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Policy and investment in German renewable energy

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A CPI Report

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Descriptors

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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.

Executive summary

The relationship between finance and policy stands at the centre of Germany's twin objectives of reaching renewable energy deployment targets and doing so cost effectively. With the renewable energy industry maturing, and calls growing for improving the cost competitiveness of renewable energy policy, German policymakers and investors must continue to improve their understanding of how policy can influence the potential investment pool, and how policy can drive a robust and low-cost mix of investors and investment to underpin the continued development of a cost-effective low-carbon energy system. Climate Policy Initiative examined the availability of capital for renewable energy, the cost-effectiveness of different mixes of capital and investors used in meeting Germany's medium and long-term deployment goals, and the potential impact of policies on this mix of investment.

Our analysis indicates that, provided an appropriate policy framework is in place, there is more than sufficient capital available to meet German renewable energy targets, but that a mix of investors is needed to meet Germany's objectives at lowest cost. To meet deployment goals most cost-effectively in the medium term, Germany must meet the challenge of creating electricity system flexibility to facilitate integration of renewable energy without imposing unmanageable risks on renewable energy investors.

More generally, for investors we find that the most relevant near-to-medium-term policy decisions regard incentive auction design, end user participation, support design and long-term targets. However, for the medium-to-long-term development of investment, issues including curtailment policy and energy market design will become increasingly important and merit immediate attention.

Table 1: Overview of policy issues

POLICY ISSUE	RECOMMENDATIONS OR FINDINGS	QUANTITATIVE FINDINGS
INCENTIVE AUCTION DESIGN	• Frequent, predictable bid rounds reduce risks and costs • Small investors fear complex and costly bid processes • Exemptions for smaller projects or simplified bidding processes are needed to preserve Germany's diverse investor base	• A gap between auction rounds causing a 12-month delay in an offshore development can increase bid prices by 21% or more if delay expectations are reflected in bids
SUPPORT DESIGN	• Stable and reliable support schemes over longer periods allow higher leverage and reduce average energy costs • Indexing support to inflation could attract some institutional investors and reduce expected lifetime costs	• Shortening revenue support from 20 years to 15 years could increase energy costs 15-18% depending on the technology • Linking revenue support to inflation could decrease energy costs by 18-20% in real terms, depending on institutional investor appetite and how actual inflation evolves
END USER PARTICIPATION	• Auction design and exemptions, end user consumption options and support design should be tailored to continue encouraging investment from all investor groups	• Over 25% of 2015 equity investment and half of 2020 potential equity investment comes from end users
LONG TERM TARGETS	• Reliable long-term targets incentivise investments in project development and business processes that increase competitiveness and reduce costs in the long term	• Halving offshore wind targets would limit learning, potentially increasing the cost of energy by 6% by 2020 • Business process improvements drive cost reductions: From 2006-2014, non-module costs for PV systems fell 11.5% p.a. for large scale projects and 7.7% p.a. for rooftop solar.
ENERGY MARKET DESIGN	• Current energy market design does not reflect the reality of a renewable energy dominated system	• Current design could lead to zero or negative electricity prices for more than 1000 hours per year by 2030
CURTAILMENT	• Policymakers should consider alternatives to curtailment at times of negative prices including take-or-pay arrangements or proportional curtailment • Significant investment in system flexibility is required	• Current proposals for curtailment of production during negative price hours could increase onshore wind bid prices by 17% in 2020, if no other flexibility measures are taken
DEVELOPMENT COSTS	• Higher development costs could amplify any cost increases resulting from incentive auction design and a lack of long-term targets; policy should seek to reduce development costs (i.e. pre-auction costs or costs of bids that fail)	• Development costs for large projects like offshore wind can run to 50 million Euros or higher

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1. Overview of investment and policy issues

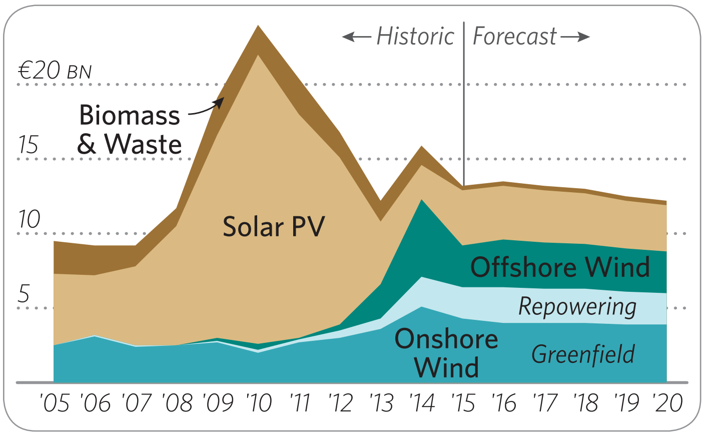
Between 2005 and 2015, investors poured over €150 billion into renewable energy in Germany (Figure 1). Energy companies and utilities, households, farmers, energy co-operatives, municipalities, banks, and institutional investors all provided capital to renewable energy projects, relying upon policy that provided reliable revenues, attractive returns and certainty. Since the cost of renewable energy was often higher than energy from more conventional energy sources, policy was needed to plug the gap between renewable energy costs and the prevailing market price for electricity.

Today, the cost of many forms of renewable energy has fallen to the point where the cost gap has virtually disappeared. Yet policy is still needed, not so much because there is a cost gap, but because the financial, operating and ownership characteristics of most renewable energy investments are different from historical, conventional electricity investments, and these different characteristics need to be integrated with the existing industry and market structures.

Policy and the cost and availability of investment are inextricably linked in balancing the German goals of meeting low carbon renewable energy deployment targets and keeping costs low. With the renewable energy industry maturing, and calls growing for improving the cost competitiveness of renewable energy policy, now is the time to evaluate the potential investment pool, and identify the investor and policy mix that can underpin the continued development of a cost effective low carbon energy system.

Climate Policy Initiative has developed the fact base upon which this evaluation can be based. In this evaluation we have addressed three main questions:

Figure 1: German investment in renewable energy 2005-2020



Source: BMWi

1. **What pools of capital are potentially available to invest in renewable energy in Germany and are these pools large enough to meet German policy objectives?**
2. **What mix of capital and investors is likely to be both low-cost and efficient and most likely to meet German renewable energy deployment targets?**
3. **How can policy enable both the right mix of investment and ensure that this mix of investment is achieved at a low cost for each individual investment source?**

In this first chapter, we summarise our assessment of capital availability and the impact of investor mix and policy.

One key difference between renewable energy and conventional power plants is the much wider range of investors that could potentially develop and invest in renewable energy projects. In Chapter 2, we identify these sets of investors and set out the motivations and constraints that drive investment in renewable energy, based on our interviews and analysis for each investor group. In Chapter 3, we offer a more detailed, quantitative analysis of the investment potential available for renewable energy in Germany for each of these investor groups.

With a more diverse set of objectives, resources and capabilities, renewable energy investors as a group will have more diverse and differentiated responses to policy than electricity industries have traditionally faced. Thus, an electricity system with a large component of renewable energy may need to think much more broadly about how policy will affect investment and the cost of energy supply. In Chapter 4, we highlight the short, medium and long-term policy concerns facing investors and assess their impact on the attractiveness and cost investment by different investor classes.

In Chapter 5, we conclude by approaching the policy analysis from four different perspectives to see how priorities could change if policy were focused on:

- Specific renewable energy technologies
- Developing a particular segment of investors
- Building renewable energy businesses as opposed to focussing on projects
- The long term of renewable energy investment versus shorter term cost effectiveness

CPI/ECF German Policy and Investors Study

Main input sources and activities:

1. Interviews with companies, financial institutions, investors and their advisors across the full spectrum of potential investors into German renewable energy;
2. Tests of opinions and responses to potential policy measures, including some of the most current relevant policy questions in play today;
3. Modelling of investment behaviour of all investor classes using financial models simulating real assets and investment decisions that these investors could face;
4. Convening of an advisory panel representing investors across the spectrum of size and industry to refine and validate the hypotheses and syntheses drawn from the interviews, analysis and modelling; and,
5. Synthesis of responses to policy and investment decisions to explore how these various pieces and investors fit together.

1.1 The availability of investment capital to meet German renewable energy targets

Provided that the right policy framework is in place, our analysis suggests that there is more than sufficient capital potentially available. Depending on the technology mix and trend in technology costs, our analysis suggests that there is potentially €25 - €35 billion of annual investment potential, 60-170% more than required to finance the German government's targeted deployment of around 7.4GW of new solar photovoltaic (PV), onshore wind and offshore wind capacity per annum in the years to 2020 (Table 2). Within technologies, there is more than double the required investment available for solar and offshore wind if attractive policy is in place for the right investors. For onshore wind there is slightly less spare investment capacity, although the greater maturity and competition in onshore wind – and the lower returns that have developed as a result - may be a contributing factor to the relatively smaller cushion available.

Table 2: Investment needs and potential

TECHNOLOGY	ANNUAL CAPACITY TARGET (MW)	INVESTMENT REQUIRED (€ BILLION)	INVESTMENT POTENTIAL (€ BILLION)	POTENTIAL/ REQUIREMENT
SOLAR PV	2.5	3.5 - 4.5	8.0 - 12.0	178%-343%
ONSHORE WIND	2.5 (net) 4.1 (gross)	6.0 - 7.0	8.0 - 12.0	114%-200%
OFFSHORE WIND	0.8	3.0 - 4.0	9.0 - 10.0	225%-333%
TOTAL		13.0 - 15.5	25.0 - 35.0	161%-269%

Source: CPI Analysis ; See Chapter 3 for more detail

Investment capital is not homogeneous. To achieve effective, low cost finance, projects or companies need at least three types of finance:

- **Short-term finance** covers the early stage, higher risk, and often higher return, segments of a project lifecycle including project development, construction and project commissioning. This capital is provided by project developers, utility companies, and banks.
- **Long-term debt** can bring in lower cost capital, generally supplied by banks or other financial institutions through project finance, or through loans or bonds to utilities, developers, companies, households or other long term equity investors.
- **Long-term-equity** is provided by the long term owners of the projects that may include utilities, developers, financial institutions, landowners, or energy consumers among others.

As in Figure 2, our analysis shows that in Germany there is sufficient capital available across all types of capital for each of the three major renewable energy technologies. The potential for long-term equity investment in solar PV is particularly large, owing to the diverse set of investors – ranging from households, commercial and industrial companies, cooperatives and financial

Figure 2: German renewable energy investment potential versus targets

	SOLAR PV	ONSHORE WIND	OFFSHORE WIND
SHORT TERM CAPITAL	156%		179%
LONG TERM DEBT	136%		291%
LONG TERM EQUITY	390%	235%	157%

Source: CPI Analysis; See Chapter 3 for more detail

investors - that are willing and able to invest in the sector.

The potential for long-term debt in offshore wind is also high, as the large project size and the professional and well capitalised position of the equity investors makes offshore wind attractive to institutional investors and banks. Since solar PV and some onshore wind projects in Germany are smaller in scale, lending directly to these projects is less attractive for lenders, as the cost of project evaluation is larger compared to the investment opportunity. Thus, lenders more often lend to the equity investor based on their credit risk, rather than to the project itself.

As we will see later, financial structuring and decision making processes have an important impact on the relationship between policy and investment. Thus, understanding where this potential lies and why these investors might invest in renewable energy may be more consequential for policymaking. There is a diverse range of motivations among different investor groups. For some it may be part of the core service of delivering energy to their customers. Others may regard renewable energy projects as a purely financial investment; some as a means to meet their own energy needs; while others are driven by a more moral imperative to contribute to the prevention of climate change, even if the financial returns on offer remain low.

1.2 Comparing the cost of renewable energy owned by different investors

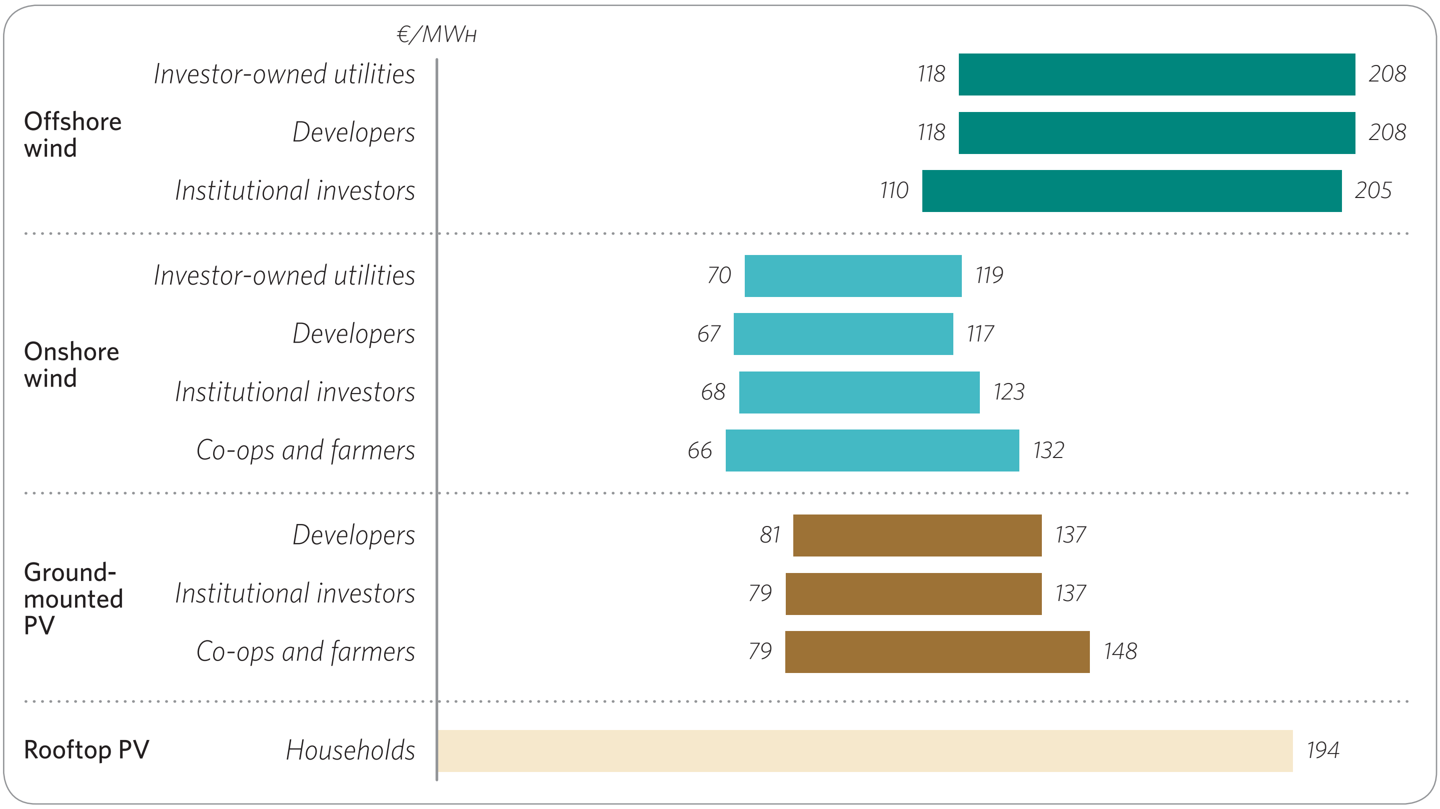
The average cost of electricity produced from a power plant over its life time – often referred to as the levelised cost of electricity - is a function of many factors including the initial capital cost, the return on that capital required by investors, expected output, fuel costs, operating costs and the lifetime of the power plant. For many new conventional powerplants this calculation is difficult because the cost of fuel and future maintenance costs can be very uncertain.

Renewable energy has no fuel costs and maintenance costs are generally much lower compared to fossil fuel power plants. However, renewable energy has wide range of potential investors which leads to large differences in the required return on capital. Since projects are site specific, initial capital costs and expected output are also very different. Furthermore, investors may make very different assumptions about costs, for instance, how much a household charges for the use of its roof, if anything.

Based on interviews with potential renewable energy investors across the investment and technology spectra, we analysed the range of lifetime prices for energy that would meet investor hurdles given their investment criteria (including the cost and availability of debt finance). For those able and willing to enter an auction process, the prices would represent the minimum price that these investors would be willing to submit or accept. Figure 3 shows the large range of potential bid prices within a technology, but also for specific investor types, often as a function of the quality of the site in question. Other investors, like some households, have completely different reasons for investing: some want hedges against future energy price rises, some want the pride of owning their own generation, while others wish to make their energy consumption more green. Many do not even think about the concept of return on investment in their decision making.

The diverse set of potential investors makes planning and optimum policy, very different for renewable energy than for conventional generation. Not only must policy ensure that the right mix of technologies get built to minimise future energy costs, but also that the right mix of investors emerge, to ensure that the low cost investor mix gets access to the market. Arguably, the optimum mix should aim to include the low cost portion of each technology.

Figure 3: Levelized cost of electricity (potential auction prices) by investor type and technology



Source: CPI Analysis

Further, these ranges will change as a function of technology development, investment in business processes, policy, experience and fashion. Fostering a range of investment now could ensure that low cost investment continues to be available in the future. Of course, this argument could apply equally to developing offshore wind as it would to ensuring that rooftop solar for households has a continued place in the policy scheme.

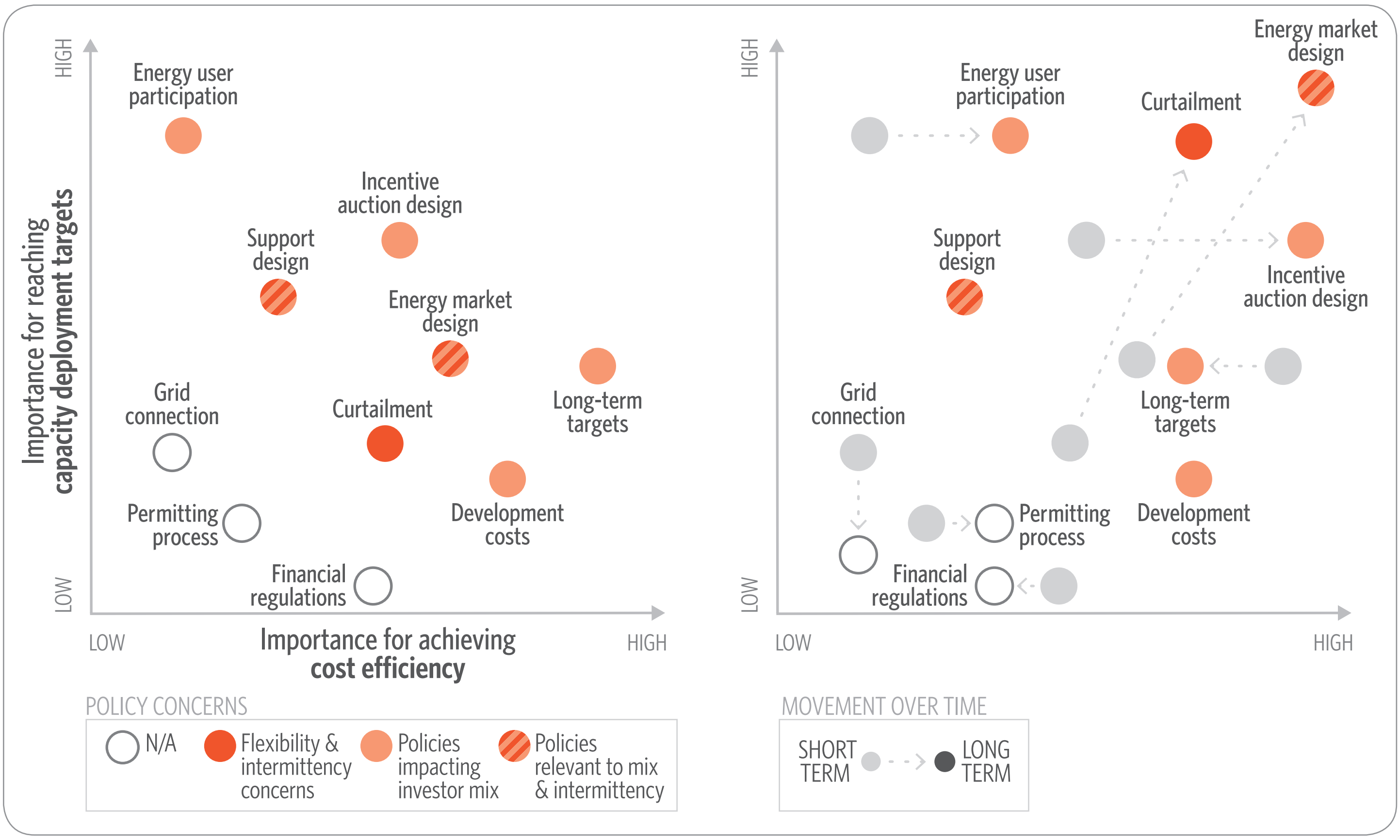
1.3 Policy elements influencing the mix and cost of investors in renewable energy

The interview process raised ten key policy areas that are of most concern to the various investor groups. While Germany has many objectives for renewable energy policy and development, we have identified the two most relevant to investor mix, investment and policy as being:

- Reaching renewable energy targets, which for investors translates into willingness to invest, and,
- The cost effectiveness of reaching those targets, which translates to the cost of investment for investors.

In Figure 4, we set each of the ten highlighted policy issues against these two objectives, showing how, given the level and nature of concern amongst the various investor groups, each of these issues could affect either the ability to meet deployment targets, or the cost of providing more renewable energy. The left-hand figure shows the more immediate concern of investors, while the right-hand chart shows how we think that concern could develop over time, given forecasts for market change and investor preferences. For example, with **energy use options,** small investors expressed concern that they were not directly able to use energy from their own rooftop PV or small scale wind turbines. As a result, they were less inclined to invest since there was a weaker link between investment and their desire to be green and self-sufficient and investment provided only a very weak hedge against rising future energy prices. In the near term, this issue has a strong impact on willingness to invest amongst "prosumers", that is, investors who would both produce and consume their electricity generation, but since there is much more than enough investment to meet targets, it has little impact on overall cost efficiency. In the future, if these excluded investors are lower cost than other renewable energy supply sources, it could have an impact on cost effectiveness as well (see right-hand figure). Each of these issues are laid out in more detail in Chapter 4

Figure 4: Key policy impacts on investment



Source: CPI analysis based on interviews

of this paper, including qualitative and quantitative analysis based on an investor type by investor type evaluation of the impact of different policies.

At a more aggregate level, the various policy issues identified reflect two general concerns facing investors:

1. How will the market design and its regulation deal with the changes needed to integrate renewable energy? More specifically, how will markets and prices adapt to the intermittency of renewable energy and the flexibility required to integrate intermittent energy into the system?
    a. Policy concerns include: the design of the energy market, renewable energy support and curtailment rules. All of these could determine how the cost of supplying more flexibility to the market will be included in energy prices, how renewable energy would be paid, and how the cost of flexibility could affect the revenues to renewable energy investments.
2. Will renewable energy policy favour one set of investors over another, potentially in the interest of cost efficiency or manageability of the industry?
    a. Policy concerns include: Energy use options (as discussed above), incentive auction design or development requirements that could be complex or costly and thus exclude small, unsophisticated players; or unreliable long-term targets that could make it difficult for large players to invest in their business and thus weaken their competitive position.

As in the right hand side of Figure 4, most of the concerns regarding either mix or flexibility are likely to grow stronger over time. The controversies around economic **curtailment** and **incentive auction design** represent the costs and trade-offs that need to be considered in the flexibility and investor mix policy arenas, respectively.

1.4 Intermittency of renewable energy and economic curtailment

Unless consumers are seamlessly able to adapt their energy usage to follow energy supply or new technologies emerge such as inexpensive energy storage, large quantities of intermittent renewable energy generation will lead to an energy system that in some hours has too much energy supply, while in others expensive plant may be needed to meet demand.

A key question for all involved in the energy system is who will pay to shift supply or demand so that they are balanced across every minute of every day. A corollary should be: what incentives are needed to create new, low cost, flexibility options on both the supply side and the demand side to reduce the future costs of balancing the market and thereby enable more investment, deployment and integration of renewable energy generation?

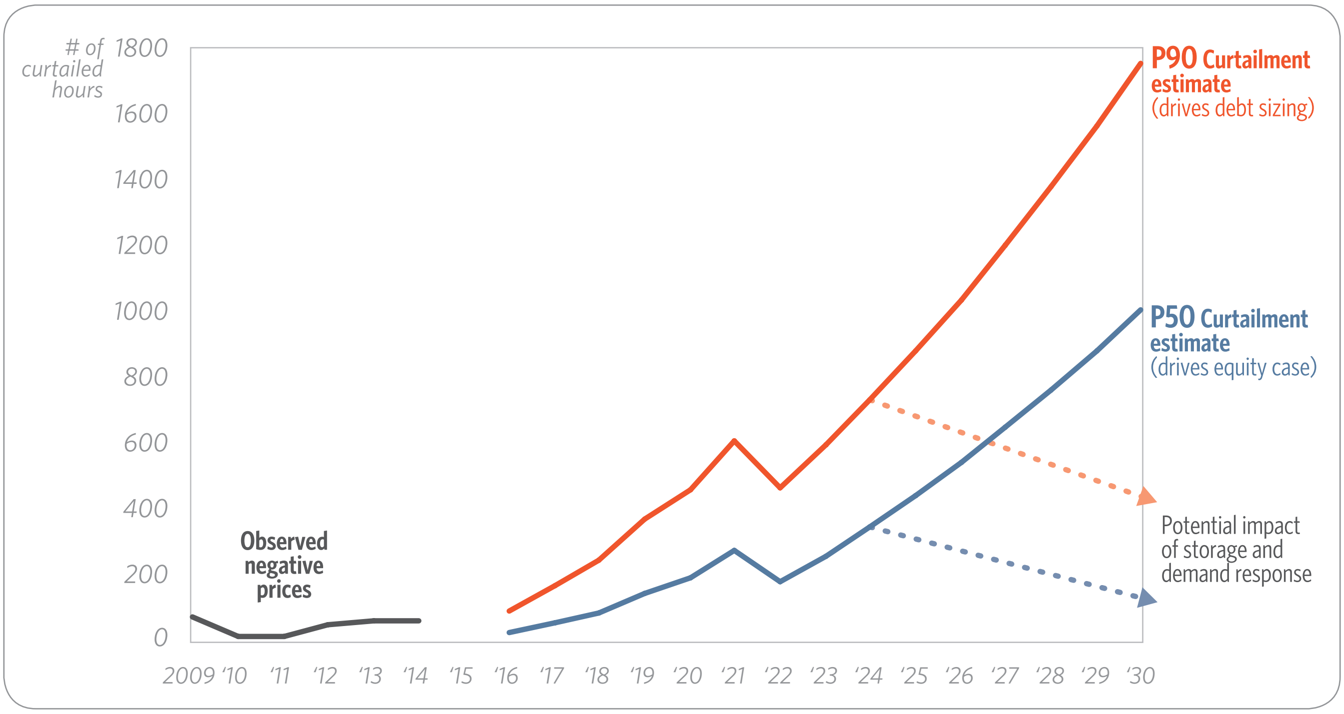
Current electricity market designs lead to negative electricity prices when there is an excess of supply on the system, effectively charging electricity generators for the cost of removing excess supply (and encouraging consumers to shift their demand to hours with excess prices). Over the last five years, prices on the German electricity system have turned negative on average less than a hundred hours a year.

With less than a hundred hours a year of negative prices, our interviews (Figure 5), unsurprisingly showed that most investors are relatively unconcerned. However, those that expressed concern often regarded negative prices as the single biggest issue facing renewable energy investment. To understand the importance of flexibility, we modelled the number of hours of negative prices – that is excess supply – Germany would face if flexibility remained at today's levels. Debt investors look at protecting their loans from default, and so look at downside probabilities as reflected in the P90 estimates above, while equity investors are more likely to look at average probabilities (P50). In either case, our analysis shows that in the absence of improved flexibility, negative prices will rise strongly in the coming years.

