Energy Transition Handbook

2022

Environmental, social and governance
Energy Transition

Hogan Lovells

Contents

Introduction

Energy transition describes the global shift in energy production and consumption away from fossil fuels, including oil, natural gas and coal, towards meeting global energy demand through a smart energy system producing a sustainable level of greenhouse gas emissions.

Energy transition is multi-faceted but can be characterized by:

- the need to meet increasing global demand for energy with reduced emissions
- a movement away from coal in power generation
- a gradual reduction in oil as the primary fuel for transport
- a desire to reduce the role of coal and hydrocarbons in high energy industrial processes
- a need to move away from solid fuels for domestic cooking and heating in emerging markets
- the increasingly widespread deployment of renewables
- a move towards natural gas and LNG as a lower carbon or transitional solution
- an increase in the value of generation and demand flexibility
- the emergence of energy and battery storage in the tool-kit to counter-balance the intermittency of renewables and "time shift" energy
- a desire to decarbonise gas and gas networks and to electrify heat
- increased use of nuclear power in some countries and a move away from it in others
- the transition from internal combustion engines to biofuel, electric and hydrogen transport
- a shift from large centralised to smaller more numerous decentralised energy solutions with increased electrification leading to a three-fold increase in the global power grid by 2050
- significant advances in energy efficiency
- the use of data, technology and automation to better understand and optimise generation, demand and asset performance

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Environmental, social and governance
Energy Transition

"Great strength, especially when dealing with large transactions. The communication is fantastic and seamless."

Energy and Infrastructure, Chambers Global, 2022

Energy transition and power

Power markets are moving from power generation being based around large, synchronous fossil fuel or nuclear, centralised, transmission connected, baseload generation assets to a world with significantly larger numbers of smaller, more diverse, decentralised, distribution connected or behind the meter, intermittent and baseload generation assets contributing to energy security and the generation mix.

This is being driven by the increasingly widespread deployment of distribution (and behind the meter) connected renewables, in particular, solar, wind, biomass and energy from waste assets and by an increase in the deployment of distribution connected flexible baseload peaking plants (eg. diesel or gas reciprocating engines or open cycle gas plants).

The pace of change shows no sign of abating. We are entering a world of smart assets and smart grids, with increasing digitalization, through exponentially increasing connectivity, data collection, aggregation and "big data" analysis. This will enable the creation of new solutions that automate active energy and asset management, facilitate demand side response, reduce friction in the markets, maximise efficient use of energy network infrastructure and change the role of system operators and utilities.

Aggregation is allowing smaller power assets to be operated at larger scale to access a broader range of revenue generation possibilities. Battery and energy storage is allowing increased opportunities for wholesale price arbitrage and system cost avoidance through structures like peak shaving. Blockchain offers great potential for wide access to fundamental energy market data, faster transaction processing and settlement and disintermediation of the energy markets. Smart meters and smart devices are increasing the role of demand side response in balancing the system. Active energy management and "energy as a service" solutions are improving energy efficiency. Distribution network operators are beginning to think of themselves as distribution system operators with a more active role in balancing their networks. And the electrification of transport and heat offers the potential for huge growth in use of the electricity system.

"Hogan Lovells has an important knowledge of all electricity markets globally."

Chambers Global-wide, Projects & Energy, 2018

Peak shaving
Arbitrage
Digitalization
Vehicle to Grid
Efficiency
Smart meters
Demand side response
Blockchain
Interoperability
Smart Grid
Frequency response
Virtual Power Plants
Aggregation
Internet of Things
Electric Vehicles
Energy storage
Automation
Dynamic optimisation
Smart devices

Digitalisation, automation, data and energy technology

Digitalisation, automation, big data and energy technology are driving the energy transition.

Technology and digitalisation are providing new and enhanced solutions after for

- better understanding of energy system performance
- when, how and where power is supplied to the grid
- balancing the network (in particular by responding to the intermittency challenge created by renewables)
- accommodating increased demand on the system (for example from electric vehicles and heat pumps)
- when and how we consume power (including through automation, smart devices and demand side response)
- choosing what power we consume (eg renewables or locally generated energy)
- reducing (and improving the energy efficiency and cost of) the power we consume
- asset management and lifecycle optimisation
- avoiding or deferring capital investment and network reinforcement
- data integrity and management
- payment and settlement
- increased consumer engagement with the energy solutions they purchase

In mature markets, technology and digitalisation are central to:

- the transition from large, synchronous fossil fuel or nuclear, centralised, transmission connected, baseload generation assets to a world with significantly larger numbers of smaller, more diverse, decentralised, distribution connected or behind the meter, intermittent and baseload generation assets contributing to energy security and the generation mix
- the increasingly widespread deployment of renewables, in particular, solar, wind, biomass and energy from waste assets
- an increase in the deployment of flexible baseload generation and peaking plants
- battery and energy storage allowing increased opportunities for wholesale price arbitrage, system cost avoidance through structures like peak shaving and managing grid constraints
- aggregation allowing smaller power assets to be operated at larger scale to access a broader range of revenue generation possibilities
- exponentially increasing connectivity, smart assets, smart grids, smart meters, data collection, aggregation and "big data" analysis, enabling the creation of new solutions that automate active energy management and "energy as a service" solutions, facilitate demand side response, reduce friction in the markets, maximise efficient use of energy network infrastructure and change the role of transmission system operators and utilities
- blockchain' s potential to offer wide access to fundamental energy market data, faster transaction processing and settlement and disintermediation of the energy markets
- the increased number of challenger energy suppliers
- the evolution of distribution network operators into distribution system operators with a more active role in balancing their networks
- remotely monitoring assets and prioritising targeted preventative maintenance and reducing operational inefficiencies
- the electrification of transport and heat

In emerging markets, the focus of technology and digitalisation has to date been to support:

- the increasingly widespread deployment of renewables, in particular, solar and wind
- the development of micro grid solutions
- the deployment of battery storage to better manage the intermittency of renewables and grid constraints
- to better understand, estimate, forecast and manage system usage, technical losses and non-technical losses (such as corruption and theft)
- to provide increased transparency and accountability for improved governance

Automation removes the need for an intelligent consumer, motivated financially or by a commitment to decarbonisation, to modify their energy consumption behaviour. It allows data driven decisions that optimise energy consumption without the need for active consumer engagement.

Technology driven big data analysis and machine learning allow us to better understand supply, demand, flexibility, asset performance and to tailor solutions accordingly

> Excellent individuals who are hard working and smart and always great to work with.
>
> *Legal500 UK, 2022*

Paris agreement and UN sustainable development goals

A changing landscape: new law, soft law and business integrity

Consumer and investor focus on climate change and corporate responsibility is prompting significant market responses to social and environmental challenges. These corporate responses are also increasingly required by a new collection of hard and soft laws which drive integrity and require responsible business practices.

Adopted in December 2015, the Paris Agreement sets out a legally binding global framework to avoid dangerous climate change by limiting global warming to well below 2°C and pursuing efforts to limit it to 1.5°C. It aims to strengthen countries' ability to deal with the various impacts of climate change and support them in their efforts. This global agreement has accelerated the energy transition due to changes in national climate policy, corporate commitments to the Paris goals, investor recognition of climate risk and consumer demand for environmentally responsible business. Other new legal frameworks, such as the European Green Deal, will further accelerate the transition to net zero.

The United Nations Sustainable Development Goals (the "**UN SDGs**") are a driving force for climate action. This set of 17 goals provides a shared global blueprint for prosperity and peace for people and the planet, now and into the future. The goals were created by businesses, governments, NGOs and civil society and were adopted by all UN Member States in 2015.

The UN SDGs act as an urgent call to action to work in partnership to tackle some of the world's most pressing issues. The 17 goals, with a series of underlying specific targets, must be achieved by 2030.

The UN SDGs have particular importance for another reason – they have global buy-in and a great visual brand. The UN SDGs have become the dominant soft law in the market that corporates seek to align with. Reporting on sustainability and bench-marking efforts against globally recognised standards and laws is critical in an era where company reputation is ever-increasingly tied to its commitment to delivering social and environmental value; this goes beyond what is legal and looks at what is right.

EU green deal and UK net zero

Net zero greenhouse gas (GHG) emissions

In June 2019, the UK Government passed legislation amending the Climate Change Act 2008, committing the UK to net zero GHG emissions by 2050. In doing so, it became the first major economy in the world to pass laws to end its contribution to global warming by 2050. The new legislation increased to 100% the UK's previous target of achieving an at least 80% reduction in GHGs from 1990 levels by 2050. Since passing this legislation, the UK Government has announced a HM Treasury Net Zero Review. This included a priority to ensure a fair balance of contributions from all those who will benefit, including considering how to reduce costs for low income households. The Review will also consider how to avoid offshoring emissions i.e. how to reduce UK emissions without causing those emissions to be created by another country. A final report is expected in Autumn 2020.

In December 2019, the EU outlined its European Green Deal to become the world's first climate-neutral continent by 2050. The European Green Deal was described as "Europe's man on the moon moment," by Ursula von der Leyen, the President of the European Commission.

In brief the European Green Deal commits to:

- net zero GHG emissions (against current EU policies that will only reduce GHG emissions by 60% by 2050)
- clean, affordable and secure energy
- a clean and circular economy
- building and renovating in an energy and resource efficient way
- a zero pollution ambition (air, water, soil, and consumer products)
- accelerating the shift to sustainable and smart mobility
- preserving and restoring ecosystems and biodiversity, and
- an environmentally friendly food system

The immediate impact of the deal is to increase the EU's GHG emission reductions target for 2030 from 40% to 50-55%.

It's been described as "a new EU growth strategy" implementing the EU's sustainable development goals. It targets a just and socially fair transition through a "Just Transition Mechanism" to leave no individual or region behind. This was of particular importance to, for example, coal producers in Poland, Czech Republic and Germany.

The European Green Deal sets out a roadmap of initial policies and measures in which no sector is off limits and in which all policy levers are available.

It recognises that the transition needs to maintain EU security of supply and competitiveness (the EU is responsible for 10% of global GHG emissions), provide certainty for investors and that there may be a need to revise relevant State aid rules in light of the policy objectives of the European Green Deal.

The European Green Deal intends to bring forward the first European 'Climate Law' to enshrine the 2050 climate neutrality objective in legislation and ensure that all EU policies and sectors contribute.

Key areas of focus include:

- **Production and use of energy**, which accounts for more than 75% of the EU's GHG emissions, targeting renewables, the phasing out of coal, the decarbonising of gas and the exclusion of new gas interconnectors, transmission and distribution projects from its future lists of projects of common interest (PCIs), amongst other measures
- **EU industry**, which accounts for 20% of the EU's GHG emissions, targeting an EU industrial strategy to address the twin challenge of the green and digital transformation and European Commission support for clean steel breakthrough technologies leading to zero-carbon steel making
- **Buildings**, which account for 40% of energy consumed, targeting a doubling of the rate of building stock renovation and rigorous enforcement of legislation related to the energy performance of buildings, and
- **Transport**, which accounts for >25% of the EU's GHG emissions, targeting an end to fossil fuel subsidies, effective road pricing and support for zero- and low-emission vehicles amongst other measures

The European Commission has brought forward a Sustainable Europe Investment Plan to finance the transition. The EU estimates that achieving its current 2030 targets will need €260 billion of additional annual investment (equivalent to 1.5% of GDP). It has unveiled a one trillion euro investment plan comprised as follows:

- approximately half coming from the EU budget (through a new 25% budget target for climate mainstreaming across all EU programmes),
- €100bn from national governments,
- €300bn from private capital – mobilised by an EU budget guarantee for the EIB and other national promotional banks when they invest in European Green Deal associated projects,
- €25 billion from 20% of EU ETS revenues; and
- €7.5 billion of 'fresh' EU budget resources coming through the Just Transition Mechanism and intended to leverage €100 billion in investments over the period 2022-2027 to support workers and citizens of the regions most impacted by the transition.

