RENEWABLE ENERGY FINANCING

The zero-subsidy renewables opportunity

January 2019

In a period of transition for renewable energy, as government subsidies in Europe reduce, where and how are investors and developers deriving value from renewable energy investments?

Contents

Introduction

The landscape for investments in renewable energy projects is undergoing a period of significant change.

Many European governments are reducing the level of support and subsidies for renewable energy investments, moving away from fixed feed-in tariffs towards competitive auctions and even ‘zero-subsidies’ in certain cases.

This is an expected trajectory as technologies mature with the costs of deployment for offshore wind, onshore wind and solar PV following downward trends and significant progress towards national renewable energy targets being achieved.

As cost to the consumer and security of supply climb higher up the political agenda, this has added further pressure on governments to reduce the support available.

However many countries are setting even more ambitious renewables targets, well above 30% of generation capacity. This is due to the reducing LCOE of renewables, for example today onshore wind and solar PV are amongst the cheapest sources of energy, increased sensitivity from consumers and climate change risks.

It is therefore timely to consider what key developments are on the horizon which are enabling zero-subsidy renewable projects in the medium to long term.

The answers lie in assessing the historical and potential future trends in key value drivers which range across technical, commercial, financial, legal and regulatory fields.

In this paper we explore a selection of the key themes, which have historically enabled renewable investments to continue to be viable and attractive, despite the reducing trajectory of government subsidies in Europe.

Against the same themes, we then identify key developments on the horizon that may enable a substantial pipeline of zero-subsidy projects to be deployed in the future.

ZERO-SUBSIDY OVERVIEW

Zero-subsidies projects today

A number of subsidy-free renewables projects have emerged in Europe in recent times, in onshore wind, offshore wind and solar PV technologies. Perhaps most striking are the Dutch and German offshore wind auctions where Nuon, Ørsted and EnBW won projects at €0 strike prices. A small number of zero-subsidy projects have reached final investment decision in the onshore wind and solar sectors, generally made possible through Corporate Power Purchase Agreements (PPAs).

Subsidy-free projects remain the exception rather than the rule at present, enabled by specific favourable conditions, such as reuse of existing infrastructure or through guarantees of development rights or grid connection. However, if the emerging developments fully materialise, the market opportunity for zero-subsidy renewables projects has a much larger potential in the medium to long term.

Zero-subsidy definition applied in this paper

In this paper, we use the term zero-subsidy or subsidy-free to refer to projects without a direct subsidy-based premium on the current or expected average market price, such as a FiT or CfD premium, or to refer to projects that have no subsidy in place at all. This definition is selected because the value of the subsidy is therefore expected to be low, and only for a minority of the time. For simplicity of the definition we do not consider wider guarantees of origin, traded certificates or carbon pricing mechanisms.

We recognise that price floors may still provide some occasional subsidy payments; as even a price floor at zero may protect the project from negative electricity market prices where permitted by regulation. The zero-subsidy concept explored in this paper includes the scenario where the subsidy is expected to provide a ‘net zero’ or minimal price-premium in the longer term.

The term zero-subsidy as used here does not necessarily mean no government support or incentives.

There are many types of government support both for renewables and other forms of electricity generation, such as tax breaks and carbon pricing which are not specifically considered in this paper.

Non-price forms of support may still exist. For example the offshore wind projects mentioned above are described as zero-subsidy. However, these projects will not need to fund all of the offshore grid infrastructure and the auction win gives the developer certain development rights. For example, for offshore wind in the Netherlands, as well as Denmark and Germany, developers do not directly cover the whole cost of the wind farm transmission connection or hub.

By the definition applied here there are already a number of zero-subsidy projects that have reached financial close. Many of these projects have contracted commercially through PPAs to manage electricity price risks, instead of relying on government programmes. We recognise that it is a minority of projects with favourable conditions which are currently able to be zero-subsidy at present, but with continuing market trends, the number of viable opportunities is likely to grow in the longer term.

Focus of this report

This paper principally focuses on utility-scale onshore wind and solar projects as the most mature renewable energy assets. However, the issues raised in this paper are relevant across a wider range of technologies and selected examples have been drawn from the offshore wind industry. We have primarily commented on the situation in Europe but similarly have incorporated selected global examples where relevant.

What have the key factors been in zero-subsidy projects to date?

A small number of subsidy-free projects already exist across the UK, Spain, Portugal and Italy, with some having secured debt financing. Selected case studies are provided in Appendix 1.

From the review of these case studies, we observe that the enabling factors in zero-subsidy projects to date include:

- Competitive costs and favourable sites or favourable integration with offtakers;
- Experienced supply chain for construction and operations; and
- PPAs stabilising electricity prices, improving bankability and enabling use of debt finance to reduce cost of capital.

FIGURE 1

Capex, Opex, Permissions, Construction Programme, Expected Yield, etc. remain key equity investment parameters irrespective of most types of Government support scheme.

CHANGE IN GOVERNMENT SUPPORT SCHEMES FOR RENEWABLES OVER TIME

FEED IN TARIFFS OR FIXED MAGNITUDE SUBSIDIES

Firm electricity tariff defined by Government provides fixed electricity price over a specified term.

Some countries offer Capacity Payments, offering further protection against uncertainties in wind or solar resource.

CONTRACTS FOR DIFFERENCE FROM MARKET PRICES (THROUGH AUCTIONS)

In moving from a FiT scheme to a CfD scheme, investors may lose upsides of favourable market prices, but in return for price certainty.

Prices obtained may be lower than FiTs, depending on the level of competition in the market and the budget or capacity being auctioned.

'ZERO-SUBSIDIES'

In moving from CfDs to 'zero-subsidies', the investor retains greater exposure to market power prices and renewables price cannibalisation, potentially mitigated to some extent by Power Purchase Agreements. While this is new for renewables, many conventional power sector investments retained electricity price risk.

WHAT KEY DEVELOPMENTS ARE ON THE HORIZON WHICH MAY ENABLE ZERO-SUBSIDY RENEWABLE PROJECTS IN THE MEDIUM TO LONG TERM?

Key technical and commercial drivers enabling zero-subsidies

This section provides an overview of both historical and potential future trends in key drivers which could bring value as renewable energy investments gradually transition away from reliance on government support.

KEY CONSIDERATIONS

A number of key drivers have enabled zero-subsidy renewable energy projects to be possible and resulted in a number of the low auction bids made by developers to deliver current or future projects. We have also identified future drivers of change on the horizon which could facilitate the growth of the market opportunity for zero-subsidy projects.

In this paper we describe these factors under four main themes which bring together drivers with a similar effect. The themes considered here are:

1	Reducing LCOE: Capex, Opex, capacity factors, repowering
2	Reducing technical risk: supply chain and industry learning curve
3	Mitigating power price risk: PPAs, storage and revenue stacking
4	Financial investor perspectives

For each theme we describe in the following pages:

- **Historical trends** which have been favourable to renewable investments, counterbalancing the reduction in government subsidies; and
- **Future trends** with potential to open up the opportunity for a significant subsidy-free renewables market.


U.S. DEPARTMENT OF
ENERGY
NREL

1. Reducing levelised cost of electricity (LCOE)

The move from fixed subsidies to competitive auctions has been made possible by reducing LCOE of renewable technologies, as these trends continue an increasing number of projects will be competitive below market prices.

The Levelized Cost of Electricity (EUR/MWh) (LCOE) represents the life-cycle costs of a power generating asset over an assumed operational lifetime, taking into account the cost of financing.

We have seen a significant fall in the LCOE of renewable energy projects across Europe and worldwide onshore wind, offshore wind and solar PV. This is most notable in solar PV, due in large part to technology improvements and manufacturing processes revolutionising panel costs and also due to the increasing scale of deployment for each of these technologies.

Figure 2 shows global benchmark figures. However we are aware of recent projects with LCOE well below even the figures shown for 2017. IRENA's auction price database also shows prices for both onshore wind and solar for 2019/20 reaching towards 0.05 USD/kWh as a global average, in some regions lower prices of 0.03 USD/kWh have been achieved.

In addition, the chart shows a spread of project LCOE around the averages, which confirms that some projects attained lower LCOEs than the benchmark figures provided.

This matches what we observe in the market, where we have seen bid prices can be even lower than those shown in the chart, and that a small number of projects are already viable without subsidies.

LCOE can be considered in the following components: Development Expenditure (Devex); Capital Expenditure (Capex); Energy Production; O&M Expenditure (Opex); Decommissioning Costs; Financing and cash flow parameters and construction and operating period.

When looking at the different components of LCOE, two things need to be considered – firstly, what is the historical trend of each component and secondly, what is driving their current trend into the future?

Trends in Capex, Opex and Capacity factors are drawn out here for particular attention.

