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By Matthew Jones and Florian Rothenberg

MARKET INSIGHT

THE RENEWABLE CANNIBALISATION PROBLEM: WHY FULL MERCHANT RISK WILL BECOME INCREASINGLY CHALLENGING

BY MATTHEW JONES AND FLORIAN ROTHENBERG **OCTOBER 2019**

EXECUTIVE SUMMARY

The rapidly falling costs of renewable energy deployment in Europe in recent years has had a major impact on the power market policies of national governments, with two distinct trends emerging:

- The first is an increasing level of renewable ambition, with both the EU as a whole and individual member states attempting to significantly boost their renewable shares by 2030.
- The second is a desire by governments to gradually move away from subsidising new renewable capacity and to rely increasingly on the private sector to finance new projects.

However, are ambitious renewable targets and private-sector financing compatible over the next decade? We used our long-term pan-European power price forecasting model (ICIS Power Horizon) to assess renewable capture prices in Germany, France, Spain and the UK based on government plans for renewable capacity growth. These countries were chosen as they are among the largest markets in Europe, with varying generation stacks and significant differences in their approaches to solar and onshore wind support systems and capacity growth targets.

Our research shows that countries with high levels of renewable capacity growth will be most severely affected by price cannibalisation, meaning that the price captured on the market by solar or onshore wind generators is eroded over time. We compared these capture prices through to 2030 to assumptions for the levelised cost of energy (LCOE) in each country to determine whether projects operating at full merchant risk would remain financially viable.

The results highlight that by 2030, the capture price for unsubsidised solar and onshore wind projects in Germany, France and Spain will fall below the respective technology specific LCOEs. This suggests that if each country is to reach its 2030 targets for renewables capacity, the governments will need to continue offering some form of subsidy for new capacity through the 2020s. In contrast, the expectation for much lower solar and onshore wind capacity growth in the UK, combined with relatively high power prices, should ensure that the prospects for subsidy-free projects improve through to 2030.

1. NATIONAL RENEWABLE GROWTH ASSUMPTIONS

In modelling the onshore wind and solar capacities in each of the four countries, we aligned with the plans of individual national governments. For Germany and Spain, the capacity assumptions were taken from the draft national energy and climate plans (NECPs), with a linear interpolation of growth between dates (2020, 2025 and 2030) included in the plans.

For capacity growth on the NECP, although the end point of the French draft plan is 2028, we expanded through to 2030 based on the targets outlined by President Macron in 2018.

Since the UK did not include capacity targets in its draft NECP, we used the National Grid 'Two Degrees' scenario from the 2019 Future Energy Scenarios report.

Figure 1 highlights the capacity expectations for solar photovoltaic (PV) and onshore wind in each country. For all other capacity types, we used our Horizon base case assumptions, which are again based primarily on the long-term plans of each government.

2. HOW ARE RENEWABLES CURRENTLY SUPPORTED?

The subsidy schemes currently available to new solar and onshore wind producers differ across the four countries. In both Germany and France, a system of competitive auctions is in place, with winners awarded a floating feed-in premium (FiP). In Spain, winners in the auctions are awarded a price floor, although since the price floors in the most recent auctions have been set at relatively low