U.S. climate initiatives under the Biden Administration

From the start of his term, President Biden has set an ambitious climate agenda, with announced metrics such as a carbon-free power sector by 2035, net-zero carbon emissions by 2050, and a reduction in greenhouse gas emissions of 50-52 percent by 2030 (compared to 2005 levels). To pursue these goals, the Biden Administration has employed a 'whole-of-government' approach to tackle methane, carbon, and other emissions, through commitments, regulatory actions, international partnerships, legislative efforts, and other methods. While legislative victories have been few, many new programs have been initiated and much has been accomplished.

President Biden set the tone early for his agenda by signing the "Executive Order on Tackling the Climate Crisis at Home and Abroad" on his first day in office, which directs that climate change be at the forefront of agency decision-making. This also created the White House Climate Policy Office to coordinate domestic climate policy and established a National Climate Task Force to develop plans to bolster U.S. climate resilience.

Environmental justice and a just energy transition are key planks of the Biden agenda. The President has committed to ensure that at least 40 percent of the benefits of the Administration's climate policies flow back to historically marginalized communities, and these goals are being implemented across the Government. For example, U.S. agencies such as the Department of Energy, Nuclear Regulatory Commission, and Environmental Protection Agency (EPA) are supporting environmental justice goals in their permitting, licensing and funding programs. Similarly, the President has continually supported a just energy transition to help revive the communities most impacted, particularly those in coal, oil, and gas areas. One example of this is a TerraPower project that aims to build a $4 billion, 345 megawatt advanced Natrium reactor demonstration plant at the site of the Naughton coal plant in western Wyoming that is due to shut down in 2025.

The Biden Administration has employed regulatory efforts such as resurrecting the Obama-era Interagency Working Group on Social Cost of Greenhouse Gases, which announced new interim valuations for the Social Cost of Greenhouse Gases, specifically carbon, methane, and nitrous oxide. The revised valuations have had far-reaching impacts on federal and state-level regulatory actions, including the crucial cost-benefit analyses that government agencies undertake as part of permitting and rulemaking.

The Administration is also stressing emissions reductions and energy efficiency. An Executive Order sets a goal for 50 percent of all new passenger cars and light truck sales to be zero emission vehicles by 2030, and another sets federal procurement metrics of 100 percent zero emission vehicles by 2035 and 100 percent zero emission light duty cars and trucks by 2027. Building on these orders, the EPA issued a final rule in December 2021 with increasingly stringent greenhouse gas emissions standards for passenger cars and trucks during the Model Years 2023-26.

Methane emissions have also been a focal point of the Biden Administration, in light of the NASA estimate that methane is responsible for one-quarter of all global warming. President Biden issued an Executive Order on his first day in office stressing the importance of tackling methane and directing agencies to pursue appropriate regulatory measures. Biden and European Commission President Ursula von der Leyen launched the Global Methane Pledge as part of the 26th annual UN Climate Change Conference of the Parties (COP26), with more than 100 countries signing on that represent nearly 50 percent of global methane emissions and over two-thirds of global GDP. Signatory countries agreed to take voluntary actions to reduce global methane emissions by at least 30 percent by 2030 (from 2020 levels). In conjunction with this pledge, the Biden Administration released a Methane Emissions Reduction Action Plan in November 2021 outlining practical steps to reduce U.S. methane emissions.

Recognizing that buildings account for 39 percent of total energy use, the Biden Administration is seeking to fund the modernization of local building codes and to invest in building technologies that integrate energy-efficient, low-carbon technologies and state-of-the-art construction methods.

The Biden Administration has also announced three "Energy EarthShots," which are goals to reduce: (i) the cost of carbon-free hydrogen by 80%, to $1/kg; (ii) the cost of CO_2 removal by 90%; and (iii) the cost of long-term energy storage (10 hours or more) to less than $100/metric ton — all in the next decade. These EarthShots are supported by cross-cutting technology investments and funding support for demonstration projects and regional hydrogen hubs.

The U.S. Congress passed the Infrastructure Investment and Jobs Act in November 2021. It aims to reduce CO_2 emissions, build a clean power grid, construct electric vehicle charging infrastructure, invest in clean hydrogen production and carbon capture technologies, and strengthen U.S. resilience to extreme weather. The more expansive Build Back Better Act remains stalled in the Senate after passing the House in November 2021. This legislation would tackle climate change through measures such as rebates and tax credits for transitioning to clean energy; bolstering coastal restoration, forest management, and soil conservation efforts; and incentivizing domestic supply chains for renewable energy.

Internationally, the Biden Administration has sought to restore and reinforce U.S. leadership in the climate change space. The President signed an instrument to rejoin the Paris Climate Agreement on his first day in office and reconvened the Major Economies Forum on Energy and Climate to address various climate-related issues, including initiatives on the clean energy transition. In April 2021, the White House hosted the Leaders Summit on Climate, with 40 world leaders and many others in attendance. The White House also finalized its International Climate Finance Plan in April 2021, the first U.S. initiative of its kind, aiming to double by 2024 U.S. annual public climate finance to developing countries.

The U.S. also took a leadership role at the COP26 summit, held in Glasgow from October 31 to November 13, 2021. The U.S. reached agreements on various climate-related initiatives and metrics, including measures to complete the Paris Rulebook (the practical guidance for implementing the Paris Agreement), help launch the Glasgow Leaders' Declaration on Forests and Land Use, commit to "end new direct public support for the international unabated fossil fuel energy sector by the end of 2022" (with certain exceptions), and donate for the first time to the Adaptation Fund — providing $50 million of a record $356 million donated to the Fund to help vulnerable communities in developing countries adapt to climate change.

Energy transition and COVID-19

COVID-19 has had a profound impact on all business sectors and the infrastructure assets classes, presenting Governments, sponsors, investors, funders, owners and other participants with problems and challenges that most had never envisaged.

COVID-19 and the resulting global lock-downs have had a number of immediate material impacts on the energy market:

- disrupting supply chains and triggering claims for force majeure or equivalent contractual relief
- triggering a collapse in oil prices (with US oil prices turning negative for the first time in history) over fears about oversupply and a lack of storage capacity
- materially reducing global production and demand for energy and thereby "accelerating" the energy transition in power with lower electricity demand met by an increasing proportion of renewables
- substantial reducing air pollution levels

History tells us that in times of crisis, Governments often turn to infrastructure and energy development as a key part of the solution. It is a way to stimulate employment and economic activity in the short-term, whilst investing in assets and networks that support prosperity and stability in the longer term.

So, while the infrastructure and energy markets are by no means immune to the fallout from COVID-19, there are plenty of reasons to be optimistic that they will come back stronger and sooner than most.

Hogan Lovells has produced a guide to the global governmental, regulatory, and other legal responses to the coronavirus pandemic, including the impact on infrastructure and energy projects. It allows you to see, by country, the relevant COVID-19 measures that have been implemented by national government that impact on the energy and infrastructure sectors.

The emergence of green finance

Whilst not a novel concept, the increasing standardisation of the market and the surge in transaction volumes has led to a recent “green ÿnance boom”, a trend likely to continue.

The role of green ÿnance

Financial institutions, and the products and services they offer, have a vital role in delivering key climate sustainability developmental goals and policies such as the United Nations Framework Convention on Climate Change, the United National Sustainable Development Goals and the Paris Agreement (to name a few), and it is increasingly evident that this is not a task for the public sector alone. The private financial sector is central to mobilising capital to meet the current significant shortfall. Green finance is vitally needed to support long-term sustainable growth and build a low-carbon, climate-resilient and circular economy by channelling funds towards well-governed responsible and ethical enterprises.

Green bonds and green loans

Green bonds are debt capital market instruments, first issued in 2007 by international development banks, but now widely adopted by corporate issuers. They tend to be medium-term, highly-rated instruments ranking *pari passu* with the issuer’s conventional senior vanilla bonds.

Green loans are any type of loan instrument (whether structured on corporate or project finance) made available exclusively to finance or refinance, in whole or in part, new and/or existing eligible Green Projects.

Market Standards

Green bond standards:

Growth in the green bond market in particular has been facilitated by the development of Green Bond Principles (**GBP**) by the International Capital Markets Association (**ICMA**) and the Climate Bond Initiative’s (**CBI**) Climate Bond Standard (the “**Standard**”).

The GBP are the most widely recognised green financing principles and they seek to enhance transparency and integrity in the green bond market. They establish a voluntary high-level framework of market standards and guidelines based around four key components:

- **Use of proceeds**: proceeds must be used for green projects with clear environmental benefits;
- **Process for evaluation and selection**: issuers must disclose processes for determining green finance eligibility and environmental risk management;
- **Management of proceeds**: issuers must implement a formal tracking process and ensure ring-fencing of the proceeds;
- **Reporting**: issuers must maintain up-to-date information on the use of proceeds.

The GBP provides a non-exhaustive definition of “Green Projects” which must meet five high-level environmental objectives (climate change mitigation, climate change adaptation, natural resource conservation, biodiversity conservation, and pollution prevention & control). Examples of Green Projects include:

- renewable energy (including production, transmission, appliances and products);
- energy efficiency (e.g. in new and refurbished buildings, energy storage, district heating, smart grids, appliances and products);
- pollution prevention and control (including reduction of air emissions, greenhouse gas control, soil remediation, waste prevention, waste reduction, waste recycling and energy/ emission-efficient waste to energy);
- clean transportation (e.g. electric, hybrid, infrastructure for clean energy vehicles and reduction of emissions); and
- eco-efficient and /or circular economy adapted products, production technologies and processes (e.g. development of environmentally sustainable products with an eco-label or environmental certification).

CBI certification is available for assets and projects that meet the Standard requirements in, *inter alia*, the solar, wind, geothermal, marine renewables (including offshore wind and solar, wave and tidal), water infrastructure, low carbon transport and buildings sectors. Certification is allowed prior to issuance, enabling the issuer to use the Climate Bond Certification mark in marketing efforts and investor roadshows.

New national green bonds developed in certain other countries are largely aligned with the GBP and the Standard, however developments in China in particular suggest that, in such a rapidly expanding market, there may be a need for greater regulatory supervision.

Green loan standards:

The Loan Market Association’s Green Loan Principles (**LMA GLP**) build on ICMA’s GBP and aim to develop the integrity and consistency of the green loan product.

The LMA GLP introduces self-certification by borrowers that can demonstrate the internal expertise to confirm alignment of the green loan with the key features of the LMA GLP.

In collaboration with its US and Asian counterparts, the LMA has also published an extended iteration of the LMA GLP, providing a more in-depth explanation on application to revolving credit facilities (**RCFs**). The challenge is in identifying the use of proceeds in an RCF, and parties should determine how to evidence the flow of funds to a sustainable objective when applying the LMA GLP.

Green horizons

Despite these relatively new market standards, the world’s largest investors/lenders, central banks, regulators and market organisations have called for the development of new frameworks setting out market terms and standards for green finance.

The U.S. Alliance for Sustainable Finance (**USASF**), formed by 15 major financial institutions, aims to provide the resources and expertise to identify and streamline existing climate-finance initiatives, encourage greater transparency across climate-related financial risks and opportunities and, ultimately, drive more capital to sustainable investments.

Similarly in Europe, in a drive to increase the impact of green finance measures, the EU Sustainable Finance Package has introduced proposals on:

- a unified EU classification system which can be embedded into different areas of EU law and which will facilitate development of standards, labels and benchmarks;
- rules on how investors integrate ESG factors in investment decisions and greater transparency relating to financial products which target sustainable investments; and
- a new category of benchmarks to facilitate a green comparison across different investments.