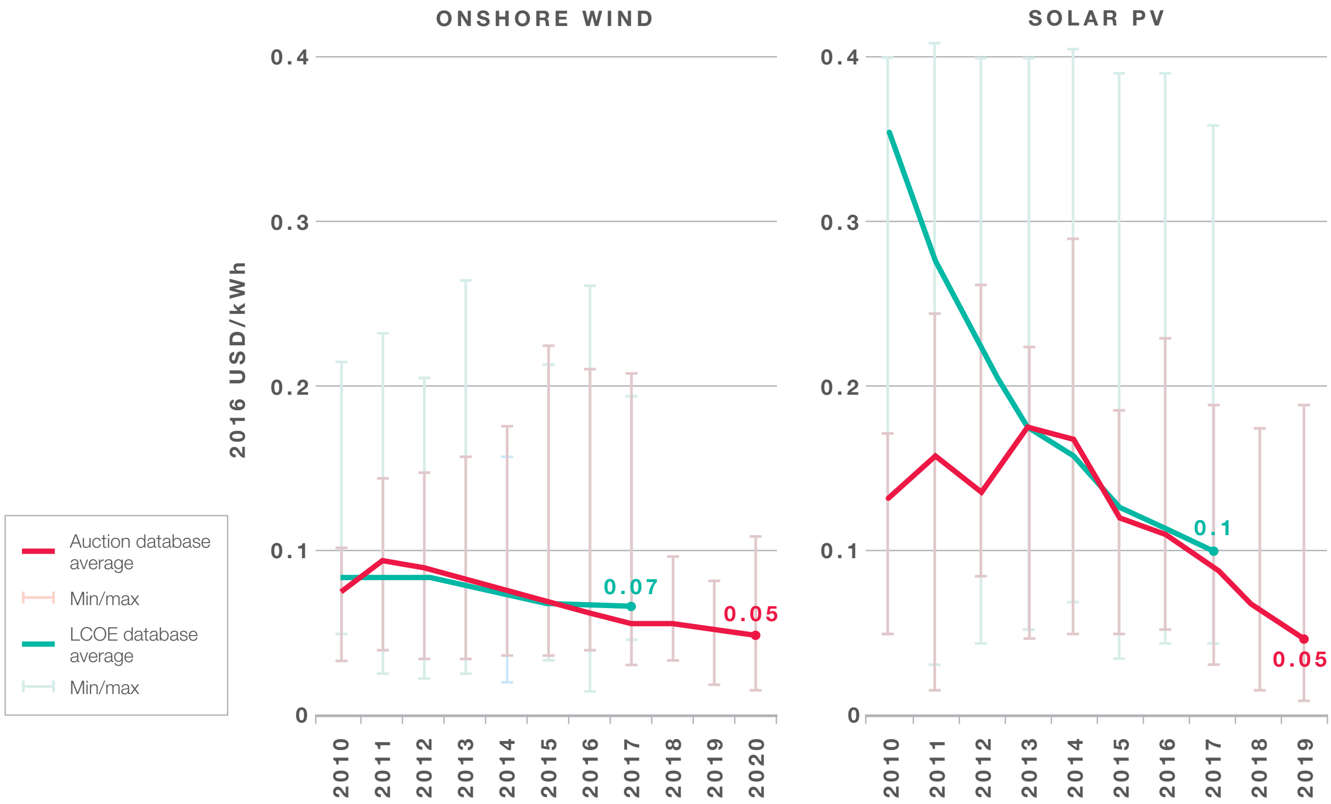
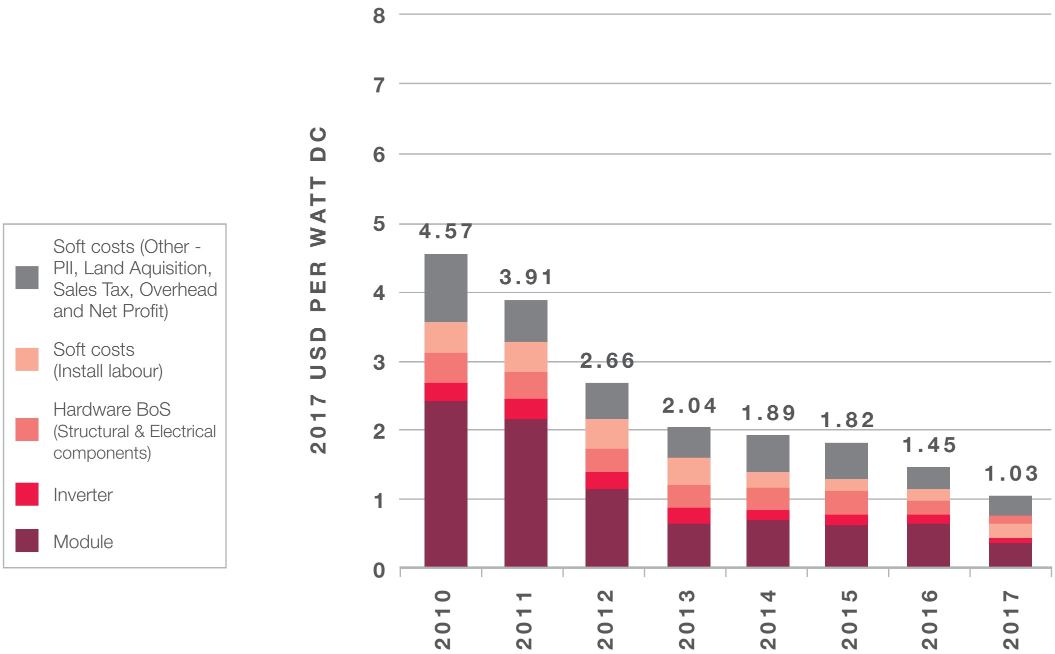


FIGURE 2
Global levelised cost of solar and wind projection 2020.

Source: IRENA renewable cost database and auctions database.



CAPEX

The historical trend in LCOE has been driven down by reducing capital costs of technologies, with solar panels a case in point. We anticipate continued research and development to drive incremental improvement.

Historical Trends

Solar PV in particular has seen a revolution in capital costs, with solar PV module prices decreasing approximately 80% from 2009 to 2017, along with reductions in tracking systems and balance of plant costs. For onshore and offshore wind, we have also seen a significant reducing cost trajectory.

There have been significant further cost reductions evidenced even in the last 18 months, with lower auction prices seen both in Europe and on other continents, particularly in Asia. Recent auction prices confirm that projects are being built with lower LCOE than even one year ago.

European examples include the three 2018 onshore wind auctions in Germany which have given average prices of €0.047 to €0.062 per kWh, although slightly increasing over the year. Similarly in Germany, LCOE of utility-scale PV is estimated in the range of €0.04 to €0.07 per kWh in 2018, showing that the declining cost trajectory is continuing. Outside of Europe, the lowest reported prices we have seen are PPAs for onshore wind and solar at $0.025 to $0.03 per kWh in countries such as India, Brazil and Mexico. As such we envisage that in the next few years European projects could attain these figures.

Future Trends

The reduction in Capex is expected to continue, particularly in solar PV and offshore wind, driven by ongoing optimisation and research and development initiatives. In addition, competitive auctions for capacity are creating cost pressures, which drive further industry innovation and optimisation.

Key drivers for Capex reduction include continued technology development and optimisation, particularly in the solar PV sector where continuing reduction in panel prices will reduce Capex.

Wind turbines continue to increase in size, with greater energy capture per unit of Capex spent. There is also growing activity in wind farm extension projects, which can benefit from existing utility connections and site infrastructure. Repowering also has potential to reduce Capex of repowered projects through re-use of existing infrastructure and increased turbine size.

Offshore wind technology development continues apace with floating foundations set to be the next game-changer, opening up sites in deeper waters, whilst mitigating the additional Capex burden this would impose if using traditional monopile or jacket foundation solutions.

FIGURE 3
System cost breakdown for solar PV, 2010 - 2017.
Source: NREL BOS Benchmark Costs (2017).

FIGURE 4
O&M costs for onshore wind in Sweden, 2008 – 2016.

Source: IRENA Renewable Power Generation Costs.

OPEX

Market competition for O&M services has grown with new parties entering the market in various geographies. Potential for synergies from managing portfolios continues to grow with greater project density.

Historical Trends

As the wind and solar PV markets mature we have seen an improvement in the O&M strategies of projects, with an increased amount of knowledge around these technologies present in the industry and lessons learnt from previous projects being applied. The industry is actively pursuing operational optimisation strategies on existing project portfolios. A number of independent operational benchmarking tools have entered the market allowing portfolio owners to test their project performance against similar projects. Data analytics are also increasingly used to identify and rectify faults and underperfomance efficiently.

Improved performance metrics for O&M providers have included moving from time-based availability incentives to energy-based incentives which better align interests and timing of maintenance with regards to resource forecasting to avoid periods of high production.

To take an example from the offshore wind sector, we increasingly see O&M optimisation through use of residential service operating vessels (SOV) solutions. These vessels remain offshore for weeks at a time and service turbines more efficiently by reducing time and costs of daily transit for technicians. For onshore projects, drones are increasingly used to optimise blade and panel inspections.

Investors are increasingly considering life extension of renewable assets, which can also affect Opex forecasts over the period if refurbishment activities are required.

Future Trends

There is growing competition in the third party O&M service provider market, particularly for onshore technologies and we see well developed markets for third party O&M services in certain countries, such as Spain, which has driven down Opex. We have seen instances in some countries where solar PV projects for example have obtained significant O&M cost reductions of 5 to 35% when negotiating older O&M contracts at the end of their term, reflecting current market rates and some centralisation of services in regions where O&M services have become most highly competitive.

The O&M strategy is going to be key going forward, as an aging asset base of renewables start to require increased maintenance there will be a drive to limit or transfer performance risk.

With the wind and solar markets moving towards zero-subsidies or reaching the end of their price guarantees, new types of O&M contract could emerge where service providers take on performance, resource and market risk in exchange for a revenue based service guarantee.

We expect that O&M strategies will continue to improve in efficiency through the implementation of operational process and the expanding use of modern technology such as drones, allowing for cheap aerial thermography – permitting thermal problems in PV plants or blade damage on turbines to be detected rapidly – or computerized management systems identifying faults at string or panel level for leaner operations at portfolio scale.

Larger service portfolios can also drive cost efficiencies by combining control centres or spares holdings, as well as technicians and skills. This could be in the form of either larger investor portfolios or third party O&M provider portfolios.

Increasing volumes of data are being collected, such as detailed 10 minute SCADA data for 10 years plus of operation. This offers the opportunity for optimization and improved efficiencies across large renewable energy portfolios. Condition-based monitoring also provides opportunities to intervene in a preventative manner, prior to failure, thus minimising downtime and component replacement costs. For example adding vibration monitoring can enable some drive train or rotational imbalances to be remediated before significant damage occurs. The development of digital twins for turbines will allow underperformance conditions to be identified and rectified.

Improved weather forecasting will also allow planned and preventative maintenance to be more targeted at periods of low resource allowing focus to shift from time-based to energy-based, and where market pressures exist even revenue-based, availability. The quality of the O&M strategy will become increasingly important in order to maintain high availability.

CAPACITY FACTORS

Capacity factors are a key driver in reducing LCOE, as higher capacity factors mean that more energy is produced per MW of plant installed.