Renewable generation in Germany is usually paid a fixed price tariff for each unit produced and so is relatively unaffected by price fluctuations. With a guaranteed price, both debt and equity investors see renewable energy as low risk, lending more to the project and requiring lower returns, leading to a lower levelised cost of electricity (LCOE). Since renewable energy providers have close to zero variable costs and cannot control when the wind blows or sun shines, even if renewable energy generators were subject to fluctuating, but positive, energy prices they would not be able to respond, so the lower risk and cost from fixed prices leaves everyone better off.

However, as the price goes negative, the theory is that renewable energy producers could curtail their output, providing the flexibility by shutting off production to help balance the system. Unfortunately, our analysis shows that the cost of curtailing renewable energy is very high due to the revenue risk and uncertainty that it imposes on investors and the higher returns (and lower levels of debt) that would be required to compensate investors for that risk.

Figure 5: Estimated hours of negative prices in Germany – 50th and 90th percentile cases



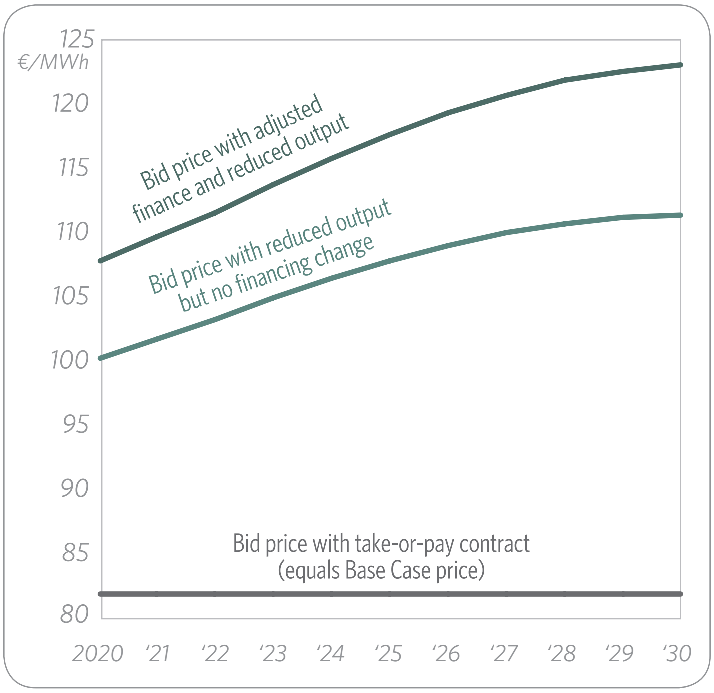
Source: CPI Analysis; historic load data compiled by Paul Frederick Bach

Figure 6 shows how investors would respond to the threat of reduced output and greater uncertainty in output if forecast curtailment levels reached those set out in Figure 5. By 2020, seeing curtailment levels approaching 500 hours by 2025 and then rising, investors would need prices over 30% higher to achieve their financial objectives than if they were paid for all of their output at the fixed price. About one third of this increase is because debt investors will lend less to the project because of the increased risk, while two thirds comes from the reduced output. In other jurisdictions, some investors have told us that an uncapped economic curtailment risk would make the market uninvestible.

The question, then, is whether there are less expensive ways of achieving this flexibility, and also whether the policy of economic curtailment of fixed price renewable energy tariffs makes sense. On the first point, clearly more research is needed and policy makers should redouble efforts to increase the number and quality of flexibility options available to the energy system. On the second point, we evaluated several different policy measures that have been proposed to address the economic curtailment issue (Table 3).

- **Take-or-pay:** One option would be to curtail production from renewable energy, providing flexibility for the grid, but continue to pay generators for the lost output. This option provides the lowest cost and risk while still offering the flexibility, but under current interpretations could run afoul of EU state aid regulations, by incentivising production when it was not needed.
- **Curtailment after six hours:** A modification that the EU deems consistent with state aid regulations restricts payment of a fixed tariff only during periods with 6 consecutive hours of negative electricity prices. This option decreases the cost of curtailment from over 30% to under 20%. In particular, this option significantly reduces the risk of particularly high levels of negative price hours and therefore increases the amount that debt investors would lend.
- **Proportional curtailment:** Negative prices generally occur when wind or solar generation is high. Our analysis shows that on average a reduction of only 15% of wind output during negative price hours would move prices into positive territory. Thus, a system that could curtail only the excess generation and allocate the cost of this curtailment amongst all fixed tariff generators would better reflect system economics. It also reduces the cost of curtailment to only 5%.

Figure 6: Impact of curtailment on energy prices or bid prices



Source: CPI analysis

- **Add to the end:** under this option any hours that are curtailed during the 20-year support period – after incorporating the 6 hour rule - can be accrued and power generation beyond this support period can claim additional support until such time as the accrued hours are used up. However, high discounting of cash flows 20 years from now, as well as the fact that such a policy does not extend the operating life of the generation assets (and therefore would add no value if future energy prices are at or higher than the fixed tariff prices), means that this policy would add almost no value to investors.
- **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. The impact varies as a function of the cap level.

From a renewable energy investor's perspective, the take-or-pay option, supported by intensive efforts to increase system flexibility is a clear low cost winner. As a next best option, caps on hours of curtailment and proportional curtailment limit the risk to investors

Table 3: Different policy options for addressing negative prices for renewable energy

	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	31.8%	7,864	-12.5%
CURTAILMENT AFTER 6 HOURS	95.9	17.4%	8,233	-8.4%
PROPORTIONAL CURTAILMENT	85.9	5.1%	8,793	-2.1%
ADD TO THE END	95.5	16.9%	8,233	-8.4%

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

and the increase in cost. Beyond these near term policy fixes, policy makers need to consider carefully how the current market design leads to negative prices and how adjustments to the energy market itself could increase the incentives provided to consumers and technology developers to invest in increasing their contribution to system flexibility.

1.5 Incentive auction design and investor mix

As renewable energy has matured, calls have grown to expose the industry to more competition to create pressure to reduce costs and to ensure that prices reflect costs. Utilities and large scale developers work assiduously to develop cost-effective projects, and to reduce the risk of those projects. Their experience engenders cost-reducing system improvements and their size allows them to access large pools of capital. Thus it is logical to think that in a more competitive world they should be the natural winners.

However, they may not have access to some of the best resources or sites, such as the south facing rooftops of warehouses, and the very cost of their professionalism and project management systems could make them more expensive than competitors. In fact, investor-owned utilities (IOUs) in Germany focus less on onshore wind and more on offshore wind because only the scale and complexity of latter offers a competitive advantage to the capabilities that the IOUs have at hand. Furthermore, the shareholding structure of the utilities demands that they seek returns commensurate with other opportunities they may have, including projects in other countries. Thus their financing costs may be higher than competitors with different objectives or fewer opportunities.

As discussed in Chapter 1.2 above, the objective should be to select the lowest cost mix of investor/developers from across the spectrum. Incentive auctions, where renewable energy project developers are awarded fixed price energy supply contracts if they submit bids with winning (low) incentives or prices, is one tool that Germany is rolling out to create a competitive market and select investors. The competitive pressure of such auctions should encourage developers to find the best projects, develop and finish them as inexpensively as possible, while identifying the lowest cost financing. Furthermore, regular and predictable auction rounds will encourage developers to invest in business processes that will continuously reduce costs, in order to maintain or improve their competitiveness, with the result that costs for the industry should decline over time.

The downside is that incentive auctions impose costs, complexity and uncertainty that, at best, will be included in bid prices, increasing energy costs. At worst, cost and complexity could discourage whole sets of investors, limiting the pool of competitive investors. More significantly, higher costs and uncertainty fall much more heavily on smaller, less sophisticated investors and developers of first- or one-of-a-kind projects.

Figure 7 shows how investors respond to the key threats of incentive auctions: high transaction costs, complexity and the threat of gaming; a competitive environment; uncertain outcomes; and the impact of possible set asides for different technologies. Larger investors like utilities and large scale developers are very comfortable with auctions, believing that they will impose a discipline on the market that will keep the industry attractive for the long term. Their largest fear, that auctions could cause them to sink millions of Euros into development only for the project to fail at the auction, could be alleviated by frequent and predictable auctions and policies that keep pre-auction development and bidding costs relatively low.

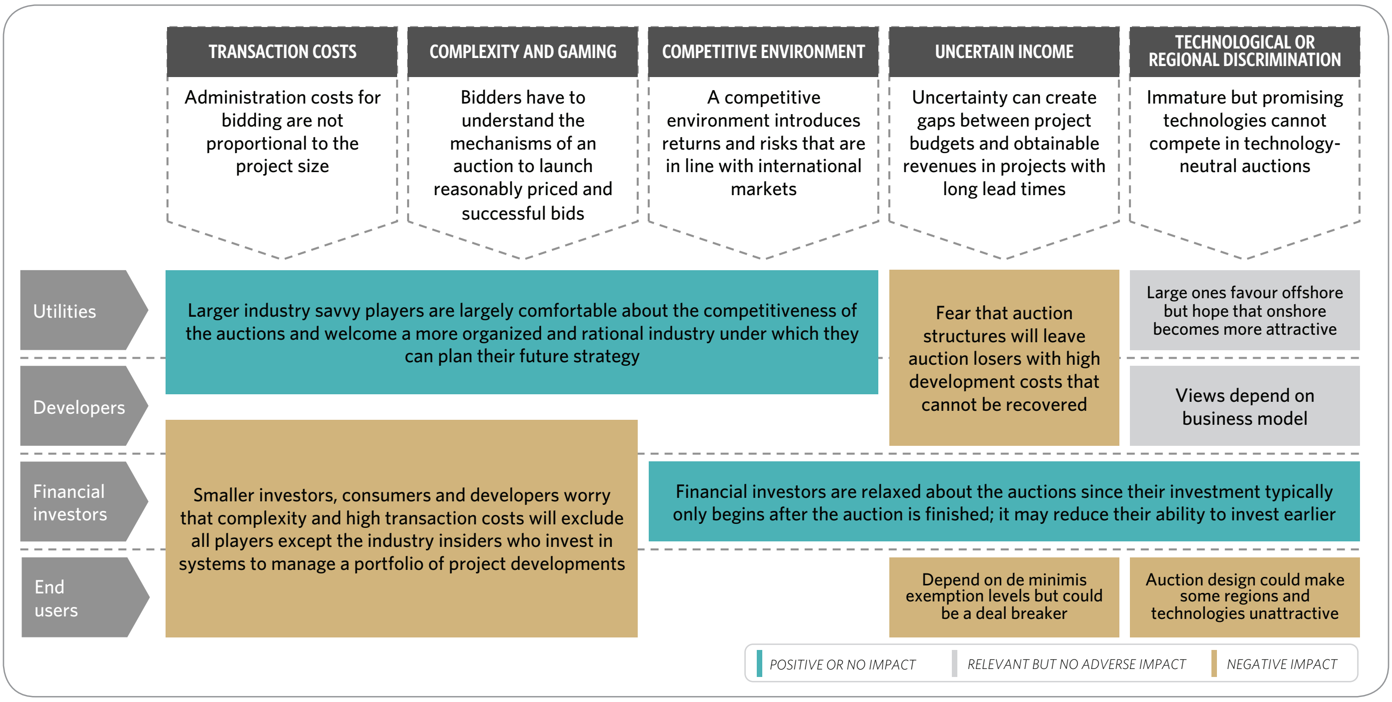
Smaller investors, including end users, are threatened by the complexity and costs of entering an auction. With no learning from participating in multiple auctions, their bid costs and risk of losing would be high, while smaller projects will have proportionally higher bid costs than larger projects that can amortise fixed costs over a larger investment (and multiple projects). Many smaller developers would choose not to bid.

The reduced competition could eventually lead to higher prices. In Germany, this effect may take some time to develop as developers and utilities told us that they have many projects in development that they can submit to early rounds. Competition amongst these projects will keep bids low. However, if development costs get too high, or the results too uncertain, decisions to stop developing new projects as a result will affect future rounds.

The absence of smaller investors could require more projects from the larger players, enabling more expensive and marginal projects to win bids. In the long-term, shutting down the small investor market could exclude many projects from development and could hamper the development of a whole range of sites, technologies and business processes that with more favourable policy could have become the most cost effective options.

Germany and the European Commission have set out de minimis exemptions, where projects below a certain size do not need to participate in auctions. Although these exemptions provide a route for the smallest of projects, auctions, along with limited end use options are providing pressure on a segment of investment that provided over a quarter of German renewable energy equity investment in 2015 and offers as much as half of the potential equity investment in 2020.

Figure 7: Issues around incentive auction design



Source: Interviews

2. Understanding the existing German investor base

The investor base in German renewable energy is heterogeneous, with material contributions from four principal groups: utilities, developers, financial investors and end users.

There are significant differences in the motivation and processes for making investment decisions, both between and within groups. Their investment potential will thus be affected by individual policies in different ways.

Unlike in other Western European markets, in Germany, investor-owned utilities (IOUs) have provided a relatively small part of the long-term equity invested to-date while consumers have played a very significant role, in particular, in relation to solar PV. IOUs typically have higher required returns than municipal utilities and many institutional investors, making them uncompetitive owners of/investors in many renewable assets.

Compared to other European markets, Germany's energy transition has been financed by a range of investors with a particularly diverse range of motives. For some, it is part of their core service of delivering energy to their customers, while for others renewable energy projects represent a purely financial investment. Some investors see renewable energy as a means to meet their own energy needs, while others are driven by a moral imperative to contribute to the prevention of climate change. An understanding of these motives is an important base for the analysis of policy options currently under discussion and the potential impact of those options on the future investor mix. We explore the implications of this analysis in greater detail in Chapter 4.

Segmenting investors by their business model or activity can help identify their motives, their relative size, their level of investment in the sector to-date, and their potential contribution in the future. We focus on four principal groups described in Table 4 as "Level 1" categories –utilities, developers, financial investors, and end users. However, our interviews revealed that there are important differences of approach within each Level 1 category, meaning that a number of sub-groups ("Level 2" or "Level 3" in Table 4) warrant more detailed investigation.

Table 4: CPI segmentation of the German investor base

LEVEL 1	LEVEL 2	LEVEL 3
Utilities	Incumbent Investor-Owned Utilities	
	Municipal Utilities	
Developers	International Developers	
	Domestic Developers	Large-scale domestic
		Small-scale domestic
Financial Investors	Banks	Investment Banks
		Commercial Banks and Landesbanks
	Non-Banks	Institutional Investors
		Asset Managers
		Other Financial Investors
End Users	Large End Users	Industrial Companies
		Large Commercial Enterprises
		Large Co-Operatives
	Small End Users	Households
		Farmers
		Small co-operatives

2.1 Utilities

Traditionally, energy utilities were stable businesses focussed on the reliable supply to end users of electricity and gas, with most procuring those commodities from a mixture of their own and independently-owned power generation and gas supply assets. Historically, investors in the incumbent IOUs (including three of the German "Big 4"- EON, RWE, and EnBW) saw value in such "vertical integration" – the ownership of assets to support downstream supply obligations – as a means to protect earnings against the impact of volatility in commodity prices. These companies are experienced in managing complex projects and **prefer those with large scale, such as offshore wind**.

IOUs have become increasingly selective about new capital investments. IOUs have access to an international range of investment opportunities and will only invest in projects where the expected return is higher than the "hurdle" rate. A "hurdle" rate is a threshold financial return (usually

Table 5: Utility summary

	INCUMBENT INVESTOR-OWNED UTILITIES (IOUS)	MUNICIPAL UTILITIES (MUNIS)
Example	EON, RWE, EnBW	MVV, Stadtwerke Munchen, Stadtwerke Hamburg
Access to capital	Unsecured and hybrid debt from a range of domestic and international bank and bond investors; public equity	Debt mostly provided by domestic banks and private placement (Schuldschein); few have access to public equity
Strategic Objectives	1. Strategic commitment to German market 2. Increase the share of earnings from renewable energy and other stable businesses to offset decline in conventional power generation earnings 3. Select the projects promising the best returns (IRR) from a wide range of opportunities across a number of geographies. Focus on countries with relatively low regulatory risk 4. Prefer larger projects where industrial scale and skills across the value chain can improve returns 5. Can be involved at all stages of a project lifecycle	1. Strategic commitment to local market 2. Many have an explicit environmental remit to deliver on local renewable targets 3. Larger entities have decision-making processes similar to IOUs with a focus on financial returns. Others may prioritise investment in their local area, even if available returns are low 4. Can pursue small, medium and large projects depending on the Muni 5. Prefer to invest during the operational phase, though some larger Munis are willing to provide construction finance
Preferred technologies	Very little investment in German solar PV and onshore wind. Favourite technology is offshore wind given that the scale and complexity means they are more competitive and potential returns are higher	Focus on local area means solar PV and onshore wind are preferred for most - in particular onshore wind given low financing costs. Offshore wind increasingly attractive for the largest Munis

expressed as an internal rate of return or IRR), which is higher than a company's weighted average cost of capital (WACC), reflecting the fact that utilities do not have sufficient capital to invest in all projects with a positive net present value and so evaluate them against a more stretching standard. The Big 4 utilities recently disclosed WACCs in a range between 7-9% pre-tax (or 5-7% after tax) (EON 2015, EnBW 2015, RWE 2015), implying that the hurdle rate for most projects would be in the high single digits or low double digits (NERA 2013).

The scarcity of capital for investment coupled with a wide range of international opportunities means that the hurdle rate and therefore the cost of IOU investment are likely to be relatively high.

Municipal utilities represent a cheaper source of capital as they typically have fewer avenues to access that capital and may have non-financial priorities that encourage investment in German renewable energy. The largest municipal utilities, such as Stadtwerke München, Mainova and MVV, operate in a similar fashion to the international utilities, making investment decisions based primarily on financial return, while the smaller ones may be more willing to accept lower returns if other local objectives, such as creating local jobs or reducing local energy costs can be met through an investment. All have a smaller range of investment opportunities than the large utilities, given their narrower geographical and technical focus, while business process costs may be lower as the businesses seek to target only parts of the energy value chain. Some can benefit from the low borrowing costs of their municipality owners, although the position varies by the credit standing of each municipality.

2.2 Developers

Developers generally focus on making returns from the service of putting a deal together and building and commissioning projects. Often, these developers cover a substantial share of the project development cost in order to get the project completed but will seek to recycle cash by bringing in other investors as a project moves towards and achieves commercial operation. We segment this group into three categories: (1) international developers; (2) large-scale domestic developers; and (3) small-scale domestic developers.

The current domestic developer base is critical to the provision of short-term finance to projects in Germany. While the smallest-scale developers may not have the capability to invest overseas and hence are dependent on the German market, international developers (such as Dong, Iberdrola) – often those whose core business is as a utility in other markets – do not have a strategic commitment to the German market and so will only invest if the expected returns are relatively attractive compared to other opportunities.

Developer capital, focussed on the riskiest phase of projects, will typically be more expensive than

Table 6: Developer summary

	INTERNATIONAL	LARGE-SCALE DOMESTIC	SMALL-SCALE DOMESTIC
Example	Dong, Vattenfall, Iberdrola	PNE, wpd, Energiekontor, juwi	Mainly small engineering firms
Access to capital	Unsecured and hybrid debt from a range of domestic and international bank and bond investors; public or government equity	Debt finance from domestic commercial banks; largest have some access to public equity, some private equity	Limited access to debt or equity capital
Strategic Objectives	1. Less strategic commitment to Germany than the incumbent utilities but more commitment to target markets than financial investors 2. Consolidate existing position as global leaders in renewable (in particular, wind) power generation 3. Select the projects promising the best returns (IRR) from international investment portfolio. 4. Prefer larger projects where industrial scale; skills and ownership of critical parts of the supply chain can improve returns 5. Can invest at all stages of a project lifecycle but prefer to sell down a significant minority or majority stake on completion. Seek to win EPC, O&M and offtake business	1. Strategic commitment to German market despite international expansion 2. Attempt to diversify business model across technologies and geographies 3. Generate a steady flow of capital to invest in new projects from sale of projects once constructed 4. Enhance returns by selling to projects to highest bidders 5. Can tailor projects of a range of different sizes for particular long-term equity investors 6. Invest principally during development and construction; may seek to retain a minority stake in order to win recurring O&M business	1. Mostly local focus within Germany 2. Plan and design projects 3. May or may not invest 4. Work only with very small site-specific developments
Preferred technologies	Very little investment in German solar PV and onshore wind but could do so opportunistically if large scale opportunities were available and returns were highe enough. Favourite technology is offshore wind given that the scale and complexity means they are more competitive and potential returns are higher	Have historically been the drivers of supply of onshore wind and ground-mounted solar PV projects. Size and risk of offshore wind projects means they are unable to continue to invest during construction without co-investmentpartners	Offshore wind too large. Small site-specific, solar, wind, bioenergy and other CHP plants

utility capital, while international developer capital is likely to be the most expensive among the developer groups. The largest international developers typically have access to a broader range of capital markets than the domestic developers, meaning that they are less dependent on the recycling of capital from completed projects to fund investments in new ones. Developers may seek to retain minority stakes in larger projects once completed in order to win a long-term operations and maintenance contract with the long-term equity owners.

2.3 Financial investors

Financial investors can be split up into banks and non-banks. While banks may assess an investment opportunity in the context of their relationship with the borrower, non-banks are more likely to assess investment opportunities on their own merits. This means assessing the expected returns in the context of an institution's particular investment mandate.

There may be large differences in strategy between the investment banks such as Deutsche Bank (and the investment banking arms of the banks that also have commercial banks, such as Commerzbank) **and the commercial banks and Landesbanks** (commercial banks with a regional focus and sometimes owned by regions), such as Bayern LB and Helaba. Investment banks seek to provide services to infrastructure projects, which require them to commit relatively little of their balance sheet for the long term (e.g. financial advisory). While investment banks seek transaction-related fees, commercial banks – in particular, the Landesbanks – continue to see long-term lending to

Table 7: Bank summary

	INTERNATIONAL	LARGE-SCALE DOMESTIC
Example	Deutsche Bank, Commerzbank, UBS, Morgan Stanley	Commerzbank, Bayern LB, LBBW, DZ Bank
Access to capital	Access to long-term capital from public and private equity and credit markets. Relatively large proportion of asset funding from wholesale (interbank) markets; relatively low proportion of deposit-taking	Access to long-term capital from public and private equity and credit markets. Relatively higher proportion of asset funding from deposits and lower proportion from wholesale (interbank) markets
Strategic Objectives	1. Little strategic commitment to German market. Mostly opportunistic	1. Strong strategic commitment to German market but most are internationally active in infrastructure finance
	2. Manage impact on return on equity of phased implementation of Basel III financial regulations	2. Ensure compliance with Basel III as its requirements are phased in
	3. Increasing focus on products which require little capital backing (e.g. advisory, underwriting and syndication, wealth management). Provide capital-intensive products (trading, long-term lending) only to the most profitable relationships	3. Continued focus on relatively illiquid infrastructure or project finance loans. Much funding for German renewable energy project finance provided by development bank funding schemes (KfW) but credit risk and monitoring borne by banks
	4. Prefer complex projects, where financial structuring and syndication skills can be of value to a sponsor.	4. Seek ways to recycle capital from illiquid loans: including through securitisation
	5. Prefer to invest only on a short-term basis: providing short-term equity and debt to project developers; construction phase equity and debt to projects	5. Content to provide long-term debt
Preferred technologies	Preference for offshore wind given greater complexity of financial structures	Willing to lend to all principal technologies

infrastructure projects as core business.

Within the category of non-bank financial investors, there are wide differences in size, investment expertise and motivation. At one end of the spectrum lie the institutional investors, that is, large insurance companies and pension funds that may have tens or hundreds of billions of euros to invest in order to cover future cash needs to service life insurance policies, annuities or pension funds for their customers (Nelson et al. 2013).

Next come asset managers who manage money for smaller institutions and individuals who may not be large or sophisticated enough to invest directly. Some institutional investors and banks also have asset management arms that invest other people's money. Finally, there are investors ranging from households, to co-operatives to small institutions, that invest in projects for the financial return – perhaps via an internet crowdfunding platform – just as these investors could invest in, say, real estate.

Institutional investors may be willing to accept lower returns in return for the potential to earn stable cash flows in the long-term, which enable them to service their long-term liabilities. These investors often tend to prefer investments with lower debt leverage.

Asset manager (e.g. private equity groups) objectives are more tailored to the specific mandate provided by their investors. Many focus on providing higher returns (IRR) in the high double digits (IRR), meaning that they typically seek to invest in riskier projects, the riskiest phase of low-risk projects, or projects where they are able to leverage their investment.

Table 8: Non-bank financial investor summary

	INSTITUTIONAL INVESTORS	ASSET MANAGERS	OTHER FINANCIAL INVESTORS
Example	Allianz, MEAG	KGAL, Capital Stage, Aquila Capital, Blackstone	Family offices, high net worth individuals, corporates, individuals (internet crowdfunding)
Capital invested	Principally insurance companies and pension funds investing for their own account	Principally specialist investment managers investing 3rd party capital	A mixture of proprietary investments and managed accounts
Characteristics	1. Maintain an investment portfolio across a range of asset classes (including equity and debt) to enable them to service long-term, reasonably predictable liabilities	1. Often aggregate investments in projects to make them available to investors that would be too small to invest directly into projects	1. A wide variety of investors may invest in specific projects. These could include individuals and corporations investing through internet crowdfunding platforms for financial reasons, rather than for their own use
	2. Find more value in illiquid investments than the market in general as they may be a better match for liabilities. Seek higher yields on low risk asset than current available from investment grade corporate bonds	2. Driven by the requirements of their investors - typically smaller institutional and other financial investors. These often seek higher net returns than they would otherwise be able to generate from their own direct investments	
	3. Manage the implications of Solvency II regulation	3. Manage the implications of Alternative Investment Fund Manager Directive	
	4. Historically largely "patient" capital but larger investors have built in-house direct infrastructure investment capacity	4. More active management of investments	
	5. Typically prefer operating projects but those with in-house capability are increasingly seeking to invest at an earlier stage in order to secure the best projects	5. Typically prefer operating projects but those with in-house capability are increasingly seeking to invest at an earlier stage in order to secure the best projects	
Preferred technologies	Preference for solar PV and onshore wind if returns are high enough. May consider offshore wind with the appropriate contractual framework and co-investors	Preference for solar PV and onshore wind. May consider offshore wind with the appropriate contractual framework and co-investors	Preference for solar PV and onshore wind. Offshore wind is too complex and large scale

Table 9: End user summary

	SMALL END USERS	LARGE END USERS
Example	Various households, farmers, small co-operatives	Various large industrials, large commercial enterprises and large co-operatives
Capital invested	Savings, co-operative equity, lending raised against the credit-worthiness of the borrower	Retained earnings, bank lending, co-operative equity
Objectives	1. Investment principally in very small facilities generating electricity for self-consumption or local direct marketing	1. Investment in larger self-consumption facilities and grid feed-in
	2. Social and environmental goals are generally more important than financial returns	2. Financial returns are the most important consideration although social and environmental concerns remain important for large co-operatives and customer facing enterprises may earn a benefit for their brand from installing green energy
	3. Varied level of understanding of financial logic	3. Key financial return metric for many commerciall companies is payback period, rather than internal rate of return
	3. Long-term hedge against rising energy prices is important for many groups, in particular, farmers	4. Renewable energy mostly considered as one of a range of energy efficiency options
	4. Households principally focus on solar PV; co-operatives invest in solar and wind projects; farmers in wind and bioenergy	5. Some energy-intensive industrials are seeking to offer flexibility to grid operators. Solar energy with storage could be part of this
Preferred technologies	Solar PV and onshore wind	Solar PV and onshore wind

2.4 End users

The investors that we categorise as end users have a particular interest in investing in generating facilities physically close to them, which is unlike most developers and financial investors and more akin to municipal utilities. **These investors have a range of investment decision-making processes and business models** including (1) self-consumption (consumption of electricity generated on the premises); (2) local production and direct marketing (i.e. selling power generated at a local level, without entering the national grid); (3) investing in facilities feeding in electricity to the grid to earn additional revenues to offset the rising retail cost of electricity; as well as (4) energy-intensive industrials seeking to earn ancillary revenues by providing flexibility to the grid.