As markets mature, green finance documentation may move beyond a simple “use of proceeds” requirement towards applying a tailored set of specific contractual consequences, such as lock-up, acceleration or a margin ratchet, in the event of a borrower/issuer failure to meet or maintain identified green eligibility criteria.

We are likely to see increasing convergence between the dedicated market for green finance and the broader ESG markets. “Greenwashing” risk remains a hot topic and borrowers and lenders should continue to ensure that their activities in this space are genuine and capable of being evidenced to the market and their stakeholders.

We have a market-leading Impact Financing & Investing group with a long history of collaborating with our clients on green finance transactions that promote a positive environmental impact.

Solar

A decade ago, the levelised cost of solar was more than US$300 a megawatt-hour (onshore wind exceeded US$100 per megawatt-hour). Today, solar is US$38 in China (onshore wind is US$37 in the U.S. and US$30 in Brazil), making it one of the cheapest sources of new electricity for at least two/thirds of the world's population.

Prices are set to decrease further, with equipment costs predicted to also fall, and governments across the world increasing their clean-power targets in response to trying to combat climate change.

Bloomberg New Energy Finance predicts the cheapest solar and wind projects will, before 2030, fall under US$20 per megawatt-hour.

With the rapid rise of solar over the past decade, what lies ahead?

Firstly, it is clear that the previous perceived weakness of solar, being that it cannot be a baseload technology, is losing ground as battery storage becomes more price competitive. The levelised cost of electricity for batteries has fallen to US$150 a megawatt-hour, about half of what it was two years ago.

Secondly, the off-grid market is set to continue its rapid ascent; the off-grid solar sector has expanded into a $1.75 billion annual market serving 420 million users over the past decade and continues to grow. As the sector matures and productive use of off-grid solar solutions such as solar water pumps, cold storage and other products servicing public institutions become natural expansion areas, companies are increasingly focused on its financial sustainability and the durability of the technologies used.

Related to this is the acceleration of climate-related events which have, and will continue to accelerate global energy decarbonisation timelines; as far as solar is concerned, the solar industry will need to find even more efficiencies to drive the already low cost of solar, even lower. Cutting edge developments in the industry will be needed to meet 20% of all global energy, let alone 45% as some scenarios demand. Perovskite-based modules can be a timely addition to the solar energy industry's push to zero energy emissions.

Case study

Hogan Lovells is currently advising the Dubai-based solar developer Phanes Group on a 46MW solar Project in Nkhotakota, Malawi being financed by the U.S. International Development Finance Corporation (previously The Overseas Private Investment Corporation). The project has secured a 20-year power purchase agreement with Malawi's national utility Electricity Supply Corporation of Malawi Limited (ESCOM).
The new solar park is expected to contribute significantly to the Malawi government's goal of increasing power access to 30% of the population by 2030, up from 15% currently. It will also help reduce the country's dependence on hydropower, which at present accounts for more than 95% of its energy mix.

Offshore wind

Only ten years ago offshore wind was a niche industry, limited to a few European countries. Since then there has been a global breakthrough of o˜ shore wind as an essential technology for electricity generation in order to reduce global greenhouse gas emissions. Impressive cost reductions, technical maturity and global support have transformed this industry into a great success story.

The global support for offshore wind beyond its European core markets has already taken off. Governments from around the world clearly have trust in offshore wind as a source of clean electricity generation. Today offshore wind turbines are up and running in countries across Asia, North America and Europe. New markets such as South Korea, Vietnam, India, Australia and Brazil are taking concrete steps to introduce regulations for the development of domestic commercial scale offshore wind projects. In addition, technological advancements such as the advent of floating foundations for offshore wind farms create further spectacular growth opportunities as they open up new "deepwater" markets such as California, Spain, Norway and Japan.

In the UK, offshore wind is now frequently hailed as the future backbone of the UK's energy system. The UK market will require a huge expansion of its currently operational 8 GW of offshore wind capacity to meet the 2050 'net-zero' greenhouse gas emissions target – it is estimated that the UK will need around 75 GW of offshore wind to hit 'net-zero'. Globally this figure needs to be nearer 1,000 GW to reach sustainability targets.

Over the next decade, the worldwide capacity of offshore wind in operation will increase by 75 GW and the European Union is expected to contribute 40 GW to it. The market volume is expected to increase by USD 230 billion in the same period. In 2018, an auction in the US of seabed rights near the Massachusetts islands of Martha's Vineyard, Nantucket and Rhode Island's Block Island resulted in bids totalling more than USD 405.1 million for three lease areas for up to a maximum of 4.1 GW of capacity. These same areas of seabed failed to attract any bids during the 2015 auction process showing the spectacular cost reductions for offshore wind development over the past 5 years. Auctioned wind capacity in 2019 surpassed 40 GW worldwide, accounting for two-thirds of total new capacity and doubling auctioned capacity compared to 2018.

The technical reliability of offshore wind is also now widely accepted. The successful track record of dozens of wind farms across Europe has proven the technology's maturity and, in 2017, the Danish Vindeby offshore windfarm project was decommissioned after 26 years of successful offshore operation.

Notwithstanding recent cost reductions and the proven track record, offshore wind is still a relatively expensive technology to develop and install.

As with onshore wind, offshore wind carries well-known challenges for electricity grids and power systems through its variability and uncertainty, as well as its distributed nature. Wind farm planning also requires sensitivity when assessing the surrounding environment and this is something which will become increasingly important as sustainable credentials and environmental impact are scrutinised in the future.

Hogan Lovells has worked with clients to deliver offshore wind projects across the world, from the UK (with the largest operating offshore wind capacity in the world) to Taiwan.

'Excellent service and expertise in wind energy. Especially good expertise in offshore wind.'

Legal500 EMEA, 2022 (Energy)

Onshore wind

Onshore wind-generated electricity remains the largest non-hydro renewable technology and generates more than all the others combined (almost 600,000 MW in 2019). China and the US remain the world's largest onshore wind markets, together accounting for more than 60% of new capacity in 2019. Onshore wind is now a mature segment, recognised as a reliable and competitive source of energy. Technical progress is driving the development of increasingly efficient equipment and lowering production costs - the cost of onshore wind turbines has, for example, been cut by over 40% since 2010.

Onshore technology has evolved over the last five years to maximise electricity produced per megawatt capacity installed to unlock more sites with lower wind speeds. Wind turbines have become bigger with taller hub heights and larger rotor diameters. The wind tower height has increased over the past few years as the wind blows more steadily at higher altitudes. In inland areas where wind turbulence is high, a greater hub height can lead to better wind yield as wind turbulence decline at higher altitudes. The rise in the height of wind towers reduces the total number of turbines required on a wind farm as they produce more power from a single turbine. Taller turbines have better energy conversion rates, which can increase the annual energy production of such wind energy projects. Also, the increase in the size of rotors and blades has led to significant growth in the power generating capacity of wind turbines.

Innovations in turbine technology such as higher capacity onshore turbines, modular turbines, 3D printing, and additive manufacturing are bringing down the overall cost of onshore wind power. Leveraging technological advancements in data analytics and the 'Internet of Things' is enabling the development of smart wind turbines with increased connectivity, operation optimization, and predictive capabilities.

Another trend shaping the market is the continued decrease in the levelised cost of electricity of onshore wind in all regional markets, making wind power increasingly more competitive with conventional fuel sources.

China holds the largest share in the global onshore wind turbine market. Europe, North America, and India are other leading regional markets. Ambitious clean energy targets are driving the rapid expansion of the onshore wind power market in India. Mature markets in the UK, Germany, and the US are expected to generate demand as a result of increasing repowering or updating activities for aging wind power farms in the regions. Emerging markets in the onshore wind space include Brazil, Mexico, Australia, and South Africa.

Onshore wind carries with it similar challenges as have been set out for offshore wind with respect to variability and uneven distribution. Planning issues can be even more acute for onshore wind with a greater likelihood of objections coming from the local community due to impacts on local landscapes.

Hydro

Hydropower is expected to remain the world's largest source of renewable electricity generation and to play a critical role in decarbonising the power system and improving system flexibility.

Hydropower is a mature technology, yet it continues to evolve. Reservoir hydropower plants and pumped storage plants are particularly suited to providing baseload capacity / system flexibility, while run-of-the river hydropower plants are themselves variable according to current or seasonal weather conditions.

Reservoir hydropower plants rely on stored water in a reservoir. This provides the flexibility to generate electricity on demand and reduces dependence on the variability of inflows. Very large reservoirs can retain months or even years of average inflows and can also provide flood protection and irrigation services.

Pumped storage plants use water that is pumped from a lower reservoir into an upper reservoir when electricity supply exceeds demand or can be generated at low cost. Generators then monitor the demand market; when demand exceeds instantaneous electricity generation and electricity has a high value, water is released to flow back from the upper reservoir through turbines to generate electricity. Pumped storage currently represents the overwhelming majority of on-grid electricity storage. Interestingly, over the five-year period 2018-23, more pumped storage plants are expected to be installed for global electricity storage than stationary battery storage technologies deployed (partially for the advantage / arbitrage described above, and as a result of a greater needs for system flexibility to integrate variable renewables in China, Asia-Pacific countries, Europe and the MENA region).

Pumped storage capacity is expected to increase 26 GW, while stationary battery capacity expands only 22 GW. That being said, financing new such projects and operating existing ones profitably remain key challenges, particularly in markets in which revenues from energy arbitrage are uncertain, grid fees exist, and/or remuneration mechanisms that value the system services provided by pumped storage projects are lacking.

Run-of-river hydropower plants harness energy for electricity production mainly from the available flow of the river. These plants may include short-term storage or "pondage", allowing for some hourly or daily flexibility but they usually have substantial seasonal and yearly variations.

Importantly, governments increasingly recognise hydropower as playing a vital role in national strategies for delivering affordable and clean energy, managing freshwater, combatting climate change and improving livelihoods, helping countries work towards UN Sustainable Development Goals.

As such, hydropower is

- proven to provide multiple services
- seen as crucial in building resilience to climate change
- naturally suited to allow digitalisation and regional interconnections to bring efficiencies to clean energy generation

"Strong international presence, high competence and experience."

Chambers Europe, 2022

Geothermal

Geothermal energy is a key renewable energy source and supplies a significant share of electricity demand in countries such as Iceland, El Salvador, New Zealand, Kenya, and the Philippines and more than 90% of heating demand in Iceland. It has tended to be geography specific, but where available, offers advantages over other renewable sources in that it is not dependent on weather conditions and has very high capacity factors. Indeed, this largely untapped renewable energy source offers the advantage of steady, predictable large-scale power generation, in comparison to the higher variability of solar and wind power. As such, unlike other renewable sources, generators can look to negotiate full “take-or-pay” arrangements with offtakers.

The amount of heat within the Earth’s surface is estimated to contain many times more energy than all oil and gas resources worldwide. Geothermal power, therefore, offers considerable potential for growth. Increasing deployment and the opening of new markets, meanwhile, should drive down the technology’s considerable upfront developments costs, further increasing the competitiveness of geothermal power. Geothermal fields require investors to explore and appraise those fields; this concept in itself allows investors / generators to negotiate arrangements whereby the planned capacity of any particular project can be increased in phases.

Case study

Hogan Lovells is currently advising the lenders to the Tulu Moye 150MW geothermal power project in Ethiopia. The project is the country’s largest foreign direct investment. As such, a key part of Hogan Lovells’ remit is to advise on Ethiopia’s energy and public-private partnership (PPP) laws. Hogan Lovells is therefore actively involved in the drafting of new geothermal laws, and is also involved in the creation of new fiscal and foreign exchange regimes to facilitate the inflow and outflow of US Dollars (for example, we are advising the development finance and multilateral finance institutions involved in this project on the mechanisms which need to be put in place by the Government of Ethiopia and the National Bank of Ethiopia in order to allow US Dollars to be repatriated).

