CLIMATE POLICY INITIATIVE

European Renewable Energy Policy and Investment

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NOVEMBER 2016

THE NEW CLIMATE ECONOMY
The Global Commission on the Economy and Climate

SEI STOCKHOLM ENVIRONMENT INSTITUTE

A CPI Report

Acknowledgements

This paper was commissioned by the New Climate Economy and sponsored by the Swedish Energy Agency. The views expressed here do not necessarily reflect the opinions or official policies of these institutions.

We would like to thank all those who contributed to this paper during our research, including utility companies, developers, financial institutions, large consumers, small consumer organisations and government. We'd also like to thank its co-authors at the Stockholm Environment Institute and those who reviewed it, including staff at the European Climate Foundation and members of the Energy Transitions Commission.

We thank CPI staff Elysha Davila, Dan Storey, Tim Varga and Felicity Carus for guidance and support in the production of this paper and to Kate Stuart for design services.

Descriptors

Sector	Renewable Energy Finance
Region	Europe, UK, Germany, Spain, Portgual, Nordic region
Keywords	European renewables, investment, policy, finance, low-carbon, energy, electricity sector, electricity industry, investors, policymakers
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About CPI

Climate Policy Initiative works to improve the most important energy and land use policies around the world, with a particular focus on finance. An independent organization supported in part by a grant from the Open Society Foundations, CPI works in places that provide the most potential for policy impact including Brazil, China, Europe, India, Indonesia, and the United States.

Our work helps nations grow while addressing increasingly scarce resources and climate risk. This is a complex challenge in which policy plays a crucial role.

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Summary report

1.1 Executive summary

The European electricity industry landscape has experienced profound changes. Energy demand growth declined after the 2008 economic crisis, and since then the energy mix has continued to change with rapid deployment of renewables, while contributions from coal and nuclear have dropped.

Commodity prices, including carbon markets, have risen and fallen dramatically, and many of the investor-owned utilities are struggling to adapt financially to this new paradigm. Climate change mitigation and falling renewable energy costs continue to put pressure on an industry that is only at the beginning of an accelerated period of evolution.

Europe's policy and finance environment has enabled some of the fastest deployments of renewable assets globally. In 2016, it became the first region in the world to surpass 100GW of solar PV capacity, with 140GW of wind power installed.

Today, policy and finance issues are now arguably at least as important as technology, with policy now the key determining factor in ensuring continued growth in renewables at least cost to consumers. Investment in the energy system has traditionally come mainly through large utilities. But policymakers are not in the same position as they were five years ago when deployment levels were lower, the costs of technologies such as solar were much higher and policy decisions had very different outcomes. Even the costs of offshore wind are falling as indicated by DONG's recent winning bids for the Borssele 1 and 2 projects at €72.2/MWh.

In future, investment will need to come from a variety of sources which means that policy will need to change dramatically to adapt to this new, broader range of potential financing options.

Crucially, our analysis suggests that:

1. The **cost of financing** will be driven as much by the types of investors as by how investors evaluate project risks, returns and policy. In other words, how investment is divided among utilities, institutional investors, households or companies is one of the most important factors determining the average cost of renewable energy to the system.

   In Germany and Spain, for example, very different policy incentives were concentrated on very specific investor categories, ie, small end users in Germany and the utility sector in Spain. Both approaches achieved high levels of deployment in a relatively short time but were not necessarily cost-effective.

2. **Policy and industry design** determines how renewable energy investments fit with the objectives and constraints of different types of investors. The impact of policy will depend on size, sophistication, risk tolerance, knowledge of the energy industry and energy consumption needs. How the policy alters and attracts different investors has a major influence on finance availability and cost. For example, the UK has phased out subsidies for onshore wind and solar, while continuing to support low-carbon sources such as nuclear and offshore wind. This consistent signal to the market for offshore wind means that this sector of the renewables market will remain attractive for some time to come but investment potential is likely to be concentrated on utilities, developers and financial institutions. Meanwhile, policies to promote greater use of flexibility options and emerging technologies that can enable higher levels of renewable integration would reassure investors, particularly in the Iberian peninsula where there is excess capacity.

3. **Business models and investor capabilities** will develop over time in response to policy signals. Policy outcomes and objectives could have very different solutions depending on whether the policy is trying to optimize short or long-term investment. Thus, policymakers need to address how their policy design will affect the development of different business models and investor group participation over time. However, to sustain reductions in the cost of capital, a broad range of investors is required, ie the more diverse the categories of investor, the cheaper financing becomes. Return requirements are also very different for large and small investors, who nevertheless can have a huge impact on the market as they have done in Germany.

1.2 Introduction

This paper is aimed at helping policymakers incorporate investor perspectives into their policymaking and industry design. We interviewed scores of analysts and investors across the range of investor types, from small household investors and their agents to incumbent utilities and banks, and evaluated their investment needs and practices. We have used these perspectives to draw insights into how policies affect renewable energy investment from each of the various investor types.

This report will help policymakers to:

1. **Balance cost effectiveness and deployment goals:** Is it more important to achieve the lowest cost mix of renewable energy or to be absolutely certain that deployment targets are achieved or exceeded? In some cases, attempting to achieve the absolute lowest cost could discourage some investors, making these targets more difficult to achieve, so this trade-off should be of concern to policy makers. Policy design can have a strong influence on each of these two goals.
2. **Balance short-term cost-efficiency versus longer term development:** If the only objective is to reach near term goals, policymakers would be wise to focus on a limited set of investors and companies that have experience and project pipelines. However, in the longer term costs could be further reduced by encouraging new types of investors and businesses to evolve or by encouraging existing players to invest in longer term cost reduction. In some cases, short term, ready to go investment could be exhausted before long-term policy objectives are met. Achieving long-term cost reduction could require policymaker to accept that some investor groups and projects might be more expensive in the short term in order to encourage their development.
3. **Develop technology mixes and options:** Policymakers should also consider how the mix of technologies could affect longer term objectives. A mix of technologies not only enables lower costs in the future, but also could enhance energy security through diversification of generation sources.
4. **Shape the industry to achieve industrial objectives and/or public support:** Involving consumers in renewable energy investment can increase public acceptance. However, building a system around large incumbents or large investors can shore up the overall industry and simplify some aspects of policymaking. Germany and Spain have taken very different paths in this regard.

Technologies

Renewable energy technologies themselves are diverse in their financial risk and operating characteristics, and are likely to benefit from different policy models that attract the most appropriate source of finance. Electricity markets are varied, not just because of their legacy market structures and incumbent players, but also because of the natural resources available to them and patterns of energy consumption. In addition, cultural and financial market conditions become particularly important when renewable energy becomes part of the equation.

For this paper, we have chosen to focus on three renewable energy technologies that dominate the policy debate.

Technologies	Markets
Solar photovoltaics Onshore wind Offshore wind	United Kingdom Germany Iberia Nordic region

The technologies listed above have the greatest levels of deployment and the markets selected represent both a range of varied market perspectives and conditions, as well as a large percentage of the renewable energy that has been developed over the last 10 years.

Analysis in this paper can also be used as a guide on:

1. Policy needs and perceptions of investor types;
2. Policy and investment impact by technology type.

Together, these reports provide unique insight into the policy and investment landscape for each of our selected markets in Europe. Additionally, we also include in-depth case studies for each of these regions or countries.

1.3 Comparisons between renewable energy investments in the UK, Germany, Iberia and Nordic region

We have focussed our evaluation on four regions that have each been important markets for renewable energy and policy over the last decade: the United Kingdom, Germany, Spain and Portugal (Iberia), the Nordic countries of Norway, Sweden and Finland[1] that are part of the Nord Pool market.

Together these countries and regions represent over 55% of total renewable energy generation in Europe in 2014, including almost 70% of wind energy generation, more than 60% of solar generation.

Table 1 below shows shares of European renewable energy production and significant market and policy issues for regions and countries included in this evaluation.

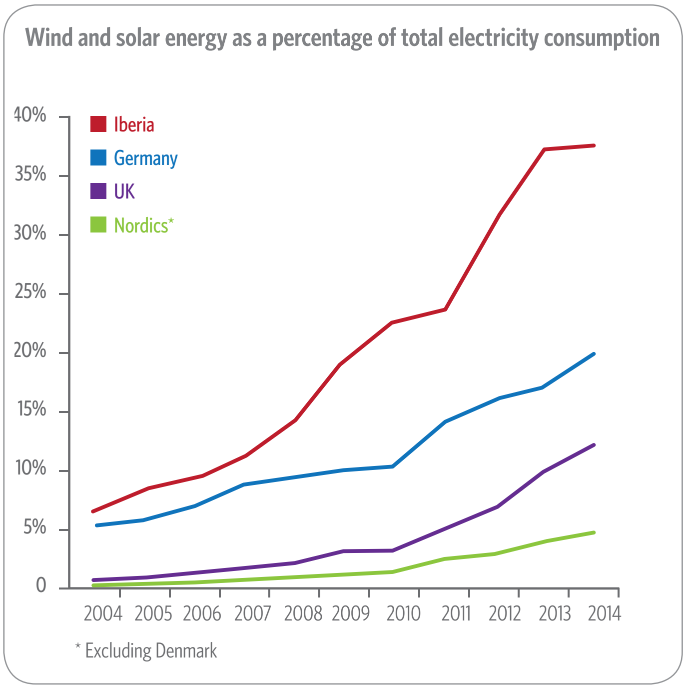
Table 1: Regional overview

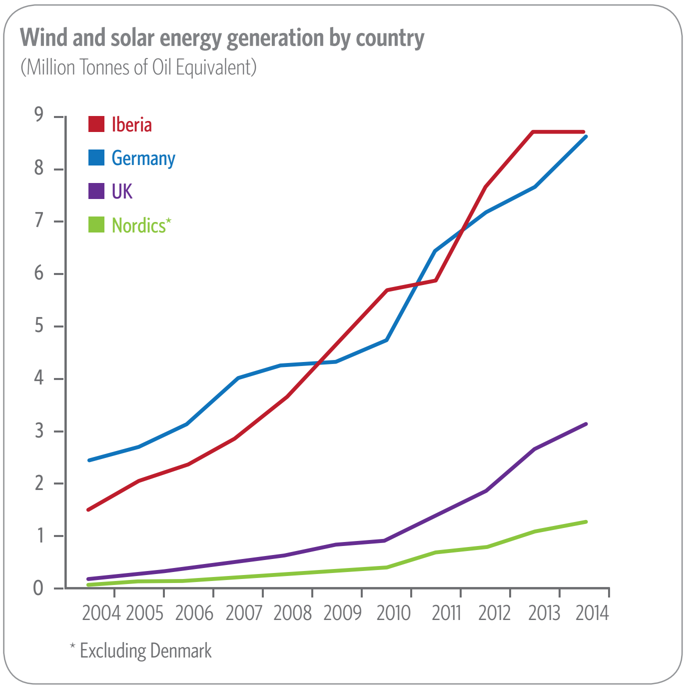
	GERMANY	IBERIA	NORDICS	UNITED KINGDOM
Wind (percentage of total renewable generation by country in 2014)	• 23%	• 25%	• 6%	• 13%
Solar (percentage of total renewable generation by country in 2014)	• 31%	• 27%	• 0%	• 3%
Total share (of renewable generation in Europe, 2014)	• 18%	• 12%	• 20%	• 6%
Significance to renewable energy development	• Largest electricity and energy consumer in Europe; largest single market for both wind and solar • Aggressive targets for renewables expansion and CO2 reduction • Viewed as a model for high renewables penetration	• High wind and solar penetration (30% of EU wind and solar capacity) • Tariff deficits and past policy failures make renewable energy reform a high priority	• Lowest-carbon electricity in Europe including hydro, nuclear and wind • Governments play an important role as institutional investors and utility owners	• One of the EU's largest wind markets and best wind resources • Support policies have recently been overhauled • Recent policy changes threaten the continued viability of onshore and solar energy investment
Other important issues	• Energiewende combines growth in renewables and phasing-out of nuclear and lignite • At risk of missing self-imposed CO2 reduction target • Major utilities facing financial crisis and restructuring	• Joint electricity market between Spain and Portugal • Cost overruns for renewable subsidies were followed by retroactive tariff cuts • Three big utilities are major wind asset owners in the region and globally	• Integrated electricity market (Nord Pool) • Large share of government ownership in electric utilities • Availability of hydro enables high renewable energy penetration	• Competitive retail electricity supply • The majority of the largest electricity companies are not UK-based • Leader in offshore wind development

Source: Eurostat, CPI and SEI analysis

1 Part of Denmark is in a different synchronous area to the rest of the Nordics within the Nord Pool market. However, it is well known that Denmark has been a world leader in wind development. Denmark is not part of the current green certificate scheme of Sweden and Norway, and has implemented an auction system for its off-shore projects. In this sense, the authors consider Denmark as a separate case study to the rest of the Nordic countries.

Figure 1





Source: Eurostat and CPI analysis

Germany offers an example of a successful renewable energy deployment program across a range of investors that attempts to make a transition to a more efficient deployment model without undermining the industry's development.

Iberia offers an example of a policy transition that was ineffective and has undermined the domestic industry. It also offers insight into how EU policy can help Europe optimize the use of renewable resources.

The **UK** presents issues around policy evolution, integration into an advanced market, and the chilling effect that policy uncertainty can have on investors.

The **Nordic** market is a prime example of how market-based incentives and a stable policy environment can work well, given a set of favourable contextual elements. Like Iberia, the Nordic market also offers insight into how EU policy can help Europe optimize the use of its renewable energy resources.

Full case studies on each country and region are available in Appendix B.

Table 2: Overview of typical investors in each subcategory with key objectives for each type

	INVESTORS	EXAMPLES	TYPICAL CHARACTERISTICS	Target technologies		
				Offshore	Onshore	PV
Utilities	Incumbent investor-owned or national utilities	• E.On • Iberdrola • RWE • Enel • Statkraft • Vattenfall	• Objective to maintain strong presence in the market • Sophisticated players • Access to capital markets • Require healthy return • Focus on large-scale projects • Global focus	✔✔	✔	✘
Utilities	Municipal utilities	• MVV • Umeå Energi • Skellefteå kraft	• Objective to supply reliable and low cost energy • Often also have an environmental objective • Some have access to below-market price debt • Preferred project size varies • Most have a regional focus	✔	✔✔	✔✔
Developers	Foreign (non-incumbent) utilities	• Incumbent utilities in out of market areas (eg DONG, Iberdrola in Germany)	• Desire projects where they can provide a strategic and cost advantage • Sophisticated players with trading operations • Access to international capital markets • Global focus	✔	✘	✘
Developers	Large-scale developers	• EnergieKontor • juwi • PNE • wpd	• Capture value by optimizing business processes • Want to recycle capital fast • Can work with strategic or financial co-investors • Prefer large-scale project but are also able to pursue smaller projects	✔✔	✔✔	✔
Developers	Small-scale developers	• Various small engineering firms	• Offer development services • May or may not invest own capital • Focus on small- to medium-sized projects • Local focus	✔	✔✔	✔✔
Financial investors	Investment banks	• Commerzbank • DeutscheBank • GoldmanSachs • Morgan Stanley • UBS	• Create value through transactions and customer relationships • Focus on larger players (utilities, developers, institutions) • Seek higher returns and are willing to accept higher risk	✔✔	✔	✘
Financial investors	Commercial banks and Landesbanks	• Commerzbank • Bayem LB • LBBW • DZ Bank • Helaba	• Focus on lending and less on transactions • Provide long-term project finance for large projects and credit extension to small projects • Often refinance loans for renewable energy projects via development banks	✔	✔	✔
Financial investors	Institutional investors	• Allianz • MunichRE/ MEAG	• Look for long-term predictable cash flows to meet their long-term liabilities • Invest in equity, debt and mezzanine • Generally prefer operating projects but are increasingly entering projects earlier	✔	✔	✔
Financial investors	Asset managers	• Aquila Capital • Blackstone • Capital Stage • KGAL	• Aggregate funds to invest in projects that would otherwise be too large for their clients • Investment preferences are driven by their clients' respective mandate and can vary • Often rather equity-oriented	✔	✔✔	✔✔
Financial investors	Other	• Corporates • Family offices • High net worth individuals • Households	• Wide variety of investors that may invest in specific projects • Generally more interested in small-scale projects • Portfolio investments usually flow through asset managers	✘	✔✔	✔✔
End users	Large end users	• Commercial enterprises • Industrial enterprises • Large co-operatives	• Commercial / industrial enterprises have limited interest as they need fast payback periods • Large co-operatives invest socially but nevertheless require minimum returns • Short-term focus • Local focus on or near own premises	✘	✔	✔
End users	Small end users	• Small co-operatives • Farmers • Households	• Co-operatives and households have an environmental objective and accept lower returns • Households value the consumption of green energy • Local focus	✘	✔	✔✔

1.4 Investor groups in European renewable energy

In general, investment in renewable energy comes from:

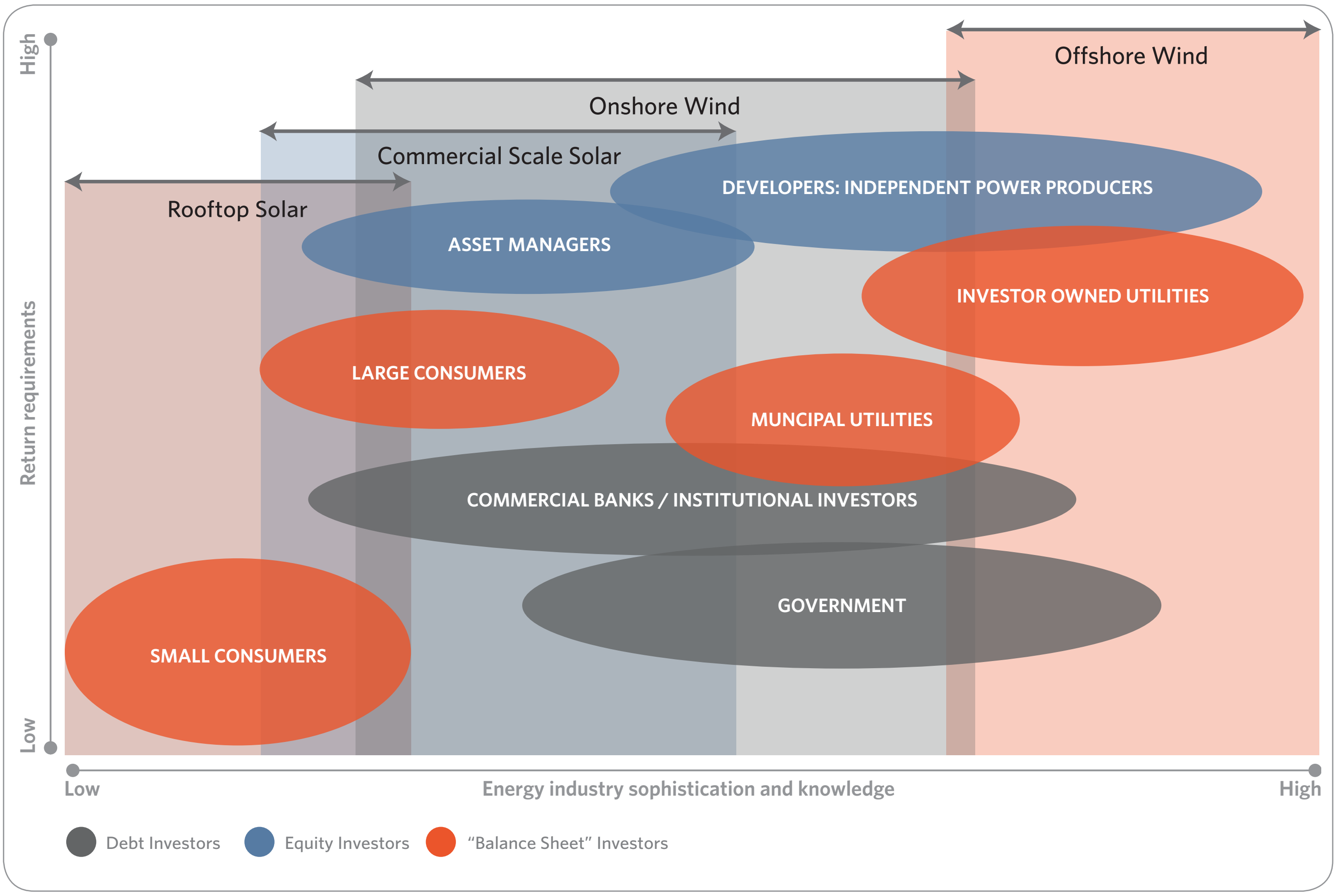
- **Utilities** whose main business is generating, transporting and supplying electricity;
- **Developers** whose business is developing projects; these include utilities who operate outside of the area where they serve customers;
- **Financial institutions** seeking financial returns but are often less active in the projects;
- **End consumers** who often, but not always, invest in generation to provide some of their own energy needs or otherwise offset energy demand.

Size & sophistication

Some renewable energy investors are deeply involved in the electricity industry and have dedicated teams that understand how to develop and operate projects. While maintaining these teams can be expensive, they can also reduce cost if the alternative is to pay a premium to advisors, especially for large scale projects like offshore wind.

As companies become larger and more sophisticated, the fixed costs of evaluating projects and integrating them within a larger portfolio increase. Thus, many large investors, including utilities, financial investors and investment banks, cannot profitably develop and invest in smaller projects. Some institutions, like banks, may have separate departments that address different parts of the market. Many others set minimum size levels for investments. For example, due to banks' high due diligence costs and lost opportunity costs it is usually uneconomic for lenders or borrowers to use bank funded project financing loans for amounts that are less than €20m.

Figure 2: Return requirements for different categories of investors versus sophistication by technology type



Source: CPI analysis

In addition to investing in renewable energy projects, sophisticated investors may also invest in the business systems, capital and teams that are needed to develop and execute projects effectively. More investment in business systems may increase competitiveness, but again, this may only be worthwhile if the investor or developer envisions an ongoing business with enough future projects to recover the investment through greater efficiency. Most large and small consumers, for example, would not have the incentive to develop skills beyond that needed for the one or two projects they want to invest in.

Return requirements

Sophisticated energy investors generally have shareholders, bondholders and lenders. Failure to meet the requirements of these investors will result in a collapsing share price and an inability to borrow more money to run the business. Likewise, institutional investors need to address the requirements of their pension and insurance policy clients. In general, these requirements express themselves in terms of both risk and return, with some investors willing to take on greater risk for more return. Smaller investors, and those investing on their own account, may have completely different investment needs that then affect their investment requirements.

While the sophistication and size requirements of renewable energy investors differ, these variations are largely mirrored by the wind and solar PV technology options available. Rooftop solar PV is generally the easiest for a potential investor to understand, followed by commercial-scale solar, onshore wind and then offshore wind (see figure below). Levels of sophistication mean some renewable technologies are more attractive than others, while investors who are prepared to accept the size constraints of a given technology may also drive the complexity of the related policy design investment.

Debt, equity and 'balance sheet' investors

Debt investors such as banks and many institutional investors prefer to lend to projects and developers rather than taking ownership. They generally demand lower returns because their returns are paid out ahead of equity returns and the loans are usually secured.

Equity investors then use this lower cost debt leverage to increase their returns, and invest in more projects; at the same time they also increase their risk since they have to be able to service the debt at all times.

"Balance sheet" investors could include households that pay cash for their renewable investments or take out a home loan to finance it. Larger, more sophisticated investors can also be balance sheet investors. An investor owned utility may choose to borrow money at the corporate level – for instance by issuing bonds against the entire company rather than just a single project or portfolio of projects. In essence, they invest in both the debt and equity of a project and may offset that investment by borrowing money themselves.

Borrowing money at the corporate level can be less expensive, but the balance sheet investor takes on additional risk. The choice can depend upon both their risk position and the relative cost of financing. In turn, the relative cost may depend on policy and its impact on revenue certainty.

1.5 Investor activity in the four markets by technology

As figure 2 showed, each investor is likely to be attracted to very different renewable energy technologies. Market design, investment and policy is set at the technology level, so policy and industry development should look at how all investor classes fit together with that technology.

- **Solar PV** – attracts the widest range of investors. Since PV installations can be quite small and the economies of scale are relatively limited, small investors have access to PV projects such as rooftop or community solar projects. However, the greater competition and the relatively small benefit of applying industrial scale and industry knowledge can make solar PV less attractive for the large, industry focussed investors such as investor-owned utilities.
- **Onshore wind** – is the next step up in terms of investment size. While there are economies of scale, modest €1m to €10m, projects are not uncommon and provide opportunities for landowners, cooperatives and smaller investors. However, attractiveness for investors is strongly dependent upon policy that could sway investment towards larger players or facilitate the entry of smaller or non-energy industry investors.
- **Offshore wind** – requires large-scale investments and significant expense, industrial scale skills and investment capabilities. Investments can exceed €1bn.

For an in-depth view of the relationship between finance and policy at the centre of Germany's twin objectives of reaching renewable energy deployment and cost-effectiveness, please see Appendix A3 which is taken from Policy and Investment in German Renewable Energy, April 2016. The table below is taken from it.

Table 3: Energy policy categories and key policy areas

Energy and renewable energy policies	Renewable energy subsidy mechanism	1. Incentive auction design 2. Support design 3. End user participation	• Auction design, coverage and process • Predictability of subsidies, perceived regulatory risk and compatibility • Availability of self-consumption options
	Renewable energy targets	4. Long-term targets	• Reliability of government plans and deployment
	Electricity market design	5. Grid connection 6. Energy market design 7. Curtailment	• Security of grid access after a plant has been realised • Electricity price mechanism and access rules to the energy market • Technology and economic curtailment
Process and other supporting policies	Regulatory process uncertainty and transition	8. Permitting process	• Costs and administrative complexity
	Planning, logistics and project development costs	9. Development costs:	• Threat of an increase in costs and standard costs
	Financial and information support	10: Financial regulations	• Trade off between capital market stability and sufficient capital for renewable energy projects

1.5.1 Solar PV

Investment and deployment of solar PV has been concentrated in the German and Iberian markets using two very different deployment and industry models. In Germany, attractive feed-in-tariffs encouraged small consumers, cooperatives and developers to install rooftop and some ground-mounted systems. In addition, German development banks such as KfW and Rentenbank offered low-cost loans, while commercial banks and other institutional investors recognized the low risk of lending to projects supported by both the development banks and feed-in-tariffs, and offered further low-cost finance. Utilities were discouraged by the small scale of rooftop solar projects and the intense competition from low-cost funding sources.

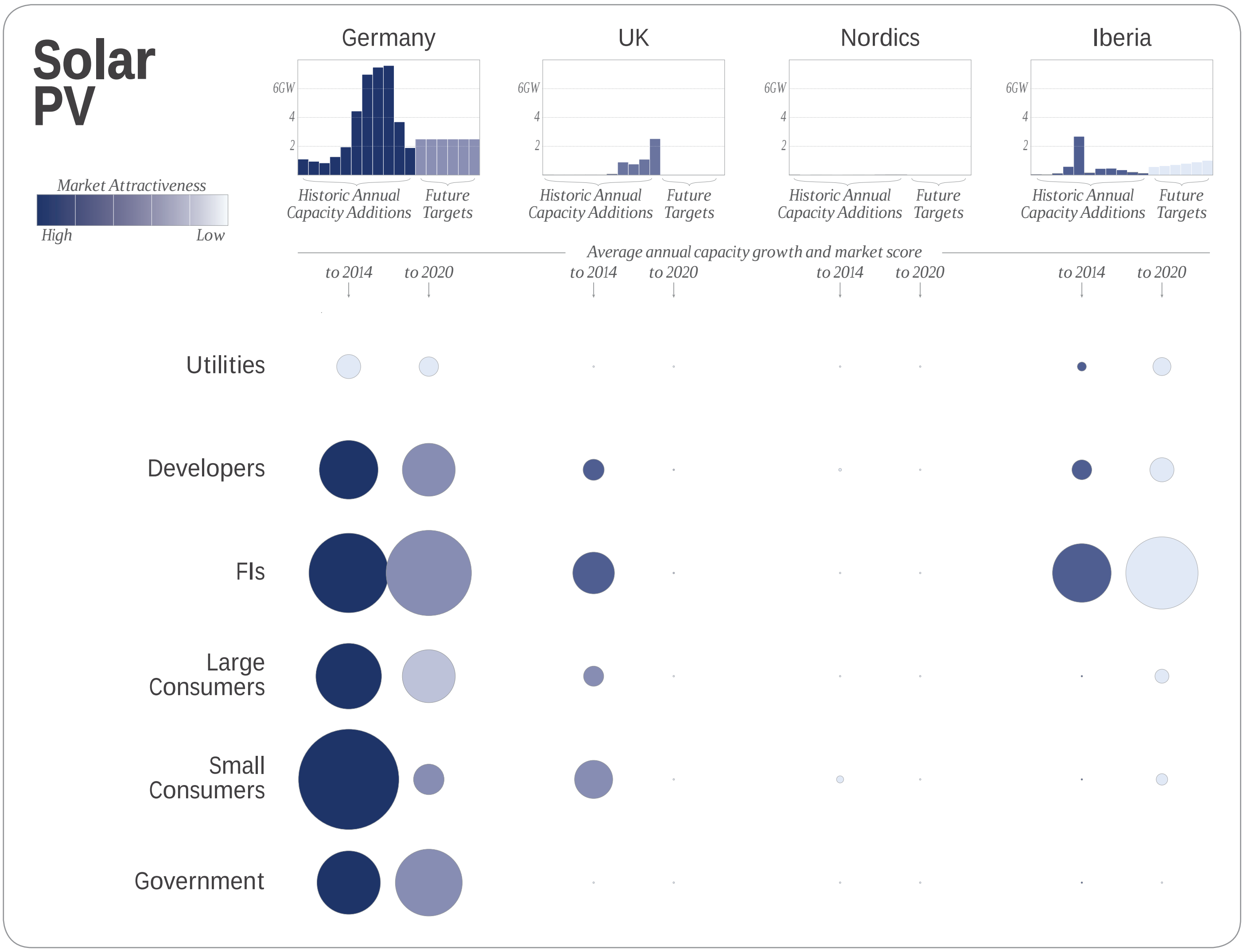
By contrast, Spanish solar PV was dominated by large-scale projects financed by utilities. Attractive tariff regimes between 2005 and 2010 encouraged significant investment, but overbuild and cuts to incentives dried up investment. The absence of feed-in-tariffs and low-cost debt, along with barriers and costs associated with connecting to the grid, has largely discouraged consumers as investors.

In both countries, installation rates have exceeded national targets which means that both policy and market environments will be less attractive across nearly every investor category.

The UK has already exceeded its unambitious PV targets, while the Nordics do not have any. The graphs in the chart below reflect these positions.

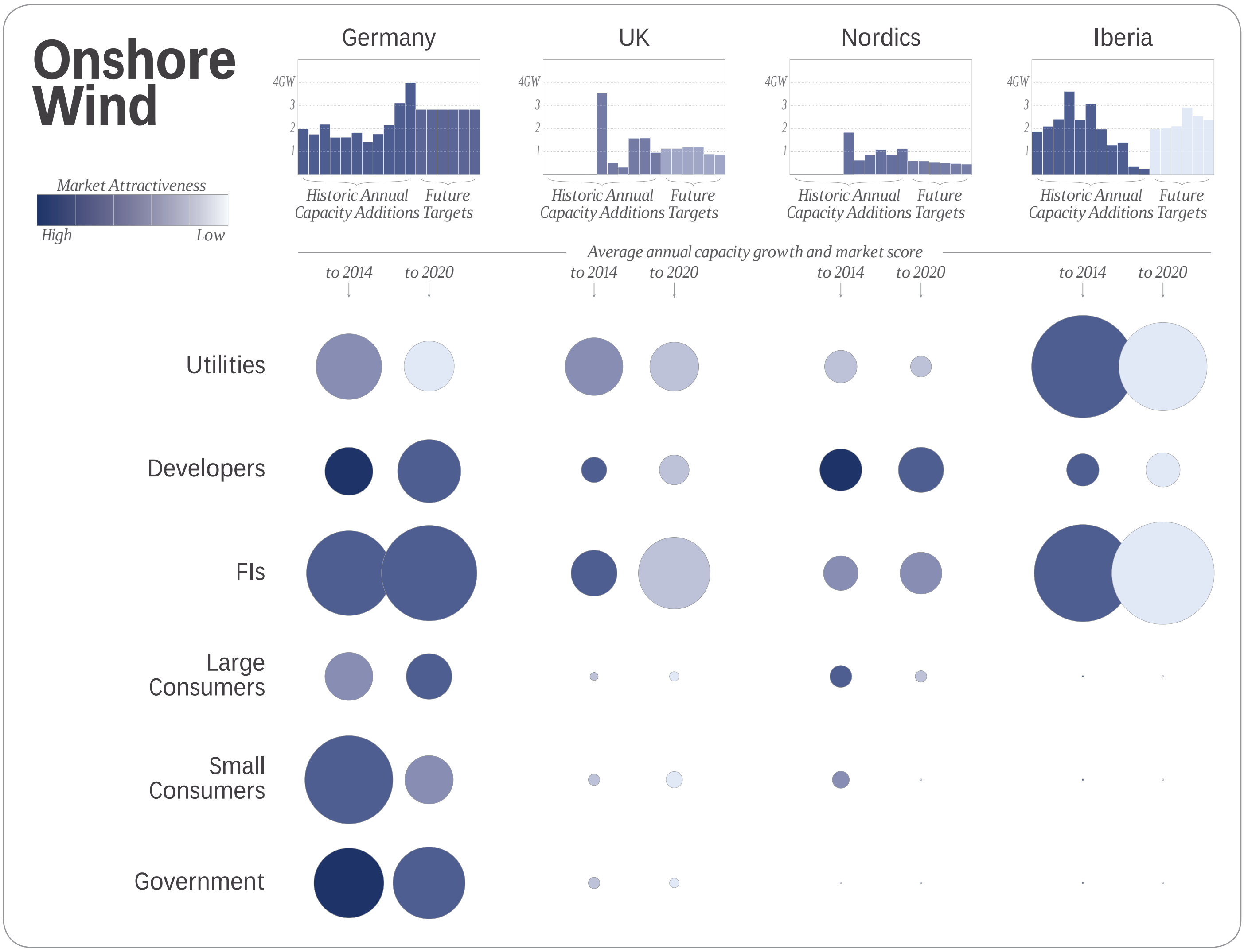
How to read these charts: The following sections include graphic representations that show historic or projected installed capacity according to the size of bubbles; intensity of the shading reflects market attractiveness.

Figure 3: Regional summary of the attractiveness of PV solar



Source: Eurostat, NREAP, German EEG targets and CPI and SEI analysis & investor interviews

Figure 4: Regional summary of the attractiveness of onshore wind



Source: Eurostat, NREAP, German EEG targets and CPI and SEI analysis & investor interviews

1.5.2 Onshore wind

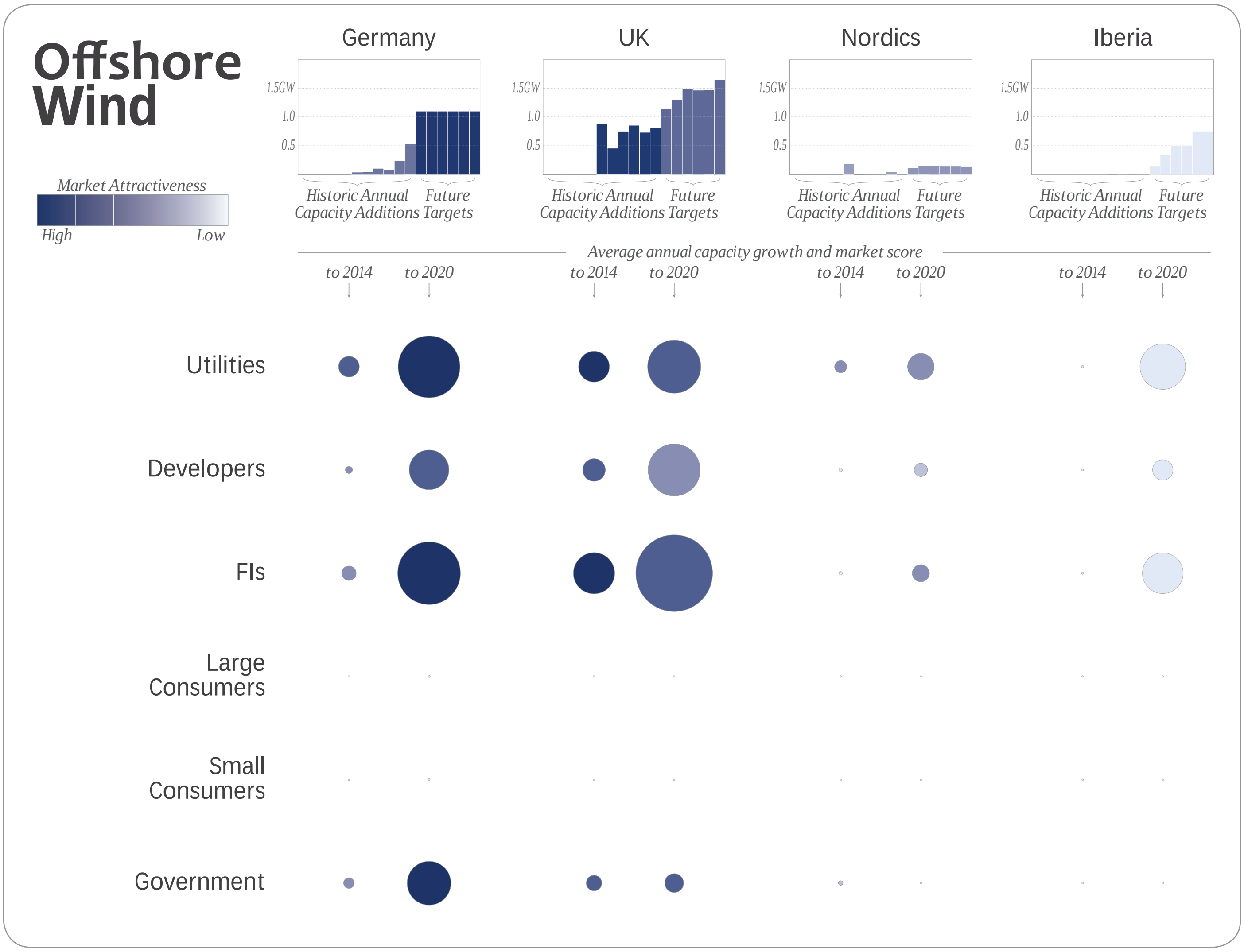
Investment in onshore wind was tilted towards Germany, led by consumers, cooperatives and developers supported by commercial and development banks, and led by utility-driven investment in Iberia. The Nordic market is smaller than the German or Iberian markets, so the substantial investment by developers, mainly working with large energy consumers, is a very significant trend. In the UK, financial investors played a strong role working with developers.

As with solar PV, the environment for onshore wind has worsened for many investors, particularly small consumers in Germany, utilities in Iberia and developers in the UK. However, the environment for other investors remains good, including for developers in Germany and the Nordics, and financial investors in all markets except Iberia.

1.5.3 Offshore wind

Investment in offshore wind presents a very different picture to either onshore wind or solar PV. By its nature, offshore wind demands large-scale and professional, industrial-scale execution. Investment by consumers is, essentially, infeasible. Offshore wind is also a less mature technology, with investment only slowly developing. Among our four regions, only the UK invested heavily between 2005 and 2014, with Germany beginning to start investment and deployment around the beginning of this decade. Going forward, both Germany and the UK have significant targets, while Iberia and the Nordics have comparably modest offshore wind targets for 2020. The policy and industry regulatory environment remains moderately attractive to investors, although investors show concerns around long-term targets and the price regulation of the sector in future. For offshore wind, the longer term policy is particularly important since projects are costlier and take longer to develop, finance and build than other renewables. Long-term policy is much more significant for offshore projects because incentives are tied to reducing the cost of the technology.

Figure 5: Regional summary of the attractiveness of offshore wind



Source: Eurostat, NREAP, German EEG targets and CPI and SEI analysis & investor interviews

1.6 What European policymakers need to think about

Europe is undergoing a transformation in which renewable energy is no longer a fringe investment and has rapidly become a mainstream source of new electricity generation. Policy can intentionally or unintentionally favour one group over another and as a result change the investor mix which can dramatically alter system costs and risks.

We have found that increased access to investing can reduce the cost of renewable energy, ie the more diverse the categories of investor, the cheaper financing becomes.

Policy should encourage the lowest possible cost investment from the most appropriate set of investors in keeping with these four objectives that we mentioned at the start:

1. Balance **cost-effectiveness and deployment** goals
2. Balance **short-term cost-efficiency versus longer-term development**
3. Develop **technology mixes and options**
4. Shape the industry to achieve **industrial objectives and/or public support**

1.6.1 Balance cost-effectiveness and deployment goals

Thanks to policies that have reduced risk and encouraged project development, deployment of wind and solar generation in Europe has exploded over the last ten years, particularly in Germany and Iberia. However, as deployment has grown, so too have costs. Thus, the focus of this maturing industry is gradually focussing on a shift from pure deployment to a trade-off between cost and deployment.

The chart below shows the relative importance of the 10 main policy issues compared with cost and deployment objectives across the regions we have studied. **Our analysis shows that long-term targets attract investment which in turn increases deployment and decreases costs.** For example, the chart shows end user participation – the ability of small and large consumers of electricity to invest in renewable energy projects – attracts the widest possible range of investors and could result in higher deployment, but may not be cost-effective.

Figure 6a: Ten key policy areas and their relevance to deployment targets and cost-effectiveness

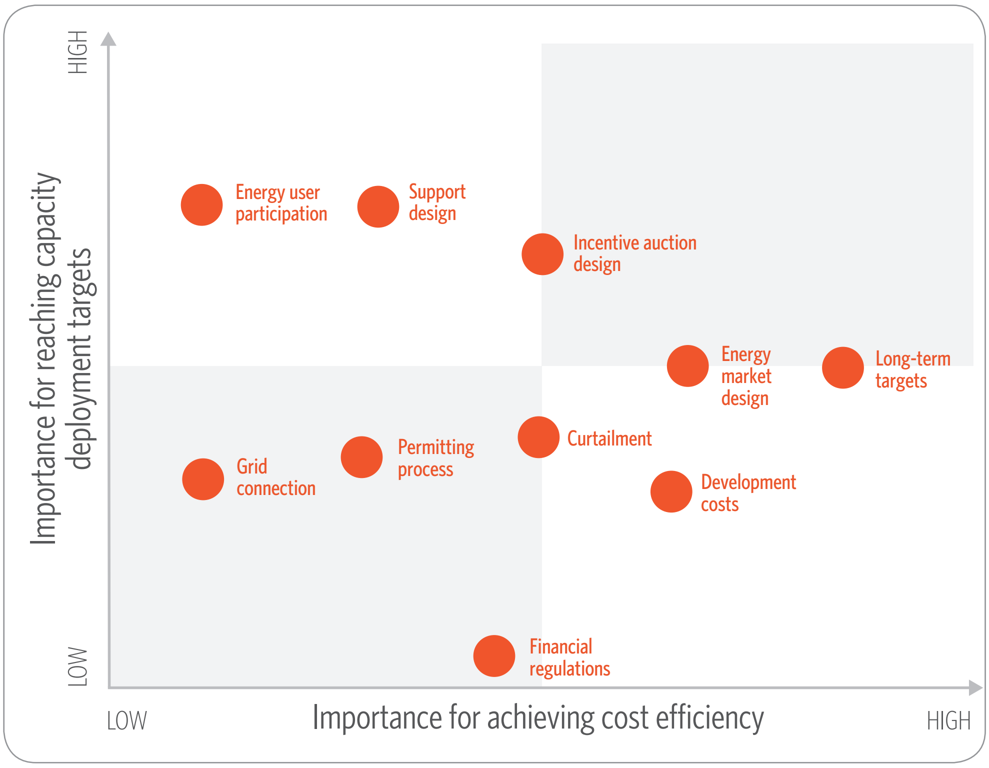
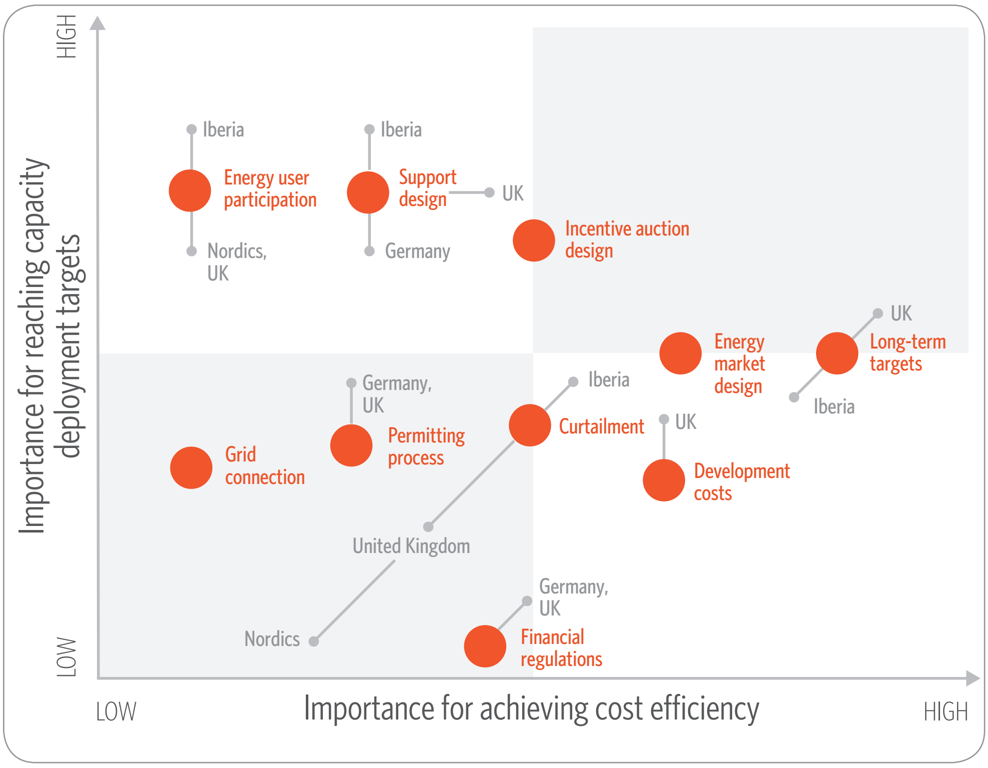


Figure 6b: Policy relevance by region and rate of deployment



In particular, **hourly market pricing mechanisms** typical of electricity wholesale markets incentivise the optimization of the dispatch, maintenance, fuel contracting and operation of fossil fuel plants.

