to the north, in Zambia's capital, Lusaka, one of the fastest growing cities in southern Africa.

ZESCO, Zambia's electricity utility, appointed Mott MacDonald as project manager to improve the capacity of transmission network infrastructure along the Kafue-Muzuma-Victoria Falls corridor to enable the grid to cope with the power generated at the new coal-fired plant.

The project involves upgrading the existing 348km transmission line from Kafue Town through Muzuma to the Victoria Falls from 220kV to 330kV. The work also includes building a new substation and control centre at Livingstone, a few kilometres from the falls, and upgrading existing substations at Muzuma and Kafue, south of Lusaka.

Maintaining power

The main challenge is to maintain supply to the Lusaka region at the same time as the work is done. In a highly interconnected grid system, a single line can be shut and power transmitted through an alternative. But in this case there is no other route.

We initially considered live-line working, but this is not allowed under Zambian regulations. Instead, our engineers decided to use a series of by-pass circuits to de-energise sections of the line, with work undertaken sequentially. It is essentially the method used when there is an emergency and supply must be restored to a power line before the problem can be fixed. However, it has not been used before on such a scale and certainly not as a means of keeping a long line, with individual bypass lengths of 30-40km, live during restringing, says Mott MacDonald project manager John Clarke.

Bypasses are created using removable steel monopoles rather than conventional lattice steel towers. The single poles are electrically safe and designed with the same clearances as a permanent line. Two restringing teams will be employed, leapfrogging each other along the line.

The temporary bypasses run within the existing power line easement, so there are no major challenges over access, land use and permissions. However, advance teams will clear African bush ahead of the work.

Security of supply across southern Africa

The need to maintain consumer supplies has also influenced the plans to refurbish two existing substations to cater for the 330kV voltage. In what is an extremely demanding logistical operation, we plan to perform the work in sections, using local bypass circuits to isolate work areas while maintaining sufficient step down capacity to supply consumers.

In terms of switchgear, our design is an interesting mix of old and new technology. Traditional air-insulated switchgear will be installed at the new Livingstone substation and the upgraded Mazuma facility, but the refurbishment of Kafue includes gas-insulated switchgear, a first in Zambia. This is because the Kafue substation is next to a chemicals factory and acid emissions from the plant had previously affected equipment, leaving it in a very bad condition. Our proposal is to shrink the size of the substation. Using gas-insulated switchgear enables us to dramatically reduce the dimensions of the plant.

The upgrade will form an important component in a proposal to establish interconnectors between the Zambian grid and those in Namibia, Zimbabwe, Botswana and South Africa, increasing the security of power supply across the region.

What happens when the wind doesn't blow?

Finding the right grid solutions

The Republic of Ireland is leading the way in wind energy for island nations. On average, more than 20% of the country's electricity is generated each year by wind and the target is to reach 40% by 2020. Unlike the UK, nearly all the generation is from land-based turbines, the Irish government having decided not to subsidise more expensive offshore wind.

A major issue with a grid heavily reliant on wind is what happens when the wind doesn't blow.

"To manage the operation of the grid with a lot of wind generation we need storage solutions for two scenarios: low wind and high demand, and high wind and low demand," says Tom Keane, manager of Mott MacDonald's power team in Ireland.

One solution is using batteries to store energy. However, we are also involved in what could be energy storage on an altogether larger scale, using compressed air in underground salt deposits.

Larne, across the Irish border in Northern Ireland, has some large salt deposits about 1.5km underground. Mott MacDonald is part of a team investigating the potential to create huge airtight caves in the salt. The caverns would be able to hold air compressed to pressures of about 190 bar.

Without storage, wind power generated at night when there is no demand is wasted. The design proposal for the project would use that power to pump air into the salt caverns, creating energy stores that can be released during the day to generate power when demand picks up. In principle, it is a variant of hydro-pumped storage schemes.

The Larne salt caves could provide storage capacity for about 300MW, whereas battery projects tend to be in the 10-20MW range. If the geological conditions are right and an appropriate funding model can be found for the £300M upfront infrastructure development costs, it could be more cost-effective than battery storage too.

Spreading the power nationwide

The largest state in the southern US is working to get energy to where the consumers are

Once synonymous with oil, Texas now leads the US in renewables generation, with wind and solar contributing 40% of the state's power mix.