Tidal

For countries with appropriate coastline, tidal power has the potential to be a predictable and reliable source of energy. The technology uses the energy present in the natural rise and fall of the ocean tides or currents, which it converts into electricity. It may take the form of a tidal barrage capturing the motion of the tides and converting it to energy, tidal stream technology or the construction of tidal lagoons.

This market is at an early stage and historically there have been significant technological and economic barriers to entry. In 2019 there was only 531 MW of marine capacity globally, most of which was located in France and South Korea. According to the International Renewable Energy Agency only 0.01% of jobs in renewable energy relate to tide, wave and ocean energy. Yet harnessing energy from the oceans could be revolutionary and across the world there are exciting start-ups looking to crack this technology.

Key risks:

- High development and construction costs
- Risk allocation on unproven technology
- Difficulties securing the government support need to make projects deliverable
- Environmental effects – large scale barrages may have long term environmental effects that are not known at the outset and might appear during the project

Case study

Hogan Lovells has been advising a cornerstone investor in the Swansea Bay Tidal Lagoon project in Wales, comprising 16 hydro turbines, a 9.5km breakwater wall and seeking to be the world's first tidal lagoon power plant generating electricity for 155,000 homes for the next 120 years.

Sea water air conditioning (SWAC)

SWAC is a renewable air conditioning system suitable for installations with high air conditioning requirements that are located near a source of deep cold water. The SWAC system collects cold water from appropriate sea depths where sea water temperature is c.5-7 degrees Celsius, pumps it to the surface and uses it to cool fresh water in the installation's air conditioning system via a heat exchanger following which the used water is returned to the sea at an appropriate temperature/depth.

A SWAC solution brings a number of advantages, including:

- costs savings, including through reduced electricity costs (up to 90% of electrical consumption compared to a standard cooling system)
- reducing the host installation's reliance of fossil fuels/other sources of cooling which increases its security of supply and reduces its carbon footprint
- eliminating conventional cooling solution exposure to electricity price volatility
- a long term solution that can provide cooling for potentially 50 years or more
- lower operation and maintenance cost
- reduced noise and vibrations within the installation compared to a conventional cooling system

Key issues/risks:

- accuracy of seawater temperature depth profiles and the impact of changes to those profiles over the life of the project
- tariff structure and tenor, including any take or pay, fixed and variable components of the tariff structure to reflect availability and usage of the solution and any linkage to electricity cost savings
- off-taker credit risk and any implicit credit exposure to demand
- seafloor characteristics and offshore pipe routing
- logistics for onshore pipeline assembly, launching and towing to the Project site
- offshore "S-lay" installation of large diameter polyethylene pipelines to depths of 1,000 meters and greater
- the broader risks associated with marine construction/installation at significant sea depths and exposure to corresponding adverse weather and health and safety risks
- vessel availability risk (including as a result of unforeseen delays to the works programme);
- cavitation (rapid changes of pressure leading to the formation of cavities) and pipe collapse resulting from water suction with the pump
- right sizing vs oversizing of the solution and potential third party access opportunities (eg to supply the terminal infrastructure at either end of the tunnel and/or local district heating/cooling schemes)
- calibration of minimum acceptance criteria/testing and availability and performance guarantees and related delay and performance liquidated damages and termination thresholds if these levels are not met
- impact of the solution on the marine environment and habitats particularly at the seawater outlet
- decommissioning obligations and risk

Biofuels and biomass

Using biomass for energy is not a new idea: civilisations have been burning wood far longer than they have been driving cars or flying in planes. Yet in a world increasingly focused on reducing carbon emissions and fossil fuel consumption, biomass and biofuels have taken on a new salience. Whether we are discussing biomass combustion (be it dedicated biomass combustion or co-firing of biomass with other fuels) to produce energy, or converting biomass to biofuels for use in transport, this is a sector that has great potential.

Sources of biomass include forest residues produced from plantations or actively managed forests and energy crops that can be grown on marginal land. Potential supply chains for biofuels include agricultural residues such as olive cake pellets, palm kernel expeller used for co-firing at coal-fired power stations or wood pellets for co-firing and electricity generation.

A key issue is the sustainability of the biomass source driving the transition from 1st generation biofuels produced from food crops to 2nd generation biofuels produced from crop and forest residues and from non-food energy crops.

An international market for the import and export of these biofuels is currently growing, although it has yet to reach maturity, and at the same time more local supply opportunities are increasingly available. This means increased competition in the biomass feedstock market and falling prices, helped by technological developments. Total biofuel output, for instance, is forecast to increase 25% by 2024.

However, there is a consensus that more needs to be done. In the transport sector alone, global biofuel output would need to triple by 2030 in order to meet the International Energy Agency's targets for sustainable growth. In 2018 aviation biofuel production of about 15 million litres in 2018 accounted for less than 0.01% of aviation fuel demand. The industry needs to continue to develop long term projects for both power plants and transportation fuel, building up the infrastructure and familiarity with the relevant markets to enable economies of scale and knowledge base required to mature the sector.

Biofuels (such as ethanol produced from sugar cane or biodiesel) offer the potential for significant reductions in greenhouse gas emissions when compared to conventional transport fuels and can play a key role in decarbonising the aviation, marine and heavy-duty road transport sectors.

Key issues/risks:

- Costs in establishing energy crops for feedstock – these tend to be upfront and the return on investment may take some time
- Reliance on energy crops in an era of global warming, threatening supply
- Competition for biomass feedstock supply from other product markets eg woodchips
- Changing views of the sustainability of biomass sources and related regulatory issues and barriers, including international standards for industrial pellets that may need to be met, and import licenses for biomass that will be required
- Quality of feedstock
- Infrastructure needed for the transport and storage of biomass feedstock
- Ensuring long term supply agreements are sustainable and any currency risks are hedged, particularly where supply chains import from emerging economies

Energy from Waste (EfW)

The global energy from waste market is poised to grow by USD 12.26 billion during 2020-2024. The market is driven by increasing urbanization and the rising popularity of integrated waste management systems.

Energy from waste plants turn waste into a useable form of energy, including electricity, heat and transport fuels (e.g. biodiesel). This can be done in a range of ways, of which, incineration is the most well-known. EfW plants have an important role to play in reducing both the amount of waste sent to landfill and greenhouse gas emissions. They can also play a role in helping to deliver zero carbon buildings, as a source of heat and electricity and particularly when connected to distributed energy networks. Generally, EfW plants use residual waste, being waste which cannot be recycled, and this produces a partially renewable energy source, sometimes referred to as a low carbon energy source. As a partially renewable energy source it contributes to renewable energy targets and it has the added advantage that it is non-intermittent, so it can complement other renewable energy sources such as wind or solar.

Key issues:

- waste supply risk
- waste composition and calorific value
- economic incentives to divert waste from landfill, such as landfill taxes
- technology risk
- municipal covenant risk
- planning and permitting issues
- change in law risk
- contamination

Case studies

Hogan Lovells advised Covanta, Green Investment Group Limited (GIG) and Veolia on the successful completion of the Rookery South Energy Recovery Facility, a deal involving the construction and operation of a 60 megawatt energy from waste facility in Bedfordshire. When operational the plant will have the capacity to treat up to 545,000 metric tons of municipal, household, and business waste per year, generating over 60 megawatts of electricity which will be sold into the grid on a merchant basis, powering the equivalent of over 112,500 homes.

Hogan Lovells advised International Finance Corporation (IFC) on a a landmark project to design, build and operate a 103 MW energy-from-waste facility in Serbia. The facility will generate electricity for the national grid and heat for Belgrade's municipal district heating company. The project also involves cleaning up one of Europe's largest landfills and constructing a new EU-compliant sanitary landfill, which will form part of a sustainable waste-management complex designed to reduce pollution and mitigate climate change. It will be delivered under a long-term contract awarded to Beo Čista Energija d.o.o., a company formed by global utility company Suez S.A., the Japanese conglomerate Itochu Corporation, and Marguerite Fund II, a pan-European equity fund. €300 million of non-recourse, project finance debt is being provided by IFC, the European Bank for Reconstruction and Development (EBRD) and the Development Bank of Austria (OeEB).

Energy and battery storage

The global energy storage market is forecast to grow from approximately 4GW of annual deployments in 2019 to more than 15GW in 2024. Energy (and in particular battery) storage can play a key role in supporting the balancing of electricity networks, through providing ancillary services such as frequency response, reducing or time-shi˜ ing energy demand and time shi˜ ing energy supply.

This growth in the energy storage market is driven by many factors, including:

- the increasingly deployed capacity of intermittent renewables and the resulting requirement to stabilise electricity systems and maintain system frequency and inertia
- the growth in electric vehicles and e-mobility
- the speed of battery storage response to a call for power, with only cutting edge super-conductors offering a quicker discharge above 1MW (at a materially higher price)
- the additional flexibility solutions storage can offer to grid system transmission operators but also corporates and consumers through managed energy solutions
- the ability of energy storage to help navigate existing grid constraints and defer or avoid grid reinforcement capital expenditure
- the decreasing cost of Li-ion batteries (from $600/kWh in 2017 to just over $300/kWh in 2020 with costs predicted to halve again by 2030)

Key issues:

- battery storage is a rapidly developing technology, with early adopters potentially risking losing out to later projects before investment is fully recouped and, at the extreme end, the risks of thermal runaway (leading to intense and all-consuming fires) are still prevalent and not entirely understood
- revenues streams for battery storage remain uncertain, making the economics of energy storage challenging
- being both consumers and generators of power, many regulatory systems and grids may not be adequately set up to cope with battery or other energy storage solutions, which may add to costs or create regulatory uncertainty
- there is a relatively restricted supply chain for the rare earth metals and other elements (including lithium and cobalt) needed to produce battery technologies at scale: the majority of these are extracted from developing markets and there are material social and environmental issues which need to be considered to ensure that the positive impact of the technology is not undone by supply chain issues

Electric vehicle and vehicle to grid (V2G)

More than 120 million full battery and plug-in electric vehicles (EVs) are forecast to be on the road in the UK, Asia and the USA by 2030. These EVs will need access to power through a network of millions of chargepoints and a smart new EV charging ecosystem that manages the impact of that charging demand on the national electricity network. When and where those chargepoints are needed (and how fast they need to be) remains uncertain.

The pace of EV uptake remains unclear and is influenced by a range of factors including national government policies, in support of the transition to low emission vehicles, and broader decarbonisation targets; the length of time it takes to reach price parity between EVs and traditional internal-combustion engine (ICE) vehicles; vehicle range and range anxiety (ie public perceptions about the ability to use EVs for longer distance journeys); and availability of public charging stations (ie public perceptions about the availability of cost and time effective public chargepoints in the right locations so that a lack, or perceived lack, of charging infrastructure is not an impediment to consumer decisions to switch from ICE vehicles to EVs).

The speed (slow, fast, rapid, ultra-rapid) and location (home, work, destination and en route) of the charging ecosystem required to support the growth in EVs also remains uncertain. Most forecasts assume a fundamental shift from fuelling en route (as we do now) to charging for a significant portion of the time at home, but the optimal charging hierarchy will vary from country to country and, within countries, from cities to rural areas driven particularly by the extent of residential access to off-street parking and the prevalence of commuting journeys by car to office locations with available workplace parking.