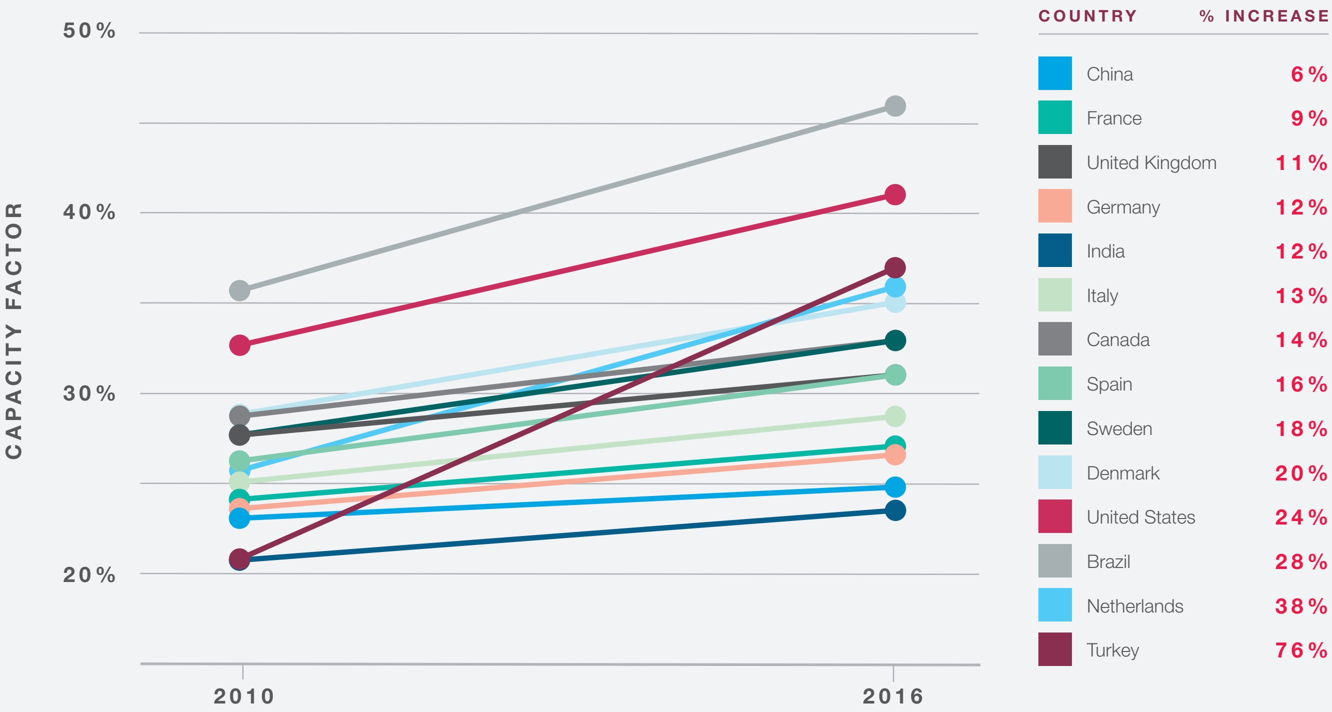
Historical Trends

Energy production for wind and solar PV farms depends on the capacity factor of the project, which is defined by the resource characteristics, technologies applied, site, layout and other project-specific factors.

Technological improvements in wind and solar generation, have allowed capacity factors to increase dramatically.

Wind projects have benefitted through increases in rotor size and hub height and offshore wind has also benefitted from increasing distances offshore, which bring more stable winds. Larger solar PV farms with more efficient designs, have increased the amount of energy that can be captured from a given site. Solar cell technologies have developed through several generations of design and are continually developed and refined.

FIGURE 5
Increase in Country-specific weighted average capacity factors for new onshore wind projects between 2010 and 2016.
Source: IRENA, 2017.



Future Trends

Capacity factors are a key driver in reducing LCOE, as higher capacity factors mean that more energy is produced per MW of plant installed.

With increased experience, lessons learnt are shared across the industry and help to reduce levels of downtime, which contribute to improved production and thus capacity factors.

For both solar and wind, improved weather forecasting allows maintenance to be increasingly targeted to periods of low production, thus increasing the energy-based availability and project capacity factor. Energy-based availability is increasingly used in performance metrics for maintenance providers in order to optimise maintenance schedules and minimise outages during periods of high production. Advances in operational wind measurement such as nacelle-mounted LiDAR allow for yaw and other parameters to be optimised to maximise yield.

Improved modelling methodologies in the area of pre-construction resource assessment, such as 3D scanning LiDAR, will allow improved layout optimisation to maximise capacity factors and provide greater certainty around P50 yields. This will be vital to investors in a zero-subsidy world requiring greater comfort around total production but also the ability to meet PPA requirements or other market incentive targets. For example some Corporate PPAs will require a guarantee of the proportion of time power will be available as well as the total production.

Improved certainty will ensure that projects will not proceed in locations without viable wind or solar resource where poorly performing projects have previously survived thanks to generous subsidies.

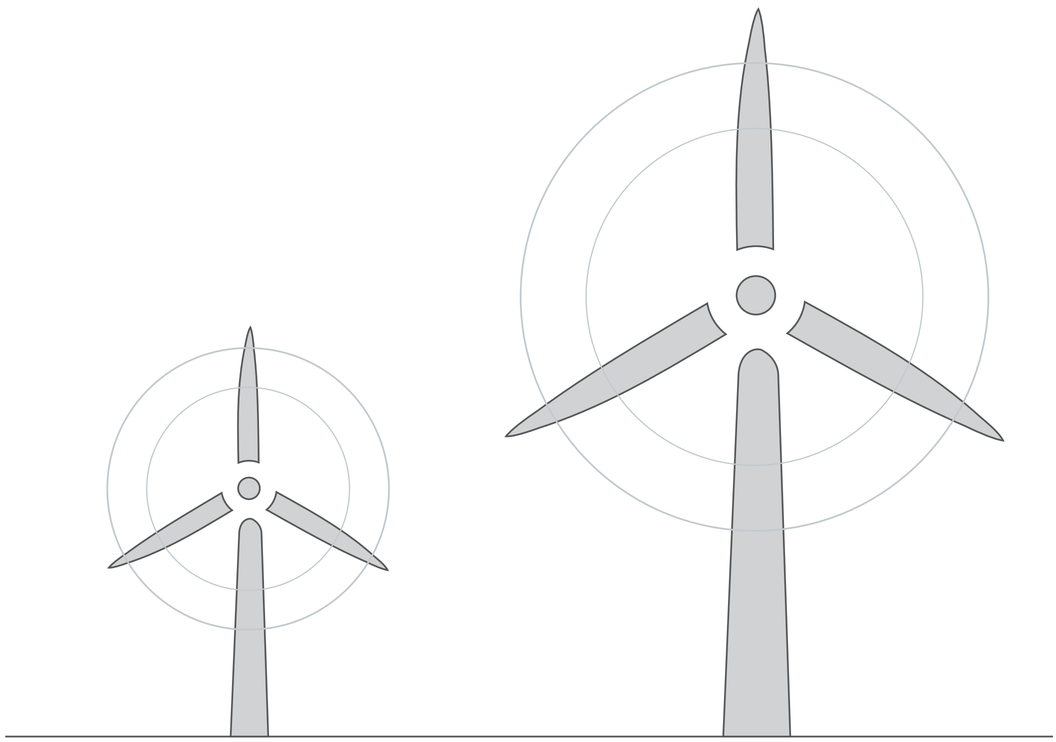


FIGURE 6
Average turbine rotor diameter increase from 2000 to 2018.

Other enhancements are increasingly being integrated into the original design, such as high wind ride through options for wind turbines or aerodynamic improvements to turbine blades. Similarly, analytics will continue to develop to optimise performance across both wind and solar technologies, including turbine management to maximise wind farm output with regards to wakes and improved tracking options for solar panels.

Repowering existing wind farms with modern turbines could also improve capacity factors on existing sites, as further explored below. Further, the co-location of storage at such sites, particularly those that have localised grid constraints, can also increase availability and shift production to more profitable times.

Continuing technology innovations will enable even higher capacity factors to be achieved. In onshore wind, technology improvements are allowing longer turbine blades, opening up projects in lower wind speed areas to achieve commercially viable capacity factors. In offshore wind, capacity factors have already reached almost 50%; new technology such as floating foundations allow turbines to move further offshore to deeper waters and higher wind speed regions, which could allow offshore wind capacity factors to rise even higher. Solar yield improvements are largely driven by advances in material science reducing defects and improving efficiency.

50%

In offshore wind capacity factors have already reached almost 50%.

LIFE EXTENSION AND REPOWERING

Repowering brownfield assets with newer technologies and optimised design can improve yield while reusing site infrastructure with a longer asset life, such as electrical assets or grid connection.

Historical Trends

Wind farms reaching their final stage of the design life are currently limited in their number but increasing. In 2017, wind farms more than 15 years old comprised approximately 15% of total onshore wind installed capacity, and this share will continue increase over time.

More and more wind farm investments will therefore be considering end-of-design-life options. Three options are analysed:

1 Lifetime extension

2 Repowering

3 Decommissioning.

Life extension is a key topic as investors are increasingly commonly considering up to 30 year operating scenarios. For solar assets, depending on the level of degradation, the assets may continue to operate beyond design life with little investment, or a refurbishment campaign to replace faulty panels may be undertaken. For onshore wind, some refurbishment of blades or gearboxes may be undertaken in order to extend operating life. Leases, planning and environmental permits for the sites would need to be extended but the costs and risks associated with this can be less than associated with developing a new site.

Repowering encompasses the updating of wind turbines by either replacing older wind turbines and foundations entirely or upgrading assemblies and components with higher capacity and more efficient technologies to increase production. Leases, planning and environmental permits would need to be revised and extended. In particular, physical turbine sizes have increased significantly over the lifetime of most wind farms at this stage of operation causing significant planning and foundation design considerations. Similar savings can be made by extending existing sites using existing infrastructure.

There are some examples of repowering already taking place in the UK, Germany, US and other geographies, although we expect that the historical volumes are much smaller than the future opportunities in light of the age profile of existing wind farms.

Decommissioning is usually required where there are no further plans to operate the wind farm after it has reached the end of its design life. In a maturing market there may be greater opportunities to recycle useful parts in this case.

REPOWERING CASE STUDIES

DELABOLE

The capacity of Delabole wind farm, Cornwall, commissioned in 1991 increased from 4 MW to 9.2 MW between 2009 and 2011 while the number of turbines was decreased from 10 x 400 kW to 4 x 2.3 MW accounting for an uplift of 133%. Hub height increased from 49m to 99m.

CARLAND CROSS

The capacity of Carland Cross wind farm, Cornwall, increased from 6 MW to 20 MW while the number of turbines was reduced from 15 x 400 kW to 10 x 2 MW in 2013 accounting for an uplift of 233%. Hub height increased from 49m to 100m.