We split this heterogeneous group by into large end users and small end users by size of investment. **Large end users also tend to be those for whom financial returns are the principal motivation while for small end users other considerations may have more weight**. Clearly the ability to generate some sort of financial return is important for all groups, although the yardstick against which that return is measured may differ.

The large end user category includes commercial enterprises, who may regard investments in renewable energy as part of a range of energy efficiency options, as well as energy-intensive users, who are exempt from the requirement to contribute to the costs of supporting renewable energy plants but who seek to generate additional revenues by participating in reserve markets.

Small end users are a diverse set of co-operatives, small businesses, farmers and private individuals. Small end users principally invest for self-consumption in rooftop solar PV arrays with capacity lower than 100kW and in onshore wind farms with a capacity lower than 1MW. They often seek to partner with developers, municipal utilities and other independent suppliers in order to market locally-generated electricity within the area where the power is generated.

3. Potential contribution of different investment pools

1. A policy framework that attracts a wide range of investors will be needed to meet Germany's 2020 renewable energy targets. If that is in place, more than €30 billion of capital could be available per year, more than double the amount required.
2. Energy policies can grow or shrink the pool of available capital and will affect the likelihood of Germany meeting its targets and the cost of doing so.
3. The mix of investors will be a key factor in determining the costs of the energy transition.
4. Not all investor groups will be attracted to every investment opportunity, meaning the available capital is spread unevenly across project lifetime and technology.
5. Short-term finance and long-term debt potential vary less between technologies than long-term equity as they are exposed to technology-specific risks to a lesser degree.
6. More than double the amount of short-term bridging or construction finance than is needed to meet the targets could be available.
7. New groups of investors could be attracted to provide long-term debt by the growth of the offshore wind sector and the implementation of the amended Solvency II capital requirements for the insurance industry.
8. Long-term equity investors focus not just on the risks related to a particular technology, but also those related to the location, size and contractual structure of a particular project.

Germany's energy policies will be a key factor affecting the future mix of investors in its renewable energy sector. The shape of the policy framework will therefore go some way to determining whether Germany meets its 2020 renewable energy targets and at what cost.

In order to meet those targets at optimum cost, a wide range of investors will need to contribute. Different classes of investors will only be willing to participate in a limited subset of the range of investment opportunities. Investors will react in different ways depending on: (1) the type of finance; (2) the availability of alternative investment opportunities; (3) the level and profile of investment returns; and (4) project scale and complexity. Therefore, meeting Germany's goals will require attracting and incentivising a diverse range of debt and in particular, equity investors who are more heterogeneous in their motivations.

Provided that there is a suitable policy framework, there would potentially be more than double the capital needed to meet Germany's 2020 renewable energy targets. Depending on the technology mix and the trend in technology costs, there could be 60-170% more capital available than is required to finance the German government's targeted deployment of around 7.4GW of new capacity per annum (Table 10).

As illustrated in Table 10, this is split unevenly between technology and type of finance.

More than double the amount of short-term bridging or construction finance could be available, focussed on the largest and most complex projects. Specialist developers and their investors are likely to continue investing in new greenfield projects if they are confident of being able to sell projects at prices consistent with

Table 10: Summary of annual investment needs vs. potential

<table>
<tr><th></th><th>SOLAR PV</th><th>ONSHORE WIND</th><th>OFFSHORE WIND</th></tr>
<tr><td>SHORT TERM CAPITAL</td><td colspan="2">156%</td><td>179%</td></tr>
<tr><td>LONG TERM DEBT</td><td colspan="2">136%</td><td>291%</td></tr>
<tr><td>LONG TERM EQUITY</td><td>390%</td><td>235%</td><td>157%</td></tr>
</table>

Source: CPI analysis

their required rates of return to providers of long-term debt and equity capital, once projects have moved into commercial operation. The largest and most complex projects, such as offshore wind, typically offer the most attractive returns.

The pool of long-term debt providers is widening. Domestic commercial banks have a strategic commitment to the German renewable energy sector and most have the solid financial standing needed to continue lending in sufficient volumes to support the targeted growth levels. The role of international commercial banks and domestic and international institutional investors could increase with the growth of the offshore wind sector and the implementation of the amended Solvency II capital requirements for the insurance industry.

A broader mix of long-term equity providers is likely to be required, with different technologies matching different investors' requirements. The success of the solar PV sector in the short term will likely be dependent on consumers and other small investors, as current returns are too low for many institutional investors[1]. To achieve the targeted increase in onshore wind capacity, the market could be reliant on municipal utilities and smaller investors if planning regulations continue to keep onshore wind project sizes small, limiting the participation of larger utilities and institutional investors seeking economies of scale. By contrast, in the offshore wind sector, reduced technological risks will continue to increase the investment potential from institutional investors, reducing the cost of growing the sector.

1 Using the CPI project finance model, we calculated a project weighted average cost of capital for a ground-mounted solar project of 3-4%, based on an assumption of 85% of long-term capital being provided by debt.

3.1 Methodology

> No one methodology to estimate investment potential is appropriate for all investor groups, for reasons including the public availability of information and the variety of motives within a group. However, for each investor group, we constructed a hypothesis and verified it "bottom-up", using a range of methods, including interview feedback.
>
> Other key analyses used to assess the adequacy of the available investment potential include the types of financial structures that are likely to be used for each type of project, specifically the mixture of short-term and long-term finance and the mixture of debt and equity.

We used a range of analytical tools to estimate the maximum potential investment in the German renewable energy sector up to 2020 for the four investor segments described in Chapter 2 – utilities, developers, financial investors, and end users. We then assessed the adequacy of that potential for each project type and type of finance, by comparing it against our estimate of the capital required to fund the targets for each technology type.

The cost to construct the desired new generation capacity will depend on the technology targets and technology costs. Our analysis focussed on the capacity expansion targets specified in the Renewable Energy Act 2014 (Erneuerbare-Energien-Gesetz, EEG): 2.4-2.6GW per annum in solar PV, a net 2.5GW per annum increase in onshore wind capacity, and an increase in installed offshore wind capacity to 6.5GW by 2020 (representing an average increase of 800MW per annum). We also reviewed a series of reports by consultancies, analysts and trade associations in order to assess the potential fall in construction cost for each technology in Germany during this period (Table 11).

However, the total capital required for a project to be viable is usually higher than the cost of constructing it. Our interviews and analysis of recent German renewable energy financing suggests that a renewable energy project may have multiple equity and debt providers over its lifetime. The specialist skills of various capital providers may make them well-suited to provide finance during certain parts of a project lifecycle and unsuited to others.

Table 11: Projected falls in renewable energy technology costs between 2016 and 2020

TECHNOLOGY	CONSTRUCTION COST 2016 FID (€/MW)	CONSTRUCTION COST 2020 FID (€/MW)	AVERAGE ANNUAL CAPACITY INCREASE (MW)	CONSTRUCTION COST 2016 FID (€BN)	CONSTRUCTION COST 2020 FID (€BN)
ROOFTOP PV	1.6	1.4	2,000	3.2	2.7
GROUND-MOUNTED PV	1	0.8	500	0.5	0.4
ONSHORE (GREENFIELD)	1.6	1.5	2,500	4	3.9
ONSHORE (REPOWERING)	1.5	1.3	1,600	2.4	2.1
OFFSHORE WIND	4	3.5	800	3.2	2.8
TOTAL			7,400	13.3	11.9

Source: VDMA and Deutsche Windguard (2015), Agora (2015), BSW Solar (2014), Fichtner and Prognos (2013), CPI

While a renewable energy project may cost €100 million to build, the total capital required during that project's lifetime will be higher than €100 million if the project developer, having invested €100 million then sells the project once completed to a set of long-term equity and debt providers for (at least) €100 million. In this example, while the developer may recycle that capital into investment in new renewable energy projects, the project will only be viable if both sets of €100 million – or €200 million in total – is available. **We term the developer's contribution "short-term finance"**.

3.1.1 WHAT IS THE LIKELY MIX OF SHORT-TERM AND LONG-TERM FINANCE?

Investors in renewable energy projects have a range of funding options of different tenor and cost, which they will choose with the aim to provide the optimum mix of cost and flexibility. We used the evidence from our literature review and interviews to estimate which financing structures will be used and therefore, the required mix of short-term and long-term finance.

We thus estimated the total cost of constructing the government's desired 7.4GW of additional renewable energy capacity per annum at €13.3 billion, with the potential capital required at €15.8 billion, including €2.5 billion of short-term finance.

How we assessed likely financing structures

Certain types of investors, such as developers and investment banks, typically seek to sell or refinance their investments in projects slightly after the start of a project's operations and try to realise a higher return to compensate them for their exposure to the project at its riskiest phase.

Short-term investors derive most value from projects with the most risky and complex permitting, construction, and financing processes. These projects are likely to use a higher proportion of short-term finance than projects where the risk profile between construction and operating phases is more similar. Consequently, we see short-term finance being used to a much greater degree with offshore wind projects than onshore wind projects, while the relatively simple planning and permitting processes for solar PV mean that it will have the largest proportion of long-term finance secured prior to operations.

For **offshore wind**, we reviewed the pipeline of projects to 2020 and estimated which financing structures were likely to be used depending on the sponsor and their recent history of financing projects around Europe. We expect three of the six projects which have not yet reached financial close to use project finance with three using balance sheet finance. For all projects, we expect at least a significant minority stake to be sold after construction.

For **onshore wind**, we first divided the targeted new capacity into three groups of small-, medium- and large-sized projects, which we expect to be owned by three different types of groups of long-term equity providers:

end users and co-operatives, municipal utilities, and financial institutions, respectively. For each type of project, we used our review of recent transactions and our interviews to estimate the extent to which long-term finance is likely to be put in place before operations. Many developers have sought to fund construction with their own funds, structuring a long-term debt package to suit a particular long-term equity provider to whom 100%of the project is sold after construction.

For the largest projects, developers may not have the capacity to fund 100% of the construction with their own funds and so arrange project finance debt prior to construction and seek to retain a minority stake after construction and a further long-term interest in the project through an operations and maintenance contract.

For **solar PV**, we expect developers to seek to fund ground-mounted projects with their own funds and then refinance them with debt after they have entered operation. Conversely, we expect rooftop projects to have long-term funding in place prior to construction, as they are typically originated by prosumers.

The results of this analysis are shown in Table 12.

Table 12: The largest, most complex projects feature more short-term finance

	CAPACITY (MW)	CONSTRUCTION COST 2016 FID (€BN)	FINANCING STRATEGY	SHORT-TERM FINANCE (€BN)	SHORT-TERM FINANCE % OF CONSTRUCTION COST	TOTAL CAPITAL NEED (€BN)	SHORT-TERM FINANCE % OF TOTAL CAPITAL
ROOFTOP PV	2,000	3.4	Long-term equity (LTE) prior to construction	0	0%	3.4	0%
GROUND-MOUNTED PV	500	0.3	Short-term finance (STF) through construction then sale to long-term debt (LTD) and LTE providers	0.3	100%	0.6	50%
TOTAL SOLAR PV	2,500	3.7		0.3	8%	4.0	8%
SMALL ONSHORE WIND	1,230	1.9	STF to permitting; LTD and LTE prior to construction	0.1	5%	2.0	5%
MEDIUM ONSHORE WIND	615	1.0	STF through construction; refinance with LTD after construction	0.7	73%	1.7	42%
MEDIUM ONSHORE WIND	615	1.0	Project finance (PF) in place prior to construction; sell to LTE after construction	0.1	10%	1.1	9%
LARGE ONSHORE WIND	1,640	2.5	PF in place prior to construction; sell to LTE after construction and retain minority stake	0.3	12%	2.8	11%
TOTAL ONSHORE WIND	4,100	6.4		1.2	19%	7.6	16%
UTILITY-OWNED	400	1.6	Balance sheet finance and sell-down 49% after construction	0.7	44%	2.3	30%
NOT UTILITY-OWNED	200	0.8	PF in place pre-construction	0.1	13%	0.9	11%
NOT UTILITY-OWNED	200	0.8	PF in place pre-construction. Refinanced after three years of operation	0.1	13%	0.9	11%
TOTAL OFFSHORE WIND	800	3.2		0.9	28%	4.1	22%
TOTAL	**7,400**	**13.3**		**2.4**	**18%**	**15.7**	**15%**

Source: CPI

3.1.2 WHAT IS THE MAXIMUM POTENTIAL OF EACH INVESTOR GROUP?

We considered whether any constraints outside of the control of German policymakers effectively limit investment potential. The maximum potential investment in offshore wind projects is limited by the number of projects, which the German government is allowed to provide support to under its current EU State Aid approval. By contrast, while the maximum potential investment in rooftop solar PV is, in theory, limited by the number of available rooftops, a recent estimate that the available German roof space could support deployment of a further 200GW of solar power, implies that there is no effective constraint, other than those related to particular groups of investors (Fraunhofer ISE 2015).

We reviewed the historic level of investment for each group over the last two years. Our interviews suggested that historic investment levels will be a more relevant indicator of future investment potential for those investors least motivated by financial returns – i.e. small end users.

We then used interviews and other research to estimate a range of future investment potential for each group, as summarised in the box below.

How we assessed investment potential by investor segment

For **incumbent IOUs** focussed on large, mainly offshore wind projects, we reviewed current publicly-stated capital expenditure plans and deducted committed expenditure on networks and non-German generation projects to derive a maximum investment potential in German renewable energy.

For example, we started our assessment of RWE's investment potential by reviewing its latest public statements on planned capital expenditure, which included total capital expenditure on renewables net of disposals of €1 billion between 2015 and 2017. RWE has a range of investment opportunities in the UK, Netherlands, Eastern Europe and Turkey, as well as in Germany. We assessed the level of committed investment in the one German offshore project it is committed to (15% stake in Nordsee 1, in construction); to offshore projects in other markets (25% stake in Galloper, UK, financial close in October 2015) and onshore wind projects in non-German markets (a pipeline of over 200MW in construction across the UK, Netherlands and Poland). We then deducted this committed expenditure to derive a range of annual investment potential for RWE in German renewables of €50 - €75 million per annum.

For **municipal utilities**, we identified the 20 largest municipal utilities in Germany and assessed the recent historic level of investment in German renewable energy projects. We then assessed the borrowing capacity of each of the principal German regions by reviewing research from credit rating agencies and considering the potential impact of incoming German legislation such as the "debt brake" (Schuldenbremse).

For **financial investors**, we split up the assessment between banks and non-banks.

For non-banks, we started by identifying institutional investors currently investing in German renewable energy projects and making an estimate of the potential investment through new vehicles. We then considered the investment potential by type of investment (including direct investment, investment through pooled vehicles, and investments in corporates), factoring in expectations for total asset growth, asset allocation strategies, and the potential impact of Solvency II regulation on those.

For banks, we split out the assessment between investment banks and commercial banks and for the latter, between domestic and international lenders. We conducted interviews with a number of the leading domestic banks, reviewed their capital positions and credit ratings (i.e. their capacity to continue lending), and reviewed their strategic and sustainability statements on future lending strategy. For the international banks, which are focussed on offshore wind projects, we considered the level of oversubscription on recent offshore wind deals as a proxy for direct lending potential in the short-term.

For **end users**, we conducted interviews with market participants across the most prevalent distributed generation business models to understand their historic level of investment in the sector and their motivations. These included co-operatives, local direct marketers and representatives of self-consumers, commercial enterprises, and large industrials. This assessment reviewed the likely availability of own funds for investment (savings, corporate cash reserves) and the likely availability of alternative, more attractive investment opportunities, which could divert these funds away from renewable energy investment.

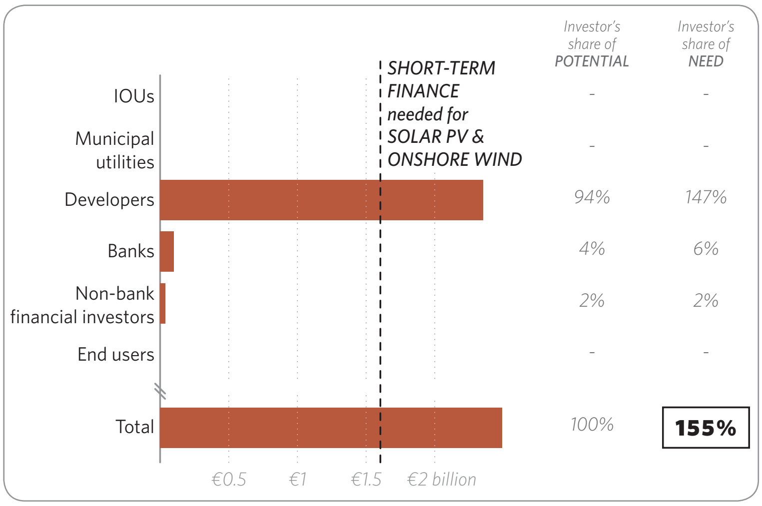
3.2 Short-term finance

Short-term finance is typically provided by developers and investment banks. It is expensive but critical to the viability of the most complex projects. We estimate the amount potentially available at around €5 billion per annum, 60-70% more than required.

Most developers do not have ready access to public debt and equity markets, so their ability to finance multiple projects at one time may be limited. The developer business model relies on the recycling of proceeds from the sale of completed projects into investment in new projects. Provided that a long-term owner is willing to pay a price for a completed project, which enables the developer to make its target return, the developer will likely be willing to finance the project's development.

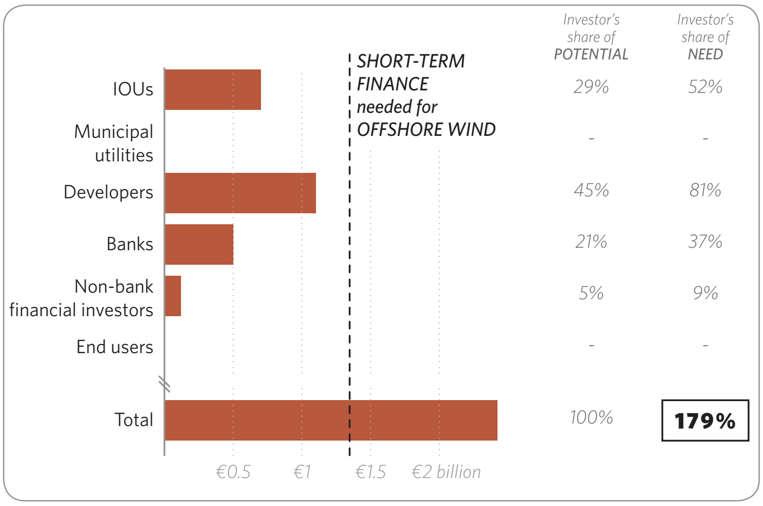
Investment banks target transaction-related fees without committing their balance sheet, although they may choose to do so in order to secure a particular deal mandate.

Figure 8: Short-term finance potential by investor group (solar PV and onshore wind)



Source: CPI

Figure 9: Short-term finance potential by investor group (offshore)



Source: CPI

In Germany, investors providing short-term finance do so using a variety of financial structures. This could be "on balance sheet" – where a company invests its own capital (most likely, a mixture of debt and equity) through an existing group company or it could be through project equity or debt finance, invested in a separate special purpose vehicle, whose sole purpose is to own the asset in question.

We estimate the short-term capital potentially available for short-term finance (for all technologies) at around €5 billion per annum, 60-70% higher than required. For solar PV and onshore wind projects, short-term finance is dominated by a large number of small to medium-sized Germany-focussed developers investing from their own balance sheets. By contrast, competition to provide capital to offshore wind projects is international and the large scale of the projects means that few utilities and developers have the capability to fund them without direct lending from banks during the construction phase.

The availability of short-term finance is conditional upon the expectation that long-term finance will be available at the right price. Our interviews confirmed our hypothesis that short-term finance providers have sufficient access to capital and will make it available if they have a reasonable expectation that they will be able to recycle it in a timely fashion, by selling a project to long-term capital providers at a price sufficient to meet their target return.

While falling feed-in tariffs have pushed down overall project returns, intense competition for operational assets (in particular, onshore wind and ground-mounted PV) from long-term equity providers have pushed asset prices up. This has ensured that development phase returns have held up relatively well compared with returns for owners of assets in the operational phase. Developer returns remain acceptable for many, although our interviews suggested that some wind and in particular, solar, developers have sought to increase returns by diversifying into neighbouring Western European markets (e.g. BayWa) or to other technologies (e.g. developers who originally focussed on solar are now installing wind farms).

Developers and investment banks will continue to dominate the provision of short-term finance. Developers and investment banks seek higher returns on capital for providing specialist services to projects in their riskiest phases. Developers, themselves mostly equity-funded, may fund project development costs on balance sheet and commit short-term project equity to larger projects, where a special purpose vehicle and project finance are put in place prior to construction. Investment banks will targethigher returns on capital through fees for financial advice without providing long-term finance.

Developer access to capital can be a constraint on the capacity to provide short-term finance. Developers of German solar PV and onshore wind projects mostly have a domestic focus and do not have ready access to public equity and credit markets in the same way as the incumbent IOUs. They thus depend on the timely recycling of capital from completed projects in order to be able to continue investing in new projects. A number of the larger developers (in particular, PNE and wpd) have diversified into offshore wind projects, which have longer development cycles. If significant capital is tied up for longer in work-in-progress, this could risk the availability of new capital available for investment in new onshore projects.

The developer business model can be precarious. In January 2014, the wind developer Prokon filed for insolvency. Prokon had raised over €1 billion in capital from more than 50,000 retail investors, but collapsed because it did not have access to alternative capital when investors sought to redeem their investment (Financial Times 2014). The investment potential of developers smaller than Prokon could decrease if proposals currently under discussion to switch to auctions are implemented. For these smaller developers, which do not have a large portfolio of projects, associated transaction costs will be significant, and the risk of not obtaining support for individual projects will be even more significant.

The involvement of investment banks increases total costs but could be crucial to the viability of the most complex projects. The involvement of investment banks will be more prevalent for offshore wind projects than for solar PV and onshore wind projects. Financing for the former are typically complex, involving multiple principal contractors as well as a range of equity and debt investors, each with different sets of rights and obligations. We understand that financial advisory fees could be in the range of 0.5% to 1% of the debt raised, implying that, for a 400MW offshore wind project, the fees could total between €5 million and €10 million.

As project structures become less bespoke, transaction costs could fall for offshore wind projects, as they have done for onshore wind and, in particular, solar PV projects, where financing structures have been homogenised to a much greater extent. However, some may retain appetite to use their balance sheets opportunistically, as witnessed by Macquarie Capital's recent participation in EnBW's Baltic 2. The bank purchased a 49.9% stake mid-construction and then structured a long-term debt finance package and sold down to long-term equity providers by the end of construction (ReNews 2015).

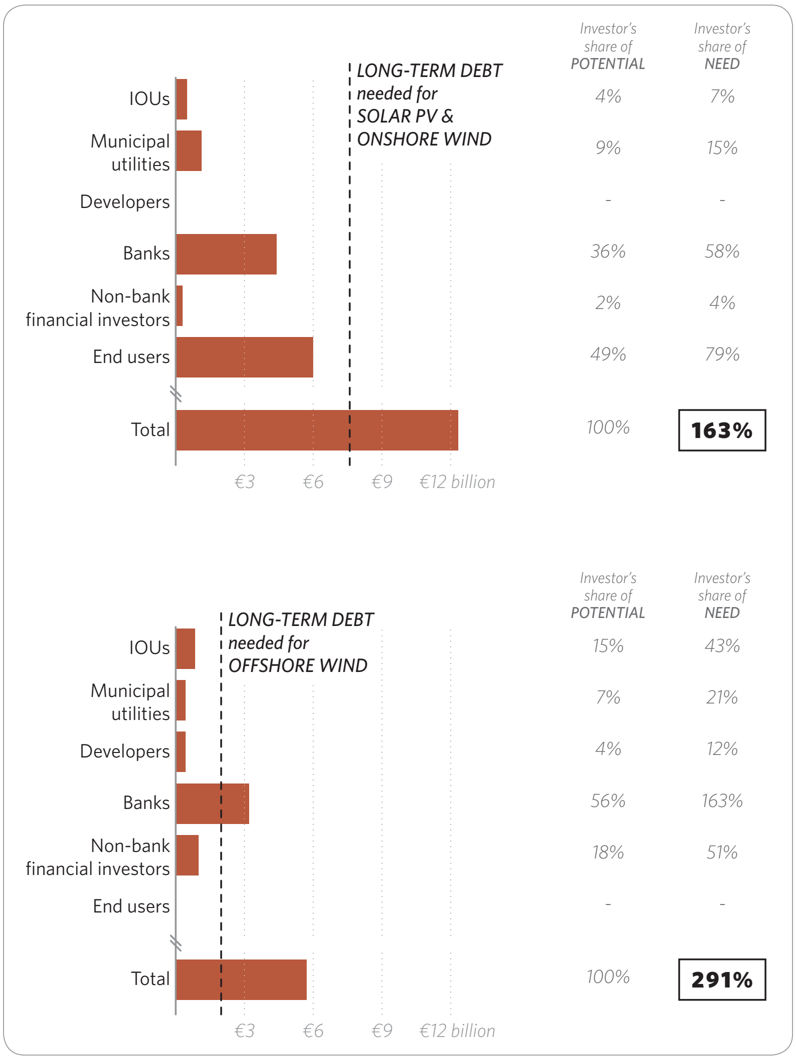
3.3 Long-term debt

Long-term debt is typically provided by banks and increasingly institutional investors. We estimate the amount potentially available at around €18 billion per annum, 75-85% more than required.

Debt costs in the German market are extremely low, due to the availability of "promotional" funding from development banks. Despite this, the renewables sector remains attractive for domestic banks, and offshore wind projects remain attractive for international banks.

The potential of these institutions to continue to provide long-term debt to the sector will be influenced by the financial standing of a particular institution and the returns on offer. Returns continue to be eroded by additional regulatory costs and fierce competition. Institutional investors are also increasingly active in this sector.

Figure 10: Long-term debt potential by investor group and technology



Source: CPI

In Germany, long-term debt is principally provided in the form of project finance to the special purpose vehicle that owns the asset in question, and the majority is ultimately funded at low cost by development banks, such as KfW and Rentenbank. We also consider some of the long-term investments made on balance sheet (principally by utilities and end users) to be long-term debt. If a hypothetical company is funded 40% by debt and 60% by equity and makes an investment backed by its own funds, we would consider 40% of this investment to be debt and 60% to be equity.

We estimate the long-term debt (for all technologies) potentially available at around €18 billion per annum, or 75-85% more than required. For solar PV and onshore wind projects, the provision of project debt is dominated by domestic commercial banks although the "debt" portion of balance sheet investments by end users is even larger due to the latter's very significant total investment potential. By contrast, the scale and complexity of offshore wind projects has meant that while some domestic lenders have less capability to participate, the opportunities have become extremely attractive to international banks and increasingly, to institutional investors.

Domestic commercial banks will continue to dominate the provision of long-term debt for solar PV and onshore wind projects. Our interviews suggested that competition remains intense between commercial banks to provide long-term debt to German solar PV and onshore wind projects. While we did not discern a desire among any of the principal lenders to the sector to increase their sector concentration to renewable energy, our interviews suggested that this remains a business where relatively attractive risk-adjusted returns can still be made. As the majority of German lenders have started expanding their balance sheets again following a post-crisis period of deleveraging, we expect potential lending to the sector to grow by at least the rate of overall balance sheet expansion: at between 1-3% per annum to the end of the decade.