The charging ecosystem that we plan today will also need to take account of the emergence of "ride-sharing" models, where personal car ownership levels reduce and mobility becomes a service and of the anticipated shift to autonomous vehicles. In both of these cases, annual mileage per vehicle (and therefore charging demand) is likely to increase significantly and optimal charging footprint (speed, frequency and location) will change.

A major potential source of potential additional revenue for home, workplace and some destination charging solutions (such as long term airport car parks) is the supply of power from vehicle to grid (V2G), vehicle to business (V2B) and vehicle to home (V2H).

V2G revenues could be generated through the software aggregation of EV batteries (combined with co-located static battery storage), operating the EVs as a virtual power station and seeking to arbitrage the power price and to sell balancing services, such as frequency response, to the grid.

V2B revenues involve the sale of EV battery power to corporates behind the meter (ie off-grid). V2B is often part of a wider energy as a service (EaaS) solution and creates an opportunity to arbitrage the wholesale and retail price of power, to avoid system costs (for example by using EV power supply to "peak shave": taking the corporate off-grid at times of peak load where systems costs are highest) and to generate revenues through a share of energy efficiency savings arising from effective energy management.

V2H revenues are similar to V2B opportunities, but targeted at residential rather than commercial users, for example by offering an integrated solar, battery and EV energy management solution to households. Although the sale of EV power to the grid or behind the meter offers a potential new and additional revenue source for EV charging providers, bi-directional power flow through an EV battery requires a more expensive bi-directional EV chargepoint and has the potential to degrade performance and lifespan on the EV battery. It remains to be seen if and how the vehicle or battery owner will be insulated from this risk and rewarded for its role in facilitating the sale of power and power services to third parties.

The EV charging ecosystem developed to support the anticipated exponential growth in EVs will need to be "smart" to time-shift and smooth out the load on the energy system and avoid a significant increase in peak load on the national electricity network (for example if people return from work and all begin to charge their EVs at the same time). "Smart" charging will also facilitate interoperability between vehicles, support the creation of an energy efficient, low carbon and lower cost energy system, allow interaction between EVs and other smart devices in the home/workplace (eg battery storage and solar generation) enabling the delivery of EaaS solutions and allow EVs to be aggregated and to operate as "virtual power stations" delivering V2G, V2B and V2H services.

Key EV charging infrastructure issues:

- Price disparity, range anxiety, and a perceived lack of access to charging stations
- The optimal balance of slow, fast, rapid and ultra-rapid charging and home, work, destination and en route solutions will emerge (and is likely to change) over time
- The increase of "ride-sharing" and the emergence of autonomous vehicles will increase annual vehicle mileage (and charging demand) and change the charging footprint
- Business models will vary with EV charging solution providers combining different available revenue streams
- The sale of power to the grid (V2G) or behind the meter (V2B and V2H) offers significant potential additional revenue
- V2G, V2B and V2H can result in battery degradation. Vehicle or battery owners will need to be insulated from or rewarded for this risk. Interaction with EV battery warranties is key
- EV charging solutions that can secure long term demand/revenue certainty (e.g. by contracting with a credit worthy fleet, last mile delivery or ride share customer or by building up a stable subscriber base) will be attractive to investors and lenders
- Site selection involves a delicate triangulation between expected vehicular footfall, land cost and grid connection cost (which can vary significantly if reinforcement works are needed)
- It is unclear how exposure to wholesale electricity price volatility will be passed on to end customers and this may vary from solution to solution
- Change of law or related technical standards may unexpectedly increase project costs
- Competitor charging solutions with equivalent or better technology, pricing or charging speeds may negatively affect demand or render solutions obsolete. Future proofing may be difficult or costly
- EV charging solutions are often heavily dependent on intellectual property (IP). Appropriate protection for IP infringement will be needed

Hydrogen

Hydrogen-based energy supply has significant potential to enable the transition to a low-carbon energy system. This is increasingly evidenced by governmental support for the creation of a hydrogen supply chain, including government-funded incentives to promote hydrogen energy studies and projects as well as the initiation of legislative processes to implement a regulatory regime for hydrogen network infrastructure which guarantees a reasonable return on investment.

Hydrogen is often called the "Swiss-army knife" of energy, providing a clean and transportable fuel to underwrite the electrification of the global energy system. This is due to hydrogen's extreme versatility as an energy carrier (it can be used directly as a zero-carbon-emission combustion fuel, or indirectly via fuel-cells or with methane blending), its diverse and scalable methods of production (using both non-renewable and renewable sources), and its ability to be transported over long-distances with minimal losses.

The properties of hydrogen enable it to generate power and/or heat through fuel cells, combined heat/power units (CHPs), burners, or modified gas turbines. Its chemical properties allow for its use as feedstock in chemical processes (including production of ammonia and methanol), and for its storage and transportation as both a liquid (e.g. ammonia or refrigerated hydrogen) and a gas.

It can be produced in a variety of ways with different cost and carbon impacts, including by electrolysis powered by intermittent renewable sources or by existing excess electricity supplies (e.g. at times of low demand), or by steam methane reforming of fossil fuels to avoid the stranding of existing assets (preferably with carbon capture to further reduce carbon emissions), or by emerging new technologies such as methane pyrolysis (which produces pure carbon as a commercial by-product). The produced hydrogen can then be used locally or transported (by pipeline, truck or ship) for use in both industrial and consumer sectors.

In addition, hydrogen production and transportation facilities can be piggy-backed on existing fossil fuel and renewables infrastructure projects (e.g. pipelines, gas plants, solar arrays, wind farms), and the produced hydrogen can power the very vehicles that transport it over large distances (for example, from areas with a high potential for clean hydrogen generation to areas with high energy demand but limited clean energy production abilities). Also, existing infrastructure, especially natural gas infrastructure, can often be rededicated for a future use as hydrogen infrastructure, to avoid stranded investments.

Key issues:

- besides first steps in the development of a regulatory regime for hydrogen infrastructure, there still is a lack of regulatory certainty on the widespread production, transportation and use of hydrogen
- the cost and timeframe for the establishment of the necessary infrastructure
- the expense of hydrogen, especially green hydrogen produced from clean renewable sources, in comparison to fossil fuels (and even to blue hydrogen created from fossil fuels)
- the multitude of technologies for hydrogen production and storage, many of which are still not bankable technologies
- a lack of knowledge and social acceptance of hydrogen by consumers, including safety concerns

Case study

Hogan Lovells is advising Riversimple, a UK car manufacturer of hydrogen-powered fuel cell vehicles. Riversimple provides a sustainable business model from the product, the governance structure and the interaction with the end consumer. The current model, the Rasa, is to be sold as a service, Riversimple retains ownership of the vehicles and the consumer pays a monthly subscription price which includes use of the vehicle and all ancillary costs.

Carbon capture utilisation and storage (CCUS)

CCUS involves the capture of CO_2, from the burning of fossil fuels in electricity generation and industrial processes, and its storage, usually underground, to prevent its release into the atmosphere. This concept has the potential to be transformative and will be required to meet global carbon reduction goals in the next three decades. There are currently 51 large-scale CCUS facilities in the pipeline.

In the UK, for instance, the Committee on Climate Change views CCUS as "a necessity not an option", and it is estimated that, in order to meet the UK Government's 2050 'net zero' carbon target the UK will need aggregate annual capture and storage of 75-175 MtCO_2 in 2050. Without CCUS in the power sector, meeting those 'net zero' carbon targets is estimated to cost the UK an extra £30 billion.

The International Energy Agency, in its IEA Clean Technology Scenario, which sets out a pathway consistent with the Paris Agreement climate ambition, concludes that CCUS can contribute almost 20% of the emissions reductions needed across industry with more than 28 GtCO_2 captured from industrial processes in the period to 2060, the majority of it from the cement, steel and chemical subsectors

Combining CCUS with other technologies has other benefits: oil that is extracted through enhanced oil recovery (EOR) methods that are driven by CO_2 capture and storage has a carbon footprint which is up to 50 per cent less compared to conventionally produced oil on a like by like displacement basis, while allowing developers to make the most of their existing assets.

Key risks:

- Stranded asset risk
- New, unproven technology risk
- Need for government support for CCUS specific risks (and related State aid issues)
- EPC vs Target Costs vs EPCM solutions
- Transport and Storage demand risk and third party access to storage infrastructure
- Long-term CO_2 storage liability and leakage
- Technology IP ownership and rights to use and modify
- Flexibility to respond to a changes in CO_2 supply and economics

Case study

Hogan Lovells team has been at the forefront of the CCUS market advising JX Nippon on the Petra Nova CCUS project in Texas, the White Rose consortium in relation to development of a £2bn, 426 MW ultrasupercritical oxy-fuel coal-fired power plant with full chain carbon capture and storage and Drax in relation to its investment in C-Capture the designer of world-leading and innovative chemical processes for carbon dioxide removal.

> "They have fantastic relationships within the industry and are able to provide very creative solutions to otherwise complex problems."
>
> *Chambers USA, 2019 (Energy)*

Gas to power

Given the current global dependence on hydrocarbons as fuel to generate electricity, and the economic and operational challenges that currently exist with renewable energy plants, natural gas has a key role to play in the decarbonisation agendas of many states and global energy companies.

Gas has already played a crucial role in shifting the world's electricity mix over the past 50 years. Between 1973 and 2018 the share of natural gas as a fuel has increased from 12% to 23% of the world's electricity generation. Gas demand is expected to further increase by almost half from what it is today by 2040. The significance of gas in the power mix is increasing as it is considered as the partner fuel for renewable energy-based generation, to level off operational and dependability challenges of solar and wind power projects.

Natural gas is also considered as a cleaner alternative to coal, which remains widely used in power generation projects internationally due to the low cost of developing and operating a coal-fired plant. Coal-to-gas switching has seen positive development in Europe and North America, with the UK planning to phase out all coal-fired power by 2025, Canada planning to phase out coal-fired thermal power by 2030 and Germany planning to the phase-out all coal-fired power plants by 2038. Since 2010, coal-to-gas switching has saved around 500 million tonnes of CO2 - an effect equivalent to putting an extra 200 million electric vehicles (EVs) running on zero-carbon electricity on the road over the same period.

Transition timelines and drivers will differ between developed countries and developing countries where electricity shortages are prevalent and where developing economies depend on cheap fuel for both consumers and industrial facilities.

Key risks:

- wholesale electricity price volatility to the extent not mitigated by a fixed capacity payment
- fuel cost volatility
- low load factors if the plant is operated on a mid-merit or peaking basis
- financial support mechanisms for providing system capacity and security of supply
- carbon taxes or emissions levies
- currency risk in relation to power purchase agreements (PPA) revenues (for projects in emerging markets)
- off-taker counterparty covenant/credit risk (for projects in emerging markets)
- public opposition (in some markets)
- merchant operation/residual value risk post expiry of the PPA and decommissioning risk
- back-up fuel storage and supply arrangements
- political considerations – some countries in which rapid development of gas-to-power had been forecast have experienced slower progress after changes in government or as a result of local elections
- inconsistency in policy - in many countries, gas-to-power projects overlap separate government departments – eg gas ministry and power ministry - meaning that such projects face two levels of oversight and regulation

LNG to power

Liquefied Natural Gas (LNG) is expected to continue to play a key role in the energy transition journey by unlocking access to natural gas where pipeline infrastructure is either not available or not feasible to develop.

The acceleration in technical innovation across the LNG value chain has increased the transition towards gas usage globally. Such access to natural gas as LNG can also help many countries manage short-term energy supply disruptions. In recent years, a growth of destination-flexible LNG exports from the United States (largely driven by a demand in Asia) is acting as a catalyst for a more liquid global gas market. Qatar, the world's largest LNG producer, is also preparing to expand its facilities by about a third by the mid-2020s. Moreover, it is predicted that the global demand for LNG will double by 2040, and with over 80% of the growth in global gas trade to 2040 coming in the form of LNG (majority being exported to Asia).

