Tracking Market Value of Wind

Analysis of the historical Market Value of Wind in Europe

Ea Energy Analyses

IEA Wind Task 26 – Cost of Wind

EUDP

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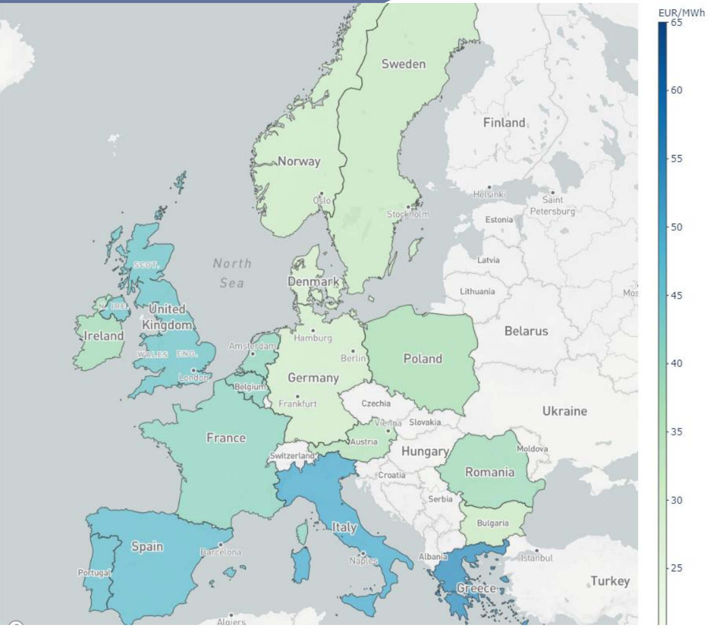
Executive Summary

Tracking Market Value of Wind analyses the historical development of *market value* (MV) of wind and *value factors* (VF) across Europe for the period 2015-2021. Both indicators depend on drivers related to technology, market and system conditions.



Market value of onshore wind, 2015-2020

Key messages identified include:

- The market value of wind follows power prices closely and is therefore very different across Europe, with higher values in the southern part of the continent and lower ones in the north.
- The absolute value of general power prices is the main driver for market value of wind. However, the degree of integration of wind is an additional factor weighting 8-32%
- The market value of offshore wind and solar is higher than onshore wind
- With respect to the value factor, the picture changes: there are higher value factors in southern Europe (where there is low wind penetration) and countries with large hydro balancing.
- Countries like Denmark, Ireland and Germany display lower value factors, given the higher wind penetration. Denmark shows a higher value factor than Germany. This is result of Denmark's closer location to large hydro and the German larger share of inflexible generation, like nuclear and lignite.
- The emergence of Covid-19 has impacted electricity demand downwards, virtually pushing up the relative wind penetrations everywhere in Europe. With this high penetration of wind, the value factor drops below 0.7 in many countries.
- The 2021 surge of power prices showed a large increase in market values.

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1.

Background & Intro

Market value as a measure of competitivity and integration

"Market value" indicates the potential profitability of a merchant project

Market value: average price captured by wind generators (EUR/MWh) in the wholesale electricity market. MV is calculated as the ratio of total market revenue captured by the generator to potential generation, including curtailment:

$$\textbf{Market value} = \frac{\text{Revenue in the wholesale market}}{\text{Potential generation}}$$

Although MV should be calculated relative to potential generation (including curtailment), we have included only actual generation, due to data availability issues. This means that our approach tends to overestimate MV and, by extension, the VF. However, this approach is not unusual in the related literature, see e.g., Eising et al. (2019) as an example.

As a metric, MV conveys the average market value of wind generation in the electricity system and the profitability of a merchant wind project.

High levels of production under low prices lead to a lower market value and lower revenue for the investor. This may take place with high penetration of wind power, as wind production tends to depress prices.

The calculation of a MV makes the simplifying assumption that all generation is traded on the day-ahead market, and that there are no balancing costs. Furthermore, the computation of market value ignores subsidies.

"Value factor" indicates how well wind is integrated in the power system

Value factor: It is calculated as the ratio of market value to the average wholesale electricity market price. It can be seen as an indicator of the degree of integration.