FIGURE 1: SOLAR AND ONSHORE WIND CAPACITY FORECASTS BY COUNTRY

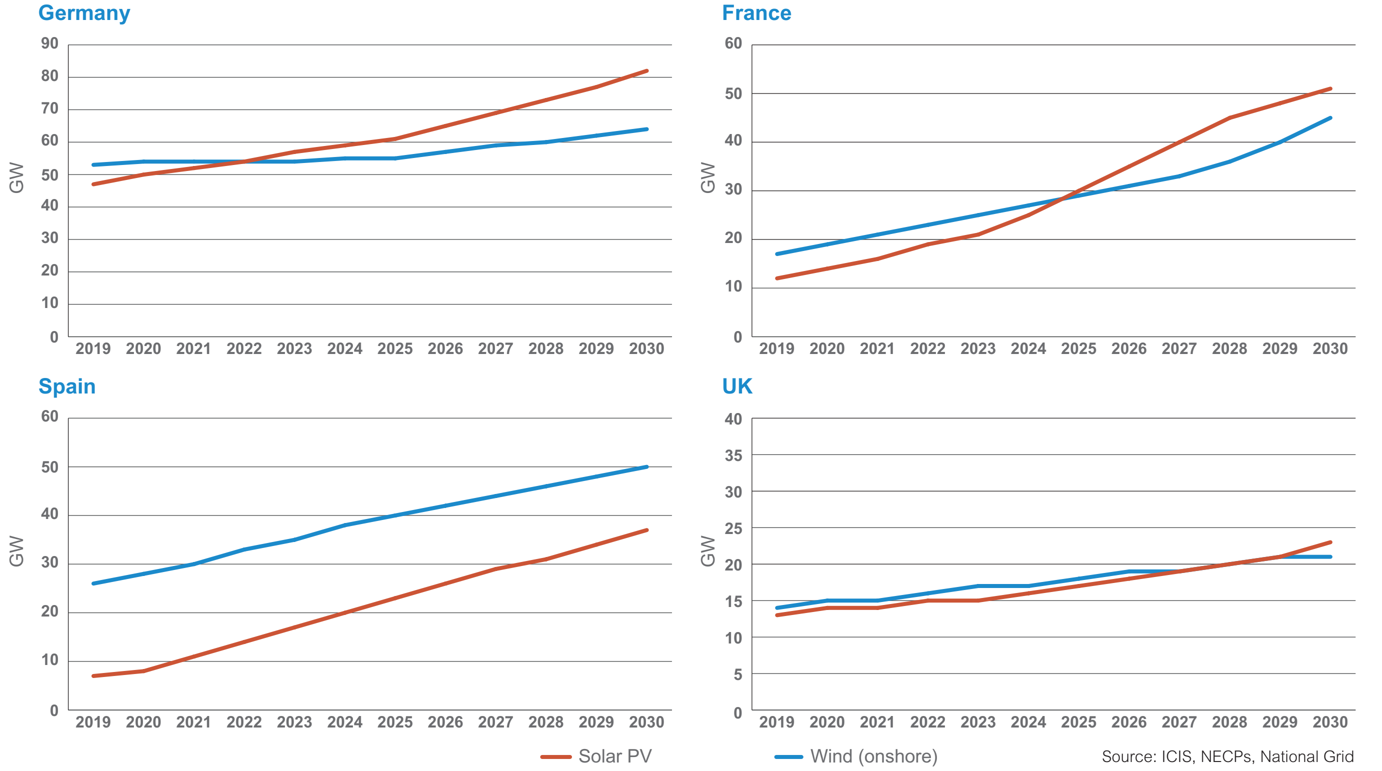


TABLE 1: CURRENT ONSHORE WIND AND SOLAR SUBSIDY SCHEMES BY COUNTRY

Country	Current subsidy scheme	Latest auctions announced
Germany	Feed-in premium	2021
France	Feed-in premium	2024
Spain	Price floor	TBD
UK	No subsidy	None

levels, and since the government has the ability to adjust the floors downwards, some operators have already decided to move forward with subsidy-free projects outside the auction structure. In the UK, onshore wind and solar projects have no subsidised route to market, which means that future growth is expected to come entirely from subsidy-free projects.

Table 1 outlines the current subsidy scheme in each country and the latest date for which the governments have announced future auctions.

3. THE LIMITS OF POWER PURCHASE AGREEMENTS (PPAS)

PPAs are deals signed between a renewable generator and either a corporate or utility/wholesale reseller client for the supply of electricity. The deals allow the buyer to meet sustainability targets and hedge against future price risk, while guaranteeing the renewable generator a route to market and a long-term income.