Local small-scale LNG facilities combined with smart meters and smart grids are anticipated to compensate for the intermittency issues that solar and wind projects can sometimes grapple with.

Key risks in full chain LNG to Power projects:

- currency risk in relation to PPA revenues/ LNG supply costs
- wholesale electricity price volatility to the extent not mitigated by a fixed capacity payment;
- fuel supply risk: cost pass-through of merchant LNG and any indigenous/regional imported gas risk and fuel price volatility
- counterparty covenant/credit risk – PPA, port and transmission
- oversizing, third party access/use and future-proofing to allow for domestic gas and third party gas off-take
- matching IPP flexible dispatch to LNG purchase/supply and related storage requirements;
- bankability of a multi-contract construction solution – availability of liquidated damages and compensation on termination covering entire debt service obligations during the development phase
- cost-overruns and retained/contingent equity risk
- conditions for achieving COD and triggering PPA revenue; impact of delay and any liquidated damages payable to host government/utility
- adequacy of existing transmission infrastructure and any required transmission upgrades or dedicated transmission assets
- achievement of Project socio-economic objectives in relation to empowerment, job creation and localisation
- any requirements for host state investment/ ownership of the project
- merchant operation/residual value risk post expiry of the PPA and decommissioning risk
- back-up fuel storage and supply arrangements and impact on PPA fixed capacity payment

Power trading in emerging markets

With an increasing number of state-owned off-takers in key "hotspots" in emerging markets suffering from growing credit issues, it is clear that there is reducing appetite to buy power from independent power producers due to perceived (real or otherwise) excess generation capacity in the near future and concerns about whether the obligations of those off-takers will be effectively backstopped by their relevant host governments.

This trend isn't being specifically driven by climate change concerns but it forms part of the transition to a new more dynamic energy system.

Certain developers, for example in Ghana, Nigeria, Mozambique and Zambia, are contemplating a strategy to limit capacity and output sold to such state-owned offtakers, with a certain volume of capacity and output sold instead to commercial and industrial end users (each being a "**C&I Offtaker**"). The benefit of this structure is to secure an enhanced off-taker credit risk.

The capacity and output may be generated by the developer, or, more innovatively, bought by them from various IPPs / state-owned offtakers, and then sold on by them (in which case, they would be a "trader").

In order for these developers/traders to be able to sell power to a C&I Offtaker, depending on the regulatory framework, they may need to enter into wheeling agreements with transmission companies in relevant jurisdiction(s) in order to purchase transmission capacity (akin to pipeline capacity), and also, potentially, with an adjacent transmission company of an adjacent country if it is possible to sell energy to a C&I Offtaker of such adjacent country.

At a very high level, in order for a developer/trader to achieve a viable project in circumstances where it can sell directly to C&I Offtakers, the developer/ trader may need to:

- enter into power purchase agreements (each, a "**PPA**") with upstream generators, whereby the developer commits to taking power for a fixed term;
- enter into power supply agreements (each, a "**PSA**") with each C&I Offtaker, whereby each C&I Offtaker commits to buying power for a fixed term; and
- put in place suitable payment security arrangements with each relevant C&I Offtaker.

Hogan Lovells has market leading experience of structuring and implementing power sale transactions to C&I Offtakers in Africa and beyond and we have been active in this sector for over 10 years. Most recently, we have advised both traders and C&I Offtakers on transactions involving various utilities and countries, across sub-Saharan Africa in particular. Our team was heavily involved in the development of many of the mine power sale agreements that are currently in use in sub-Saharan Africa. We have also worked on numerous captive power projects in Africa.

Decarbonisation of long distance transport

Long-distance transport accounts for 12% of global emissions. There is a viable pathway to decarbonising heavy road transport and rail but maritime transport and aviation present a greater challenge.

Heavy road transport

The Energy Transitions Commission reports that heavy duty road transport accounts for 2.5Gt of CO2 emissions annually, which represents 7.3% of total global energy system emissions. But under a business-as-usual scenario, this could rise to 4.6Gt of CO2 emissions annually by mid-century, as total road freight volumes rise rapidly in many parts of the developing world, and up to 11.6% of remaining emissions, as emissions fall in other easier to decarbonise sectors of the economy such as power generation.

In the EU, transport is the only sector that did not record any important decline in greenhouse gas emissions in the last decades. Its emissions started to decrease slightly only after 2007 but are still higher than in 1990. Road transport is the biggest cause of greenhouse gas emissions responsible for around 20% of EU's total emissions of CO2 (cars and vans 15%, heavy-duty vehicles 6%).

Decarbonising road transport and reducing its dependency on oil is therefore a key target of energy transition. Electric vehicles provide an immediate pathway for decarbonising passenger vehicles and light commercial vehicles in many markets. Biofuels provide a transitional solution for reducing internal combustion engine emissions and hydrogen powered vehicles offer good long term potential in the freight sector. Road pricing linked to vehicle emissions is also politically attractive as a means to offset falling fossil fuel duty fiscal revenues that will result from the transition.

Aviation

Air travel is more accessible than ever. Pre the COVID-19 pandemic, aviation carried 4.5 billion passengers and over one third of traded goods by value globally in 2019. At the same time those flights produced 915 million tonnes of CO2. But while the global aviation industry is a relatively small contributor to GHG emissions (producing around 2% of all human-induced CO2 emissions), decarbonising aviation is arguably the greatest challenge that the air transport industry faces.

Aviation is clearly under increasing pressure to decarbonise. It is a very long-term industry, with returns on investment measured in decades, which makes it really difficult to decarbonise quickly. In addition, the industry is at risk of having its emissions locked in due to the growth in passenger numbers and aircraft fleet. While uncertainties exist (and are growing due to the Covid-19 pandemic) the sector will have a substantial fuel demand well into the 2030s and 2040s, a period when the global economy needs to increasingly decarbonise.

Aviation was the first industrial sector to set a target for CO2 emissions reduction, pledging to introduce Carbon-Neutral Growth from 2020 (CNG2020) and aiming to achieve a 50% reduction of emissions by 2050 when compared to those emitted in 2005. The United Nations' International Civil Aviation Organisation (ICAO) adopted a four-pillar approach to deliver on this. This consists of more efficient aircraft technologies as incentivised by the CO2 standard, operational improvements such as more efficient flight procedures, the development and use of sustainable alternative fuels and market-based measures, such as CORSIA.

Maritime

The most recent study by the International Maritime Organisation (IMO) estimates that international shipping represented 2.2% of global CO2 emissions in 2012. If no further action is taken, then the IMO suggest that the CO2 emissions from international shipping could grow by between 50% and 250% by 2050, and a study for the European Parliament suggests that international shipping could account for 17% of global CO2 emissions by 2050. This is why the IMO's Initial GHG Strategy states that international shipping's total GHG emissions must be reduced by at least 50% by 2050.

Decarbonisation in the maritime transportation sector poses a major challenge that will require a revolutionary shift to alternative renewable fuels. Regulatory uncertainty is viewed as one of the biggest potential barriers to shipping's decarbonisation in the next 10 years. Zero-carbon fuels and vessels are not yet a reality, and their competitiveness with fossil fuels and vessels remains unclear. Although environmental regulation could help the industry overcome these barriers, there is uncertainty as to which measures can be agreed on and in what timeframe. Many believe that slow-steaming is the most effective way to reduce greenhouse gas emissions from ships in the short-term, but it is hardly an emissions wonder cure. Although slow-steaming significantly reduces fuel consumption, the longer journey times lead to higher operating costs that come with operating more ships at any given time.

Rail

Rail is a relatively low-carbon form of transport and is one of the most efficient ways of moving high volumes of people and goods. New trains generate fewer emissions and increasingly electrification combined with the decarbonisation of domestic electricity generation is helping to support emissions reductions. There is also "low hanging fruit" in diverting existing road and aviation transport to rail and inland waterways.

The UK government has determined that the main way to achieve rail freight decarbonisation is to stop using diesel traction, through direct government intervention to roll out further electrification. It has concluded that current alternatives to overhead electrification, such as hydrogen and battery, do not have sufficient power to pull heavy freight trains although there is potential for bi-modes to reduce emissions.

Decarbonisation of heat

Heating accounts for almost a third of GHG emissions globally and is also one of the most complicated areas to decarbonise.

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There are a number of low carbon technologies which can be utilised as sources of heat, but there is a considerable amount of information lacking on how these technologies can be integrated with each other at a large scale. The scope of the available options is changing dynamically, with main technological developments emerging over the last ten years. Currently, the most viable choices are district heating networks or “greening” of the gas grid. It is not clear, however, if either will deliver significantly lower emission gas, without being very expensive at the same time. There is also a lack of hard evidence as to how it might be rolled out in a safe and effective manner.

Use of electricity as a mean to decarbonise heating seems to be a more deliverable idea in practice. At the moment electricity has a very similar proportion of carbon content as gas, but significant technical progress is being made to reduce that. As a result of moving away from coal power stations to solar PV and wind farms the emissions from grid electricity have nearly halved over the last twenty years.

The European Commission is currently considering the following three options for future investments in gas infrastructure that would contribute towards achieving climate neutrality by 2050: (i) a gradual shift away from natural gas; (ii) a green gas grid option, focused entirely on the repurposing of gas grids to handle renewable gases such as hydrogen, power-to-gas and biogas; and (iii) an electricity only option, aimed to move all funding for gas to electricity and smart grids. In line with the European Commission’s policy position funding will only be provided for “future-proof” gas infrastructure capable of handling low-carbon gases, such as hydrogen, to avoid a “lock-in” to fossil gas.

Large Fission, SMRs/Advanced Reactors, and Fusion

At this critical juncture in the fight against climate change, nuclear energy — conventional power plants and advanced reactors — is increasingly acknowledged across the political spectrum as an important component of the global energy portfolio, as it boasts safe, reliable, zero-carbon power and many other benefits. It is also one of the largest sources of carbon-free power in the world, second only to hydro power. This source of energy is also important to energy security and grid reliability. Nuclear can offer a complementary source of energy to intermittent renewables such as wind and solar, and provides reliable base-load power that is relatively unaffected by extreme weather phenomena that are becoming increasingly frequent and violent.

Some 440 nuclear reactors are operating in 32 countries with about 55 reactors under construction in 19 countries. There are also nearly 150 small modular reactors (SMRs)/advanced reactor projects under development, using cutting-edge technologies and capabilities that range from tiny (less than one megawatt) to large (over a thousand megawatts). Nuclear reactors do not produce carbon or other greenhouse gases. Nuclear fusion also appears on the brink of commercialization, backed by significant recent technical advances and large private capital investments. On the back end, more than 180 commercial and prototype reactors and over 500 research reactors retired and are at varying levels of decommissioning.