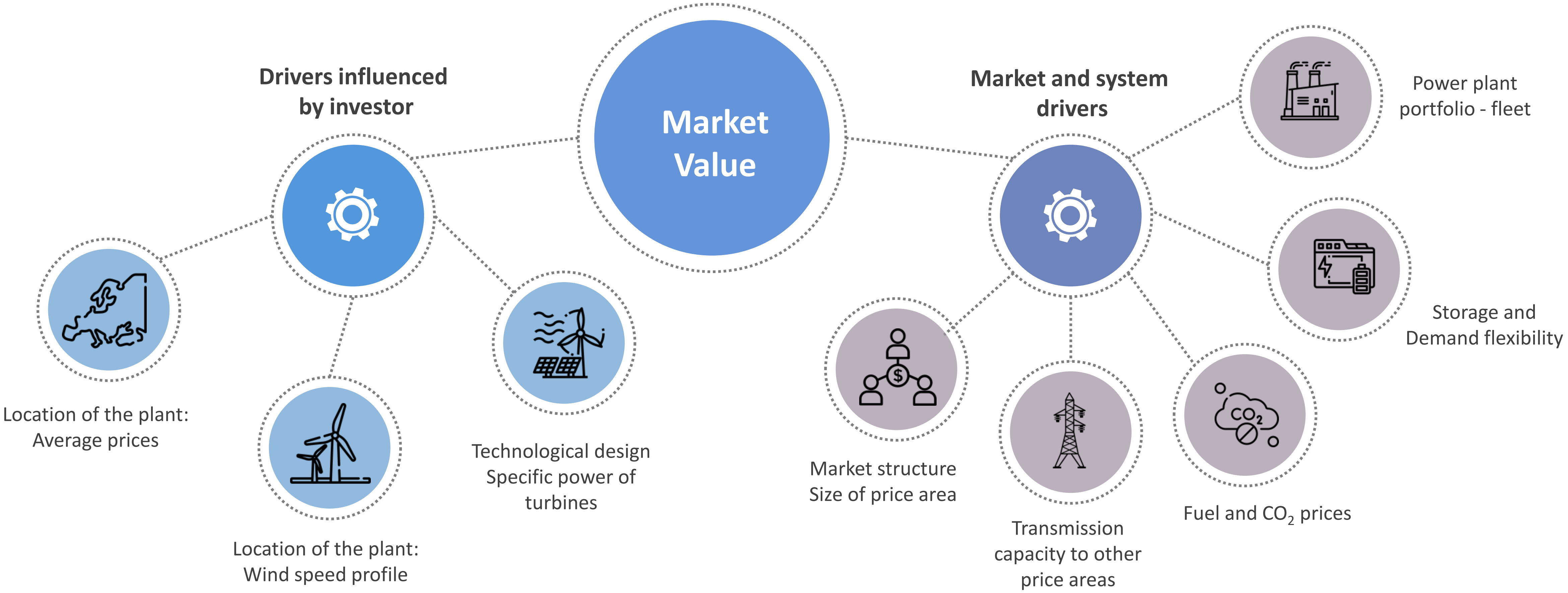
$$\textbf{Value Factor} = \frac{\text{Market value}}{\text{Average wholesale market price}}$$

For example, if the value factor is below 1, then the captured price is lower than the average wholesale price.

The value factor tends to decrease as the market share of wind increases in the system.

A decrease of the value factor in line with wind integration may also reflect *self-cannibalization*. More wind power drives the wholesale electricity market price down in specific hours, thereby decreasing the price captured by producers, resulting on a diminishing force against the profitability of additional projects.

Drivers behind the market value of wind



The drivers behind the Market Value are diverse, since both wind production patterns, and power price formation affect it.

Literature focuses on empirical impacts and on future projections

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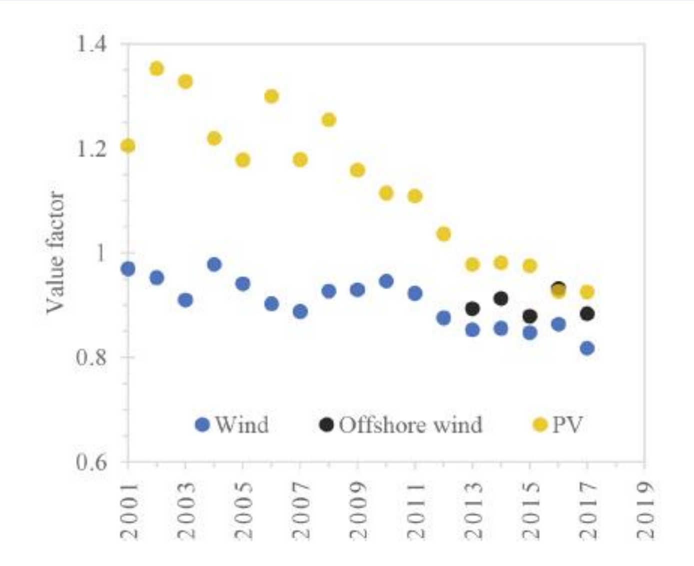
Several historical reviews of market value have focused on Germany. For example, Manuel Eising et al. (2019) find that the value factor has declined in the period 2001-2017, with a steeper decline for solar PV than that observed for both onshore and offshore wind (see figure to the left).

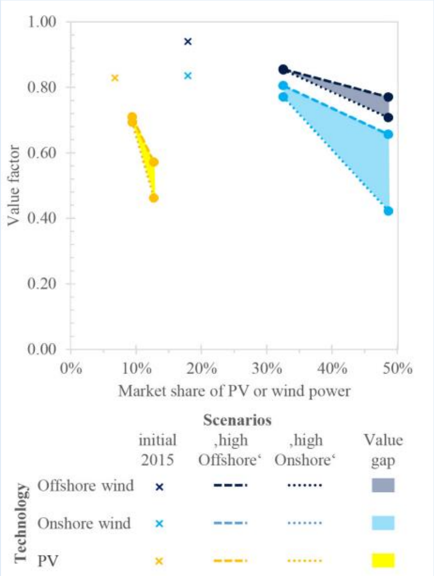
The finding by Eising et al. (2019) confirms a combination of aspects addressed earlier by authors such as Hirth and Radebach (2016):

- *Increasing VRE penetration:* as VRE production increases, the merit order effect on the formation of prices becomes more evident. As VRE becomes more prevalent in the price formation process, VF tend to decrease over time. This is true for wind but also for solar PV.
- *VF greater than 1:* at low penetration rates, the merit order effect is relatively weak and specific market revenues may thus exceed the average electricity price, e.g., for solar generating during mid-day high prices.
- *Steeper decline for solar PV than for wind, at higher penetration rates:* as solar PV has higher impact during peak hours, revenues decrease more strongly, leading therefore to a steeper reduction in VF for solar PV. Solar is strongly corelated across areas and has less smoothing than wind.