Wind and solar cannot be dispatched according to energy prices, but since the wholesale market sets the benchmark, investors tend to view renewable energy projects as riskier even when they have feed-in-tariffs or contracts that protect them from wholesale price risk.

This risk is particularly acute for projects under development or investors in businesses where the future price is not yet guaranteed.

A regional context

Regional differences are due to industry structure, tendencies of investors, existing resources and policies. The chart above shows how the relative importance of the policy can vary by region, for example in the top left corner, energy user participation was a more important policy focus in Germany in the deployment of renewables than in Iberia, where utility-scale solar dominated.

Beyond the perception of risk, European regulation is pushing to make the wholesale price linkage more explicit – for example as set out in the discussion of **curtailment** below. The result could raise the cost of renewable energy by as much as 17% or more according CPI's findings in Policy and Investment in German renewable energy, April 2016.

Cost effectiveness

In the short term, cost reductions are achieved by eliminating risks and providing incentives that appeal to the lowest cost investors.

- **Energy market design** should create as few risks to target investors as possible. EU market design has been evolving for three decades in an effort to improve the efficiency of the system and incorporate objectives like competition, decarbonisation and energy efficiency. With large amounts of investment already sunk into infrastructure and existing investments, and a 30-year history of optimizing a system largely based on fossil fuels and nuclear, it is unsurprising that the current system and some of the design philosophy for future development sits uncomfortably with the very different financial and operating characteristics of renewable energy.

As long as the industry pricing structure is dominated by the current risk and reward paradigm, renewable energy investors will continue to frame their investment strategies with the risks, and higher costs of capital, associated with the riskier businesses of fossil fuel generation.

- **Curtailment** risk means that renewable energy generators may not be paid for their output due to market conditions, ie negative pricing over an extended period. It is an element of energy market design that deserves special mention as it is both large and beginning to affect the policy and investment debate.

  EU state aid guidelines published in 2014 require that there be "no incentive to generate electricity under negative prices". This has been widely interpreted to mean that revenue support cannot be provided to renewable generation during these periods and so it is not economic for them to continue generation.

Some EU countries are not affected because prices have a floor price set at zero. Additionally, punishing renewable generators for factors outside of their control is not conducive to encouraging investment. **Improved forecasting, grid management, flexibility planning and market design are all options that can mitigate the risk of economic curtailment.** However, renewable generators have a limited influence on any of these options so are not best placed to take economic curtailment risk.

State aid approval for the UK and Germany allows prices to be negative for six consecutive hours before support payments are retrospectively cut from the time that prices turn negative. This reduces economic curtailment risk to an extent, although as more and more renewable energy is deployed the greater the risk becomes. Germany is in the process of developing further policies to reduce economic curtailment risk. It will be interesting to see what they come up with and whether they will need to be ratified by the EU. See Appendix A3 for a more detailed explanation of curtailment as well as the results of analysis in relation to economic curtailment that we have prepared for our Policy and investment in German renewable energy study.

- **Incentive auctions,** where investors bid on the price that they will supply energy from renewable resources, should improve price discovery and create incentives for investors and developers to reduce cost. **If there is enough competition such that only the most cost effective projects are successful, lower prices will be achieved and only the best-performing investors will survive in the industry.**

  In principle, the largest and most professional of the investors like auctions as they create advantages for those investors who develop sophisticated project development and business systems and they clear the market of less disciplined competitors. However, for the large investors, design is very important. Auctions that have unpredictable outcomes, involve large upfront pre-auction development costs and are infrequent – so that a loss in a bidding round can mean long delays – all make auctions expensive and unattractive.

- **Long-term targets** are important in providing visibility to investors as a whole and make it attractive. **If investors trust targets, they will compete to establish market position and invest in developing capabilities that will lower their costs over time.** Generally, targets are in place in Europe, but in some markets such as Spain, targets have not been backed up by credible policy in other areas. Long-term targets generally affect incumbents and larger players who regard current investments as part of a long-term strategy. One off project investors are relatively unconcerned.

- **Development costs** are an important multiplier to risk and cost effectiveness of policy. **The higher development costs are, the more investment a developer will have at risk at any one time which can discourage investment.** Development costs are typically a function of many policy and other factors in the business environment.

Deployment goals

Meeting deployment targets requires a system that encourages alternatives in case one investor group falls short, or higher returns to make sure that investors are incentivised to participate even if costs unexpectedly rise.

- **Incentive auction design** should, in theory, ensure that deployment targets are met, since the auction sets the deployment level as an input parameter as to how many incentives are issued. However, a design that encourages or enables investors to back out could lead to deployment levels that fall short. Alternatively, imposing large penalties for failure to deliver may help ensure deployment, but is likely to increase risks and, therefore, financing costs.

  Auction designs could also discourage investors and therefore reduce the potential investment in the system to below the levels needed to meet targets. For example, from a small investor perspective, auctions can be daunting, creating complex bidding rules, raising development costs and discouraging investors who might pursue a single project. In the solar PV rounds in Germany, small investors were almost entirely excluded from the winning bid pool. **If policymakers wish to maintain a diversified pool of investors there are several adjustments to incentive auction design that could help, including de minimis exemptions that allow small projects to access the market without entering the bidding** if they meet the winning bid price, or separate auction pools for smaller bidders.

- **End user participation** can be affected by policies that discourage sets of investors or change their economics. **In Spain, for example, households are charged large fees to connect their systems to the grid in order to compensate distribution system companies for the costs that rooftop systems could impose on distribution system operators.** The impact is to make rooftop solar uneconomic.

1.6.2 Balance short-term cost-efficiency versus longer term development

The initial impacts of policy on cost versus deployment can change rapidly. For instance, if there already is a large pipeline of fully developed projects in place, policies that raise development costs and risks would have little impact on either cost or deployment in the short term. However, as those developed projects were exhausted, the impact would rise.

- **Energy user participation:** While focussing on a single, lowest cost, investment class may reduce costs in the short term, additional investors may be needed or useful in the future, either because relative costs change and different types of investment become more cost effective. Our analysis suggests that rooftop investors have different expectations than utilities or developers, and in many cases this investment is already lower-cost than investment in utility-scale solar projects. However, as rooftop solar costs fall relative to utility-scale projects, a greater proportion of this investment may become lower cost. **Therefore, if utilities exhaust their financial capacity or the stock of low-cost land available for utility-scale projects, rooftop solar projects would be needed to fill the gap and keep costs low.** Since costs fall partly as a function of experience and time, policy that encourages rooftop solar investment today could be helpful in ensuring that low-cost investment options are available in the future.
- **Curtailment** that is due to a lack of transmission capacity is well understood by investors and can be modeled and addressed in the investment decision. However, as renewable energy penetration grows, curtailment due to excess on the energy system which creates negative prices is likely to increase, as our analysis of Germany shows. Our research indicates that very few investors are aware that negative prices could increase over time and that EU law may imply that renewable energy generators cannot be paid for energy delivered during periods of negative prices. Although both technical and economic curtailment provide an element of uncertainty for investors, the latter is far less predictable and so is a risk that is much harder to price. As such, some investors may take the view that they cannot participate in a market with such a degree of uncertainty. **However, our analysis suggests that within the next five years the number of negative price periods each year could increase up to tenfold without significant improvements in flexibility options.** At that level of uncertainty on the likely output of an investment, investors will either find the industry uninvestable, or demand much higher prices to invest, raising overall system energy costs.
- **Incentive auctions** typically rely on a pipeline of projects that are already developed. Auctions should be competitive and drive down prices as developers strive to recoup their costs. However, over a longer time frame, auctions must provide incentives to develop new projects, as well as incentives for participants to continually improve their cost position. **Auctions that create sufficient but not excess earnings for developers and maintain a robust degree of competition to avoid a monopoly are needed to provide for a longer term future.** Furthermore, separate auctions may be needed to ensure diversity of technology, resources and investors.
- **Energy market design** is currently not optimal for low-cost renewable energy. **Over time, new models for the energy market need to be designed that allocate risks between consumers and generators in ways that reduce the overall risk-adjusted cost to the system.**

1.6.3. Develop technology mixes and options

For cost and energy security reasons, among others, energy policy is likely to require a diverse set of renewable energy technologies. In much of Europe there is more wind in the winter, but more sun in the summer. Offshore wind provides a more constant baseload supply of energy. Working together, these technologies provide a more balanced energy supply and reduce the costs of balancing the system. Furthermore, as relative prices change, policy may need to shift to the lower cost technology, but the lower cost technologies may only develop if there is continued deployment of that technology that allows the economies of scale and cost reductions to kick in. Meanwhile, as we have shown, investors, financial and policy needs can be very different from technology to technology and even for different types of projects and locations within a technology. **It is likely that the best solution will be one that creates different policy regimes and markets for each technology, even once the technologies are completely mature.**

Additionally, there are sets of policies that are needed to integrate the resources across Europe and ensure access to the best and lowest cost resources is achieved cost effectively.

- **Transmission interconnection.** As renewable energy has become a major source of energy in many national markets, the benefits - and requirements - of balancing intermittent energy supply across ever wider regions has also grown. In Spain, the main driver of a negative policy outlook is the excess capacity in the region, driven by a rapid build out over the last decade. **Investors with access to some of the best solar and wind resources in Europe are discouraged because of the lack of a reliable market in which to sell the energy.** From an investor point of view, the shift in policy from positive to negative has been driven as much by the excess capacity and the lack of market as it has been by austerity measures and attempts to reduce costs.

  In 2002, the EU set a non-binding target for 10% of a nation's generation capacity to be connected to other EU countries by 2020 in order to eliminate isolated electricity systems, facilitate mutual support between countries and promote the single European energy market.

  In 2015, after an almost 30 year hiatus the capacity of interconnection between Spain and France doubled to 2.4GW. **Feasibility studies for a further 1Gw-2GW of capacity have been undertaken although even if these lines were installed interconnections levels would still be well below the approximately 10GW level required by 2020 to meet the 10% target.**

  Meanwhile, the Nordic region is pursuing significant new interconnection capacity with Germany, the Netherlands, the UK and the rest of Europe. This capacity would not only enable the region to bring forward development of attractive wind regimes, but would also provide additional value of using the region's hydro resources to balance the intermittent supply from renewable resources in Germany and elsewhere. However, the interconnections are costly and the final design and cost benefit is uncertain, which is delaying new build.

  Overall, increased interconnection capacity will provide many benefits to the system that will encourage investors. But uncertainty and timing around expansion means that investors are not yet in a position to consider or benefit from any major new interconnection.

- **System flexibility.** In addition to increasing transmission interconnection, another important way of reducing the risk of negative prices – and the impact of intermittency in general – is to increase the flexibility of demand and supply in the electricity system, and the responsiveness of each to market conditions. As batteries shift load from day to night and from calm periods to windy periods, as consumers adjust their demand, and as other sources of flexibility are built into the system, the threat of negative prices diminishes.

  Those investors that view negative prices as a threat and are sophisticated enough to try to quantify the impact, will take a view on how much flexibility will develop in the system over the coming years. At this point, the development path for many of the new potential sources for flexibility remain uncertain. **Investors are unlikely to incorporate significant increases in flexibility into their future projections until there are stronger, more visible and more certain policy efforts underway.**

1.6.4. Shape the industry to achieve industrial objectives and/or public support

Investment in large-scale coal, gas, nuclear or hydroelectric power plants, extensive transmission systems and complex energy and balancing markets has been at the heart of electricity system development for many years. These large-scale, complex and interrelated investments all benefit from the professional, industry-focussed leadership of utilities, independent power producers and other sophisticated industrial companies. **Renewable energy is not necessarily as complex and so opens the potential for new types and classes of investors.** The question posed by the contrast of the recent developments of the German and Spanish electricity systems is whether policy should change its structure to encourage more types of investor.

Although utilities across Europe are struggling due to declining growth and increased competition, with the appropriate policy utilities could meet all new investment needs. Continuing to focus on incumbent players might be the least disruptive path, but it could raise costs in both the short and even more so in the long term, as many low cost renewable energy investment opportunities could become excluded by utilities focusing on projects with the scale and characteristics they are designed to address.

Beyond incumbents versus new entrants lies the question of small versus large investors. Small projects, and investors who develop only single projects, are likely to have higher initial investment costs due to the lack of economies of scale and inexperience. However, in some cases lower land costs and opportunities to offset costs in other ways can lower the initial investment cost. More significantly, consumers may have other needs – for instance a desire to use only green energy or a wish to hedge future energy costs – that lower their required return on investment.

Our interviews suggested that some investors only seek to recover their initial investment. **Despite some initial data that suggests higher short-term costs for small projects, the low return requirement and ability to offset costs could lead to lower costs per unit of energy and thus lower overall systems costs.**

Innovative business concepts could exploit these cost lowering opportunities and unleash significant new low cost investment from small investors, given the right push.

Several policy elements could push the industry one way or another. Complex planning or bidding schemes raise the transactions costs to small players and discourage their involvement. Rules around net metering or how systems costs are charged for self-generators can also provide barriers as they do in both Spain and in Germany. On the other hand, carve outs for small investors, targets, feed-in-tariffs, information provision, and low-cost loans can all assist in the development of the small investor segment, but each of these have costs associated with them as well as benefits.

Although the near-term lower disruption and apparent cost advantages make policy supporting larger players attractive, longer term cost optimization could make continued development of smaller scale solutions a priority. There is no right answer for the long term structural debate, but policymakers today need to consider now, more than ever, how small policy changes can lead to different future industry models, and how other policy decisions could cut off entire ranges of potential future investment.

1.6.5 Conclusions: investment potential

At the country level

Germany continues to lead the way with its ambitious *Energiewende* plans. However, the future of Iberian and UK renewables looks much more uncertain. The Nordics benefit from high levels of hydropower generation but whether there is real ambition to push for further renewable deployment remains to be seen.

Germany's feed-in tariffs attracted a broad range of investors. Individuals and local communities were incentivised to invest which helped with public acceptance but it is not the most cost-effective approach since returns were high even for plants in locations with suboptimal renewable resources. It remains to be seen how a planned transition to auctions will affect the investment mix, although auction an exemption for solar and wind farms below 750kW may adversely affect investment in small multi-turbine wind projects.

The **UK** government has decided to support offshore wind and nuclear power, while phasing out subsidies for the onshore and solar markets under the pre-text that these technologies are competitive and no longer require it. Renewable developers and end-user investors that consume their own production, or 'prosumers', are therefore likely to have a very limited role in the future of UK renewables and it is hard to see how this outcome can be reversed in the near term.

The **Nordics** do not imminently require new wind turbines. Electricity prices are currently too low to support new build for any type of power plant at present so the energy market design will need to be revisited before significant levels of wind can be deployed. Wind is still a technology that is currently too large and expensive for small prosumers to invest in, so micro-generation is not a viable option in this region at present. Greater interconnection has the potential to significantly improve deployment levels in the region however because the potential wind resources are very favourable.

Iberia is another area with excellent natural resources, including solar. Historic levels of renewables deployment exceeded Germany's but investment has now ground to a halt as a result of a lack of revenue support in Iberia as a whole and questionable policies in Spain in particular. Spain's government appears to have been somewhat disingenuous by superficially supporting renewable technology while designing policies that on closer inspection are un-investable. The country is hampered by over-capacity and a lack of interconnection to France. The French do not want their electricity market to be flooded with cheap and volatile Spanish generation and until this issue is addressed there is no potential for further investment. Meanwhile, self-consumption is not an option in Spain as utility business models dominate the market.

At the European level

There are significant risks and opportunities at the European level. The threat of economic curtailment has been increased by EU rulings on state aid and could increase the cost of power from renewable energy plants by 17% or more. Further interconnection is vital to address balancing and renewable deployment requirements and could help drive further investment and reduce costs. If these issues are addressed then the focus can shift to how financing costs can be reduced to bring down the overall cost of renewable energy. YieldCos, crowd-funding vehicles and municipal funding all provide excellent potential sources of low cost capital. Europe has served as a model for low-carbon transitions and the opportunity for it to maintain leadership and maximize the benefits of this transition remains.

Part two

Appendix A: Companion papers

Appendix 1
Policy by investor type

UTILITIES

Utilities face a difficult investment environment due to a variety of factors including policy challenges, low electricity prices, market over-capacity, balance sheet pressure and competition from developers and financial institutions.

Among the four regions we studied, the impact of policy on utilities' investment in renewable energy has varied significantly. In Iberia, policy has driven very substantial, large-scale investment by utility companies which led to the rapid deployment of wind.

In other countries, outside of offshore wind, investor-owned utilities (IOUs) have taken much smaller roles and have faced less favourable policy, compared to other investors (with the exception of UK onshore wind). Municipal utilities on the other hand have had lower funding costs and return requirements and so have been more willing to compete with developers in the more established onshore market.

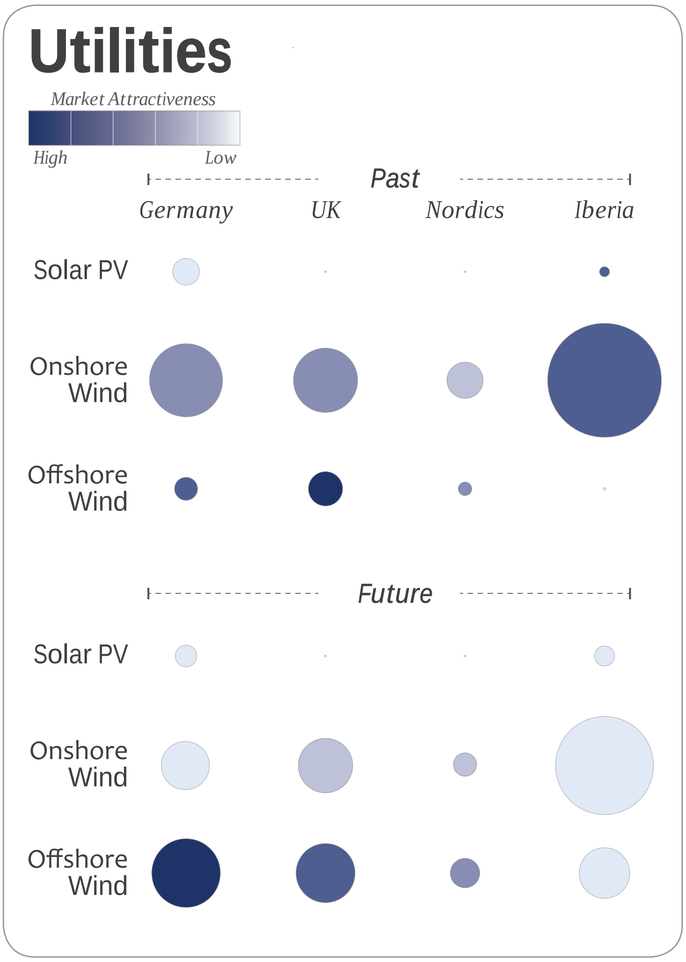
Offshore wind requires the scale and sophistication that the utilities bring, and has been a mainstay of the early development of offshore wind energy in the UK.

Going forward, IOUs face a relatively unattractive investment picture. In Iberia this picture reflects the generally unappealing environment for the industry, while in other jurisdictions, they are finding it increasingly difficult to compete with developers (including some that are subsidiaries of foreign-owned utility companies) and financial institutions, due to the better match of renewable energy cash flows to the investor return requirements and business processes.

In Germany, utilities identified grid connection policies and grid curtailment as issues that affect their business. IOUs are almost exclusively focussed on offshore technologies and so visibility of future deployment levels through long-term targets is considered important alongside mitigating auction risks, in particular around development costs which can exceed €50m for a single project.

In the UK, utilities have told us they are struggling to invest because of a lack of capacity on the balance sheet to borrow more debt without further jeopardising their credit ratings and increasing their cost of capital, although arguably this is an even greater issue for the German IOUs (two of which are also incumbent in

Figure 7



Source: Eurostat, NREAP, German EEG targets and CPI and SEI analysis & investor interviews

the UK). Despite this, utility investment in UK wind has been moderately high primarily due to attractive revenue support with offshore wind investment picking up notably in recent years as the technology matures. Capacity margins are set to decrease further as old coal plants shut down and its nuclear development program suffers further delays.

In Sweden, the government is allowing nuclear operators to replace ageing reactors with new ones. Utilities told us that until there is greater interconnection with the UK and mainland Europe there is no real incentive to develop higher levels of renewables, particularly in Norway which already has very high levels of green generation.

In Iberia, the utilities have no inclination to develop more renewable sites because of the tariff deficits from previous support design errors, and because of over-capacity issues. Much more interconnection with France is required despite this doubling last year.

DEVELOPERS

Developers will continue to be major players in the regions studied, with the exception of Iberia, where policy is unattractive for most investors. Overall, the policy and investment environment is more challenging than it has been in the past.

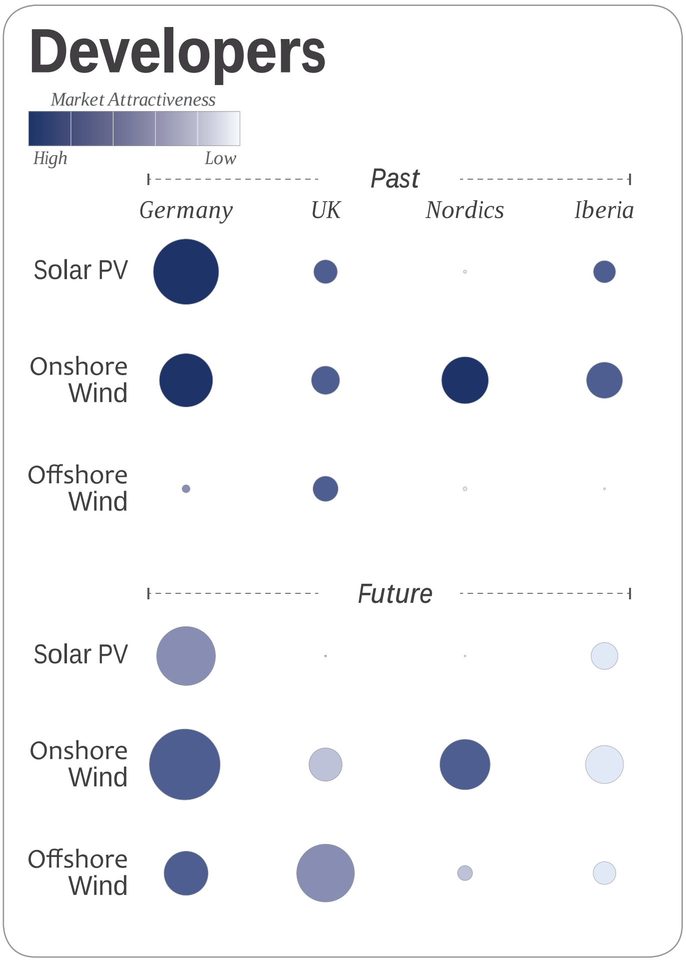
Developers have played major roles in deploying renewable energy, particularly onshore wind. A wide variety of strategies and business development models are available to developers, including independent power producers, equipment manufacturers or pure play renewable energy project developers, and development companies of international utilities seeking to diversify. Developers have been able to take a large role across the variety of country regulatory regimes and technologies.

Overall, the policy and investment environment is more challenging than it has been in the past. However, we expect that developers will continue to innovate and evolve and will retain their position as major players. Iberia, where Spanish policy is unattractive for most investors, will be the exception, albeit the outlook is more positive in Portugal.

In **Germany**, developers (and other players willing to take development risk) are affected by a variety of issues. Incentive auction design was particularly topical in the interviews we conducted, most likely because details had yet to emerge of the new design, but it was widely acknowledged that it would inevitably introduce a greater element of development risk. Other topics raised include long-term targets, support design, permitting, development costs and grid-connection.

In the **UK**, the focus is on the lack of revenue support from the new government. There is a consensus that the Levy Control Framework (LCF) budget is being used as an excuse for tightening the purse strings although there is a lack of clarity around how much of the budget remains unspent. The UK has also been singled out as a particularly difficult country in which to get planning permission, and this has become more difficult as recent planning policy changes give local residents greater powers to block developments.

Figure 8



Source: Eurostat, NREAP, German EEG targets and CPI and SEI analysis & investor interviews

In the **Nordics**, developers are struggling to raise funding for new projects because overcapacity is pushing down power prices and because green certificate prices are too low due to their over-supply and a lack of a floor price. Until price signals become adequately high, development will be limited.

In **Iberia**, there is limited revenue support for renewables, although some subsidy free solar PV is being developed in Portugal.

FINANCIAL INSTITUTIONS

Financial institutions continue to find an encouraging policy and investment environment in wind, particularly in **Germany** and the **UK**. Policy and revenue concerns in the Nordics and Iberia are more challenging.

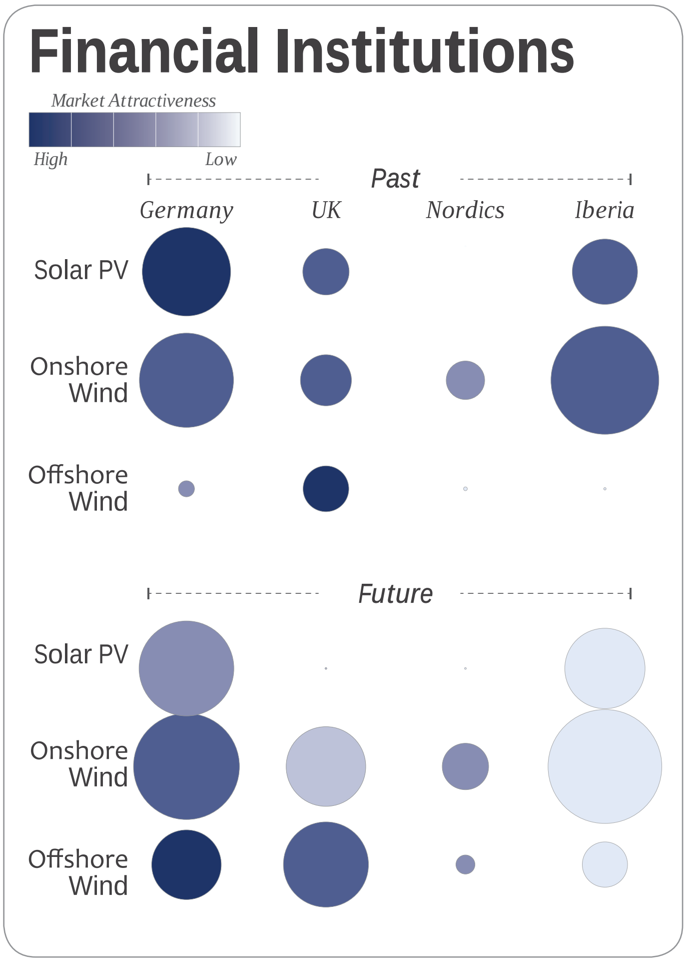
Financial institutions have invested billions of euros and pounds across all of the renewable energy technologies. Much of this investment has come in the form of bank debt, but asset managers and institutional investors have also played important roles in providing equity. In Germany, the interest rates on debt have been relatively low, but the good match of the reliable cash flows, the need for conservative investments, and low cost finance provided by KfW have all contributed to significant investment. In the UK, past policies have been reliable and attractive, and financial institutions in Iberia have also found attractive investment opportunities.

Going forward, the regimes in Germany and the UK seem likely to continue to be relatively attractive. In particular, we expect to see financial investors taking outsized roles in offshore wind. However, budget constraints and auction timing uncertainty make the UK a notch less attractive than it was previously.

In **Germany**, financial institutions are attracted by the revenue certainty that support policies can provide. A transition from feed-in tariffs to direct marketing under a contract for difference (CfD) increases revenue risk a little as generators have to enter into their own offtake contracts with third parties rather than export to the grid and receive a guaranteed FiT revenue. However, competition for assets remains high and capital costs are exceptionally low because of the cheap debt available from the development banks. Financial regulation has an impact on returns and thus influences investor appetite, loan margins and equity prices.

In the **UK**, a transition from Renewable Obligation Certificate (ROC) feed-in-premia to CfDs has provided greater revenue certainty. Support payments are linked to inflation which is particularly attractive for institutional investors who have index-linked liabilities, although CfD support periods are for 15 years as opposed to the 20 years under ROCs. It should be noted that whereas ROCs have been linked to the Retail Price Index (RPI) the CfDs are linked to the Consumer Price Index (CPI) which is usually a lower rate of inflation.

Figure 9



Source: Eurostat, NREAP, German EEG targets and CPI and SEI analysis & investor interviews

Financial regulation under Basel III and Solvency II is also of particular significance to financial investors in the UK.

In the **Nordics**, financial institutions are concerned with revenue certainty, although in Sweden this is particularly low because there is no floor price for green certificates, which in turn pushes up capital costs.

In **Iberia**, financial institutions have been severely affected by retroactive tariff cuts. This move has damaged investor confidence so even if policies that properly support renewable investments were introduced it is far from certain that financial investors would be willing to risk their money again without substantial risk premia.

LARGE CONSUMERS

Large consumers are likely to show continued interest in German solar and onshore wind (though there is concern about EU competition law and curtailment), but will likely invest little elsewhere.

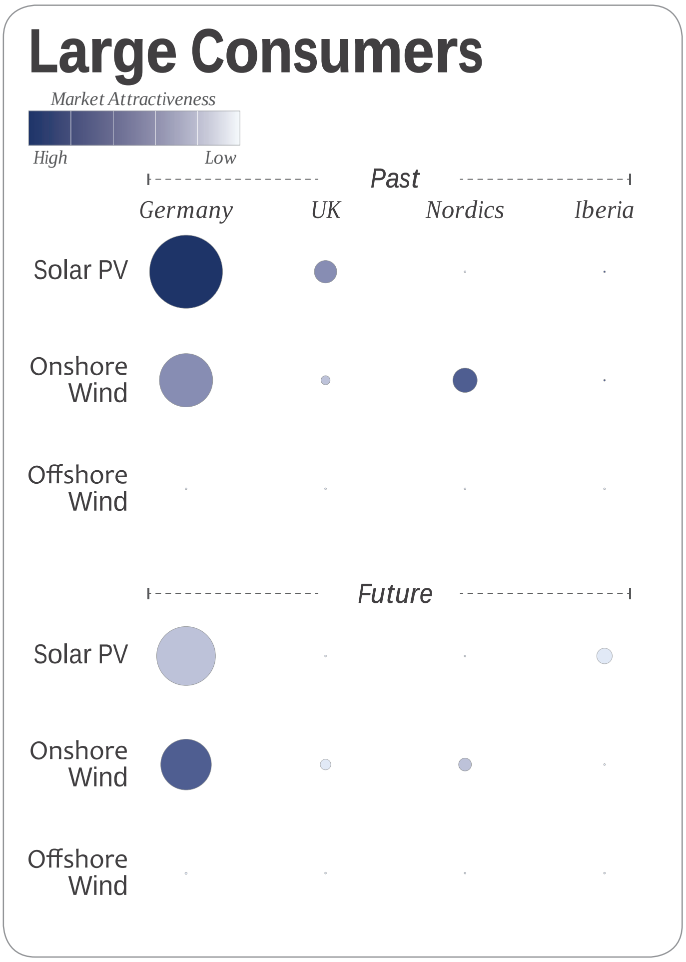
Large consumers can invest in renewable energy to meet their own needs or as general investors. Here we focus specifically on generation to meet their own needs, which faces a different set of regulatory, pricing and business considerations. In some cases, large consumers could build renewable energy to offset their own energy consumption and thus hedge energy prices into the future.

In Germany, attractive feed-in tariffs have encouraged industry and particular commercial consumers to install solar PV on their available rooftops. In the UK, large consumer participation has been small although there is potential for growth through corporate power purchase agreements (PPAs), while in Iberia consumers have been discouraged by regulation.

Going forward, we expect continued large consumer investment in Germany, but little investment elsewhere. Current investment environments are likely to continue in Iberia and the UK, while in the Nordic regions there are fewer industrial concerns that have either not already invested or have the desire to enter this market. Meanwhile the incentives, such as the certificate market, have made investment less attractive for large consumers.

In **Germany**, large consumers and 'prosumers' (consumers who produce their own electricity) can qualify for a variety of benefits including surcharge exemptions, tax benefits and levies which can be vital to the ongoing future of the businesses. Some of these policies have changed adversely in the past and there is an inherent fear that EU competition law, public opinion or lobbying groups could influence further policy changes to the detriment of these beneficiaries. Curtailment is also an area of concern for prosumers if they are unable to export electricity during times of excess generation.

Figure 10



Source: Eurostat, NREAP, German EEG targets and CPI and SEI analysis & investor interviews

The role of large consumers in other regions has been very limited and is set to remain so for the foreseeable future. While self-consumption is a viable option in the **UK** and **Portugal** with minimal or no revenue support as panel prices continue to fall, prosumers in **Spain** are required to disconnect from the grid, so this is not an option until storage technology becomes economic.

Sweden has a history of large consumers such as pulp and paper manufacturers generating their own power although this is widely viewed to have run its course, at least until energy market design results in an expectation of higher power prices and/or a more effective revenue support mechanism is established.

SMALL CONSUMERS

Tighter incentives and targets lower than previous deployment levels will likely lead to significantly reduced participation from small consumers in Germany. With no other region looking to follow Germany's example, small consumers look set to take a much smaller role in the medium term.

Like utilities, the participation of small consumers is strongly dependent on policy and national energy strategy. Germany has been the biggest proponent of involving small investors in its energy transition. The result has unleashed billions of euros of investment in the rooftop solar space, as well as community and cooperative-based onshore wind projects and wind projects owned by landowners.

While the strategy has provided large sources of investment that lie relatively untapped in the other jurisdictions, there are questions as to whether small consumers are cost-effective.

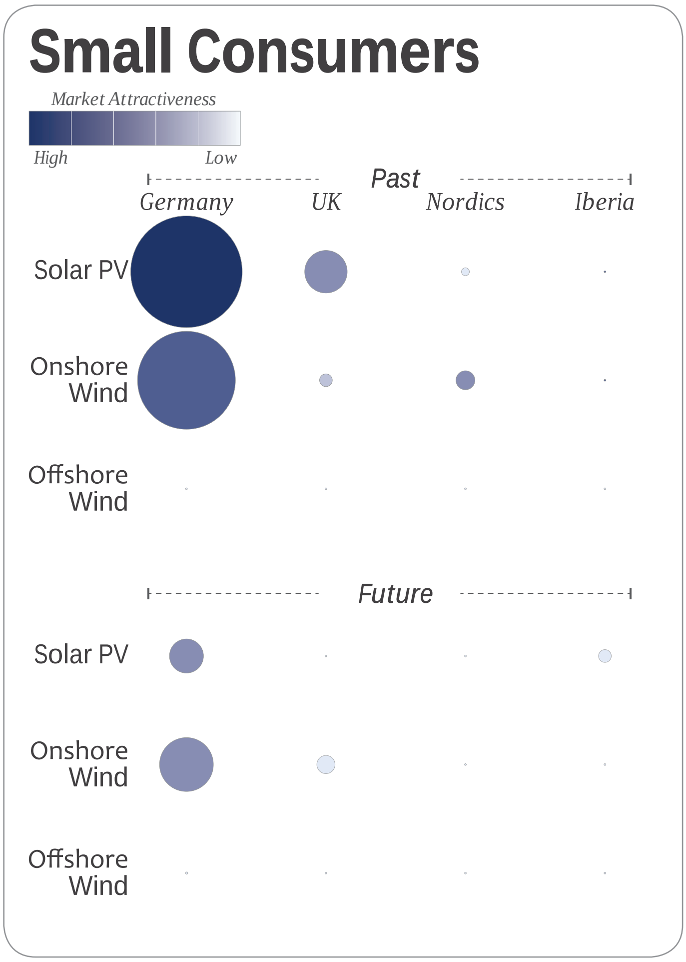
These investors are relatively unsophisticated and so do not often respond to the balance of risk and reward as with other investors. In order to build and incentivize this market, Germany offered incentives that appeared lucrative even at face value. The result was that investment was often relatively expensive. Furthermore, the smaller scale of many consumer projects means that performance is lower and the cost per unit of capacity is usually higher than large-scale projects.

Our interviews and analysis, however, pointed to areas where costs might be lower for small consumer projects, such as lease costs, and where the cost of capital might also be lower due to differing investor expectations. Therefore, it is not clear whether investment from small consumers is always likely to be more expensive than from other sources.

For example, Germany is attempting to tighten incentives to ensure that small consumer investment is competitive with other sources. That, combined with lower targets and expectations, will likely lead to significantly reduced participation from small consumers. However, as policymakers search for investment sources to meet renewable energy targets and programs to generate greater public acceptance, small consumers remain an interesting option.

In **Germany**, future prosumer participation will depend principally on the level of revenue support available. Cooperatives are also interested in how the new

Figure 11



Source: Eurostat, NREAP, German EEG targets and CPI and SEI analysis & investor interviews

support regime will work and will need to establish whether it is preferable for their returns to build below auction *de minimis* levels or not.

In the **UK**, the crowd-funding market for developers that were too small to attract traditional sources of project finance was primarily concerned with how to satisfy the requirements of financial regulators, particularly around making investors fully aware of the risks and the creation of a more liquid market. However, these fledgling platforms have been stymied along with the rest of the renewables industry following a series of changes introduced after the last general election, despite tax-free savings and favourable pension rules having attracted investors to a limited extent.

In **Spain**, small prosumers face similar penalties to large prosumers. Cooperative funding projects have started emerging in recent years as a backlash to the removal of political support for renewables. The high electricity prices in Spain help the cooperatives to compete with utility generation even without subsidies although this market is still very small at present. Self-consumption remains a viable option in Portugal, however.

In **Sweden** the biggest issues have been around energy tax exemption rules which can reduce electricity costs by as much as 50%. These exemptions have been withdrawn and amount to a retroactive cut which has wiped out investor appetite.

GOVERNMENTS

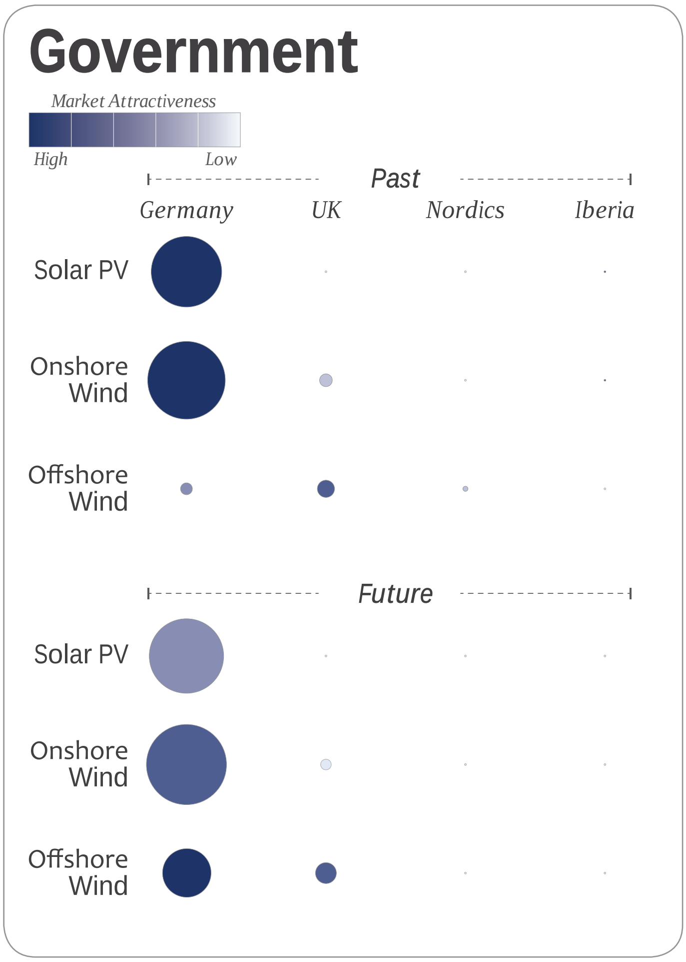
European governments are looking to the private sector to meet renewable targets; they will likely continue to play a smaller role in directly funding projects.

While governments are able to influence investment in renewables using many levers such as policy, utility ownership, subsidies, grants, guarantees and taxation, one of the options is to directly invest in renewable energy. The UK and German governments have both used the banking sector in different ways to make money available for loans and equity that fund developments. Local governments also benefit from low funding costs on the capital markets because of the implicit support that they are receiving from the national government.

With so many options available to governments one of the challenges is to determine the best way of supporting renewable generation. Even defining what 'best' means can be a challenge since there are so many considerations such as the definition of costs, impacts on jobs and industry, and creating 'fair' competition, to name but a few.

European governments are looking to the private sector to meet renewable targets. Energy consumers ultimately foot the bill for renewable support and we are not seeing high levels of borrowing from European governments to fund further deployment. This is because high debt levels will push up borrowing costs and because the industry can be supported in other ways which do not require large sums of government capital.

Figure 12



Source: Eurostat, NREAP, German EEG targets and CPI and SEI analysis & investor interviews

Appendix 2 Technology investment and policy by region

As we have seen in the previous section, every investor is different and they are likely to be attracted to very different renewable energy technologies. Market design, investment and policy is set at the technology level, so policymakers should consider how all of the investor classes fit together within and across the renewable technologies that are likely to contribute the most to meeting their deployment targets.

Solar PV attracts the widest range of investors. The small size of PV installations and the fact that economies of scale are limited compared to other technologies allows small investors access to rooftop or community solar PV projects among others. However, the greater competition and the relatively small benefit of applying industrial scale and industry knowledge can make solar PV less attractive for the large, industry focussed investors such as the investor owned utilities.

Onshore wind is the next step up in terms of investment size. While there are economies of scale, modest €1m-€ 10m projects are not uncommon and provide opportunities for landowners, cooperatives and smaller investors. However, the attractiveness to different types of investors here is strongly dependent upon policy. Different policies could attract more investment from larger players or facilitate the entry of smaller or non-energy industry investors.

Offshore wind requires large-scale investments in projects that involve significant development expense, and industrial-scale skills and investment capabilities. Investments can exceed €1bn. These characteristics increase the attractiveness of the technology for large utilities, developers and financial investors and mean investment is beyond the reach of medium and small scale investors.

Future investor mixes in different countries depend strongly upon the future technology mix and the willingness of policymakers to encourage a given technology. Differing national conceptions of energy markets can also influence which investors are able to invest and therefore the types of technologies and projects that get built. To better inform policymakers' decisions, we reveal the interplay between policy, deployment and investors separately for each of the three renewable energy types listed above.

SOLAR PV

Our analysis suggests that policy and market environments will be considerably less attractive across every investor category, making sourcing the investment to meet 2020 renewable deployment targets challenging, particularly in Spain. The UK has already far exceeded the somewhat unambitious National Renewable Energy Action Plan (NREAP) target of 2.7GW however.

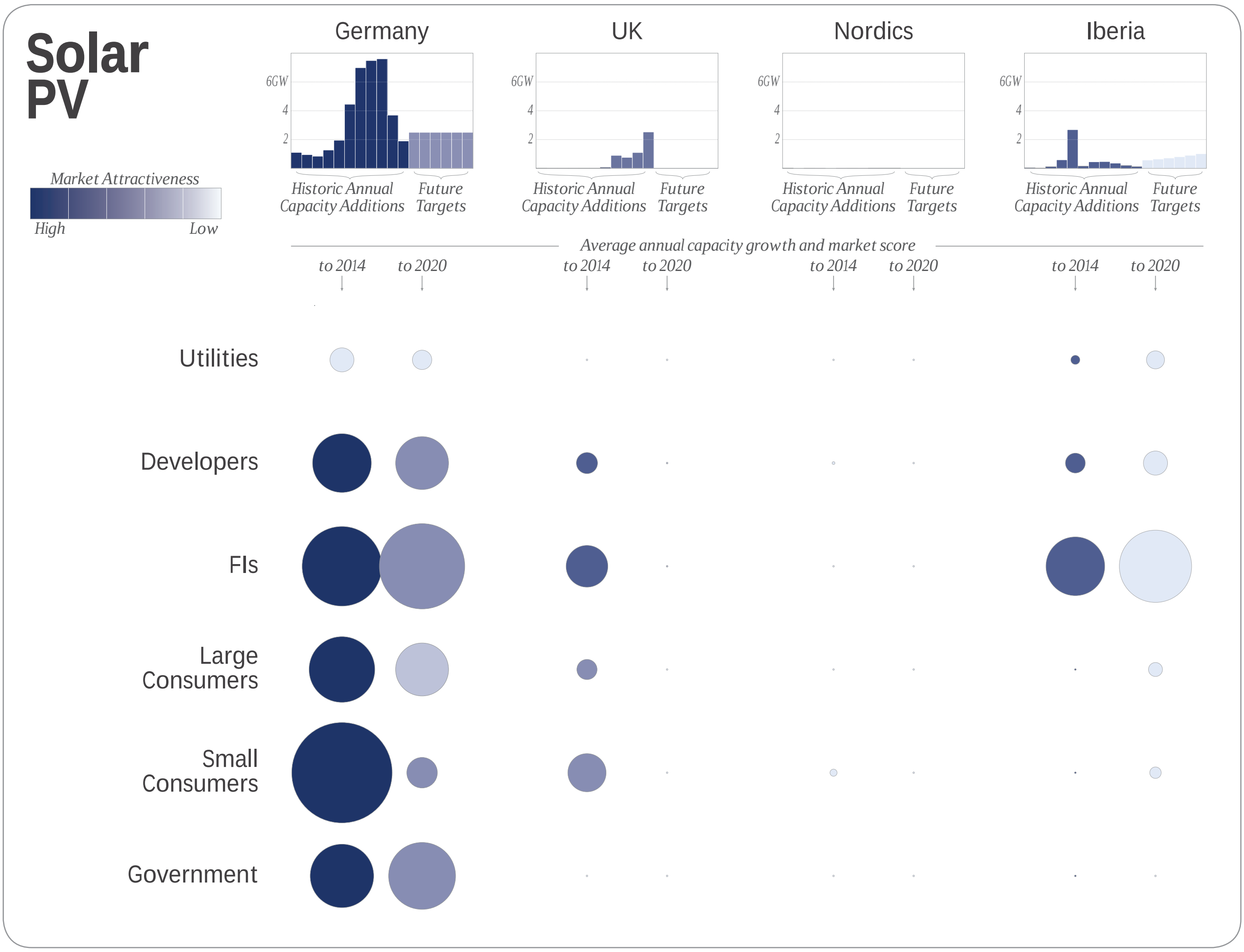
Investment and deployment of solar PV to date has been strongest in **Germany**. Attractive feed-in tariffs encouraged small consumers, cooperatives and developers to install rooftop and some ground mounted systems. In addition to the feed-in tariffs, German development banks, like KfW and Rentenbank, offered low cost loans, while commercial banks and other institutional investors recognized the low cost and risk of lending to projects using established technologies supported by both the development banks and feed-in tariffs, and therefore offered low cost finance in addition to the development bank finance. The small scale of rooftop solar projects and the intense competition between providers of low cost funding sources reduced project returns and thereby discouraged utilities from getting heavily involved.