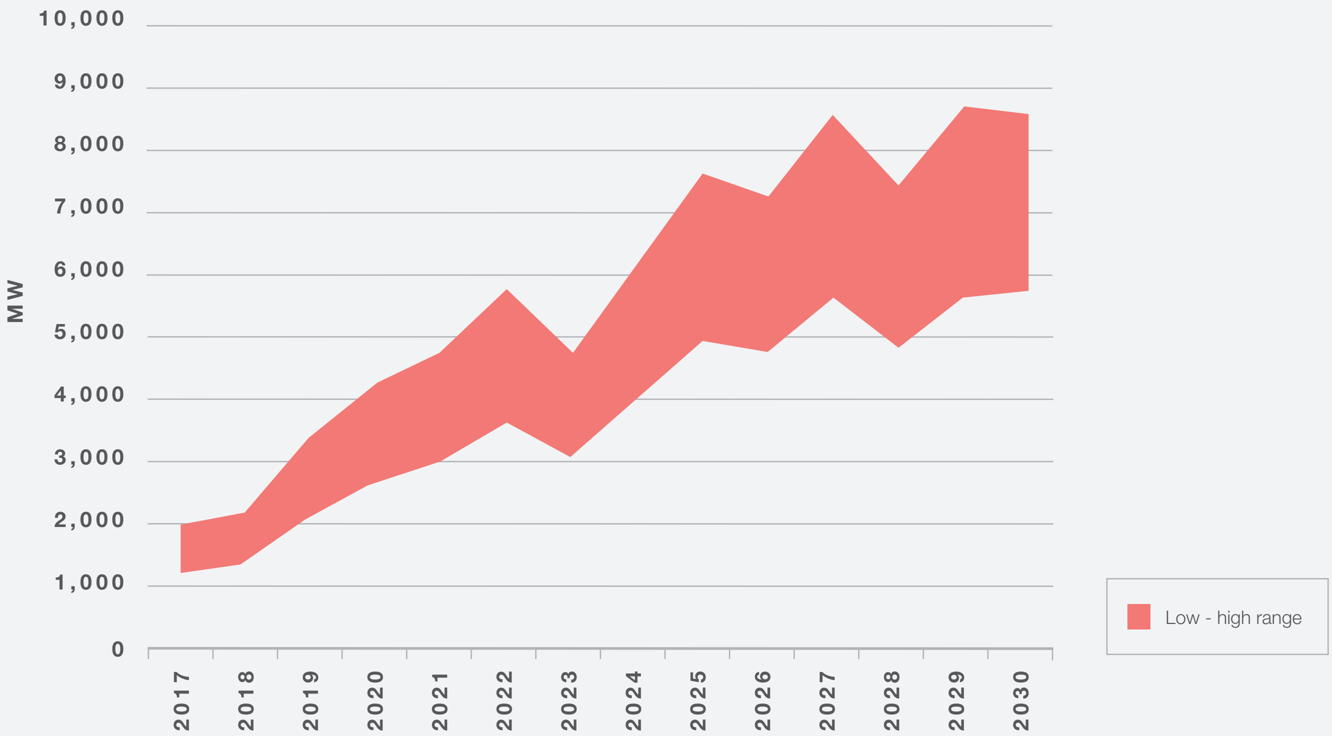
Future Trends

Repowering brownfield wind assets with newer technologies and optimised design can improve yield while reusing site infrastructure with a longer asset life, such as electrical assets or grid connection. Therefore repowering can obtain a reduced LCOE compared to greenfield wind projects.

In addition, the 15+ years of operational data provide a stronger certainty for yield studies, whether life extension or repowering, providing greater investment confidence. Nevertheless, there are a number of project issues to consider when repowering, including existing land agreements and consents, grid connection, visual and radar issues, which can have a significant impact on the viability of a zero-subsidy repowering project.

WindEurope estimates a yearly repowering volume of 1-2 GW in 2017 that reaches 5.5 to 8.5 GW by 2027.

FIGURE 7
Repowering volume estimates for Europe.
Source: WindEurope.



2. Reducing technical risk: Supply chain and industry learning curve

As the supply chain continues to mature and experience of all parties grows, lessons learned are integrated into standard industry practice and risks are better understood and mitigated.

Historical Trends

A number of factors have contributed to improvements in technical risk as the renewables market has matured.

The supply chain has been a key part of this as equipment manufacturers, construction contractors and O&M providers have all benefited from growing experience through the wide deployment of renewable generation technologies across Europe and beyond. Examples of improvements include optimisation of performance and lessons learned in design and manufacturing; greater understanding of foundations, loads and soils; as well as greater understanding of weather impacts such as icing on turbines or dust on solar panels. These lessons learned contribute to reducing technical risk as more is known in advance about expected performance and investigations into some key risks or mitigating actions can be carried out earlier in the process before capital is fully committed.

The maturity and experience of the supply chain is also an important determinant of how efficient and predictable total installation costs are. In some zero-subsidy projects, we see vertical integration of the construction party and the owner party, due to the confidence in in-house delivery experience.

Permitting process are better understood today meaning that the related risks are better accounted for and the development process planned accordingly.

There are a good number of portfolio-scale developers in the market today who have built up experience and are more familiar with and efficient at navigating the required permitting processes.

Yield assessment techniques have been refined over the years, with many opportunities for yield modelling validation against actual performance. Improved methodologies in yield assessment result in greater certainty on capacity factors and reduce uncertainties.

The increased scale of deployment of turbine models from first tier manufacturers also provides benefits such as an increased level of sharing of spare parts between wind farms, reducing deployment costs and downtime risks due to part lead times. The larger fleets of turbine models in operation also offer improved risk management and performance optimisation opportunities through portfolio data analytics and knowledge sharing.

As demonstrated by the examples above, many of the risks in renewable generation investments in European countries are better understood today, with opportunities for minimisation and mitigation as the market has matured. This has contributed to enable the cost of capital to reduce accordingly and renewables investments in Europe have grown over the period.

Future Trends

As renewables deployment continues to grow globally, experience and risk management in international markets will continue to mature, thus improving risk profiles in international greenfield investments. In particular, we see implementation of onshore wind and large scale solar, established technologies in Europe, across Asia-Pacific and South America already achieving competitive auction prices in line with, or even lower than, those in more established regions with prices in Brazil, Mexico and India reaching as low as $0.03 per kWh.

Globalisation of supply chains may also increase efficiency in transportation due to scale of procurement, as companies compete to accommodate this increasing demand. This is already seen to a greater extent in solar panels, but could further develop in wind technologies.

The offshore wind industry is less mature than onshore. We expect that offshore wind will continue to mature and become more attractive, with a larger international activity stimulating progress through lessons learned and technology developments. For example, wider implementation of the new larger turbines and maturing of floating foundation technologies will contribute to de-risking their application as well as making a wider area of sea accessible for offshore wind farm developments.

Developers of the offshore wind projects who have bid at zero-subsidy anticipate some benefits of technology development and cost efficiency in the years before the projects are due to be constructed.

For onshore wind, the industry is further along the maturity curve, but continued improvements in the industry are expected to improve returns for investors, either through improved efficiencies thanks to larger and better blades or in application of new technologies such as drones and improved resource forecasting to improve operations.

Solar power has seen the most dramatic reduction in LCOE over the last few years driven largely by the potential for efficient mass production of components. Technological improvements are expected to continue in this sector with potential Capex savings on module and panel manufacture, improved efficiency of new panel designs and improved Opex through better monitoring and increased inverter lifetimes.

3. Mitigating Power Price Risk

With increasing renewables penetration in electricity markets, there is a risk of increased price volatility and cannibalisation. PPAs and electricity storage offer opportunities to mitigate against low price capture.

LACK OF LONG-TERM INVESTIBLE PRICE SIGNAL

There have been a few examples of subsidy-free/merchant deployment of renewables in the UK. These have tended to be where projects are benefiting from use of existing infrastructure of adjacent subsidised renewable projects, with Clayhill Solar Farm (10 MW) and Withernwick II onshore wind extension project (8.2 MW) being high-profile examples.

Investors to date have been less comfortable assuming merchant wholesale market price exposure compared to the relative security of long-term (15-20 year) subsidised price levels which were historically offered by Government subsidy schemes. Where there is limited certainty of revenues over the project payback period, far fewer projects proceed. However there are mechanisms such as PPAs which can provide alternative business models, discussed further overleaf.

CANNIBALISATION EFFECT

The effect of significant volumes of low-cost renewable energy being brought to the wholesale electricity market at the same time can lead to periods of low, even negative, wholesale electricity prices – this is termed the power price ‘cannibalisation effect’. This effect is seen where there are substantial amounts of weather-driven renewable power generation. This results in lower capture prices for renewable generation and increasing discounts to the wholesale electricity price. This can be seen in Figure 8 which shows wind installations in particular achieving significantly less than the market price.

The European Commission, in an effort to reduce the extent of the distortive effect that weather-driven renewables in receipt of subsidies have on wholesale electricity market prices has imposed European Commission State Aid Requirement that generators do not have an incentive to generate electricity under negative prices. If the day-ahead power auction hourly price is below zero, support will be capped at the strike price. Moreover, if prices remain negative throughout a six-hour period or longer then the subsidy will be set to zero for the entirety of that period. This is know as the ‘6+ hours negative price event’ rule.

To mitigate against these challenges, PPAs, can provide fixed or floor electricity prices, and/or energy storage can be installed, which can offset time of sale of the electricity generated. These are both considered in the following sections.