In their scenario analysis (see figure to the right), Eising et al. (2019) find that offshore wind generation is less vulnerable to declining electricity prices. At the observed market share of 18% in 2015, the difference in VF between offshore and onshore is of 0.1, in favor of offshore. At the forecasted market share of 49% in 2035, this difference is as high as 0.11 in favor of offshore wind, in the “high offshore” scenario and of 0.29 under the alternative “high onshore” penetration scenario.



Manuel Eising et. al., 2019



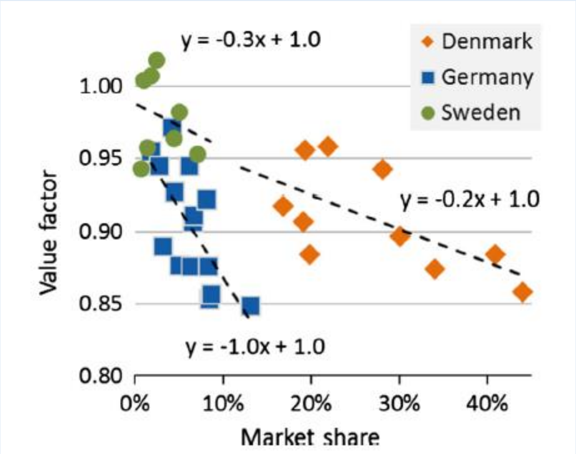
Manuel Eising et. al., 2019

Literature focuses on empirical facts impacts and on future projections

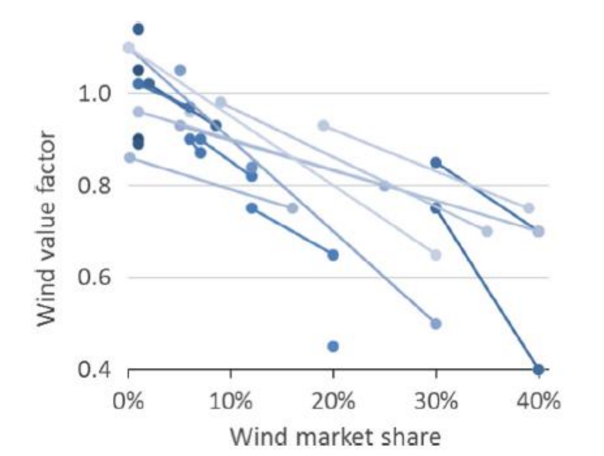
Other studies have investigated the MV of wind energy in power systems where hydroelectric stations with large reservoirs prevail.

With data for the period 2001 – 2015 (see figure to the left), Lion Hirth (2016) finds that the wind power VF declines with market share, but that the decline is steeper in countries like Germany, where the power system is dominated by thermal power production. In contrast, Sweden - which has a 50% share of reservoir-based hydro – and Denmark, which is highly interconnected to both Sweden and Norway, where hydropower supplies nearly 100% of demand, have a flatter decline rate in their VF.

Furthermore, Lion Hirth (2016) summarizes several studies, all of which confirm the inverse relation between VF and wind market share. In the figure to the right, each line represents a study, and each dot represents the minimum and maximum penetration rates, respectively.



Lion Hirth et. al., 2016



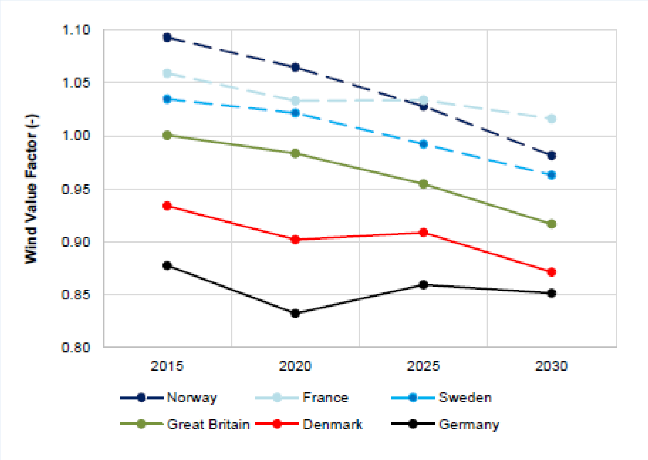
Lion Hirth et. al., 2016

Literature focuses on empirical facts impacts and on future projections

As the existing literature on the MV of wind lacked a comprehensive treatment of all European electricity markets, the report by Alberto Dalla Riva et al. (2017) sought to build several scenarios to characterize the evolution of the power system up to 2030. In the likely scenario (see figure), a tendency toward to a reduced VF was confirmed for the period 2015-2030. However, in line with other studies, countries with access to hydropower exhibited higher VF than those without it.