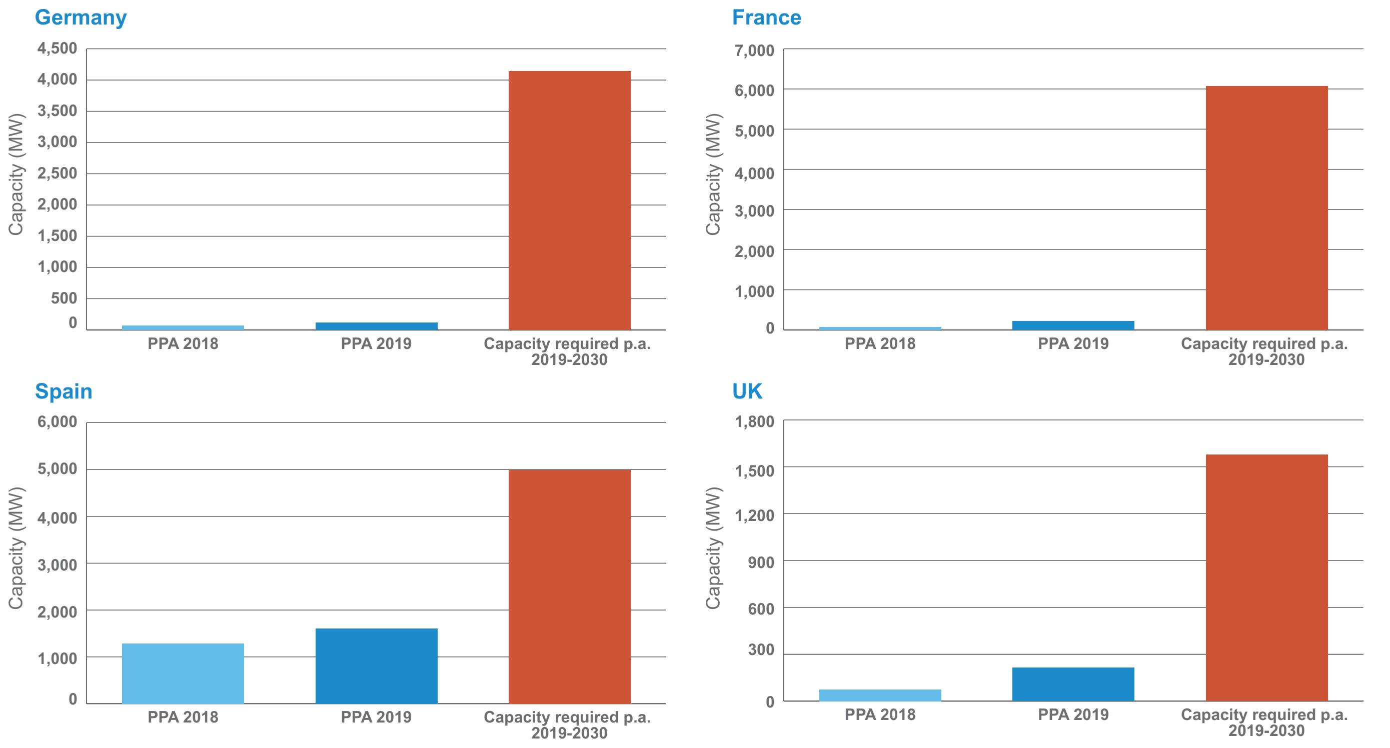
Figure 2 shows the quantity of solar and onshore wind capacity signed to PPAs (including utility and corporate deals) in each country in 2018 and 2019 and compares this with the annual capacity additions required per year between 2019 and 2030 to meet the national targets set out at the start of this paper.

Germany and France have both seen minimal quantities of PPAs to date, which is largely due to the presence of the FiP subsidies in each country, which makes such deals unnecessary for generators. The majority of PPAs seen in 2018 and 2019 in both countries are for existing projects that are due to drop out of support schemes in the coming years. Undoubtedly, the number of PPAs for new projects would surge if the German or French governments decided to stop subsidising new capacity.

However, as can be seen in both the Spanish and UK cases, where government subsidies have been either partially or completely withdrawn, the quantity of PPA capacity signed over the past two years remains well below the annual capacity additions required to meet 2030 targets.

While we expect further growth in the volume of capacity signed to PPAs, there are limits to the upside potential. On the corporate side, the majority of commercial and industrial organisations do not have the requisite credit rating, power market experience or power price exposure to sign a long-term PPA, while on the utility side there is a

FIGURE 2: ONSHORE WIND AND SOLAR PPA VOLUME VS. CAPACITY REQUIREMENTS BY COUNTRY



Note: Our data is based on publicly announced PPAs   Source: ICIS

limit to the amount of risk each company will take on their books.

As a result, the PPA market can help bring some subsidy-free projects online but will not reach the scale required to replace governments as the primary source for supporting new renewables. Therefore, for capacity additions to be based primarily on subsidy-free projects, the majority of new capacity would have to come online at full merchant risk, earning their revenues solely from the wholesale market.