A number of new fission and fusion activities are underway around the globe, such as:

- The U.S. has the largest nuclear power program in the world, with some 93 reactors providing about 20 percent of the country's power, and over 50 percent of its carbon-free power. A number of existing plants have experienced economic downturn as they are not credited for their carbon free power, but the American Nuclear Infrastructure Act, passed near the end of 2021, contained $6 billion in credits to help keep plants open and preserve their carbon-free power. The U.S. also continues to enjoy a surge of SMR/advanced reactor activities, with 10 reactor developers winning awards from the U.S. Department of Energy under the Advanced Reactor Demonstration Program (ARDP) to support commercial deployment of their technologies, with two developers — TerraPower and X-energy — receiving ARDP awards of over $1 billion dollars each to deploy commercial facilities in the 2028 timeframe. The U.S. Nuclear Regulatory Commission (US NRC) approved an SMR design for the first time, the NuScale reactor design, with its first expected US customer planning to submit an application to the NRC to construct and operate the plant in the near future. Several other applications are, or will soon be, under review by the NRC.
- In the United Kingdom, British Prime Minister Boris Johnson's Energy Security Strategy aims to construct up to eight new nuclear reactors (roughly one per year), plus SMRs, and a government whitepaper demonstrates the intent to tackle climate change with both large and small scale nuclear. Rolls-Royce is also working to build 16 SMR plants in the UK within 10 years.
- A number of European countries are planning to deploy new reactors, with particular interest in Eastern Europe — e.g., Poland, Romania, Czech Republic, Hungary, and Ukraine — for reasons of energy security and to replace retiring coal plants. Countries like Finland and France also plan to build additional nuclear power plants domestically. Shortly before Russia's invasion of Ukraine, France, which already gets roughly 70 percent of its power from nuclear energy (the largest percentage in the world), announced plans for a so-called nuclear renaissance, including construction of up to 14 new reactors in France and continued development of SMRs.
- China is moving ahead on nuclear and aims to be a competitor in the global nuclear market. It currently has 53 operable nuclear reactors and 19 under construction domestically. Its recent construction of four Hualong One reactors is the first nuclear plant project in the country to use private funding. In late 2021, China also connected its first advanced reactor to the grid.
- Canada's SMR Action Plan promotes advanced nuclear to help achieve a zero-emission economy by 2050, and the Canadian nuclear regulator is reviewing 10 advanced reactor design applications, with two more under development. Additionally, Ontario Power Generation selected GE Hitachi to partner on deployment of a BWRX-300 SMR at the Darlington site in Ontario by as early as 2028.
- Russia has 37 operable reactors and 3 under construction domestically, 20 reactors confirmed or planned for export construction, and a stated book of business for nuclear construction projects at well over $130 billion, although some orders are being cancelled in light of recent world events (e.g., Finland's decision to cancel a planned Russian nuclear power plant). Russia developed the first modern floating SMR technology, and is paving the way for fast reactors through its Proryv Project where fuel is recycled to reduce nuclear waste.
- Roughly 30 countries across the Middle East, Africa, Central and South America, Europe, and Southeast Asia are considering or beginning new nuclear power programs.
- On the fusion front, there have been a number of exciting recent achievements in fusion energy, from start-ups to global collaborations. Examples include Helion Energy in Washington state, which received a $2.2 billion private capital investment and made significant technical advancements, including reaching 100 million degrees Celsius last year. Commonwealth Fusion in Massachusetts just raised $1.8 billion and achieved a significant magnet advancement to form the most powerful magnetic field of its kind ever created on Earth. Canadian company General Fusion expects to demonstrate its technology through a UK plant it will build and operate by 2025. To support these ventures, the White House recently held a Fusion Summit for development of commercial fusion within the decade, and the UK government issued a white paper outlining its fusion development strategy. Both the US and UK regulators are evaluating the appropriate regulatory framework for fusion.

Key issues:

- While carbon-free, nuclear can sometimes struggle to be recognized as 'green', especially by the investment community, although this is slowly starting to change.
- Traditional large scale nuclear has had large capex requirements, meaning that fewer owners are able to finance projects on balance sheet, and projects are rarely able to be financed using debt without some form of underwriting from a government entity.
- Advanced reactors are generally expected to be smaller and simpler, but this is subject to confirmation once first-of-a-kind projects are built, usually with significant government support. Advanced reactors are also seen as having more flexible uses, including non-power uses such as water desalination and processing heat for industrial use.
- Complex and lengthy permitting and licensing regimes.
- No solution to spent fuel disposal in many countries.
- Political sensitivity and public opposition in certain countries – for example, the requirement for all German nuclear power stations to cease operation. However, others such as France have taken a very different position and aim to expand nuclear.
- Fusion still has significant technological hurdles to overcome and faces uncertain regulatory frameworks that can significantly impact construction costs and schedules.

Green corporate PPAs

A green power purchase agreement (PPA) or electricity supply agreement (ESA) allows a business to directly purchase renewable electricity, equal to the power it consumes, in place of the "brown" power it would traditionally purchase from its electricity supplier. In doing so, the PPA or ESA directly supports the development of identified renewable generating assets and evidences a corporate's integrity and commitment to the environment.

A number of different approaches can be used to document a green PPA or ESA. These include "sleeved", "back-to-back", "tripartite", "virtual", "synthetic" or "guaranteed price" agreements with the structure typically determined by the corporate off-taker's objectives and the identity of the renewable generator and licensed supplier involved in the transaction.

In negotiating a green PPA or ESA, key issues will include:

- successfully navigating the regulatory framework to ensure that the corporate off-taker does not engage in licensable activities (such as the supply of electricity) without a licence
- creating a robust nexus between the corporate off-taker, the renewable generator and the green attributes that attach to the renewable power, to defend against allegations of "greenwashing" in the structure
- ensuring that the corporate off-taker will have an uninterrupted source of power at each of its consumption sites for a reasonable cost
- settling the tariff, allocating the financial value of the green attributes between the parties and preserving any required flexibility to forward trade or hedge the wholesale power price
- future proofing the agreement against change, by allowing for changes to the demand curve to accommodate changes to the corporate off-taker's footprint or power consumption over the term and by providing for the impact of changes to the green attributes attaching to the renewable power

Case study

Hogan Lovells advised Mars on a 10 year energy supply agreement to purchase green electricity from Eneco's new 20-turbine Moy Wind Farm, located south of Inverness in the Scottish Highlands. The Moy Wind Farm is owned and operated by Eneco UK and will generate the equivalent of 100% of the electricity required to power all 12 Mars UK sites. The transaction marked the latest step on Mars' journey towards making its global operations fully carbon-neutral by 2040. The Moy Wind Farm has an export capacity of 60 MW and an annual production of over 125,000 megawatt-hours. The power generated is equal to that used by 34,000 average UK households.

> 'Extensive industry knowledge and valuable experience, also in non-ordinary matters.'
>
> *Legal500 EMEA, 2022 (Energy)*

Demand side response

Demand side response (DSR) refers to the increase or decrease of power consumption in response to price or regulatory signals. It broadens the toolkit available to network system operators by allowing them to modulate electricity demand as well as electricity supply to balance the network.

DSR is an important tool to help ensure a secure, sustainable and affordable electricity system by softening peaks in demand and filling in the troughs, especially at times when power is more abundant, affordable and clean.

It is increasingly importance in a multi-directional energy system where power no longer simply flows from large generation plants onto the high-voltage transmission network, through the distribution network and to consumer. In mature economies, electricity markets are increasingly flexible with significant electricity demand being met directly by distribution network connected renewables or behind the meter generation and energy storage.

To be effective, DSR relies on price or regulatory signals incentivising behaviours that contribute to system efficiency, lowest cost and lowest carbon footprint. In many markets, system cost allocation was not designed for the operation of the current more agile electricity system. That has led to opportunities for arbitraging and avoiding system costs, for example, by load shedding at times of system peak. This has led to calls for system cost allocation reform.

For business and consumers, DSR is a smart way to save on total energy costs and reduce their carbon footprint. DSR enables businesses to save on use of system costs as well as generate income by reducing or shifting consumption or switching to on-site generation when asked to do so by the DSR partner and/or system operator. It can also involve increasing consumption at times when the system has too much capacity. There are various ways for businesses and consumers to participate, from flexing operational processes to utilising on-site generation or battery storage.

Historically only available to the largest energy players, DSR is now opening up to business consumers and small generators with the role-out of smart meters and smart devices is making DSR easier than ever for domestic consumers.

Energy as a service

Energy is no longer simply a commodity with new and increasingly sophisticated "Energy as a Service" (EaaS) solutions offering access to renewable power, combined with energy storage, energy efficiency measures and intelligent energy management and asset optimisation.

The general shift from asset-focused, centralised power generation and one way, vertically integrated supply towards multi-directional, distributed generation combined with advances in technology, digitalisation and big data analysis has increased the value of energy flexibility and the potential of active energy management solutions.

The early EaaS market began with energy efficiency and renewable related business models, from LED lighting retrofits, where repayment for the upgrades is through the energy savings made, to residential solar systems, and payment for the installation and maintenance is made under a "solar lease" or "solar PPA" arrangement with a supplier, rather than the customer incurring upfront capital costs. These models allowed service companies to profit from energy cost savings, promoting the adoption of energy-efficient technologies and closing the "energy efficiency gap".

Today's EaaS solutions use technology and algorithmic automation to offered managed solutions combining clean power, microgeneration and decentralised supply, energy/battery storage, new technologies such as electric vehicles and the use of smart meters and smart devices and data to optimise asset management how and when we consume or generate power and to reduce our overall consumption and carbon footprint.

EaaS solutions create an opportunity to arbitrage the wholesale and retail price of power, to avoid system costs (for example by "peak shaving": taking a corporate off-grid at times of peak load where systems costs are highest), to generate revenues through a share of energy efficiency costs savings arising from effective energy management and to generate additional revenue streams by using corporate and residential energy demand flexibility to provide demand side response and other ancillary services to system and network operators. They can also create steady, ongoing revenue streams for the solution providers through subscription or service payments, rather than traditional energy supply payments.

Case Study

In March 2019, Mitsubishi Motors Corporation unveiled "Dendo Drive House", a packaged energy system comprising an electric vehicle (EV), a bi-directional charger, solar panels and home battery, and that bundles together the sale, installation and after-maintenance of the system components. The package allows the customer to charge their EV (or plug in hybrid) at home using solar generated power, and to supply electricity from their EV into the home. The Dendo Drive House system reduces reliance on the grid and aims to deliver significant cost benefits to the customer. The power in the EV could also serve as a backup in the event of a power cut in the home.

Aggregation and virtual power plants

Energy transition has created an intermittency challenge as large capacities of renewable generation assets are added to the electricity system. It has also driven the shift from large transmission connected centralised solutions to smaller more numerous decentralised energy solutions. Those shifts provide a role for aggregation and virtual power plants.

A virtual power plant uses wireless technology to aggregate multiple electricity generation, storage and demand assets and operate them as if they were a single larger physical power station or energy consumer. They bring natural benefits of scale (both financial and risk mitigation) as well as enabling the aggregator to access revenue streams (such as in relation to grid ancillary services) that are only available to larger generation assets.