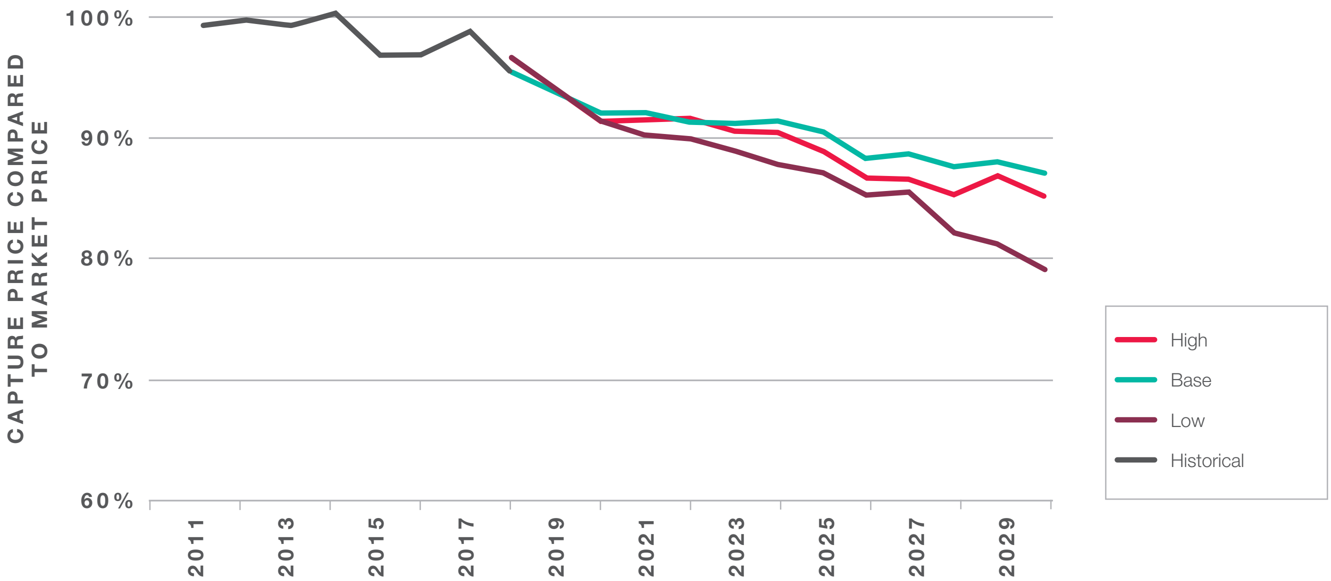


FIGURE 8
Annual GB wind power capture spread.

© Arup

FUTURE TRENDS

Some of this excessive price variability is likely to reduce with:

- Technological advances in smart metering and appliances and energy storage levelling demand processes;
- The move to half-hourly settlement and increasing use of time of use tariffs to incentivise consumers to utilise excess electricity; and
- Improved interconnectors across Europe allowing excess power in windy/sunny regions to be exported further afield.

Moves to electrify the transport and heat sectors, in particular the roll-out of electric vehicles, are likely to result in higher electricity demand to maintain prices.

CORPORATE POWER PURCHASE AGREEMENTS

Some countries are already seeing renewable projects reach financial close without price support from governments. An increasing number of such projects are using Corporate PPAs to provide price certainty.

Power Purchase Agreements

To date PPAs provide a route to market for the electricity produced by renewables projects, allowing the exchange of physical electricity for cash flows aligning to the terms of the relevant government-backed subsidy. With the withdrawal of these incentives, there is a need for other mechanisms to address the lack of a long-term investible price signal.

The evolution of Corporate PPAs has been seen by some as the principal means of allowing developers to de-risk projects by:

- Providing a degree of longer term certainty in project revenues for investors and lenders;
- Seeking to substitute to some extent the support that government subsidies traditionally provided;
- Mitigating against increasingly volatile power prices; and
- Offering an alternative route to market from the traditional offtaker.

Corporate appetite to enter into Corporate PPAs is driven by a variety of factors, including:

- Greater power price certainty;
- The desire for green credentials, for example the RE100 initiative where 156 global companies have committed to source 100% of their global electricity consumption from renewable sources; and
- Increased energy security.

Nevertheless, these drivers differ between Corporates and there is no single "type" of Corporate PPA offtaker. Entities who have signed Corporate PPAs include Google, Facebook, Norsk Hydro, Ikea, Unilever, McDonalds, and Mars, with the predominant technology being onshore wind.

Further, electricity procurement is not the core business of these entities. The corporate offtakers must be comfortable signing off on longer-term energy deals in the place of the short to medium term contracts that they are accustomed to, which requires additional understanding of energy markets and future power prices amongst other things. As a result, the execution of a Corporate PPA can be a lengthy, complex and time-consuming process and the lack of standardisation in the market presents a barrier for zero-subsidy projects where efficiency is key.

156

In the RE100 initiative, 156 global companies have committed to source 100% of their global electricity consumption from renewable sources.

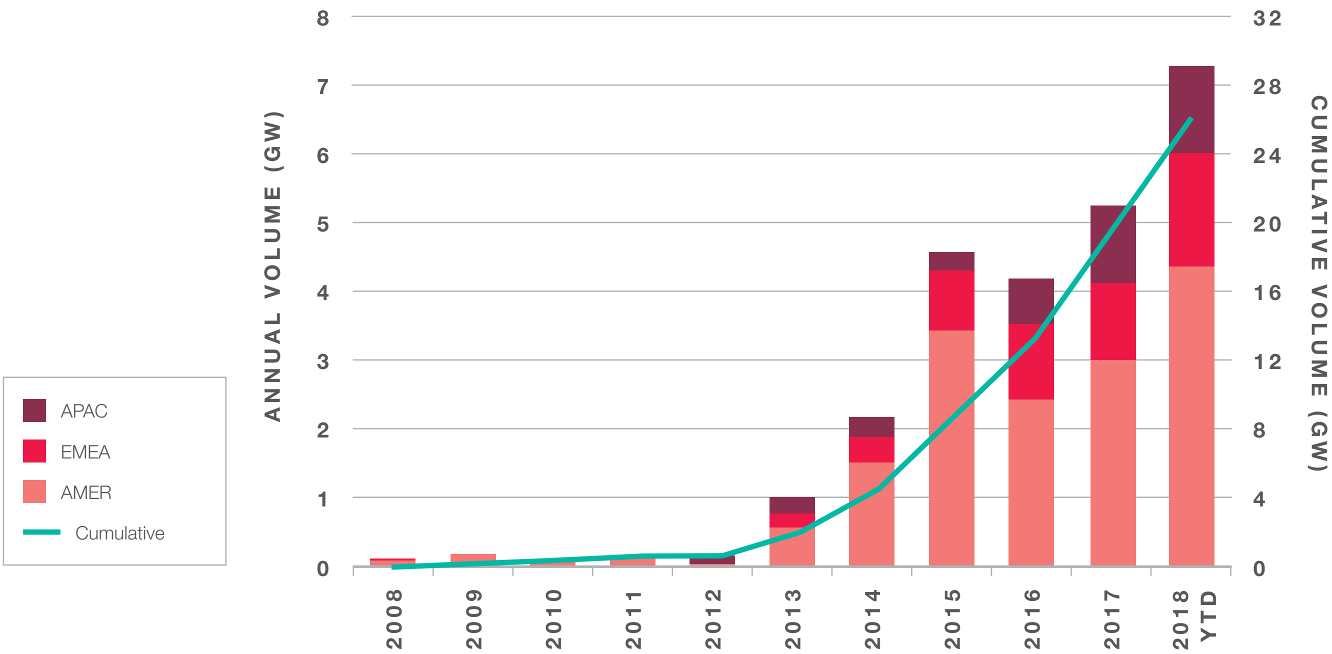


FIGURE 9
Global Corporate PPA volumes by region

Source: Bloomberg NEF.

Note: Data is through July 2018. Onsite PPAs not included. APAC number is an estimate. Pre-market reform Mexico PPAs are not included. These figures are subject to change and may be updated as more information is available.

Historical Trends

Corporate PPAs are not new, however, there has been a significant growth in the volumes of Corporate PPAs being procured over the past five years.

In Europe, activity to date has focused on jurisdictions such as the UK, Nordics and the Netherlands, however, other markets are now developing. European Corporate PPA volumes amount to approximately 1 GW of capacity in 2016 and 2017. The 650 MW Markbydgen PPA has contributed significantly to the 2017 volume.

However, there are still only a handful of renewables projects that have managed to be completely financed with Corporate PPAs alone without government subsidies and many of the Corporate PPAs captured in the chart above exist alongside subsidies.

The lack of standardisation in the Corporate PPA market has been a barrier to wider deployment, as each Corporate PPA has different requirements depending on the geography, technology and capacity of the project, market conditions, counterparties, financiers etc. Nevertheless, there has been a trend of cross-fertilisation of practice across jurisdictions, which has seen:

- The main sleeved or virtual structures emerge, depending on the local regulatory requirements; and
- A move away for more simplistic long term fixed pricing, particularly in light of falling power prices in recent years.

Future Trends

The Corporate PPA market is very dynamic and we expect to see further innovation in Corporate PPA structures, including:

- Increased use of a stacked PPA approach, whereby the Corporate PPA accounts for a percentage of the volume, with other top-up arrangements being put in place in addition;
- More sophisticated approaches to volume, balancing and shape risk by both generators and Corporates and the role that utilities can play in taking on balancing responsibility in such structures; and
- Aggregated / multi-party PPA models, such as the structure proposed for Vattenfall's South Kyle onshore wind farm, which is offering index-linked fixed prices for periods of between 10 and 20 years in multiples of 1 MW.

There is currently a significant imbalance between the number of prospective zero-subsidy renewables projects and the number of potential Corporate counterparties and this is expected to continue for the foreseeable future, in part for the following reasons:

- Some Corporates, such as Apple, have already achieved their goal of sourcing 100% of their electricity from renewables;
- There are also questions over whether the procurement of green electricity is always achieving the desired additionality of unlocking investment in new projects, or whether such procurement simply relates to existing renewables projects (which are likely to benefit from subsidies); and
- Conversely, only a small overall proportion of Corporates have a renewable energy procurement target.

100%

Some Corporates, such as Apple, have already achieved their goal of sourcing 100% of their electricity renewables.

We expect to see an increase in appetite from Corporates in jurisdictions where power prices are predicted to increase over the coming years.

This can result in an unbalanced negotiating position between developers and Corporates. Nevertheless, we expect to see an increase in appetite from Corporates in jurisdictions where power prices are predicted to increase over the coming years.

Corporates are likely to seek a more holistic approach to their procurement, for example via tender exercises, in order to ensure to the extent possible uniformity of approach and transaction efficiency across their portfolio of PPAs.

It is clear that Corporates will continue to gain in sophistication and their requirements, such as in respect of the construction and O&M documentation and security provided in the context of debt financing.

These issues are driving the market to consider the next tier of medium – smaller sized Corporates, which:

- Individually have a smaller demand requirement; and
- May be less creditworthy than the traditional "blue chip" counterparties.