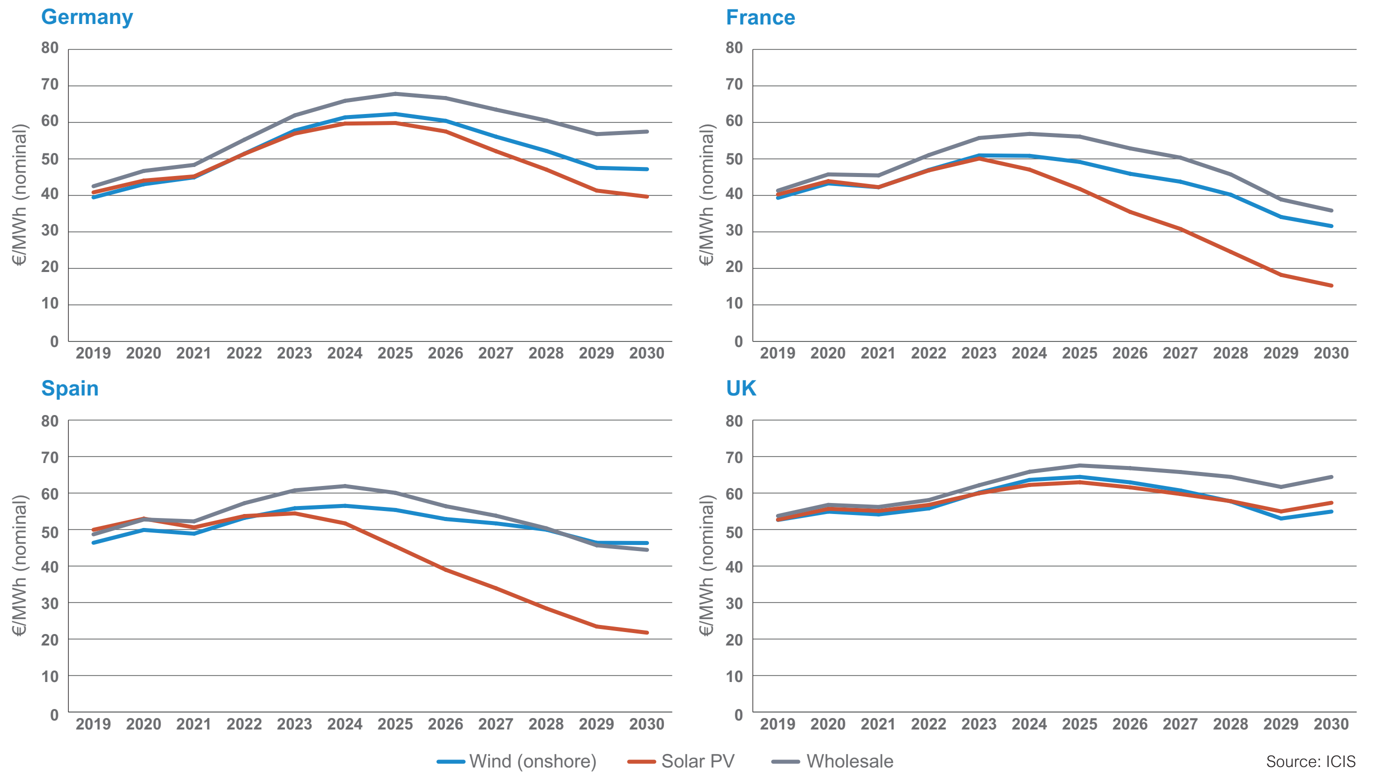
4. WHOLESALE PRICE FORECASTS

We used our pan-European ICIS Power Horizon model to assess the implications of capacity additions on generation and prices. In each of the four countries, we expect an increase in the wholesale power price through to the mid-2020s, which is driven partly by a phasing out of fossil fuel and nuclear capacity, but mainly by our assumptions for carbon prices.

For carbon price projections, we used the forecast from our long-term carbon price model that is directly linked to the ICIS Power Horizon model. We believe the market stability reserve (MSR) will lead to EUA prices rising above €40/tonne between 2023 and 2025, before seeing a subsequent decline due to the combination of abatement and a relaxing market balance following a reduction of the MSR withdrawal rate as of 2023.

The bullish trend in carbon in the early 2020s, along with increasing coal and gas prices, will push up the wholesale price in each country, which will lead to an increase in solar and wind capture prices across all four countries

FIGURE 3: WHOLESALE AND CAPTURE PRICE FORECASTS BY COUNTRY AND TECHNOLOGY



Source: ICIS

during this period. However, the subsequent bearish trend in carbon prices in the second half of the 2020s will weigh on power prices at the same time as increasing renewable generation also asserts a bearish impact on prices.

For our full coal, carbon and gas price assumptions, see the graphs in the appendix of the report.

5. CAPTURE PRICE FORECASTS

The revenue that an onshore wind or solar project is able to achieve on the market is known as the capture price and is calculated as the average market price weighted of the hourly production. The capture price reflects the fact that the market income for a renewable project is dependent on its generation profile and can therefore deviate from the wholesale market price. In the absence of government subsidies or an offtaker agreement, capture prices are the key metric in determining how much revenue a project can realise by selling its generation on the Day-ahead market.

Currently, there is only a small difference between the average annual capture price and the wholesale price in each of the countries analysed in this report. However, as more wind and solar capacity is added over the coming decade, the zero marginal cost nature of these plants displaces higher-cost generation sources in the merit order, leading to lower-cost sources setting the price. This can have a depressive impact on wholesale power prices during times of high renewable output, in an effect known as price cannibalisation. Since each new solar unit produces with a similar profile to other solar units on the system (and likewise for onshore wind), the effect is exacerbated with each new generating unit that is added, with new solar or onshore wind capacity cannibalising the revenue for earlier projects.