The present analysis updates the analysis presented by Alberto Dalla Riva et al. (2017), by including hourly data (which was then averaged to monthly values) data from January 2015 to September 2021 for Denmark, Norway, Sweden, Italy, Spain, France, Poland, Netherlands, Belgium, Ireland, Portugal, Romania, Greece, Bulgaria, Germany and Austria. Because of the period covered, the analysis contributes with insights into the impact of:

- COVID-19 on the MV of wind in Europe
- The recent price surge in electricity and other commodity markets on the MV of wind in Europe



Alberto Dalla Riva et. al., 2017

A few formal definitions and caveats

Market Value of Wind is formally defined as the ratio of market revenue to potential generation of wind power, including curtailment:

$$\textbf{Market value} = \frac{\sum_{t=1}^{T} p_{t,z} \cdot E_{t,g,z}}{\sum_{t=1}^{T} E_{t,g,z}} = \bar{p}_{g,z}$$

where:

t: time step (*1, …, T*)
g: technology (land-based wind, offshore wind)
z: country or bidding zone considered (DK1, DK2, France, etc.)
T: total time steps in the period considered (8,760 hours if 1 year is assumed)
E: potential energy production, including production that is curtailed
g: technology-specific generation (in this case, wind)
p: average electricity market price

<u>**Caveat:**</u> Because curtailment data is not publicly available, we use instead the formula used by Eising et al. (2019) (see also Hirth (2016, 2013) where actual generation is used instead:

$$\textbf{Market value} = \frac{\sum_{t=1}^{T} g_t^{tech} \cdot p_t}{\sum_{t=1}^{T} g_t^{tech}} = \bar{p}^{tech}$$

where:

g_t^{tech}: technology-specific generation
p_t: electricity price

The Value Factor of Wind is a normalized metric, which facilitates the comparison of MV across time periods and markets. It is defined as the ratio of Market Value to the average electricity price in a market zone or country:

$$\textbf{Value Factor} = \bar{p}_{g,z} \cdot \frac{1}{\sum_{t=1}^{T} p_{t,z}/T}$$

where:

$\bar{p}_{g,z}$: market value
p_z: average electricity market price in the zone or country

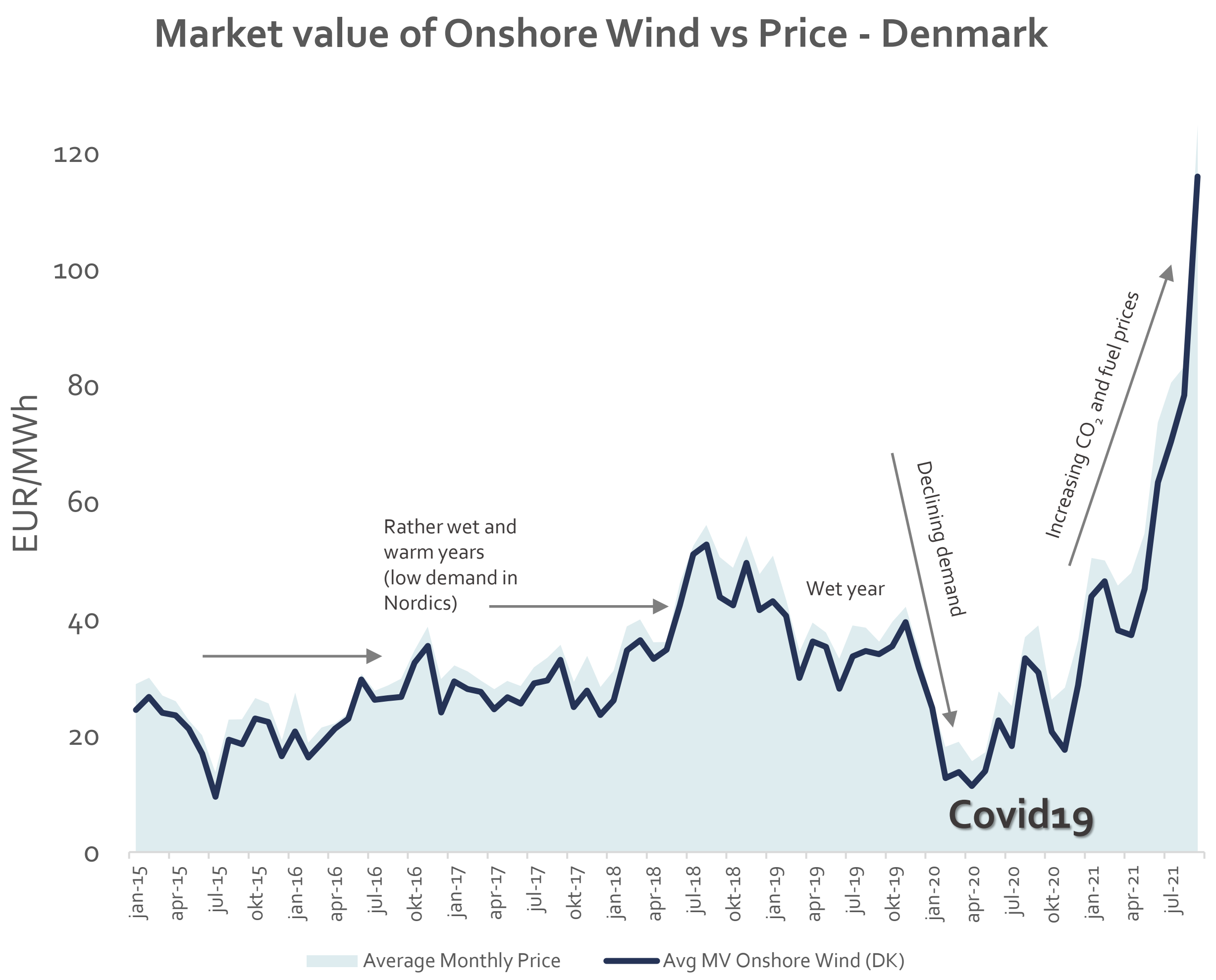
<u>**Caveat**</u>: to be consistent with the previous observation that we did not have access to curtailment data, we use the VF formula presented in Eising et al. (2019) :

$$\textbf{Value Factor} = \bar{p}^{tech} / \bar{p}$$

where $\bar{p} = \sum_{t=1}^{T} p_t / T$

2.
Tracking the Market Value (EUR/MWh)

Price development is the main driver for wind MV



MV is strongly correlated with **price developments** in the wholesale power market.