The long-term creditworthiness of the Corporate counterparty (and wider viability of the Corporate group's industry) will continue to be an area of focus for developers and lenders. We expect further innovation in this area, particularly in light of the diversification of corporate offtakers, for example, the use of export credit agencies to provide assurance has already been trialled.

Where Corporate PPAs are not required or available, traditional utilities have a role to play. In some countries such as Spain, offtakers such as Statkraft, are enabling subsidy-free projects to reach financial close without any guaranteed price support by providing 15 year PPAs on terms that enable the project to be developed.

Floor prices structures on offer from utilities also have a place in unlocking investment in zero-subsidy projects and this is an area in which we expect further development. Other approaches may include moves towards vertical integration from the more sophisticated developers seeking to avoid profit leakage.

REVENUE STACKING

Subsidy schemes often prevent renewable technologies from competing in other markets. As subsidies are removed opportunities emerge to explore secondary revenue streams.

Renewable energy projects can mitigate against exposure to fluctuating electricity power prices and merchant risk to some degree by offering multiple services and combining several revenue streams, for example, by providing system services and/or participating in balancing services, in addition to the sale of electricity.

By having more than one revenue stream, zero-subsidy renewable energy projects can diversify their level of risk when compared with the sale of electricity to an offtaker alone.

Revenue stacking can boost revenues and profitability, however, such an approach adds complexity and introduces potential downside risks, for example, non-delivery penalties. As a result, such arrangements may be less attractive to investors who are not familiar with the different revenue streams and should be carefully considered depending on the technology, location, available revenue streams and contractual arrangements in place.

Potential revenue stacking could include:

- Participation in a capacity market;
- Energy arbitrage with associated storage facilities;
- Participation in trading and system balancing; and
- Provision of system services, such as frequency response, reactive power etc.

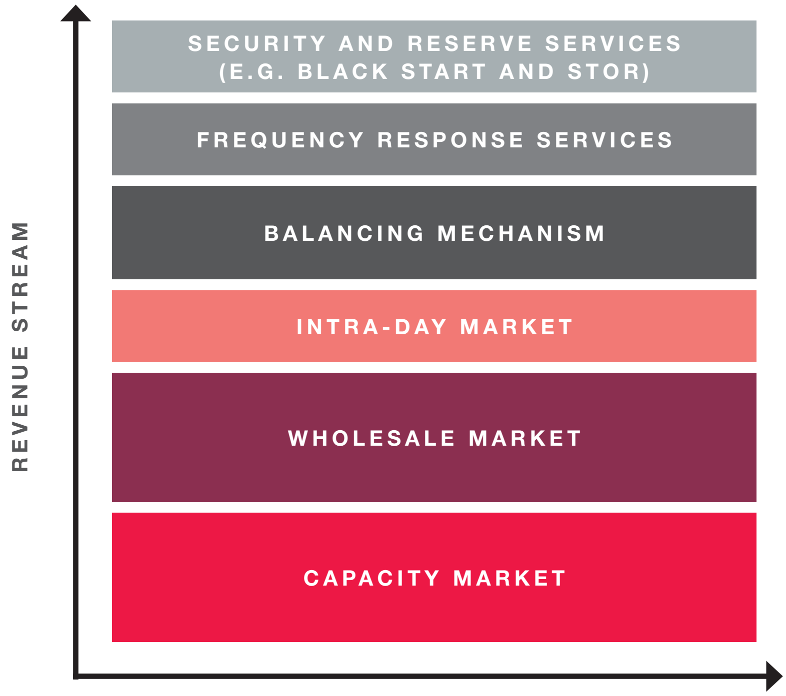


FIGURE 10
Illustrative revenue stack for flexible generator.

The approach can allow for some contracted revenue streams of different contract lengths, which can underpin any debt financing, while allowing participation in other revenues to provide upside to equity investors.

In order to successfully stack revenue streams, the relevant project must meet the technical requirements (de-minimis capacity threshold, ramp rate, response rate etc.) for the relevant services, which differ between countries. The commercial implications of contracting to deliver multiple services at the same time must also be carefully considered. For example, specific balancing services may prohibit contracting for multiple revenue streams in their terms and conditions.

Historical Trends

To date, there has been little take-up of revenue stacking by renewable projects, other than:

- Participation in curtailment / balancing services, which can be particularly lucrative depending on the jurisdiction; and
- Where projects are obliged to provide certain system services to the system operator.

One barrier to the uptake has been the approach of offtakers, who have tended to restrict the ability of generators to participate in balancing and system services under their PPA terms.

In addition, only a handful of projects have co-located energy storage to date, which is a key enabler of revenue stacking for wind and solar, given the intermittent nature of the technologies.

Future Trends

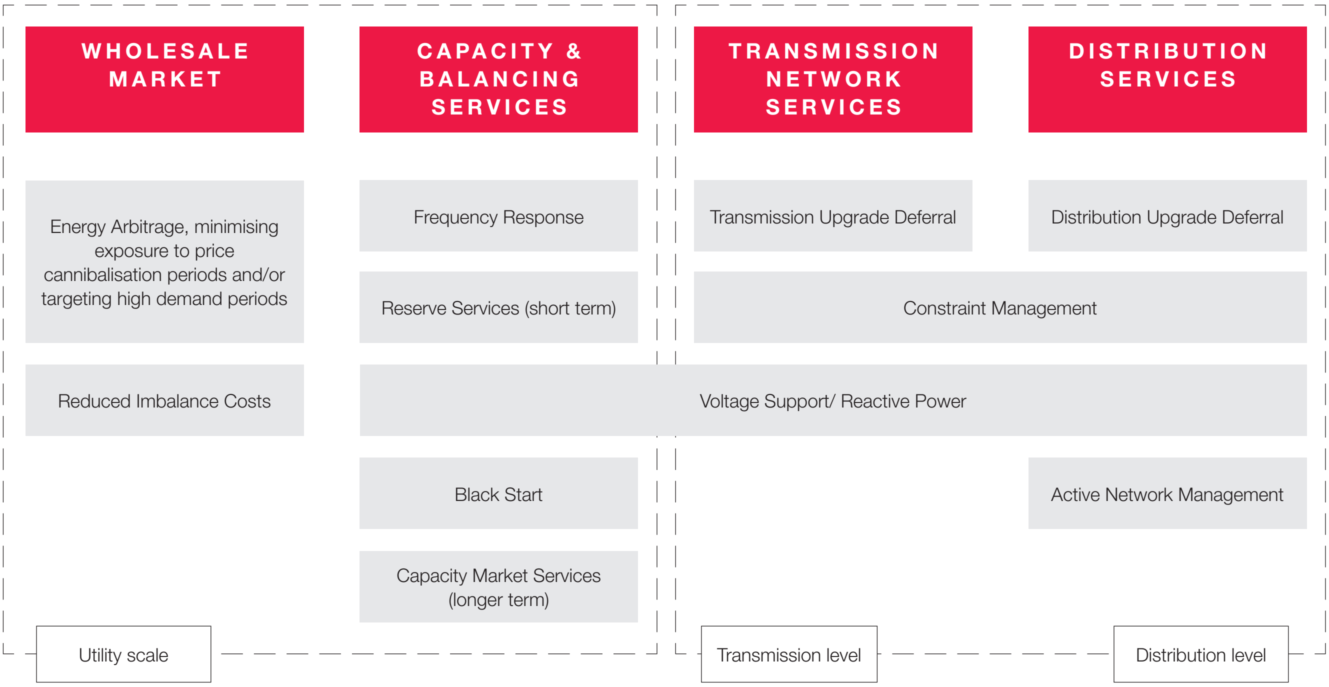
The level of uptake of revenue stacking for zero-subsidy projects will depend on the regulations of the relevant jurisdiction, which may limit the revenue streams that renewable projects are able to participate in. A key enabling factor in facilitating further revenue streams will be the removal of regulatory barriers in order to allow renewable projects to participate in the different energy markets. For example, the UK government is considering allowing wind and solar to participate in its Capacity Market, although the de-rating factors that are proposed to apply to these technologies are very low.

Nevertheless, such additional revenue streams are subject to regular regulatory reforms, reducing prices due to increasing competition and, unlike many subsidy regimes, do not often benefit from grandfathering, which can add further uncertainty. In addition, we expect system operators to continue to move to shorter lead times in the procurement of system services.

There are likely to be further revenue opportunities for zero-subsidy projects, for example, pan-European mechanisms such as Project TERRE, for developers and investors to consider in the near future. As a result, we expect projects to seek to retain a degree of flexibility in their revenue strategy in order to be able to amend the revenue stacks as more lucrative revenue streams become available.

We anticipate that utility offtakers will increasingly allow developers to participate in other system services (in return for a share of upside). However, Corporate offtakers may be more reluctant in this regard, given the potential that such services conflict with the Corporate's drivers for energy security and green credentials and the further complexity revenue stacking introduces.

It is expected that more complex operations and maintenance arrangements will be required given the more sophisticated operational requirements for such projects pursuing revenue stacking. There may be an increasing role for aggregators who are able to offer access to revenue stream procurement expertise and support in delivery of the services procured.



ENERGY STORAGE

The majority of investment in the energy storage sector to date has focused on stand-alone energy storage, where projects stack revenues from a number of different 'markets' such as capacity, wholesale electricity, balancing services, frequency response and local network services with typically single digit returns.

Nevertheless, co-location of energy storage with zero-subsidy renewables projects provides risk diversification and a range of potential benefits, such as:

- Maximising generation output and managing intermittency and balancing costs;
- Enabling projects to avoid grid constraints issues;
- Revenue stacking opportunities (as detailed in Figure 11); and
- Access to price arbitrage and limiting exposure to negative power prices, for example, as well as the opportunity to seek to benefit from possible cheaper grid connection arrangements and other cost associated with sharing infrastructure.

However, there are a number of issues for zero-subsidy projects to consider when co-locating storage, for example, the import and export agreements (if any) between the renewables and storage projects, the impact on the construction and operation agreements and the grid connection arrangements (for example, the extent to which the storage device will import electricity from the system). The relevant issues are shaped by who owns and operates the storage device and whether this is the same entity as owns and operates the renewable project.

Further, there are a range of options in terms of technical configuration, such as metering, and whether the storage device is considered to be part of the generation station, is separately metered or is "network side" within the connection point. The configuration of the generating station and the storage device directly influences the relevant issues to consider.