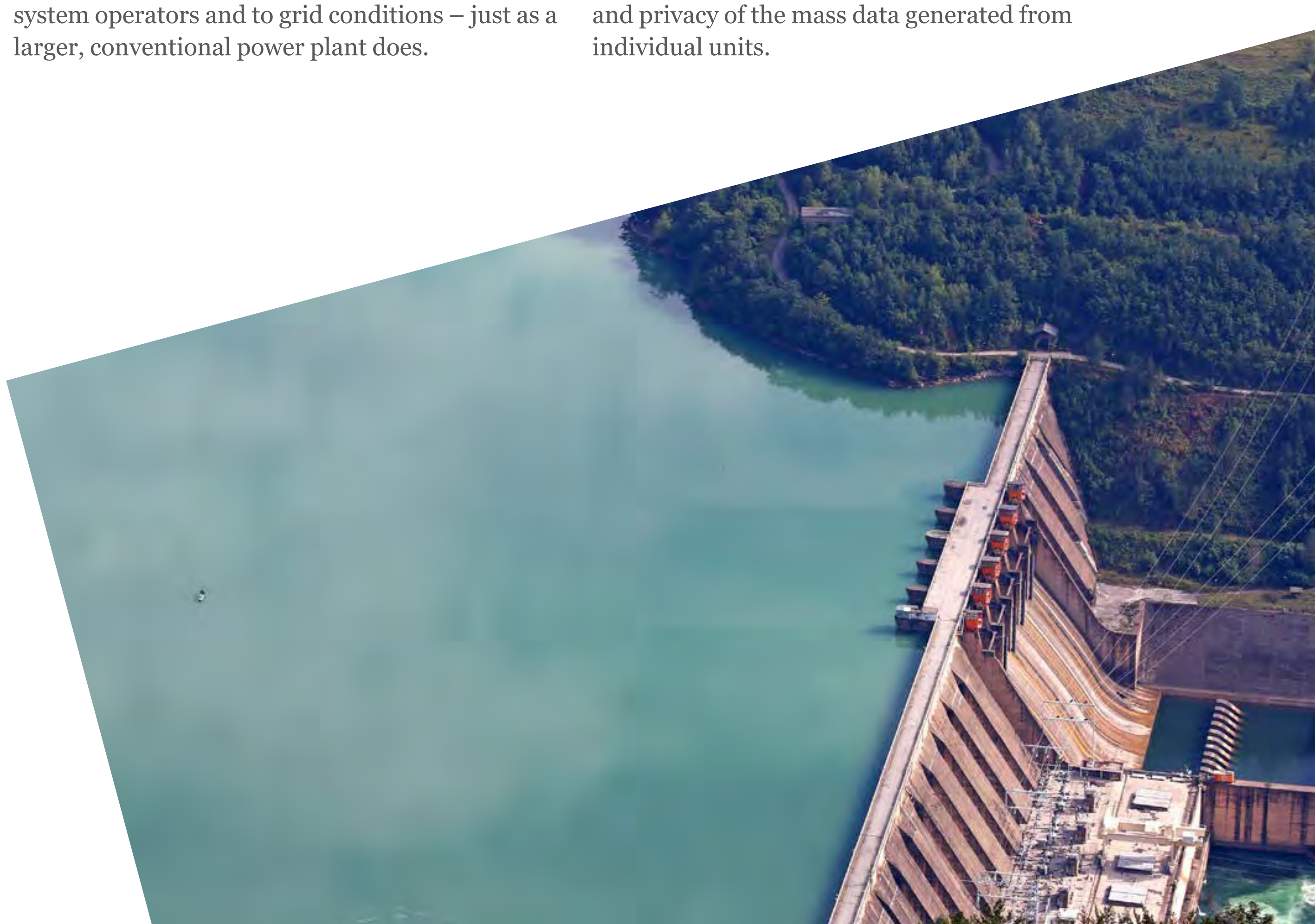
Electricity networks are increasingly volatile and virtual power stations serve to pool resources and allow assets to be traded collectively in an attempt to combat this risk.

In addition to operating every individual asset in the virtual power station, the central control system uses a special algorithm to adjust to balancing reserve commands from transmission system operators and to grid conditions – just as a larger, conventional power plant does.

The virtual power station can also react quickly and efficiently when it comes to trading electricity and can generate revenue by helping to stabilise the grid.

The rising numbers of EVs and of network hubs and computer centres in response to digitalisation, all require vast amounts of electricity. With conventional power supplies, these demands cannot be met sustainably. The hybrid and decentralised approach of a virtual power station, which utilises a wide range of technology and energy sources, can provide low carbon flexible solutions at scale to respond to this increased demand and system volatility.

Virtual power stations do face some particular challenges however, including the threat of cyberattacks and the maintenance of security and privacy of the mass data generated from individual units.



Blockchain and energy

The global market for blockchain and associated technologies is estimated to be between USD5.4 billion and USD28.4 billion. Blockchain provides a platform for the disintermediated verifi ation of data recorded on open and transparent ledgers.

In the energy sector, blockchain offers the potential to disrupt existing business models and platforms for:

- energy trading
- electricity network balancing and imbalance settlement
- trading renewable certificates and emissions allowances
- customer billing and payment processing
- electric vehicles charging infrastructure availability
- consumption, generation and aggregation/grid balancing services
- enhanced, real-time and remote asset management
- selling anonymised system data to feed big data analysis and machine learning and develop new product lines

Blockchain solutions can also facilitate new energy sector business models such as

- purchasing energy directly from generators dis-intermediating the role of energy suppliers
- purchasing energy from different suppliers in close to real time
- peer to peer community energy schemes
- automated network balancing without a physical system operator
- accelerated imbalance settlement providing close to real time reliability of system data
- faster customer switching and onboarding
- aggregating smart devices and generation, storage and demand assets

Blockchain solutions face a number of barriers to entry however including

- challenges to their ability to perform verification in close to real time
- how energy system costs and support mechanism costs would be allocated without an intermediary
- high cost and barriers to changing existing systems even if blockchain can offer more agile, lower cost and/or more secure solutions
- the size of the proof of work carbon footprint, which for Bitcoin generates as much CO_2 a year as 1 million transatlantic flights and more power than Republic of Ireland and where the financial incentives to mine and consume power increase as the value of Bitcoin rises

ESG and you – making the complex manageable

Environmental, social, and governance considerations are driving signifi ant change for every single organization – but identifying and effectively managing the right mix varies greatly from company to company. We combine cutting-edge understanding of the diverse issues at play with our vast global experience across a wide range of industries to craft the right solution to your unique ESG focus, whatever it may be.

Energy Transition
Solar, Wind, Hydro, Battery, Interconnectors, Hydrogen, Energy from Waste, Electrification, Energy Efficiency, Smart Metering, Carbon Trading, Nuclear

Environmental
Climate Change, Carbon, Pollution, Plastics, Real Estate, Environmental Permitting, Water, Biodiversity

Sustainable Financing and Investing
Responsible Investment Policies, Green Loans, Green Bonds, Measurement, Disclosure and Reporting, Training and Compliance, Financial Regulation, Capital Adequacy, Sustainable Insurance

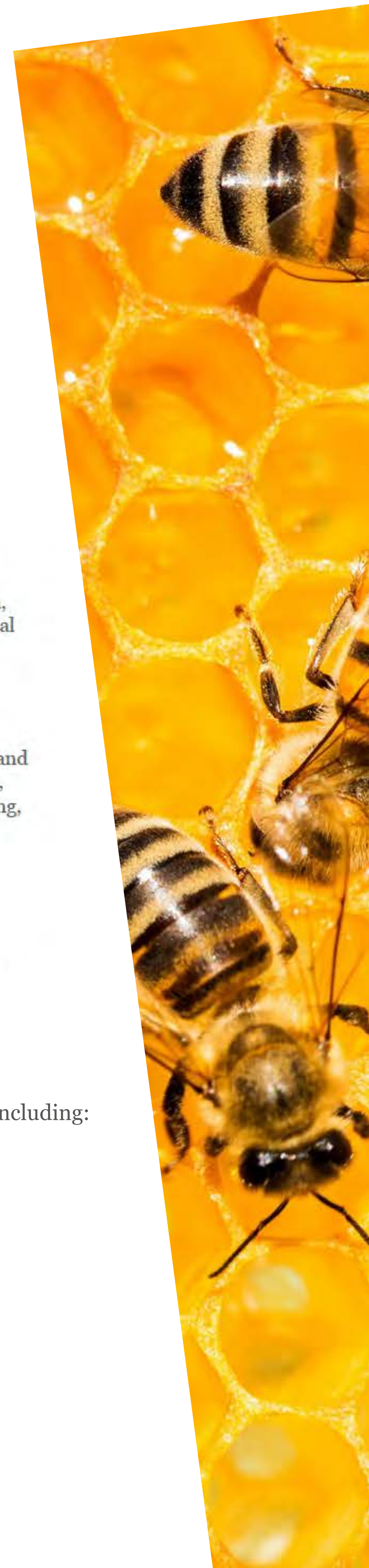
Social
Pensions, Supply Chain, Business and Human Rights, Indigenous People, Impact Measurement and Reporting, Justice and Rule of Law, Diversity and Inclusion

Governance and Corporate
Corporate Governance, ESG Policies, Shareholder Activism, Listing and Reporting, Remuneration and Incentives, Key Performance Indicators (KPIs), Brand, Green IP, Digitisation, Data and Technology, Transparency

Our tools

Our cross-functional team has created a number of free resources for you to use, including:

- A guide to current trends in ESG
- A guide to current ESG regulations
- An app to help you determine whether your business is fit for purpose
- A diagnostic to help you assess how ready you are for a crisis
- A guide to ESG issues for consumer companies
- A video guide on ESG issues for Real Estate companies
- A guide to global issues and regulation in offshore wind
- Thought leadership on sustainable investing
- Thought leadership on ESG issues in UK2030



HL Business integrity group

We understand that business integrity, positive social and environmental impact and addressing climate change are core to your continued success. Our Business Integrity Group (BiG) can work with you to help enhance brand integrity and top-line growth and demonstrate that your commitment to combating climate change goes beyond "compliance"; we can work with you to ensure that this commitment is embedded in your legal arrangements and drives long-term value for your investors and stakeholders.

We can also work with you to audit how your legal infrastructure shapes up to delivering value, business integrity and a positive environmental impact. We focus on ensuring your business and legal structures (and those of your investments and supply chain) underpin and compliment your brand, business plan and net zero targets, driving governance and financial incentives that are aligned to that mission. Our cross border, multisector know-how can then help you find solutions to any issues uncovered to ensure your business maintains its social licence to operate.

The Hogan Lovells Business integrity Group (BiG) can help you respond to changing demands and in turn deliver strong and sustainable ÿnancial performance.

Tools and resources

Across our business we have tools to support you, including:

Russia sanctions topic center and navigator tool
Keep on top of sanctions and other related issues here.

FIS Horizons 2022
A snapshot of key legal topics and market trends across the globe, shaping the future of the financial institutions industry

Our popular and updated Key ESG Trends for 2022

2021 M&A Year in Review
In addition to showcasing significant transactions on which we advised across industry sectors globally, our *Review* looks forward to M&A trends we anticipate for the remainder of 2022.

Access the report here.

References

What clients are saying about us

These are **top-tier attorneys**, their work is solid and reliable. They are on a shortlist of go-to firms when dealing with complex and high-risk problems.

Chambers USA, 2018 (Energy)

Leading Firm for Projects and Energy

The Legal 500 Asia-Pacific

Exceptional breadth and depth of **knowledge within the sector.** Commercial and pragmatic in all aspects of the transaction. Easy to work with, they take a collegiate approach and allow open discussion with a good mix of advice and challenge.

Legal500 UK, 2022 (Projects, Energy and Natural Resources)

Ranked **Tier 1**, Projects, energy and natural resources - Infrastructure (including PFI and PPP)

Legal 500

Ranked among the **top 10** most innovative law firms in Europe for the third year running.

Financial Times

Ranked **Tier 1** in Energy and Infrastructure

Legal500 UK

Strong team with a wide range of expertise available to address complex legal matters across a range contractual matters.

Legal500 UK, 2022

Extensive **industry knowledge** and valuable experience, also in non-ordinary matters.

Legal500 EMEA, 2022 (Energy)

We find them to be diligent, thorough and commercial in their advice. They offer **pragmatic solutions** to complex challenges and we value their no-nonsense and focused approach.

Chambers Global, 2019

Hogan Lovells International LLP is noted for providing **"responsive,** practical, commercial and imaginative advice."

Legal 500 UK, 2018

Abundant knowledge on power projects.

Chambers Asia Pacific, 2020

Ranked **No. 1 for Renewables** (globally – Infrastructure Legal Advisers)

IJGlobal Q1, 2022

Ranked No. 2 for **Power** (globally)

IJGlobal Q1, 2022

The team offers in-depth knowledge of the markets, **excellent strategic thinking** and truly international coverage . . .which is essential for clients around the globe.

Legal 500 UK, 2022

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