The largest impact on both price and MV is given by **fundamental conditions**, such as weather (rainfall, wind speed, solar irradiance), demand, fuel costs (for coal and natural gas) and CO2 prices.

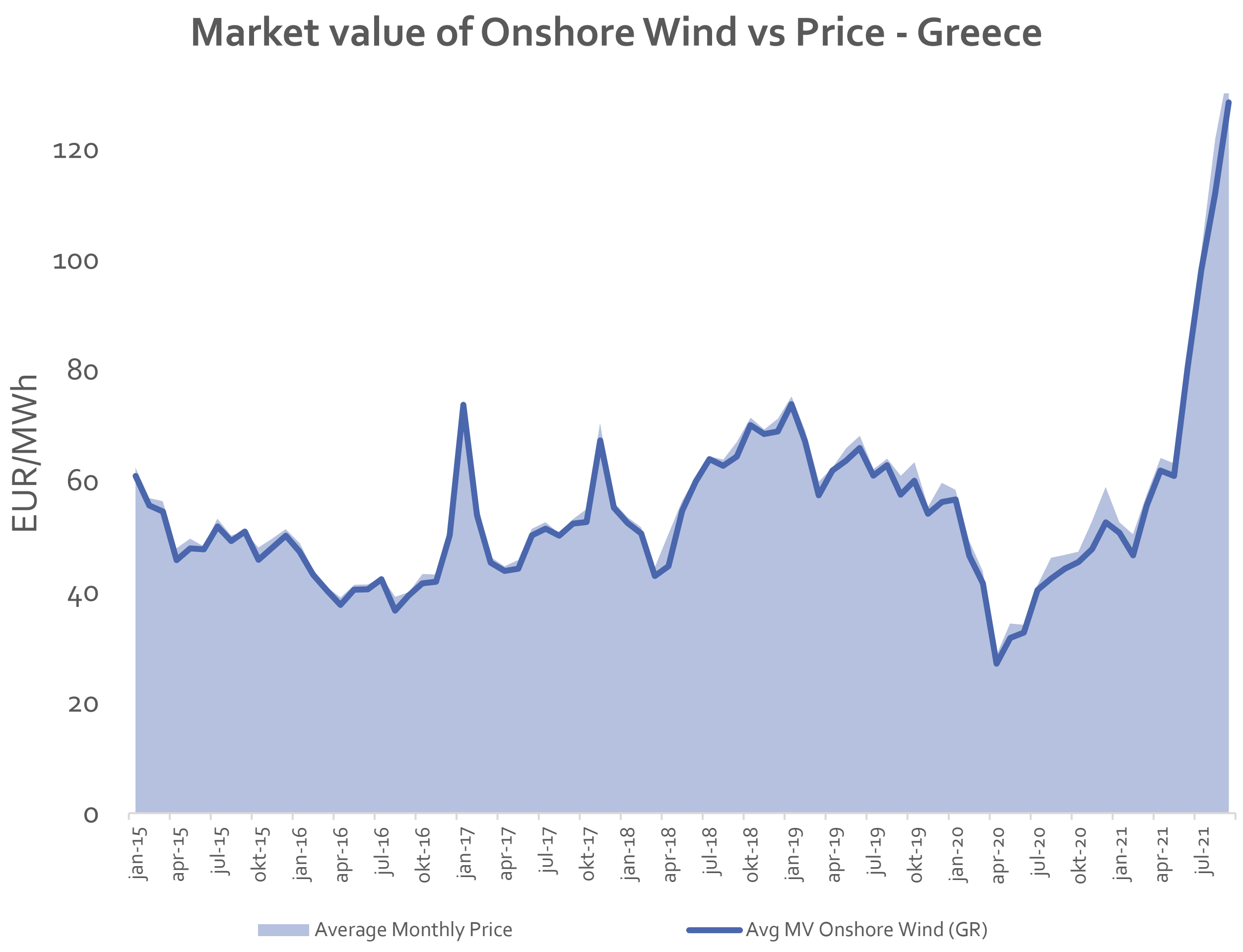
As an example, the figure on the left shows the evolution of the average price in Denmark and the MV for onshore wind in the period January 2015 - September 2021.