FIGURE 11
The range of services offered from electricity storage coupled with utility-scale renewable generation.

Historical Trends

Whilst it remains more the exception rather than the rule, co-location
is gaining more traction with recent examples including:

- ACCIONA Energía's 3 MW wind turbine in Spain, which is co-located with storage consisting of two batteries - one fast-response battery capable of maintaining 1 MW of power for 20 minutes and other slower-response battery capable of maintaining 0.7 MW for 1 hour; and
- Anesco's Clayhill solar farm / battery energy storage project, with 10 MW solar PV with 6 MW / 6 MWh of energy storage.

Some of the services that co-locate storage technologies such as batteries with renewable energy sites could provide are highlighted in figure 11.

Future Trends

Further growth in the co-location of storage as part of the design of new-build zero-subsidy renewable projects is expected for the reasons set out above.

This will be further enabled by future cost-reductions in lithium-ion batteries, but will also be driven by the extent of market volatility and whether the additional revenue streams and risk diversification can justify the additional interfaces and complexity.

We anticipate the proportion of storage capacity when compared to renewables capacity will increase in the future.

The scale of the storage will be significant in defining which and the extent of the services can be offered by the co-located zero-subsidy project. Much of the storage deployed to date has been de-minimis when compared with the total capacity of the renewable projects.

As other energy storage technologies develop and mature to deliver at lower cost, this may support growth in this area. Two in particular are:

- Vanadium redox batteries, which are better suited to longer term storage than lithium-ion technology, and are able to provide green solutions for islanded networks; and
- The production of hydrogen by the renewables project. There are various opportunities in hydrogen in terms of injection into the gas network, transport fuelling, additional electricity generation and wider chemical applications.

4. Financial Investor Perspectives

In the transition of renewable energy towards zero-subsidy, the bankability of commercial and technical solutions applied will be key. Investors are seeking solutions to achieve price stability for bankability.

Historical Trends

Internal Rates of Return (IRRs), debt and funding margins for renewables projects have declined in past years owing to the following key drivers:

- Better industry understanding of the renewables asset classes;
- More competition between equity providers/more renewables-specific mandates; and
- Better technical execution of projects.

Future Trends

We see that CfDs or other subsidy types retain an important role in offering price stability, even if the premiums to market electricity prices are declining.

In the transition of renewable energy towards zero-subsidy, the bankability of the commercial and technical solutions and business models applied will be a key consideration for renewables project design and development.

We recognise that investors and lenders consider pricing and revenue risk in light of:

- Extent of exposure to market prices;
- Term of any price support or stabilisation; and
- Strength of payment counterparties.

Projects operating under a merchant model (focused on ancillary services and wholesale hedging) as opposed to with contracted revenues such as capacity market contracts, PPAs, FiTs or CfDs are expected to have a higher cost of finance as merchant revenues are less certain. The challenges are both due to the difference in price certainty, but also price stability. We anticipate that in a zero-subsidy context, PPAs will be required for bankability.

It will therefore be important to manage risk with respect to each of these when establishing a Corporate PPA or other commercial solution to replace subsidies. However we note that PPAs are often short-term, and therefore longer-term PPAs may be required to open up the zero-subsidy potential.

PPAs are often short-term, and therefore longer-term PPAs may be required to open up the zero-subsidy potential.


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FIGURE 12
Historical monthly average gilt yields.

Source: United Kingdom Debt Management Office.

Note: The historical monthly average gilt yields shown above are simple averages of the close of business redemption yields for each month of the prevailing 5 (short), 10 (medium) and 30 year (long) benchmark gilts, then averages.

IMPACT OF MARKET TRENDS FOR DEVELOPERS AND INVESTORS

In conjunction with the creation of this report, we have created a high level financial model to analyse the potential impact on returns of the future trends discussed in this report and whether they could enable projects to become attractive to a developer or an investor in a subsidy-free scenario.

Focussing on the Spanish and German onshore wind and solar PV markets, we have undertaken a high level review, drawing from insights from experts at Arup to benchmark revenues, costs and financing to support the findings discussed in the following sections.

Financing of projects

Project subsidies usually provide the projects with price stabilisation and minimise exposure to market prices for a period of c. 8-20 years, attracting lower cost of capital and providing value to the project sponsors.

In the current market, fixed priced contracts can last up to five years, however we believe that an investor would require a longer term to repay financing in the project.

In this instance, we would expect that a shorter term PPA with a fixed price profile would initially be put in place (c. five years), and that this would be renewed, or a new fixed price PPA put in place following the expiration of the initial period.

Note that this does not fully mitigate pricing risk, however we believe that in the future the PPA market will be able to provide longer term fixed price PPAs.

Rather than fully fixing prices, some PPAs provide a price floor instead. Whilst this does not fully mitigate pricing risk, it does reduce the impact of price cannibalisation and removes negative pricing risk.

Timeline

As our understanding of the maintenance requirements for a project increases, there is the potential to extend the life of the asset providing more value to investors.

Similarly if technology advances enables the reduction of time and costs to construct the wind farm, this would also enhance returns for investors.

Key assumptions

During the production of the model, we have taken a view on certain assumptions including PPA and tenor, which we have noted below.

Project Life

We have assumed that the operational life of the project is 30 years.

PPAs

We have assumed that one or more PPA will be in place over a 20-year period, enabling the project to be financed over this period. We have assumed that the price is fixed at a discount to the annual forecast price in the year, and hence no floor is considered.

Revenues

All revenues result from selling power to the grid, and no ancillary revenue is produced through other subsidies and methods of revenue stacking.

Please note that there are many different approaches and base assumptions that could be used, and investors often take different views on these.

IRR response to input changes

SENSITIVITY	ONSHORE WIND	SOLAR PV
CAPEX* REDUCTION OF 10%	1.5% - 2%	2% - 3.5%
CAPACITY FACTOR** INCREASE OF 2%	1.5% - 1.8%	2.7% - 4.6%
OPEX REDUCTION OF 30% P.A	1.1% - 1.3%	2.8% - 3.9%

*Many projects in the market that have been referred to as 'subsidy-free', may not have direct price subsidy, but often have reduced capex costs, or certain permits already approved prior to the commencement of the project. Repowered sites also provide savings if certain permits and infrastructure are already in place.

**Repowered sites could provide comfort to developers and lenders, as there will be historical data regarding the energy yield previously at the site. This could lead to better energy yield forecasting, reducing risk adjustments in the EYA.

Concluding Thoughts

To answer the question "What key developments are on the horizon which may enable zero-subsidy renewable projects in the medium to long term?", we have identified selected key drivers, summarised in Figure 13, that all have the potential to facilitate the growth of the market opportunity for zero-subsidy projects.

In order to support renewable deployment targets, we consider that there remains a need for a government support/subsidy mechanism at present to support the required volume of renewable energy investments required by environmental policies. In particular electricity price certainty brings a lot of value to investors and many may find it difficult to invest with no subsidy regime, unless a PPA is established to provide some price visibility. The few zero-subsidy examples in the market at present have generally benefited from favourable aspects, whether site characteristics or commercial opportunities.

However, certain projects are viable in a zero-subsidy context and this is expected to increase in the medium to long term as the trends described in this report develop.

We are entering a new period of gradual transition which may lead to significant growth in the subsidy-free market opportunity in the longer term.

Historical trends, including reduction in LCOE and technical risks have enabled renewable investments to remain attractive, even in the context of declining subsidies and tariffs over time.

We are entering a new period of gradual transition which may lead to significant growth in the subsidy-free market opportunity in the longer term. As the renewables market continues to mature, developments such as further LCOE and risk reduction, operational optimisation and commercial solutions (including PPAs, revenue stacking and energy storage) may enable investors to engage with new business models offering stable revenues and with viable investment returns.

FIGURE 13

Summary of future trends key to achieving zero-subsidy projects.

WHAT KEY DEVELOPMENTS ARE ON THE HORIZON WHICH MAY ENABLE ZERO-SUBSIDY RENEWABLE PROJECTS IN THE MEDIUM TO LONG TERM?

REDUCING LCOE
Capex, Opex, capacity factors, repowering.

REDUCING TECHNICAL RISK
Supply chain and industry learning curve.

MITIGATING POWER PRICE RISK
PPAs, storage and revenue stacking.

FINANCIAL INVESTOR PERSPECTIVES
Bankability of the commercial and technical solutions and business models will be key.

Appendix 1: Subsidy-free renewables projects examples

Portugal

VALE MATANÇAS

7.2 MW Solar, Portugal

Under construction

Construction in process for a subsidy-free Foresight solar park in Portugal. The UK developer's 7.2 MW park, located in Alcácer do Sol will be backed by a 10-year PPA.

OURIKA

46 MW Solar, Portugal

Operational

Construction completed in July 2018 for a subsidy-free WElink Energy solar park in Portugal. The UK developer's 46 MW park, located near Ourique will receive no government subsidies thanks to reduced costs and high irradiance.

ÉVORA

29 MW Solar, Portugal

Under construction

Construction in process for a subsidy-free Dynavolt Renewable Energy solar park in Portugal. The 29 MW park will be backed by a 10-yr PPA with Axpo Iberia.

SOLARA 4

221 MW Solar, Portugal

Under construction

Construction is advanced for a subsidy-free WElink Energy solar park in Portugal which will be the largest subsidy-free site in Europe. The UK developer's 221 MW park, located in Vaqueiros will receive no government subsidies thanks to reduced costs and high irradiance.

UK

WITHERNICK II

8.2 MW Wind, UK

Under construction

Financial close reached in May 2018 with Nord/LB for first subsidy-free wind farm in UK. Commissioning expected in early 2019. Project has reduced Capex thanks to utilising infrastructure from Withernick I, knowledge of this site's performance also provides greater certainty on yield giving confidence to lenders.

OUTWOOD AND TROWSE-NEWTON

16 MW Solar, UK

Under construction

Wirsol acquire development rights in December 2017 for two subsidy-free solar parks in UK. Both projects are extensions and have reduced Capex thanks to utilising existing infrastructure. Projects will be enabled through long-term PPAs and potential is in place for storage to be retrofitted.

CLAYHILL

10 MW Solar, UK

Operational

Optimisation of supply chain and combination with 6 MW of battery storage allowed Anesco to build first subsidy-free solar park in UK.