With generous tax breaks and the Environmental Protection Agency's efforts to shut down most of the country's coal plants, the US, at least in the pre-Trump era, has been an unsung champion of renewable energy.

From west to east

But it is not simply a matter of building capacity and plugging in. Although Texas is blessed with abundant sun and wind, these resources are mostly in the western part of the state, where relatively few people live. So the challenge is getting the power from where it is generated to where it is needed.

Traditional thermal generation tended to be closer to the cities, and as these plants are retired, power delivery is becoming a big issue. New transmission lines are required in Texas and across the US, which is good news for companies providing power delivery services.

Another challenge relates to patterns of air circulation: the wind rarely blows in the afternoon in western Texas. Turbines are therefore idle when people come home from work and the demand for power is at its peak. This demand is being met by traditional coal-fired power generation. One solution to this conundrum is to spread wind generation around different areas. The wind on the coast of the Gulf of Mexico in Texas blows consistently between 4pm and 7pm, so with a recent surge in renewables developments, electricity generated there is being transmitted to other parts of the state. Another option is to mix wind and solar generation. The sun continues to shine in west Texas during the late afternoon peak, even if the wind has died down.

Combining wind and solar

Across the US, solar plants are now being built near wind generation sites – mixed-use facilities are now mandated in California. Large-scale solar generation was until recently lagging way behind wind, but is now fast catching up, bringing down the cost. Meanwhile, battery storage is crucial to addressing the challenge of balancing a grid reliant on renewables and meeting peak demand. Mott MacDonald has worked with battery storage companies across the US and has designed multiple facilities in four different states and on Caribbean islands for one major firm.

The increase in renewable generation in the US has led to significant investment in transmission infrastructure. Texas recently completed its US$9bn Competitive Renewable Energy Zones (CREZ) programme to move the power from the west of the state to four major cities – Houston, Dallas, Austin and San Antonio. And there is much more to come.

With transmission distances increasing, projects are moving away from using alternating current. One is a 1100km high-voltage direct current (HVDC) transmission line running through Oklahoma, Arkansas and into Tennessee. Another runs from Texas through Louisiana and Mississippi. We are providing services for the latter and expect similar projects to emerge over the next five years.

Engineering innovation

When working on new technology, such as HVDC transmission, battery storage or balancing the grid for a greater contribution from renewables, there is no template. "You have to put innovative engineers who think outside the box on these kinds of projects," says Bob Beckage, programme director in the US.

Embracing flexibility

Demand-side response is vital to meeting future energy needs

Demand-side response is the term given to deals between power network operators and large consumers to reduce or shift their electricity use at peak times.

The agreements are seen as increasingly vital to meeting future energy demand. Across the world, governments recognise that they cannot fund the construction of enough conventional infrastructure to meet the expected increases in demand for power. Creating more flexibility through demand-side response is one solution to addressing the shortfall.

Until now, network operators have had limited incentives to encourage flexibility. Creating competition could change that. “We see a future in which the power utility has to take on a little bit more market risk and is forced to rely more on flexibility,” says Martin Wilcox, a senior power consultant at Mott MacDonald.

Despite the relatively simple concepts that underpin flexibility, the devil is in the detail: what a business energy customer is charged varies depending on where it is geographically and the way in which the power network is put together around them. In effect, every deal between supplier and consumer will be bespoke.

Martin says negotiating an equitable agreement requires a combination of a strong understanding of the local network and regulations combined with technical design expertise. Companies will also need access to ‘behind the scenes’ economists who have a much better take on how to use financial levers to achieve the desired outcome.

Ireland’s power consumers take the lead

Contestable grid connections accelerate construction of datacentres

Where a power generator in Ireland needs a new transmission connection to the power grid, it can opt to build the necessary substation and link to the grid, and then hand over the assets to the utility. This is known as ‘contestability’ and is the right of connected customers to construct all or part of their grid connection to the transmission system.

In many countries, utility companies construct their own new connections to the grid. This can often result in significant delays, especially where the firm’s resources are already constrained.