International banks will expand the supply of capital for offshore projects. The mainly larger sponsors of offshore wind projects have in 2014 and 2015 been able

The impact of Basel III on project finance lending

The Basel III capital adequacy regime has introduced a series of tougher requirements for banks, which are being phased in over 2014-2019.The regulation introduceS (1) a tougher capital adequacy requirement, which requires banks to hold more, better quality capital; (2) restrictions on the use of short-term wholesale funding (the "Net Stable Funding Ratio"); (3) maximum leverage and minimum liquidity conditions.

The changes have a much more significant impact on the investment banks lending to the German renewable energy sector than the other commercial banks. The greater focus on the trading book of the former has meant that meeting its new capital requirement has been particularly onerous, whereas the lack of deposit funding has made it more challenging to achieve its Net Stable Funding Ratio (NSFR).

The NSFR, whilst not requiring banks to match-fund twenty year project finance loans, has made many investment banks think again about the use of capital in illiquid products, such as project finance. This may continue as a "loss-leader" for selected client relationships, but it is likely that future investment in the German renewable energy sector from investment banks will fall as the rise of institutional investor lending provides sponsors with a cheaper range of funding options. For all banks, the new maximum leverage ratio will limit the extent to which banks can expand their lending without strategies to recycle capital.

to use their relationships with international banking groups to obtain project finance to offshore wind projects in deals of a size beyond the German banking sector's capacity for individual projects. The German market is benefitting from the greater knowledge of the risks associated with the technology gained by many banks from participation in recent deals in other offshore wind markets, principally the UK and Belgium. The three pre-construction financings closed in 2015 involved nearly twenty banks and were mostly significantly oversubscribed (Green Giraffe 2015, ReNews 2015b).

Development bank funding schemes reduce the cost of debt for the sector. We estimate that between 60-70% of the total funding for renewable energy investment in 2013 and 2014 was funding originally provided by development banks (principally KfW and Rentenbank) under "promotional" loan schemes and "on-lent" by commercial banks to projects (BMWi 2015c and KfW 2015). By reducing the cost of debt funding through these schemes, the government has reduced the cost to the electricity consumer of the Energiewende by reducing the cost of capital for the projects whilst still allowing many investors to meet their targeted equity returns.

The capacity of banks to provide this funding is contingent on the availability of sufficient high quality capital to offset the credit risk associated with those loan assets. This responsibility, along with the assessment and monitoring of credit risk, remains with commercial banks under the promotional loan schemes. If a project defaults, the commercial bank will be exposed to a shortfall should the proceeds from realisation of the security be insufficient to repay the development bank funding.

Competition within a strong German banking sector could offset the impact of additional costs and risks from regulatory and policy changes. While our interviews suggested that lending to the sector is likely to remain attractive for banks, we reviewed credit rating agency reports (Moody's Investors Service 2016) and the results of the most recent European Central Bank stress tests (EBA 2016) in order to assess whether the capacity of the banking sector might impede this potential from being realised. While Moody's has most of the sector on negative outlook, the majority appear comfortably capitalised compared with the Basel III minimum capital requirement of 8% common equity tier 1 (Moody's Investors Service 2015).

Our interviews suggested the impact of higher capital requirements being phased in over 2014-2019 has not yet resulted in higher debt costs, as intense competition has prevented margins from increasing significantly. This competition could also mean that the impact of policy changes currently under discussion – for example in relation to the eligibility of projects to continue receiving support when wholesale prices are negative – only affect debt structures and lending potential at a lag.

Basel III will impact banks differently depending on their strategies. The new Basel III framework is likely to impact investment banks to a greater degree than commercial banks, given investment banks' focus on trading activities and greater reliance on short-term wholesale funding markets.

Solvency II and the challenge of institutional investor investment in infrastructure debt

From 1 January 2016, insurers operating in European markets have been subject to a revised capital adequacy and solvency regime, Solvency II. The final rules of this regime, long in gestation since the adoption of the Solvency II directive in 2009, incorporate the September 2015 advice from the European Insurance and Occupational Pensions Authority on Infrastructure (EIOPA), which were specifically designed to scale up the amount of institutional capital available for investment in infrastructure debt.

The final rules will resolve most of the uncertainty over the treatment of infrastructure assets by creating a specific "qualifying infrastructure" asset class with reduced capital requirements, relative to non-infrastructure listed and non-listed securities. This followed a recognition that the historic default rate for infrastructure project finance loans has been significantly below that of similarly-rated corporates. Compared with the previous version of the rules, the capital charge related to qualifying instruments has been significantly reduced: by over 30% for Baa-rated bonds and by over 40% for unrated bonds. The capital charge differential between investment grade and sub-investment grade remains severe, cementing the importance for insurers of investing in high quality projects, which are likely to perform in a stable way over the long-term.

The introduction of the leverage ratio will place constraints on the extent to which commercial banks will be able to expand their exposure to the sector. Our interviews suggested that the ability to recycle capital was a key concern of institutions around their continued participation in the sector. Some interviewees suggested that the refinancing guarantee that KfW provides in relation to loans made using certain of its schemes was particularly helpful as it provides lenders with a backstop refinancing option after ten years for certain products.

There are also a number of other options for banks to recycle capital more quickly, by passing some of the credit risk associated with their portfolios onto institutional investors. Securitisations such as Nord LB's "Northvest" are complicated and time-intensive to structure but can be an attractive way for lenders to rotate their portfolio, provided that the often questionable liquidity available in structured credit markets remains available. To-date, Nord LB has transferred nearly €600 million of credit risks to institutional investors related to a portfolio of almost €15 billion of illiquid assets across the renewable energy, aircraft and real estate industries (Nord LB 2015).

Greater clarity around Solvency II could expand the potential from institutional investors. The recent resolution of the uncertainty around the treatment under the Solvency II framework (see box) of infrastructure investments could significantly increase the competition for debt funding of renewable energy projects across Europe between banks and institutional investors, in particular, insurance companies who had hitherto eschewed large scale investments in the asset class because of that uncertainty (EIOPA 2015 and Clifford Chance 2015).

Institutional investors with long-term, relatively predictable liabilities may derive greater value from illiquid long-term loans than banks and, if they have in-house direct investment capabilities, may be able to offer sponsors greater flexibility by providing longer tenors.

The recent bond issuances in relation to the Gode Wind and Meerwind projects, rated BBB and Baa3 by Euler Hermes and Moody's respectively (Talanx 2015, Moody's Investors Service 2015b), illustrate that this potential is most likely to appear in relation to projects with larger scale, such as offshore wind projects, as these are likely to have greater liquidity. The pricing competitiveness of institutional investors will also be higher in relation to offshore wind than onshore wind and solar PV, as low-cost development bank funding dominates onshore wind and solar PV to a greater extent.

3.4 Long-term equity

Long-term equity is typically provided by all principal groups other than banks. We estimate the long-term equity potentially available at €5 to €7 billion per annum or over two times higher than required.

Long-term equity investors bear most of the technology- and project-specific risks associated with a project's performance. Different investors have different required returns for such investments, and financial returns are not a primary concern for some, such as small end users and some munis..

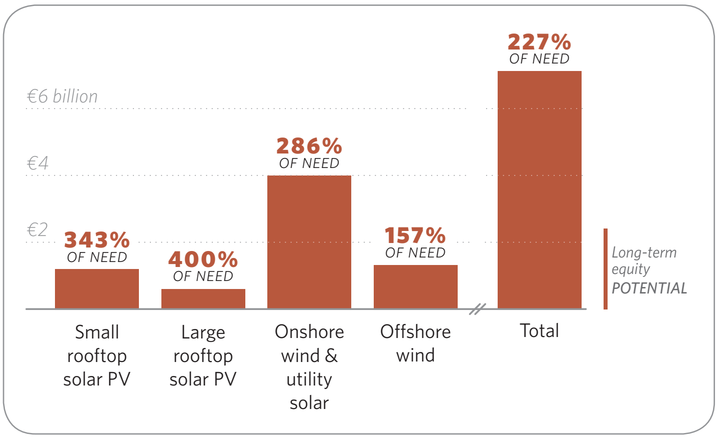
IOUs and many institutional investors now prefer offshore wind to solar PV and onshore wind projects, as falling feed-in tariffs have pushed returns down for the latter. End users and municipal utilities are less affected by the fall in returns and will be critical to the future financing of solar PV and onshore wind.

In this study, we consider as long-term equity investors all those who receive variable returns on their long-term investments. In practice, this category ranges from those investors who target a certain financial return following a detailed assessment of the financial risks they face, to those who may be willing to invest in a project with a negative net present value, provided that it helps them to meet other objectives, including self-sufficiency and hedging against future energy cost rises.

As with our assessment of long-term debt, we count the "equity portion" of potential balance sheet investments within this group. For utilities and developers, we use a typical capital structure for each sub-group based on recent market practice rather than using actual capital structures for each of the individual companies we reviewed. We followed a similar practice for large end user investments similarly made by corporates from their own capital.

A similar approach is problematic for small end users, who are likely to use a mixture of savings, home equity loans, crowdfunded equity and debt as well as bank debt. **We did not identify a typical "capital structure" for households, farmers or small co-operatives and so have treated their investment potential as 15% equity/85% debt, in line with our assessment of the likely long-term investment needs for a typical solar PV project**.

Figure 11: Equity investment potential is spread between project type



Source: CPI

We estimate the long-term equity (for all technologies) potentially available at €5 to €7 billion per annum, or over two times higher than required. This range is much wider than for short-term debt and long-term finance because the extent to which the investment potential of end user investors – recently investing at a level materially below their historic average – has been curtailed by recent policy changes.

Key Findings

A wide range of long-term equity providers is likely to be required. A key finding of our interviews and research was that the equity investor base for each technology is not homogeneous. Project size and commercial objective (feeding power into the grid or self-consumption) will attract some groups of investors and rules others out.

Falling feed-in tariffs and competition among long-term equity providers has pushed returns down, making solar PV and onshore wind unattractive for many financial investors. The market for mid-to-large sized (larger than 1MW) operational solar PV and onshore wind assets with strong load factors has been extremely competitive in recent years. Of the financial investors that we interviewed, many mentioned that they had halted activity in the German solar sector until returns rise. Many have found relatively more attractive returns in other European markets, where more relaxed planning regulations have meant larger project sizes, where investors can benefit from economies of scale.

However, financial investors' interest in offshore wind is increasing. There is a perception that if available returns remain where they are for solar PV and onshore wind, the larger institutional investors may find better value in other geographical markets or in offshore wind. Our interviews suggested that the number of institutional investors competing for stakes in offshore wind projects has increased significantly, as they perceive that the industry has matured.

End users and some municipal utilities are less affected by the fall in returns and will be critical to the future financing of solar PV and onshore wind. Although investment in solar PV fell short of the government's EEG 2014 target in both 2014 and 2015 (BNetzA 2016), investment levels in smaller scale projects (in particular, rooftop solar arrays smaller than 100kW and onshore wind installations smaller than 1MW) have been most robust to the fall in returns since 2012 because their investors are the least motivated by such matters. While returns remain low, government targets may not be met and certainly not without the continued large scale participation of these groups.

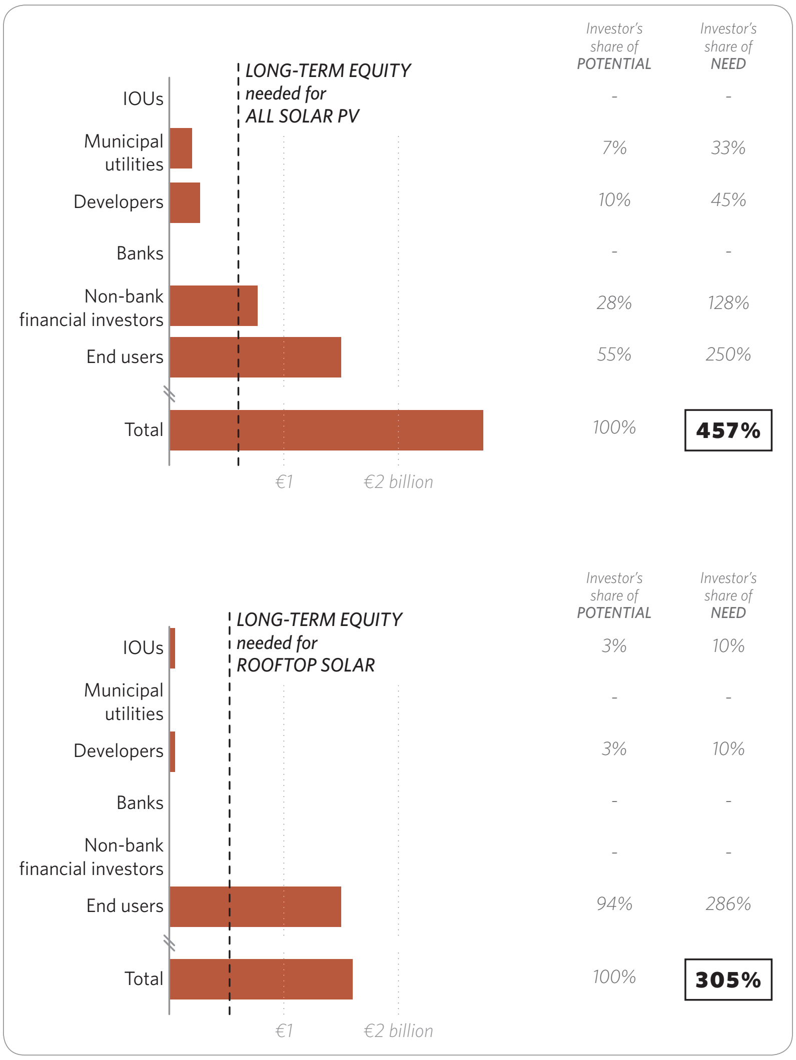
Regulatory uncertainty has curbed investment by co-operatives in renewable energy projects. Energy policy changes introduced by the EEG 2012 and 2014 laws and the recent government (BaFin) investigation into the regulatory status of energy co-operatives have reduced investment potential from co-operatives (Osborne Clarke 2015). The growth of the market for private and corporate investment through internet crowdfunding portals could replace some of this potential, although these investors are focussed to a much greater degree on financial returns than co-operative investors.

IOUs remain capital-constrained but increasingly committed to renewable energy. Falling credit ratings have forced German and international IOUs to rein in new investments and dividends. However, as a number have resorted to increasingly radical strategies to reorient their businesses, the strategic importance of renewables has increased. This investment could yet materialise through a variety of business models, from developer activity in relation to offshore wind projects to installing solar as part of a full service energy efficiency consulting offering for large industrials (e.g. E.ON Connecting Energies).

3.4.1 SOLAR PV

> The long-term equity investor base for solar PV projects varies significantly between ground-mounted and rooftop installations. The former typically feed-in electricity to the grid and offer the economies of scale and hence higher returns that are most attractive to return-seeking financial investors and utilities, while the latter are smaller-scale and are more likely to consume the power they generate.
>
> The German government's current policy indicates that at least 80% of the market in the near term will be focussed on rooftop installations. We estimate the long-term equity potentially available for solar PV investment is at around €7 billion per annum, more than three times the amount required.
>
> End users are critical to the continued growth of rooftop solar PV and are the most likely to be deterred by policy complexity.

Figure 12: Solar PV investment potential by project type



Source: CPI

The long-term equity potentially available for investment in solar PV projects is more than three times the amount required. Around €7 billion per annum could be available compared with closer to €2 billion required. Figure 12 illustrates that the potential is very different for rooftop and ground-mounted installations.

Key findings

Recent energy policy decisions have sharply reduced investment levels in recent years and could do so further if policies currently under discussion are implemented. Annual solar PV capacity installation is not only significantly lower than the historic trend (investment peaked at nearly €20 billion in 2010) but materially below the government's 2.5GW per annum target for both rooftop and ground-mounted solar PV. With only 1.9GW capacity installed in 2014 and less than 1.4GW in 2015, a positive resolution to the current uncertainty around the EEG surcharge and other tax exemptions will be needed for the investment potential to be able to reach the deployment targets.

Rooftop projects attract different investors with different business models compared with ground-mounted projects. The government carried out three tenders in 2015 for 500MW of ground-mounted solar PV projects and set out the intention to tender for a further 400MW in 2016 and 300MW in 2017, implying that it expects only 15-20% of its targeted 2.5GW annual capacity expansion to come from these projects. The different scale and complexity of these projects and the different business models which underpin their investment case means that ground-mounted projects typically attract a different set of investors, whose potential will not be realised unless the government increases the amount of capacity it will auction for. The significant oversubscription in these tenders (up to three times) indicates that excess investment potential for this type of project still exists.

Table 13: Solar PV project returns are very sensitive to load factor

AUCTION PRICE (€/MWH)	LOAD FACTOR (%) 10	11	12	13	14
85	1	2.1	3.1	4.1	5
90	1.6	2.8	3.8	4.7	5.6
95	2.2	3.4	4.4	5.4	6.3
100	2.8	3.9	5	6	6.9
105	3.4	4.5	5.6	6.6	7.6

Source: CPI

UTILITIES

We estimate the long-term equity investment potential for solar PV from utilities is between €200 million - €400 million per annum. While many utilities are generally seeking to increase their investment in renewable energy projects, the limit on support for ground-mounted solar means that they are likely to prefer investments in larger-scale onshore or offshore wind farms.

Expected returns from solar PV are below IOU cost of capital meaning they are unlikely to invest. According to their most recent annual reports, the weighted average cost of capital (WACC) of the Big 4 incumbent German utilities is between 7-9% before tax (5-7% after tax). Our analysis shows that the expected after-tax project return on ground-mounted solar PV projects is between 2 and 4% lower than that WACC. The paucity of investment opportunities offering higher returns than their WACC means that the potential of this group to invest in land-based renewables will be limited in the coming years.

Municipal utilities' lower cost of capital means they may consider solar investments with returns that are not attractive for larger utilities. Some of the largest municipal utilities, which have similar decision-making processes to IOUs, have also sought to deploy capital elsewhere in recent years (e.g. Stadtwerke München's investments in UK offshore wind (RWE 2010) and Swedish onshore wind (RES 2015)). Others, such as MVV have sought to gain access to the higher returns available from investing in the riskier phases of projects by acquiring stakes in developers (a majority stake in Juwi in MVV's case (PV Magazine 2014)). However, a project promising such returns may be acceptable for the smaller municipal utilities, especially if it meets other objectives, such as a contribution to the decarbonisation of that utility's local area.

DEVELOPERS

We estimate the long-term equity investment potential from developers in solar PV is between €300 million - €600 million per annum. As with utilities and financial investors, this potential almost entirely relates to ground-mounted projects although many are now seeking to diversify into other technologies and markets following the decision to cap potential deployment from such projects. Developers may seek to retain at least a minority stake in projects they have developed as they provide a stable source of cash flow to support future investments and because it provides a commercial advantage when tendering for recurring operations and maintenance contracting work.

Developers' long-term investment potential is limited by their access to capital. Without ready access to debt capital markets and only limited access to public equity markets, most developers have only been able to fund new developments from the proceeds of selling completed projects.

A number of smaller pooled investment vehicles have listed in Germany – most recently Chorus Clean Energy in October 2015 (PV Magazine 2015) – associating themselves with the "yieldco" business models which have become popular in the UK and in particular, in the US. Yieldcos are are a listed portfolio of low risk renewable energy projects designed to provide stable and growing cash flows to mainstream equity investors. In the US model, developers have used the vehicles to retain a controlling interest in the stable cash flows from operating projects while diversifying the funding sources for new projects although many equity investors have recently lost confidence in the sustainability of the model. This model could potentially enable developers to provide long-term capital to solar and wind projects; however, appetite for the business model in Germany currently remains limited given the low interest rate environment.

FINANCIAL INVESTORS

We estimate the long-term equity investment potential from financial investors for solar PV is between €400 million - €1 billion per annum. This potential almost entirely relates to ground-mounted projects and is uncertain given that low returns have pushed many larger institutional investors and asset managers out of the market in recent years.

Implementation of the revised Solvency II framework could encourage more insurance companies to build direct investment capability, but its impact on yieldcos

is more uncertain. Only the largest institutional investors – such as Allianz and MEAG – developed capabilities for direct investment in infrastructure while the Solvency II outcome was more uncertain. Many now have separate funds to manage money for their own accounts and for third parties (i.e. acting as asset managers). Smaller insurance companies could now follow suit.

As with debt, under Solvency II, equity investments in "qualifying infrastructure" projects will be subject to lower capital charges in the final implementation of the regulation announced in September 2015 (EIOPA 2015a) and thus more attractive.

Uncertainty remains around the treatment of investments in "infrastructure corporates" as opposed to projects. The European Commission is currently seeking advice from EIOPA as to which investments in corporates have similarly low risk characteristics to investments in infrastructure projects, and should therefore benefit from reduced capital charges (EIOPA 2015b). Under the current definition of the rules, equity investments in relatively illiquid projects could attract a lower capital charge than investments in relatively liquid yieldco shares, which are not currently captured by the "qualifying infrastructure" definition. One of the principal attractions of yieldcos such as the ones in the UK in recent years (e.g. Greencoat UK Wind) has been their relative liquidity and diversification compared with investments in single projects. The future potential of yieldcos in Germany will be partly dependent on the successful resolution of this uncertainty, expected in mid-2016. The attractiveness of these vehicles may also increase when interest rates start to rise.

Competition for capital from financial investors will not just come from onshore wind projects, but increasingly from offshore wind and energy efficiency. Liability-driven institutional investors have been a sought-after source of long-term capital by solar PV developers. With many willing to accept a lower IRR for long-term stable cash yield than utility buyers, they have been willing to pay a higher price for projects. However, our interviews suggested that many larger institutional investors are seeking alternative opportunities such as offshore wind and energy efficiency, which benefit from Germany's stable regulatory framework but are marginally less competitive and hence promise higher returns.

Internet crowdfunding platforms have shown similar trends to financial investors. Our review of the German internet crowdfunding platforms such as Econeers and LeihDeinerUmweltGeld suggest that, like many financial investors, several platforms have been seeking to diversify their offerings towards property, energy efficiency, heat networks and riskier solar PV projects in emerging markets, which promise higher returns (Solarplaza 2015).

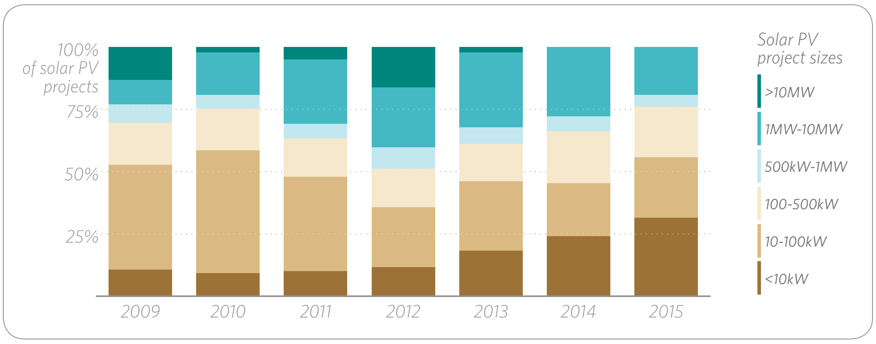
The investment potential of investors through these platforms has been limited by the new regulation for the sector. The Small Investor Protection Act, introduced from July 2015, requires those seeking to invest over €1,000 in a project to confirm that they are investing no more than twice their monthly income or have assets of at least €100,000 easily available to them (Dentons 2015). There could be scope, as witnessed in the UK, for such platforms to team up with financial investors to co-finance future developments (Big 60 Million 2015).

END USERS

We estimate the total investment potential from end users for both solar PV and onshore wind is around €8 billion per annum, of which we attribute nearly €2 billion to long-term equity. We consider the investment potential of end users in solar PV and onshore wind together as we see investors to be agnostic between the technologies and will invest in whichever is the appropriate local opportunity. This potential almost entirely relates to rooftop solar projects with a capacity of less than 100kW and community scale onshore wind farms with a capacity of less than 1MW, and is split around 70/30 between small and large end users. This is less than in the boom years for the industry in 2009-2010 and closer to the level of actual investment in 2012.

End users are motivated to a lesser degree by financial returns and our interviews showed that those who are motivated by financial returns use a wide variety

Figure 13: Smaller projects have remained most resilient to the fall in financial returns



Source: Fraunhofer ISE

of return metrics (including interest rate and payback period as well as IRR). Figure 13 illustrates that the share of the smallest projects (below 100kW) being installed has risen sharply as feed-in tariffs have fallen since 2012. We found that small end users could be willing to invest to meet non-financial objectives even if the expected financial return is very low.

The availability of roof space, rather than access to capital, is the effective constraint on small end user investment in rooftop solar. While the investment potential of larger commercial and industrial users is limited by similar factors as for utilities and developers (credit quality, access to capital, competing investment opportunities), the investment potential of smaller end users is much less constrained, provided that the right policy incentives are in place.

Small end user finance is made up of a mixture of savings, home equity loans and unsecured personal or small business loans. Banks provide these loans based on the creditworthiness of the individual or the available security (in the case of home equity loans, the house) and repayment comes from the earnings or resources of the borrower, rather than the asset that the loan is used to acquire. When banks assess concentration risk, they will therefore assess it in relation to the customer group, rather than in relation to the renewable energy business. With Bundesbank data showing new long-term lending to households averaging at between €1 to €2 billion per month since 2010, we do not see lending capacity as an effective constraint on small end user investment potential (Deutsche Bundesbank 2016). This means that the effective constraint on small end user maximum investment potential is therefore the available roof space.

Government policy has already narrowed the range of potential investors and could continue to do so further, risking a shortfall compared with deployment targets. While end users have been more resilient to the fall in financial returns, deployment of even the smallest projects dropped by 70% in absolute terms between 2012 and 2014. Government policies introduced over this period have reduced the potential investor base in the solar sector in general, and some of the options currently under discussion could do so further, specifically:

1. **EEG 2014 has started to phase out the exemption from paying the EEG surcharge on self-consumed electricity**. With only the smallest installations (smaller than 10kW) remaining exempt, this could make commercial self-consumption (i.e. for supermarkets, warehouses, and local manufacturing) more unattractive for most commercial and industrial end users who pay the retail price rather than the wholesale price for electricity. This policy has reduced the investment potential from both the largest small end users and smallest large end users.
2. **Proposed smart metering obligation could further impact affect the smallest end users**. The proposed obligation to install smart meters for installations larger than 7kW could, if implemented, further knock the investment potential of small end users due to the costs associated with this technology.
3. **Uncertainty around the regulation of co-operatives has stunted the investment potential of end users**. According to the results of the annual survey of the German Co-operative and Raiffeisen Confederation (DGRV) released in July 2015 (DGRV 2015), only 54 energy co-operatives were founded in 2014, a fall of 60% compared to the 129 founded the previous year. This was partly due to a period of prolonged uncertainty for the vehicles during which the financial regulator BaFin had queried whether these organisations should be regulated as collective investment schemes (Osborne Clarke 2015). The current uncertainty over the future shape of the German electricity market could slow or stop any short-term recovery. In addition, the growth of internet crowdfunding platforms has provided individuals with an interest in environmental issues with another channel through which to invest in renewable energy projects.

Higher capital costs and longer payback periods disadvantage solar PV and other renewable energy generation among larger end user investors, when compared to other energy efficiency measures. Our interviews largely confirmed the findings from the extensive literature on barriers to take-up of energy efficiency measures (DECC 2014). These suggest that – whether self-consumed or not – generation from renewable energy facilities (in particular, solar PV) is often seen as one of a range of options to reduce (net) energy costs in the short-term and to provide a longer-term hedge against rising retail electricity prices. Solar and other generation systems are disadvantaged compared to other measures, such as LED lighting, given their relatively higher proportion of capital expenditure in the total lifetime cost.