Figure 3 shows our modelled forecasts for onshore wind and solar capture prices, as well as wholesale prices, in each of the four countries. Since the focus of this paper is the prospects for subsidy-free projects, the capture prices do not include any hours where the price falls below zero as we assume that subsidy-free projects will shut down when the price turns negative. The capture prices for subsidised projects would in fact fall below the values shown here because they may be incentivised to keep producing at negative prices, which has implications for the level of government support required for each project.

In the below sections, we analyse the main trends in capture prices that we expect to see.

5.1 The rate of capacity growth

The most important factor in determining the level of cannibalisation of capture prices in each country is the size and the speed of capacity additions. As can be seen in Table 2 below, the massive increases in solar capacity in Spain (+461%) and France (+315%) are the main reason why solar capture prices fall so significantly in the

TABLE 2: CAPACITY ADDITIONS 2019-2030 BY COUNTRY AND TECHNOLOGY

Country	Solar increase 2019-2030		Onshore wind increase 2019-2030	
	Capacity (MW)	Percentage change	Capacity (MW)	Percentage change
Germany	34,170	72%	10,942	21%
France	38,720	315%	28,080	166%
Spain	30,306	461%	24,561	96%
UK	9,958	76%	7,388	53%

Source: ICIS

second half of the 2020s in each country. Conversely, with Germany (+72%) and the UK (+76%) set to see lower solar capacity additions, in percentage terms, capture prices do not see such a cannibalisation effect through to 2030.

Similarly, the reduction in capture prices across the four countries is not as significant for wind compared with solar in part because the scale of capacity growth is not expected to be as strong. However, as we explore in the section below, there are factors beyond simply the scale of growth that determine both national and technology differences in the captured price.