In contrast, **Spanish** solar PV was dominated by utility-scale projects financed by developers using project finance loans from banks. Attractive tariff regimes from 2007-2009 encouraged significant investment, but overbuild and retroactive changes to public support frameworks due to higher than anticipated costs to public budgets caused investment to falter. In Spain, the absence of feed-in tariffs and low cost debt, along with the barriers and costs associated with connecting to the grid has largely discouraged small consumers from investing in solar PV.

The **UK** has experienced a boom in solar since 2013 and deployment was approximately almost double the level in Iberia at the end of Q1 2016. Revenue support is likely to be limited in future since the UK will have already far exceeded its low National Renewable Energy Action Plan (NREAP) targets for 2020. However, corporate Power Purchase Agreements (PPAs) may represent an opportunity for developers to build new projects without revenue support.

Our analysis suggests that both policy and market environments will be considerably less attractive across nearly every investor category, making sourcing the necessary investment more challenging, particularly in Spain.

Figure 13: Regional summary of the attractiveness of PV solar



Source: Eurostat, NREAP, German EEG targets and CPI and SEI analysis & investor interviews

GERMAN PV

Based on past performance, Germany's annual deployment targets of 2.5GW appear achievable despite the recent slowdown, but it is clear that investor returns need to improve to achieve the required level of investment.

Despite not having the best solar resources in Europe, Germany has embraced solar PV in a major way with deployment levels of around 40GW as at the end of 2015. This is more than double the level achieved in Italy, the next highest European country. Feed-in tariff cuts in recent years have seen a significant decrease in deployment levels with an estimated 2GW of installations in 2014 and a provisional estimate of 1.4GW in 2015. Based on past performance, annual deployment of 2.5GW as targeted under 2014's Renewable Energy Sources Act (Erneuerbare Energien Gesetz - EEG 2014) still appears achievable but given the recent downturn it is clear that investor returns need to improve to achieve the required level of investment. The introduction of targets which will limit deployment and more careful cost control will reduce the returns of all investors.

Developers are likely to face a stable outlook although the smaller ones are concerned about the small consumers market.

Financial institutions are likely to be deterred by lower returns for equity but debt will still be an attractive proposition, although less revenue support will result in lower leverage if costs do not decrease commensurately since debt will be sized off lower cash flows. Competition to invest is still high in the current low interest rate environment as investors seek higher yields, and this pushes down returns both for debt and equity investors.

Large consumers are primarily motivated by the prospect of hedging against rising electricity costs and as solar PV costs fall further, this technology will become more attractive to them. For this investor group, cost savings are as important as revenue support. However, the complexity of auctions is likely to deter some of the mid-tier corporates. Some investors are cautious about making long-term investments and locking in an electricity price now while solar PV and electricity prices continue to fall and the potential of storage has not yet been realised.

Small consumers provided a large proportion of finance for solar PV deployment in Germany in the past and at low-cost but the future is far more uncertain. Rooftop installations are generally balance-sheet financed, ie, through cash surpluses or general loans, so there is comparatively little project-specific debt funding required for solar in Germany despite high installation levels. Future market attractiveness remains uncertain for these investors however as a result of large feed-in-tariff cuts.

Government support has been available for some time and shows no sign of being withdrawn. Through development banks such as KfW and Rentenbank there are long term low interest loans available for solar installations up to a maximum loan size of €25m. Additionally, KfW offer 20-year fixed rate low-interest loans that can fund up to 100% of the cost of storage units and only require 70% of the loan to be paid back.

UK PV

Solar PV deployment has accelerated impressively in the UK over the last two years but is likely to stall now the previous support scheme has been withdrawn.

Despite relatively modest deployment levels up to the end of 2013 and even more modest NREAP targets for 2020 which were already met by 2013, the UK solar industry has been thriving in the last two years. Total capacity increased by 89% in 2014 to 5.5GW and it reached 10.6GW by the end of March 2016. This has been driven by a rush to complete installations before the withdrawal of the generous Renewable Obligation Certificate (ROC) feed-in-premium subsidy.

Now the ROC support has been withdrawn the future of the UK solar industry looks weaker with just 150kW added between April and July 2016. Some developments greater than the 5MW capacity limit for ROC eligibility have already been trying to compete under a new auction regime but almost all have lost out to cheaper bids from onshore wind, and the frequency of and eligbility for these auctions has been cast into doubt as a result of budget constraints and policy uncertainty. Feed-in tariff support has decreased substantially with tariff cuts for the smallest scale installations of 10kW or less by as much as 63.5% from February 2016.

Developers have experienced a temporary boom but bankruptcies are expected now that revenue support has dried up. The larger UK developers are looking for opportunities overseas as well as the corporate PPA market which may enable developments to be made without revenue support although the success of this route is dependent on how much the utilities or other licenced suppliers charge for being the intermediary (referred to as "sleeving") and for balancing services.

Financial institution's provision of project finance loans to UK developers will depend on achieving a bankable degree of revenue certainty. PPAs represent a new opportunity to secure a reliable source of revenue at a premium to the wholesale market price but strong contractual arrangements with a well-established counter-party will be required. Loans based on balance sheet strength will also be available for consumers.

Large consumers are unlikely to invest from Q2 2016 because of the withdrawal of solar PV revenue support. Removing revenue support harms the economics of future investments. Until cost-parity is achieved, it is thought that there are not going to be significant levels of investment, even though low prices combined with historically low interest rates mean that now is a good time to hedge against price rises. The long asset life compared with the relatively short tenor that a finance director typically spends at a company can create a conflict with long-term thinking.

From 2017, small consumers are unlikely to invest significantly in rooftop solar until technology prices fall further. The 63.5% feed-in tariff cuts in February 2016 reduce the attractiveness of investing in rooftop solar for consumers. Until solar PV prices fall and electricity prices rise sufficiently to achieve cost-party then there is limited potential in this market.

NORDIC PV

Due to the northerly location of this region, solar PV is not yet a cost effective investment. Rotating panels are required to track the sun, which increases the price of the units, whilst snow fall can block out light to the panels and ice can freeze the rotating mechanism.

Further cost advances are required before significant solar opportunities in this region become feasible. However, there are tentative signs of a solar PV market, with new companies following the model of Solarcity model in the US. Target applications have so far been small businesses or apartment blocks, where the system is spread across several users.

IBERIAN PV

In Spain, policy from 2005 to 2010 was especially favourable to developers using project finance loans from banks. However, policy and market changes including retroactive changes between 2008 and 2012 as well as overcapacity and lack of transmission links with the rest of Europe mean Spain is an unattractive investment environment across all investor categories. Portugal has encountered similar issues although the outlook for investors is more positive.

Annual solar PV deployment peaked at 2.7GW in 2008 in Spain, where 90% of all Iberian solar PV installations are located.

Developers drove the brief boom in deployment while policies were favourable and they relied on project financing from banks. Incumbent developers that are still in business are now exclusively looking to opportunities overseas. In Portugal, solar PV is not far from achieving cost-parity for rooftop installations, so interest could pick up in the next few years once this is realised.

Financial investors have invested alongside developers, typically in the form of project finance loans. Just as developers have had little opportunity to invest in Iberian solar in recent years, so too have financial investors.

Small prosumers looking to install solar PV of less than 100kW have been actively discouraged in Spain and regulatory changes mean investment will become even more unattractive for them. This is driven by concerns from utilities that distributed generation imposes costs on utilities as owners of the distribution networks. In response, the government introduced a new law in 2015 that prevents small consumers from selling excess electricity to the grid. A new law introduced at the end of 2014 that allows prosumers in Portugal to sell excess power to the grid may help stimulate investment.

ONSHORE WIND

Onshore wind has provided investment opportunities for many categories of investors. However, while the policy and market environments remain strong for some investor categories, they are becoming less attractive for others.

In absolute numbers, investment in onshore wind was tilted towards Germany and Iberia. As for German solar PV, investment from consumers, cooperatives and developers have led the way, supported by commercial banks and development banks, while in Iberia, utilities have dominated the investment landscape. The Nordic market is smaller than the German or Iberian markets, so the substantial investment by developers, mainly working with large energy consumers, is a very significant trend. In the UK, financial investors play a strong role in driving investment, alongside utilities.

As for the solar PV industry, the policy and investment environment has worsened for many investors, particularly small consumers in Germany, utilities in Iberia, and across the investor spectrum in the UK. However, the environment for other investors still remains relatively good, including for developers and financial investors in Germany and Nordic countries.

GERMAN ONSHORE

In Germany, while onshore deployment has been comparatively strong, deployment levels need to meet the 2.8GW annual targets included as part of the energy act known as EEG 2017. Increasing competition and the introduction of auctions have made the market less attractive and riskier for some investors. There is a conflict between high deployment levels and cost efficiency, and how this will be resolved may depend significantly on the auction design and support for the smallest investors.

The 2.8GW targets from 2017-2019 and 2.9GW from 2020 are now absolute capacity numbers. This amounts to a reduction from EEG 2014 targets which were 2.5GW with an additional annual repowering of 1.6GW of old capacity that was estimated by the Federal Ministry of Economic Affairs & Energy (BMWi).

Data from BMWi indicate that 3.6GW of net onshore wind capacity was introduced in 2015, so there is clearly still a lot of ongoing activity in the onshore sector. The question will be whether this activity is a result of developers trying to rush through developments before the government switches from a feed-in tariff support mechanism to a competitive auction approach, which is

Figure 14: Regional summary of the attractiveness of onshore wind

Source: Eurostat, NREAP, German EEG targets and CPI and SEI analysis & investor interviews

likely to be a riskier investment proposition for them.

Utilities were early investors in German onshore wind but increasing competition from independent developers has squeezed margins to such an extent that it is no longer attractive for them to invest. This is particularly clear when comparing to both investor-owned utilities' own finance costs and the returns available from other opportunities. The exception is municipal utilities, which benefit from lower funding costs and often invest on a less commercial basis after taking into account local considerations. Only the largest utilities, who are best placed to focus on offshore and international opportunities, are likely to keep investing.

Developers seeking to secure pre-operational project financing will only be able to do so after submitting a successful bid price once auctions are introduced, exposing them to an extra level of risk which could discourage investment from small developers in particular. Small developers without a varied portfolio consider themselves to be most at risk because the greater risk that they hold means that planning and auction success are most critical for them.

Financial institutions particularly some institutional investors, are being squeezed out of the market, due to lower returns. Weighted Average Cost of Capital (WACC) for onshore projects is typically between 3.5-4.5% for onshore so equity returns are relatively modest without very high debt levels which are only available for the best sites. WACC has been driven down by high levels of competition for assets and cheap debt that is available from development banks, creating lower returns. Domestic institutional investors are looking overseas where both risks and yields are higher.

Large consumers may be put off by a switch to auctions, although the need to bid may encourage them to develop projects below the 750kW threshold. Industrial and commercial consumers typically use payback periods as an evaluation tool, which does not necessarily favour long-term, low-risk, low-return investments like onshore wind. Higher electricity prices could spur faster growth.

Small consumers are facing decreasing and riskier investment opportunities. Co-operatives are the typical way that a small consumer invests in wind. The number of new co-operatives has decreased significantly in recent years, which is symptomatic of regulatory issues as well as investment returns decreasing as a result of lower feed-in tariffs. Existing co-operatives are looking to other types of investment such as property to boost returns. Farmers are able to install turbines on their land thanks to low cost loans, and they often club together to realise economies of scale that can be achieved by installing multiple turbines across greater land areas. Smaller projects typically have higher development costs compared to the total investment opportunity, thus auctions, which make investment in development more risky, may disproportionately affect small to medium sized projects. This is because the higher income requirements to cover higher costs increases the uncertainty around making a successful bid, which may deter these types of investors.

Government influence looms large in the form of low cost loans from development banks, similar to solar. This assistance seems set to continue for the foreseeable future.

UK ONSHORE

The deployment of onshore wind has been reasonably successful over the years, with most investment funding coming from utilities as well as developers and their debt backers and equity co-investors from financial institutions. Recent deployment of onshore wind has been strong as developers strived to qualify for subsidies before they ran out in March 2016. Support has since been cut altogether, which is likely to have very serious consequences for the industry that is already struggling. Recently introduced guidelines for local governments imply a 125m hub height cap although 100m or below is more typical. This affects project economics it requires more turbines that are less efficient.

Developers will continue to experience a temporary boom in the short term as the existing pipeline gets built out. But removal of revenue support, a result of the May 2015 general election, represents a serious blow to developers operating in the UK. Prior to the election, onshore wind was viewed as a relatively benign operating environment. As for solar PV, corporate Power Purchase Agreements (PPAs) represent a potential source of long-term fixed price revenue, but the market is in its infancy. To compound this, planning laws have been changed to give local residents much more power to stop future developments and this is expected to most affect onshore developments due to aesthetic and environmental impacts once the existing pipeline of permitted projects runs out.

Financial institutions will continue to be active in the market although financing for new projects will be difficult to come by without sufficient revenue certainty. A strong secondary market has attracted cheap capital from institutional investors who value the index-linked ROC income that can offset their index-linked liabilities. A number of YieldCos have been successfully launched in the innovative UK financial market. They offer stable returns to institutional investors that otherwise might not have invested in renewables.

NORDIC ONSHORE

Although a quota system with tradable green certificates has enabled the Nordic region to expand wind capacity dramatically, investments have recently stalled due to oversupply. Proposed increased quotas could drive more investment, but they will need to be supported by the right policies.

The Nordic region has seen a rapid expansion of onshore wind in the past decade. Since 2007, there has been a significant expansion of wind power, growing from 1TWh to 11.5 TWh of production in just seven years in Sweden alone. Even so, the share of total wind electricity production is modest, at 8% of total generation. The main policy behind this expansion has been a quota system with tradable green certificates. This policy has allowed for the build out of onshore wind at relatively low costs and has attracted low cost capital.

More recently investments have stalled due to oversupply leading to low electricity prices and low green certificate prices. According to data from Bloomberg New Energy Finance, investment in utility-scale Nordic wind assets fell by 76% to $1.2bn in 2014, compared to peak investment in 2011.

Proposed increased quotas for Norway and Sweden and the nuclear repowering program in the latter country could create a capacity gap. The question is whether policymakers are willing to create effective policies to encourage more wind deployment now or whether they are content to wait until nearer the time that this capacity is absolutely required.

Utilities have remained on the sidelines of the onshore wind boom, getting out-competed by more specialized wind developers with lower return requirements. Their competitive advantage lies in more complex, larger projects and they have therefore have preferred to invest in offshore wind developments outside the Nordic region. The outlook for these investors remains weak in onshore wind in the Nordics.

Developers have been the main driver behind the rapid expansion of the onshore wind industry in the Nordics. They represent the largest ownership category with over 50% of total installed capacity in 2014, and a still larger share of new additions between 2012-14. The recent low prices have significantly reduced the returns expected on wind projects (now around 4% return on investment), leading to reduced activity by investors.

Financial institutions have become increasingly prominent over time, participating in more recent, larger wind developments. They are attracted by the inherent good wind resources of the Nordic region and by the relatively stable policy outlook. They have participated in several financing models, ranging from joint ventures with wind developers on specific projects to direct ownership of wind development companies that own significant wind assets across the Nordics.

IBERIAN ONSHORE

Iberian onshore deployment was commensurate with Germany until as recently as 2012, with very generous feed-in tariffs stimulating investment in the pursuit of wind-fall profits. Retroactive changes to these tariff levels have since created huge uncertainty for investors, so much so that they were unwilling to invest.

Utilities have dominated the market historically, but are facing a less attractive market due to a variety of factors. Utilities have invested heavily into a market that favoured investors who had intimate knowledge of the market and other generation assets to use in an integrated energy generation strategy. However, in the last five years, general overcapacity in the electricity market has not only made the investment case for wind less attractive, it has also hurt the existing Iberian businesses of all of the utilities. Spain now has 23GW of wind installed (onshore and offshore), covering around 19% of energy demand. Interconnections are very limited so there is nowhere for large amounts of excess generation to be exported. Spain's incumbent utilities in particular have increasingly sought to invest internationally.

While Portugal no longer offers revenue support to renewables, Spain has policies in place which superficially seem to promote deployment of renewable energy. However, on closer inspection, the ability to reduce support levels retroactively at defined periods during the life of the asset makes such investment highly unattractive.

Developers have been going out of business, and those domestic companies that have not are operating overseas. Just 17MW of onshore was capacity was installed in Spain in 2014, followed by zero capacity installed last year.

Financial institutions have never been major players in Spanish onshore wind, due to the historic dominance of the utilities. The utilities were able to finance using balance sheet financing and retained equity in the developments. Now they are unable to sell the assets without realising large losses so they are keeping the assets on their books despite impaired returns.

OFFSHORE WIND

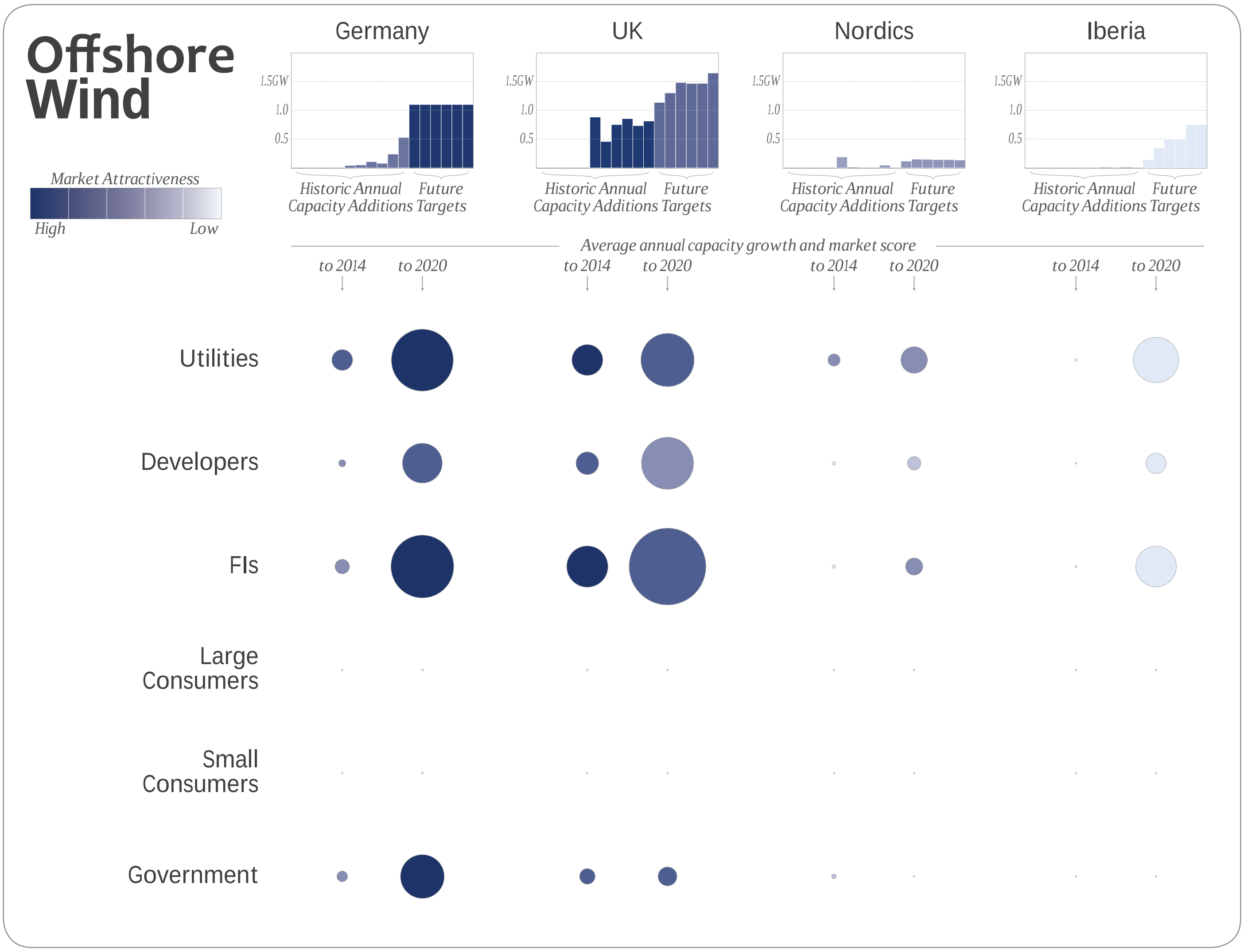
Offshore wind is a maturing technology that is still considerably more expensive than onshore wind but the gap between the two is reducing. Project developments are very large, expensive and lengthy so only investors with the deepest pockets are able to participate in this market, but competition for these big ticket assets has increased substantially in recent years as investors become more comfortable with the investment risks.

By its nature, offshore wind demands large-scale and dedicated, professional, industrial scale execution. Investment by consumers is, essentially, infeasible. Offshore wind is also a less mature technology but despite the higher costs the pipeline looks strong where the technology is being adopted. Among our four regions, only the UK invested heavily in the 2005-2014 period, with Germany beginning to start investment and deployment around the start of this decade. Going forward, both Germany and the UK have significant targets, while Iberia and the Nordics have comparably modest offshore wind targets in their plans to 2020.

The policy and industry regulatory environment remains attractive to investors in the regions with the most ambitious targets, although investors show concerns around long-term targets and the longer term price regulation of the sector. For offshore wind, longer term policy is particularly important since the projects are costlier and take longer to develop, finance and build than other renewables. Investment in these longer term business processes will lower the cost of developing and building offshore projects so long term policy is even more important than for solar PV and onshore wind.

Offshore wind in the graph below for the Nordic region excludes Denmark's installed capacity.

Figure 15: Regional summary of the attractiveness of offshore wind



Source: Eurostat, NREAP, German EEG targets and CPI and SEI analysis & investor interviews

GERMAN OFFSHORE

Germany is likely to meet its scaled back target for offshore wind deployment by 2020. Growing demand for projects among a number of investor categories means financing needs should be met but longer-term targets will be key to the development of the technology. Compared to the UK, the current world leader, Germany has been slow to embrace offshore wind. This has mainly been because some of the early projects were delayed by grid connection issues. Other reasons include the high costs involved (which are now reducing significantly), and because the wind resources off the German coast are generally not as favourable as sites off the UK coast (and technological improvements are bridging the impact of this difference).

The National Renewable Energy Action Plan (NREAP) target of 10GW by 2020 was scaled back to 6.5GW under the EEG 2014 and subsequently increased to 7.7GW under an amendment known as WindSeeG, which we consider to reflect Germany's stalled but then rapid progress in deployment to date. The likelihood of meeting this revised target is relatively strong. There is now a clear pipeline of projects and if they all get built on time, then this target should be achieved.

Utilities envisage their future in the renewable energy space to lie mostly with offshore wind over the longer term. The riskier nature of the technology means returns are higher and they can best utilise their in-house expertise for this technically challenging industry. The scale of the developments creates a barrier to entry that smaller investors cannot overcome and this helps increase investment returns. Ideally they are looking for equity investors that take construction risk, and invariably they have a strategy to recycle capital and share risk by reducing their holdings in the short- to medium-term. Long-term targets are crucial to encouraging investment, as is adopting the Danish approach to auctions where high survey and design costs are paid for by the government and shared with all bidders.

Developers have consolidated and the limited number of large developers that now operate in this space have increased their capacity to invest should long-term policy frameworks continue to be attractive after 2020. Developers such as Bard and Windreich have gone out of business while solvent developers such as PNE Wind and wpd have a number of projects in the pipeline until 2020 and are well-positioned to continue to invest in projects successfully for the foreseeable future.

Financial Investors perceive offshore wind as being more established and reliable as construction delays become less common and better O&M strategies emerge and this is resulting in more interest from financial investors on both the debt and equity sides. Project financing is a very common way of funding these large projects and competition is high for these assets. Project bonds are emerging as a way for financial institutions to invest with two of these successfully launched in 2015, including the Gode Wind project. On the equity side more and more financial institutions - including institutional investors - are looking to offshore wind projects to enhance their returns and this is pushing up the price that developers can realise for their holdings.

Government is willing to offer significant amounts of finance but given the demand from other investor groups they may be required to do so less often. The German development bank KfW offers low cost loans for up to €700m or 70% of the debt for German offshore, although despite this some developments have gone ahead without them. KfW states that there is a limited number of these loans available, although there is no indication as to how much this limit is.

UK OFFSHORE

The UK is likely to meet its 2020 targets for offshore wind but its current position as the world leader is under threat as pressure on the renewable energy budget is likely to limit future investment and see development proposals being scaled down. Amber Rudd, the former Energy Secretary, stated that the future role for offshore wind depends on how quickly costs can be reduced, stating that "if, and only if, the Government's conditions on cost reduction are met, we will make funding available for three auctions in this Parliament. We intend to hold the first of these auctions by the end of 2016".

The new government that was formed after the referendum in June 2016 created the Department of Business, Energy and Industrial Strategy (BEIS) which now has responsiblity for energy and climate policy. More details regarding volumes and minimum cost reductions are yet to be announced but it is thought that only bid prices below the £92.50/MWh strike price that has been agreed for the Hinkley Point C nuclear plant will be considered, which is a challenging target.

Utilities have dominated the early stage equity investment market but their investment to 2020 will be hit by uncertainty around future auctions. As the key industry players in the offshore market (alongside the large developers – see below) the UK's six major utilities, British Gas (Centrica), EDF Energy (Électricité de France), Scottish Power (Iberdola), E.ON (E.ON Germany), NPower (RWE) and SSE are most affected by uncertainty around when and whether future auctions will proceed as the government cites affordability issues with offshore costs in particular and the budget for the Levy Control Framework in general.

Developers for this technology are mainly non-incumbent utilities such as DONG, Vattenfall and the Norwegian state-owned company Statkraft and they are likely to increase their investment through to 2020. However, their ongoing participation is affected by the same auction uncertainties as the incumbent utilities.

Financial institutions are proving willing to provide growing amounts of institutional equity investment, usually once the risky construction phase is over, as in Germany, although some are now willing to take on construction risk. This interest has been partially stimulated by an inflation-linked revenue support which acts as an attractive hedge to investors with inflation-linked liabilities. The scale of the projects are also suitable for the position that institutional investors wish to take, and are large enough to justify the expense of hiring an investment team. Institutional investors have provided very little debt in the UK until now because of the historical dominance of incumbent utilities and these utilities' preference for balance sheet finance over project finance. In other words, the contractual arrangements are not geared towards debt investors. This could change as non-incumbent utilities scale up investment.

Government has raised further institutional investment through the Green Investment Bank (GIB), the government-owned green development bank which has successfully launched the first offshore wind fund in the world but increased demand from financial investors is likely to make future contributions less necessary. To date £818m has been raised out of a target capital commitment of £1bn. As there are plans to sell-off the GIB, its future contributions to renewable energy will no longer be categorised as government investment although we have not factored this into our chart since no sale has yet been agreed.

NORDIC OFFSHORE

There has been very limited development of offshore wind in the Nordics with less than 250MW across the region, principally in Sweden. There is nothing in these countries' NREAPs or project pipeline that indicates a surge in offshore investment is likely to take place in the near future.

IBERIAN OFFSHORE

Spain is targeting 3GW of offshore deployment by 2020 in their National Renewable Energy Action Plan (NREAP) but with no developments in the pipeline this ambition will not be met. Portugal has no plans for any offshore by 2020 according to their NREAP targets.

The Spanish utility Iberdrola is highly active in offshore wind markets in other parts of Europe but does not consider its home market to be a viable investment. The same retroactive changes to remuneration regimes, overcapacity in power generation, and lack of transmission links with the rest of Europe that make solar PV and onshore wind unattractive investment propositions in Spain affect offshore wind.

Appendix 3 Impact of policies on investor decision making

This section is taken from the report *Policy and investment in German renewable energy*, April 2016

A3.1 Introduction

In 2000, Germany introduced its first version of the Erneuerbare Energien Gesetz (EEG) to reach its objective to double the share of renewable energy in the total energy mix within ten years (Gesetz für den Vorrang Erneuerbarer Energien 2000). This act created fixed feed-in tariffs for each kWh of electricity generated from renewable sources. The EEG set feed-in tariffs that differed by renewable energy technologies, with the added cost passed on to consumers through a surcharge on electricity prices (EEG surcharge). The German Renewable Energy Act was very successful in reaching its objective, leading to a substantial increase in renewable energy generation. However, with an increasing share of renewable energy, the EEG surcharge has also increased.

The growing EEG surcharge and EU regulation, has led the German government to prioritise cost effectiveness alongside deployment targets.

- **Deployment:** Germany has its own renewable energy capacity and production targets, as well as commitments within the European Union. According to the EU 2009/28/EG Directive, Germany must cover 18% of its total energy consumption with renewable energy (EP 2009) by 2020. In addition, the current coalition contract of the German government includes long-term targets for renewable energy penetration to reach 40-45% of electricity supply in 2025, 55-60% in 2035, and 80% in 2050 (CDU, CSU, and SPD (2013); BMWi 2015a). **The availability of investment and finance is dependent on policy and will determine whether these deployment objectives can be met.**
- **Cost effectiveness:** Germany would like to achieve these deployment goals at the lowest possible cost, both in the short and long-term. EU Energy Directives also place added emphasis on achieving cost effectiveness within the renewable energy sectors. The cost of finance, and how that finance is structured, is often a determining factor for the cost of renewable energy. **Since policy influences financing costs and structures, it is also a key link to cost effectiveness.**

A3.2 Overview of policies affecting investment potential

Policies that influence renewable energy investment are set and administered at many levels. Some have an obvious link to investment and others a less straightforward one. Starting with the most obvious connections, a potential investor may ask the following questions:

- What revenues and costs will my renewable energy project/business have and what are the risks to these revenues?
  - » How certain are these risks?
  - » How sustainable are the revenues?
  - » Over what timeframe do I have certainty?
- How does this project fit within the wider electricity or energy sector?
  - » Does the relationship with the wider sector create risks or opportunities for this project or business?
  - » How does the wider sector affect the competitive environment?
- How do general commercial, financial, and administrative polices affect revenues, risks, and costs?
  - » What impacts, costs, and uncertainties are generated by the regulatory, planning, and permitting environment?
  - » How will this investment be affected by risks or opportunities from the taxation system?
  - » How will financial regulation affect each particular investor?
  - » Will regulation allow or restrict use of the electricity produced by the investment?

Our interviews with investors involved in renewable energy in Germany revealed a wide range of policy issues that could potentially influence the attractiveness of renewable energy investments. These questions fall into two main categories: those that are more directly related to the project and industry itself, i.e. energy and renewable energy policies, and those that reflect more general business conditions, i.e. process and other supporting policies. Policies affect both the deployment and cost effectiveness objectives that are driving German renewable energy policy.

Table A3.1: Energy policy categories and key policy areas

ENERGY AND RENEWABLE ENERGY POLICIES	Renewable energy subsidy mechanism	Incentive auction design:	Auction design, coverage and process
		Support design:	Predictability of subsidies, perceived regulatory risk, and complexity
		End user participation:	Availability of self-consumption options
	Renewable energy targets	Long-term targets:	Reliability of government plans and deployment
	Electricity market design	Grid connection:	Security of grid access after a plant has been realised
		Energy market design:	Electricity price mechanism and access rules to the
		Curtailment:	Technological and economic curtailment
PROCESS AND OTHER SUPPORTING POLICIES	Regulatory process uncertainty and transition	Permitting process:	Costs and administrative complexity
	Planning, logistics and project development costs	Development costs:	Threat of an increase in costs and stranded costs
	Financial and information support	Financial regulations:	Trade-off between capital market stability and

Overview of energy policy areas of concern to investors

Energy and renewable energy policies

- Renewable energy subsidy mechanism
  - » What mechanism will provide incentives to renewable energy investors in the future?
  - » What will be the duration and stability of support?
  - » What competitive mechanisms will be applied in delivering this support and how will they be structured?
  - » Will there be a risk of generation from the project not being accepted by the grid for technical or economic reasons (curtailed)? How would this affect payments and risks?
  - » Will existing support and adjustment mechanisms be "grandfathered", that is, will they be immune from negative impacts of future regulatory changes?
- Targets and government commitment
  - » How secure and ambitious are targets in the short and long term?
  - » Can these targets be relied upon as a guide for investment in developing new projects and investing in a larger or more efficient business design?
  - » Will targets be cut in the future, causing existing investment in project and business development to be wasted?
- Electricity market design
  - » How will wholesale prices evolve in the broader electricity market, as changing prices alter risk perceptions as to the sustainability of tariffs that may be offered to renewable energy?
  - » More specifically, how will market design lead to negative prices, which some interpretations of EU directives imply would lead to curtailment, and therefore lower output?
  - » Will capacity payments and their design affect prices (thus compounding the risks above) or create opportunities for additional revenues for renewable energy generators?

- » Will ancillary market design (for services to maintain system stability) also have an impact on pricing or potential revenues for renewable energy generators?
- » Will transmission pricing and interconnection affect costs, risks and production levels, and thus cash flows?
- » Will distribution pricing and regulation affect costs, risks and production, especially for distributed generation?
- » Can the owner of a renewable energy generator use its output to meet their own energy use needs?
- » If so, what is the cost and regulatory burden of doing so?
  1. How would self-consumption be affected by taxes, distribution and backup energy supply costs and pricing, net metering policy, and so forth?
  2. How would the generator be paid for excess generation sold back to the grid?
- » If not, will owners be able to use ownership as a way to hedge against future energy price changes or to lower their effective carbon footprint?

Process and other supporting policies

- Regulatory process uncertainty and transition
  - » How will new regulatory and competitive arrangements affect existing projects and projects under development?
- Planning, logistic and project development costs
  - » How much do government planning and permitting processes add to the cost, risk and uncertainty of project development?
    1. How will these costs and risks fit within new subsidy and market designs?
  - » Who will bear the costs and risks associated with transmission interconnection delays and costs, and how will these be accounted for in new policies?
  - » How can processes and models be built to encourage and improve local acceptance? How much risk and cost will local matters add?
  - » How much will it cost for developers to develop new customers and new project options?
- Financial and information support
  - » How does financial regulation – such as Basel III and Solvency II – affect the structure, attractiveness and viability of investment in the sector?
  - » How do these regulations interact with other policy concerns?
  - » How will tax issues affect investors, on both the taxation side as well as incentives that may be unrelated to renewable energy specifically?
    1. For example, depreciation treatment including accelerated depreciation, tax credits and incentives, as oppose to the standard treatment of earnings through income and corporate taxes and royalties.
  - » How do policies interact with government loans that may be available as policy drivers at lower cost (for example from KfW and Rentenbank)?

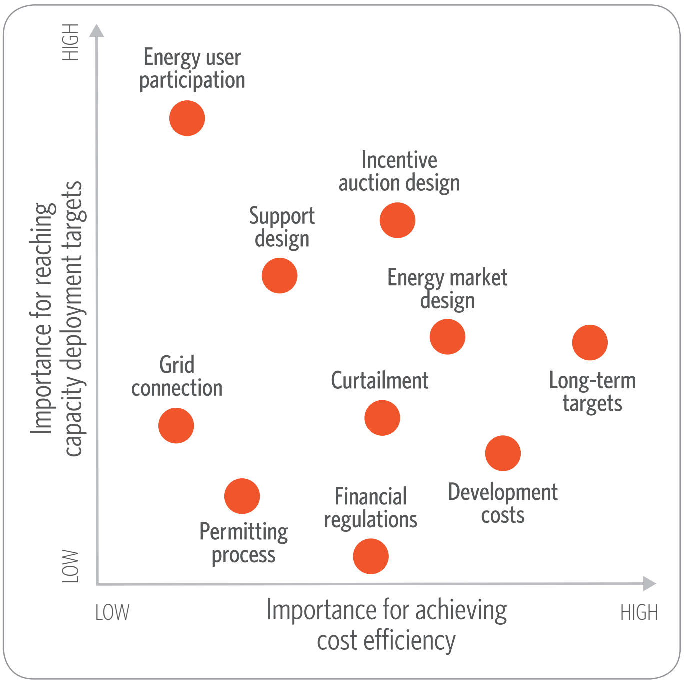
Combining the key policy areas' importance for both main objectives of the German energy transition leads to the conclusion that the three most important in the medium term are: end user participation, incentive auction design, and long-term targets.

- **Incentive auction design:** The complexity of an incentive auction design determines how sophisticated a player must be to successfully participate in an auction. If the complexity is too high, it would mainly exclude smaller investors that cannot manage bidding in a complex auction regime. If the auction regime creates unnecessary uncertainty about the possibility of a successful bid or if it creates obstacles for second chances after a bid has been lost, the interest of investors will be limited. This results in low competition in bids for auctions and thus higher bid prices.

- **Long-term targets:** Reliable long-term targets must be in place to justify investments in business process optimisation and in the development of less mature technologies.
- **End user participation:** Investors in small rooftop PV systems and small wind parks are interested in using the energy themselves or marketing it locally. The implementation of strict consumption feed-in rules for such investors might significantly limit the willingness of, for example, private rooftop owners to invest. This in turn makes it hard to reach the PV targets.

Policymakers have to consider multiple factors in ten key policy areas. In discussions with our interviewees, we have defined the most important questions for policymakers.

Figure A3.1: Relevance of key policy areas in the medium term



Source: CPI analysis based on interviews

Table A3.2: Key questions for policymakers

KEY POLICY AREA	KEY QUESTIONS FOR POLICY MAKERS
INCENTIVE AUCTION DESIGN	Will auctions lead to better pricing? Do auctions raise transaction costs? Do auctions restrict competition?
SUPPORT DESIGN	How do support and pricing policies impact the potential investor pool? How do support policies affect the cost of capital of different investors?
END USER PARTICIPATION	To what extent should end users be involved in the energy transition? How can end users be included?
LONG-TERM TARGETS	How much do long-term targets de-risk project development? How important are long-term targets to long-term strategy and how valuable is the extra cost reduction?
GRID CONNECTION	Not in the focus of our analysis as lower relevance in the medium term
ENERGY MARKET DESIGN	What is the influence of energy market design on specific project investments? Will different energy market designs attract different investor classes? Which aspects become important in the long term?
CURTAILMENT	How do investors consider curtailment? How will attitudes evolve towards economic curtailment? What impact will economic curtailment have on renewable electricity pricing? What policies could mitigate the impact of economic curtailment?
PERMITTING PROCESS	Not in the focus of our analysis as lower relevance in the medium term
DEVELOPMENT COSTS	How do auction design, long-term targets, and development together affect renewable energy projects? How can policies minimize the overall development costs?
FINANCIAL REGULATIONS	Not in the focus of our analysis as lower relevance in the medium term

A3.3 Ten key policy areas that are most relevant for the German energy transition

1 INCENTIVE AUCTION DESIGN

Key considerations for policymakers:

- Auction design elements can contribute to, or stall, continuous cost reduction
- Small investors fear higher transaction costs which could reduce investment
- Complex auctions will limit the range of investors

Background and summary

German success in growing its renewable energy generation and supply has been built upon feed-in tariffs. By setting different fixed prices for energy produced from each form of renewable energy, Germany has given potential investors and developers certainty around the economics of projects they may pursue. This certainty has given developers confidence to invest in project development, while certain, fixed and transparent revenue potential has encouraged lenders and financial investors to offer attractive low-cost finance.

However, designing feed-in tariffs that meet the twin objectives of deployment and cost effectiveness is very challenging. If the tariffs are too low, projects will be uneconomic and not proceed, developers will cease developing new projects, the industry will stutter and stop growing, and deployment targets will not be met. If the feed-in tariffs are too high, deployment may exceed targets (causing higher than expected costs to the government or consumers if costs are passed on to electricity tariffs), developers and investors will make excess profits causing wealth transfers and political embarrassment, and the industry will have less incentive to drive down costs. For their part, the administrators who set the tariffs lack the comprehensive information on costs and potential that would be required to get the tariffs right as industry players guard this confidential information carefully. Further, costs are changing fast, and many potential investors may themselves be unsure about costs and return requirements.

Since the introduction of the EEG in 2000, the German solution to these challenges has been to adjust tariffs in several revisions of the law. Furthermore, the government set feed-in tariffs to decline gradually over time. The decline in tariffs reflected perceptions about how fast costs should decline. Nevertheless, the difficulties of setting an appropriate price have not gone away completely, and other concerns have arisen (Grau 2014):

- If costs stop declining or begin to rise, deployment could grind to a halt
- The threat of an imminent tariff decline could cause developers to rush projects, leading to riskier or less developed projects hitting the market
- The threat could also cause developers to prioritise short-term projects in order to get higher tariffs, rather than investing in developing better, but longer-term projects

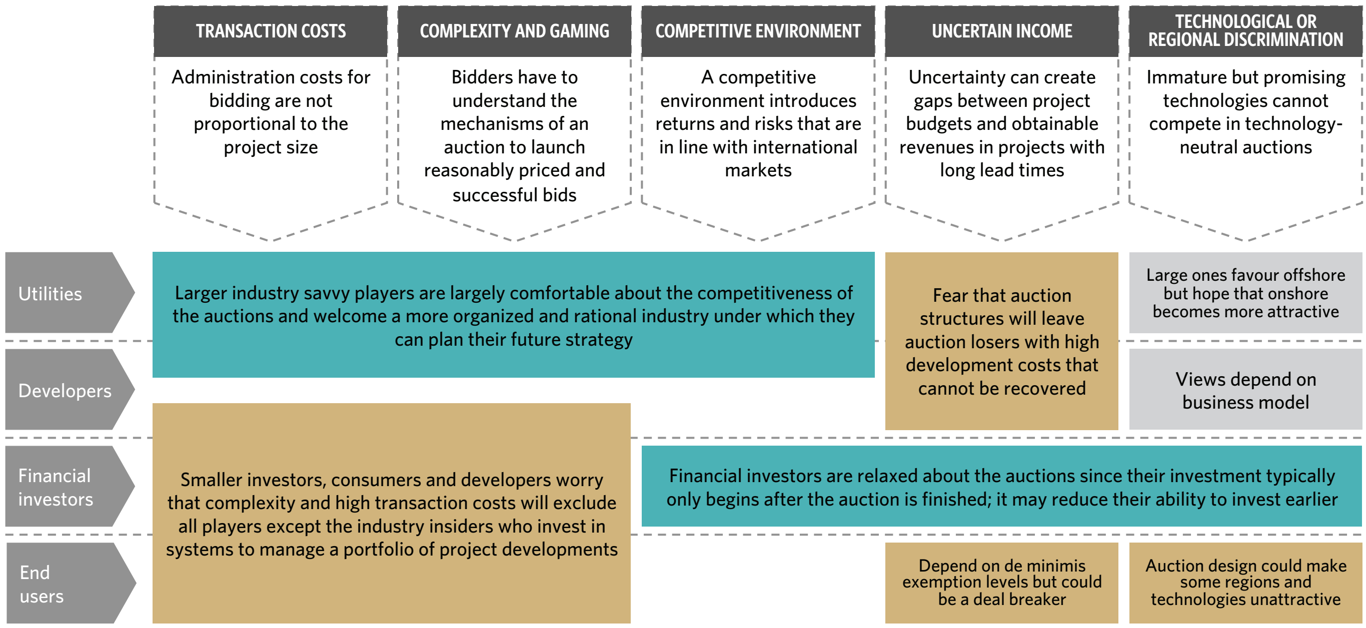
With the revised EEG 2014, Germany decided to introduce competitive auctions to set the price for renewable energy projects by 2017. Under these auctions, each potential renewable energy project will submit a bid, with the lowest cost bids accepted up to the point where deployment targets are met. Germany began these auctions in 2015, focusing on ground-mounted PV. However, the design, process and coverage of the auctions are not yet defined. Based on our interviews and analysis, auction design, coverage and process could make the difference between success and failure in meeting the German government's goals for renewable energy.

Impact on investors

Auctions, and their design, will affect each investor, but in different ways (Figure A3.3: Issues around incentive auction design).

- **Large-scale developers and utilities** are comfortable with competition, as they believe that properly structured competition could bring rationality to the market. This could be beneficial for them as they are sophisticated and relatively low-cost players. However, they are concerned that poorly structured and infrequent auctions could create risks that their development expenditure will rise and may take longer to recover. A developer mentioned that "there should be at least 3-4 auction rounds per year."
- Since **financial investors** are less involved in development, they have less to lose from failed auctions. The only problem for them is that it may restrict the number of projects

Figure A3.2: Issues around incentive auction design



Source: Interviews

to be developed, which could reduce the opportunities for them to invest.

- **End users, small utilities, and small-scale developers** are concerned that the auctions will be too complex, or too costly, for them to participate. A representative of the solar industry told us that "auctions for private investors are too complex and they would not know how much to bid or how to bid at all." They fear that their development costs will not be compensated if they lose the auction, and since they may have only one or two projects, they will not be able to make up development costs through subsequent projects. They are also concerned about gaming by other industry participants. In the first ground-mounted PV auctions, 40% of the auction volume went to one player. Only three out of the 25 bids were for plants with capacity below 2 MW.

Key considerations for policymakers

AUCTION DESIGN ELEMENTS CAN CONTRIBUTE TO, OR STALL, CONTINUOUS COST REDUCTION

For policymakers, it is important to know whether auctions lead to better price discovery and whether pricing via auctions enables continuously improving costs and prices over the long-term. The former depends not only on the auction design but is also highly dependent on competitive market forces, which are hard to predict. The latter requires an analysis of the specific design characteristics of an auction. Generally, for each investor, it was the design of the auction – and whether they would be subject to it – that raised the biggest concerns. Table A3.3: Auction design elements summarises feedback from various potential investors, utilities, developers and end user groups about auction design.