The developing storage market could drive demand for solar PV systems later in the decade. Battery storage systems could provide some flexibility services to grid operators but are not currently eligible to participate in reserve markets. While subsidies for battery systems are tied to the installation of solar PV systems (through the KfW solar-plus-storage product (GTM 2015)), the storage market could be a driver of demand for PV systems installed by larger end users seeking to avoid exposure to peak prices.

3.4.2 ONSHORE WIND

The onshore wind equity investor base for the onshore wind projects with the strongest wind resources overlaps substantially with that for ground-mounted solar PV projects as they provide financial investors and the larger utilities with stable cash flows, low operational risk and the ability to invest at scale. However, while the growth of the sector remains geographically broad-based, municipal utilities and end users will continue to be a critical source of capital to provide investment at a level higher than the historic run-rate.

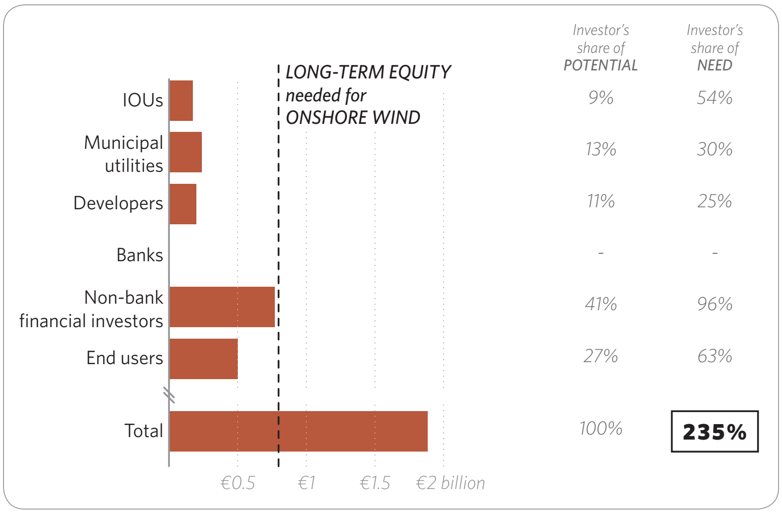
We estimate the long-term equity potentially available to be around €10 billion per annum, more than two times the amount required.

With sites for new greenfield projects increasingly limited by planning laws, the share of new capacity coming from the repowering of existing sites is likely to rise, drawing potential investment from investors seeking higher returns, such as utilities.

The long-term equity potentially available for onshore wind is more than two times the amount required. Around €10 billion per annum could be available for investment, while only €4 to €4.5 billion per annum is required to meet the 2020 targets. Figure 14 shows that this is split between IOUs, municipal utilities, developers and financial investors.

There is significant crossover between investors interested in utility-scale ground-mounted solar and onshore wind. Similarly, larger end users could equally target rooftop solar or onshore wind, depending on opportunities in the local area.

Figure 14: Onshore wind potential by investor group



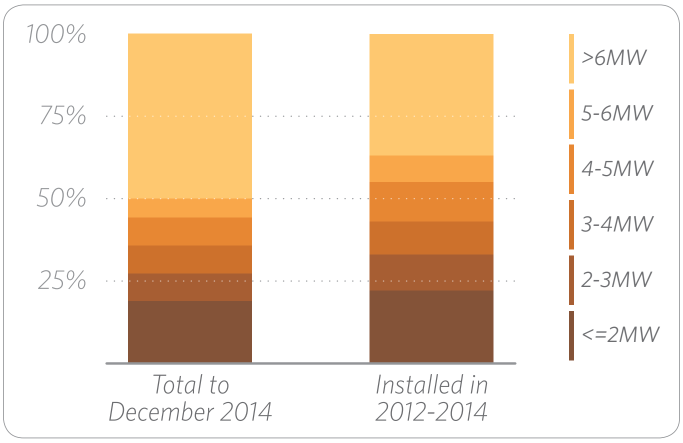
Source: CPI

KEY FINDINGS

Planning laws are making greenfield developments increasingly challenging. Following a record year of investment (€5.4 billion on a 4.7GW gross capacity increase) in 2014, net capacity additions fell to 3.5GW (Deutsche Windguard 2016). A number of new state-level planning restrictions have been introduced in recent years, which seek to place restrictions on new developments close to residential settlements. Bavaria's "10H Law", introduced in November 2014, is a particularly prominent example, requiring new wind farms to be situated away from the nearest dwelling by at least ten times the height of the maximum turbine tip. This is likely to have the effect of severely restricting the development of a recently buoyant wind market in the state.

The restrictions imposed by German planning laws and relatively high population density have resulted in the relatively low average size of German onshore wind sites. As Figure 15 shows, close to 50% of onshore wind farms as at the end of 2014 had an installed capacity of 6MW or less. This has historically weighted the market away from larger utilities and towards smaller utilities and end users.

Figure 15: Size distribution of onshore wind projects has remained fairly stable over time



Source: BMWi

Significant repowering opportunities could attract new types of investor once regulatory uncertainty is resolved. Investments to "repower" existing facilities, i.e. to replace existing older turbines with more powerful ones, have grown significantly in recent years. As illustrated in Figure 16, there was a boom in 2014 as the government's "repowering bonus" (which provided a preferential feed-in tariff to repowered projects) expired at the end of the year. Experience from other countries suggests that local opposition to repowering existing sites can be less significant than to new developments, meaning that repowered sites could become an increasingly important part of the German market in the coming years.

No successor policy to the repowering bonus has yet been announced and it remains unclear as to whether repowering projects would be subject to competition against greenfield projects in a future auction. However, the nature of the projects is likely to attract investors such as utilities and financial investors seeking scale. As the earliest developed wind sites in Germany, these are likely to have among the best wind conditions and significant space for a large number of turbines.

UTILITIES

We estimate the long-term equity investment potential from utilities for onshore wind is between €400 million - €700 million per annum. This potential mostly relates to municipal utilities, whom we expect to favour this technology over solar PV given the likely higher available returns and the greater number of opportunities compared with ground-mounted solar PV. Provided that the right projects are available, municipal utilities have the potential to continue increasing their investment levels as they seek to diversify their power procurement and meet local renewables targets.

EnBW's attempt to buy the developer Prokon's operational portfolio suggests that portfolios of repowering opportunities are likely to be attractive for the Big 4 utilities, although their strained financial standing and greater focus on offshore wind means that this potential is likely to be limited, at least in the next few years.

Return on capital will be most attractive for repowered projects, while greenfield project returns will be well below the cost of capital for IOUs, making them less attractive. As with solar PV projects, our analysis suggests that project returns for greenfield onshore projects are likely to be lower than investor-owned utility WACCs, meaning that investment is unlikely to be attractive. We expect the capital expenditure associated with repowering projects to be somewhat lower than that for a greenfield project, although there is significant uncertainty about the price, which utilities would have to pay to secure existing sites.

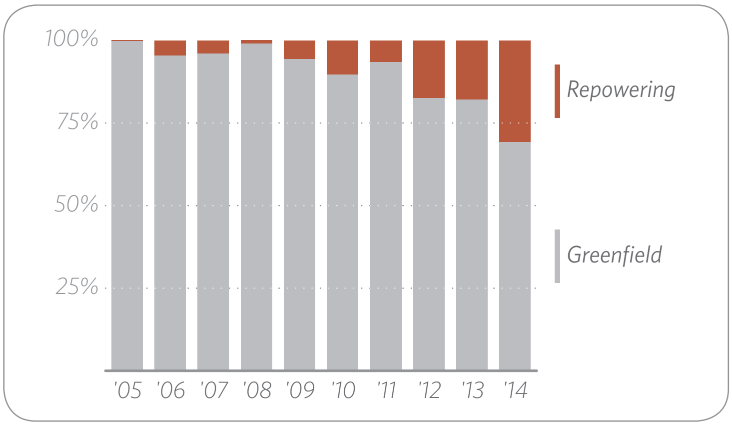
Available returns for onshore wind projects are likely to vary significantly depending on their location in Germany, as shown in Table 14, as there is a wide range of wind resource:

Table 14: Onshore wind project returns are sensitive to load factor

ESTIMATED PROJECT WACC (FID 2020, AUCTION PRICE €80/MWH) (%)					
LOAD FACTOR (%)	23	24	25	26	27
GREENFIELD	3.8%	4.3%	4.7%	5.2%	5.6%
REPOWERED	4.2%	4.7%	5.2%	5.6%	6.1%

Source: CPI

Figure 16: Repowering is increasingly driving onshore wind capacity expansion



Source: Fraunhofer ISE

Policy treatment of low load factor locations will impact the investor mix. Submissions to the network regulator by Germany's four transmission grid operators suggest generation capacity expansion in the years 2016-2023 will be well-spread across the country, as illustrated in Table 15. Unless low load factor locations continue to receive differentiated support, a significant proportion of new capacity may only be attractive for municipal utilities co-investing with co-operatives or other end users, as low single digit returns are likely to be unattractive for financial investors and IOUs.

Table 15: Current plans for onshore wind expansion evenly spread across the country

LAND	CUMULATIVE CAPACITY TO 2014 (GW)	BNETZA 2023 MID CASE (GW)	IMPLIED ANNUAL INCREASE (GW)	BNETZA 2023 HIGH CASE (GW)	IMPLIED ANNUAL INCREASE (GW)
Lower Saxony	8.2	9.6	0.2	14.2	0.8
Brandenburg	5.5	5.9	0.1	8.1	0.3
Schleswig-Holstein	5	6.3	0.2	13	1.0
Anhalt-Saxony	4.3	4.3	0.0	5.4	0.1
North Rhine-Westphalia	3.7	5.7	0.3	10.3	0.8
Mecklenburg-Pomerania	2.7	4.1	0.2	8.4	0.7
Rhineland-Palatinate	2.7	3.2	0.1	6	0.4
Bavaria	1.5	2	0.1	4.3	0.4
Hesse	1.2	1.7	0.1	3.4	0.3
Thuringia	1.1	2.7	0.2	6.1	0.6
Saxony	1	1.1	0.0	1.4	0.1
Baden-Wurttemberg	0.6	1.9	0.2	4.4	0.5
Saarland	0.2	0.3	0.0	0.5	0.0
Bremen	0.2	0.2	0.0	0.2	0.0
Hamburg	0.1	0	0.0	0.1	0.0
Berlin	0	0	0.0	0.1	0.0
Total	**38**	**49**	**1.2**	**85.9**	**4.9**

Source: BNetzA Netzentwicklungsplan

DEVELOPERS

We estimate the long-term equity investment potential from developers in onshore wind assets is between €300 million - €700 million per annum. We see this as predominantly coming from domestic developers or independent power producers, although this capacity may not be sufficient to fund all the investment required given that (1) the investment required is higher than the historic run rate and (2) the disparate (unconsolidated) number and small size of German renewable energy project developers means that their access to capital is limited.

However, a recent increase in investments from the likes of ERG (Italy) and Cez (Czech Republic) suggests that there could be increasing competition from international investors for the best greenfield and repowering projects.

Developers' long-term investment potential is limited by access to capital. Without ready access to debt capital markets and only limited access to public equity markets, most developers have only been able to fund new developments from the proceeds of selling completed projects.

PNE are one of the largest German wind developers, which has a public listing (market capitalisation of around €150 million[2]) and has announced plans to sell a stake in what could be the first wind-focussed yieldco in the German market. A successful sale or listing of the vehicle could provide PNE with a method of more quickly recycling capital from its developments. However, market appetite for such a vehicle remains uncertain in light of the US yieldco "crash" in the second half of 2015.

FINANCIAL INVESTORS

We estimate the long-term equity investment potential for onshore wind from financial investors is between €400 million - €1 billion per annum. This is the same level as for solar PV, as we expect most investors will be agnostic between the specific risks of the two technologies. This potential is likely to be lower than investment levels in previous years as falling returns have pushed many larger institutional investors and asset managers out of the market.

2 As at 4 April 2016

The same factors will affect the investment potential of financial investors in onshore wind projects as in solar PV projects, including (1) whether the investor has in-house direct investment expertise; (2) whether developers and investment banks can structure projects to achieve the "qualifying infrastructure" classification under Solvency II; (3) whether an investment has the right return profile to fit within a given portfolio; and (4) whether the return on offer compares favourably with the expected returns on other retail investments.

We expect that the best repowering projects could attract investment from opportunistic international financial investors who have historically not invested in the German market, such as the recent acquisition of the repowered 89MW Klettwitz project by British asset manager John Laing in October 2015, which was part financed with a privately-placed debt instrument from public pension fund Bayerische Versorgungskamme.

END USERS

We estimate the total investment potential from end users between solar and onshore wind is around €8 billion per annum, of which we attribute nearly €2 billion to long-term equity. This potential almost entirely relates to rooftop solar projects with a capacity of less than 100kW and community scale onshore wind farms with a capacity of less than 1MW, and is split around 70/30 between small and large end users.

The same factors will affect the investment potential for end user investors in onshore wind as in solar PV although the relatively higher importance of co-operatives and the local direct marketing business model and the relatively lower importance of physical self-consumption models mean that small-scale onshore wind projects have been affected to an even greater degree than utility-scale solar projects by historic policy changes that have reduced returns.

Co-financing schemes with municipal utilities have the scope to draw in capital from individuals and small businesses, providing an alternative to co-operatives and investments in developer/ independent power producers, such as Prokon. However, these are likely to attract those investors more motivated by financial returns, which according to trend:research and Leuphana Universität Lüneburg (2013) make up a higher proportion of small end users than for solar PV.

3.4.3 OFFSHORE WIND

Offshore wind projects are complex and offer higher returns and thus present opportunities for those seeking higher returns to make large-scale investment. The pool of long-term investors has widened considerably over the last two years as the German offshore sector has started to build out a series of projects with delayed grid connections.

We estimate the long-term equity potentially available for offshore wind to be around €1.5 billion per annum, 55-70% more than required.

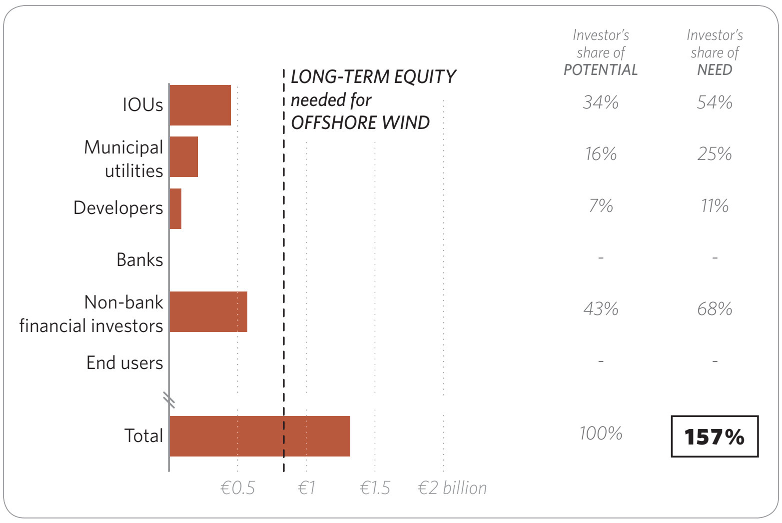
IOUs, who have been a key investor group in the growth of the European offshore sector, are increasingly capital constrained and thus will increasingly take the opportunity to sell down stakes to financial investors, enabling them to recycle their capital faster and boost their returns.

The long-term equity potentially available for offshore wind is around 55-70% higher than required. Around €1.5 billion per annum could be available for investment, while only €0.8 billion per annum is required to meet the 2020 targets. Figure 17 shows that this is fairly evenly spread between IOUs, municipal utilities, developers and financial investors.

KEY FINDINGS

EU State Aid approval limits support to a specific group of projects. While our analysis shows that there is more capital potentially available for investment in

Figure 17: Offshore wind potential by investor group



Source: CPI

offshore wind than required, there is currently no scope to expand investment in this sector before 2020, as the current EU State Aid approval (EC 2015) only provides for the German government to support a limited number of specific projects. As set out in Table 16, of the projects required to be delivered to meet the target of an additional 4GW connected by 2020, financing has been committed for more than half. The achievement of the targets is thus conditional on the financing of six specific projects, although the availability of equity for those may be conditional on the refinancing of existing projects.

UTILITIES

We estimate the long-term equity investment potential of utilities for offshore wind is between €600 million to €900 million on average per annum. This is dominated by the German IOUs, all of which are experienced in constructing and operating offshore wind farms and which are attempting to increase the share of group earnings from renewable power generation.

This long-term investment potential is higher than the recent trend for the municipal utilities but lower than the recent trend for the IOUs. The increasing desire of IOUs to recycle capital through sell-downs of minority or even majority stakes means that a smaller proportion of their investment should be regarded as long-term and a larger proportion as short-term. This recycling is increasingly taking place earlier, during the construction phase, as shown by recent transactions, such as the multi-step change in the ownership of the Baltic 2 wind farm and E.On's investment in the construction-phase Rampion in the UK (ReNews 2015a). The increasing availability and variety of long-term debt and equity investors interested in the sector offer these utilities the opportunity to increase the return on its investment in the project by selling down a stake at a high price to an investor with a lower required return.

Offshore wind project returns are likely to be higher than utilities' cost of capital and so could make them attractive investments for this investor group. Our analysis suggests that project returns for offshore wind projects are likely to be around 8-10% or higher than most investor-owned utility WACCs. These investments could therefore be attractive for incumbent IOUs in particular given their strategic commitment to the German market. However, the current financial standing of the incumbent IOUs and the increasing size of offshore wind projects means that it is now unlikely that a utility will seek to concentrate so much of its limited investment budget in a single asset.

Table 16: Offshore wind capital to 2020 almost secured

PROJECT	CAPACITY (MW)	INVESTMENT REQUIREMENT (€BN)	LIKELY FINANCING METHOD	PRINCIPAL SPONSORS	PROJECT STAGE
Gode Wind 1 and 2	582	2.2	Balance sheet	Dong Energy	Construction
Sandbank	288	1.2	Balance sheet	Vattenfall	Construction
Wikinger	350	1.4	Balance sheet	Iberdrola	Construction
Veja Mate	400	1.9	Project Finance	Highland Group, Siemens, Copenhagen Infrastructure Partners	Pre-construction
Nordsee 1	332	1.3	Project Finance	Northland Power, RWE	Pre-construction
Nordergrunde	110	0.4	Project Finance	WPD	Pre-construction
Borkum Phase 2	200	0.8	Project Finance	Trianel, EWE	Pre-financing
Borkum Riffgrund II	450	1.8	Project Finance	Dong Energy	Pre-financing
Merkur	400	1.6	Project Finance	DEME Concessions	Pre-financing
Arkonabecken Sud Ost	385	1.5	Balance sheet	EON	Pre-financing
Deutsche Bucht	252	1.0	Project Finance	Highland Group	Pre-financing
Hohe See	497	2.0	Balance sheet	EnBW	Pre-financing
Total	4,246	17.2			

While the returns may be attractive, the projects are likely to be too large and high risk for even the largest municipal utilities to lead by themselves. These utilities may choose to partner with each other (e.g. Trianel and EWE plan to invest in Borkum West (ReNews 2015c)) or with one of the incumbent IOUs (e.g. Vattenfall and Stadtwerke München have taken 51%/49% stakes in Sandbank (ReNews 2014)), which has access to sufficient capital and the technical expertise to manage the construction and operation of these assets.

DEVELOPERS

We estimate the long-term equity investment potential from developers in offshore wind assets is between €100 million and €400 million per annum. We see this as principally coming from large experienced international developers, such as Dong Energy and Iberdrola, although a number of the larger German developers – in particular, wpd – have shown a clear strategic intention to make both long-term and short-term investments in offshore wind projects.

These international developers typically have investment grade credit ratings and hence ready access to a range of capital instruments although, in a similar way to the German IOUs, they have also recently sought to sell down stakes to institutional investors.

FINANCIAL INVESTORS

We estimate the long-term equity investment potential from financial investors in offshore wind farms is between €600 million - €1.1 billion per annum. This is slightly higher than the potential for onshore wind and solar PV as it takes into account both that (1) many of the smaller domestic financial investors in German renewable energy will find direct investment in offshore wind projects too complex and risky; and that (2) returns from onshore wind farms and solar PV will be unattractive for a larger number of international institutional investors and asset managers, such as Copenhagen Infrastructure Partners, who have experience with offshore wind investments from the UK and Belgian markets, for whom returns from onshore wind farms and solar PV will be unattractive.

This is higher than recent history as the immature technology and contractual frameworks for offshore wind projects had previously limited the investment base to utilities, developers and companies involved in the supply chain.

The same factors will affect the investment potential of financial investors in offshore wind projects as in solar PV and onshore wind projects, including (1) whether the investor has in-house direct investment expertise; (2) whether developers and investment banks can structure projects to achieve the "qualifying infrastructure" classification under Solvency II; and (3) whether an investment has the right return profile to fit within a given portfolio.

The potential for asset managers such as infrastructure funds is larger in offshore wind than for onshore wind and solar PV given the higher returns available. These investors may have a greater focus on equity IRR as an investment metric than institutional investors and thus may seek to invest in projects with high gearing. Conversely, institutional investors may prefer more lowly-levered projects in order to safeguard their desired predictable cash yield. The potential of each group to invest will therefore depend to a large extent on the financial structure put in place by the sponsor.

Financial investors' lack of technical expertise means they will only be able to invest if there are appropriate contractual structures and experienced principal counterparties in place. While financial investors increasingly have in-house direct investment expertise, they mostly do not have the technical expertise necessary to manage power plant operations. The operation of an offshore wind farm is significantly more complex than for onshore renewables and the number of counterparties able to provide such services is much more limited, so an experienced principal (for example, operations and maintenance) contractor will be critical. The complexity of a wind farm's financing structure also means that a clear governance structure will be a prerequisite for the large scale participation, in particular, of institutional investors.

END USERS

End users generally do not have the potential to invest in offshore wind farms and are unlikely to be able to do so in future. Private investors and small corporates may be able to invest in offshore wind farms through pooled investment vehicles, but we would classify these as "other" financial investors, alongside internet crowdfunding.

4. Impact of policies on investor decision making

4.1 Introduction

In 2000, Germany introduced its first version of the 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.**

4.2 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. Within each of these categories, interviewees and our research highlighted specific concerns, which are illustrated in the box below. A review of these issues, in combination with advice from our interviewees and the advisory panel for this project, identified ten policy areas that are of the greatest near to medium-term concern (Table 17).

Table 17: 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)?

Policies affect both the deployment and cost effectiveness objectives that are driving German renewable energy policy. Figure 18 identifies the relative importance of the key policies for renewable energy investments in Germany over the next five years. However, impact on both deployment and cost effectiveness will evolve over time. In Chapter 5.5, we provide an outlook of how the relevance of each key policy area might shift in the long term. A detailed discussion of the key policy areas is presented in the subsequent chapter.

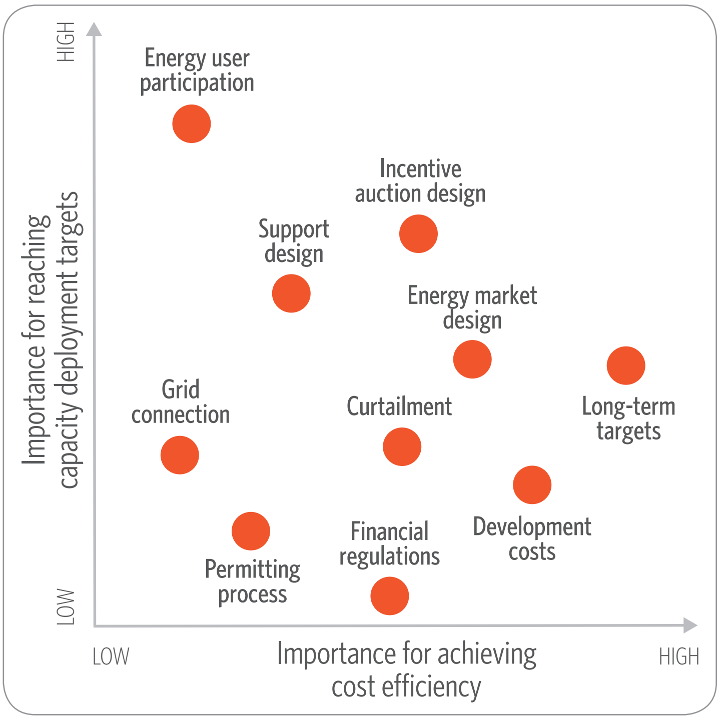
Combining the key policy areas' importance for both main objectives of the German energy transition leads to the conclusion that the three most important in the medium term are: end user participation, incentive auction design, and long-term targets.

- **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 mostly 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 several aspects with regard to ten key policy areas. In discussions with our interviewees, we have defined the most important questions for policymakers (Table 18) and address these questions in Chapter 5.1.

Figure 18: Relevance of key policy areas in the medium term



Source: CPI analysis based on interviews

Table 18: 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

4.3 Ten key policy areas are most relevant for the German energy transition

4.3.1 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

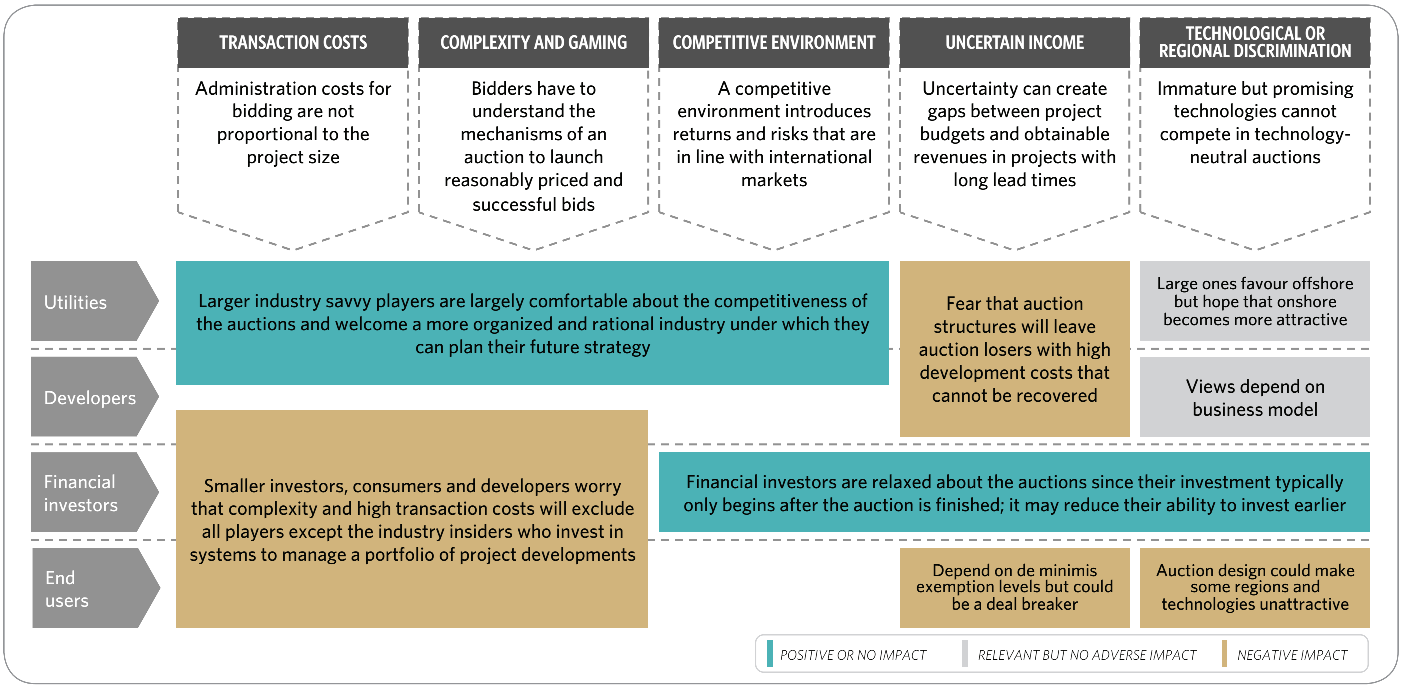
With the revised EEG 2014, Germany decided to introduce competitive auctions to set the price for renewable energy projects by 2017. Under these auctions, each potential renewable energy project will submit a bid, with the lowest cost bids accepted up to the point where deployment targets are met. Germany 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 governments goals for renewable energy.