Italy

MONTALTO DI CASTRO

64 MW Solar Parks, Italy

Operational

23m financing package has been provided by MPS Capital Services Banca per le Imprese for 64 MW (5 solar projects) in 2017 which are described as zero-subsidy by fund manager Octopus Investments.

Spain

GOYA PROJECT, ENGIE

300 MW, Wind, Spain

In development

ENGIE, Forestalia, General Electric and Mirova an innovative agreement to develop nine subsidy-free wind farms with a total capacity of 300 MW, awarded at the first Spanish renewable generation auction in 2016. ENGIE signed a 12-year Power Purchase Agreement (PPA), to buy at a large part of the electricity generated by the future nine wind farms. The facilities are due to be in operation by or before March 2020. Debt finance has been arranged with BBVA acting as agent bank and secured by BBVA, Banco Santander and CaixaBank with the EIB providing a €50m loan.

TORRE DE COTILLAS 1

3.9 MW Solar, Spain

Operational

Construction completed in September 2018 of a subsidy-free Foresight solar park in Spain. The UK developer's 3.9 MW park, in the Murcia region is part of a larger development and is reported to be backed by a 10-year PPA with Emergya-VM.

DON RODRIGO

174 MW Solar, Spain

Under construction

Nord/LB signed a €100 million bridge loan to fund construction of a subsidy-free BawWa AG solar park in Spain. The German developer's 174 MW Don Rodrigo photovoltaic solar park, near Seville, in Andalucia is reported to be backed by a 15-year PPA with Statkraft.

Onshore Wind Case Studies

GOYA PROJECT

300 MW, Wind, Spain

ENGIE, Forestalia, General Electric and Mirova have entered in to an innovative agreement to develop nine subsidy-free wind farms with a total capacity of 300 MW, awarded at the first Spanish renewable generation auction in 2016. ENGIE signed a 12-year Power Purchase Agreement (PPA), to buy a large part of the electricity generated by the future nine wind farms. ENGIE will be responsible for managing the civil and electrical works for the project.

Debt finance has been arranged with BBVA acting as agent bank and secured by BBVA, Banco Santander and CaixaBank with the EIB providing a €50m loan.

The facilities are due to be in operation by or before March 2020.

Success factors

The project has secured a long duration PPA (12 years) which provides a floor price for a large portion of the capacity. This has allowed involvement of debt finance, which is expected to improve the project's cost of capital. The scale of the projects and alignment of involved parties offers potential cost savings.

Lessons learned

This project demonstrates that debt finance is obtainable under the right conditions, particularly where the PPA contract provides the necessary assurances.

WITHERNICK II

8.2 MW Wind, UK

Energiekontor UK has successfully developed the first subsidy-free wind farm in the UK with a capacity of 8.2 MW. The project signed a long term Power Purchase Agreement (PPA) with a Corporate, who will buy the electricity generated by the wind farm.

Project finance has been arranged with Nord/LB.

Financial close was achieved in May 2018. Project is due for operation in early 2019.

Success factors

A long duration PPA has been secured which provides price certainty to investors and lenders allowing involvement of finance, which is expected to improve the project's cost of capital.

The project has benefited from using existing infrastructure from the Withernwick I wind farm allowing cost savings during the construction stage as well as certainty in the wind resource based on the operational data from the earlier development.

Lessons learned

Project extensions provide certainty on yield as well as Capex savings where existing infrastructure such as access tracks and substations can be utilised. This certainty along with the comfort of a long term PPA allows for banks to invest in the project.

Solar PV Case Studies

DON RODRIGO

174 MW Solar, Spain

The 174 MW Don Rodrigo Solar PV project, located near Seville in Andalucia, Spain, is currently under construction and will be one of the first projects of this scale to be built in Spain with no Government subsidy.

The German developer BayWa r.e. has signed a 15-year PPA for the site with Norwegian Energy group, Statkraft.

The project has secured a €100 million bridge loan with Nord/LB to fund the construction of the solar park. In January 2019, it was announced that the project had been sold by BayWa.r.e to MEAG.

Success factors

Having a 15-year PPA backed by Statkraft, provides the project with a stable revenue stream for a significant proportion of the project's lifetime.

The PPA is rumoured to be just below €40 per MWh but is not fixed for the whole contract term. BayWa describes the PPA to offer a fixed price for the first five years, followed by a floor price. The project is expected to generate approximately 300 GWh of energy per year and has significant scale.

Lessons learned

The different parties active in the renewables sector are becoming increasingly familiar with the varied PPA structures available and we anticipate that some structure will become more better recognised in the market as well as bilateral discussions continuing to produce bespoke structures to suit the parties' needs.

CLAYHILL

10 MW Solar, UK

The Clayhill site in Bedfordshire, UK, consists of 10 MW Solar PV with 6 MW of battery storage co-located.

It is the first subsidy-free ground mounted solar PV project to be constructed in the UK and started operation in September 2017. The project was developed by British developer, Anesco.

The project uses BYD solar panels and battery storage units, along with China's Huawei invertors – which was their first installation in Europe. The project was reported to be completed in 12 weeks.

Success factors

Optimization and communication with Anesco's supply chain, developed over 100 solar farms across the UK, allowed their input into the design, technical specifications, the use of the latest technology and costs of various components and allowed the project to be delivered at lowest cost. The site has also co-located batteries and provides National Grid, the UK transmission network owner, with system services to ensure that the grid remains stable.

Lessons learned

Anesco are quoted as saying that the Clayhill farm would not be able to pay for solar by itself and that the storage support is key to its viability by stacking revenues from providing grid services.

Appendix 2: Current renewable electricity price subsidies

COUNTRY	CURRENT SUBSIDY MECHANISM
GB	New renewable generating stations can seek support under a CfD (contract for difference) mechanism, although the CfD is currently open only to those so-called "less-established" Pot 2 technologies (including offshore wind) and not to the "established" Pot 1 (e.g. onshore wind and solar). In September 2017, the Department for Business, Energy & Industrial Strategy (BEIS) announced the results of the second round of CfD allocations for the "less established technologies" – Advanced Conversion Technology (ACT), dedicated biomass and offshore wind. The strike prices achieved (GBP 74.75 for delivery year 2021 / 22 for all technologies, GBP 57.50 / MWh for offshore wind and GBP 40.00 / MWh for ACT for delivery year 2022 / 23) are significantly below those seen in the previous allocation round. The third allocation round will take place in 2019.
FRANCE	The current support scheme for renewable energy sources in France is based on Law No. 2015-992 of 17 August 2015 "on energy transition for green growth which introduced a mechanism of contracts for difference. Producers must sell their energy produced on the market, and they receive, through an ex post mechanism, an additional variable remuneration (complément de rémuneration) from EDF in the form of a monthly premium. The premium is based on a formula, which includes a reference tariff set by a ministerial order for each type of energy. Where the market price exceeds the reference tariff, the generators must reimburse the difference.
GERMANY	In January 2017, a revision of the German Renewable Energy Sources Act (EEG 2017) came into force, which replaced the fixed tariff for wind, solar and biomass with a market-based tender model. The results of the first tenders demonstrate that the renewables industry seems to be able to accept lower support – or, in the case of offshore wind – even no support at all. EEG remuneration is generally granted for a period of 20 years, starting from the entry of operation of the relevant plant.
SPAIN	A "specific remuneration" regime is assigned following competitive auctions and limited to a certain amount of GW. Generators are entitled to receive both the "specific remuneration" (if their projects are awarded at the auction) and the price obtained from the sale of energy in the electricity market. The "specific remuneration" regime allows for the payment of a "reasonable return", which is a percentage applied to a theoretical initial investment value. The parameters can be adjusted at the end of every six-year regulatory period. At present, we are in the first regulatory period (2014 to 2019). Therefore, in 2020 the Government will revise the reasonable return, and there is a risk that the revision will be downwards. For new installations, the reasonable return was determined by reference to market yields for the 10-year Spanish government bond calculated as the average of the months of April, May and June of 2013 plus a spread of 300 basis points (which resulted in a rate of return of 7.503 per cent). So far, the Spanish government has carried out three auctions that have ended with a result that no incentive (or a very low incentive) has been granted to the projects, and most of their remuneration comes from the market price.
PORTUGAL	The feed-in tariff scheme was revoked in 2012 (except for small generation units and self-consumption units), but was maintained for ongoing projects.
ITALY	PV: To control future capacity installations, Ministerial Decree 5 July 2012 provided for a specific indicative annual aggregate cost cap equal to EUR 6.7bn per year, which is the maximum amount of incentives which could be granted to PV plants. This cap has been reached, and no further incentives are currently granted for new PV plants under the decree. Non-PV technologies: A feed in tariff support mechanism for non-solar renewable technology (e.g. wind, biogas, hydro, biomass, bioliquids, geothermal). Incentives were granted either by direct access or through a specific registration procedure, or by means of auction processes, depending on the size and type of technology. The support mechanism is now applicable only to those plants that registered on time for the relevant registers held by the GSE and those that successfully participated in the auction processes pursuant to Decree 6 July 2012. By means of Ministerial Decree 23 June 2016, a new incentive scheme was adopted pursuant to which new, completely re-built and reactivated plants whose capacity is higher than 5 MW compete for incentives in specific auction processes (aste al ribasso). EUR 5.8bn per year is the maximum amount of feed-in tariffs that may be granted to non-solar renewables.

Glossary

BEIS	Department of Business, Energy & Industrial Strategy
CAPEX	Construction expenditure
CF	Capacity factor
CFD	Contract for difference
CMS	CMS Cameron McKenna Nabarro Olswang LLP
DEVEX	Development expenditure
EEG	German Renewable Energy Sources Act (EEG 2017)
EIB	European Investment Bank
FIT	Feed-in tariff
GW	Gigawatt
GWH	Gigawatt-hour
IRR	Internal rate of return
KW	Kilowatt
kWh	Kilowatt-hour
LCOE	Levelised cost of energy
LIDAR	Light detection and ranging
MW	Megawatt
MWH	Megawatt-hour
O&M	Operations and maintenance
OPEX	Operational expenditure
PPA	Power purchase agreement
PV	Photovoltaic
SCADA	Supervisory control and data acquisition
SOV	Service operating vessels
WTG	Wind turbine generator
ZSR	Zero-subsidy renewables

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