SMALL INVESTORS FEAR HIGHER TRANSACTION COSTS WHICH COULD REDUCE INVESTMENT

Most interviewees from large investors were of the opinion that auctions need not significantly raise their transaction costs compared to pre-defined tariffs if they are well designed. However, there was no indication that participants had yet developed a costing model that incorporated recovery of costs for failed auctions.

In contrast, the complexity of an auction system could drive out smaller investors. This could have an impact on long-term cost effectiveness as small investors are likely to have different capital and construction costs compared to large investors. The impact of the low return requirements of small investors on auction prices is unquantifiable because smaller investors usually do not run financial models and present highly variable bids. However, interviews indicated that equity capital from small investors can be much cheaper than from

Table A3.3 Auction design elements

DESIGN ELEMENT	DESIGN ISSUE	COMMENTS FROM INTERVIEWS AND RESEARCH
AUCTION FREQUENCY AND AUCTION VOLUME	Fuelling competition but at the same time reaching the capacity extension targets	More frequent auction rounds on a reliable scale reduce development risk and allow bidders to refine projects over time. However, if rounds are too frequent, transaction costs could rise.
UNIFORM VERSUS PAY-AS-BID PRICING	Most efficient pricing without incentives for gaming	Uniform pricing is theoretically most efficient. Pay-as-bid pricing may be politically most palatable, but could be subject to anchoring and inefficient project selection.
		Both may be subject to gaming. In theory, pricing should converge in the long run, but difference in short-term incentives is unclear.
ELIGIBILITY CRITERIA AND DE MINIMIS EXEMPTIONS	Maintaining actor diversity without impacting competition/ short-term cost efficiency	Criteria could exclude some bidders and developers.
TECHNOLOGY-NEUTRAL OR CARVE OUTS	Short-term vs. long-term cost efficiency	Technology-neutral auctions will lead to lowest short-term cost of deployment, but could prevent the development of technologies with the greatest cost reduction potential.
BID BONDS (FOR ENTERING AN AUCTION)	Prevention of speculative bids without limiting competition by scaring off bidders	Bid bonds raise costs and discourage some developers. However, they also reduce risk for the remaining bidders as they do not need to face spurious, speculative bidders.
TRANSFERABILITY OF RIGHTS TO REMUNERATION	Limitation of bidding risk without fuelling speculative bids	Transferable rights reduce development risk, but could increase speculative bidding and layer in middleman costs.
		Could also encourage innovative solutions for new resources.
INFORMATION ON BID PRICES	Administrative complexity vs. cost efficiency	Trade-off between value of confidentiality and the cost reduction incentives that might be fostered by providing information.

Source: Interviews

large investors. With regard to construction costs, it is unclear whether they will be higher or lower for small investors, compared to large investors. According to interview responses, many costs such as land may be lower whereas construction costs might be higher.

COMPLEX AUCTIONS WILL LIMIT THE RANGE OF INVESTORS

The complexity of auctions is considered a threat to the smallest investors. For example, small-scale developers claim that the difficulty in understanding the market will force them to stop investing in an auction regime. De minimis rules could exempt the smallest investors from the auctions and avoid crowding them out. On the other hand, large investors argued in the interviews that too many exemptions from open competition could hinder an effective price discovery mechanism. In summary, having no de minimis rules would reduce actor diversity and prevent less sophisticated investors from developing and reducing the costs for renewable energy. It could also reduce competition in the long-term, leading to higher auction prices. De minimis rules should be set at a level where the transaction costs become a material part of a project, and would become an entry barrier for smaller investors. However, de minimis rules must not lead to excluding a majority of players as this would prevent representative pricing in auctions.

2 SUPPORT DESIGN

Key considerations for policymakers:

- Stability and duration of the support structure will influence the cost of new investment
- A well-designed support system will reduce the costs of an energy transition
  - » Longer support periods will help meet Germany's cost effectiveness goals
  - » Inflation-linked tariffs make investments from risk-averse investors more likely

Background and summary

What do we mean by "support design"?

Support design refers to the mechanism that is used to pay for electricity generation from renewable resources. More specifically, it is the difference between the market price for electricity and the support for feeding in electricity that is generated by renewable energy technologies. Common mechanisms to support renewable energy are feed-in tariffs, tax credits, accelerated depreciation, and direct subsidies.

The German government has primarily based its support framework on feed-in tariffs, which have been the key driver of renewable energy expansion. Investors in Germany are used to easy-to-understand and predictable pre-defined feed-in tariffs. As a result, perceived uncertainty among investors is low. The introduction of auctions has high disruptive potential as it can increase the perceived risk among potential investors.

From previous research (Varadarajan et al. 2011), we identified key issues with support design:

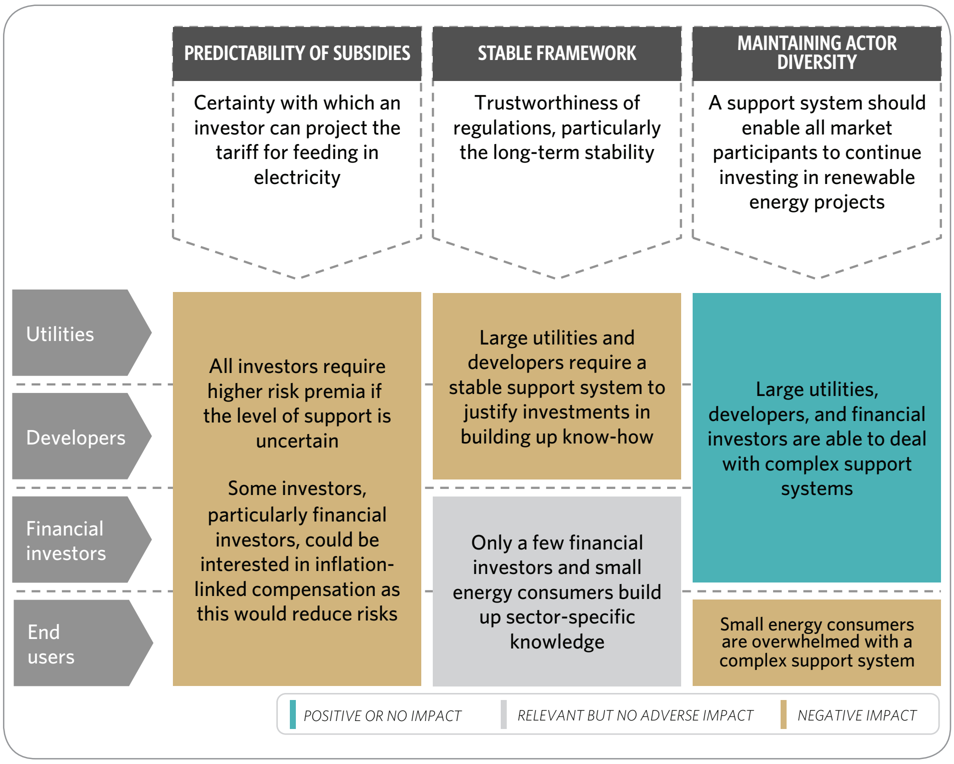
- **Predictability of support:** Longer support durations result in lower risk perceptions, especially when the type of remuneration is a fixed tariff. Furthermore, the type of remuneration decides how much uncertainty is introduced in a support system. The support design with the least additional risk after pre-defined feed-in tariffs would be a PPA with a fixed tariff. Other possible options, such as a flexible market premium, fixed market premium, or fixed capacity premium, create higher uncertainty.
- **Perceived regulatory risk:** Some countries made retroactive changes to their support mechanisms, which resulted in significantly worse-than-expected performances of running projects. Consequently, these changes had negative consequences for future investment (Frisari and Feás 2014). The perceived regulatory risk determines risk premia for markets and, thus, the required returns. Furthermore, investors will avoid markets where the perceived regulatory risk is too high.
- **Complexity:** If the support system is highly complex, less sophisticated players, such as co-operatives, might be overwhelmed and pushed out of the market. Such players are generally small investors that focus on local investments instead of the locations with the optimal renewable resources. However, maintaining actor diversity is one of the goals of the German auction systems. Diverse groups of investors may help drive down technology costs over the long-term and provide more sources and options for investment.

Impact on investors

Support design affects all investor groups (Figure A3.4: Issues regarding support design):

- **Utilities'** profit margins are declining and they want to make sure that future projects deliver secure long-term profits. They need a regulatory environment that gives them certainty that investments in the optimisation of technologies will be amortised. A large utility mentioned that "changes in the rules are upsetting potential developers as they cannot reliably plan anymore." A stable framework is a key requirement for them. Building up know-how in a certain area requires financial and time resources. However, business models have been made unprofitable by changes in the support design, leading to uncertainty.

Figure A3.3: Issues regarding support design



Source: Interviews

- **Developers** want to be sure that a project can achieve revenues after its realisation so that it can be refinanced by other investors. Similar to large utilities, they require a stable support system to justify investments in business models. They fear that additional pre-approval costs related to bidding for a project will reduce their margins.
- **Financial investors**, mostly banks and institutional investors, look for stable and secure cash flows once a renewable energy plant is operating. They are less concerned with pre-approval costs. Inflation-linked compensation could further reduce the risks they perceive and is particularly interesting for conservative institutional investors with inflation-linked liabilities.
- **End users** prefer an easy-to-understand support mechanism. Too much complexity in an auction regime might be overwhelming for small end users. For example, they are not able to market electricity directly on their own. The need to involve a third party in selling electricity reduces margins of small investors if this is not reflected in the support mechanism. A manager from a utility was "not sure how a farmers or citizen cooperative or an insurance company can manage [direct marketing]."

Key considerations for policymakers

STABILITY AND DURATION OF THE SUPPORT STRUCTURE WILL INFLUENCE THE COST OF NEW INVESTMENT

A support system can encourage or discourage investments from the different investor groups. Interviews revealed that an important criterion for conservative investors is protection against merchant risk, i.e. the exposure to fluctuations in electricity prices. Another issue is whether support design elements can scare off investors. In particular, smaller investors fear that the support mechanism is becoming too complex and they could refrain from investing in renewable energy systems under an auction regime.

A WELL-DESIGNED SUPPORT SYSTEM WILL REDUCE THE COSTS OF AN ENERGY TRANSITION

Different investor sets will bear different risks at different premia. Support mechanisms will affect the cost of equity, debt margins, and the mix of debt and equity.

The support system under an auction regime should be designed in a way that does not increase the perceived uncertainty too much. One way to avoid higher risk perceptions is to provide long support periods of 20 years, as introduced in the first ground-mounted PV auctions. Adjustments for inflation are an option to reduce the risk of cost inflation while the revenues remain at the same level. Such an inflation adjustment would provide an index-linked return on investment and some investors may accept a lower target return.

LONGER SUPPORT PERIODS WILL HELP MEET GERMANY'S COST EFFECTIVENESS GOALS

The duration of support periods is critical to determining how long a project can support debt funding. Project finance lenders are typically unwilling to offer loans beyond the tenor of the support regime, and often require a tenor that is 12 months shorter than the duration of policy support, so that if the project is delayed it is still possible to restructure the loan without taking merchant price risk.

Table A3.4: Support system design elements

DESIGN ELEMENT	COMMENTS FROM INTERVIEWS AND RESEARCH
REGULATORY STABILITY	A stable support system is a key requirement for all market players that build up know-how in a certain area. As this requires financial and time resources, it must lead to an advantage in the long-term to justify investments.
DURATION OF SUBSIDIES	Longer duration periods of subsidies lower the effect of merchant risk on project values.
	Regional quotas lead to a more even distribution of build out and could encourage development of renewable production that otherwise might never be accessible. However, they can also raise the overall costs of achieving targets.
SUPPORT OF LOW LOAD FACTOR LOCATIONS	Regional quotas lead to a more even distribution of build out and could encourage development of renewable production that otherwise might never be accessible. However, they can also raise the overall costs of achieving targets.
INFLATION INDEXATION	Inflation indexation mitigates the risk of rising operational costs while the revenues remain constant.
TYPE OF REMUNERATION (FIXED PRICE VERSUS PREMIUM, ETC.)	Revenue uncertainty is the second most important factor influencing financing costs (see: Climate Policy Initiative, 2011).

Source: Interviews

Shorter subsidy periods reduce the amount of debt that is available. Thus, more expensive equity funding is required, which pushes up the cost of capital. Additionally, in order for equity return requirements to be met, shorter support periods require disproportionately higher subsidies. All of these factors raise the required support levels.

We modelled the impact of shorter support periods by comparing projected auction prices for 20, 15 and 10-year support regimes. We assumed lenders require a one-year time cushion so debt repayment periods are 19, 14 and 9 years respectively, and that the debt sizing approach will be unchanged so that the only factors impacting the leverage are the different tenors and auction prices.

The impact of shorter support periods varies for each technology, but the trend in increased costs is apparent across all of them. Solar PV is the most affected

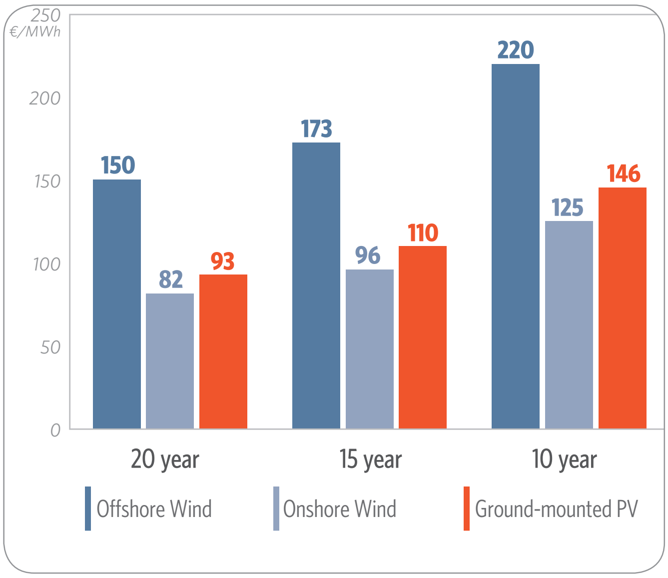
Addressing inflation risk

Investors who take a long-term view are typically more comfortable with steady returns from reliable long-term investments rather than higher returns from riskier short-term investments, and this lower return requirement reduces the cost of renewable energy projects. Because of the extended investment period there is uncertainty about the level of return as a result of inflation some investors may be willing to accept lower return requirements if this risk could be mitigated.

As well as directly affecting the value of cash returns, inflation can indirectly affect the amount of cash available to shareholders. There is a correlation between operating costs and inflation, though this correlation is imperfect and varies by technology. Costs may even decrease during times of positive inflation as a result of markets becoming more competitive and improvements in technology and learning. Operating costs are less material for renewable energy projects since they are low relative to capital costs (unlike feedstock-dependent thermal generation plants for example).

If support payments are not linked to inflation, then the higher inflation becomes, the worse the situation is for the investor. EEG support in Germany is ultimately paid for by the consumer, and given the general correlation between earnings and inflation consumers are usually well placed to take inflation risk in return for a lower starting level of revenue support. This correlation is also imperfect however and during the economic life cycle there are times when it breaks down altogether. Due to the potential for inflation to be volatile, there are often caps in place when inflation risk is being passed to another party, and these ultimately limit the value of the arrangement and the premium that would be paid for such an arrangement. Nonetheless, the UK is an example of a country that links revenue support to inflation on a notionally un-capped basis.

Figure A3.5: Impact of a shorter support period

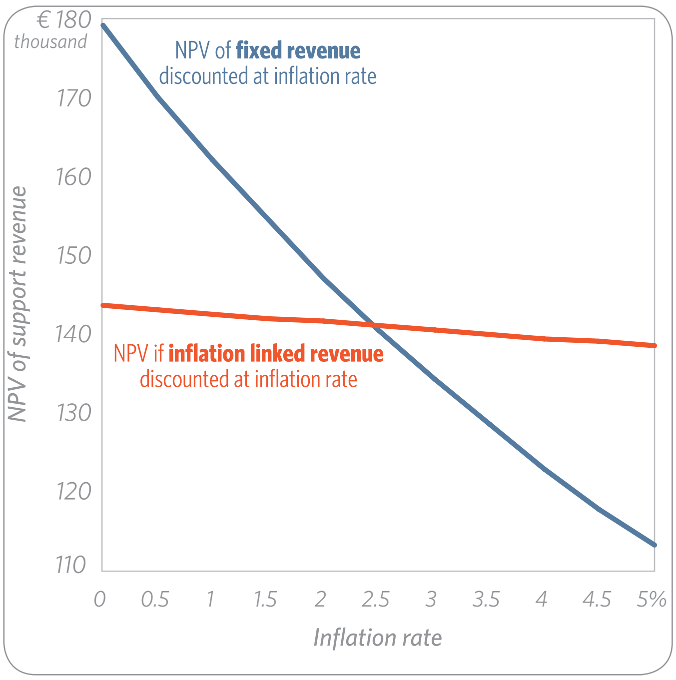


Source: CPI analysis

because of its higher leverage compared to offshore wind. Furthermore, the relatively low operational costs result in a greater proportion of revenues being used to service investor returns compared to both types of wind technology.

The relative cost in net present value (NPV) terms to the consumer for each option depends on the discount rate applied. The higher the discount rate the better value the long-term support duration appears and vice versa.

Figure A3.6: Impact of inflation-linked support on support revenue



Source: CPI analysis

Inflation-linked tariffs make investments from risk-averse investors more likely. Institutional investors could be particularly interested in inflation linked tariffs. They have liabilities which increase over time based on the cost of living. The ability to match assets to liabilities on an inflation-linked basis could be a benefit for which they may be willing to pay a premium which could result in a lower auction bid price.

In order to model the impact of applying inflation to auction prices, we started with an onshore wind case which assumes no inflation linkage and requires an €81.7/MWh auction price. We then assumed the auction price would increase by a 2% annual inflation rate and that investors were willing to discount their weighted average cost of capital by 0.5% in order to receive this inflation hedge. This number was arrived at by a comparison of gilt rates in the UK where indexed and non-indexed gilt instruments are available as well as index-linked revenue support for renewables.

Under this scenario, the real index rate is €65.5/MWh, and in nominal terms if an NPV is calculated by discounting at the rate of inflation then NPV of support is lower than for the original case because of the assumed 0.5% reduction in the return requirement.

3 END USER PARTICIPATION

Key considerations for policymakers:

- Germany is unlikely to meet deployment targets without small investors
- Regulation and market structure should address small investor objectives to create room for these investors and maintain a diverse mix of finance sources

Background and summary

End users are interested in renewable energy investments for different reasons (Table A3.4: Investment rationales of end users). Private households and co-operatives are mainly interested in self-sufficiency and environmental goals and they want to physically consume green electricity. However, electricity that is remunerated according to the EEG becomes so-called 'grey electricity', ie electricity that cannot be distinguished from electricity generated in fossil fuel power plants. Farmers and small businesses want to unlock financial advantages and to hedge against energy prices in the long-term as well as to use green energy for their own consumption.

Small private consumers are an important end user. Citizen energy projects accounted for 43% of renewable electricity generation capacity in 2012 (trend:research and Leuphana Universität Lüneburg 2013). Private consumers are most concerned with taxes, distribution charges, and net metering. They are also interested in how they will be paid for excess generation that they feed in into the grid. However, they will not be able to successfully participate in a complex auction system.

Going forward, policymakers have to address these concerns if they want to include small private investors in the energy transition.

Impact on investors

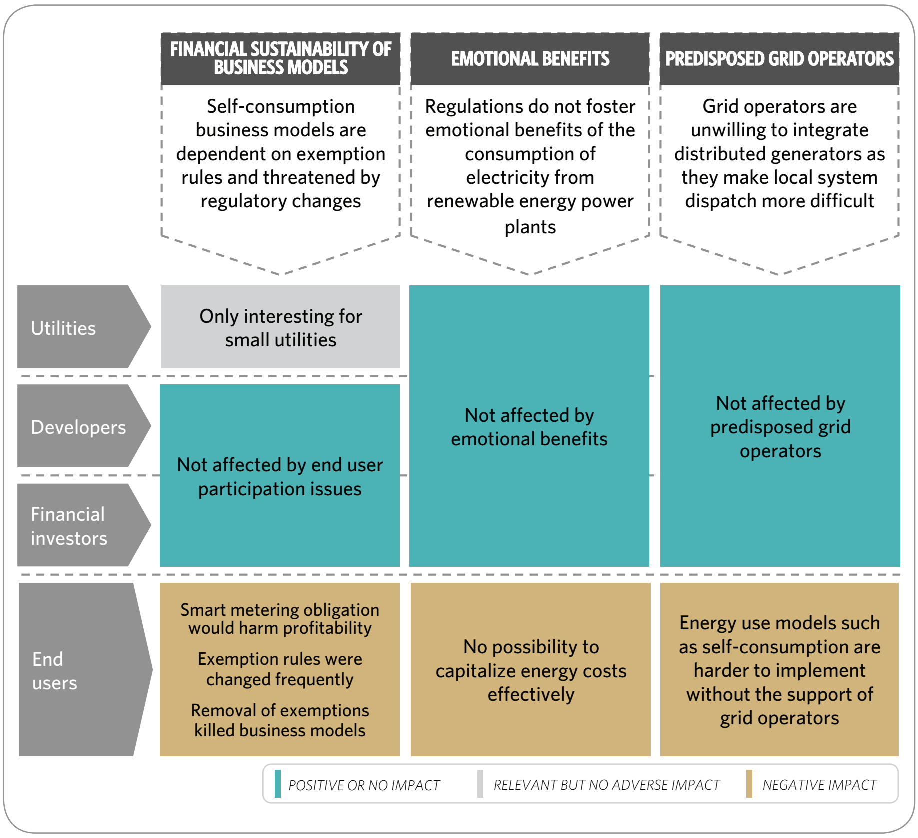
End user participation issues mainly affect **small end users** (Figure A3.5). The sustainability of self-consumption business models is doubtful because of the uncertainty around future regulations. Exemption rules (e.g. charges, taxes, and EEG surcharge) for self-consumption models were changed frequently in the past but several self-consumption business models are only feasible with such rules in place. A representative of the PV industry mentioned that an "elimination of the EEG allocation exception for self-consumption will lead to a decrease in systems with capacities of 10-30kW". Other regulations also affect the sustainability of

Table A3.5: Investment rationales of end users

	SOCIAL AND ENVIRONMENTAL GOALS	SELF-SUFFICIENCY	LONG-TERM PRICE HEDGE	FINANCIAL RETURN
PRIVATE HOUSEHOLDS	✓✓✓	✓✓✓	✓✓	✓
CO-OPERATIVES	✓✓✓	✓✓	✓	✓✓
FARMERS	✓	✓✓	✓✓✓	✓✓
SMALL BUSINESSES	✓	✓	✓✓	✓✓✓

Source: CPI analysis based on interviews

Figure A3.7: Issues regarding end user participation



Source: Interviews

rooftop solar business models and self-consumption. For example, introducing obligatory smart metering for rooftop solar PV systems would increase costs so that investments are no longer attractive. In addition, rooftop solar PV owners do not have the feeling under the current remuneration scheme to provide for their own electricity needs sustainably because electricity generated from renewable energy technologies become 'grey electricity' when remunerated according to the EEG. As a result, there is a lack of financial and emotional benefits of self-consumption under the current regulations. There is no possibility for energy price hedging. Neither do small private end users have the ability to capitalise energy costs effectively by buying electricity upfront. Lastly, grid operators are predisposed against self-consumption because reduced information about renewable energy output and consumer demand can make local system balancing more difficult.

Key considerations for policymakers

GERMANY IS UNLIKELY TO MEET DEPLOYMENT TARGETS WITHOUT SMALL INVESTORS

A large share of distributed electricity generation is harder to manage than centralised large-scale plants. On the other hand, there are also benefits and costs of including small end users. In particular, small end users may have lower return expectations as they focus on aspects like long-term price hedges, grid independence, or low-carbon electricity consumption. Furthermore, deployment of clean energy by end users can reduce local opposition against other renewable energy projects. Another important factor is whether the capacity extension targets can be met without small end users. With the current PV extension rates, Germany will be unlikely to reach the annual target of 2.5 GW without small investors.

REGULATION AND MARKET STRUCTURE SHOULD ADDRESS SMALL INVESTOR OBJECTIVES TO CREATE ROOM FOR THESE INVESTORS AND MAINTAIN A DIVERSE MIX OF FINANCE SOURCES

Interviews revealed that some regulations could strongly decrease the investment appetite of small investors. These regulations include the planned obligatory installation of smart meters or restrictive de minimis criteria for the exemption from auctions. Small-scale PV systems are a vital component for reaching the capacity extension targets for this technology. Thus, de minimis levels should be set in a way that does not lead to less investment or smaller system sizes for residential PV systems. Furthermore, de minimis rules make small investor involvement more likely because they would not be required to face the complexity of an auction system. With no exemption, many small investors would be crowded out and this would result in lower renewable energy capacity deployment rates. More importantly, it limits actor diversity which would lead to lower competition and less cost reduction potential in the long-term.

4 LONG-TERM TARGETS

Key considerations for policymakers:

- Business model investment lowers the non-system costs of renewable energy
- Unstable long-term targets will decrease investment in business model improvement, slowing the decline in renewable energy costs
- Increasing interest rates could reduce the future competitiveness of renewable energy - a 2% increase in interest rates could increase the average cost of renewables by 12.8%

Background and summary

Reliable long-term targets reduce the risk of stranded investments in process optimisation. Such long-term targets include the consistent commitment of policymakers to drive forward the energy transition. More specifically, they include target ranges for capacity deployment for the different renewable energy technologies.

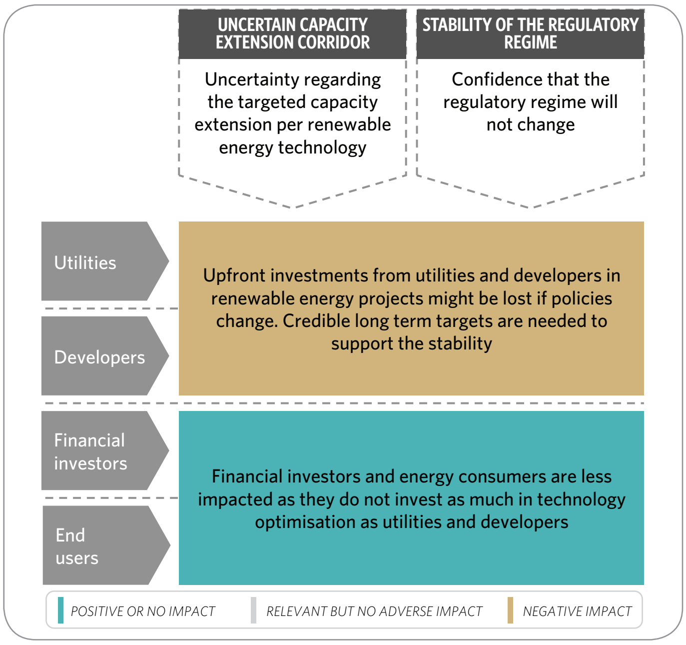
Reliable long-term targets can lead to lower costs as investors are incentivised to invest in process optimisation. For example, utilities have to invest in skills, pipeline and long-term cost effectiveness. These developments are more risky if there are no clear and reliable long-term targets. Consequently, reliable long-term targets are needed to justify these investments.

A competitive environment is seen as potentially more stable and thus more conducive to investments in building a portfolio and industry know-how. Such investments are particularly important for investors who have the capability to decrease costs by implementing best practices and continuous process improvements. The stability of long-term targets determines how much a player wants to invest in developing a business.

Impact on investors

Long-term targets are important for **utilities and developers** (Figure A3.8): They do not want to invest resources in building up know-how that is related to technologies that might not be supported by future regulations. Policy changes threaten the profitability of existing long-term investments. Offshore wind projects are particularly affected because "such projects need a period of 3-5 years before construction starts and changes in regimes affect such projects" (comment from a large utility). Sophisticated utilities and developers fear that projects with long lead times may be affected by changes in a remuneration scheme during the project development stage. Furthermore, building up know-how for a certain sector is costly and time-consuming. Upfront investments in renewable energy projects might be lost if a policy change affects the support mechanism for renewable energy plants.

Figure A3.8: Issues regarding long-term targets



Source: Interviews

Key considerations for policymakers

Reliable long-term targets are a better basis for long-term planning. Our interviews indicate that those investors that can become cost leaders by optimising costs as well as those players that could invest in less mature technologies are discouraged if regulatory changes reduce the returns from their existing project portfolio. Without trust in long-term targets, such investors will either require higher risk premia or will be unwilling to invest.

BUSINESS MODEL INVESTMENT LOWERS THE NON-SYSTEM COSTS OF RENEWABLE ENERGY

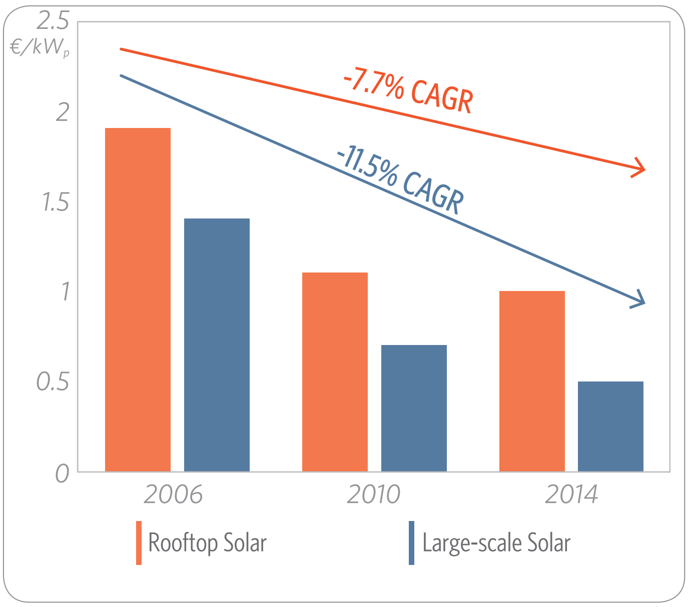
Figure A3.9 illustrates the impact of investments in process improvements for the construction of PV systems. Large-scale systems are those that are built and operated by developers and utilities, i.e. companies that invest in process improvements. Over the period from 2006 to 2014, the non-module cost reductions for PV systems were substantially higher for large-scale projects. Thus, process improvements clearly have a favourable effect on overall system costs.

UNSTABLE LONG-TERM TARGETS WILL DECREASE INVESTMENT IN BUSINESS MODEL IMPROVEMENT, SLOWING THE DECLINE IN RENEWABLE ENERGY COSTS

Clear targets are important for creating investor confidence and so encouraging investment. Our interviews revealed that a reduction in long-term targets can be as harmful as a retro-active tariff cut to investors that are taking development risk. They invest significant development costs in projects if they believe that they have a good understanding of the probability of successfully reaching completion. If the likelihood diminishes significantly as a result of lower targets, then they face write offs of the development costs.

Less deployment reduces the level of cost-savings arising from cumulative experience, making the technology more expensive than it otherwise might have been. Additionally, cuts in long-term targets can result in greater levels of uncertainty for early-stage investors in other renewable technologies which may push-up their return requirements.

Figure A3.9: Impact of business model investments



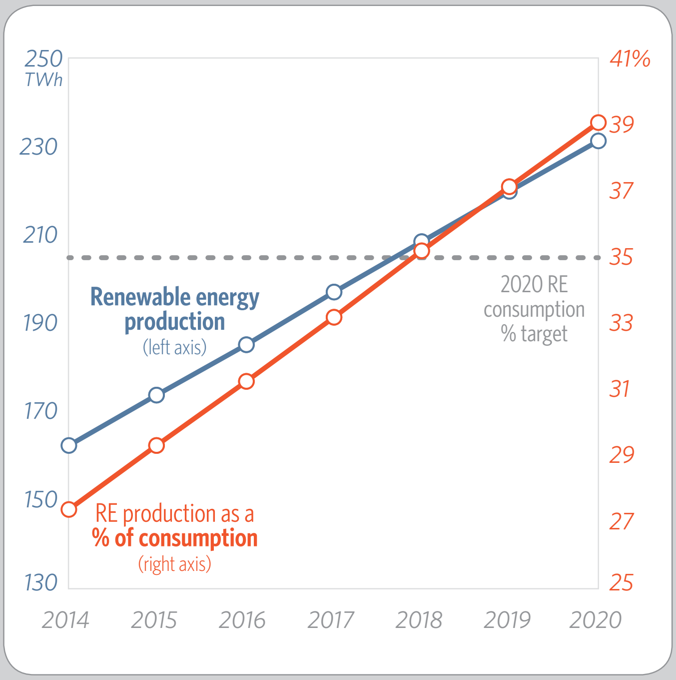
Source: IEA-PVPS 2006-2014

Putting deployment targets in context

According to the latest data available from Germany's Federal Ministry for Economic Affairs and Energy (BMWi), 162.5TWh of power in Germany was produced by renewable sources in 2014 and constituted 27.4% of total electricity demand of 593TWh.

Annual capacity targets of 2.5GW for onshore wind, 2.5GW for solar and 800MW of offshore wind imply additional production of 10.9TWh if the respective load factors, the ratio of electricity produced compared to a plant or turbines full capacity, of 25%, 11.1% and 42% in our modelling analysis are assumed. However, the onshore target is a net target after taking repowering needs into account; BMWi forecasts that over the next 10 years an average of 1.6GW per annum will be repowered. If we assume that the average load factor of sites with older turbines is closer to 18% (so 2% below the German average), then the net production requirement increases, as older turbines are replaced by more efficient modern ones, to 11.8TWh.

The German government's target for 2020 is for 35% of consumption to be provided by renewable energy sources. The graph here shows how achieving the deployment targets may impact the consumption target while conservatively assuming consumption/demand remains unchanged from 2014 levels and that 2015 production matches our forecasts for 2016 to 2020 (Quaschning 2016).



Source: CPI analysis

We have modelled a scenario where offshore targets are reduced from 800MW to 400MW per annum so offshore contributes less to the energy mix. In addition we have assumed that cost reductions are half of what they would otherwise have been to take account of a lower rate of learning. Table 22: Impact of changes in long-term targets for offshore wind, from 800 MW to 400 MW shows the results for this scenario.

Under this scenario the cost of offshore wind increases by 6.1% to €159.5/MWh although the blended price for new renewable energy actually decreases by 5.1%. These overall cost savings are achieved because offshore wind is more expensive than onshore wind and solar. Whereas the reduction in renewable capacity per annum is 5.4% as a result of a reduction in targets, the reduction in generation is almost double this level at 10.3%. This reduction is explained by the higher load factors associated with offshore wind.

Table A3.6: Impact of changes in long-term targets for offshore from 800MW to 400MW

	BASE CASE	TARGET REDUCTION CASE	% CHANGE
Capacity installed (MW)	800	400	-50%
Generation (GWh)	2945	1473	-50%
Electricity price	150.3	159.5	6.1%

Source: CPI analysis

INCREASING INTEREST RATES COULD REDUCE THE FUTURE COMPETITIVENESS OF RENEWABLE ENERGY

When interest rates do ultimately start increasing, it remains to be seen whether investors will seek high returns elsewhere or whether the government will be willing and able to accept higher levels of consumer-funded subsidies in order to meet renewable targets. Rapid increases to the EEG surcharge could have a knock-on impact on the level of public support for renewables. One interviewee noted that the politically acceptability of surcharge levels can be hard to predict as EEG surcharge levels can increase year on year without much interest but then suddenly they can reach a level where they become a hot topic and have a major impact on public acceptance.

Interest rate risk

Interest rates have been persistently low since 2008/09 when a series of base rate reductions were announced as a result of the financial crisis. With the European economy taking a long time to recover, market rates have continued to fall rather than increase as investors originally expected. This low interest rate environment has seen bond prices increase, and investor return requirements adjust to the market accordingly.

The forward curves of the Euro Interbank Offered Rate (EURIBOR), the average interest rates at which Eurozone banks lend to each other, already factor in expectations of rises in interest rates. These rises are not expected to happen imminently and, when they do, rates are not anticipated to increase rapidly so long-term debt rates should remain fairly low and stable for the next few years. As a result, this is still an opportune time for renewable energy investment because when rates do start rising to pre-crisis levels, not only will debt become more expensive, equity return requirements will also have to increase in order to maintain the risk premium between debt and equity. This will require support payments to increase in order to meet higher capital costs (see below for analysis).

If support levels do not ultimately increase as a result of increasing interest rates then future deployment levels will be jeopardised because not only are equity return expectations likely to be higher, the returns will actually be lower than during times of low interest if new, more expensive debt is required. Such a lack of investment would likely result in bankruptcies and consolidation across the industry, and those that survive may have to concentrate on overseas opportunities to stay in business.

We assumed a 2% increase in the base rate and a corresponding 2% increase in equity return requirements. Equity return requirements are not necessarily directly proportional to base rates but we believe it is reasonable to assume that base rates will not only impact the cost of debt. The results are summarised in Table A3.6 and Figure A3.10: Impact of changes in interest rates on different technologies.

As a result of a 2% increase in return requirements, the weighted average cost of renewables increases by 12.8%. The impacts would be even greater if we did not assume that the domestic solar market receives pre-defined feed-in tariffs so there is no option to increase returns as there is for auction participants. It is difficult to predict whether the rooftop PV market would be content to continue receiving the same return in a higher interest rate environment or whether investment at this level would simply dry up.

Table A3.7: Overall impact of 2% change in interest rate

	BASE CASE	RATE INCREASE	% INCREASE
Weighted average renewables price (€/MWh)	97.6	110.1	12.8%
Weighted average equity IRR	9.1%	10.8%	19.0%

Source: CPI analysis

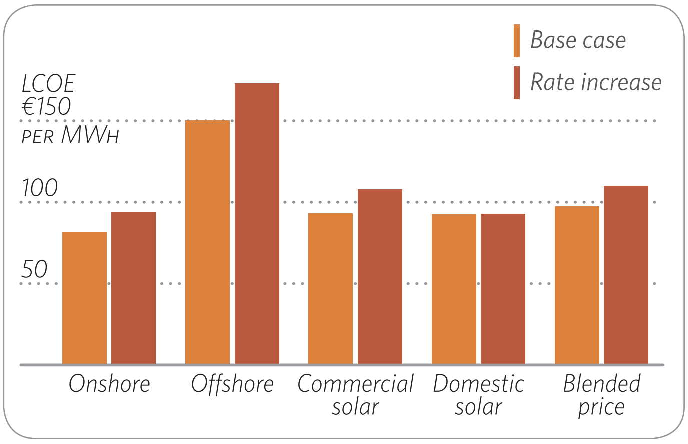
5 GRID CONNECTION

Background and summary

Designing an optimal grid for the energy transition is becoming more challenging as the share of distributed generators increases. Electricity grids are highly regulated and policies will shape the grid structure going forward. Uncertainty in grid connection planning could lead to grid connection delays, which have happened in the past.

Offshore wind projects have been particularly prone to grid connection issues due to imprecise planning and

Figure A3.10: Impact of changes in interest rates on different technologies



Source: CPI analysis

estimations about the required grid strength. Regulatory changes have provided more transparency with regard to the liability of grid operators in the case of a delay (Gesetz über die Elektrizitäts- und Gasversorgung 2005).

Projects in urban areas are not affected as the grids are generally strong enough to connect them already. While the chance to get economic compensation is limited in the case of grid connection delays, the risk of revenue losses is also lower. The lower risk is due to the significantly lower lead times of ground-mounted PV systems, compared to offshore wind plants. Construction of ground-mounted PV systems usually starts after grid connection has been secured. Thus, it is unlikely that grid connection delays will affect a project that has entered the construction phase.

Impact on investors

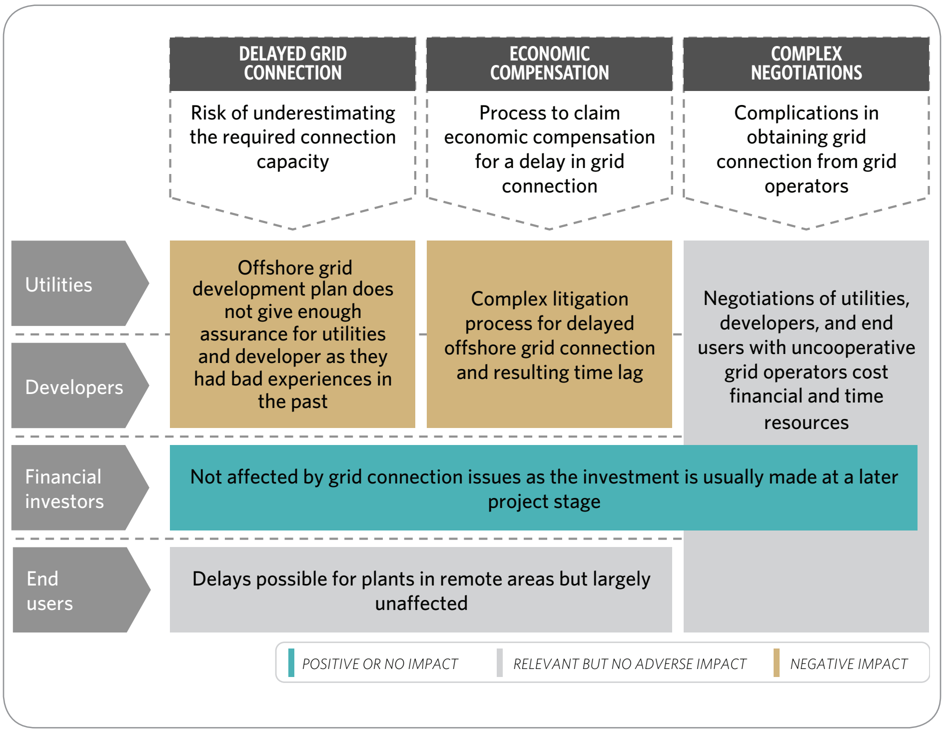
Grid connection issues affect utilities, developers, and end users (Figure 3.11: Issues regarding grid connection):

- **Large utilities and developers** that build offshore wind plants have experienced delays in the past. Potential cash flow disruptions at the beginning of projects with such high capex requirements discourage these investors. They do not feel that the offshore grid development plan gives them enough assurance. Economic compensation can be claimed for delays in grid connection. However, legal actions are time consuming and do not fully compensate for lost revenues.
- **End users** that focus on rooftop PV do not fear issues with grid connection: "Grid connection for small systems is no problem at all" (representative of the PV industry). Projects in urban areas are generally not affected as the grids are built-out enough. In contrast, ground-mounted PV plants in remote areas run greater risk of being connected with delays, but risks are still low.
- **All affected investors** are concerned about complex grid connection negotiations. They cost financial and time resources. In particular, renewable energy power plant operators sometimes have to deal with uncooperative grid operators that delay the grid connection process.

Key considerations for policymakers

The interviews revealed that investors do not expect grid connection issues to be a major issue in Germany. Nevertheless, the cost effectiveness of grid connection and grid operation costs is an important factor that policymakers should consider. Currently, renewable energy plant operators have the incentive to minimise costs at the plant level. Instead, policymakers should give the appropriate incentive to minimise total systems costs by considering transmission costs, transmission capital costs, transmission losses, and transmission restraints through appropriate energy price signals. In doing so, they should also consider technology and financing costs and their response to the regulatory incentives they put in place.

Figure A3.11: Issues regarding grid connection



Source: Interviews

6 ENERGY MARKET DESIGN

Key considerations for policymakers:

- Energy market design influences the cost of capital for renewable energy investments
- Changing rules could create new risks and favour one group of investors over others
- A coherent energy market design will become the single most important issue in the long-term

Background and summary

Although most renewable energy projects in Germany have fixed price feed-in tariffs that shield them from volatile energy prices that result from the energy market design, the market design can nevertheless affect investors in at least four ways:

1. The perceived riskiness of the fixed price tariffs themselves, i.e. the risk that tariffs may be changed or become less reliable, is a function of the difference between the fixed prices and the market prices. Although Germany has shown solid commitment to the feed-in tariffs, experience in places like Italy or Spain cause investors to hesitate, especially if the fixed tariffs are well above market prices. Therefore, a market design that creates a risk of low or negative prices increases risk perceptions to renewable energy investors.
2. Even with fixed price tariffs, investors will be exposed to wholesale prices once the fixed price tariff expires. In general, this is far in the future and so should have only a minor impact on investment.
3. Developers, manufacturers and others relying on the long term stability of the industry will feel threatened by the volatility of the market that will place risk on the future development of renewable energy projects. This uncertainty could reduce investment and therefore slow the decline of costs.
4. In some cases renewable energy could be eligible for additional revenues from ancillary services. More likely, the markets for these services could depress wholesale prices and enhance the risks spelled out in 1, 2 and 3.

The current market is ill-equipped to meet a future with significant intermittent, non-dispatchable renewable energy supply. The current electricity market is an energy-only market which means that the market price for energy is set on an hourly basis as a function of the hourly supply and demand. One alternative is to institute a capacity market where in addition to paying for the energy, consumers must also pay for the capacity needed to generate that electricity in the hour. Such a market gives both generators and consumers the incentive to respond to supply and demand by making more supply available during peaks, or consuming less energy during those peaks. The German government recently announced that the implementation of a capacity market is not intended. However, it also explicitly mentions the option to introduce capacity mechanisms. Capacity markets will have the impact of reducing hourly energy prices by shifting some value to the capacity mechanism. Since intermittent suppliers cannot guarantee that capacity will be available at peak, this could reduce revenues or heighten risks.

On the other hand, market mechanisms that created stronger incentives for increasing flexibility while maintaining a fair price for energy from intermittent generators, could reduce risk perceptions for renewable energy. Thus, the form of the market and capacity mechanism could have a large impact on the risk of renewable energy.

As renewable energy production increases, the current energy market design is beginning to exhibit flaws. As we will show in the next section on curtailment, the current market design will respond to larger amounts of renewable energy by pushing prices below zero for many hours a year. At its limit, a market like the current version but with very high penetrations of renewable energy could have zero or negative prices for all but a few hours of the year. Under such a market neither renewable energy nor conventional generation will be viable.

Reaching ever higher levels of renewable energy will require either a new market design, or breakthroughs in technology and energy consumption patterns that enable energy supply and demand to shift seamlessly to match each other. The likelihood, however, is that improved and revised market design will be required to develop these new technologies and processes and that without new market designs the changes will not come to pass.