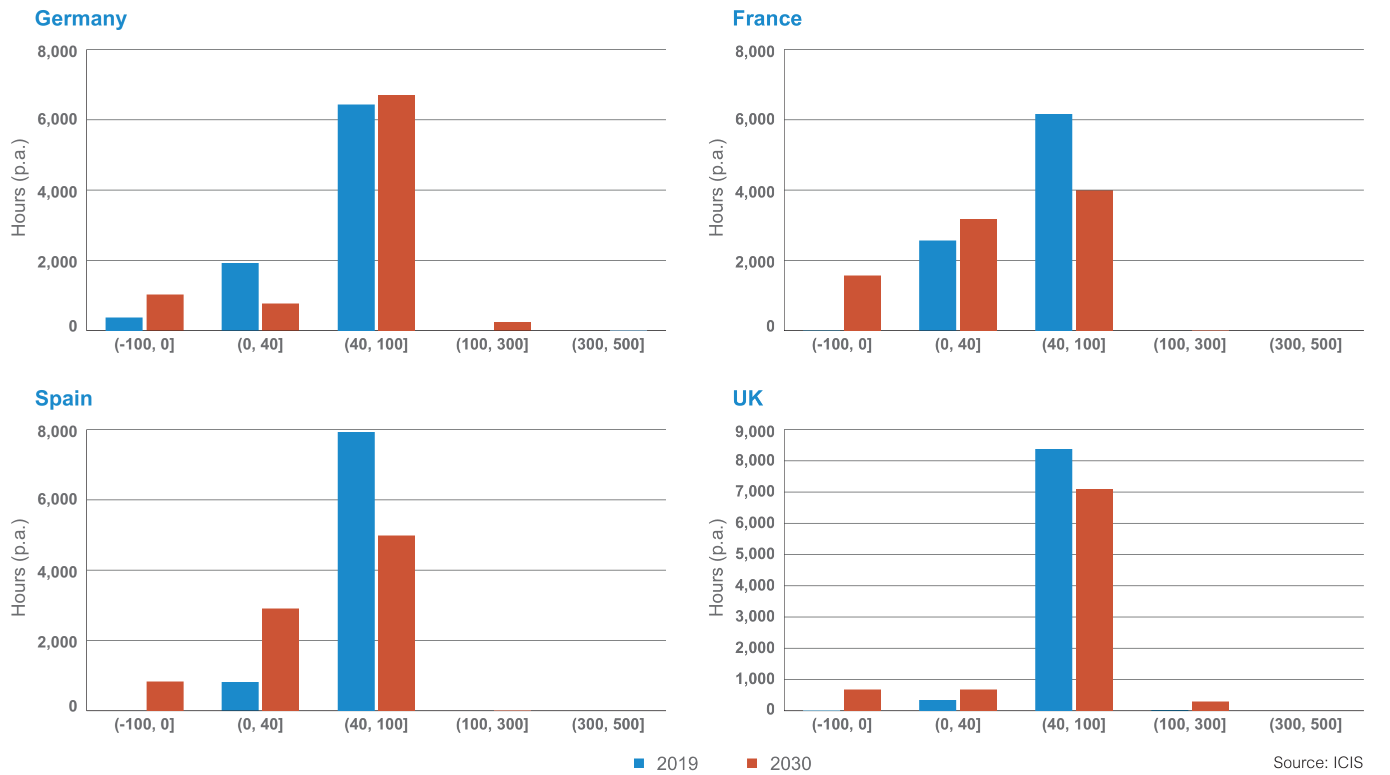
5.2 Price distribution

A crucial factor that determines the strength of price cannibalisation is the supply structure of each country and the marginal costs of the plants that set the prices in most hours. Under the capacity assumptions outlined above, we see massive overcapacities of wind and solar in Spain and France by 2030. The average load in Spain rises from 21.8GW in 2019 to 23.7GW in 2030, while the combined capacities of solar and onshore wind increases to 87.1GW by 2030. As a result, in 650 hours in 2030 (roughly 8% of the time), the production from solar alone would be sufficient to cover electricity demand entirely. Consequently, we see a large shift in the price distribution bins in Figure 4: in 2019, for 91% of total hours the wholesale price is between €40/MWh and €100/MWh, but by 2030 prices stay below €40/MWh for 43% of total hours.

A similar trend can be observed in France. In addition to the strong increase in renewable capacities, hydro and nuclear power become price-setting plants more frequently. Load factors for gas decrease from 32% in 2019 to 14.6% in 2030, thus potentially triggering some closures/mothballing. Overall, this results in a similar shift of the price distribution.

Looking at the price distribution in the UK and Germany, we see a much smaller shift in prices. This is partly due to the absence of a large share of hydro and nuclear power plants and the fact that fossil generation with high marginal costs continues to account for the price setting in

FIGURE 4: WHOLESALE PRICE DISTRIBUTION 2019 VS. 2030 BY COUNTRY



Source: ICIS

LCOE METHODOLOGY

ICIS conducted extensive research to calculate current LCOEs for onshore wind and solar and to predict the future costs of these technologies.

We projected future LCOEs using a learning curve approach for future capital expenditures (CAPEX) of utility scale solar and onshore wind projects. In the past, costs have fallen quickly due to the acceleration of economies of scale and, in the case of solar, due to the establishment of new manufacturers in Asia. Therefore, both the development of the local market and the development of a global market is taken into account.

We also made assumptions on system degradation, operating expenditures and project lifetimes where improvements will lead to decreasing costs in the future. We interpolated the development of these factors linearly.

the vast majority of hours.

6. CAPTURE PRICE FORECASTS VS. LCOE ASSUMPTIONS

6.1 LCOE definition

LCOEs are a common measure to compare different sources of electricity regarding their costs. A standard interpretation is to read LCOE as the average price a project needs to capture on the market over its lifetime to break even.

The upper LCOE values in Figures 5 and 6 result from taking average load factors of existing onshore wind and solar plants in our model. Therefore, we believe that most of the projects would have LCOEs around this border. In contrast to the lower boundary, these LCOEs also account for decreased generation in the future for hours in which wholesale prices are negative and renewable operators without subsidies would curtail their production. The load factor is averaged over the lifetime so that already LCOEs in 2019 account for this lower yield. Beyond 2030, the load factors are assumed constant.

The lower boundaries in Figures 5 and 6 result from best-case capacity factor assumptions. In the case of solar, these were derived from Fraunhofer, while for onshore wind the latest IRENA data was taken. Note that the LCOEs based on these load factors do not include any curtailment assumptions. Since these are lower boundaries, we assume that only a small number of projects will be able to achieve a LCOE this low.