For many years now, renewable generation developers in Ireland have mostly opted to build their grid connection substations contestably and then, on completion, hand them over to EirGrid. This enables developers to accelerate the build; manage the construction costs directly; appoint a specialist consultant and contractor; quickly complete the design and connect turbines to the grid; and start generating power and earning money. Ireland has recently experienced an increase in demand for datacentres to store and process electronic data. The power requirements for these are significant and many require transmission connections at 110kV, 220kV or 400kV.

Datacentre developers can also benefit from self-building grid connections. The sooner the link to the grid is in place the sooner the developer can have their facility up and running and generating revenue.

Mott MacDonald’s combination of local knowledge and global expertise, increasingly makes us the go-to consultant for grid connection design and development work, including for datacentre developers.

Putting a price on power

Reputation and expertise count for a lot in the power sector

Mergers and acquisitions in the power sector can be complicated because of the complex, technical and high-value nature of the assets.

Where the owner of a utility puts all or part of its assets up for sale, how do you determine, as part of the due diligence process, whether a potential vendor is offering the right price? Or that the business model on which the offer is based is robust?

Financial expertise

Answering these questions requires financial expertise and technical capabilities. "In the case of a utility coming up for sale, you could be looking at thousands of substations, tens of thousands of kilometres of cables, transformers, and even vans and people," says Duncan Broom, who heads up advisory services in Mott MacDonald's power transmission and distribution business.

A utility business will have capital and operational expenditure models that underpin its business plan, but there will be technical assumptions within these, and this is where Mott MacDonald can help, he says. "You know there are a certain number of transformers on the network of a particular age profile from which you can forecast what the age-related capex replacement should be. If you don't do this, there can be adverse knock-on effects; for example, equipment may may start failing and the opex will increase. You can also look at how efficiently a utility is being run and identify areas where money could be saved – essentially upsides for investors that allow them to make their bid more competitive."

Another key common focus area, says Duncan, is technical and non-technical losses – assessing whether the target acquisition has a handle on these, how they are trending and whether there are any opportunities to drive the trends harder going forward.

Due diligence

Essentially, the due diligence process is all about drilling down into the financial business models and pressure testing the technical assumptions in them. It is broadly: the owner wants to divest some capital and will reach out to potential buyers through a global investment bank. The potential buyer will then assemble a team of advisors with, for example, legal, insurance, and financial expertise.

Duncan says Mott MacDonald has both the breadth of expertise to provide technical support as well as financial, tariff, regulatory and environmental advice. "We can also review the commercial and contractual documents to make sure they are consistent and protect the lenders from risk." He says the scope of work can vary from an initial quick-see assessment to assist a potential buyer in determing whether they should proceed, through to detailed due diligence to facilitate a successful transaction.

Identifying the unknowns

"It is much more than assessing the condition of assets. That is the easy part of the process," says Duncan. "Drilling into the technical side of the financial models almost invariably identifies new unknowns, defining a whole new set of risks to work through and mitigate.

"What we do in our advisory work has no clear boundary. Delivering advisory reports is very different to delivering design services. The mindset is very different. You also need to communicate in a very different way than in a construction environment. And you absolutely need to recognise what concerns a potential lender, be able to speak the language of banks and meet the challenging time-scales driven by transaction deadlines."

It's a process

Offshore wind transmission assets have been a busy area in recent years for the Mott MacDonald advisory team.

Power generators wanting to connect to the grid need first to reach an agreement with the grid operator. Then they must understand what infrastructure is required, what type of contract to use, how much the connection will cost, how long the project will take, and where the risks are.

Ultimately the risk profile is largely dependent on the regulatory regime.

In the UK, offshore windfarm developers are legally required to transfer transmission assets to an offshore transmission owner, which receives revenue for keeping the connection to the farm operating.

Energy regulator Ofgem put this arrangement in place to attract investment into offshore transmission. It also enables developers to recover the capital invested in the windfarm, freeing up money to reinvest in other projects. The current high level of activity in the UK's offshore wind sector suggests the approach is working.

The bottom line

Whether you are the generator or the transmission owner, the interfaces are nevertheless both technical and commercial.

As Duncan sees it, attracting investment into the offshore transmission industry is about understanding the risk profile and the technical drivers: "If you can change the risk profile, you can change the pattern of investment. That's the bottom-line."

Making BIM part of standard delivery

Building information modelling (BIM) is a process for creating and managing information on a construction project through the entire lifecycle.