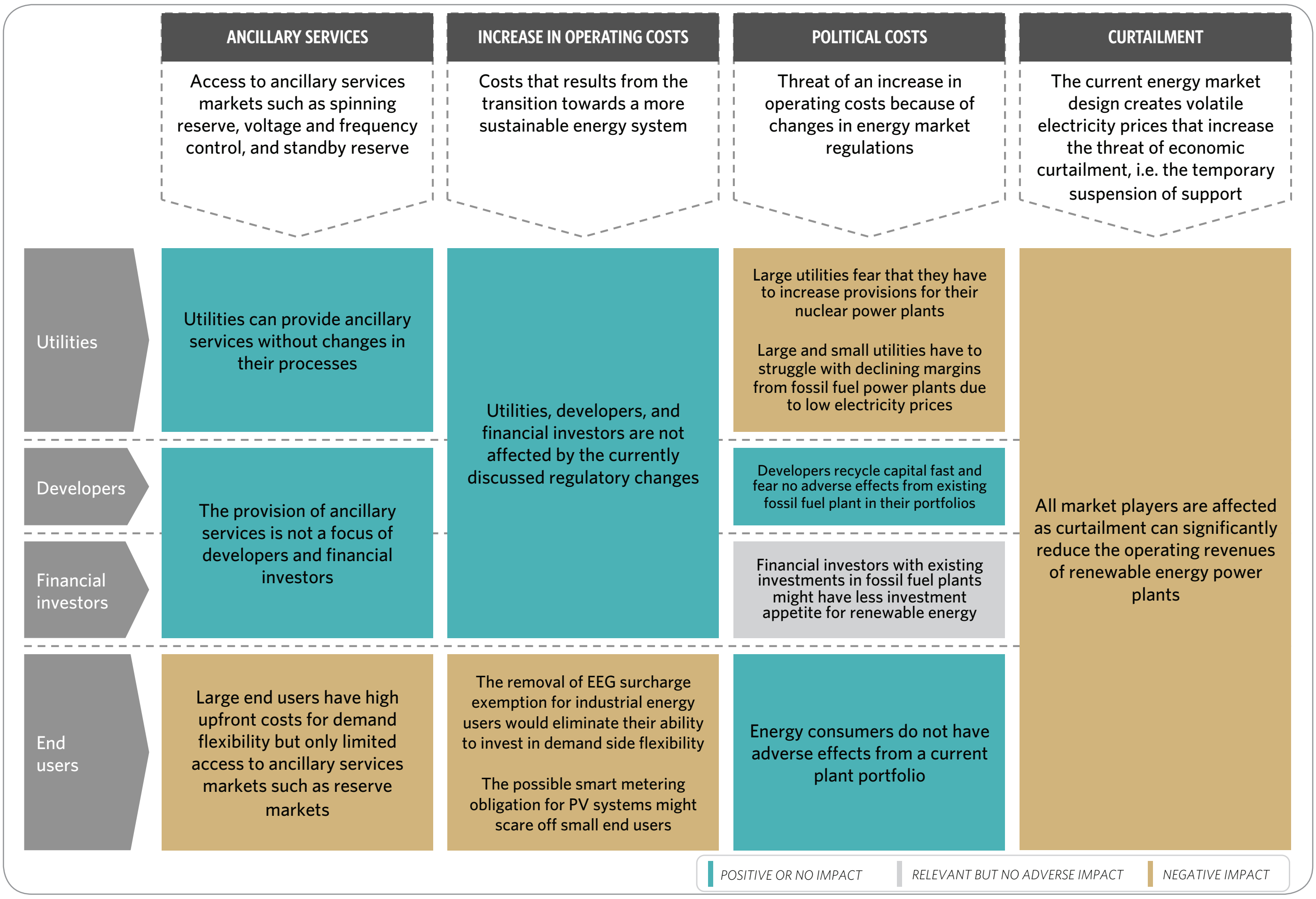
Energy market design determines not only the price setting mechanism but also the broader aspects of market access. For example, it determines qualification criteria for participating in the electricity and ancillary services markets. Strict technological criteria for participating in the energy market, such as sophisticated metering equipment for electricity feed-in, make it hard for some investors to see a valid business case. The same is the case for ancillary service markets such as the reserve markets in which renewable energy technologies with fluctuating feed in cannot participate.

Impact on investors

Energy market design affects a wide range of investors in the industry (Figure A3.12: Issues regarding energy market design):

- **Small and large utilities** have to bear many of the political costs of the energy transition: they have financial constraints because the fossil fuel power plants in their portfolios are currently less profitable in the energy-only market. Furthermore, large utilities face the threat of an increase in provisions for nuclear power plants. Such an increase would render large investments impossible and would complicate organisational changes to better adapt to the energy transition.
- **Large industrial end users** fear regulatory changes that increase their operating costs. Some of the large industrial end users that are currently exempted from the EEG-surcharge would have to file for insolvency if this exemption were withdrawn. Furthermore, the realisation of load shifting potential in production processes requires substantial investments but large industries' access to reserve markets is currently restricted. The Federal Ministry for Economic Affairs and Energy (BMWi) has published a white paper that includes the option to enable the participation of new players such as large industrial end users in the balancing power markets (BMWi 2015b). However, the actual design of these regulations is not yet known.
- **Small end users** are threatened by an obligation to install smart meters for rooftop PV systems which would make investments unattractive. A representative of small end users commented that "smart metering for small generators is a problem because of the additional costs

Figure A3.12: Issues regarding energy market design



Source: Interviews

associated with the required top end smart meters". Furthermore, small investors that do not have the capability to run their own direct marketing efforts have reduced margins as it becomes necessary to commission an aggregator to do this for them.

- **All players** are affected by the threat of an increase in negative electricity prices. In the current energy market design, an increasing share of fluctuating electricity feed-in will lead to more volatile electricity prices. In particular, larger onshore wind capacity could lead to negative electricity prices and, thus, to a suspension of support to renewable energy plant operators.

Key considerations for policymakers

ENERGY MARKET DESIGN INFLUENCES THE COST OF CAPITAL FOR RENEWABLE ENERGY INVESTMENTS

From the interviews, we learnt that the market design significantly changes the risk profile of investments. However, only interviewees from utilities raised this as an issue. Another important aspect is whether the energy market design influences development and construction costs. The interviews revealed that the current infrastructure and sector organization is not perfectly adapted to renewable energy projects: under the current energy market design, conventional projects have a structural advantage over renewable energy projects because an investment in fossil fuel power plants requires a lower proportion of upfront investment, compared to renewable energy projects. Energy market rules also impact the cost of capital.

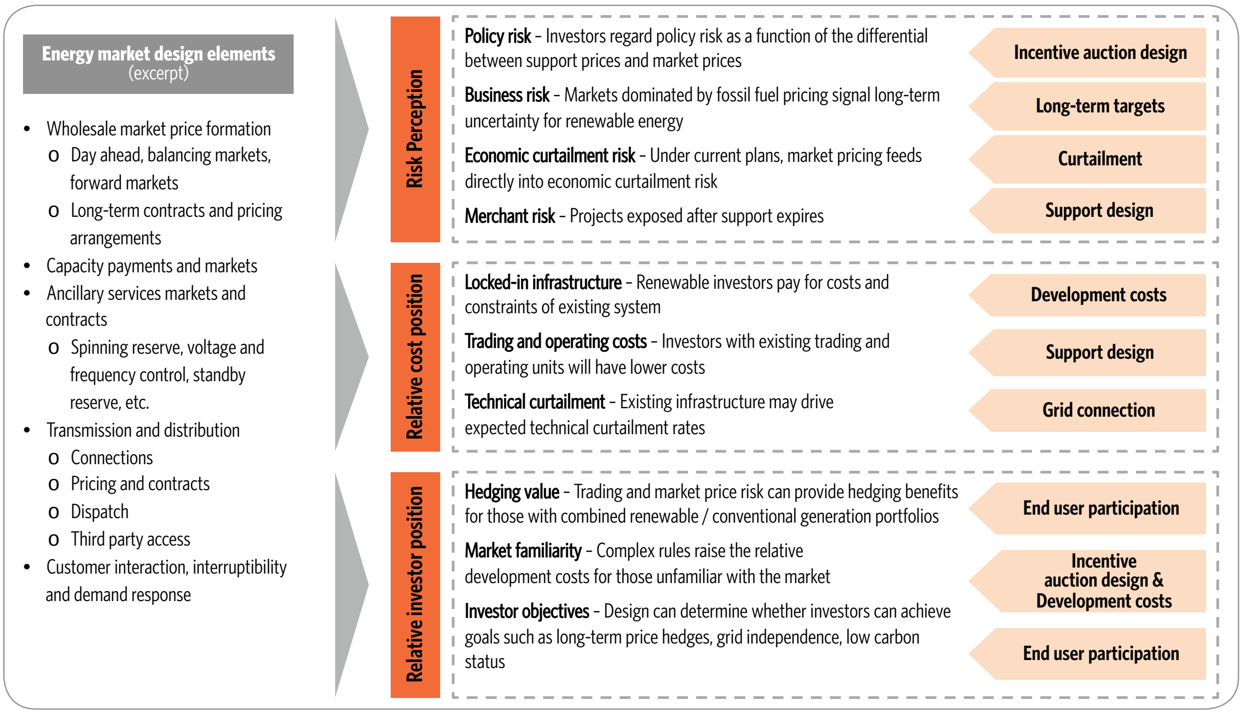
CHANGING RULES COULD CREATE NEW RISKS AND FAVOUR ONE GROUP OF INVESTORS OVER OTHERS

We analysed the impact of energy market design on different sets of investors' willingness to invest. Our conclusion from the interviews is that easier different rules, such as access to electricity markets, could encourage new types of investors, investment vehicles or corporate structures. On the other hand, regulations can also discourage whole investor groups. For example, industrial investors and aggregators will only invest in demand flexibility options if there is a visible business case. However, this is currently not the case as they do not have easy access to the reserve markets. An expression of intention, as in BMWi's electricity market white paper, is not an appropriate basis for substantial investments. The German government must define which investor structure it envisages for the energy transition and design the market accordingly. In doing that, clarity is crucial so that investors can align their capital accordingly.

A COHERENT ENERGY MARKET DESIGN WILL BECOME THE SINGLE MOST IMPORTANT ISSUE IN THE LONG-TERM

One of our main findings is that energy market design feeds into most other polices. The energy market design elements are (1) wholesale market price formation; (2) capacity payments and markets; (3) ancillary services markets and contracts; (4) transmission and distribution; and (5) customer interaction, interruptibility and demand response. Policy issues can be addressed by isolated changes of auction design elements, support design elements, or other policy instruments. However, a coherent energy market design will become the single most important issue in the long-term because it sets the rules for implementing larger shares of renewable energy. Figure A.3.13: Link between energy market design elements and other polices gives an overview of the energy market design elements and how they influence other polices.

Figure A3.13: Link between energy market design elements and other polices



7 CURTAILMENT

Key considerations for policymakers:

- Most investors are not yet focused on the disruptive potential of economic curtailment
- Economic curtailment will lead to higher prices and lower production
- The negative impact of curtailment can be mitigated by policy, market and technology development

Background and summary

What do we mean by "curtailment"?
We distinguish between two types of curtailment: The first type is technical curtailment, i.e. physically reducing the feed-in of electricity from renewable energy technologies in order to guarantee grid stability. Technical curtailment is also referred to as "Einspeisemanagement" and regulated according to EEG 2014 §14. The second type is economic curtailment, i.e. the suspension of subsidies for feeding-in electricity from renewable energy technologies in periods of negative electricity prices. Economic curtailment is relevant for renewable energy power plants that started operating from 1 January 2016 and is regulated according to EEG 2014 §24

Technical curtailment poses a limited downside risk for renewable energy plant operators. They are compensated for at least 95% of lost revenues in the case of technical curtailment measures. In fact, technical curtailment can be an option for keeping the costs of the energy turnaround low. In the short-term, a combination of support for high deployment of renewable energy capacity and compensation for technical curtailment can be cheaper than the implementation of storage systems or large cold reserve capacities (Müller et al. 2013). Utilities and developers generally feel technical curtailment is manageable as grid studies have become more reliable and transmission expansion offers some capping of risk.

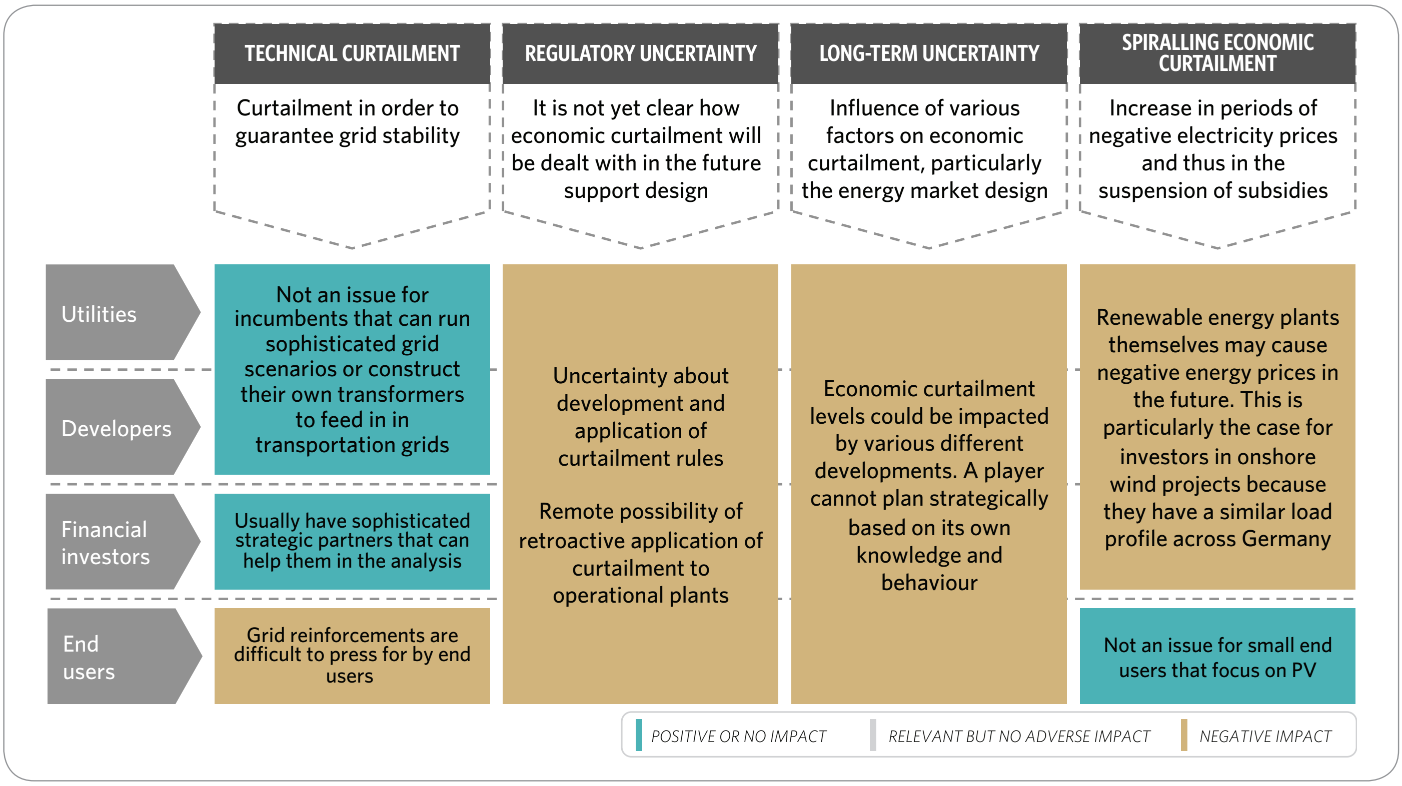
Economic curtailment is a more contentious issue. This issue is not well understood and different investors have widely diverging views on the potential adverse effect of economic curtailment on their projects. Some investor groups have not analysed the potential impact of economic curtailment on their investments at all but developers in particular think that this could be a major problem in the future. The European Commission set guidelines that require member states to remove "incentives to generate electricity under negative prices" (EC 2014). The pivotal question is whether the downside risk for investors in renewable energy plants can be limited without impinging on these guidelines.

Impact on investors

Curtailment impacts small investors, large utilities and industry participants, and financial investors (Figure A3.14):

- **Utilities and developers** are comfortable with technical curtailment caused by local grid capacity constraints, but their level of concern over economic curtailment varies. A developer mentioned that economic curtailment is "the major issue in discussion with investors". Since renewable energy itself may be a large cause of negative energy prices, the highest potential for curtailment may be precisely when generators are running at their peak. In other words, the biggest risk to wind parks may be the future development of wind generation: attractive wind energy incentives and more deployment could lead to higher levels of economic curtailment.
- **Financial investors'** levels of concern vary. An asset manager stated that "curtailment does not raise concerns".
- **End users** are often unaware of potential curtailment or are isolated from its impacts. However, they could be confronted with technical curtailment in the future. While it is relatively predictable and easy to manage in theory, it requires analysis and familiarity with the system and thus favours incumbents such as large utilities and developers. Distribution-level curtailment is opaque and it may be difficult to press for reinforcement to the grid, which can be a disadvantage for medium to small facilities.
- **All players** fear regulatory uncertainty around curtailment which makes it hard for them to plan for the long term. In particular, there is uncertainty about how curtailment rules may be developed and applied. There is also uncertainty about the remote possibility of a retroactive application of economic curtailment to existing projects. Furthermore, economic curtailment levels could be impacted by economic growth, international energy planning, technology development, the effectiveness of various energy subsidies, and the strategy of various companies including renewable energy providers. How these various forces interact is virtually impossible to know in advance and therefore leaves a completely unknowable risk. In extreme cases, a combination of these factors could mean debt providers become unwilling to lend to projects.

Figure A3.14: Issues regarding curtailment



Source: Interviews

Key considerations for policymakers

MOST INVESTORS ARE NOT YET FOCUSSED ON THE DISRUPTIVE POTENTIAL OF ECONOMIC CURTAILMENT

Only a few interviewees considered economic curtailment as a serious threat to their investments. However, we expect this to change if the amount of curtailed hours increases. Regulations will have a great impact on the evolution of negative prices. We prepared a dispatch model based on historic wind production, long-term wind expectations, base load generation forecasts and improvements in energy efficiency reducing demand.

Figure A3.15: Estimated negative prices 2016-2030 shows our estimates of curtailment based on our modelling of the German electricity system. The "P50" level represents a median number of hours of negative prices, leading to economic curtailment, in a given year. That is, there is a 50% chance that curtailment hours could be higher and a 50% chance that it would be lower. Equity investors have both upside potential (from lower curtailment) and downside (from higher curtailment) and so would use this case for their base case analysis. The "P90" is our estimate of what the worst level of curtailment could be (that is, a level reached or exceeded 10% of the time). Debt investors have only default, or downside risk, and so are more interested in worst (reasonable) case scenarios.

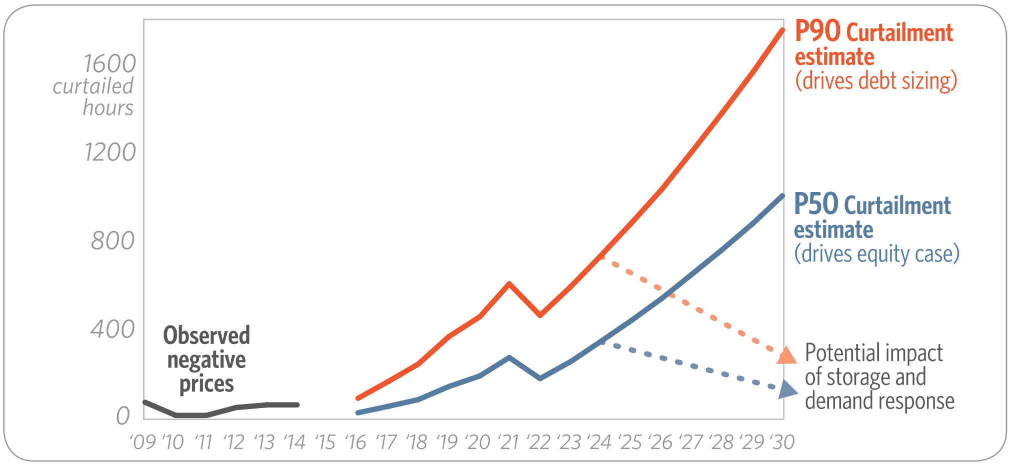
Figure A3.15: Estimated negative prices 2016-2030 shows that both the P50 and P90 curtailment will rise steadily over the next 15 years, except for 2021-2022 when nuclear power plants come off line in Germany. Since the output from nuclear power plants is relatively inflexible, with more nuclear power on the system there is a higher chance that too much generation will be on the system in any hour, causing prices to go negative. Our estimates assume that the level of flexibility (such as storage, or consumer load shifting) does not grow from today's level. Developing greater flexibility is one approach that could reduce the impact of negative electricity prices. However, our interviews suggest that investors will not assume a greater increase in flexibility until they observe the policy and response in place, so we have modelled the system as investors would see it from today's viewpoint.

ECONOMIC CURTAILMENT WILL LEAD TO HIGHER PRICES AND LOWER PRODUCTION

The state aid approval given to Germany by the EU Commission has refined the rule on negative prices to extend only to those hours that are part of six consecutive hours or more of negative pricing. This rule reduces the impact of freak conditions or negative prices that could occur when the system does not adjust fast enough to rapidly changing conditions. The attempt here is to focus on those hours where there is legitimately too much energy generation on the system and to eliminate the incentive to generate during those hours. With this rule in place the potential impact of economic curtailment falls, as in Table 24: Impact of curtailment on auction price and production volume.

Table A3.7: Impact of economic curtailment on financing risk and bid prices represents the estimated effect of economic curtailment on the LCOE. Economic curtailment affects both revenue – by affecting the

Figure A3.15: Estimated negative prices 2016-2030



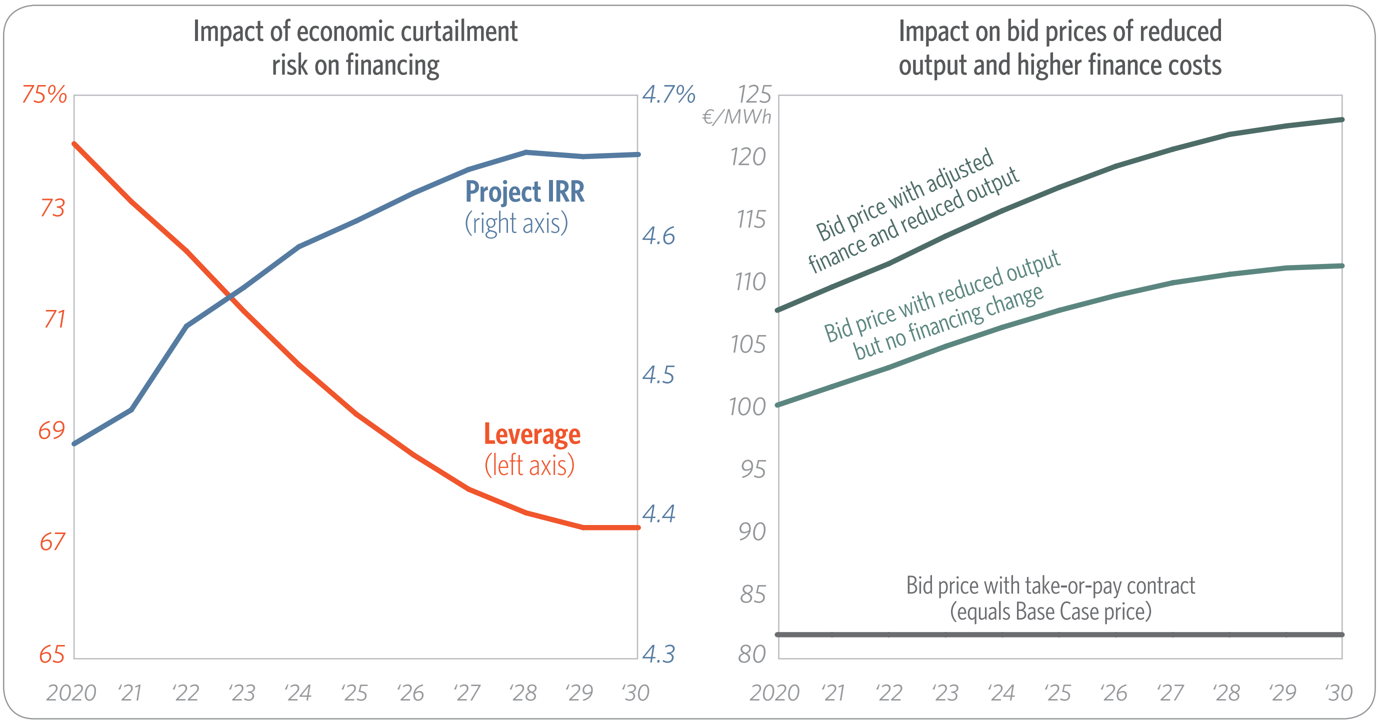
Source: CPI analysis

Table A3.8: Impact of curtailment on auction price and production volume

	AUCTION PRICE (€/MWH)	PRICE INCREASE	10-YEAR P50 ANNUAL AVERAGE PRODUCTION (GWH)	PRODUCTION DECREASE
Base case (no curtailment)	81.7	n/a	8985	n/a
Hourly curtailment	107.7	31.8%	7864	-12.5%
Curtailment after 6 hours	95.9	17.4%	8233	-8.4%

Source: CPI analysis

Figure A3.16: Impact of economic curtailment on financing risk and bid prices



Source: CPI analysis

output for which the generator is paid – and debt levels – since the higher risk of curtailment will cause lenders to decrease the amount that they are willing to lend. Both revenue and debt levels have an impact on the auction price. The left hand graph in Figure 32: Impact of economic curtailment on financing risk and bid prices shows that possible leverage levels will fall over time, from over 74% in 2020 to 67% in 2030 as the threat of curtailment grows, meanwhile optimum financing costs will increase. Leverage will be based on the curtailment risk over the lifetime of the project debt, thus, as each year passes, the threat of higher curtailment in the future draws nearer, and so leverage decreases and financing costs rise.

On the right, we have included a "no-financing change" scenario to separate out the impact of the financing change from the revenue change. That is, if leverage stays constant, bid prices would rise to just above 110 €/MWh, rather than over 120 €/MWh with decreased leverage, compared to just above 80 €/MWh with no economic curtailment.

THE NEGATIVE IMPACT OF CURTAILMENT CAN BE MITIGATED BY POLICY, MARKET AND TECHNOLOGY DEVELOPMENT

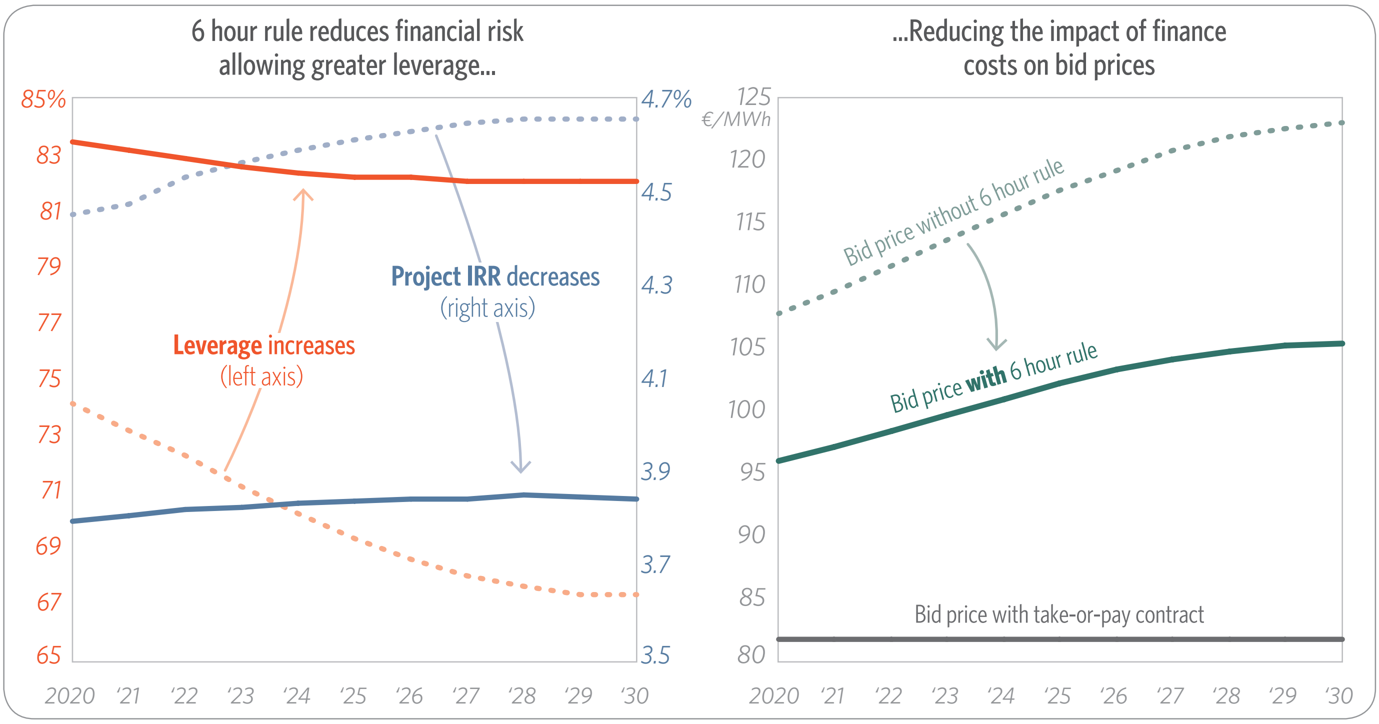
We have tested a handful of potential policy approaches that could mitigate the impact of curtailment, the results of which are summarised below alongside a description of each option. We assumed that curtailment beyond 2030 will remain at 2030 levels for modelling purposes rather than increase because of further renewable deployment or decrease because of technological or market developments.

- **Take-or-pay:** this is the same as our base case and so assumes that the full auction price is received regardless of whether curtailment is enforced or not
- **Curtailment after six hours:** this option is consistent with the German state aid approval of the European Commission
- **Proportional curtailment:** under this option curtailment is limited so that demand and supply are equal, meaning prices are no longer negative
- **Add to the end:** under this option any hours that are curtailed during the 20-year support period can be accrued and power generation beyond this support period can claim additional support until such time as the accrued hours are used up
- **Cap:** under this option we assume that in addition to the 6 hour cut-off there is a limit to the number of hours that can be economically curtailed each year

CURTAILMENT AFTER 6 HOURS

The six-hour rule partially mitigates the potential impact of economic curtailment as Figure A3.17

Figure A3.17: Impact of applying the 6 hour rule



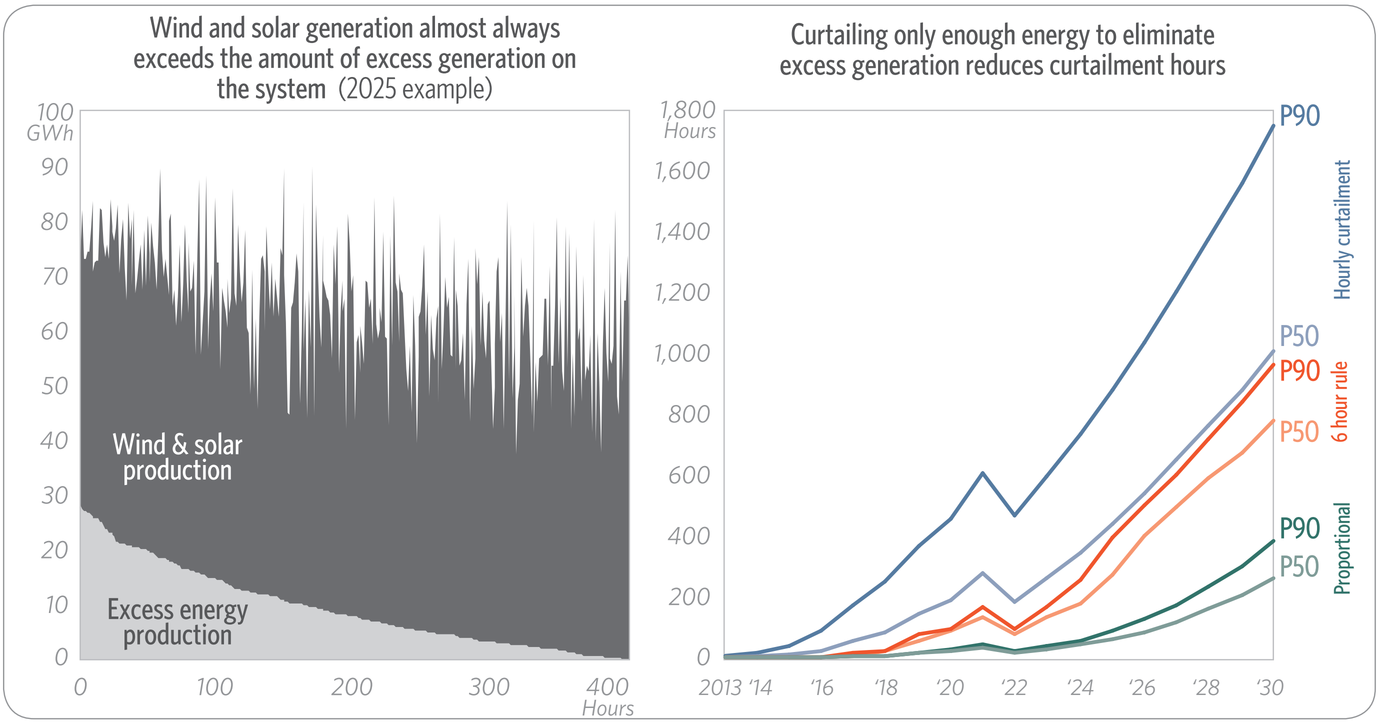
Source: CPI analysis

demonstrates. The relative impact of reduced production hours on auction prices is less significant than the impact of increased financing costs when compared to a scenario without the six-hour rule.

PROPORTIONAL CURTAILMENT

Negative prices occur when there is excess generation on the system, which is generally when there are large amounts of wind or solar generation combined with nuclear output and relatively low demand. In most cases, the system needs some, but not all, of the wind

Figure A3.18: Impact of proportional curtailment



Source: CPI analysis

generation to meet demand, but because there is more total energy than the system needs, prices go negative for all production. The left hand side of Figure A3.18 compares our forecast, hour by hour, of the amount of wind and solar generation our model predicts would be on the system in 2025 for those 400 or so hours where there is excess wind on the system. This analysis shows that nearly 85% of the wind and solar energy generated by the system during negative hours would actually be needed to balance the electricity system.

Put another way, reduction of output by an average of less than 15% during these hours would restore prices to zero or higher, eliminating negative pricing. Competitive behaviour prevents producers from colluding to reduce the output of each wind farm proportionally, but a policy that distributed the reductions proportionally (whether economically through reduced compensation or physically through technical curtailment) would both lower the cost of electricity generation compared to a curtailment scenario and provide better incentives for competition. The right hand graph in Figure 34 shows the impact in decreasing curtailment hours.

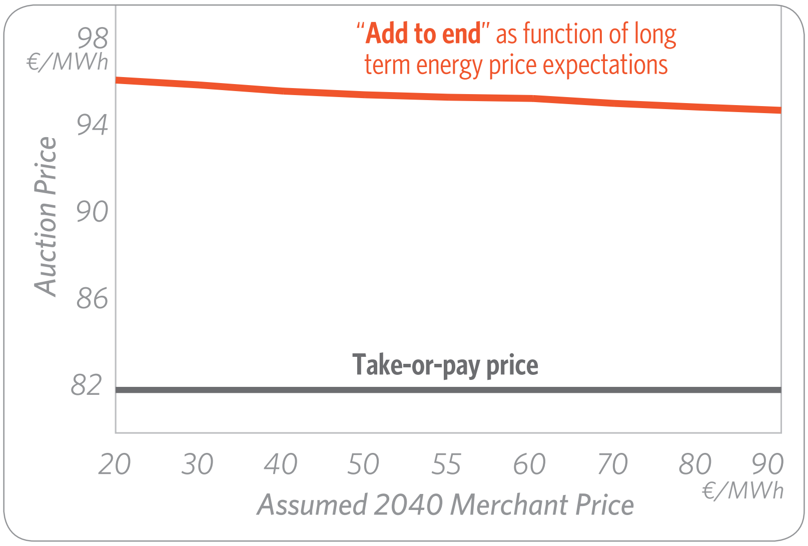
ADD TO THE END

Another proposal is to add the support that would have been available to wind and solar producers during the negative pricing hours to the end of the contract or feed-in tariff agreement. Thus, if the contract ran for 20 years over which 1,000 hours of output was curtailed, this rule would add 1,000 hours of support to year 20 or 21. Once the accrued curtailed hours are used up, the project will earn merchant revenues, so the impact on auction price depends significantly on merchant revenue price assumptions in 20 years' time. The lower the merchant revenue assumption, the greater the apparent benefit of achieving a higher level of revenue support instead, and so the lower the auction price becomes.

This approach is unlikely to add much value to most investors and will have little impact on auction prices for the following reasons:

- Some investors will assume either repowering or no terminal value beyond the feed-in tariff life. Debt investors, in particular, are unlikely to lend beyond the 20 year project life so the add to end policy will have no impact or improvement in the cost or availability of debt.

Figure A3.19: Impact of extended fixed price period



Source: CPI analysis

- Wholesale prices – and the shape of the market – are very uncertain 20 years in the future. Many investors will assume that prices will rise to the contract price, making accruals worthless. Others will see the uncertainty as making these revenues impossible to value.
- High discount rates applied over 20 years will reduce the value of any incentive which makes this policy a very inefficient way of compensating investors.
- Extending the fixed price period will not increase the life of the project so the only benefit will be the difference between the fixed price and investors' assumptions on future wholesale prices (see Figure A3.19: Impact of extended fixed price period).

CAP

Under this option we assume that in addition to the six-hour cut-off there is a limit to the number of hours that can be economically curtailed each year. A cap of zero hours of curtailment per year amounts to a take-or-pay/base case where there is no impact from curtailment whereas a cap of 600 hours or more is ineffectual since the auction price is the same as for a scenario without a cap (Figure A3.20).

Auction prices increase with the capped number of hours relatively linearly until the point where the cap becomes too high to have any material benefit.

Figure A3.20: Impact of different curtailment cap levels

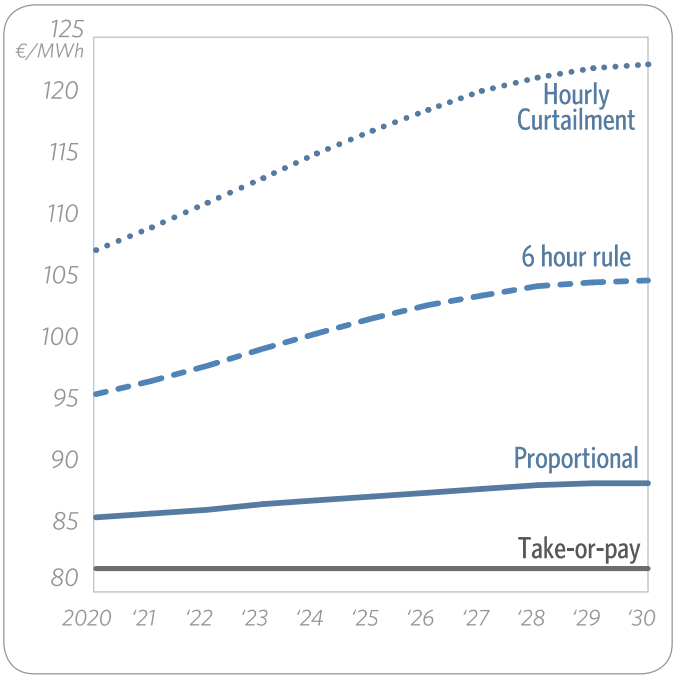
Source: CPI analysis

SUMMARY

Figure A3.21: Impact on bid prices of hourly, 6 hour rule and proportional curtailment provides a simple comparison between the scenarios detailed above.

The results for each scenario described above are summarised in Table A3.8: Impact of different mitigation options for curtailment.

Figure A3.21: Impact on bid prices of hourly, 6 hour rule and proportional curtailment



Source: CPI analysis

Curtailment rules can have a very large impact on the price that a developer would need to make investment in a wind or solar farm attractive. If lowering bid prices were the sole objective, the optimal solution would be the take-or-pay option since it eliminates all economic curtailment risk. As curtailment risk increases – for instance as the cap level increases – required contract or bid prices increase. In this example, proportional curtailment offers prices that are essentially the same as a 100-hour per year cap. The least attractive option is the one where all wind farms in the affected market are forced to curtail production where there are 6 hours of consecutive negative prices, which increases required prices by over 17% by 2020 or almost 30% by 2030.

8 PERMITTING PROCESS

Key consideration for policymakers:

- Permitting processes in Germany are relatively straightforward. If they remain so, the issues are not a major concern for investors in the medium-term.

Background and summary

The permitting process involves several administrative steps that an investor has to complete to obtain the permission to construct a renewable energy power plant. A potential investor needs to build up project

Table A3.9: Impact of different mitigation options for curtailment

	AUCTION PRICE IN 2020 (€/MWH)	PRICE INCREASE COMPARED TO TAKE-OR-PAY	10-YEAR P50 AVERAGE PRODUCTION P.A. (GWH) 2020 GOING FORWARD	CHANGE IN PRODUCTION COMPARED TO TAKE-OR-PAY
TAKE-OR-PAY	81.7	n/a	8,985	n/a
HOURLY CURTAILMENT	107.7	31.80%	7,864	-12.50%
CURTAILMENT AFTER 6 HOURS	95.9	17.40%	8,233	-8.40%
PROPORTIONAL CURTAILMENT	85.9	5.10%	8,793	-2.10%
ADD TO THE END	95.5	16.90%	8,233	-8.40%

CAP LEVEL AT	0 HRS	50 HRS	100 HRS	200 HRS	300 HRS	400 HRS	500 HRS	600 HRS
AUCTION PRICE (€/MWH)	81.7	83.5	85.1	88	90.7	93.2	95.1	95.9

Source: CPI analysis

management capabilities to efficiently navigate through this process. If a potential investor cannot manage the permitting process, he will not be in the position to construct a renewable energy power plant.

An additional factor in an auction system is the risk of stranded permitting costs. Once a project has been permitted, the plans are hard to change, even if developers identify an improved technological set up that they want to use. In such a case, the permitting process has to be repeated.

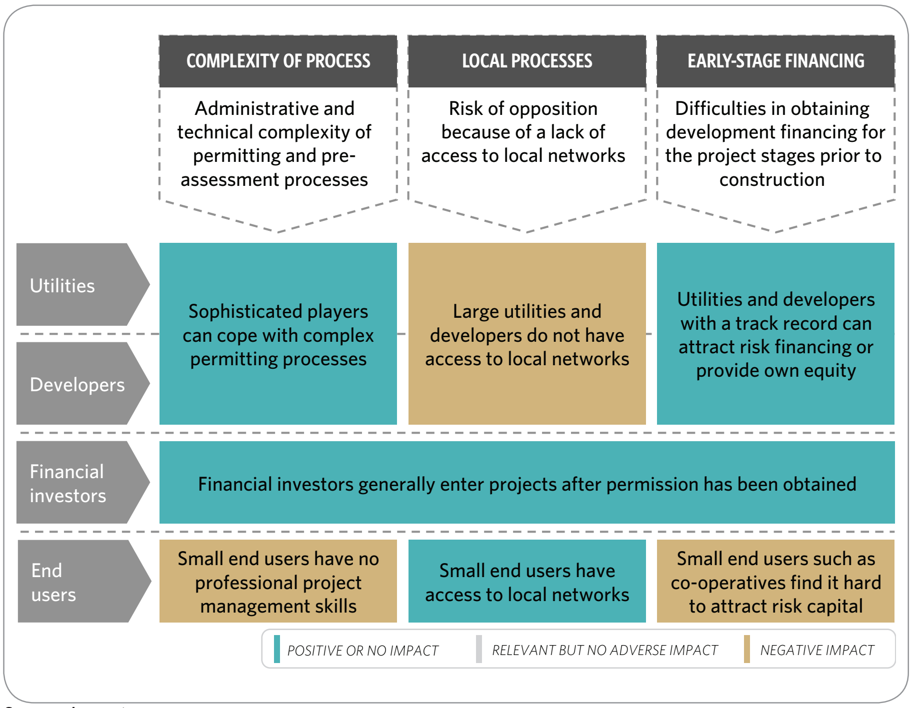
Furthermore, large investors that focus on the development of offshore wind projects have to invest substantial amounts of capital in pre-development assessments. Policymakers should evaluate whether and to what extent pre-permitting and pre-assessments of potential sites for renewable energy plants are cost-effective.

Impact on investors

The permitting process is important for investors that deal with renewable energy projects before the construction stage, i.e. utilities, developers, and end users (Figure A3.22)

- **Large utilities and developers** find local processes opaque as they do not have direct access to local citizens. Thus, they could experience project delays due to local opposition.
- **Small utilities and end users** have difficulties with complex permitting processes as they are often run by volunteers that do not follow a comprehensive project management approach. Furthermore, they have difficulties in acquiring

Figure A3.22: Issues regarding the permitting process



Source: Interviews

financing in an early project stage as they often do not have a track record in project development. In particular, co-operatives have a business model that makes it hard for them to get access to risk financing. Municipality-owned utilities have easy access to capital as they generally have access to cheap loans.

Key considerations for policymakers

Permitting costs can seriously affect smaller projects because they constitute a relatively large share of the total costs. Such projects are usually realised by smaller investors with access to local networks such as co-operatives. However, these investors face two issues. First, they find it difficult to cope with unsuccessful permission applications as they do not have a portfolio of projects to offset such costs. Second, they might be intimidated by the complexity of the permitting process and decide not to invest in renewable energy projects. Policymakers should ensure that the permitting process is as simple as possible. In comparison to other markets, the permitting processes in Germany are relatively straightforward. If the current permitting processes remain so, the issues related to permitting are manageable.