6.2 LCOE vs. capture prices: Solar

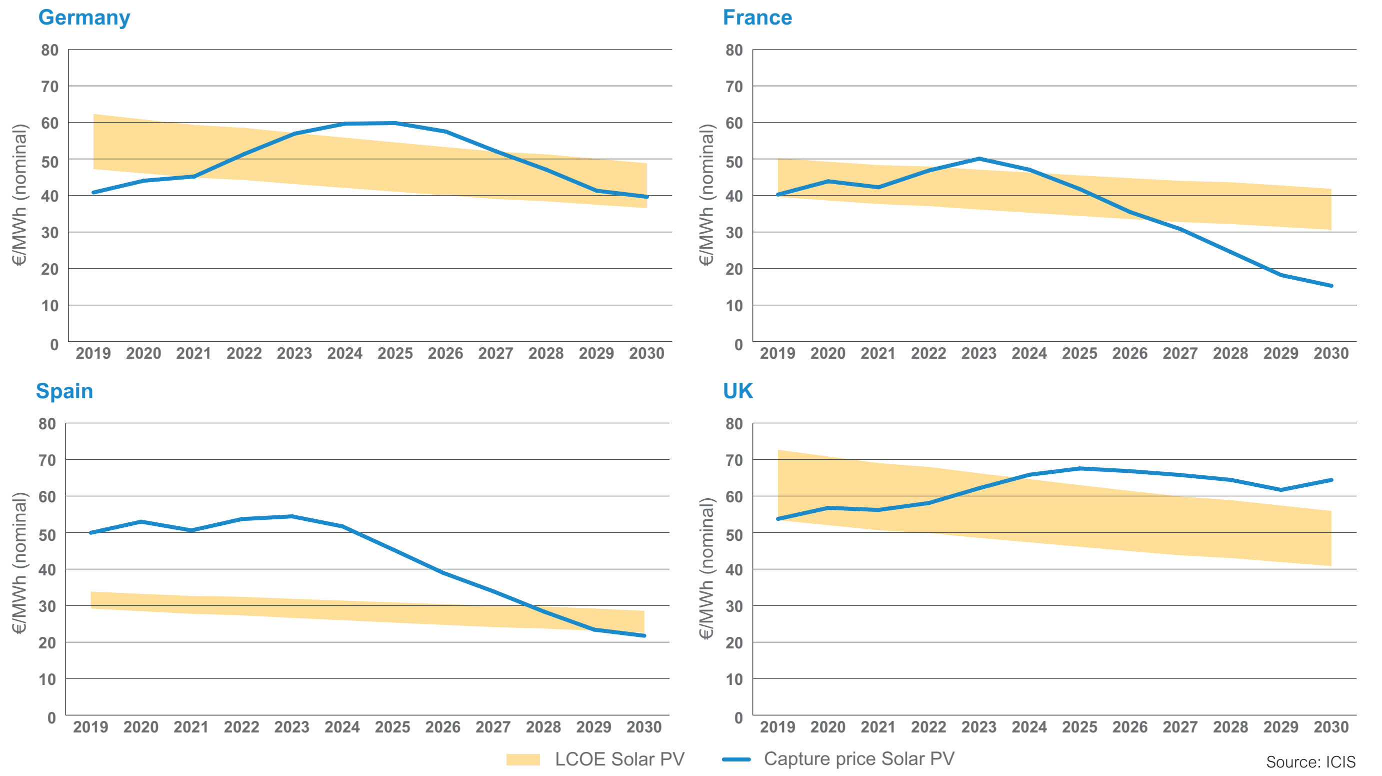
In Figure 5, the average and lower values for solar LCOEs are plotted against our capture price forecasts for each country. The results show that for the UK, the capture price and the LCOE will move in opposite directions over the next decade, leading to gradually increasing prospects for the profitability of subsidy-free projects. While only the lowest-cost projects would be able to turn a profit in the early 2020s, between 2025 and 2030 capture prices are expected to sit comfortably above the LCOE assumption.

However, in Germany, France and Spain the cannibalisation of capture prices in the second half of the 2020s is expected to outpace declines in LCOEs and challenge the economics of subsidy-free projects.

Germany is expected to see an initial increase in capture prices, due to the impact of coal and nuclear phase-out and a bullish carbon price, at the same time as LCOEs decline. As a result, the capture price is expected to rise comfortably above the average LCOE in the mid-2020s. However, by the late 2020s cannibalisation of the capture price will mean that only the lowest-cost projects continue to be profitable.

A similar pattern is expected to be seen in France initially, with capture prices rising above the average LCOE. However, the significant increase in solar capacity over the coming decade would have a substantial cannibalisation impact on capture prices, meaning that by the late 2020s the revenue for even the best projects are

FIGURE 5: SOLAR CAPTURE PRICE FORECASTS VS. LCOE RANGES (€/MWH - NOMINAL)



Source: ICIS

substantially below the levelised cost.

Spain is currently in a unique position among the four countries, with capture prices sitting comfortably above the levelised cost and margins likely to improve through to the early 2020s as market revenue increases and LCOEs continue to decline. However, the depressive impact on capture prices from additional capacity will mean that by 2028 the capture price is likely to fall below the average LCOE. This means that the first wave of subsidy-free projects currently being built are likely to break even over their lifetime, but that subsequent subsidy-free projects arriving from the mid-2020s may risk being unable to turn a profit.