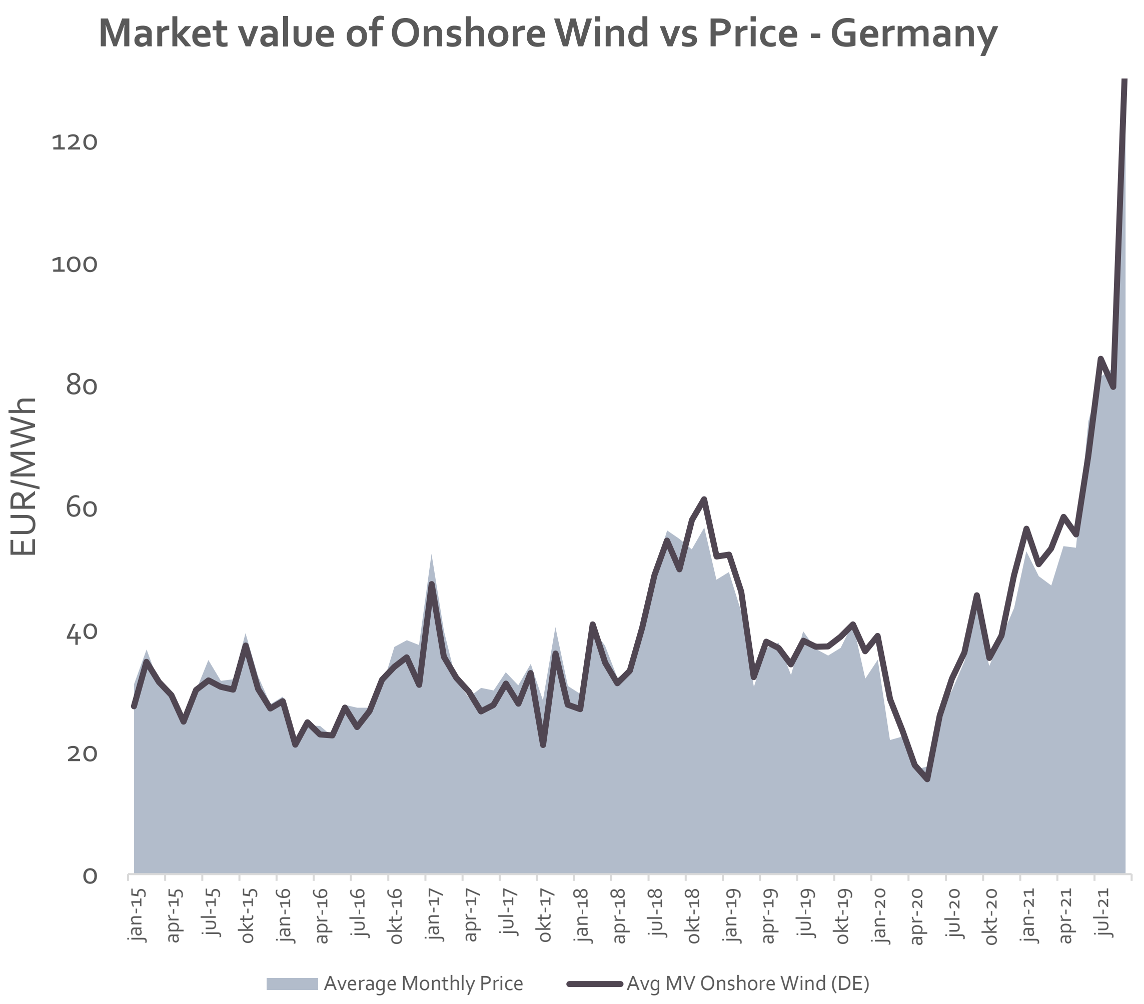
It can be observed how the wholesale price and MV for onshore wind remained relatively stable and low in the period up to December 2019.

With the COVID lockdown taking place in the first quarter of 2020, electricity demand experienced a dramatic reduction, and with it a marked price decline.

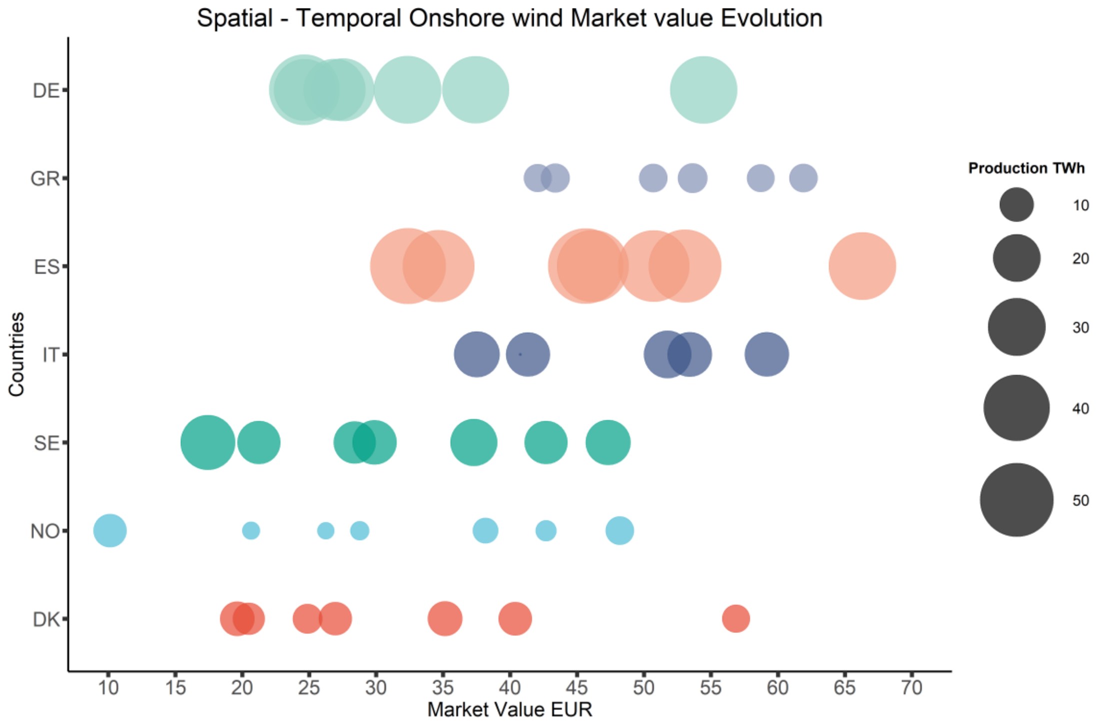
In the later part of 2020, a combination of fuel and CO2 price increases derived in a strong increase of electricity prices.