9 DEVELOPMENT COSTS

Key considerations for policymakers:

- Project delays significantly increase the levelized cost of electricity
- Centralized pre-permitting lowers the development costs but reduces the cost reduction potential

Background and summary

In and of themselves, higher development costs do not necessarily lead to higher project or energy costs. For example, higher development costs could be the result of more detailed project evaluation and greater effort to secure the best possible finance, both of which could ultimately lead to lower overall costs. However, higher development costs can put more investment at risk earlier in a project life. By shifting this investment earlier in the project life, the investment that could be at risk to delays or cancellations becomes greater. Thus, higher development costs increases the risks around policies such as incentive auctions.

With higher development costs, losing an auction at best delays recovery of development costs until the next auction. At worst, the entire development investment is lost. One result is that required returns on development investment are much higher than those for the projects themselves. With pre-defined tariffs, an investor can be relatively certain that a finished renewable energy plant will generate a certain amount of revenues. Thus, they can cancel the project early if it becomes obvious that the project will not meet the return requirements. With auctions the outcome is less certain, so some marginal projects may not be developed as a result. Offshore wind projects in particular, are affected by policy changes because they require significant upfront development.

One option is to provide some of the development services centrally, for instance, by providing grid connection planning to all bidders for a certain lot. However, interviews with investors indicated that this option could make the investment less attractive as it would remove their ability to fine tune the project in ways that would create more value. Alternatively, bids could be designed to make decisions earlier in the development process. Although this option could reduce the development capital at risk, it could also increase the number of development mistakes and the risk that winning projects will not be built.

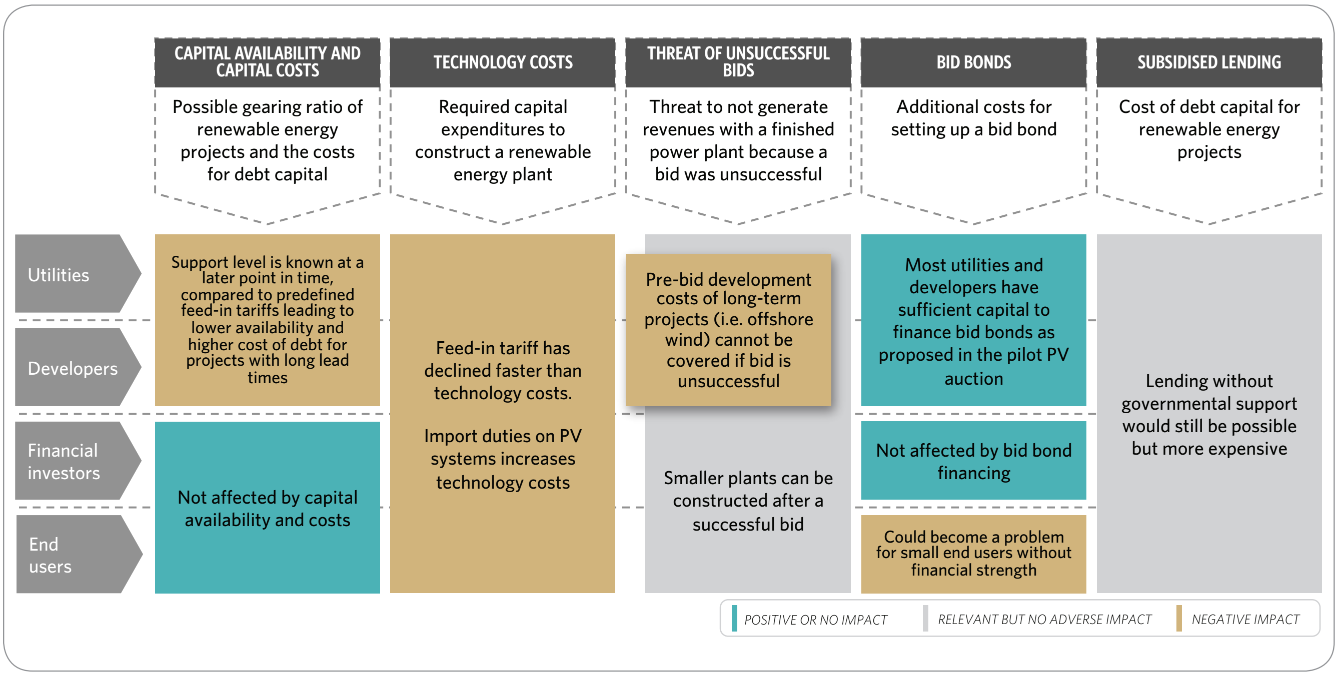
Other policies that affect the development costs of renewable energy projects include the import tax on PV systems that were manufactured in China. Such an import tax increases the system costs. Furthermore, there are several development banks that offer programmes which help provide debt capital to renewable energy projects. In fact, most loans are backed up by such a programme which has helped to keep debt capital costs at very low levels.

Impact on investors

Development costs affect all investor groups (Figure A3.23):

- **Utilities and developers** fear that uncertainty around the support level might limit debt capital availability and raise debt capital costs. "The risk of financing a project until after a bid has been won is hard to quantify" (mentioned by a developer) because in an auction system, prices for fed-in electricity will be known at a later project stage. In an auction regime, many capital providers are inclined to invest only after the support level is determined. Furthermore,

Figure A3.23: Issues regarding development costs



Source: Interviews

the threat of unsuccessful bids is relevant for developers and utilities that build plants which are not exempted from auctions because they do not fall under the de minimis level. It is possible to enter a subsequent auction if a bid is unsuccessful. However, losing out on revenues would substantially worsen the financial performance of a project.

- **Small end users** will have difficulties with the additional financing costs for bid bonds in an auction regime. The significance of this problem depends on the size of a bid bond. In any case, providing a bid bond adds to the complexity of a support mechanism and could scare off less sophisticated investors.
- **All players** have suffered from decreasing feed-in tariffs that led to shrinking margins across all technologies. This development could continue if there is strong competition in the forthcoming auctions. However, auctions could also lead to a higher support level and create a business case for currently unattractive technologies. The cost of PV systems is a special case as they are often produced in China and import duties apply. The cost reduction potential for PV plants is approximately 10% (Solar Alliance for Europe 2015) if the customs duty is removed. The threat of penalties is also relevant to all investors.

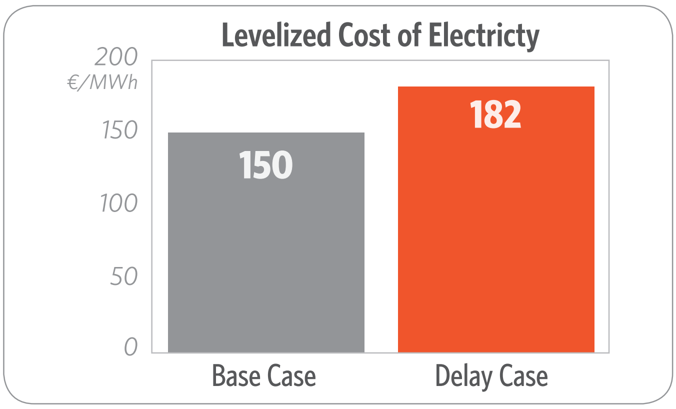
Key considerations for policymakers

PROJECT DELAYS SIGNIFICANTLY INCREASE THE LEVELIZED COST OF ELECTRICITY

A challenge for investors is the potential delay of project revenues when a bid is not won. In such a case they have to wait for a subsequent auction and have to bear ongoing planning and permitting costs in the meantime without being able to generate project revenues. Figure A3.24: Impact of a one-year delay on the auction price for an offshore wind farm illustrates the potential effect of this uncertainty on the auction price.

Offshore wind is the most complex to install and so is the most likely technology to be delayed. We assumed that one-year less revenue support is available and

Figure A3.24: Impact of a one-year delay on the auction price for an offshore wind farm



Source: CPI analysis

an increase in construction and development costs of 20% to take into account greater capex and financing expenditure. It is possible that liquidated damages may be available from the construction contractor to offset the impact of delay but we have ignored these for the purposes of our analysis.

If the risk of delay is perceived to be high enough, then more conservative bidders could start factoring it in to their auction price. If the risk is considered to be too high, it is possible that some bidders would exit the market, which would also have the potential to increase the price of successful bids since auctions would be less competitive.

CENTRALIZED PRE-PERMITTING LOWERS THE DEVELOPMENT COSTS BUT REDUCES THE COST REDUCTION POTENTIAL

Investors have to conduct pre-assessments before starting the construction process. Thus, various potential investors could accumulate costs spending on pre-assessments for the same site. The result is a non-optimal allocation of resources and higher bid prices. Centralised pre-assessing can reduce development costs and has been done for offshore wind locations in France and Denmark (IRENA and CEM 2015). The question is to what extent pre-permitting is reasonable, i.e. for which technologies and project sizes. Another issue that should be weighed against short-term cost optimisation is that pre-assessment could also adversely affect technology development by offering more generic and less tailored information package to bidders that might prefer to use their in-house expertise to spot competitive advantages and cost reductions.

10 FINANCIAL REGULATIONS

Key consideration for policymakers:

- While there is still uncertainty around what form changes to financial regulation will take, this challenge will most likely be resolved and is not a major concerns for investors in the medium term

Background and summary

After several capital market disturbances in the last decades, policymakers expect financial institutions to change the way they make their investments so that the financial markets can continue to work and the financial system becomes more resilient. In this context, policymakers are confronted with two conflicting goals: stabilising financial markets by enforcing more conservative investment requirements for financial investors and at the same time enabling them to invest in renewable energy projects.

Impact on investors

Financial regulations have an impact on financial investors and end users (Figure A3.25: Issues regarding financial regulations):

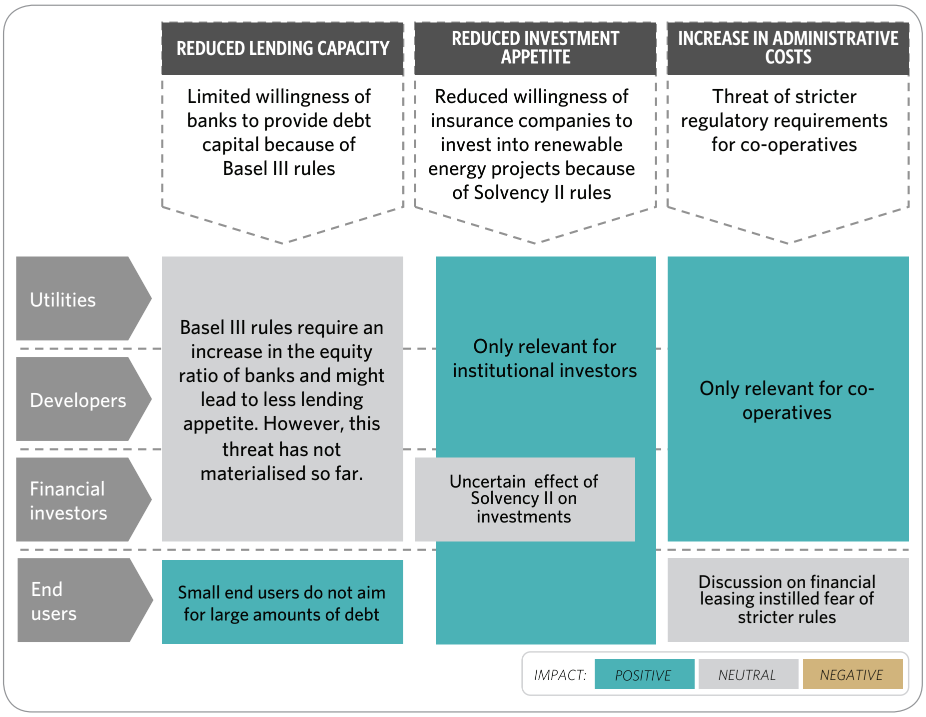
- Two types of **financial investors** are mainly affected. The Basel III framework could reduce banks' lending capacity. One of the introduced changes is an increase in the amount of high-liquidity capital that banks have to hold (Bankenverband 2012). This requirement impacts investor returns and could adversely affect the willingness to lend long-term capital or increase pricing. Long-term loans to low-risk projects, such as renewable energy, are most affected as they yield low margins and tie up capital for a long period of time. Furthermore, the original Solvency II framework reduced insurance companies' investment appetite because it made investments in illiquid renewable energy projects less attractive. It was recently announced that investments in renewable energy assets will be made easier under amendments to the framework (PwC 2015). However, some remaining uncertainty with regard to the implementation of Solvency II rules may slow the take-up of renewable energy investments, although this uncertainty is likely to fade in due course.
- Among **end users,** co-operatives were facing an increase in administrative costs due to financial regulation as there was a discussion on whether co-operatives are offering financial leasing models. Had Germany's Federal Financial Supervisory Authority (BaFin) found this to be the case, cooperatives would have been regulated like asset managers according to the 'Directive on Alternative Investment Fund Managers'. As a result, they would have faced increased costs that would have made investments in renewable energy projects unviable. While BaFin has announced that co-operatives will not be subject to their supervision, this example illustrates that financial regulations can render certain business models impossible.

Key considerations for policymakers

Financial regulations strongly influence how the portfolios of asset managers are managed. The German interpretation of the original Solvency II framework had led to uncertainty for asset managers with regard to how investments in infrastructure projects will be treated. However, recent changes could encourage greater investment in infrastructure projects including renewable energy, when there is clarity about how these will be applied in practice.

Another option to drive institutional investments in renewable energy projects is the increase of the liquidity of such projects. Increased liquidity can be achieved by the implementation of innovative financing structures, such as a revised structure for YieldCos. The effect of Basel III on the lending capacity is less critical. In fact, there is fierce competition among banks to act as a lender to renewable energy projects despite Basel III. Furthermore, it helps that loans to renewable energy projects are often backed by a development bank that takes on the refinancing risk.

Figure A3.25: Issues regarding financial regulations



Source: Interviews

Part three

Appendix B: Case sudies

Appendix B1
United Kingdom

Summary

While the UK has a solid track record with building renewable power assets and is the global leader in offshore wind, its slow progress with decarbonising the heat and transport sectors means that it is unlikely to hit its 2020 renewable energy targets with the current suite of policies. The result of the recent referendum to leave the European Union has made this prospect even more remote as political uncertainty – especially given the dissolution of the part of government responsible for setting policy in this area (Department for Energy and Climate Change) – will adversely affect the investment environment. This summary assumes that all obligations agreed while still a member state of the EU will still be met.

Over the last six years, the British government has changed several key renewable energy support policies including making cuts to feed-in tariffs for small and large-scale renewables, the transition away from a 14-year-old green certificate scheme with support levels set by government (the Renewables Obligation or RO) towards a Contract for Difference (CfD), with support levels set by competition. These changes have caused a period of uncertainty among investors. However, they have not yet had a material impact on levels of investment in onshore and offshore wind and solar PV. Conversely, the closure of a well-understood regime resulted in a spike in investment in solar PV and onshore wind across the period 2014 to 2016.

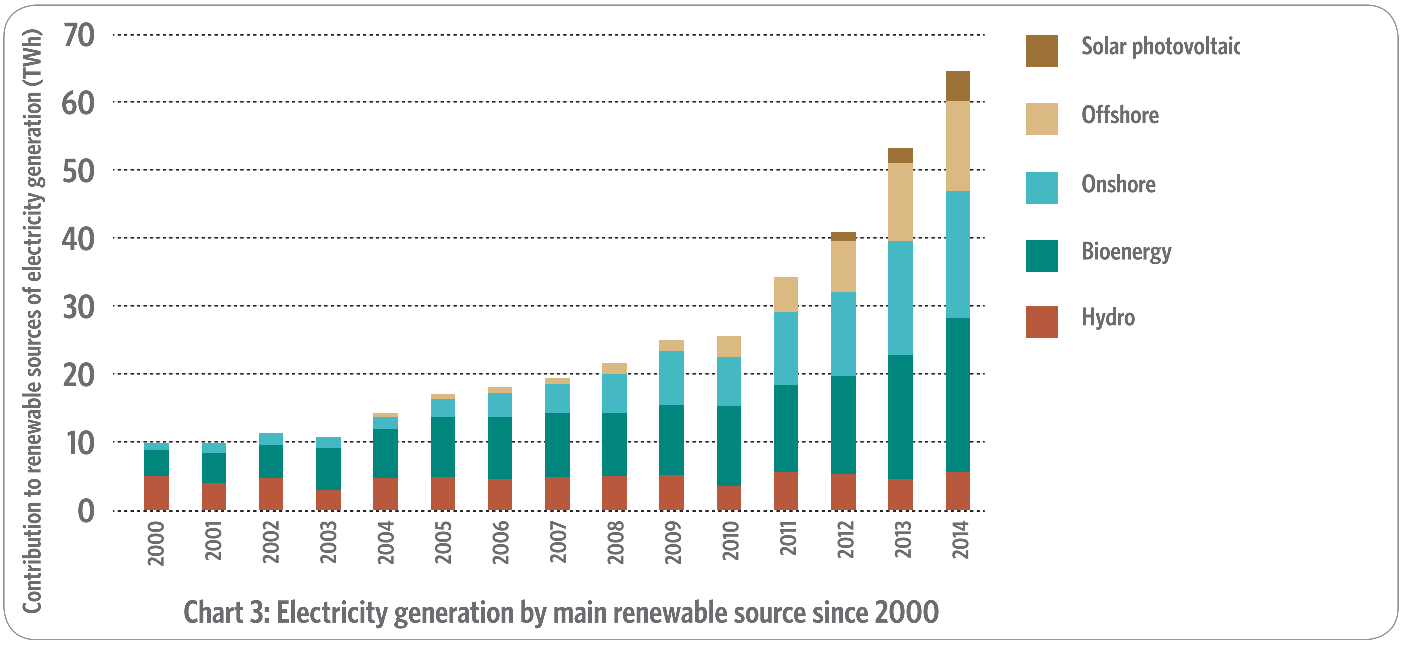
Financial investor appetite for the market – in particular from institutions domiciled in Eurozone countries - has remained robust, perhaps driven by an increase in the number of institutions seeking direct investment in infrastructure assets. The turn by pension funds and insurance companies towards renewables has allowed some to offset part of the decline in returns following the collapse in bond yields after the belated launch of a quantitative easing program by the European Central Bank in 2014.

If the current macroeconomic environment persists, investor interest in the UK market will likely mean sufficient capital is available to fund the existing project pipeline. However, it is likely that there will be less competition for projects as some investors are put off by political uncertainty, meaning less downward pressure on the cost of capital than there otherwise might have been.

1. Progress toward renewable energy targets

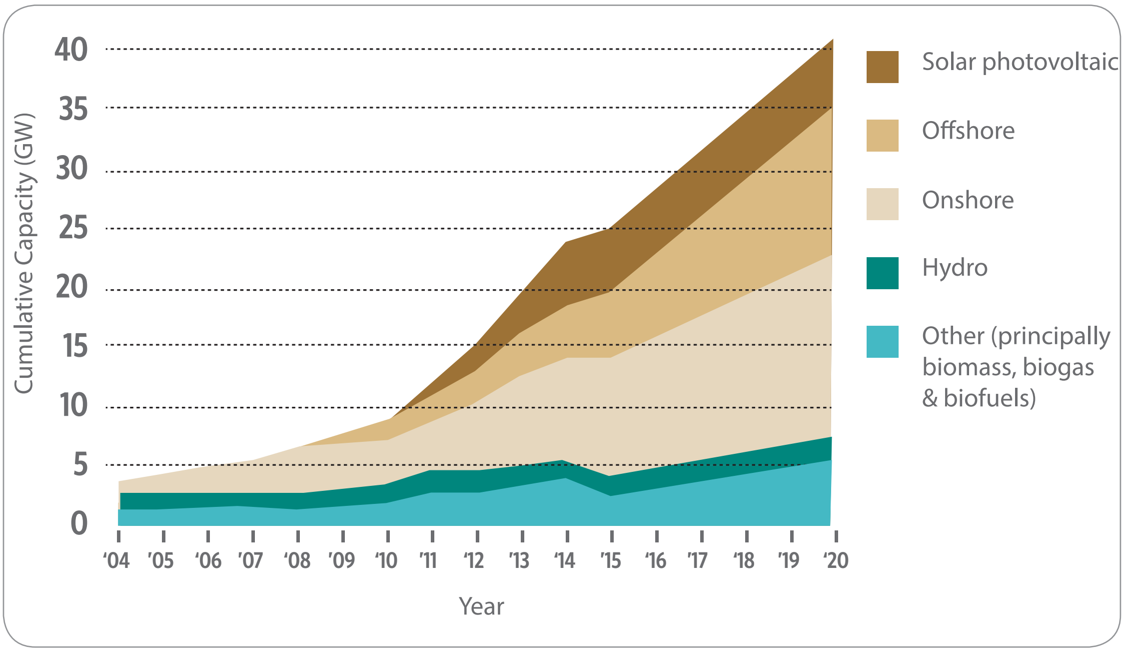
The UK has a legally binding EU target to source 15% of energy from renewables by 2020, of which the government expected the lion's share to be achieved in

Figure: B1.1 Renewable generation in the UK since 2000



Source: Department for Energy and Climate Change

Figure B1.2: Historical renewable capacity and future growth if UK targets are met



Source: Eurostat, NREAPs and CPI

the electricity sector. It has set its own sub-targets of circa 30% of electricity generation from renewables, 12% of heat and 10% of transport fuel.

As illustrated in figures B1.1 and B1.2, onshore wind and bioenergy were for many years the principal drivers of progress towards the 2020 targets. The principal investors were the historically dominant players in the UK generation market – investor-owned utilities and Independent Power Producers (IPPs) – seeking to defend market share by leveraging their technical skills and existing infrastructure by converting coal plants to biomass. In the last five years, the UK's offshore wind market has flourished with nearly 7GW of capacity installed or under construction up to July 2016 and over 10GW expected to be installed by 2020.

Only since 2013 has a landscape dominated by large projects and sophisticated, specialist investors started to change. In the European context, the UK solar sector was a relatively late starter, but installed capacity has grown nearly fivefold in the three years to March 2016, spurred on by sharp reductions in the cost of solar and revenue support levels.

In 2015, renewables accounted for 24.7% of generation, putting the UK well on the way to meeting the government's original 2020 target for the power sector. However, the figures for heat and transport stand at just 2.6% and 4.4%. Based on the current trajectory and policies, the UK will only reach 11.5% of the 15% energy target.

After a brief surge of investment in rooftop PV installations in 2014-2015, government has redoubled support for large-scale projects at the expense of small scale ones. This is likely to mean that offshore wind will receive the majority of revenue support available between now and the end of the decade with a slowdown, if not a pause, in the onshore wind and solar PV sectors until global supply chains have brought costs down sufficiently for new projects to compete without support.

2. The role of investors to date

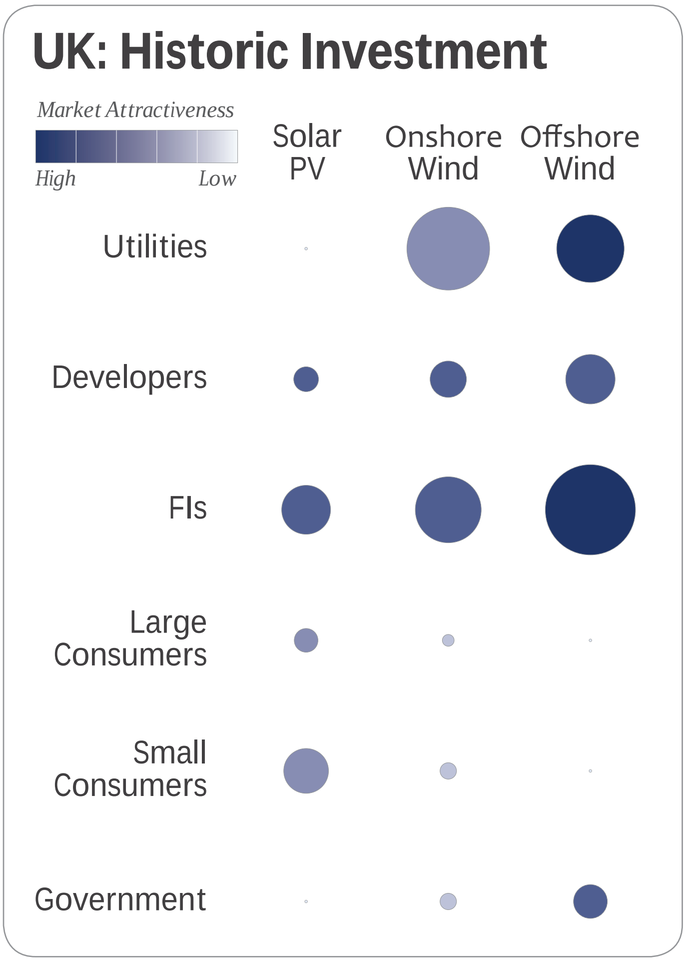
The rapid growth in onshore wind, offshore wind and solar PV in the first half of this decade was driven by a long-running and transparent set of policies, which, in particular, incentivised the development of large-scale installations (those with capacity greater than 5MW). The large-scale incentive, a green certificate scheme called the Renewables Obligation, will close to most new installations in 2017 and is being replaced by Contracts for Difference (CfDs), which will also be available for new nuclear projects. Smaller scale projects, incentivised through feed-in tariffs (FiTs), were not seen as a priority by the government and policy has consequently been less consistent. The result has been a different and narrower mix of investors than in Germany.

Figure B1.3 overleaf shows the amount invested by different types of investors and the perceived attractiveness of the opportunity. The participation of small consumers - mostly in rooftop solar - has only been significant in recent years. The market was originally dominated by large incumbent investors (in particular, the "Big 6" utilities) and developers able to use existing infrastructure and with detailed knowledge of an often complicated planning system. As the financial position of the Big 6 weakened, the government sought to catalyse investment in less mature technologies using additional financial incentives including the Infrastructure UK guarantee scheme and the Green Investment Bank (GIB).

The original intention behind both institutions was that government would invest in commercially viable projects, who were struggling to raise long-term finance because of uncertain financial market conditions. In doing so, the government would "crowd in" private sector money to renewables and other infrastructure projects via the provision of debt, equity and guarantees. The GIB has sought to draw in less experienced financial institutions to the offshore wind sector, by transferring several of its equity investments in the sector to a closed-end fund, which has raised over £800 million.

The investment proposition and attractiveness of renewable investment has been very different for each investor category.

Figure B1.3



Source: Eurostat, NREAP, CPI and SEI analysis & investor interviews

Table B1.1: Historical reasons and attractiveness of investment in renewable energy by investor type

	INVESTMENT PROPOSITION	INVESTMENT ATTRACTIVENESS
Utilities	• The Big 6 – Centrica, Scottish Power (Iberdrola), nPower (RWE), E.ON, EDF Energy and SSE are listed companies with a range of investment opportunities across a variety of business lines and geographies. The UK has been a core market for all for more than a decade, but even within the UK, investment opportunities have competed with those in fossil-fuel generation, exploration and production, and electricity and gas networks.	• The Big 6 were able to influence the policy and regulatory direction in a way that generally benefitted them until the last few years. This has meant a focus on large projects and revenue support for large projects based on green certificates, rather than feed-in tariffs. • A focus on large projects (especially offshore wind) gave them a competitive advantage through large project management skills, and financial strength. By contrast, solar PV investments, which are typically much smaller, have been less attractive for large investor owned utilties, as in other markets covered in this study.
Developers	• Developer business models have ranged from electricians offering rooftop panel installations to large non-incumbent utilities such as DONG who invest in offshore wind. • Return requirements depend on the complexity of the development as well as the level of uncertainty around achieving completion. • Short-term funding is usually required as developers seek to recycle capital rather than invest for the long-term, although strategies can vary significantly given the broad range of this category.	• Developers have sought to target the highest quality projects – i.e. those with above-average natural resources and with the lowest grid connection costs. • PV projects have predominantly been installed in the south west where solar resources are best and population density is relatively low. • Onshore wind has been more evenly distributed although Scotland has a particularly high concentration. • With increasingly mature technologies and low-risk financial investors getting comfortable with long-term ownership of wind and solar assets, recycling of capital is increasingly taking place earlier in a project's lifecycle.

Financial institutions	• The UK has five major high street banks (Lloyds, RBS, HSBC, Santander and Barclays) and a number of smaller banks and building societies. Additionally, the City of London has offices of numerous European and international commercial and investment banks with global customer bases. The smallest lenders do not operate in the renewables market but there is plenty of finance available for the best projects. • Institutional investors are also investing in UK renewables, primarily through equity investments but also through debt investments, in particular, when refinancing operational projects.	• Debt margins have been decreasing in recent years and are pretty much at pre-financial crisis levels as a result of healthy levels of competition for what is perceived as an attractive investment class which has low default rates and high recovery rates. • Some lenders, influenced by Basel III capital adequacy regulation, have decreased the tenor of their project finance loans to seven years or less which introduces refinancing risk since the loan is often sized off a longer notional tenor and is therefore not fully repaid at maturity. Longer tenor loans are still available from many banks, however, in particular from German, Japanese and Canadian banks.
Financial institutions, continued	• Indirect investments through listed infrastructure funds such as Greencoat UK Wind and The Renewables Infrastructure Group are enabling insurance and pension funds without direct investment teams to invest in the market by buying shares in portfolios of de-risked operational assets, which are listed on the stock market. Some investors are prevented from investing in assets that are not listed on a public market and hence easy to sell (or "liquid"). The emergence of these vehicles has thus allowed a broadening of the investor base.	• The combination of an established mature technology and relatively attractive returns have led to increasing interest from institutional investors who have large amounts of capital to invest and are searching for attractive yields in a historically low interest rate environment. • They are able to invest more economically by investing in a few large projects rather than numerous small- and medium-sized projects.
Large consumers	• Rooftop solar, on-site wind turbines and biomass plants (especially with combined heat and power) have all been options for this group of investors. While sustainability can be an important motivation, investments are in most case not made unless they promise attractive financial returns and a short payback period. • The emergence of a corporate market for Power Purchase Agreements is another way that large consumers can participate in the sector. By providing a long-term commitment to buy electricity above the wholesale price but below the retail price developers are able to finance new projects while the large consumers can benefit from cheaper electricity than they otherwise would be able to purchase without having to make an upfront investment.	• Investing directly in renewable energy projects offers a hedge against the risk of rising retail power prices. • The long-term nature of the investment and payback can put off some company directors that are judged on short term financial performance metrics.
Small consumers	• As an investor group, small investors' appraisal techniques are often less sophisticated than those of larger, more experienced investors. Instead of thinking about rates of return, this group might think in terms of annual income or payback periods - if they focus on any financial metrics at all. In fact, a more powerful motivating factor might be non-financial, relating to self-reliance or making a contribution to climate change • Crowdfunding platforms dedicated to renewable energy investments have emerged in the last few years, promising returns that compare favourably with retail investments, such as cash ISAs.	• Around the start of the decade, both cash grants and highly attractive feed-in tariffs were available, which provided obvious financial benefits to small consumers investing in rooftop solar. The benefits were so obvious that they did not need sophisticated financial analysis to see the benefit. • Crowdfunding gives investors the opportunity to make loans to developers in exchange for annuity repayments which can be attractive for individuals saving for their retirement or investing their pension pot. Recent legislative changes in early 2016 have also made investments through crowdfunding platforms eligible for inclusion in tax-efficient saving products, such as ISAs.
Government	• The GIB has focussed on commercially feasible projects and technologies, such as wind and biomass rather than early-stage ventures in wave and tidal power. Its focus has been on providing debt and equity capital to solid projects where the availability of capital had become scarce. After an initial focus on large projects such as biomass conversion and offshore wind, the GIB has since extended its mandate to cover community-scale projects which covers a range of technologies including onshore wind, energy efficiency, waste, hydro and biomass. • The UK government has made the decision to privatise the GIB, meaning prolonged uncertainty. The sale will be a bellwether for investor sentiment in the UK market following the referendum decision to leave the EU.	• The GIB has aimed to assess investments in a similar fashion to any bank or equity investor, although unlike those, it has been constrained to specific technologies by the terms of its state aid approval from the European Commission.

3. The role of investors in the future

It is not clear how much investment in new renewable electricity assets will be made in the next few years as the government decided shortly after the general election in 2015 to rein in the amount of revenue support available for new projects. The government justified the decision after raising concerns about the affordability of surcharges on electricity bills used to pay for supporting renewables.

According to a 2011 intra-governmental agreement, the surcharge relating to renewables policies was to rise to no more than £7.6bn in 2011/12 prices by 2020, with some explicit margin for error ("headroom"). Information about the ongoing position in relation to this budget (known as the Levy Control Framework or LCF) has only been published sporadically since the cap was agreed and has become perhaps the key source of uncertainty for developers of new projects. Most considered that the risk of policy change would increase sharply as cost to the consumer approached the LCF cap.

That point came in the weeks following the general election in 2015, when the new government claimed that the risk of costs exceeding the LCF was now overwhelming. On this basis, it took a decision to implement a radical reduction in the level of support available for new projects. Even now, there is confusion about the assumptions being used to reach this cconclusion. See the box on the right for further details.

The UK has a new support system for large-scale renewables. The earliest CfDs (or "investment contracts") were awarded on a bilateral basis and priced attractively. Subsequently, the government sought to reduce support levels by allocating future support through an auction system. The CfD scheme in theory provides greater revenue certainty for investors than under the RO as it removes exposure to the wholesale market price. Revenue support is a variable top-up to a contractually agreed strike price, which itself increases annually by inflation. By reducing revenue risk, government hoped to decrease investors' required returns and hence, costs to the consumer of future renewable projects.

The first round of CfD auctions went ahead in October 2014 with budget allocated between two "pots", one for "established technologies" (including onshore wind and solar PV) and the second for "other less-established technologies" (including offshore wind). Previewing its post-election concentration on offshore wind, government allocated the majority of funding to less established technologies. Contracts were awarded for 1.3GW of less established technologies (including 1.2GW offshore wind), 750MW onshore wind and only 72MW of solar PV.

Since the first auction, little clarity has been received about the timing of future auctions, let alone the amount of budget that will be available in each round.

The same goes for solar PV. Following the early withdrawal of ROC support for projects larger than 5MW in March 2015 and smaller than 5MW projects in March 2016, small-scale feed-in tariffs for rooftop projects also suffered a range of very significant cuts.

A closer look at what's driving uncertainty around policy support

Many developers fear dwindling support given increasing pressures on the Levy Control Framework (LCF) budget, which covers Renewable Obligation Certificates (ROCs), small-scale Feed-in Tariffs (FiTs) and Contracts for Difference (CfDs).

Reasons that the LCF is thought to be over-budget include:

1. A rapid growth in the solar market which was driven by an unforeseen rapid reduction in panel costs, which was not matched by a commensurate decrease in revenue support.
2. An under-estimation of load factors for offshore wind and the large coal units converted to biomass firing at Drax. This resulted in higher levels of ROCs being allocated than originally anticipated.
3. Declining wholesale power prices (driven by falling commodity costs) meant that CfD support payments were higher than expected.

As well as the impact of falling commodity prices, the decline in wholesale prices is partly driven by the merit-order effect whereby low- or zero marginal cost renewables increasingly reduce the utilisation of fossil fuelled plant. As this results in faster use of the LCF budget, renewables have to some extent become a victim of their own success.

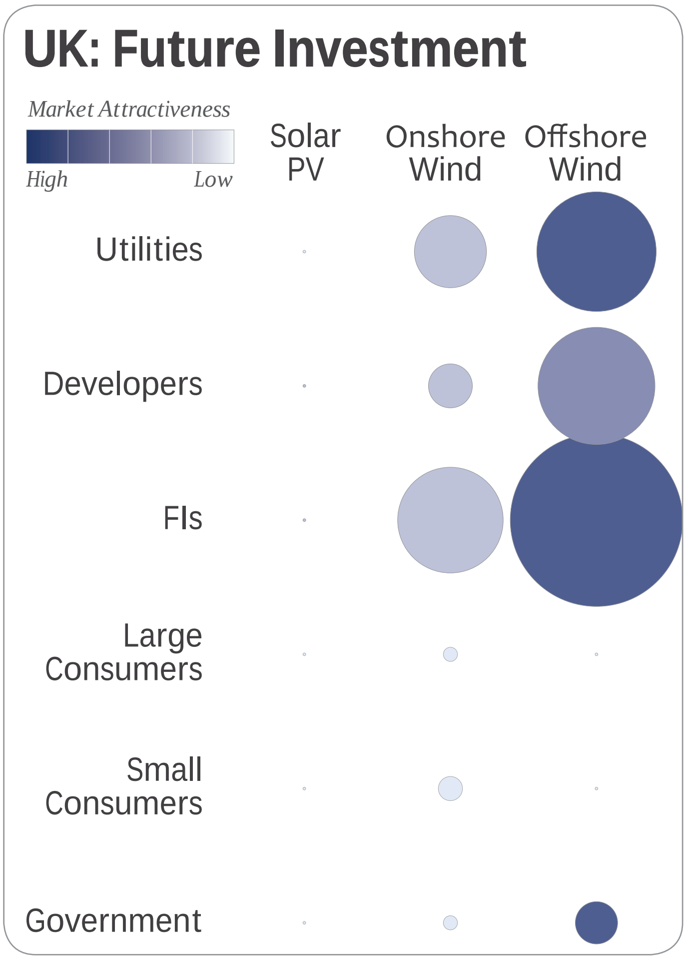
For residential scale projects, the FIT has been cut 63.5% from 12.03p/kWh to 4.39p/kWh.

The recent referendum on membership of the European Union could have implications for the targets the UK has set for itself under the UK National Renewable Energy Action Plan, although unlike many other countries, the UK's targets are enshrined in UK law.

Assuming these targets and the overall environment for investors remains stable in the UK, Figure B1.4 shows the market and policy landscape investors expect to face in the coming five years. While the solar and onshore wind industries will shrink following their recent booms, the announcement that there will be a 2016 auction for offshore wind is a positive step forward for the industry. However, the dangers of focussing support on only one technology have been illustrated by the decision in July 2016 by the Edinburgh Court of Session to quash the planning consents with a combined capacity of 2.3GW, upholding an objection by the Royal Society for the Protection of Birds. This could reduce competition in a future CfD auction, limiting downward pressure on cost to the consumer.

Beyond this, future CfD auctions ostensibly will be dependent on offshore wind developers' ability to continue pushing down costs. In particular, developers will seek to encourage the recent trend of low-cost investment by insurance companies and pension funds in the sector. Interest in offshore wind has broadened in recent years as growth has been focussed in jurisdictions with support systems with lower risk (Germany, Netherlands, Belgium) and as falling investment grade bond yields have forced such institutions into riskier assets in the search for yield.

Figure B1.4



Source: Eurostat, NREAP, CPI and SEI analysis & investor interviews

Table B1.2: How the investment landscape and attractiveness are evolving

	CHANGE IN INVESTMENT ATTRACTIVENESS
Utilities	• Opportunities for onshore wind will be much more limited as a result of the reduction in revenue support opportunities and changes to planning regulations. Offshore wind projects continue to offer utilities the most attractive return potential although there is a lack of transparency around the timing and volume of future auctions and there are an increasing number of opportunities in other, possibly more stable, regulatory frameworks.
Developers	• Developers of all sizes are likely to struggle as the availability of revenue support remains uncertain. Bankruptcies are inevitable and those that survive will need to consider investing overseas for increased opportunities.
Financial institutions	• High levels of competition for limited numbers of assets are pushing down the cost of capital. In particular, this is eroding the historically significant spread between available returns for offshore wind and onshore wind projects and between construction-phase and those in operation. The outlook in the primary market is poor and prices will increase in the secondary market because of a slowdown in supply.
Large consumers	• This market looks set to continue to be relatively small as there are no policies in place that will stimulate investment. Cost-parity is likely to be the milestone that stimulates investment.
Small consumers	• Co-operative and crowdfunded projects are likely to be dominant.
Government	• The future role of the GIB remains uncertain. Whether this sale will proceed following the decision in the recent referendum to leave the EU remains in question.

4. The evolving policy and market environment

Focus on offshore ahead of onshore and solar

The UK government has firmly committed to offshore wind as the main source for future renewable energy deployment. Despite being more expensive than onshore wind, the perceived visual impact is considered to be more acceptable and they offer a more reliable source of power generation which is easier to balance.

Onshore wind is now cheaper based on the Levelised Cost of Electricity (LCOE) than new-build Combined Cycle Gas Turbines (CCGT) in the UK, but because of low and volatile wholesale prices, neither onshore wind farms nor CCGTs can currently be built without some sort of revenue support.

The growth of the market for corporates to provide long-term fixed Power Purchase Agreements (PPAs) as is the case to a much greater extent in the USA offers a potential route to growth for both onshore wind and solar projects. However, a number of technical and legal issues have to be resolved before this can become a significant, bankable segment of the market.

The capacity market has undergone a number of design changes as the original one had failed to incentivise new large-scale gas plants. While the government has finally given permission for Hinkley Point C nuclear plant, the project's estimated 10-year construction period means that uncertainty will continue over what will cover the capacity gap as coal plants are phased out over the next five years.

Transition from the Renewables Obligation to Contracts for Differences

The Electricity Market Reform process which has seen the RO support mechanism being phased out to be replaced by an auction-based CfD system was initially welcomed by investors. The greater revenue certainty was viewed as a useful way of reducing the cost of capital and making renewable energy cheaper.

However, CfD support is for 15 years - five years shorter than under the RO. Lenders are typically not willing to lend to projects beyond the term of the support period so a shorter support period decreases the amount that project developers can borrow. This means a higher proportion needs to be funded with more expensive equity, thereby offsetting some of the benefit on the cost of capital.

The biggest issue with a switch to competitive auctions has been a lack of clarity with respect to the timing of auctions and the budget available. It is very difficult for them to manage their substantial development costs when they do not know if and when they might be able to secure a CfD.

5. Conclusions and issues for further thought

UK energy policy is going through a long period of transition. Policy is still evolving and a lack of information is creating uncertainty for investors. There are challenges around capacity margins which can only be solved through large amounts of investment. More interconnection is planned and will be required as new power plants are built. But whether these plants will be predominantly nuclear or CCGT as a result of price signals through the capacity market, or whether another technology will have to be favoured remains to be seen.

However, it seems clear that policy will continue to favour large-scale projects built and owned by large, sophisticated investors. More clarity about the future of the LCF is expected to be provided in early 2017 and this may help investors to understand the future potential of the market. This will potentially have a larger impact on the availability of investment as financial investors across Europe continue to compete for a limited supply of high-quality infrastructure assets.

Appendix B2
Germany

Summary

Germany has been a leader in renewable energy deployment, and it has ambitious targets well above the minimum levels set out by the EU, which it is largely expected to meet. While investment will continue to come from a broad range of sources including households, cooperatives, banks, institutional investors, developers and large utilities, the growing cost of past subsidy levels combined with the European level energy market and state aid rules are driving Germany to focus more on keeping costs low for consumers. A maturing and more competitive investor landscape, lower subsidies and a transition to competitive auctions for large-scale projects, present some new challenges for investors, and the outcomes will offer a number of lessons for the rest of Europe.

1. Progress towards targets

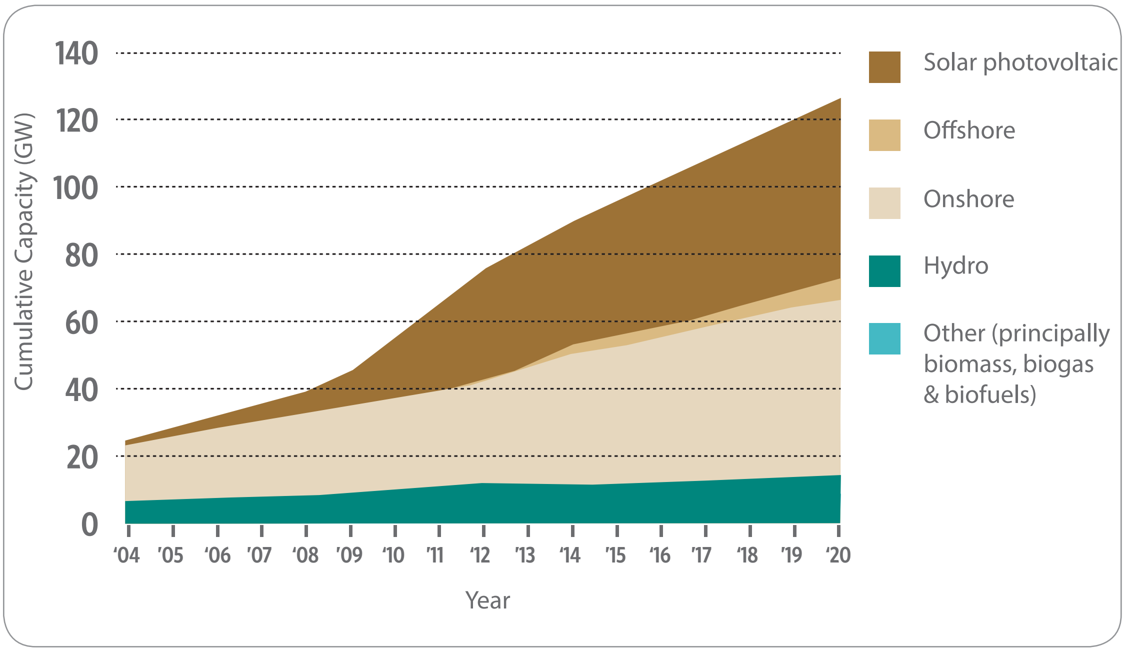
Germany has the third-highest level of renewable energy installations by capacity in the world behind the US and China. It also has a range of ambitious targets that exceed the minimal levels set out by the EU. These targets include achieving 35% of generation from renewables in 2020, 50% by 2030 and 80% by 2050, and keeping CO_2 levels at 60% of 1990 levels by 2020. In the past, onshore wind and solar have been the main renewable energy sources of electrical power. However, in order to meet the renewable energy targets of the future, the latest draft of the Renewable Energy Sources Act 2017, known as Erneuerbare Energien Gesetz (EEG 2017) sets out expansion corridors, which are effectively annual capacity targets for each type of technology.