6.3 LCOE vs. capture prices: Onshore wind

In Figure 6, the upper and lower values for onshore wind LCOEs are plotted against our capture price forecasts for each country. The situation for onshore wind in both the UK and Germany is similar to the results for solar. In the UK, the relatively small increase in capacity will lead to low cannibalisation. When added to the high overall power price in the UK compared with other markets, this means that capture prices are expected to exceed average levelised costs from the early 2020s onwards, which should encourage subsidy-free developments.

Germany will see an initial boost in capture prices, followed by a cannibalising impact in the second half of the 2020s, which will push the capture price below the levelised cost for some projects.

France currently has the highest LCOE and the lowest onshore wind capture price among the four countries. While capture prices are expected to rise in the early 2020s, subsequent cannibalisation will mean that by the late 2020s no projects would be viable at full merchant risk.

For Spain, the capture price is expected to sit between the upper and lower LCOE assumption throughout the next decade. This suggests that the viability of subsidy-free projects will remain site specific.

7. CONCLUSIONS

Our modelling highlights how the capture prices for onshore wind and solar projects across the four countries considered in the report will be affected by price cannibalisation as the deployment of wind and solar projects increases. By comparing the modelled capture prices with our assumptions on LCOEs, we demonstrated that the viability of subsidy-free projects operating at full merchant risk will become increasingly challenging in the second half of the 2020s.

The findings suggest that there is a potential incompatibility between high levels of renewable ambition and the ability to rely on the private sector to take on the responsibility of supporting capacity growth, since projects relying solely on the market for their revenue may be unable to recover their costs as capacity additions escalate and capture prices are increasingly cannibalised.

The results show a contrast between the UK and the three other countries considered in the report. Since the UK has already withdrawn subsidies for onshore wind and solar, and there is an expectation for modest capacity growth, this will reduce price cannibalisation and lead to an improving outlook for subsidy-free projects through to 2030.

In contrast, the faster rate of solar and onshore wind capacity expansion in France, Germany and Spain

FIGURE 6: ONSHORE WIND CAPTURE PRICE FORECASTS VS. LCOE RANGES (€/MWH - NOMINAL)

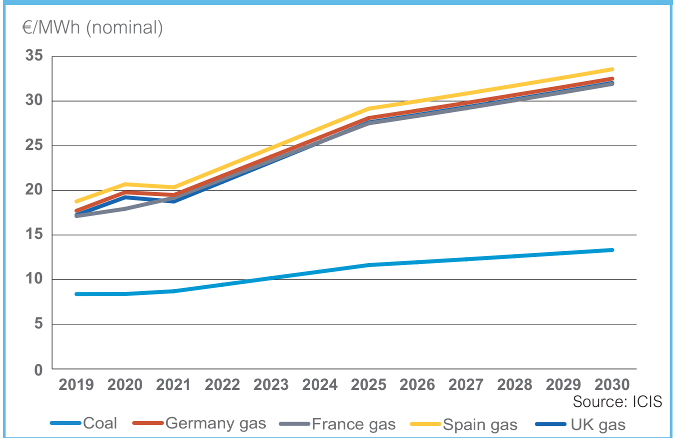
Source: ICIS

will mean that market revenue becomes increasingly cannibalised in the second half of the 2020s, which will threaten the economics of subsidy-free projects. In the absence of an adequate PPA market to de-risk projects, the results suggest that the governments of each country will need to play a role in ensuring that projects remain viable if national 2030 targets are to be achieved.

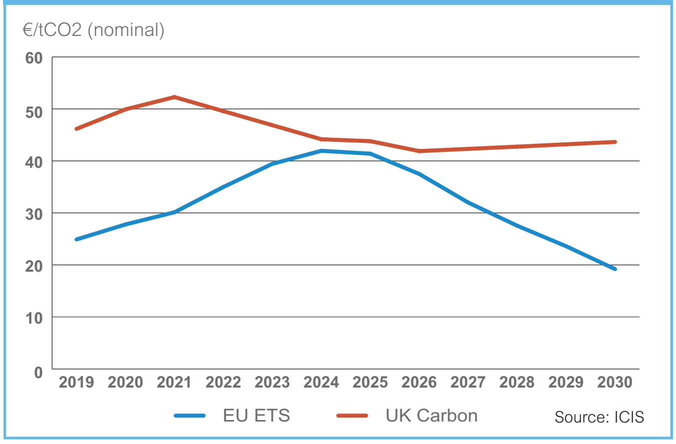
APPENDIX

The two graphs below show the gas, coal and carbon price assumptions used in the modelling for this report.

GAS AND COAL PRICE ASSUMPTIONS



EU ETS AND UK CARBON PRICE ASSUMPTIONS



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