Price development is the main driver for wind MV





Market values differ largely across Europe

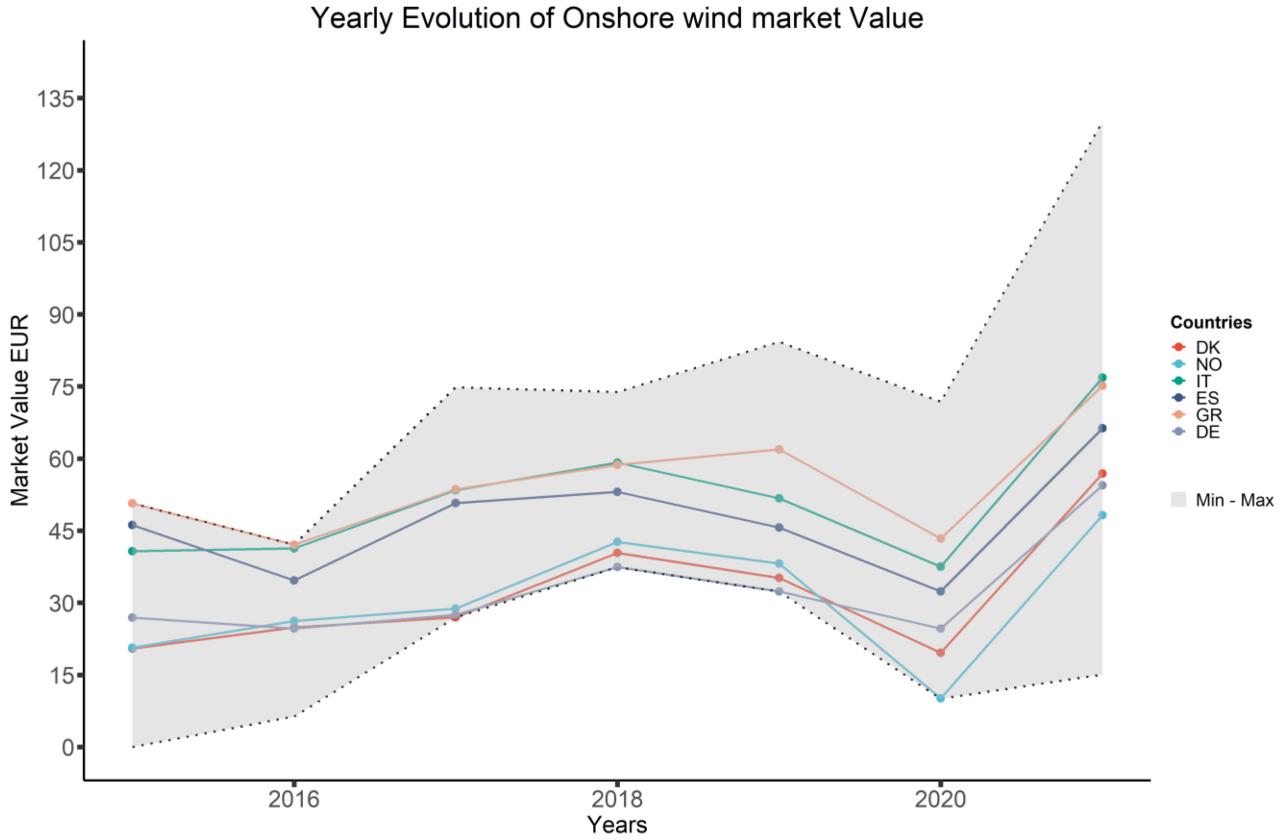


The analysis reveals that there are considerable variations in the MV of wind, both in time and across European countries.

For example, there is a consistent difference in the MV of onshore wind between Nordic and Mediterranean countries. This is of approximately **20 EUR/MWh**. While the MV is in the range of 20 – 40 MWh, the corresponding MV for Mediterranean countries is 40 – 60 MWh.

This consistent difference can be attributed to the energy mix of the countries in the sample. For example, thermal generation in Greece and hydropower in the Nordics.