Impact on investors

Auctions, and their design, will affect each investor, but in different ways (Figure 19).

- **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 19: 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 19 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 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

Table 19: 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

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.

4.3.2 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.

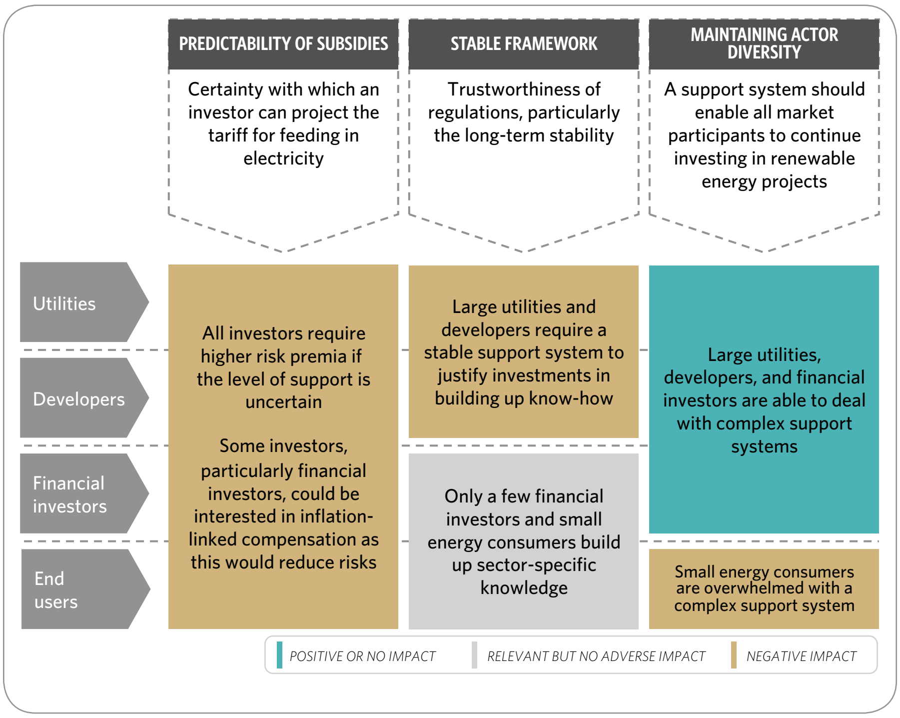
The design of a support system influences how a renewable energy project can be financed. A higher perceived risk leads to two possible outcomes. First, the required return of equity and debt investors increases as it has to account for a greater margin of error. Second, the availability of debt capital for a project will decrease because capital providers are less willing to lend against less certain projected cash flows.

Impact on investors

Support design affects all investor groups (Figure 20):

- **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 20: 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. Table 20 gives an overview of important support system design elements and how they can affect the pool of potential investors.

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 20: 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 cost of equity is the same for each scenario and the results are shown in Figure 21.

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 because of its higher leverage compared to offshore

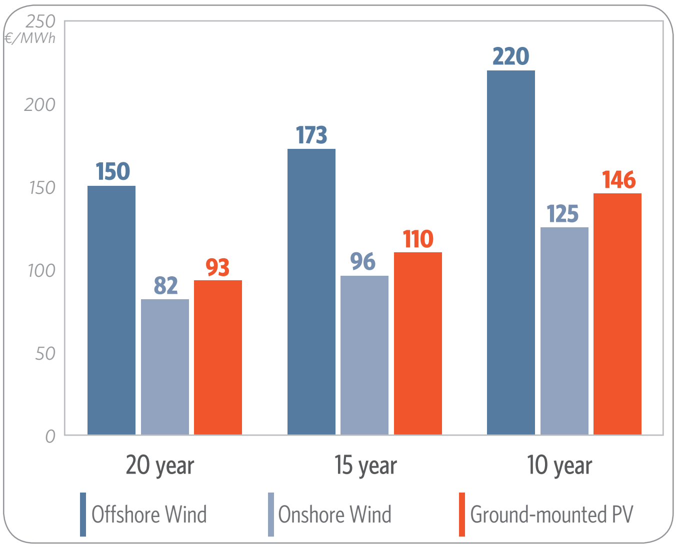
Addressing inflation risk

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 21: Impact of a shorter support period

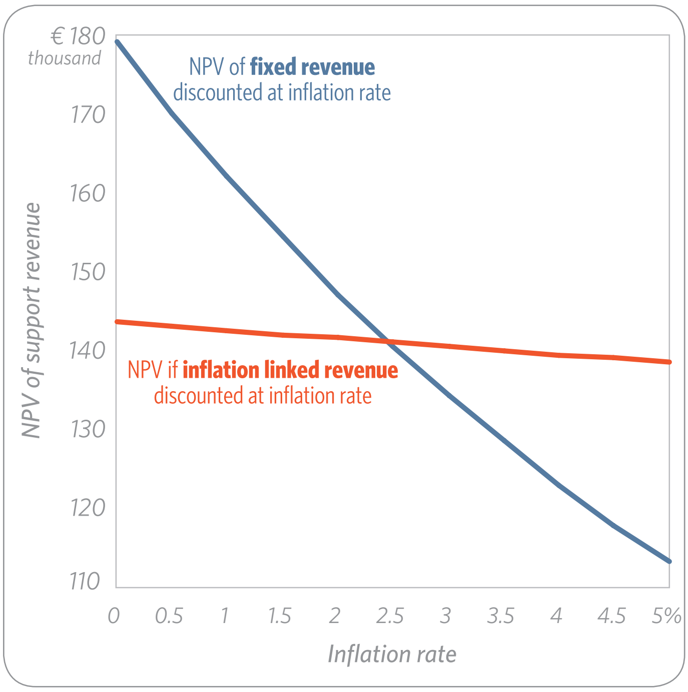


Source: CPI analysis

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 22: 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. Below 2.5% inflation the NPV of the index-linked support payments are lower than for the fixed payments, and the lower the inflation rate the greater the differential. Conversely, if inflation is greater than 2.5% the NPV of the inflation linked support payments start to become more expensive than the fixed revenue payments (Figure 22)

Using the example above, the NPV of revenue support compared to the base case is 4% less if inflation is at the predicted 2% level over the entire 20 year support duration. The greater the difference between return requirements for institutional investors compared with other equity and debt holders, the more attractive an inflation linked tranche of revenue support would be to policymakers.

4.3.3 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 21). 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', i.e. 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

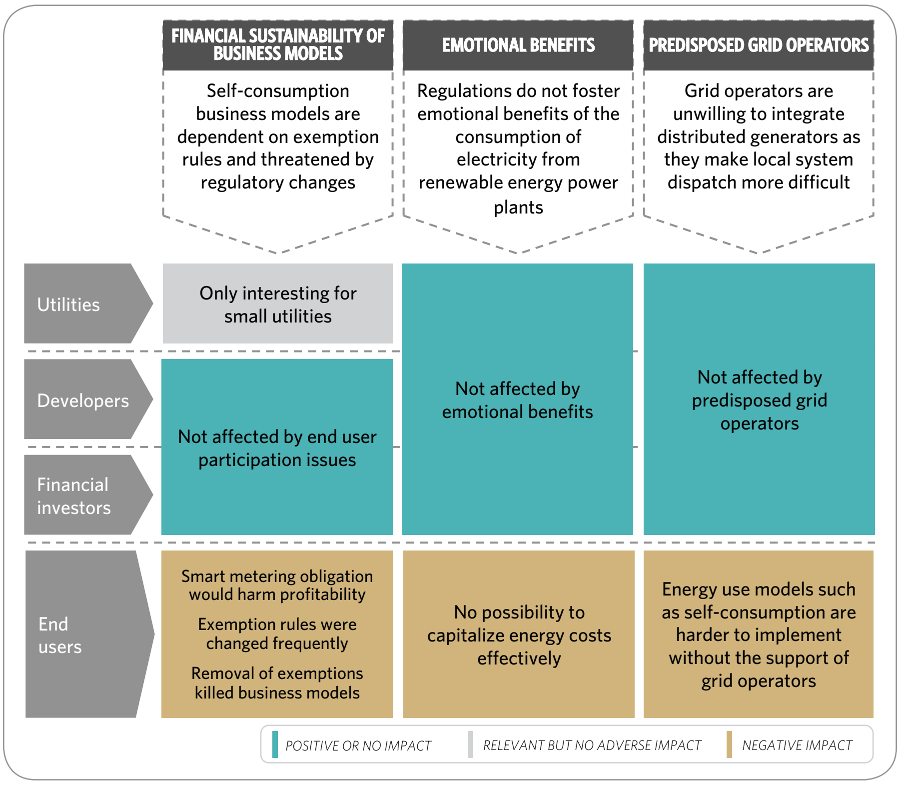
End user participation issues mainly affect **small end users** (Figure 23). The sustainability of self-consumption business models is doubtful because of the uncertainty around future regulations. Exemption rules (e.g. charges, taxes, and EEG surcharge) for self-consumption models were changed frequently 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 21: 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 23: 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.

4.3.4 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 24): 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.

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 not be willing to invest.

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

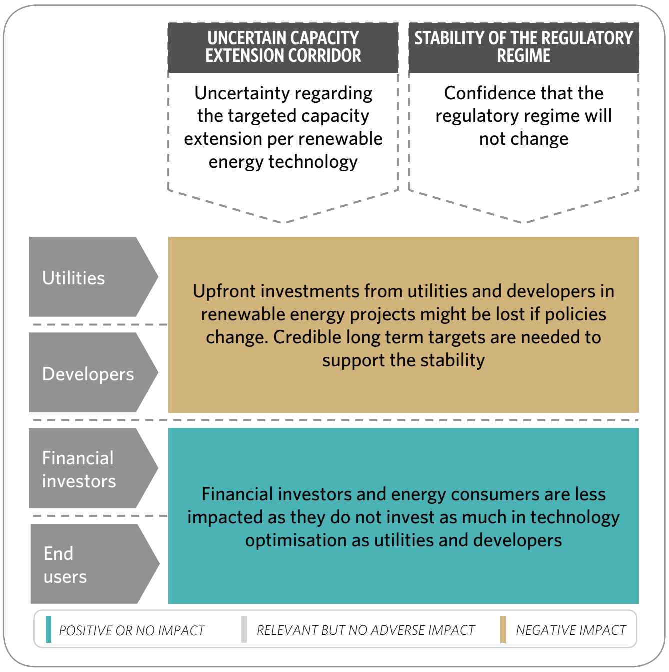
Figure 25 illustrates the impact of investments in process improvements for the construction of PV systems. Large-scale systems are those that are built and operated by developers and utilities, i.e. companies that invest in process improvements. Over the period from 2006 to 2014, the non-module cost 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.

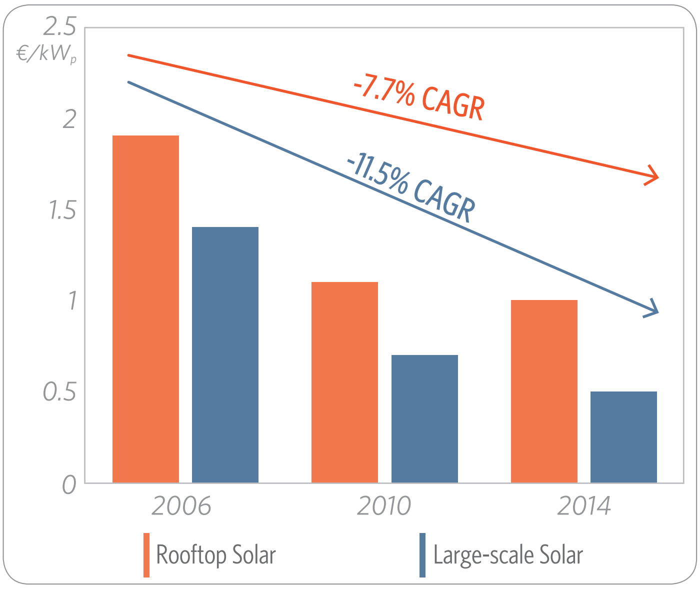
Less deployment reduces the level of cost-savings arising from cumulative experience, making the technology more expensive than it otherwise might have been. Additionally, cuts in long-term targets can result in greater levels of uncertainty for early-stage investors in other renewable technologies which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

Figure 24: Issues regarding long-term targets



Source: Interviews

Figure 25: Impact of business model investments



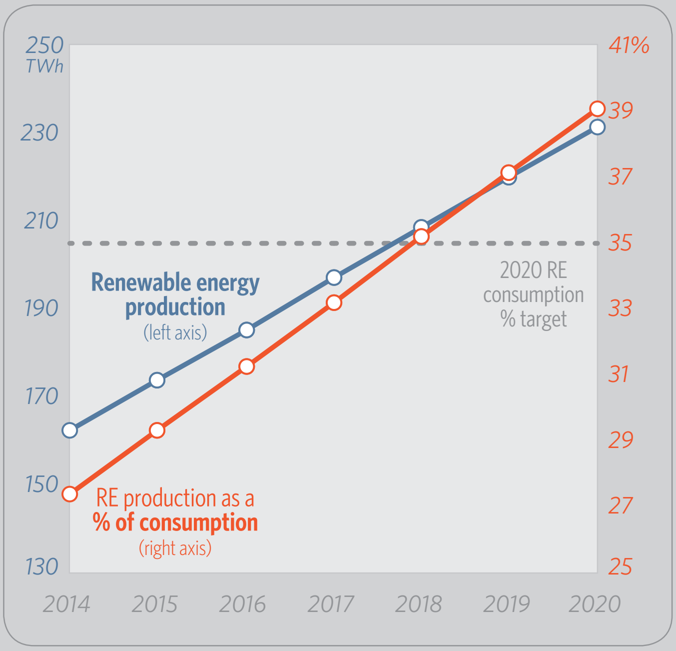
Source: IEA-PVPS 2006-2014

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 below 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 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 22: Impact of changes in long-term targets for offshore wind, from 800 MW to 400 MW

	BASE CASE	TARGET REDUCTION CASE	% CHANGE
Capacity installed (MW)	800	400	-50%
Generation (GWh)	2,945	1,473	-50%
Electricity price (€/MWh)	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

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.

acceptance.

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 23 and Figure 26.

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

Table 23: 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

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.

4.3.5 GRID CONNECTION

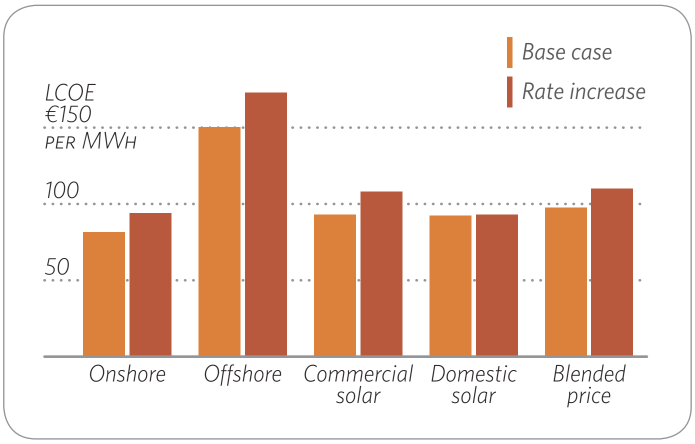
Key consideration for policymakers:

- Grid connection issues are not major medium term concerns for investors

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

Figure 26: Impact of changes in interest rates on different technologies



Source: CPI analysis

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 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

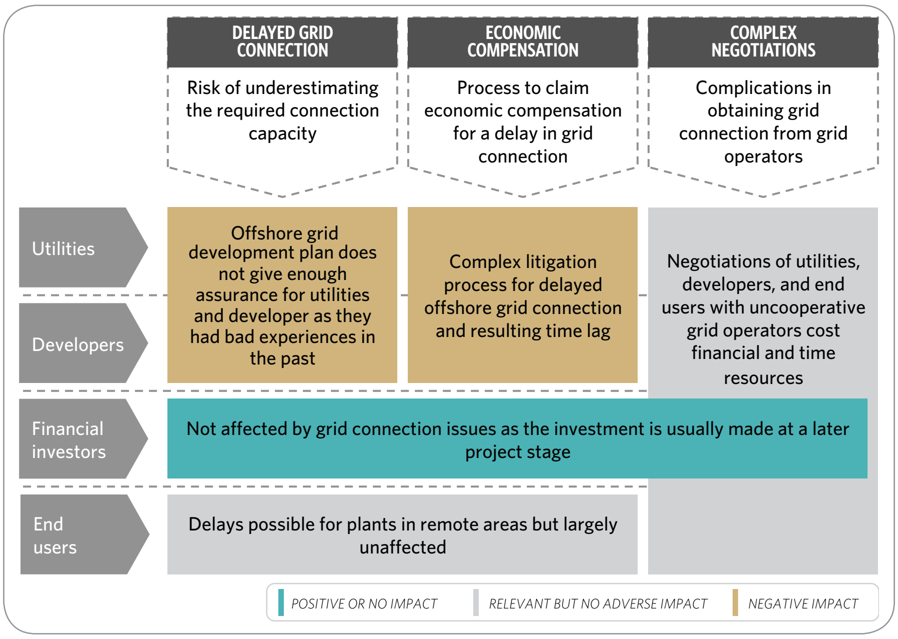
Grid connection issues affect utilities, developers, and end users (Figure 27):

- **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 system 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 27: Issues regarding grid connection



Source: Interviews

4.3.6 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, that is 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.

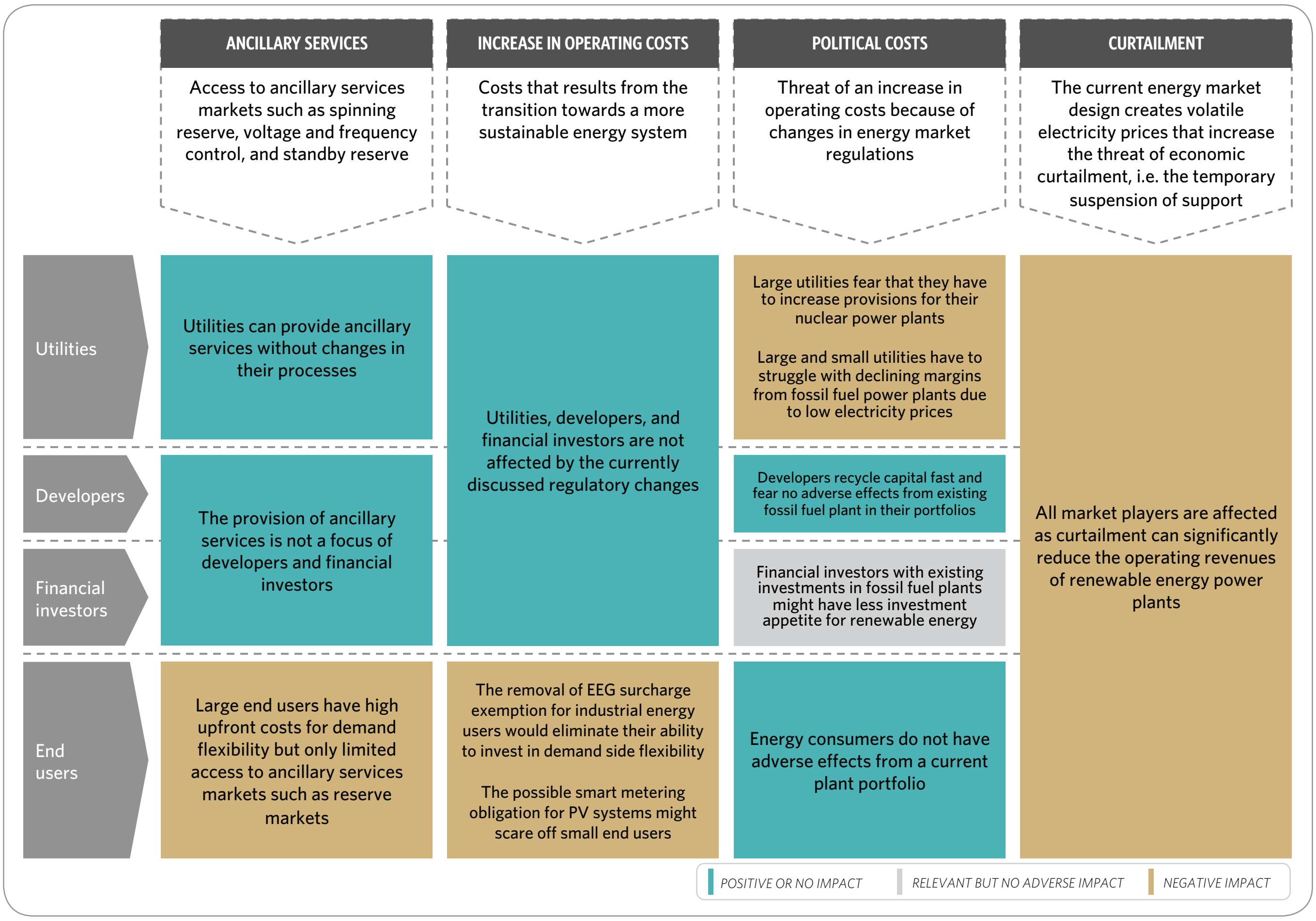
Energy market design determines not only the price setting mechanism but also the broader aspects of market access. For example, it determines qualification criteria for participating in the electricity and ancillary services markets. Strict technological criteria for participating in the energy market, 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 28):

- **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 book 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

Figure 28: Issues regarding energy market design



Source: Interviews

a problem because of the additional costs 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.

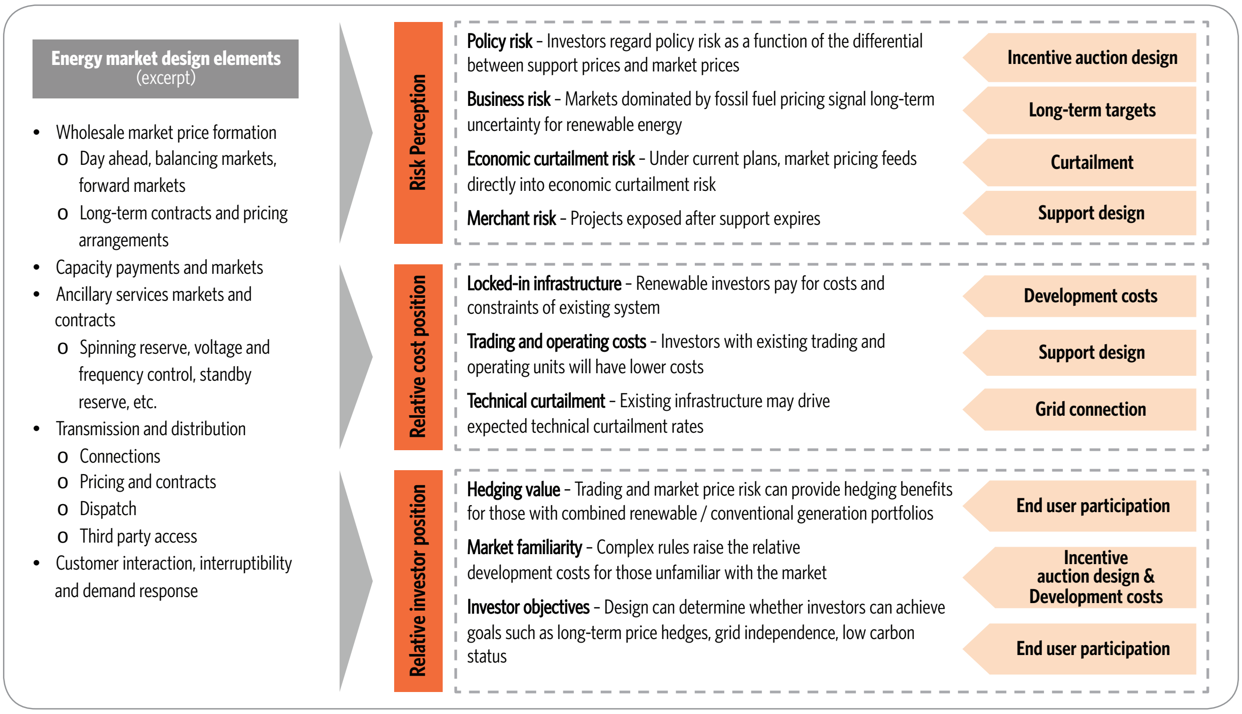
CHANGING RULES COULD CREATE NEW RISKS AND FAVOUR ONE GROUP OF INVESTORS OVER OTHERS

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 29 gives an overview of the energy market design elements and how they influence other polices.

Figure 29: Link between energy market design elements and other polices



4.3.7 CURTAILMENT

Key considerations for policymakers:

- Most investors are not yet focussed 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.

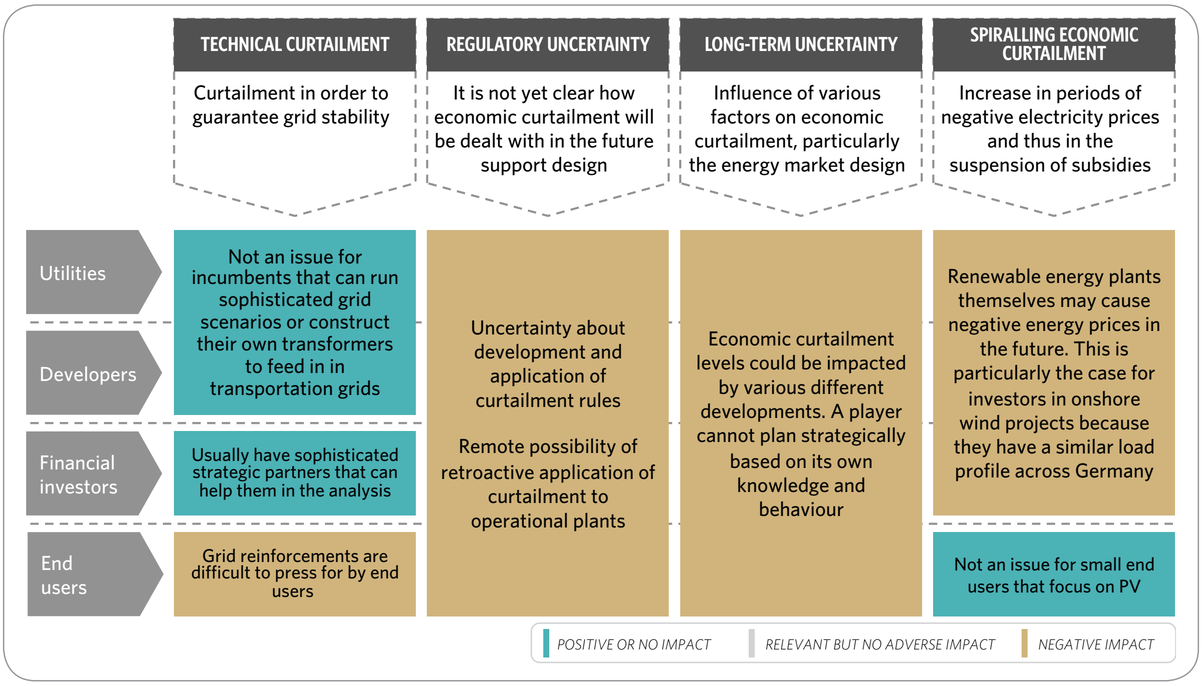
Economic curtailment is a more contentious issue. This issue is not well understood and different investors have widely diverging views on the potential adverse effect of economic curtailment on their projects. Some investor groups have not analysed the potential impact of economic curtailment on their 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 30):

- **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 30: 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 31 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.