These targets are as follows:

1. 2.8GW for all onshore wind (including repowering) per annum from 2017 to 2019 and 2.9GW thereafter
2. 7.7GW of offshore wind by 2020 and 15GW by 2030
3. 2.5GW of solar power per annum with 600MW through auctions
4. 150MW of biomass per annum to the end of 2019 then 200MW for a further 3 years

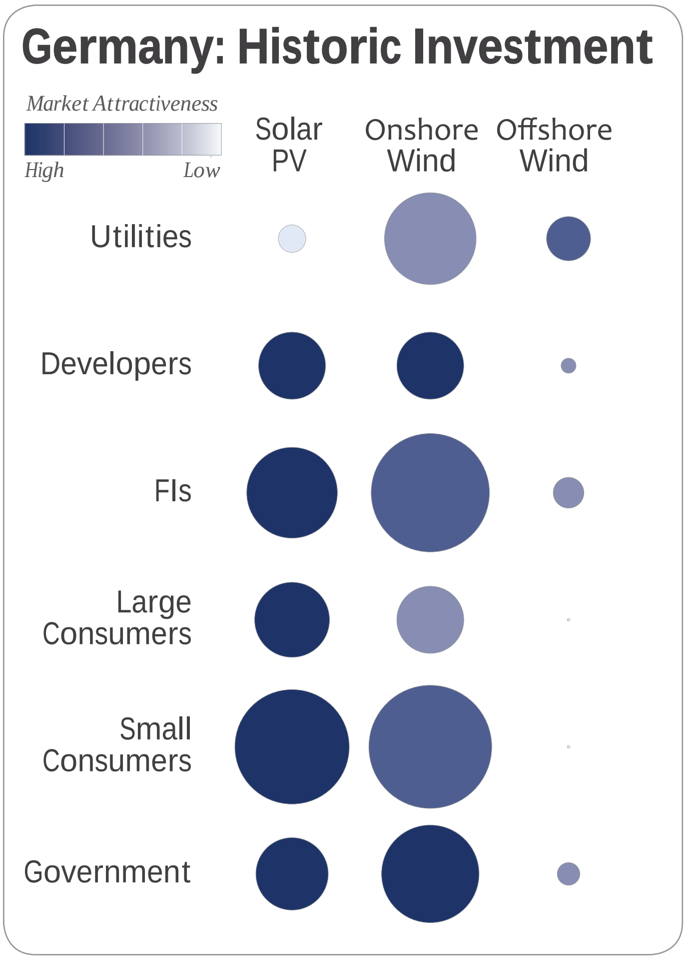
While Germany's goals for onshore wind and solar remain ambitious, it is clear that policymakers are setting their sights on offshore wind as a major new source of energy. Our analysis indicates that these targets are, overall, achievable.

Figure B2.1: Electricity capacity by renewable energy source provided German EEG targets are met



Source: Eurostat, German EEG targets and CPI

Figure B2.2



Source: Eurostat, German EEG targets and CPI and SEI analysis & investor interviews

2. The role of investors to date

Germany has a long track record of supporting renewable energy through feed-in tariffs and government supported finance programs. These programs and tariffs have reached large and small consumers, and encouraged financial institutions, resulting in a diversified set of investors including households, cooperatives, banks, institutional investors, developers, and large utilities.

Figure B2.2 shows the amount of investment in Germany by different categories of investors and the perceived attractiveness of the investment opportunity by these groups. Investments in solar PV have been attractive to a wide variety of investors over the past decade, leading to a particularly diversified set of investors. While slightly less attractive for some investors, onshore wind has attracted even more investment, particularly from developers and financial institutions. Across Germany, the largest utilities have found most investments increasingly less attractive as tariffs have decreased, and therefore have made up a relatively small proportion of investment in renewable energy, with the exception of offshore wind.

The investment proposition and the attractiveness of renewable investment can be quite different for each investor group.

The offshore deployment target is expected to be readily achievable as the developing market picks up, and may in fact be too small since it equates to just two developments per year, which might result in a less competitive auction process. The EEG allows for an upper limit of 7.7GW by 2020 if grid connections are applied for by the end of 2017. The 2.8GW target for onshore is inclusive of repowering. The previous 2.5GW was net of repowering so gross targets would have been substantially higher as an average of 1.6GW of capacity is expected to come off-line between 2015 and 2025, according to the Federal Ministry for Economic Affairs and Energy (BMWi). The solar target seems more ambitious because of a variety of factors, not least because of a substantial decline in installations in recent years (driven by a sharp decrease in Feed-in Tariffs in 2012) with just under 1.4GW installed in 2015 according to BMWi.

Table B2.1: Historical reasons and attractiveness of investment in renewable energy by investor type

	INVESTMENT PROPOSITION	INVESTMENT ATTRACTIVENESS
Utilities	• The large German investor owned utilities (IOUs) are international players that look for the most attractive investment opportunity globally, given their range of technical and financial capabilities. • Municipal utilities seek attractive investment opportunities, but they often have a smaller global reach and also have an obligation to promote energy supply and investment within their region or within Germany.	• Offshore wind investment requires the industry expertise, large project management skills, and financial strength that investor owned utilities (IOUs) can bring to bear. For onshore wind and solar PV, these skills are less important, so the IOUs face greater competition and thus find these markets less attractive. They also have a higher cost of capital than many long-term investors. Thus, IOUs in Germany are focussing on offshore wind, except where client relationships and other strategic considerations encourage them to invest in other renewable sectors. • The municipal utilities have some interest in offshore wind, but are mainly focussed on onshore wind that fits their scale and their local presence.
Developers	• Sizes range from electricians offering rooftop panel installations to large international wind developers investing in both onshore and offshore wind. • Return requirements depend on the complexity of the development as well as the level of uncertainty around achieving completion. • Short term funding is usually required as developers seek to recycle capital rather than take long-term holds, although strategies can vary significantly given the broad range of this category.	• Generous feed-in-tariffs have stimulated investment in solar, onshore wind and biomass. Developments in sub-optimal locations have been successfully built out because revenue support has been sufficient to make such projects economically viable. • More recently, the offshore market has opened up and the largest wind developers are participating alongside utilities.
Financial institutions	• Germany has a complex banking system with more banks than any other country in the EU. These can be broken down in to 3 categories, usually referred to as pillars: - Private commercial banks: These are privately owned and include the Commerzbank, Deutsche Bank and Hypovereinsbank. - Public banks: These include regionally owned state banks known as Landesbanken such as Nord LB and Bayern LB as well as savings banks known as Sparkassen which are municipally owned. - Co-operative banks: These are local banks that are owned by members and are the most numerous type of bank as well as typically being the smallest. Examples include the Volksbank and Raiffeisenbank brands. • Just as the ownership of these banks vary significantly so too do their objectives, sizes and funding structures. Deutsche Bank for example is an internationally listed bank with a large capital intensive trading book and a relatively high return on equity target, so there is very limited appetite to invest in low risk but low return renewable energy projects. When loans are made in this sector they tend to be short-term bridging loans for large projects.	• Debt margins are comparatively very low as a result of cheap funds from development banks (see the Government section below) but also high levels of competition between lenders. The most desirable assets can attract project finance debt at over 85% leverage and repayment tenors of up to 20 years which matches revenue support periods. • The combination of relatively attractive returns and a perception of reduced technology risk have led to increasing interest from institutional investors who have large amounts of capital to invest and can do so more economically by investing in a few large projects rather than numerous small and medium sized projects.
Financial institutions, continued	• On the other hand, co-operative and savings banks tend to take a longer term view on profitability and have access to retail deposits as a cheap source of funding so they are better suited to lending on a long term basis to local, small-scale, steadily performing renewable projects. • Institutional investors are also investing in German renewables through equity investments as well as bond and debt instruments.	• To date, institutional investors have had limited appetite for taking construction risk although this varies by institution. As one institutional investor pointed out, taking construction risk is a simpler way of securing a desirable asset than trying to buy it at a higher price in a more competitive environment once the asset has been completed.

Large consumers	• Rooftop solar, on-site wind turbines and biomass plants are all options for this group of investors. Whilst sustainability can be an important motivation, investments are not made unless they are financially attractive.	• Investing directly in renewable energy offers a hedge against the risk of rising retail power prices and the potential loss of various surcharge exemptions, tax benefits and levies that certain large consumers benefit from. • The long-term nature of the investment and payback can put off some company directors that are judged on short-term performance, however.
Small consumers	• As an investor group, small investors' appraisal techniques are less sophisticated than larger, more experienced investors. Instead of thinking about internal rates of return for equity holders, for example, this group tends to think in terms of annual income or payback periods - if they focus on any financial metrics at all. Often, in fact, this investment group is motivated in part by the feelgood factor arising from investing in their own or local green energy projects. • Within the small consumers there are several sub-segments, including the co-operatives that have aggregated small community investors to create community investment projects and farmers and land owners that have benefitted from programmes to encourage their investment.	• Small consumers were offered highly attractive feed in tariffs, which provided obvious financial benefits to many small consumers. The benefits were so obvious that they did not need sophisticated financial analysis to see the benefit. • Additionally, KfW and Rentenbank – the German development banks – offered low cost loans to consumers and farmers that made the financing more attractive while reducing initial out of pocket costs. • Cooperatives found these investment opportunities attractive and found that there was both the appetite and desire amongst citizens as potential investors to invest in clean energy solutions.
Government	• The government invests through government development banks. These institutions do not look to influence government policy, rather they are a vehicle for helping to carry out the policies and their influence is considerable. Last year alone KfW loaned €4.5bn while Rentenbank leant €3.5bn in total over the last two years to farmers and co-operatives ('Buerger und Bauernwindparks'). This cheap source of funding has been critical in reducing the overall cost of capital in Germany, which is thought to be the cheapest in Europe, allowing investment to continue despite decreasing return margins. Additionally, KfW is able to support German industry abroad both through the on-lending scheme described above and directly through their commercial International Project and Export Finance division (KfW IPEX).	• As part of the German government's commitment to renewable energy they have utilised their AAA credit rating to enable development banks such as KfW and Rentenbank to raise the cheapest capital possible in order for them to provide loans through commercial banks. These banks then pass these low cost funds on to renewable developers, potentially alongside an element of their own capital. The borrower benefits from a very low cost source of funds, the intermediary banks take credit risk but are able to benefit from charging a structuring fee, charging a restricted margin on funding costs and reduced refinancing risk. Development banks take refinancing risk on the funding they provide as well as credit risk on the bank rather than the ultimate borrower, and the government is able to support renewable energy deployment and jobs through providing a AAA-rated guarantee rather than raising funds themselves.

3. The role of investors in the future

The German government has indicated that it is concerned about rising household energy bills, which are now the second highest in Europe after Denmark. As part of Germany's affordability objective, Feed-in Tariffs (FiTs) have decreased substantially in recent years, particularly in the solar sector as a response to a rapid decline in system prices and an accompanying boom in deployment.

The combination of high levels of competition and lower support levels has resulted in an ongoing reduction in investor returns. Today, some overseas investors consider Germany un-investable because the returns are too low when compared to the risk profile and/or other markets.

Germany views competition as an important way of reducing the cost of renewable energy. At the same time, the European Commission has issued guidance on state aid for environmental protection and energy states that by January 2017 aid must be granted in a competitive bidding process on the basis of clear, transparent, and non-discriminatory criteria.

As a result, Germany is in the process of phasing out uniform feed-in tariffs for its larger developments and replacing them with Contracts-for Difference as in the UK. These contracts are being be awarded via competitive auctions.

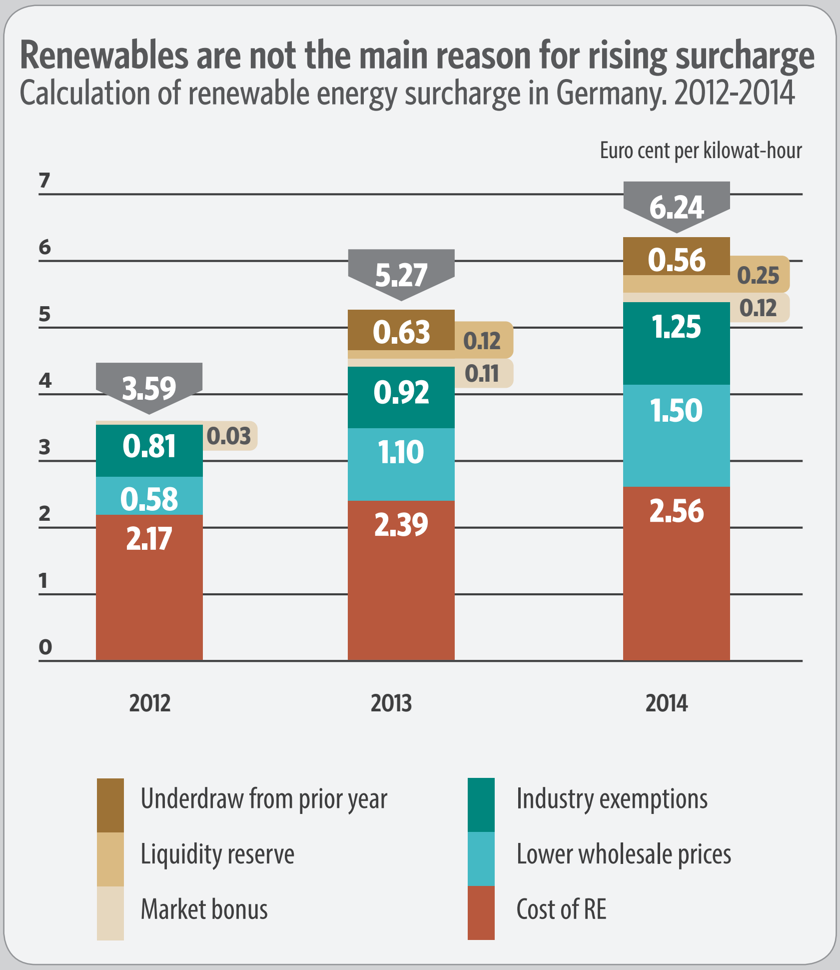
Whether cost savings can be achieved via competitive auctions depends on a number of inter-related factors. Careful consideration has been required to strike a balance between maximising participation levels, which will help push down prices and thus costs for government, as well as to reduce the costs and risks for the participants since these will inevitably push up the auction bids and so increase the required support level. These issues are discussed in more

A closer look at what is behind rising subsidy costs in Germany

Subsidies are financed through surcharges introduced under the Renewable Energy Sources Act, known as the Erneuerbare Energien Gesetz or EEG.

It should be noted that while the EEG surcharge rose by 74% between 2012 and 2014 as shown in Figure B2.3, the cost of renewable energy rose by only 18% during this time. The EEG surcharge actually decreased in 2015 to 6.17cts/kWh before increasing to 6.36cts/kWh in 2016.

Figure B2.3



Source: Based on BEE data from energytransition.de

The German think tank Agora has predicted that the EEG surcharge should peak around 2023 as expensive renewable plants reach the end of their 20-year subsidies and they become replaced by cheaper more efficient plants. This raises the question as to how necessary a switch to auctions really is, albeit the European Commission is driving this requirement so the government has little choice.

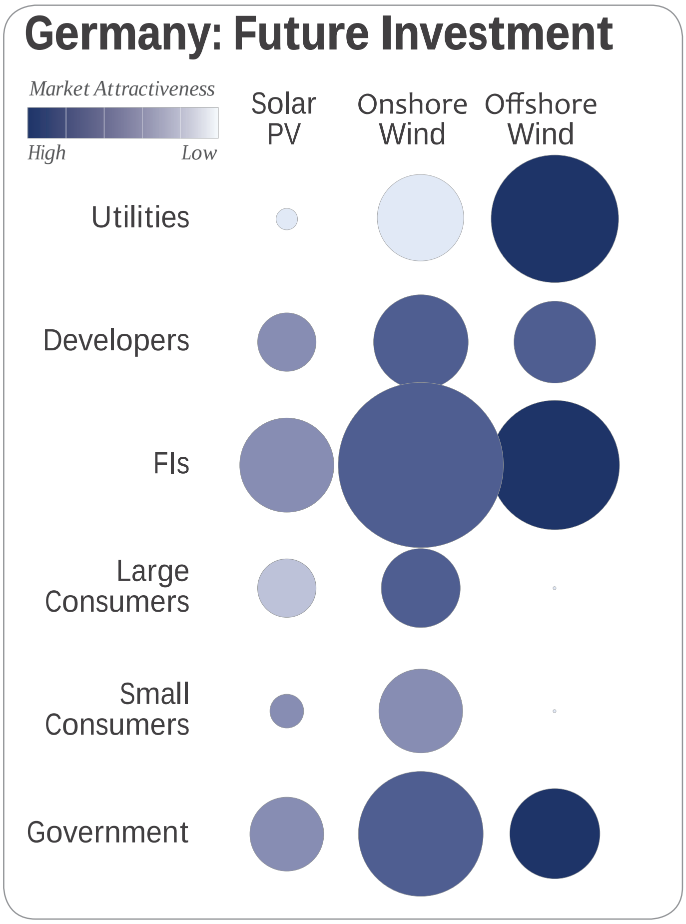
depth Appendix 3 which is taken from our report Policy and investment in German renewable energy.

New solar and onshore wind auctions will start in 2017. Solar auctions will apply to installations larger than 750kW (the *de minimis* level for onshore wind is not yet clear). A maximum price will be announced before the tender, successful bidders will receive their pay-as-bid price and the support will be available for 20 years. Auctions will be frequent (three or four a year) and a security deposit will be required, although this will be lower for small cooperatives. Cooperatives will also benefit from less stringent pre-qualifying criteria and they will receive the clearing price even if they bid a lower price. Offshore auctions will take longer to phase in as a result of the longer construction periods for these projects.

The auctions are one of several changes that affect both investor perception and investor mix. Figure B2.4 shows what market and policy environment investors expect to face in the coming five years. In general, policy around solar PV is becoming less attractive across most investor categories. However, since the industry is now well-established and more competitive, it is possible that the market will still be attractive enough to meet targets. These targets themselves are lower than historic levels of PV buildout although deployment has dropped markedly in 2014 and 2015 as a result of lower support payments.

Onshore wind remains moderately attractive for all, except large utilities and the smaller consumers who may find their role reduced, particularly in the face of competitive auctions that reward scale and developed business processes to deliver competitive bids.

Figure B2.4



Source: Eurostat, German EEG targets and CPI and SEI analysis & investor interviews

Offshore wind will be attractive in the medium term, and will need to remain so in order to meet the 15GW target by 2030. Table B2.4 shows how the investment landscape and attractiveness is evolving.

Table B2.2: Historical reasons and attractiveness of investment in renewable energy by investor type

	CHANGE IN INVESTMENT ATTRACTIVENESS
Utilities	• Following numerous delays, cost overruns and bankruptcies the offshore industry is starting to emerge as an attractive market for large utilities although they are somewhat capital constrained as a result of wider issues around their business models.
Developers	• A greater element of development risk as a result of the switch to competitive auctions is likely to result in consolidation at the lower end of the scale. Auction gaming may prevent developers from realising a premium for the extra risk element in the short term.
Financial institutions	• A greater degree of comfort with the developing offshore market will result in more investment in this area although opportunities in the solar market are likely to be more limited than they have been at the peak because of capacity limits and lower profit margins.
Large consumers	• The 750kW de minimis level will limit the size of developments commissioned by these investors since they are less likely to be willing to participate in auctions given the complexity and industry knowledge required.
Small consumers	• Diminishing support levels in recent years have seen a significant reduction in deployment levels for rooftop solar and lower support levels seem set to continue for the foreseeable future.
Government	• Cheap government backed loans follow the market demand so we expect offshore investment to be more attractive and solar to be less so.

4.The evolving policy and market environment

Investment mix

Historically Germany has had significant levels of investment from small scale investors such as households, farmers and co-operatives. This has helped with public engagement as many people have had positive experiences either directly or indirectly of investing in renewable energy, but it has not always been the most cost-effective way of deploying renewable energy.

This is because economies of scale are not realised and these types of investments are sometimes located where resources do not necessarily maximise asset performance. Conversely, these types of investors do not invest on a purely financial basis and they can be willing to accept a lower return than more commercially minded investors. With very generous Feed-in Tariff levels in the past, this willingness has not always been exploited to its maximum potential.

Germany is at a crossroads where a new support system has been designed and there is a greater emphasis than ever on cost. Larger-scale sites in the best locations offer the greatest value for money, but this can result in an uneven spread of technologies across the country and a feeling that the *Energiewende* is not fair for everyone. It can also result in higher grid costs which begin to cannibalise any economic benefits and balancing the system can become more difficult. The latest EEG attempts to tackle this issue by limiting onshore wind capacity in “grid congestion zones” located primarily in northern Germany to levels that are 58% of the 2013 to 2015 installation average. The bid evaluation process also takes into account regional variations to ensure a wide distribution of sites at the expensive optimal economic efficiency.

Incentive auction design

The auction design will enable developers to plan more effectively for the future. With key questions around *de minimis* levels and auction frequency now answered, the uncertainty that investors strongly dislike has started to fall away. Regardless of auction design, developers inevitably face an extra element of risk since they need to win an auction for the project to have any value. This increases the development premium that they will require although it should be outweighed by the benefits of introducing competition.

Capacity auctions are a useful way of controlling deployment levels. The government has taken the opportunity to set clear targets for a five-year horizon which gives investors comfort that support will be available for current and future projects and enables them to plan their investment portfolio with a degree of certainty around how likely their projects are to come to fruition.

Flexibility & curtailment

As Germany achieves its ambitious target, the risks from economic curtailment become more significant. The German government is in the process of devising policies to mitigate this somewhat under-appreciated risk. Whilst flexibility solutions in the form of smart-grids, storage, reserves, demand side response, etc, will evolve as a result of technological improvements and a genuine need, the speed of this evolution cannot be predicted.

Savvy investors will take a cautious view by assuming the worst case economic curtailment scenario when submitting their auction bid prices and this will push up the cost of energy. This is why policy is needed now to reduce the risk even though it is very likely (but, crucially, not certain) that greater flexibility will mitigate this risk anyway.

5. Conclusions and issues for further thought

Germany has made good progress in transitioning towards renewables and away from a coal and nuclear based electricity market. There is still a long way to go but the government remains committed to this transition and is in the process of revising policies to help this happen as smoothly as possible. Now that the EEG 2017 amendments have been announced uncertainty has reduced, although it will take some time before the significance of these changes is understood. Once investors fully understand the impacts of policy changes, then it is very likely that the ambitious renewable deployment targets can be achieved.

It remains to be seen how the challenge of meeting targets while reducing support levels for future developments will be addressed, but an element of compromise will inevitably be required. As the share of renewables increases there will be a greater emphasis on market design since the right incentives will need to be in place for the market to support the large amount of investment and innovation that will be required to cope with high levels of non-dispatchable generation on the grid networks.

Appendix B3
Iberia

Summary

The last decade has seen a period of upheaval in Spanish and Portuguese politics, and in particular in their once-thriving renewable energy sectors. Following the global financial crisis, governments in both countries have taken greater control of rates of growth in the renewable sector.

The investor pool has shrunk, chilled by uncertainty and losses because of a series of regulatory changes. Concern that the structural problems in the Iberian electricity market (such as overcapacity, the lack of interconnection with Europe and a ballooning "tariff deficit") have not been resolved will discourage most potential investors in new large-scale projects – in particular in Spain. Failure to achieve EU 2020 renewable energy targets will be the likely result.

Figure B3.1 below shows the capacity up to 2015, but the future projections to 2020 are regarded as unrealistic.

Investment activity instead will focus on refinancing, including the restructuring of debt from projects in technical default and the sale of long-term equity stakes by developers in financial distress. Portugal is seen as a more stable market than Spain and so asset prices have been higher, attracting a different type of financial investor, although interest in Spain has been increasing in recent months. Unlike in many parts of the rest of Europe, neither the Spanish nor the Portuguese markets have shifted significantly towards distributed generation, in part due to punitive regulation of self-consumption in Spain.

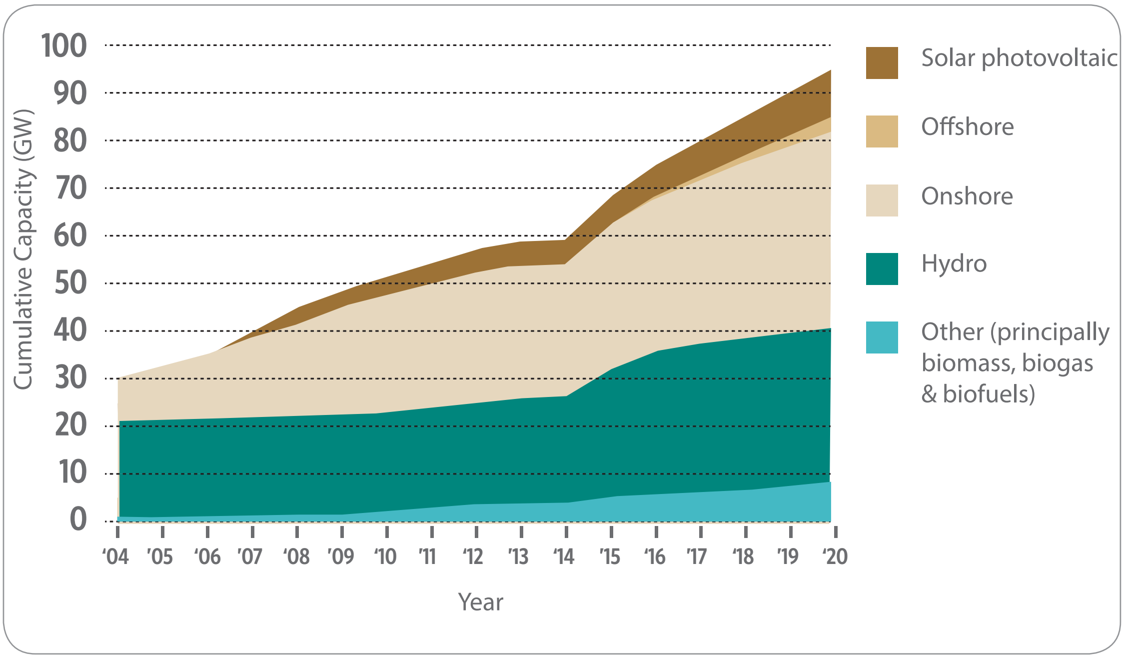
While the majority of Spanish parliamentarians oppose the "sun tax", its repeal has been delayed by political deadlock over the last 12 month which has stymied the development of system flexibility options, such as storage. For the foreseeable future, the Iberian region is likely to remain an "energy island", with little connection to the rest of Europe.

Progress towards renewable energy targets

According to the latest report by the EU Tracking Roadmap group. In 2013, 36.4% of electricity in Spain was generated from renewable sources and 15.4% of energy, with a target for energy overall of 20% in 2020. In Portugal, the figures were 49.2% and 25.7% against a target of 31%. Both are expected to fall short if significant changes are not made to the current policy suite.

The projected shortfall is principally the result of the failure to make significant headway in decarbonising the heat and transport sectors. However, the investment hiatus since 2012 in the electricity sector also means that Iberia may struggle to meet its targets. Fearful of driving up end-user costs and destabilising electricity markets in a similar manner to the pre-crisis

Figure B3.1: Renewable capacity targets in Iberia to 2020



Source: Eurostat, NREAPs and CPI
* Growth in renewables expected to be much less than 2020 targets suggest

period, both Spanish and Portuguese governments have reined in the level of support available for new projects to such an extent as to dry up a previously healthy pipeline. Furthermore, most international investors will continue to avoid even the limited opportunities in Spain as the current policy framework anticipates the government making future, regular retroactive changes.

For new investment to flow, investors will need to be confident that the historic structural problems in the peninsula's energy markets, which precipitated damaging policy changes across 2007-2012, have now been resolved. The crux of these problems was a long-running mismatch between the costs of the electricity system and the revenues raised through regulated end user tariffs. In Spain, costs rose sharply over that period as new solar PV and Concentrated Solar Power (CSP) installations boomed at a time when revenues from end users were falling and demand contracted during the global financial crisis.

Recent signs, however, are positive. A return to economic growth has firmed up electricity demand since 2014. The lack of new installations since 2012 and the fall in commodity prices have limited the rise in system costs. In 2015, the Spanish system generated a tariff surplus for the year (€550m) for the first time in 10 years and by the end of the year, Portugal had liberalised all retail tariffs. These changes will result in greater stability. However, the system remains one of the worst interconnected to the wider European market (interconnector capacity of only 2.8GW or just over 2% of total generation capacity), meaning that the system is likely to remain oversupplied beyond 2020. Without a significant increase in system flexibility, neither government has a significant incentive to support new generation capacity beyond the requirement to comply with EU targets.

Whether the political will to do so exists remains in doubt. Political uncertainty in Spain persists despite the recent decision not to hold a third general election in 12 months. With all the manifestoes of all the major parties focussing on energy efficiency and the reduction of fuel poverty, it seems unlikely that there will be appetite for an increase in tariffs that would be sufficient to fund significant new build without adding to the existing tariff deficit backlog, which was just over €25 billion at the end of 2015.

In Portugal, the general election in 2015 produced a ruling coalition following a period of uncertainty. However, the country's economy remains one of the weakest in the EU and its retail energy bills, already some of the highest in the continent, are set to increase with the liberalisation of retail tariffs. Further large projects are therefore likely to be supported in the coming years, although the recent introduction of net metering rules may accelerate the development of the country's solar market, focussing on rooftop installations where the majority of power generated is consumed onsite.

The role of investors to date

The dominant investors in Spain and Portugal's wind sector to-date have been domestic utilities, such as Iberdrola and Energias de Portugal (EDP) and developers, such as Enel Green Power and Acciona, with the latter being supported by domestic banks providing project finance debt. By contrast, utilities have hardly invested in solar PV installations, and non-Iberian financial investors providing both debt and equity have been more prevalent.

Figure B3.2 shows the amount of investment in Iberia by different categories of investors and the perceived attractiveness of the investment opportunity by these groups. The story is dominated by Spain which has a population around 4.5 times that of Portugal's.

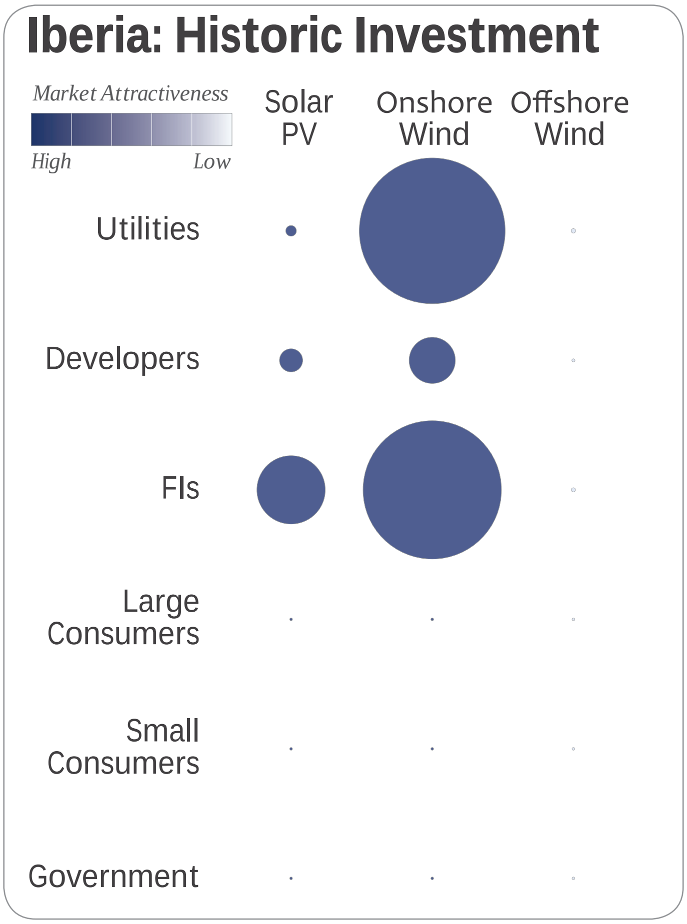
Despite the impact on the tariff deficit of the Spanish investments in solar PV (2007-2009) and solar thermal (2011-2013) , non-hydro renewable generation remains dominated by onshore wind, of which 52TWh was produced in 2014 compared with only 7.8TWh of solar PV and 5.5TWh of solar thermal.

Some 25 large utilities and developers own 70% of the total installed wind capacity in Spain, with the largest two, Iberdrola and Acciona, owning over 40% of the total.

The ownership of solar PV and solar thermal plants is much less concentrated, with a much more significant proportion owned by international financial investors who had sought to reap high returns by investing in what at the time was a stable regime promising a relatively attractive feed-in tariff. Spanish developers traditionally active in other renewable energy and construction sectors, such as Acciona, Grupo ACS and Abengoa, also sought to take advantage of the availability of cheap credit and financial investor demand for solar assets.

As international investor appetite dried up following Spain's regulatory changes, buyers for these projects became more scarce. Increasingly in need of cash to reduce debt levels, many of these developers have

Figure B3.2



Source: Eurostat, NREAP, CPI and SEI analysis & investor interviews

sought the investment of financial investors, bringing new sources of capital into the sector, either through listed "YieldCos" (such as Atlantica Yield, formerly Abengoa Yield, and Saeta Yield) or through unlisted strategic partnerships (such as Acciona's joint venture with KKR). Despite the initial success of its YieldCo, Abengoa filed for bankruptcy in November 2015, illustrating the extent to which debt-fuelled investment in the last decade continues to weigh down some of the largest investors in Spanish solar.

By contrast, Portugal did not provide support for solar thermal and large scale solar PV, meaning that investment in non-hydro renewables was dominated by wind. Ownership of onshore wind capacity is concentrated in a similar fashion to Spain, with the largest three porfolios (owned by EDP, Cheung Kong Infrastructure and First State Investments) constituting around 50% of the total installed capacity.

The role of investors in the future

Summary

The lack of appetite from both Spanish and Portuguese governments for supporting more generation capacity means that the role of investors in the years to 2020 will be more focussed on refinancing operational assets than on funding greenfield projects.

As illustrated in Figure B3.3, both Spain and Portugal nominally retain plans to build significant new wind and solar capacity, which would be needed to meet their EU 2020 targets. However, much has changed in the energy markets of both countries since these targets were submitted to the EU in National Renewable Energy Action Plans (NREAP) in 2010.

In reality, neither government has shown much appetite to expand generation capacity to any significant degree. In December 2015, Spain tendered for 700MW of new wind and biomass capacity, the first support provided to any new installations since the introduction of its new regulatory framework in 2013. With an estimated additional 16GW of onshore wind and solar PV due to be built according to its NREAP and no sign as to when any further tender will take place, the Spanish government shows little willingness to meet the EU 2020 target.

Portugal, whose NREAP assumes a more modest addition of 2GW of onshore wind and 1GW of solar PV, has a longer history of tendering for renewable energy support. However, the only investment in large-scale projects in recent years has been the financing of the 172MW Project Ancora wind project, which had been procured through a tender in 2006 but only reached financial close in 2015. The absence of a clear pipeline of new tenders suggests that large-scale new build will be limited in the coming years. In contrast, the adoption of new net metering rules in late 2014 is likely to spur an increasing contribution to the sector from consumers seeking self-consumption projects.

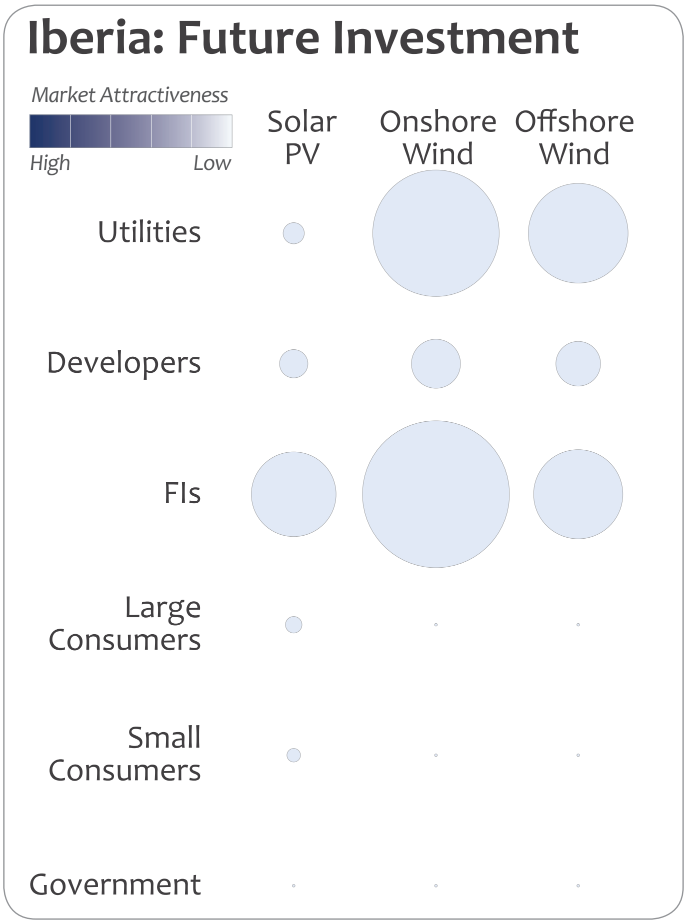
Providers of long-term debt to individual projects may be motivated differently depending on whether they had been part of the original lending group during construction or whether they are considering the provision of debt to a project for the first time.

For projects originally funded with a substantial proportion of debt, retroactive cuts to regulatory support – in particular in Spain – will have constrained the ability to make debt service payments and could have resulted in technical default. For lenders to

Table B3.1. Historical reasons and attractiveness of investment in renewable energy by investor type

	INVESTMENT PROPOSITION	INVESTMENT ATTRACTIVENESS
Utilities	• The large Iberian investor owned utilities (IOUs) are international players that look for the most attractive investment opportunities globally, given their range of technical and financial capabilities.	• Generous feed-in tariffs offered very attractive returns when first introduced. • Since they have been withdrawn there is little incentive for them to invest in Iberian renewables when they can achieve higher returns in other regions with more stable regulatory regimes.
Developers	• Large scale PV and CSP and onshore wind have been installed by medium to large scale developers.	• Developers broadly faced similar positive and negative dynamics to utilities.. They also were buoyed by the easy availability of cheap credit prior to the financial crisis. • In particular, construction such as Abengoa and Acciona viewed renewables as an attractive market to operate in given the slowdown in the Spanish property market. They favoured solar over wind given the less technically demanding nature of the installations.
Financial institutions	• Financial investors have been active both in providing project finance debt to developers and through direct equity investment, in particular, in solar PV and solar thermal projects. • In recent years, there has also been a degree of new capital from from institutional investors through a number of YieldCos listed in 2014 and 2015.	• During the peak the market was very attractive as a combination of excellent natural resources and strong levels of support made the economics of investing very favourable. • Following retroactive tariff cuts, some projects are close to or even breaching default levels while equity returns have been wiped out altogether. The weak position of the Spanish banking sector since the financial crisis has reduced the availability of credit.
Large consumers	• This group of investors only represented a small proportion of investment in solar PV as the technology was relatively expensive in the years before retroactive cuts and self-consumption regulations were unclear.	• Large consumers in Spain are allowed to sell excess electricity to the grid provided they are registered to so.
Small consumers	• Relatively modest numbers of individuals invested in small scale renewables during the boom period but without corporate limited liability protection some of these have been worst affected by retroactive tariff cuts of up to 50%. • A small number of co-operatives have been set up as a response to the anti-renewables policies of the Spanish government such that most deployment in Spain in recent years has come from this group of investors, although profitability has been a secondary consideration.	• "Sun tax" effectively makes self-consumption uneconomic for small installations with capacity less than 100kW. • However, all but one of the principal political parties have resolved to repeal the law, should they get into government.
Government	• Neither government has been making direct investments in the renewable markets, although EDP is one of the largest wind investors in Portugal and globally. As of May 2012, the Government of Portugal divested its remaining stake in the company through a sale to China Three Gorges company. We now consider the company as a utility.	• N/A

Figure B3.3



Source: Eurostat, NREAP, CPI and SEI analysis & investor interviews

these projects, the choice to participate in a debt restructuring could improve their recovery prospects compared with the alternative scenario of trying to realise their security and potentially crystallising a loss. Potential new lenders are likely to prefer projects with stronger financial positions, in particular, those originally funded wholly with equity although these will be in short supply. In particular, they will consider whether a project's financial structure provides adequate financial protection against future retroactive changes in regulatory support.

By contrast, future providers of long-term equity – most likely through the acquisition of equity stakes in projects, developers or utilities – will be exposed to the risk of future regulatory change. As this risk is difficult to hedge against, such investors may only be willing to provide long-term equity at a discounted valuation. The identity of the financial investors investing in Spain (private equity funds seeking high returns) and in Portugal (pension funds seeking lower returns) in 2015 provides an indication that investors perceive the regulatory risk in Spain to be higher than in Portugal.

Spain

Confidence in the stability of the investment framework in Spain is only slowly starting to return following a series of retroactive changes implemented between 2008 and 2012.

The changes were ostensibly aimed at controlling a tariff deficit that had ballooned from around €7 billion in 2007 to close to €25 billion in 2012 as the inflexible design of its attractive feed-in tariff programme left government without an effective cost control mechanism as solar module prices started to drop dramatically, spurring a surge in deployment (and hence system costs) at a time when system revenues had contracted due to the impact of the global financial crisis on domestic demand.

The policy changes were wide-ranging, and while they affected all elements of regulated system costs within the government's control, investors in renewable electricity projects were particularly affected. They faced losses in earnings resulting from, inter alia, a generation tax, reduced scope of generation volume and hours available for support, curtailed support for new generation and finally the removal of the entire feed-in tariff system altogether. Investor confidence in the Spanish regime was not only impacted by the actual losses suffered, but also by the perceived lack of independence of the regulators from the government and the opaque, non-consultative nature of the policy-making process.

With a relatively stable framework since 2012, the investment outlook has brightened somewhat with significant investment provided for refinancing operational projects: (1) by banks (€600 million of debt for T-Solar in December 2015); (2) institutional investors (€285 million project bond for Solaben 1 and 6 CSP projects in July 2015) and (3) financial investor equity investment in developers (KKR investments in Acciona Energia Internacional and Gestamp Solar in October 2014 and July 2015) and in specific projects.

However, the appetite of less specialist investors or those prioritising stability of cash flows over returns will remain uncertain while the Spanish government and regulator have not built a track record of a transparent and predictable regulatory framework. This was illustrated by a decision by Bluefield, a UK-based fund manager, to postpone a planned listing of a Spain and Italy-focussed YieldCo in the summer of 2015.

The willingness of international investors to provide equity to the sector will also be influenced by the results of the numerous cases brought by international financial investors against the government under the Energy Charter Treaty, an investment treaty to which over 50 countries are party, which since 1991 has sought to promote investment in energy-related assets. The investors had alleged that the Spanish government, in making such retroactive cuts, had not treated foreign investors fairly and equitably. However, the first decision resulting from the arbitration process, published in February 2016, has ruled in favour of Spain.

With support for new grid feed-in projects now more tightly controlled, the Spanish market had the potential to attract significant long-term investment from consumers intending to use the majority of the power produced by rooftop solar arrays onsite. However, as punitive regulations for these types of installations were introduced in 2015, any potential investment from consumers has stalled for the moment. This position could be reversed depending on the final make-up of the new government as all major parties other than the incumbent Partido Popular had vowed to repeal the laws if elected.

With its very restrictive laws on self-consumption and support capacity for grid feed-in projects now controlled via tenders, Spain now has greater control over the amount of future capacity to be installed in the next few years.

Portugal

In Portugal, reduction in electricity demand driven by a 3% contraction of GDP in 2009 also resulted in a rising tariff deficit. However, unlike Spain, the country did not face the same expansion of system costs as it had only very limited support in place for solar PV and none at all for CSP. In implementing more measured changes to regulatory support and in a more consultative fashion, investor confidence in Portugal was not damaged to anywhere near the same extent as in Spain.

In Portugal, cuts included (1) reduced capacity payments; (2) a cut in the recovery by former incumbent EDP of certain historic stranded costs from the period before the market was liberalised; and (3) changes to the profile of remuneration of certain wind farms installed before 2005.

Most renewable energy investment in 2015 related to refinancing, with Hong Kong infrastructure investor Cheung Kong Infrastructure (CKI) buying Iberwind in October; First State Investments buying Enel Green Power's portfolio in November and EDP selling a minority stake in December to its strategic partner, China Three Gorges. This trend is likely to continue, although the proportion of long-term investment provided by consumers is likely to rise following the introduction of net metering regulation in late 2014 and as the country attempts to triple its installed capacity of solar PV by 2020.

The evolving policy and market environment

In Spain, investor confidence remains fragile in the short-term despite a new regulatory framework and the hunt for yield

Since 2013, no further changes have been made to the support regime for large-scale renewable capacity as a new system of remuneration based on capacity (MW) replaced a system based on production (MWh). Furthermore, no new support for large-scale installations will be allocated outside of a tender process. In theory, these changes would make the system more sustainable as it would make the cost of supporting renewable power generation more predictable and therefore prevent a future sharp inflation of the tariff deficit

However, greater government control of the support mechanism is a double-edged sword. The government has argued that it reduces the risk of misforecasting and therefore, the need for future drastic intervention. However, the in-built mechanisms, which allow the government to make material changes (including retroactive ones of the sort made in 2008-2012) every six years, ring alarm bells for investors, especially those currently engaged in Energy Charter Treaty cases.

The principle underlying the very complex new scheme is that owners of well-run and efficient renewable projects should be able to earn a "reasonable" rate of return. For onshore wind, solar PV, CSP (among others) the framework defines a series of standard "efficient" facilities. Each category includes an estimate of the capital and operating costs associated with such an efficient project. The government then defines the reasonable rate of return to be applied to the standard investment cost. The cost to the system of supporting an efficient project is therefore the residual revenue required to achieve the return after taking into account expected revenues from sales of electricity in the Spanish pool market.

The new system could in theory result in more predictable operating cash flows than under a feed-in tariff. In particular, a MW- rather than MWh-based remuneration scheme should effectively remove resource risk for investors as projects should in theory receive the same revenue whether they are generating or not (subject to generating a minimum number of operating hours during the year).

The framework also includes a concept, superficially similar to tried-and-tested network regulation, of an asset earning "allowed" revenue based on a "reasonable return" on assets, which would be subject to regulatory review (in this case every six years). This comparison is, at best, misleading, as owners of renewable assets have much less flexibility to adapt to periodic changes in allowed return than network owners. The effect of a downward revision in the allowed return would be akin to the impact of the retroactive changes imposed in 2008-2012.

The current post-tax return of just under 5.4% is not only significantly lower than returns obtained by developers prior to the retroactive changes but also, by comparison with the levels of return assumed by the government when originally setting the feed-in tariff rates. The return is also only marginally higher than the current level in Germany, where developers benefit from much cheaper debt costs through the development bank promotional loan schemes.