Tony King, BIM systems co-ordinator in Mott MacDonald's power transmission and distribution division, is on a mission to push the benefits of the technology throughout the group, particularly in infrastructure and utilities. "BIM is something we should be doing as part of standard delivery, rather than being held up as an innovation," he says.

Tony recently completed an MSc in BIM at Salford University. Here, he answers some questions about BIM.

What is the excitement over BIM?
BIM was central to the UK Government Construction Strategy, which was published in 2011 and outlined a four-year programme to modernise the construction sector, and reduce the capital cost and carbon burden of the built environment by 20%. It set the foundation for the BIM revolution to take off. The government set up the BIM Task Group, which has driven the standards and requirements to enable adoption of the technology. It also established the principle that future government-funded contracts should be BIM compliant.

How do you describe BIM?
BIM is simply a digital representation of the physical and functional characteristics of an asset. It is an integrated process that provides coordinated and reliable information on all phases of a project – from concept, through to detailed design, construction and operation. The goal is to construct things that are better, cleaner and cheaper, and to do so quickly and with minimal risk.

How does BIM lead to efficiencies?
The benefits vary greatly depending on where someone is involved in the process. From a design perspective, a BIM model brings together a huge amount of work from different stakeholders. Designers get an amalgamation of information from various sources and teams, all pulled together into the same place. They enjoy unprecedented sharing of information, helping them knock out any kinks in the design and construction phases virtually before building work starts.

BIM also helps avoid data atrophy: if someone completes a concept design and then passes it on to another party for the next phase of design, there is a risk that the new designer will opt to start again from scratch, repeating work that has already been done. With BIM, the digital model will include space holders for every element, together with the appropriate level of associated information. The space holder objects can then be swapped for more defined elements, both in terms of geometry and information, so that when a project moves from concept to detail design the focus is on refinement rather than beginning again.

Other benefits include the ability to interrogate the model and do additional modelling. In the case of an electrical substation, for example, interrogation of the design might include checking electrical clearances. The model allows you to see where there may be issues.

You're working on a catalogue of objects. What is that?
Underpinning BIM at Mott MacDonald is a searchable, central database or catalogue of standardised components. Once fully implemented, this will enable designers to easily source components with consistent levels of information attached. It is a rationalisation of a process that occurs already.

The first question when a new project commences is invariably: Have we done this before? Followed by: What did we do? Integrating the catalogue of objects into the BIM design process formalises that process, leading to greater efficiencies in time and cost to pass back to the client.

It is a unified approach across Mott MacDonald departments and the company is pushing it in transmission in a big way. Once everyone is on board, we're going to end up with a very powerful catalogue of components at our disposal across a variety of sectors.

We'll have immediate access to the information we must attach to an object. The objects carry data with them and this can be tracked through the model. During construction, operation and at later stages in the life of an asset, information can be extracted, providing owners with a much better understanding of the design and how best to operate the asset.

You mentioned that people tend to get a bit lost in the model. Elaborate?
It is easy to miss the detail when looking at the striking graphics. It's important to use the model appropriately; a quick glance does not necessarily convey that the design has been engineered to the correct specification. The focus should always be on the engineering, not the pretty pictures you can export from it.

The power of BIM is the information in the model and attached to objects – where they are in the world, how they behave, their relationship to other objects. That is the real advantage. The client receiving a model is receiving a huge amount of information relating to their asset. Harnessing the data is as important for the client as it is for the designers and contractors.

So the fancy rendering to create the graphics is essentially an add on?
Ultimately, what we deliver is traditional 2D drawings broken out of the 3D model. It must be in a format people understand and site staff will still refer to a 2D technical drawing.

BIM was introduced as a way of achieving efficiencies, are those being realised at the rate hoped for?
It's very hard to get metrics on the savings. People frequently talk about achieving a 30% reduction across the project lifecycle, from concept to as built, but it is difficult to pull the numbers together. The challenge, particularly in an area like power transmission and distribution, is the project scope is different every time. That makes it hard to get a good comparison between the costs of a BIM project and a traditional design.

However, it is true that, because we are seeing much greater context and can interrogate the design to a greater level, we are identifying more errors than previously. The upside of this is a more robust design and we sort problems out earlier and can eliminate issues in construction and cost.

Opening opportunities with connected thinking.

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