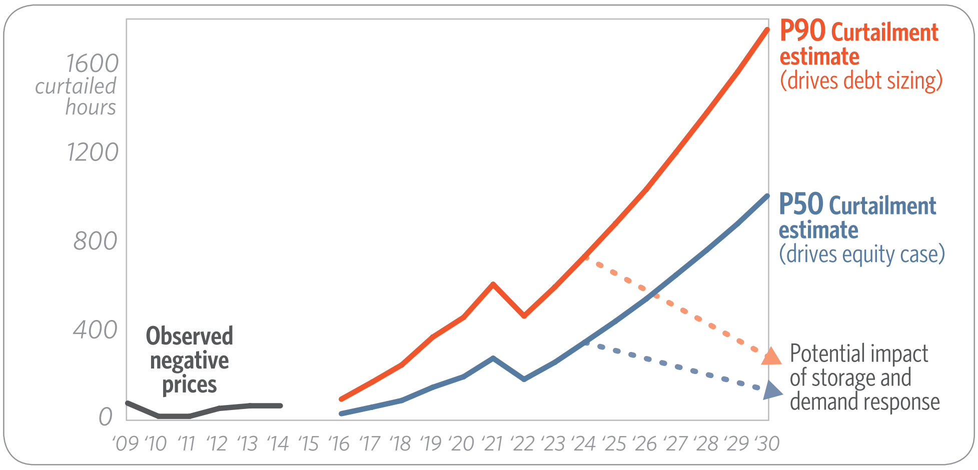
Figure 31 shows that both the P50 and P90 curtailment will rise steadily over the next 15 years, except for 2021-2022 when nuclear power plants come off line in Germany. Since the output from nuclear power plants is relatively inflexible, with more nuclear power on the system there is a higher chance 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.

Figure 32 represents the estimated effect of economic curtailment on the LCOE. Economic curtailment affects both revenue – by affecting the 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 shows that possible leverage

Figure 31: Estimated negative prices 2016-2030



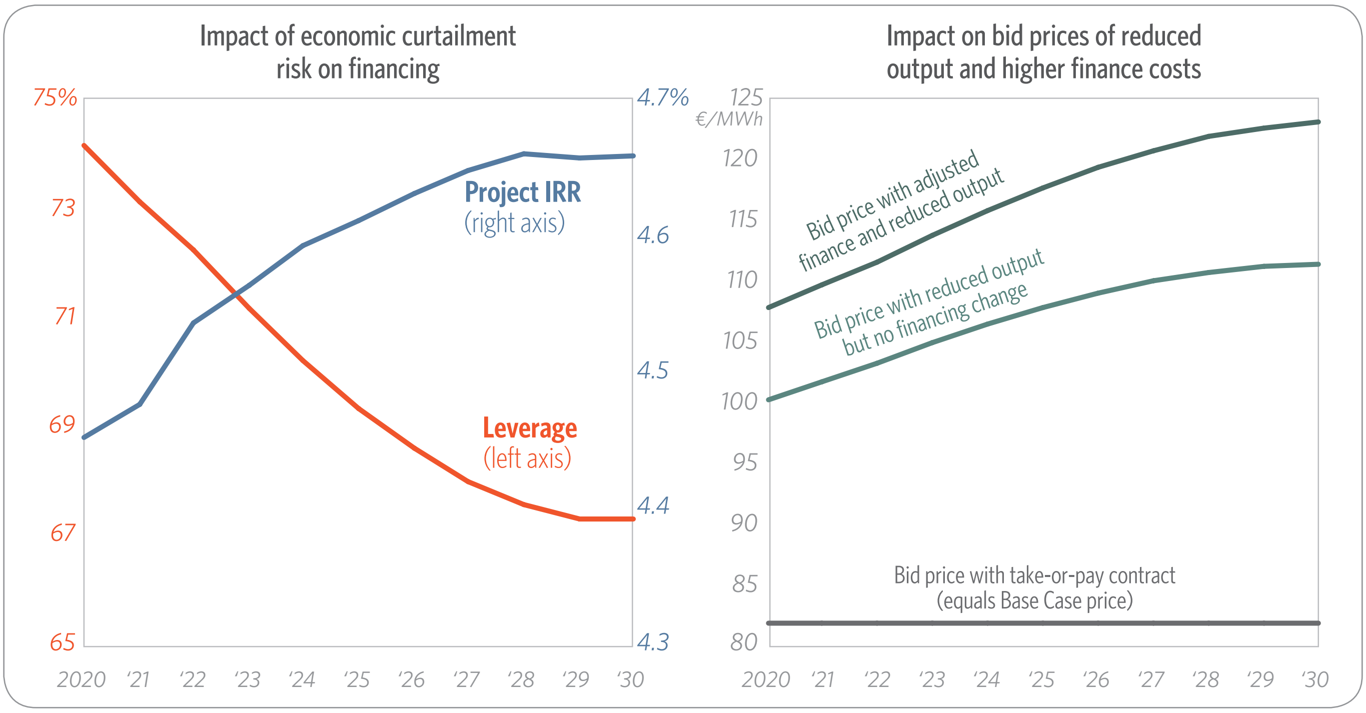
Source: CPI analysis

Table 24: Impact of curtailment on auction price and production volume

	AUCTION PRICE IN 2020 (€/MWH)	PRICE INCREASE	10-YEAR P50 ANNUAL AVERAGE PRODUCTION (GWH)	PRODUCTION DECREASE
Base case (no curtailment)	81.7	n/a	8,985	n/a
Hourly curtailment	107.7	31.8%	7,864	-12.5%
Curtailment after 6 hours	95.9	17.4%	8,233	-8.4%

Source: CPI analysis

Figure 32: Impact of economic curtailment on financing risk and bid prices



Source: CPI analysis

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

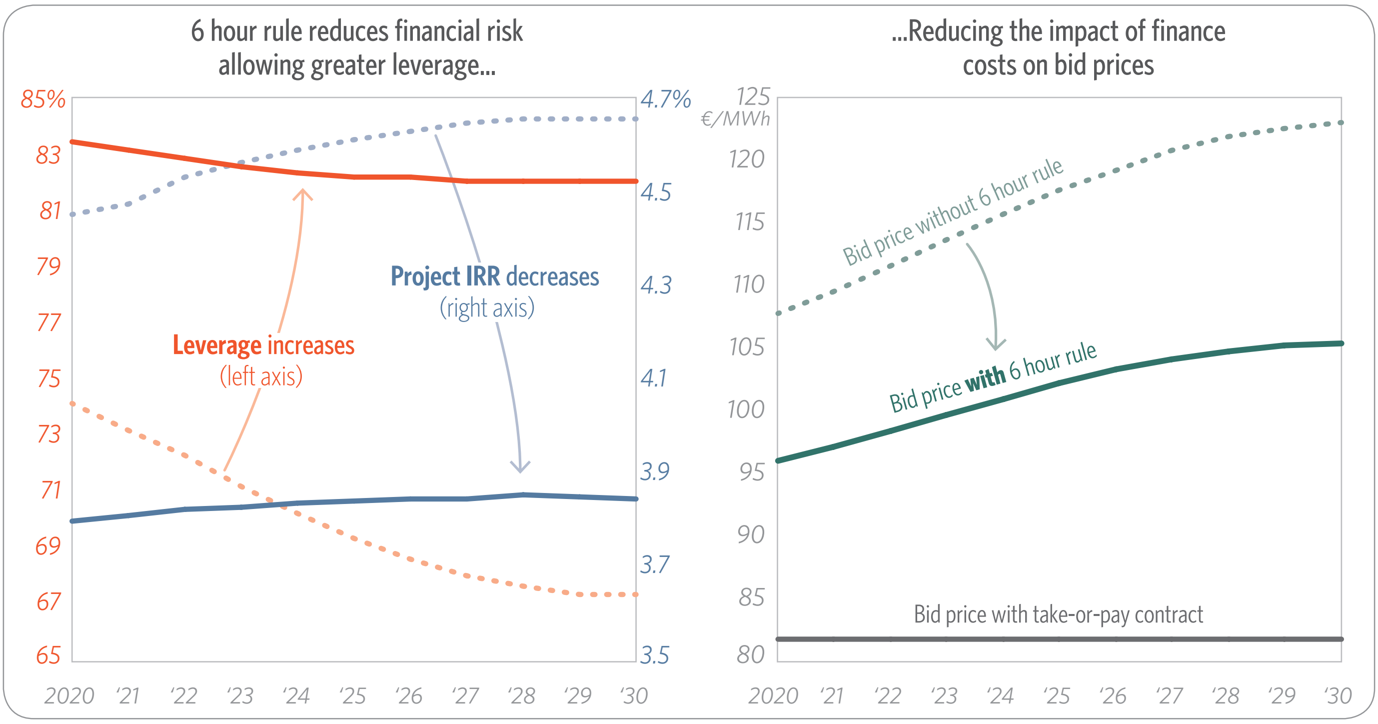
We have tested a handful of potential policy approaches that could mitigate the impact of curtailment, the results of which are summarised below alongside a description of each option. We assumed that curtailment beyond 2030 will remain at 2030 levels for modelling purposes rather than increase because 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 from the EU 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 33 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.

Figure 33: Impact of applying the 6 hour rule

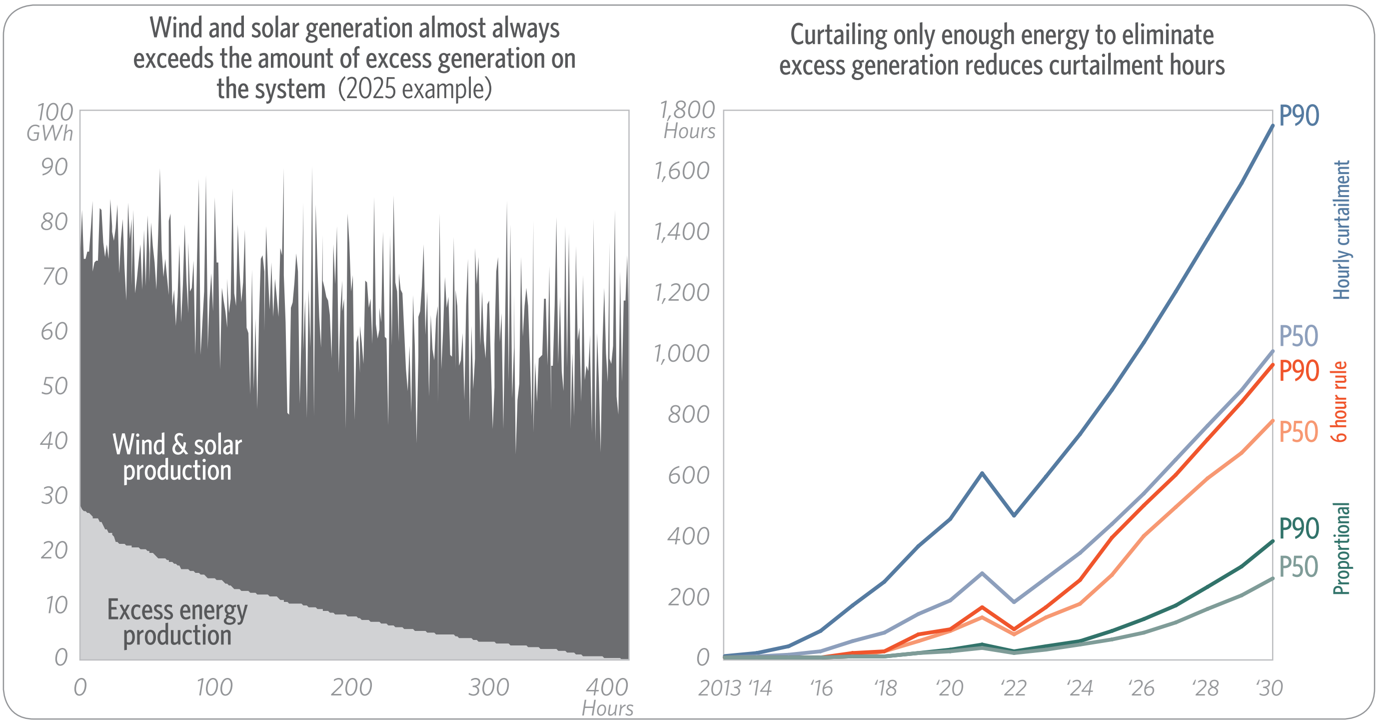


Source: CPI analysis

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 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 34 compares our forecast, hour by hour, of the amount

Figure 34: Impact of proportional curtailment



Source: CPI analysis

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.

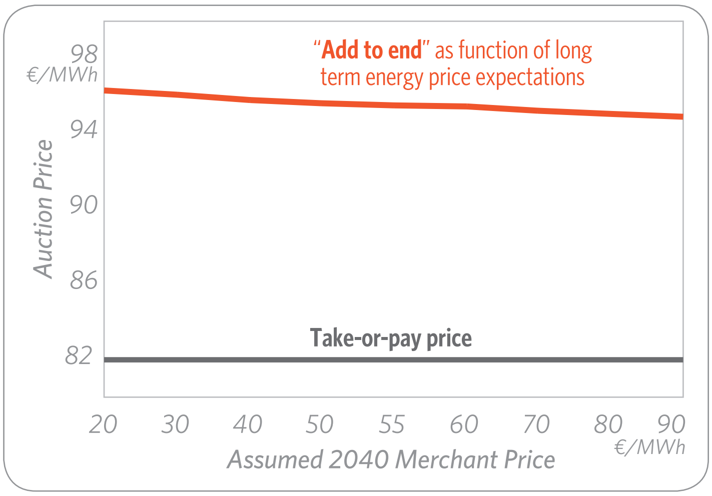
ADD TO THE END

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 35: 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 35)

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 36).

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 36: Impact of different curtailment cap levels

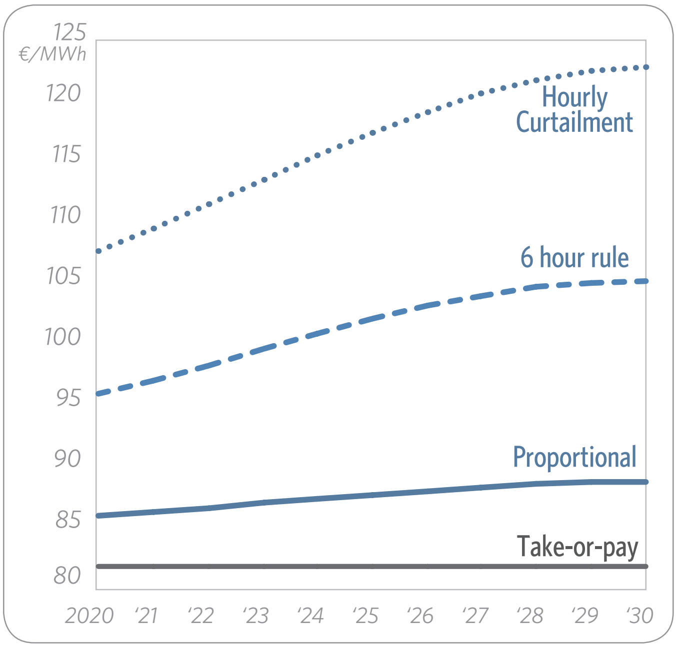
Source: CPI analysis

SUMMARY

Figure 37 provides a simple comparison between the scenarios detailed above.

The results for each scenario described above are summarised in Table 25.

Figure 37: 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 the example below, 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.

4.3.8 PERMITTING PROCESS

Key consideration for policymakers:

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

Background and summary

The permitting process involves several administrative steps that an investor has to complete to obtain the

Table 25: Impact of different mitigation options for curtailment

	AUCTION PRICE IN 2020	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	31.8%	7,864	-12.5%
CURTAILMENT AFTER 6 HOURS	95.9	17.4%	8,233	-8.4%
PROPORTIONAL CURTAILMENT	85.9	5.1%	8,793	-2.1%
ADD TO THE END	95.5	16.9%	8,233	-8.4%

CAP LEVEL AT	0 HRS	50 HRS	100 HRS	200 HRS	300 HRS	400 HRS	500 HRS	600 HRS
AUCTION PRICE IN 2020 (€/MWH)	81.7	83.5	85.1	88.0	90.7	93.2	95.1	95.9

Source: CPI analysis

permission to construct a renewable energy power plant. A potential investor needs to build up project 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.

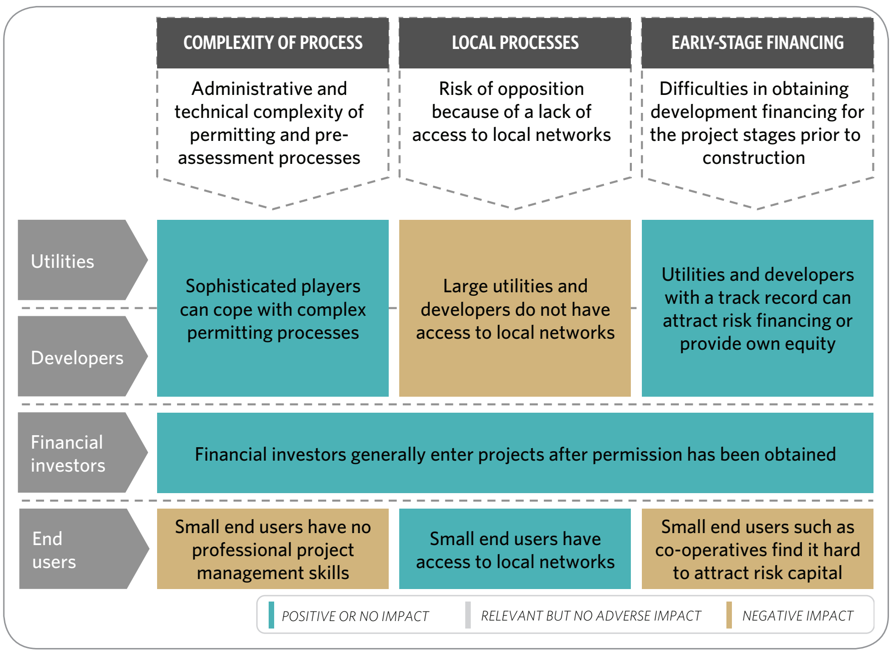
An additional factor in an auction system is the risk of stranded permitting costs. Once a project has been permitted, the plans are hard to change, even if developers identify an improved technological set up that they want to use. In such a case, the permitting process has to be repeated. Furthermore, 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 38):

- **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 38: 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 development 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 as they are, the issues related to permitting are manageable.

4.3.9 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.

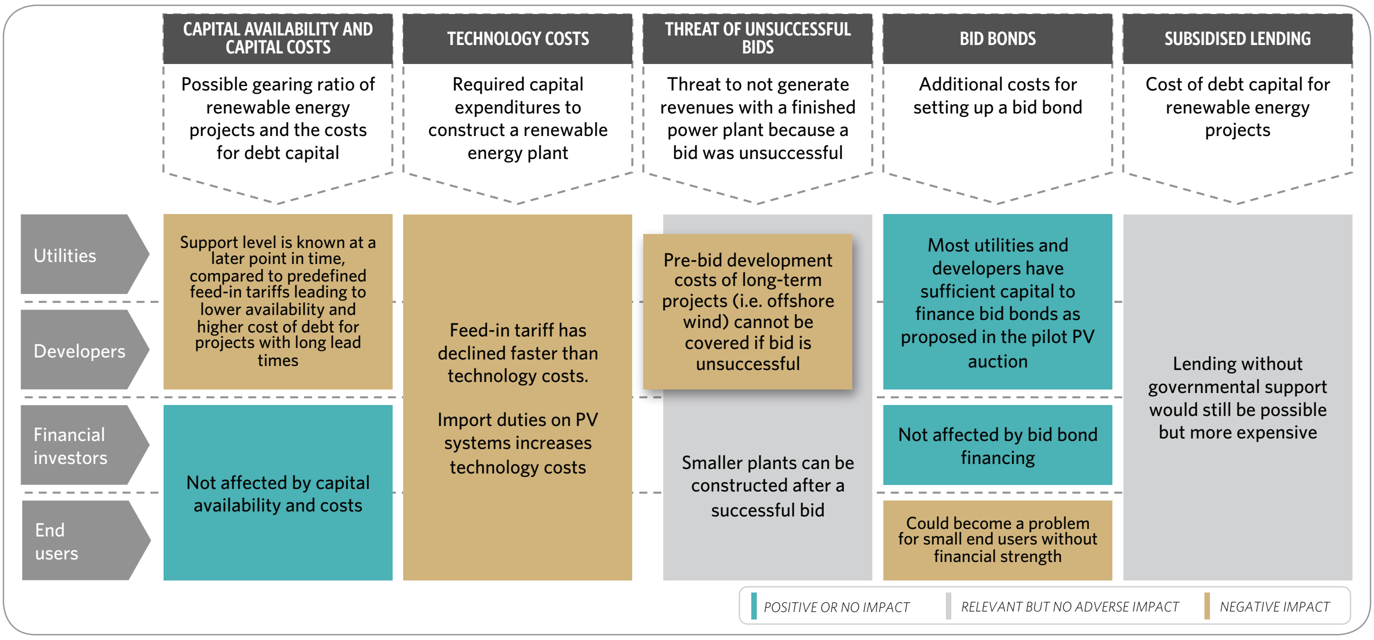
Other policies that affect the development costs of renewable energy projects include the import tax on PV systems that were manufactured in China. Such an import tax increases the system costs. Furthermore, there are several development banks that offer programmes which help provide debt capital to 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 39):

- **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 39: 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.

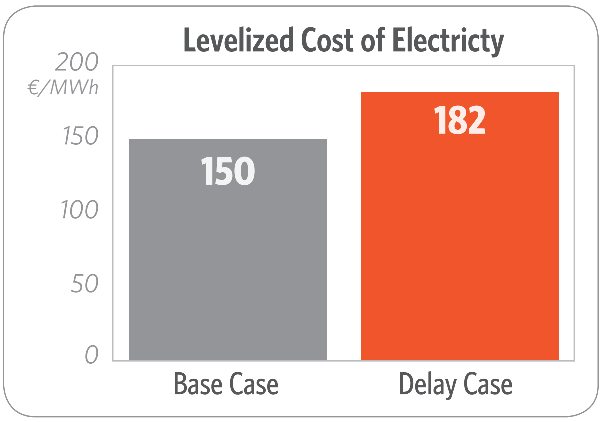
Key considerations for policymakers

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 40 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 an increase in construction and development costs of

Figure 40: Impact of a one-year delay on the auction price for an offshore wind farm



Source: CPI analysis

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.

4.3.10 FINANCIAL REGULATIONS

Key consideration for policymakers:

- While there is still uncertainty around how these changes will look, this challenge will most likely be resolved and are no major medium term concerns for investors

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 41):

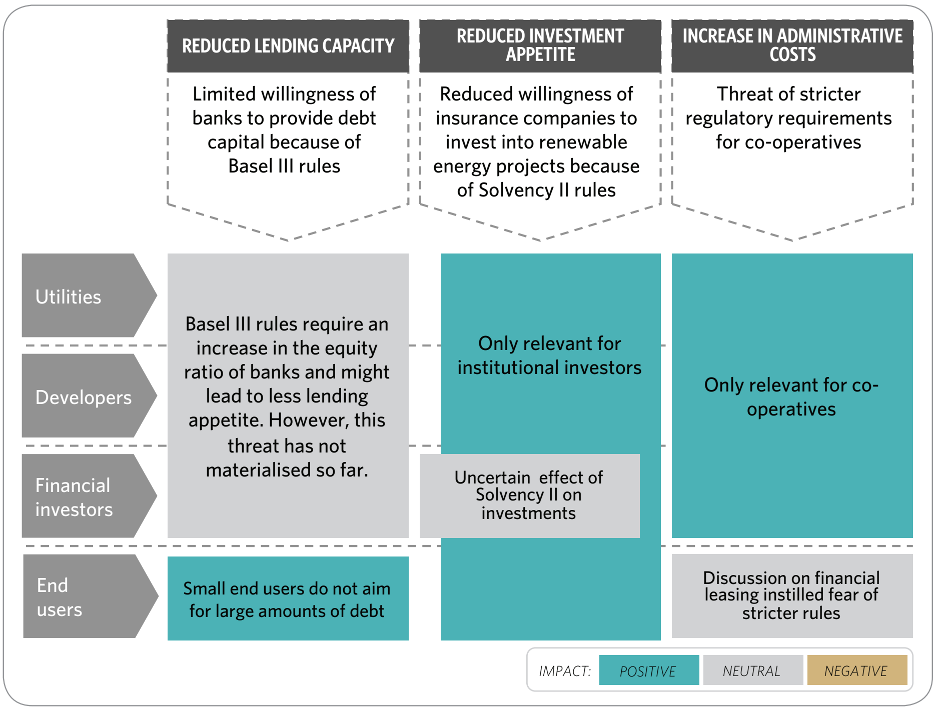
- Two types of **financial investors** are mainly affected. The Basel III framework could reduce banks' lending capacity. One of the introduced changes is an increase in the amount of high-liquidity capital that banks have to hold (Bankenverband 2012). This requirement impacts investor returns and could 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 (see also Chapter 3.4, p.32). 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 (see also Chapter 3.4, p.33).
- 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 41: Issues regarding financial regulations



Source: Interviews

5. Conclusions and policy implications

Addressing the two main policy objectives, i.e. reaching deployment targets and achieving cost-effectiveness, requires considering policy from different perspectives that address Germany's long and short-term goals. Our policy analysis began by identifying the ten most relevant policy areas for reaching the capacity deployment targets and for achieving cost effectiveness (Chapter 4.3).

We also discuss each policy area in detail in the next chapter and apply four perspectives from which to view these key policy areas in order to determine priorities for stakeholders:

1. **The technology perspective** explores how policies will have different impacts on the three key technologies, i.e. offshore wind, onshore wind, and PV.
2. **The investor perspective** assesses how the impact of the key policies will be felt by different investor groups and how policies could favour one group over another.
3. **The project lifecycle perspective** focusses on different incentives that policy could have on renewable energy businesses versus the projects themselves.
4. **The long-term perspective** looks at how the relative importance and impact of policies will evolve.

5.1 Key considerations for policymakers

We used insights from the interviews and results from financial modelling to address the key questions for policymakers which we introduced in Table 18 (p. 39). Our conclusions are presented in Table 26.

It is apparent that many policy options are relevant for balancing the two main objectives of the energy transition, i.e. capacity deployment and cost effectiveness. Taking all key policy areas, all technologies, all investors, all project types, and all time horizons into consideration is complicated. Thus, the subsequent chapter provides different perspectives on the key policy areas.

5.2 Technology perspective: different technologies require different policies to attract investors

The relevance of key policy areas differs for the technologies:

- For offshore wind, the most relevant key policies areas are: long-term targets, grid connection and development costs
- For onshore wind, the most relevant key policies areas are: incentive auction design, support design and curtailment
- For PV, the most relevant key policies areas are: incentive auction design, support design, permitting process and end user participation

Findings from quantitative analysis:

- A 12-month delay in an offshore development can increase the LCOE by 21% or more so if delay expectations are significant enough this will be reflected in substantially higher auction prices.
- Halving offshore wind targets would limit learning opportunities and potentially increase the cost of offshore by 6% while at the same time reducing renewable generation levels

The German government focuses on three renewable energy technologies to reach its capacity extension targets. These are (1) offshore wind; (2) onshore wind; and (3) PV. Each of these technology options attracts different investor groups with different investment approaches (Table 27). As a result, the relevance of the key policy areas identified in Chapter 4.3 are different for the three technology options.