There is therefore a significant degree of subjectivity which the government will be able to use when reviewing an appropriate level of return in 2019/2020, which it could use - if expedient and as per historic practice – to control end-user prices at the expense of investors. While the framework does contain a number of positive features for investability – in particular, the fact that the government cannot make changes to the parameters of the standard facilities such as regulatory useful life and the standard capital costs – it will only be of value for many investors once an independent is seen to apply the rules in a consistent and predictable manner.

Significant investment under the scheme is therefore unlikely until after 2020, the first time when the government will have the opportunity to change the allowed return.

Limited interconnection with the rest of Europe is unlikely to be resolved in the near term

In 2015, the 1.4GW San Llogaia-Baixas interconnector was completed after a decade-long planning period. This doubled the interconnection capacity between the Iberian peninsula and the French market but still left Spain far short of the 10% interconnection set out by the EU in 2002.

Political and financial constraints appear likely to prevent the connection of any further lines in the near future. A proposed subsea line with a capacity of up to 2GW between Aquitaine in France and Basque Country in Spain through the Bay of Biscay has been designated by the EU as a project of common interest and could receive financial support, but it is likely to be technically complex and unlikely to come to fruition until the mid-to-late 2020s.

Without a significant increase in system flexibility through demand response, storage and flexible generation capacity, this limits the scope for the system physically to accommodate a significant increase in intermittent generation capacity. However, even if an adequate regulatory framework was adopted to encourage such investment, the addition of further low- or no marginal cost generation to an oversupplied stack will further depress wholesale prices as they reduce the running hours of fossil-fuelled generation, raising the risk of a renewed tariff deficit.

‘Sun tax’ will hinder not just small-scale solar but flexibility options as well

The “sun tax” introduced in 2015 was the culmination of years of regulatory uncertainty for the rooftop solar industry in Spain. It ostensibly seeks to ensure that grid-connected “prosumers” (those who consume the majority of electricity they generate onsite) remunerate grid operators for providing them with security of supply for when the sun does not shine or wind does not blow. However, the regulations impose additional taxes, first on total installed capacity and second for installations larger than 10kW and in the Balearic islands, on self-consumed electricity.

By itself, this “double” taxation will make most self-consumption options uneconomic. Further elements of the regulation also appear designed to prohibit or at least severely limit community ownership and local marketing of community-owned generating facilities. However, the most damaging element of the regulation is the prohibition on facilities smaller than 100kW from selling excess electricity in the grid with non-compliance punishable by a fine of up to €60 million.

In practice, the “sun tax” will also hinder the development of the energy storage industry which could provide the additional system flexibility required to accommodate higher penetrations of non-hydro renewables, especially in the short-term given the limited prospects for further interconnection with the French market.

A stunted distributed generation market would reduce the risk that demand is substantially shifted away from the transmission network. This will mean higher revenues for network operators (volume-based charges for use of the network) and higher wholesale power prices than would otherwise have been the case.

Although the tax should reduce the risk of accumulation of new tariff deficits, it will be unambiguously positive for the region's incumbent utilities, whose financial position following the financial crisis has increasingly strengthened. While their Northern European peers have suffered the impact of renewable deployment on power prices to a much greater degree.

It would therefore be negative for those network-owning utilities if, as promised by the main opposition parties, the law is repealed.

Conclusion and issues for further thought

In Spain, future large-scale investment in new renewable electricity installations is unlikely until the government regains the trust of investors by developing a track record of consistent and transparent policy making. In Portugal, recent M&A transactions suggest that international investor confidence in the sustainability of the regime remains, however, as in Spain, short term political objectives remain uncertain given the result of recent general elections.

There are important lessons to be learned by policymakers both in the peninsula and outside about the importance of long-term planning, transparent regulation made by independent regulators, and a balance between the interests of all stakeholders in the energy system. These will be instructive if the countries are to pursue the next phase of decarbonisation successfully in the 2020s. Reducing the tariff deficit and increasing interconnection with the rest of Europe will be vital steps towards strengthening the case for more renewables.

If maintained, the "sun tax" in Spain could in the short term help prevent the further accumulation of the tariff deficit. However, it would likely help prevent the development of the technologies and business models required for the next phase of the low carbon transition.

Appendix B4
The Nordics with a focus on Sweden

Summary

The Nordic region's objective is to accelerate and implement a smooth energy transition in a market characterized by general over-capacity, low wholesale prices, flat or limited demand growth and most of the EU 2020 targets already achieved. In such a market, maintaining the momentum of the transition is not an easy task. In fact, investors that had initially piled into the Nordic wind market due to its intrinsic resource value, have more recently been hurt by low prices due to the oversupply of green certificates. These have resulted in investor losses, reduced incentives for new wind investments and an overall reduction in investor interest in the region. However, investors and capital remain available, while the intrinsic long-term value of Nordic wind resources remains world class, so policymakers need to ensure the matching continues. Two critical paths should be pursued:

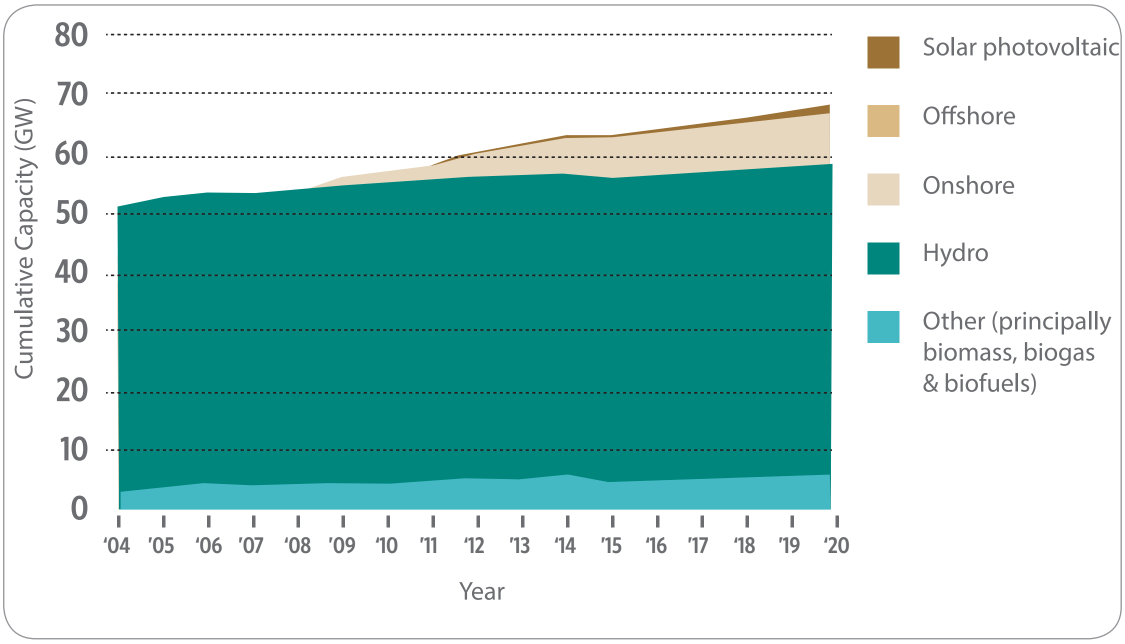
- **Implement market design** options to increase wholesale prices to a level that are attractive to investors, stimulating the necessary flow of investments required to fuel the transition;
- **Reduce uncertainty and minimize political risk** by setting clear, predictable support policies that factor in Sweden's nuclear repowering.

Unlike other EU countries that face an immediate pressing need for action, the Nordic countries and Sweden in particular, have the luxury of a few years to really think through and implement an efficient energy transition. This opportunity should not be wasted with years of inaction and limited investments.

1. Progress towards targets

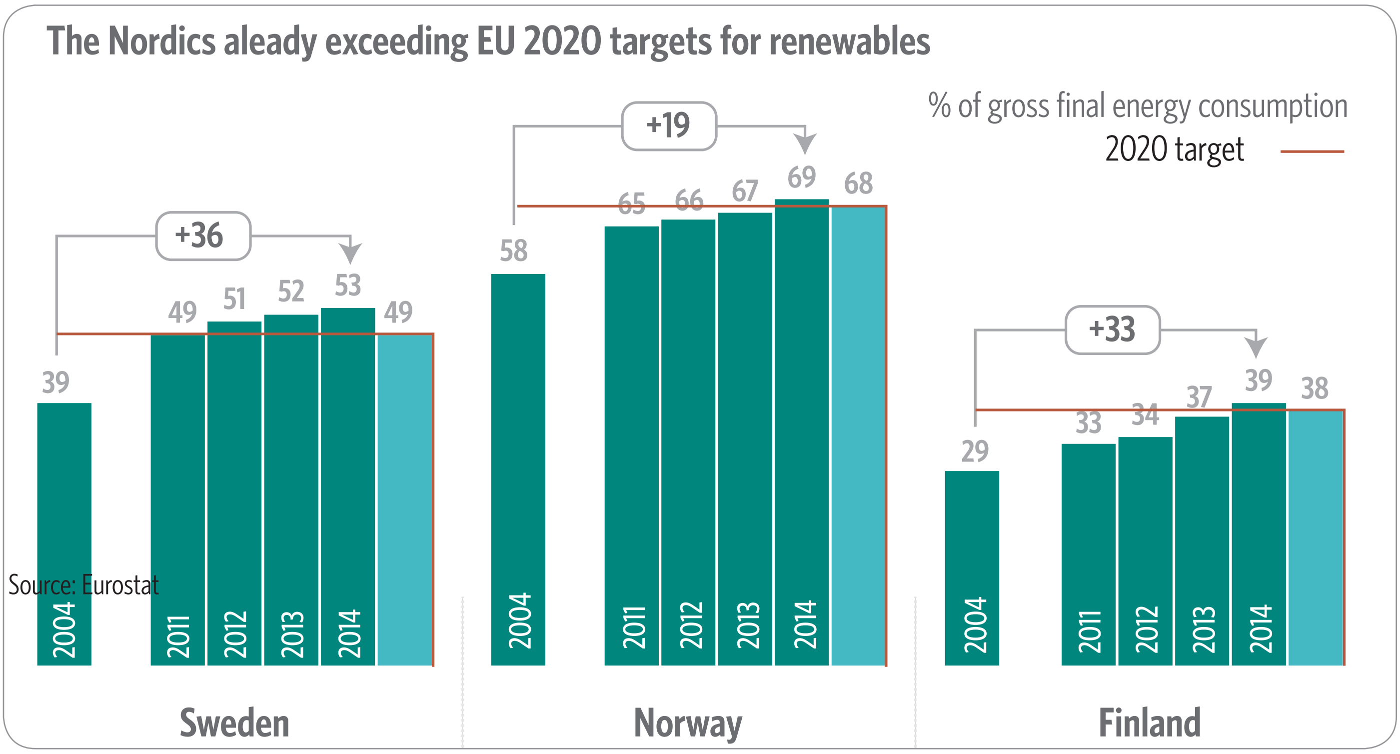
The Nordic region has historically been at the forefront of renewable energy adoption and is set to reach or even exceed its renewable energy EU commitments. According to Eurostat data, as of the end of 2014, Norway (69.2%), Sweden (52.6%) and Finland (38.7%) have all already achieved their 2020 targets as % share of final energy consumption. In this context the Nordic countries are revising the targets for 2020 upwards and are establishing 2030 targets. Historically, hydro has made up the majority of the renewable energy contribution, especially in Norway and Sweden. More recently, developments in bioenergy (mainly Sweden and Finland) and wind power (mainly in Denmark and Sweden) have entered the mix and pushed renewable energy shares even higher.

Figure B4.1: Renewable capacity targets in the Nordics to 2020



Source: Eurostat, NREAPs and CPI

Figure B4.2 Share of energy from renewable sources as a percentage of final energy consumption



Source: Eurostat

2. The role of investors to date

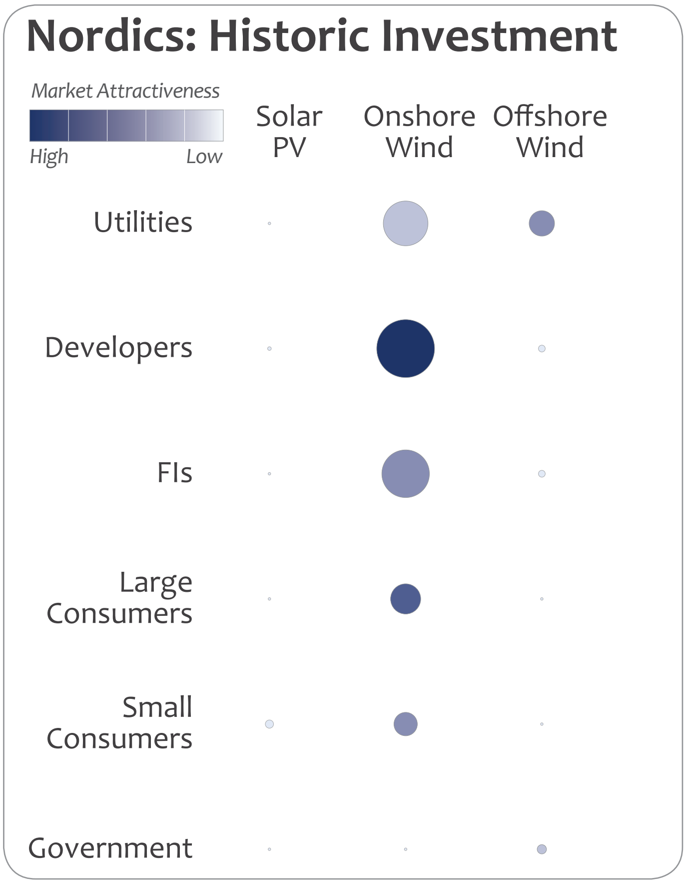
The history and dynamics in the Swedish electricity certificate markets (see section 3) have had a major impact on which investor groups have participated in the market, and on the development of financing models.

Figure B4.3 (right) shows the amount of investment in the Nordics by different categories of investors and the perceived attractiveness of the investment opportunity by these groups between 2004 and 2014.

In the past decade, investment in renewable energy has been primarily about onshore wind developments, geographically focused in Sweden. Hydropower (and biomass) have historically played a major role in the Nordic system, but have not been the main driver of renewable expansion recently.

In fact wind investment in Sweden was very small, at an average of 40MW per year in the decade to 2007, but already presented a number of different investment models and ownership forms. Early investors included large power companies financing investments primarily through their balance sheet, but also the beginnings of dedicated wind development companies and the introduction of project financing mechanisms, typically with low leverage. Alongside these, wind

Figure B4.3



Source: Eurostat, NREAP, CPI and SEI analysis & investor interviews cooperatives as well as individuals also accounted for a substantial share of investment, motivated in part by the exemption from energy taxation of wind power production for self-consumption.

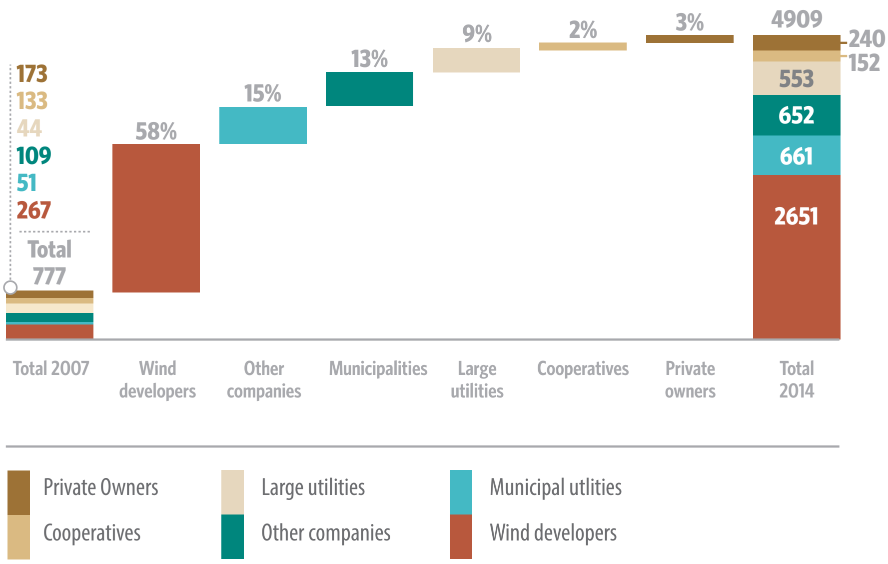
From 2007, investment volumes grew rapidly, reaching 500MW a year by 2010. The main factor behind this was the improving economics of wind power due to technological developments, which made wind power the technology of choice for the production of green certificates. In 2014, volumes had almost doubled, reaching over 900MW of installed capacity, and adding more than 4GW of capacity in the period 2007-14.

This recent expansion was undertaken by a diverse group of investors, as the investment proposition and the attractiveness of renewable investment can be quite different for each investor group.

Figure B4.4 Increase in installed wind power capacity between 2007 and 2014

Swedish wind power ownership is increasingly concentrated on wind developers, with a falling role for households and large utilities

MW and % increase



Source: BEE

Table B4.1. Historical reasons and attractiveness of investment in renewable energy by investor type

	INVESTMENT PROPOSITION	INVESTMENT ATTRACTIVENESS
Utilities	• Large power companies have a 12% share of wind capacity, and a roughly similar size of new construction. This development is in sharp contrast to the expectation when the current policy regime was first introduced. • As the boom in investment started around 2007-08, it was expected that large power companies would be major investors once wind developments grew in size. Large utilities, therefore, were also the investors in mind when making policy, including the choice of a certificate system. In reality, the large power companies active in Sweden, namely Vattenfall, E.ON, Fortum and Statkraft, have not taken large positions. • Instead municipal utilities have grown to become a large owner of wind power, at just under 15% of total capacity. Their investment criteria often differ from those of larger utilities, including clearer mandates to provide "green" electricity to their customers. Their overall business model also differs from larger utilities, with much less emphasis on managing complex risks and associated higher returns.	• The relatively low share of wind ownership confirms what many other countries have experienced that large, incumbent utilities find it challenging to compete in the onshore wind market. • A major factor is that the expected rates of return available on wind power are lower than those available in other types of investment. Any comparative advantages in terms of organisational returns to scale, operational efficiency, or synergies (for example portfolio effects with other generation) have not been sufficient to outweigh this. • Much of the recent investment by large utilities has been undertaken in joint ventures with other parties. One option is with landowners, notably large forestry companies, where utilities can get access to attractive wind resources and terms for land.
Developers	• The largest ownership category is wind development companies, owning over 50% of total installed capacity in 2014, and a still larger share of new additions between 2012-14. These companies in turn are owned through a variety of financial/ownership structures.	• The green certificate market has represented an attractive proposition for wind developers. Initial returns have been sufficient to meet requirements, thanks to efficient financing models and underlying good onshore wind resources.

Financial institutions	• Financial institutions have become very important investors in recent wind developments. One model for their involvement has been through joint venture structures. Another has been through ownership of wind development companies with significant ownership of wind capacity. More recently, a number of insurance companies, in particular, have also taken direct ownership of wind assets. In all cases, institutional investors have participated through direct equity investments, and although precise data is lacking it is clear that they are becoming a major source of capital in Swedish wind power investments as other sources of finance dry up due to decreasing rates of return.	• In many cases, these are institutional investors in search of yield in an overall investment environment that offers few investment opportunities. Some indicate they have accepted an expected rate of return below 5%, and with significant downside risk. • A notable feature of this type of capital flow, is that it has increasingly been international (eg, Allianz), with German, Australian, and British investors entering the Swedish market. For these, investment in Swedish wind power additionally represents a choice to have exposure to revenues denominated in Swedish Krona, and more generally to the perceived stability of Swedish economic outlook, with wind power a relatively attractive option given this choice. • These investors often have a long-term perspective. They have regarded the Swedish wind resource as a fundamentally attractive energy resource in the context of a low-carbon transition for the wider EU energy system.
Large consumers	• Industrial consumers, such as pulp and paper companies have been heavy investors in Swedish wind power. For these investors, wind power has provided an attractive mechanism to achieve another revenue source from existing assets, such as forest land. • Integrated pulp and paper companies are highly electricity-intensive, and ownership of wind power has had long-term hedging value, providing a hedging opportunity over much longer periods and at more attractive prices than are available through power market derivatives. Some companies now produce wind power corresponding to half of their expected electricity consumption, signifying a significant step away from relying on the NordPool electricity market.	• As predominantly balance sheet investments, the hurdle rates required by these investors have been relatively high, reflecting the opportunity cost of other investments available in the overall company. There is a clear slowing trend here, as initial targets have been met and Nord Pool prices seem in a stable low range.
Small consumers	• Smaller consumers have been active, with a diverse set of motivations. • A large number of farmers, who take advantage of their land holdings to achieve an additional revenue stream through small-scale wind power developments. • Real estate companies procuring electricity at attractive prices for their tenants. • More recently, some major consumer-facing organisations (from bakeries to major retailers) have also made pledges to power all their activities with renewable energy, and invested in ownership of wind power on the back of this. • Cooperatives and individuals still own some 8% of installed wind power capacity. However, their share is declining, and only 1-2% of new investment has been undertaken by these categories.	• For non-industrial companies, the investment case for wind power has been very attractive, as electricity produced for own consumption is exempt from energy taxation. At 294 Swedish krona (€30) per MWh, this can amount to as much as half the cost of electricity produced from wind power, and larger than the revenue available from certificates. • However, this has proven an unreliable guide to investment. For example, it was determined in 2012 that this tax exemption would not apply to cooperative ownerships. In 2015, it was decided to remove it altogether, including for future electricity consumption by pre-existing windfarm owners.
Municipalities	• Municipalities already are major participants in the Swedish energy market, through a large number of municipally owned utilities active across district heating, combined heat and power production, and hydropower.	• In addition to investment through their utility companies, municipalities also have invested in wind power in their capacity as large consumers of electricity, as well as on a perceived popular mandate to undertake climate mitigation at the local level. They have often used their access to relatively cheap finance (including through semi-banking vehicles such as Kommuninvest), with many project appraisals undertaken at a financing cost of 3%-5%.

Given this context, several observations can be made about the ownership structure of Swedish wind energy assets:

- *Diversity of investor base* - There is significant diversity in the current investor base. They range from the very smallest (individuals), to large multinational industrial and energy companies, to financial investors.
- *Diversity in motivations* - Motivations similarly have been very diverse. At least one-third of new capacity in 2012-14 is owned by companies and organisations whose main activity is entirely outside the energy sector, which are neither power companies nor wind developers.
- *Local involvement* - Wind farms are often owned through either municipalities, local companies, or households. Interviewees noted that this has been an important factor in giving local legitimacy to wind farm developments near population centres. By some estimates, as much as 40% of capacity is local in this sense. [Ref Wizelius]
- *Increasing internationalization of investor base* - More recently, a diverging trend has taken hold, with an increasing share of international capital entering Swedish wind power. Sources include insurance companies and infrastructure funds.

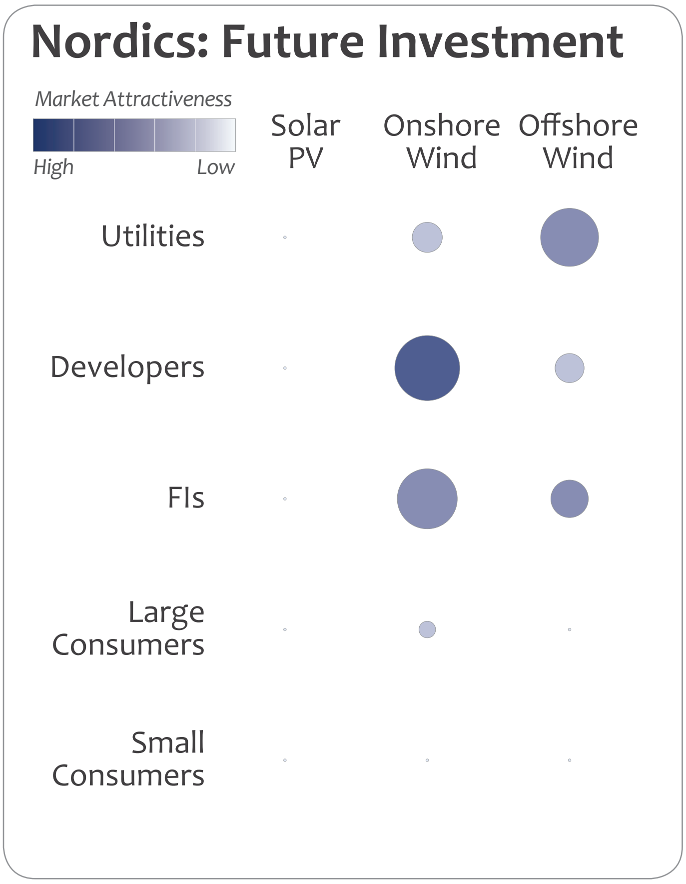
3. The role of investors in the future

Overall, the development of the renewable energy market in Sweden has been advantageous to consumers, who have benefited both from lower electricity prices resulting from a capacity expansion, and from very low costs of reaching renewable energy targets. However, this has come at the expense of investors. This situation has now finally caught up with the system, which in its current guise is not able to attract more investment. There is a real risk of a sustained "investment pause", which can significantly harm and dismantle the wind industry that has been built so successfully over the past decade in Sweden.

The Swedish government has come to the rescue by approving to raise the quotas of the renewable targets.

As figure B4.5 shows, onshore wind remains the most attractive renewable option and will be the technology of choice for new capacity additions. The growth of wind developers in this area is expected to continue, with a growing involvement of financial institutions providing the required investment via developers.

Figure B4.5



Source: Eurostat, NREAP, CPI and SEI analysis & investor interviews

Offshore wind has the potential to be attractive, and specifically to pull investment from large utilities. However, offshore wind is not expected to play as big a role while more cheap and accessible onshore wind locations are available.

Although growing, solar PV remains a marginal option for the Nordic countries until costs will decline further and is expected to be seen only on specific niche applications.

As we describe in further detail in the next section, the evolving policy and market environment rotates on: i) a few critical elements of the current green certificate system, namely the setting of the target quotas to and beyond 2020 and price setting of the green certificates; ii) the future of the existing nuclear fleet.

Table B4.2. Historical reasons and attractiveness of investment in renewable energy by investor type

	CHANGE IN INVESTMENT ATTRACTIVENESS
Utilities	• Recently utilities are seeking direct collaboration with institutional investors, building joint venture partnerships to finance wind projects. The motivation is primarily to reduce the strain on balance sheets. If anything, the outlook for utilities remains primarily linked to larger offshore wind projects, as they do not seem to be able to compete with more nimble, specialized onshore wind developers or municipal utilities with access to low-cost capital.
Developers	• The decrease in both electricity and certificate prices have recently hit the actual returns hard, causing a stalling of investments from this investor class and putting some strain on the cash flows of existing and proposed projects. The outlook remains positive: if the policy measures proposed will be able to attract investment, developers will be the prime channel for onshore wind projects to be financed.
Financial institutions	• Although the volumes of institutional capital has been large compared to the overall investment volume in Swedish wind power, it is far from clear that this source of capital would continue to be available for future build-out of wind power in Sweden. In particular, it has been driven by extreme paucity in other investment opportunities.
Large consumers	• Like many other companies the investment case for wind power has been challenged by falling power and certificate prices. Hedging for electricity prices is no longer a real motivation and it is increasingly difficult to build a valid business case for such investments.
Small consumers	• Tax exemption policies, a very significant driver of investment for small consumers, have been changed, including for investments that have already been undertaken. There is little appetite for further investment for this class of investors.
Municipalities	• Like other non-industrial investors, municipalities may see a major change in their rate of return in investments undertaken for own consumption, due to the change in energy taxation. The general outlook for municipalities is less attractive than in the past, although they might still participate in some regional projects thanks to their ability to raise cheap capital and the emerging use of green bonds.

4. The evolving policy and market environment

Sweden has a virtually carbon free electricity sector. Hydropower was built in the decades prior to 1970, and a significant expansion of nuclear power in the 1970s meant that by 1981 these two sources of power provided nearly all power (95%) in almost equal shares. In the last 15 years new forms of renewable power have entered into the mix, thanks to the introduction of a renewable quota obligation and a tradable green certificate system in 2003. A significant amount of bioenergy has been added since the early 2000s, to provide approximately 7TWh-8TWh per year, and since 2007 there has been a significant expansion of wind power, mainly onshore, growing from 1TWh to 11.5TWh of production in just seven years. Forty per cent of this was added in 2013-14 alone, with additions of 1.5GW. Total per capita production of wind power is now at 1,097kWh, higher than every other country other than Denmark (1,163kWh). Even so, the share of total wind electricity production is modest, at 8% of total generation.

The expansion of onshore wind power has occurred because it is the cheapest available renewable technology, and therefore the investment of choice under Sweden's system of quota obligations and tradable green certificates. The underlying wind resource is highly attractive. The Swedish Energy Agency estimates that as much as 12TWh of wind potential exists at a cost of approximately €50/MWh, and another 140TWh at costs below €62/MWh. This is highly favourable compared to many other locations.

This entry of new power has changed the supply demand balance and resulted in downward pressure on electricity prices. Electricity consumption has not increased over the last 20 years, while hydro and nuclear capacities have remained constant (albeit with lower utilization of nuclear power). The entry of 15TWh of new power therefore has made Sweden an oversupplied market and increasingly a net exporter of electricity, even with lower levels of nuclear production. It also has resulted in downward pressure on wholesale power prices, which are now too low to support investment in new power generation capacity. Investors are reducing their exposure in wind farms in Nordic nations as the lowest electricity prices in 12 years have cut into the profitability of new projects. No wind farms were commissioned in Sweden in the second quarter of 2015. This compares to 50MW in the same period in 2014, according to the Swedish Wind Association. According to data from Bloomberg New Energy Finance, investment in utility-scale Nordic wind assets fell by 76% to $1.2bn in in 2014, compared to peak investment in 2011.

Policy objective: accelerate transition in a market with flat demand growth

In Sweden, policy support for renewable energy is primarily about attracting new investment rather than making renewable energy the choice of investment over other sources. Financial support for wind power in Sweden is not primarily required to fill a "cost gap" between wind power and alternative sources of new power. Its role instead is to provide incentives for the construction of new power capacity in an over-supplied market. This distinction is fundamental to understanding how future renewable energy policies can best be implemented in Europe; it is about how to accelerate a transition in a market with flat or limited demand growth. Whether or not renewable energy is at cost parity with alternatives is not the only, or even the most important issue. Even if new renewable power were the cheapest option, it would not be built on the back of wholesale market prices unless new investments were required in the first place.

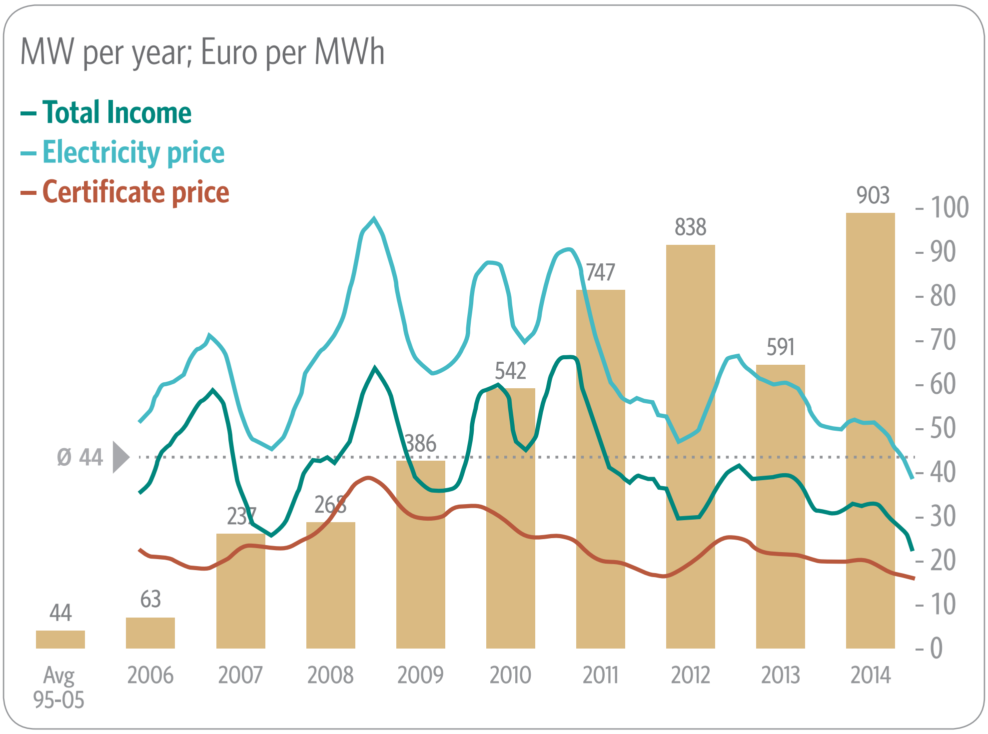
This dilemma is common to much of Europe. Over-capacity at national or regional levels is a feature also of the German and Spanish markets (the United Kingdom being a significant exception). In order for continued investment in renewable energy to be viable through market signals, one or two mechanisms would have to be in place. Either pre-existing capacity would need to be closed, whether by mandate (eg, through air pollution regulations as in the UK, or the nuclear phase-out in Germany), or become uneconomical relative to prevailing wholesale prices (eg, via very high CO_2 prices or other environmental prices). Alternatively, the investment in new renewable capacity needs to be supported by mechanisms other than the wholesale electricity market (eg, via quota obligations). In practice, the latter has been the choice of most EU countries. Clarity about this objective in turn has important implications for the choice of policy instrument.

Sweden's challenge: low price levels have halted new investment

Falling wholesale power prices have interacted with Tradeable Green Certificate (TGC) prices to dramatically change the investment case for new wind power. Contrary to expectation of an inverse correlation, TGC prices have fallen even as electricity prices declined. As a result, the total remuneration available to wind power in Sweden has fallen substantially. As the investment boom began (2009-11), total compensation averaged €75/MWh, but it then fell by 25% to €55/MWh (2012-14). In 2015 it has fallen to levels as low as €40/MWh. Forward markets indicate no substantial change is expected in their underlying value. The absence of any form of floor price in the certificate system design has precluded a safeguard to this type of dynamic.

In March 2015, the Swedish government appointed a parliamentary commission charged with developing a basis for a broad political agreement on the direction of the energy policy with a focus on 2025 and in early in 2016 it approved a revision of the quota levels. In June 2016, the government further announced its intention to scrap the capacity tax on nuclear installations and to allow operators to replace ageing reactors with new ones. This is effectively providing a lifetime extension to the existing nuclear fleet.

Figure B4.6 Annual capacity additions and remuneration from electricity and certificate prices



Source: Nord Pool and the Swedish Energy Agency

Low prices driving down the cost of wind while new investment dries up

The dynamic of lower prices has had dramatic consequences for investors. First, it has led to widespread losses on existing investments. An almost unique feature of the Swedish system for renewables support is that, like power market prices, the level of future support is uncertain and subject to no guarantees (ie, investors are fully exposed to market risks).

As long as additional capacity needs to be built, the price of certificates should in principle rise to the level sufficient to attract further investment in installations. For a long time this led to concerns that it would result in unnecessarily high revenues for early installations; the assumption was that the cost of attracting additional investment would rise as the early, low-hanging fruit was exhausted and ever costlier new projects would be required, namely in worse wind conditions. In practice, just the opposite has occurred. Improved technology, a maturing supply chain, and cheaper finance have dramatically reduced the cost of new wind power in Sweden. Instead of large profits to early installations, the result has been losses to early investors.

Our interviews indicated that a large number of existing projects, undertaken at a time of higher electricity and certificate prices, are no longer breaking even. So far bankruptcies have been few, but breaking of financing covenants is already widespread. During the initial phase of wind deployment debt played a significant role and there was a non-trivial share of project finance among projects undertaken by wind developers. Although leverage levels have always been relatively low in the Swedish market, several interviewees speculated that, in the absence of regulatory reform, the industry will see a significant number of bankruptcies followed by consolidation as the assets of failing companies are put up for sale.

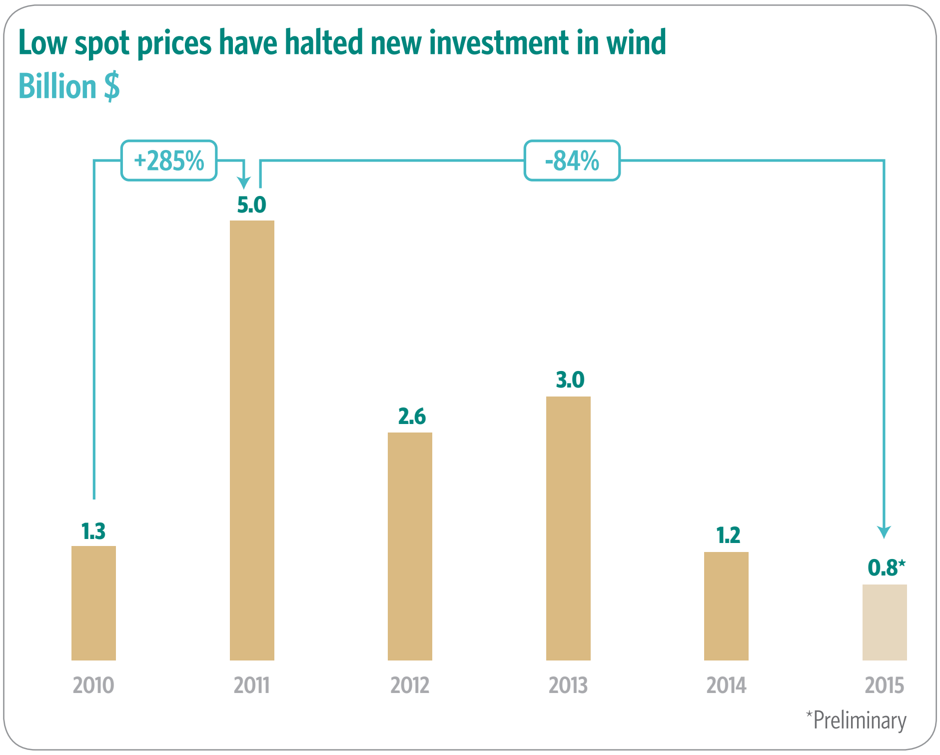
The second consequence of the falling prices is that new investment has ground to a halt. The first quarter of 2015 saw a sudden stop in the number of new projects announced, and none at all during the second quarter.

There has been no reversal to this trend so far in 2016. Interviews with investors confirm that returns are now inadequate for new projects. With the current market outlook, total returns on investment available on wind farms are in the region of 5%, with significant downside risk. Some projects that were already far gone in the development cycle, or which had exceptionally favourable parameters with respect to wind conditions, financing, permitting, grid, and other factors continued to go ahead early in the year. Most market participants expected even this trickle to dry up in the absence of significant changes. Some spoke of the prospect of a 3-5 year hiatus in investment as a possibility, at which point the withdrawal of some nuclear capacity (scheduled for 2018-19) might start to exert upward pressure on prices. Although the latest agreement on nuclear energy taxation will limit this effect. The dominant business model of wind developers will not support such a gap. A likely result of such a scenario therefore would be the failure of much of the industry that has been built up to date.

Price formation in the green certificate market – a key to unlock investment for a continued transition

The fall in electricity prices in Sweden has puzzled policymakers and market participants alike. Both had expected that certificate prices would "self-adjust": if

Figure B4.7 Investment in utility-scale wind projects in the Nordics



Source: Data from Bloomberg New Energy Finance electricity prices fell, certificate prices would rise to keep the total compensation available at a level that would attract additional investment. In practice, no such inverse correlation has been observed.

Various observers have suggested that a large accumulated reserve of certificates is the main reason for depressed certificate prices. The certificate system allows for "banking", that is the ability to set aside certificates for compliance with quota obligations in future years. By mid-2015, the reserve of banked certificates had grown to a cumulative 13 million, up from a 4 million to 8 million buffer in the past. There are multiple reasons for this. One is that rapid early build-out brought online a large number of "legacy" certificates into the market. Another is that electricity consumption among parties with a quota obligation has been significantly lower than expected (forecasting error). As the quota is set as a proportion of consumption, the absolute quota has declined.

A fix to this problem would be to raise the quota so that additional capacity is definitely required to meet obligations, but this could turn out to be a temporary fix. A review was concluded by the Swedish Energy Agency in 2015 recommending that quotas be raised and the Swedish government has approved that in the 2016 budget review. The motivation was that the system otherwise would not reach the objective of increasing the production of renewable electricity by 13.2TWh in the period 2012-2020. The proposed revisions entail a drastic revision of the near-term demand side of the market, raising near-term quotas by as much as 60%. These adjustments enable a decrease of the certificate excess which should restore price levels and as such have a positive effect on investments – both existing and new. Cumulatively, however, the change is less drastic and it is unclear whether it will have enough impact to reignite investment flows to the levels of the past years.

Several market participants do in fact expect such a reform to pull up prices. However, it postpones rather than solves the underlying issue. Price formation may become unstable once again when the system reaches the point where total existing capacity can supply the entire future expected quota. Anticipating this, market participants may not bring investment forward.

The Swedish system has been subject to revision, but overall has been considered remarkably free of regulatory risk. The same system has been in place since 2003, with few major changes, the main exception is the pooling of the system with Norway, in 2012. This is in sharp contrast to the significant changes that have been made to corresponding frameworks in many other countries. However, the above pressures mean that discretionary regulatory change may become a major driver of investment conditions in Sweden.

Swedish-Norwegian proposed revision of quotas

The Swedish government recently approved an increase to the quotas for electricity certificates with the aim of increasing renewable electricity production under the Swedish-Norwegian electricity certificate market from 26.4TWh to 28.4TWh by 2020. It is proposed that this production increase of 2TWh is to be financed by consumers on the Swedish market. The government has also decided to drop the tax exemption for production of renewable energy for personal use by 2016.

The proposals come after bilateral discussions in connection with the first revision period for the agreement between Sweden and Norway on a common market for electricity certificates. Under the agreement, Sweden and Norway have operated a joint electricity certificate market since 2012 with the objective of increasing renewable electricity production. In March 2016, the Norwegian Oil and Energy Ministry announced that it is planning to opt out of the common market for electricity certificates by 2021.

To meet the increased target, the Swedish government has set a linear increase of the quotas during the three-year period between 2018 and 2020. The aim is to produce increased demand for renewable energy, as well as to increase the price of electricity certificates. According to the proposal, the model requires a production increase of 0.67TWh per year, meaning that the target increase of 2TWh will be reached after three years (ie, 2020).

5. Conclusions and issues for further thought

Investor sentiment in the Swedish renewable market is showing signs of weakening. Looking ahead, the focus needs to be on maintaining the momentum seen in recent years, by incentivising and attracting future investments. Policymakers need to ensure that enough attractiveness is created to stimulate the flow of investment required to continue to fund the energy transition. Investors have to deal with an increased level of uncertainty as the 2020 targets are approaching, and post 2020 plans remain less certain.

Finding the right policy mechanisms to achieve investment in new power is no longer primarily a question of climate policy, nor of meeting renewable energy targets. It is instead a matter of finding the long-term mechanism to support investment in new capacity, whether to meet possible future increases in demand or export demand, or to replace other capacity that is retired. Furthermore, this needs to be done in a context of flat or limited demand growth and an already relatively high penetration of renewable electricity generation.

For many of the investors mentioned, the conditions for pre-existing and future investments are changing:

- ***Low certificate and power prices*** have driven down profits below levels that were expected when investments were first made. While there have been few outright bankruptcies so far, many investors have broken covenants with capital providers, and some interviewees expected some bankruptcies in the absence of a major change in policy.
- ***Although the main support system has been stable for a long time, taxation has been an important auxiliary driver of investment, but is now being changed.*** This is likely to create losses for a significant amount of existing capacity, and also to sharply reduce investment among non-industrial consumers (municipalities, real estate companies, individuals and cooperatives, and other non-energy intensive companies). On the other hand, it puts wind on a more equal footing in these parties' choices for energy supply.
- ***The relatively large risks involved in investments means that debt has played a minor role,*** especially in the last 3 to 4 years. Prior to this, debt played a significant role and there was a non-trivial share of project finance among projects undertaken by wind developers. Even then, leverage levels were significantly lower than in other markets with less revenue uncertainty, with debt shares of 60-70%, as compared with as much as 90% in the German market. More recently, however, the role of debt has been very limited. New investments have depended instead on balance sheet financing and, increasingly, on equity investment by institutional investors. Looking ahead we see this trend continuing.
- ***More finance is being concentrated in equity finance by financial institutions,*** combined with municipal finance through municipally owned utilities. Balance sheet finance, whether by large utilities or large consumers, has been hedged out as returns have decreased. Debt finance has declined for the same reason, and additionally because risk levels have been too high to secure debt at acceptable rates. Meanwhile, the additional lines of finance (crowdfunding, bank loans, etc) used by small consumers are becoming less relevant as these investors see much lower returns as taxation rules are being changed. Policy aiming to make wind power investable in Sweden therefore needs to speak to these potential investor groups to be efficient.
- ***Wind development companies are rapidly becoming the main vehicle for new development.*** Depending on classification, 50%-60% of recent investments have been undertaken through these companies. However, their ownership is in turn diverse. Some are listed on stock exchanges and have a correspondingly broad ownership base. Others effectively function as special purpose vehicles for a diverse range of investors to access the underlying wind power investment opportunity, including pension funds, insurance companies, private equity, industrial companies, and individuals (through crowdfunding). Low returns are also creating a trend where wind development companies transition away from their own long-term ownership of wind power assets, to one where they increasingly provide the development finance for assets that are subsequently sold on, often to institutional investors. Nonetheless, these companies are vulnerable to the current decline in overall investment volumes. Their business model relies on a continuous stream

of new deals, and if investment volumes shrink enough some companies are unlikely to remain in their current form.

This project has not estimated the total available capital and associated cost of capital in different investor groups. However, a preliminary conclusion is that the current policies do not seem to take into account the variety of potential investors and the current investment models may not be robust to future development. In particular, it relies on tolerance for debt finance by municipalities, and high-risk yet low-return equity finance by financial institutions. Both of these have limitations, and are vulnerable to a change in economic conditions. A more in-depth assessment of available capital and investment models would be highly valuable to Swedish policymakers as they consider future policy options.

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