Since project financial and operational characteristics and the investors differ by technology type, it is unsurprising that policy concerns related to each technology are also very different.

Table 26: Key considerations for policymakers

KEY POLICY AREA	KEY CONSIDERATIONS FOR POLICY MAKERS
Incentive auction design Auction design, coverage and process	• 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
Support design Predictability of subsidies, perceived regulatory risk, and complexity	• 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
End user participation Availability of self-consumption options	• 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
Long-term targets Reliability of government plans and deployment targets	• 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
Grid connection The cost and certainty of access to the grid	• No major medium term concerns for investors
Energy market design Electricity price mechanism and access rules to the energy markets	• 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
Curtailment Technological and economic curtailment	• Most investors are not yet focussed 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
Permitting process Costs and administrative complexity	• No major medium term concerns for investors
Development costs High development costs increase the impact of project cancellations or delays	• Project delays significantly increase the levelized cost of electricity • Centralized pre-permitting lowers the development costs but reduces the cost reduction potential
Financial regulations Impact of changing financial regulations	• No major medium term concerns for investors

Source: CPI analysis based on interviews

Table 27: Relevance of policies to different technologies

	MOST RELEVANT INVESTORS	INVESTMENT APPROACH	MOST IMPORTANT POLICIES
OFFSHORE WIND	• Incumbent investor-owned utilities • Some large municipal utilities • Large-scale developers • Investment banks	• Sophisticated investment appraisal and development process • Mostly long-term focus, as development requires investments in know how • High upfront costs (development and permitting)	• Long-term targets • Grid connection • Development costs
ONSHORE WIND	• Municipal utilities • Large-scale and small-scale developers • Asset managers	• Less sophisticated players fear complexity • Entails the threat of triggering economic curtailment • Mostly regional investments focus	• Incentive auction design • Support design • Curtailment
PV	• Municipal utilities • Small-scale developers • Asset managers • Small end users	• Less sophisticated players fear complexity • Many end users do not focus solely on financial return • Mostly regional focus	• Inventive auction design • Support design • End user participation • Permitting process

Source: CPI analysis based on interviews

OFFSHORE WIND

- Offshore wind projects are highly complex and require large amounts of capital. Thus, only sophisticated players such as large utilities and developers can realise offshore wind projects.
- **Reliable long-term targets** enable large players to invest in skills, systems and know-how to reduce costs and develop this maturing technology. The lead time for an offshore wind project is up to 10 years (Klessmann 2015). In this period, developers have to invest development and permitting costs and they want reliable targets to be confident that they can recover such costs.
- High upfront **development costs** put larger sums of investor money at risk making investors more susceptible to delays driven by unreliable **incentive auction design** or **grid connection** delays. Just the perception that these risks exist can reduce investment and increase costs.

ONSHORE WIND

- Utilities (mostly municipal), large-scale and small-scale developers, and asset managers are interested in onshore wind projects. The restricted availability of land for large-scale projects limits the interest of large players.
- A simple **incentive auction design** is important for smaller, less sophisticated investors that fear too much complexity.
- Additional **support design policies** could make it possible to invest in project locations with lower wind resources. In addition, a more balanced regional distribution of offshore wind could limit public opposition to overdevelopment.
- **Economic curtailment** could significantly increase as onshore wind capacity grows. As a result, onshore wind power plants would bear higher uncertainty around the returns on these investments that would be magnified if most of these curtailments occur during periods of the most favourable wind conditions.

Onshore wind load factors: increasing load factors can significantly lower auction prices

Historically, German load factors have been comparatively low. This is partly because Germany is not a particularly windy country, but mainly because policies have incentivised a high proportion of small wind farms to be deployed across the country rather than at the optimal sites. As at the end of 2014 about 54% of all installed capacity was at sites with a capacity of 6MW or less and about 29% of all installed capacity was at sites with less than 3MW capacity.

Small wind farms have been useful for public acceptance since citizens across the country benefit from onshore wind and particular regions are less likely to be perceived as over-developed. High levels of onshore wind farm concentration in windier regions may be cheaper (subject to transmission line costs) but such an approach is potentially unpopular both for residents of these regions who object to the high concentration levels, and for residents outside of these regions who pay the same EEG surcharges but do not receive the green electricity.

That said, increasing load factor can reduce auction prices. A switch to auctions is likely to incentivise developers to target the windiest sites, which will increase load factors from the German average of c. 20%. Technological improvements are also raising load factors, and for these reasons we have assumed a load factor of 25% by 2020 in the base case used in our analysis. Our analysis, summarised in the table below, shows just how big an impact the load factor can have on auction prices.

	PRODUCTION CHANGE	AUCTION PRICE (€/MWH)	PRICE CHANGE
BASE CASE (25% LOAD FACTOR)	-	81.7	-
30% LOAD FACTOR	20.0%	68.5	-16.2%
20% LOAD FACTOR	-20.0%	101.5	24.2%

SOLAR PV

- Ground-mounted PV attracts larger investors such as municipal utilities whereas rooftop PV is more relevant to small investors, such as co-operatives or homeowners.
- A simple **incentive auction design** and support design is important for less sophisticated investors, which are the majority in this technology segment. They want to be excluded from the auction system via de minimis rules.
- **Policies that support end user participation** are relevant for many investors that are investing because they want to invest in sustainable electricity generation and physically consume green electricity. Other investors could also be attracted to self-consumption projects as a long-term energy price hedge, if that option were available.
- The **permitting process** is important for PV projects as permitting costs make up a larger share of total development costs compared to larger-scale wind projects.

5.3 Investor perspective: policy priorities differ for each investor group

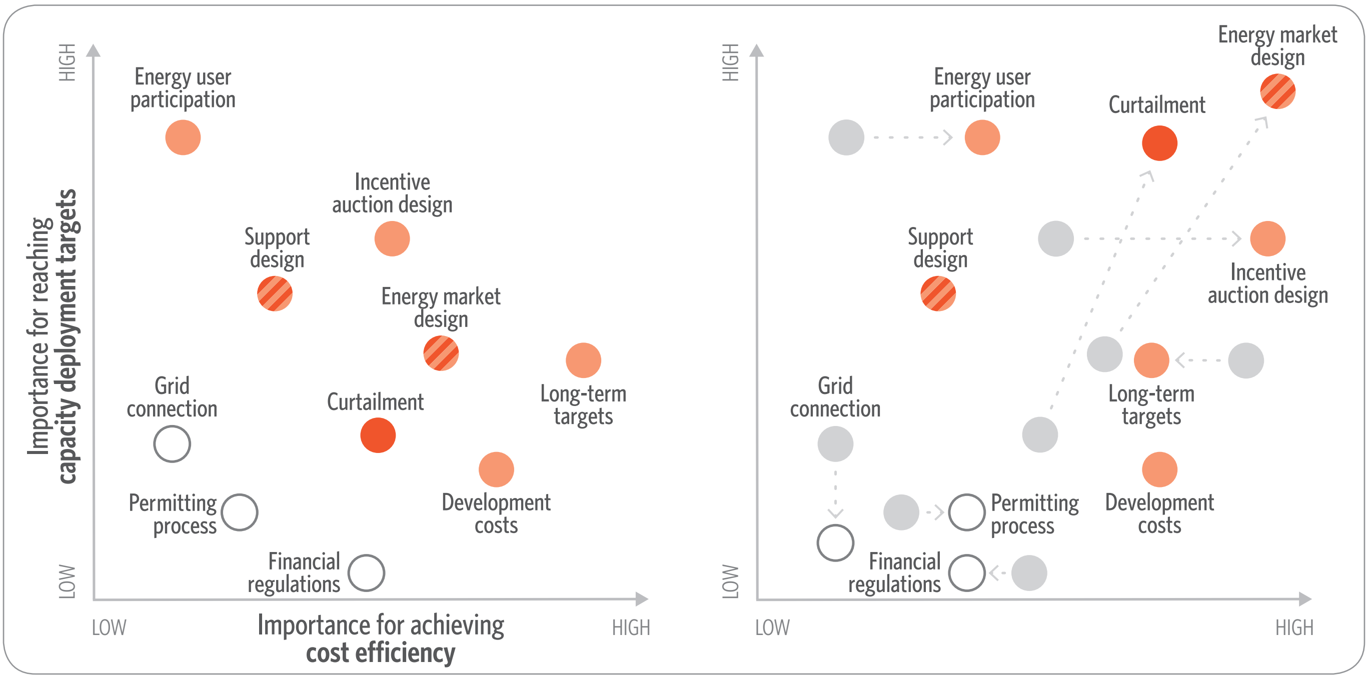
In Chapter 2, we introduced the various investor groups that provide capital for renewable energy investments. These are (1) utilities; (2) developers; (3) financial investors; and (4) end users. The key policy areas presented in the previous chapter have different impacts on the investors. Figure 42 gives an overview of the four investor categories introduced and how much they are affected by the key policy areas.

Across the different investor groups, a distinction can be made between small and large investors. There are three topics on which they have significantly contradictory opinions: incentive auction design, end user participation, and long-term targets (Table 28). From our interviews, we conclude that some of these policy areas could discourage whole investor groups from participating in the market. Policymakers have to weigh the benefits of a concentrated energy system with fewer large players or a system that includes smaller and more diverse players.

INCENTIVE AUCTION DESIGN

- **Small investors** fear an increase in transaction costs under an auction regime. Transaction costs make up a larger share in small projects compared to larger projects and an increase could render smaller projects impossible. Furthermore, strict eligibility criteria could increase realisation rates but at the cost of driving out small investors who find it difficult to finance upfront costs. They will invest if they consider a renewable energy project interesting but they are not planning their investments strategically.

Figure 42: Relevance of policy areas to different investors



Source: CPI analysis based on interviews

Table 28: Different positions of small and large investors on key policies

	SMALL INVESTORS	LARGE INVESTORS
INCENTIVE AUCTION DESIGN	• Fear of an increase in transactions costs in an auction regime • Strict eligibility criteria could increase realisation rates but drive out small investors	• Have the capacity to adapt to the auctions and align their internal processes
END USER PARTICIPATION	• Look for hedges against increasing electricity prices • Want to do business with local end-users • Strict self-consumption rules render some citizen projects impossible	• Business models are not tailored to small customers • Not interested in small-scale projects • Argue that exemptions would water down the purpose of cost efficiency
LONG-TERM TARGETS	• Small end users and co-operatives do not tailor their business model according to development targets	• Require credible targets to justify investments in business models and long-term cost reductions • Credible targets can reduce auction risk by creating second chances

Source: CPI analysis based on interviews

- **Large investors** have the capacity to adapt to the auctions and align their internal processes.

END USER PARTICIPATION

- **Small investors** look for hedges against increasing electricity prices. They also want to do business with local end-users but strict self-consumption rules render some citizen projects impossible.
- **Large investors** do not focus on small customers as they are less interested in small-scale projects. They argue that exemptions for small projects undermine the purpose of cost efficiency goals.

LONG-TERM TARGETS

- **Small investors** do not have business models that are affected by long-term targets.
- **Large investors** require credible targets to justify investments in business models, which can spur long-term cost reduction. Credible targets can also reduce the auction risk by creating second chances for those investors that have the capacity to wait for subsequent auction rounds.

In addition to the differences in the needs of small and large investors, we explored the needs of four main investor groups: utilities, developers, financial investors, and end users.

UTILITIES

- Utilities are worried that the **incentive auction design** creates uncertainty around the recovery of project development costs. They invest in large projects with high upfront development costs. Thus, they are concerned about auctions with uncertain outcome or timing.
- Utilities require reliable **long-term targets** to invest in longer-term business optimisation. In other words, they can build investment pipelines and develop business capabilities if they have confidence that there will eventually be a market for their projects and competitive skills.
- The **energy market design** will determine both the profitability of new projects and how those projects impact the profitability of their existing power plants.
- As **development costs** rise, the impact of uncertainty, especially that generated by policy, increases.

DEVELOPERS

- **Incentive auction design** affects large developers in the same way it affects utilities.
- The **support design** is important for selling realised plants and freeing capital. If a support design is in place that increases the number of potential investors in operating projects, recycling capital is easier for developers.
- **Permitting process, grid connection and development costs** are interrelated. Developers are more significantly exposed to the permitting process and grid access because of their strategic focus on the development stage of a project.

SMALL AND LARGE INVESTORS HAVE DIFFERENT POLICY PRIORITIES:

- Small investors need a simple auction design and favorable end user participation rules
- Large investors require stable long-term targets

THE IMPORTANCE OF KEY POLICY AREAS DIFFERS FOR UTILITIES, DEVELOPERS, FINANCIAL INVESTORS, AND END USERS:

- For utilities, the most relevant key policy areas are: incentive auction design, support design, long-term targets, energy market design, and development costs
- For developers, the most relevant key policy areas are: incentive auction design, support design, long-term targets, grid connection, permitting process, and development costs
- For financial investors, the most relevant key policy areas are: support design and financial regulations
- For end users, the most relevant key policy areas are: incentive auction design, support design, end user participation, permitting process, and development costs

FINDINGS FROM QUANTITATIVE ANALYSIS:

- Business process improvements are an important driver for cost reductions: from 2006-2014, non-module costs for PV systems have been decreased by 11.5% p.a. for large scale projects and 7.7% p.a. for rooftop solar.
- Shortening the period of revenue support from 20 years to 15 years could increase the required LCOE between 15-18% depending on the technology.
- Linking revenue support to inflation may be attractive to institutional investors who have index-linked liabilities and could be willing to pay a premium for such a link. This could potentially decrease the LCOE by between 18-20% in real terms although ultimately the difference would depend on how actual inflation compared to forecast levels.

FINANCIAL INVESTORS

- The **support design** must provide stability and predictability because most financial investors seek conservative investments.
- **Financial regulations** determine how much capital financial investors can invest in renewable energy and how attractive an investment is.

END USERS

- End users are often less sophisticated than larger utilities and developers. They fear that the **incentive auction design, the support design, or the permitting process** may be too complex for them to successfully participate in an auction.
- **End user participation** policies are important for them as they have an interest in consuming their own electricity.

5.4 Project life cycle perspective: the importance of key policy areas changes throughout the life cycle of projects

Investors in different stages of a project (business model development, project development, financing, operating, post incentive re-development stages) have different policy priorities:

- Business model development: most relevant are incentive auction design, long-term targets, and development costs
- Project development: most relevant are incentive auction design and development costs
- Operating stage: most relevant are support design, energy market rules, curtailment, and end user participation

The key policy areas presented in Chapter 4.3 have diverging impacts on the different stages of renewable energy projects. These are (1) business model development; (2) project development; (3)

financing; (4) operating stage, and (5) post incentive re-development. Table 29 outlines the important policies across a project's life cycle.

Different policies will be more important at different stages of a project (Figure 43). Attractive policy frameworks will draw more competitors with new business models and will drive down costs. Some policies will affect the actual project development, and project financing and operating cash flows, while others will determine whether the projects have residual value and will then be repowered – that is, the projects will be upgraded when they near the end of their useful life.

BUSINESS MODEL DEVELOPMENT

- **Incentive auction design and long-term targets** must create trust to enable investments in business models and process improvements. For example, a predictable frequency of auctions would reduce the risk of stranded projects in an investment portfolio.
- Investors need certainty that they can recover upfront **development costs**. The threat of unsuccessful bids or expensive bid bonds is a barrier to entry that could drive out investors.

PROJECT DEVELOPMENT

- The **incentive auction design** must provide enough certainty that realised projects have a second chance to win if a first bid is unsuccessful. The earlier a bid has to be filed, the lower the risk of stranded development costs as fewer development expenses have arisen.
- Investors need confidence that upfront **development costs** can be recovered. Otherwise, they require risk premia or might not invest at all.

FINANCING

- There is enough capital available to finance the targeted capacity extensions on an accumulated basis. Nevertheless, early-stage capital is sometimes hard to raise for unsophisticated investors.
- Development banks have heavily supported loans to renewable energy projects and made cheap debt financing possible. While enough capital would still be available without engagement from development banks, the costs would be higher for most players.

OPERATING

- The **support design** impacts the certainty of project revenues. Greater uncertainty around the support level leads to higher risk premia.
- **End user participation** policies are important for investors who are less interested in feeding electricity into the grid but instead want to physically consume green electricity.
- **Curtailment and energy market design** determine the perceived revenue certainty. Curtailment could become a risk with an increasing onshore wind capacity since this technology has the most volatile generation profile. The design of the energy market could limit the risk of negative electricity prices.

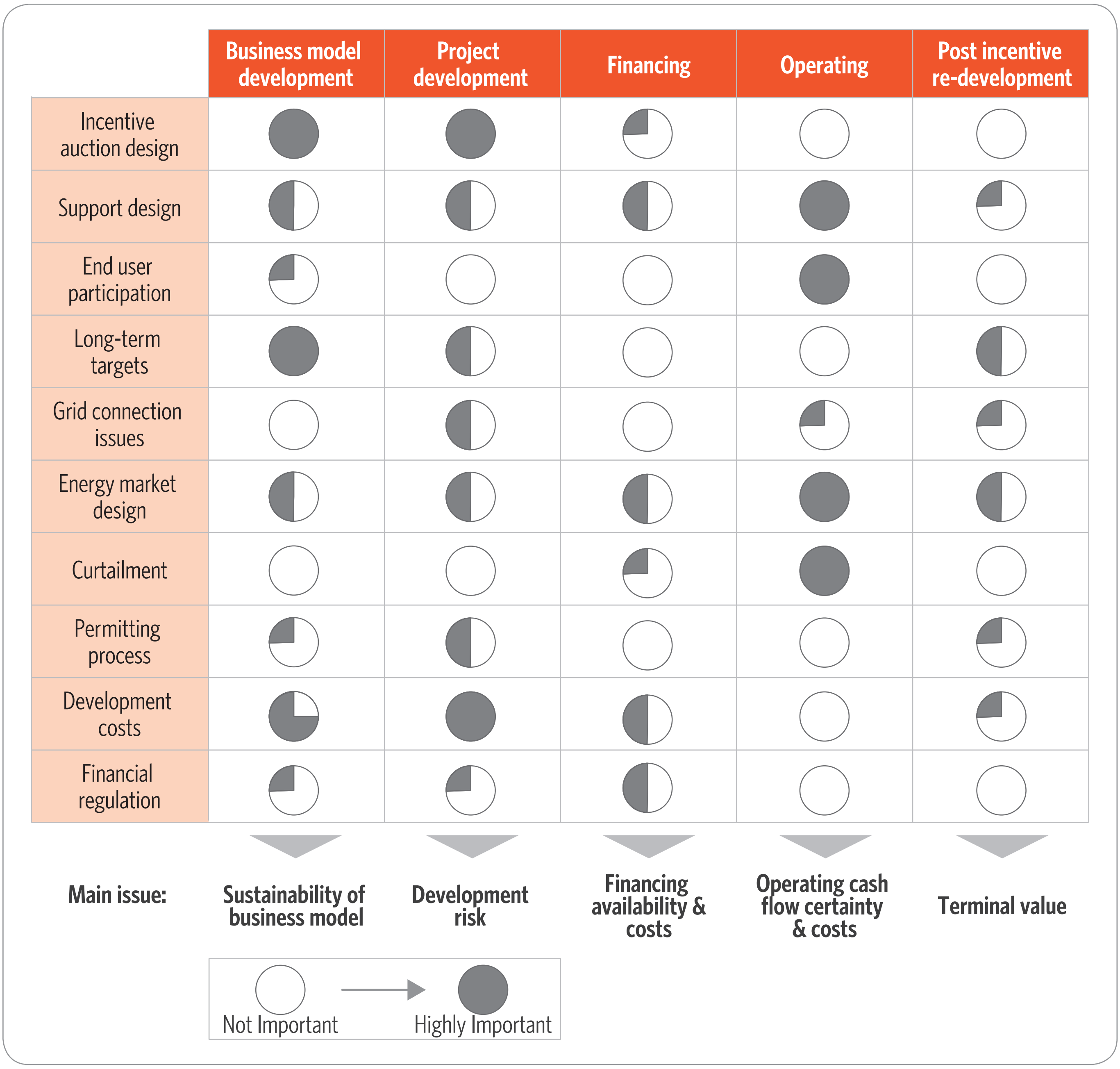
Table 29: Influence of policies during the project life cycle

Project/business life cycle →

	BUSINESS MODEL DEVELOPMENT	PROJECT DEVELOPMENT	FINANCING	OPERATING STAGE	POST INCENTIVE REDEVELOPMENT
ISSUES	Under a longer-term strategy, businesses can invest in skills, resources and processes to lower project and development costs over time.	Lower cost and less risky development can encourage existing investors and new entrants, increasing competition, ultimately leading to lower costs.	Policies can exclude segments of investors or make the sector less attractive.	Uncertainty around cash flows or greater volatility can discourage investors or change the investor mix and financial structure of projects.	Terminal value and repowering options provide an additional source of investment upside that can be attractive to investors.
	Investors will make these investments if they see a long-term profitable industry where they can be competitive.	However, less development effort could also allow poor projects through.	More scarce or higher cost financing can raise costs and discourage developers.	Different structures can raise or lower energy costs.	

Source: CPI analysis based on interviews

Figure 43: Relevance of key policy areas for projects at different stages



POST INCENTIVE REDEVELOPMENT

- This issue will become more important once the first renewable energy power plants cease receiving feed-in tariffs under the EEG in 2020. Nevertheless, repowering will become a relevant topic much earlier.

Projects at different stages require different types of capital. While investors generally seek short-term capital at the business model development and project development stages, long-term capital is needed for the subsequent project stages. As a result, the importance of the availability of short-term and long-term capital changes during a project life cycle. This issue is discussed in detail in Chapter 3.2.

5.5 Long-term perspective: end user participation, incentive auction design, curtailment rules and especially energy market design will become increasingly important over the long-term

Incentive auction design, energy market design, curtailment, and end user participation will gain importance in the long term.

Findings from quantitative analysis:

- If interest rates increase by 2% and the cost of equity does the same then the LCOE increases by 15-18% depending on the technology. This represents a significant increase in subsidies that would be necessary in order to achieve target deployment levels.
- If the issue of curtailment during times of negative prices is not addressed then the LCOE of onshore wind could increase by over 17% by 2020 and by even more in future years.

In Chapter 4.3, we presented the policy areas that are most important in the medium term. The higher the relevance of a certain policy in the medium term, the more important it is to achieve short-term capacity extension targets and short-term cost effectiveness. However, policymakers also have to bear in mind how the relevance of key policy areas will evolve in the long-term. Some key policy areas have only a medium relevance in the short-term but will become crucial in the long run. If these policies are neglected in upcoming decisions on how auctions should be implemented, short-term objectives might be reached by sacrificing the chance to meet long-term goals. Figure 44 presents the evolution of the importance of key policy areas for reaching the capacity extension targets and achieving cost effectiveness.

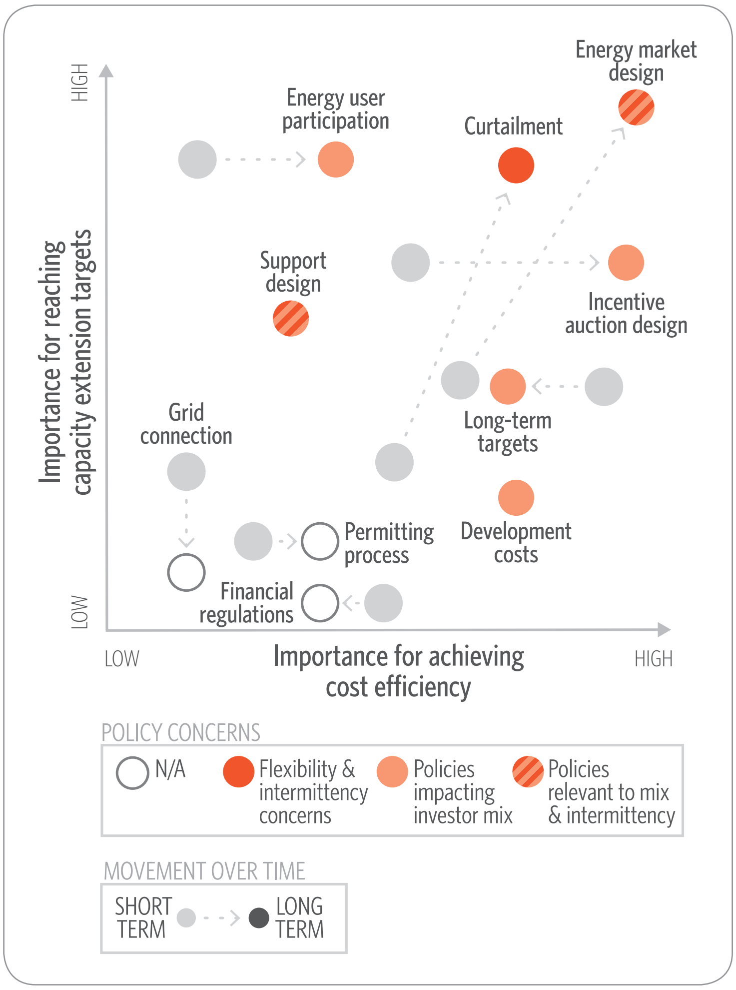
INCENTIVE AUCTION DESIGN

- The design of the incentive auction will influence whether small players will continue to invest under an auction regime. Neither short-term nor long-term capacity extension targets can be met without small investors.
- The oversubscription in the pilot PV auctions shows that there is plenty of potential investment to tap, so the exclusion of small players would not have an adverse effect on competition in the short term. However, pushing out small players would limit actor diversity in the long-term and, thus, limit competition.
- Difficult or risky auctions where the probability of winning is low could discourage investors from developing new projects. In the short-term, there appear to be many fully developed projects that are ready to be built. However, when these developed projects are exhausted and newly developed projects are scarce, a costly and uncertain auction design will present its full effect, as it will have discouraged competition.

END USER PARTICIPATION

- The effect of end user participation policies on cost efficiency will be higher in the long-term when actor diversity becomes more important.

Figure 44: Change in relevance of key policy areas to German government targets from medium- to the long-term



Source: CPI analysis based on interviews

LONG-TERM TARGETS

- Credible long-term targets are crucial in the current transitional phase in Germany, as they are a requirement to invest in process optimisation.
- In the long-term, large players will already have optimized their processes for the mainstream technologies. While long-term targets will still be important to achieve cost reductions for less mature technologies, its relevance will decline.

GRID CONNECTION

- While there have been delays in the past, the evolving offshore grid infrastructure will ease grid connection of new offshore wind farms. Thus, the relevance of grid connection issues should decrease in the long-term.

ENERGY MARKET DESIGN

- The energy market design can either create or reduce risks for every type of investor. Current design creates implied fuel price risk for renewable energy, as the perception that renewable energy prices are high or low are driven by market prices that are based mainly on coal and gas fired generation.
- If the current design remains in place and renewable build continues, market prices will turn negative for more hours each year, creating real or perceived revenue risk, depending on regulation.
- Energy market rules determine which actors will have access to the electricity and ancillary services markets and the value of providing these. The amount of market participants has an impact on the competition and on long-term cost efficiency.

CURTAILMENT

- Economic curtailment could become an increasingly important issue in the long term. Onshore wind will be particularly exposed to this risk.
- Either the issue is taken care of or it will become a deal breaker for investors in the future.

PERMITTING PROCESS

- Permitting does not seem to be a major concern to the investors that we interviewed.
- However, it will become more important when repowering becomes a topic. As a result, the permitting process will have a higher impact on cost effectiveness.

FINANCIAL REGULATIONS

- Because sufficient capital is available for renewable energy projects, financial regulations mainly impact cost effectiveness.
- Uncertainty around the interpretation of rules will be lower in the long-term.

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