Market values largely differs across Europe

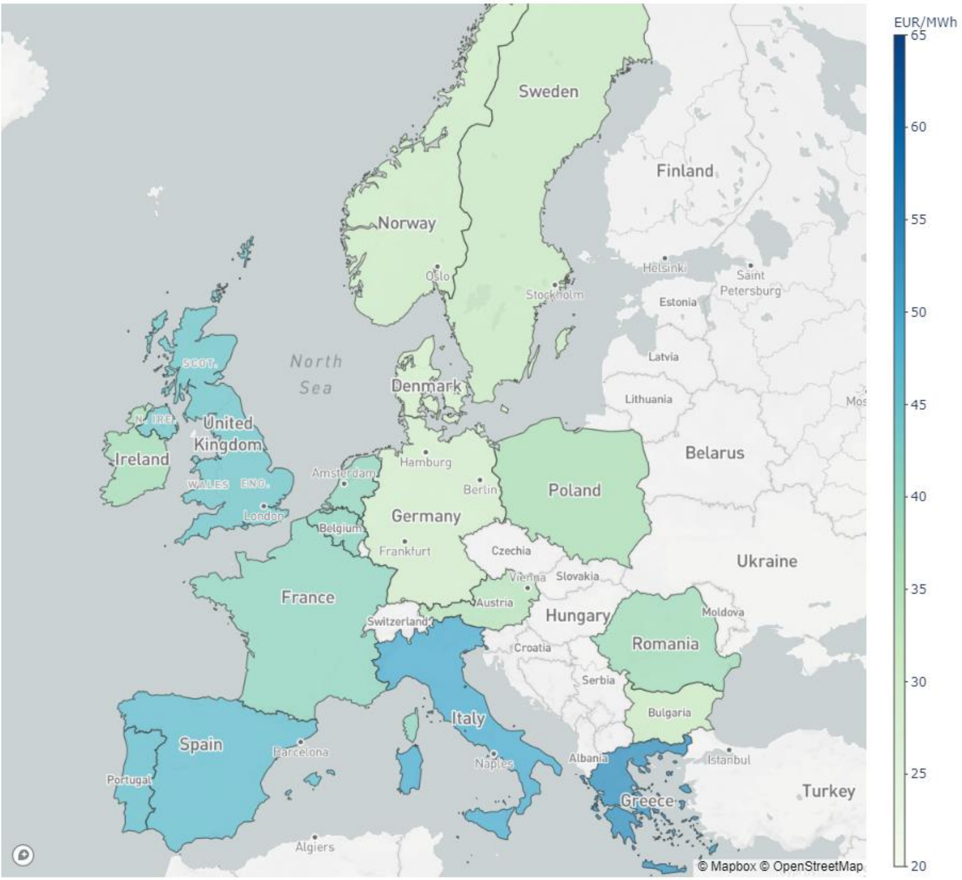


** 2021 data covers Jan-Sept; Min-Max refers to the minimum and maximum of all countries in the sample under consideration*

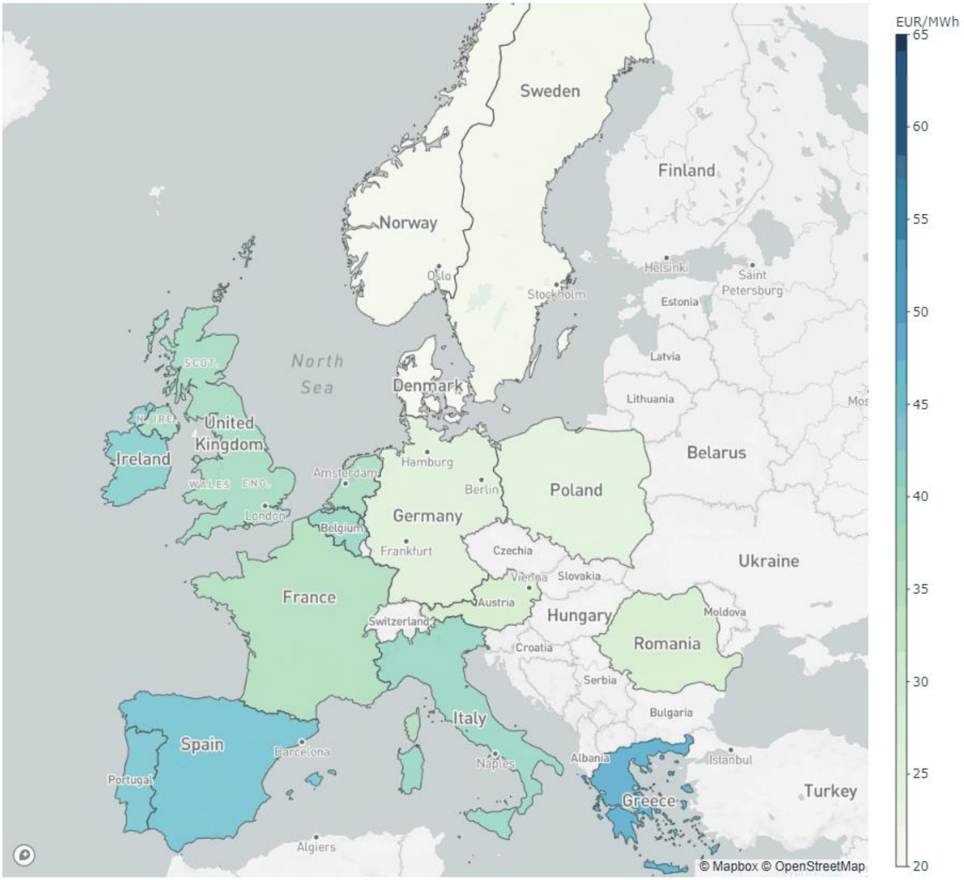
- Large variations across Nordic countries and Mediterranean countries
- Consistent **difference of around 20 EUR/MWh:** Nordics range 20-40 EUR/MWh, Mediterranean 40-60 EUR/MWh

Mapping historical onshore market value across Europe

Market Value of Wind Onshore - 2015-2019

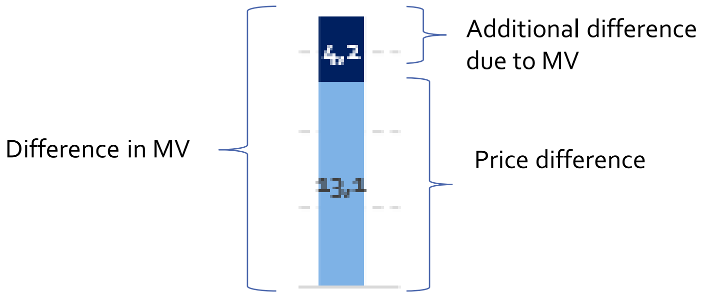


Market Value of Wind Onshore - 2015



Does market value depend only on price?

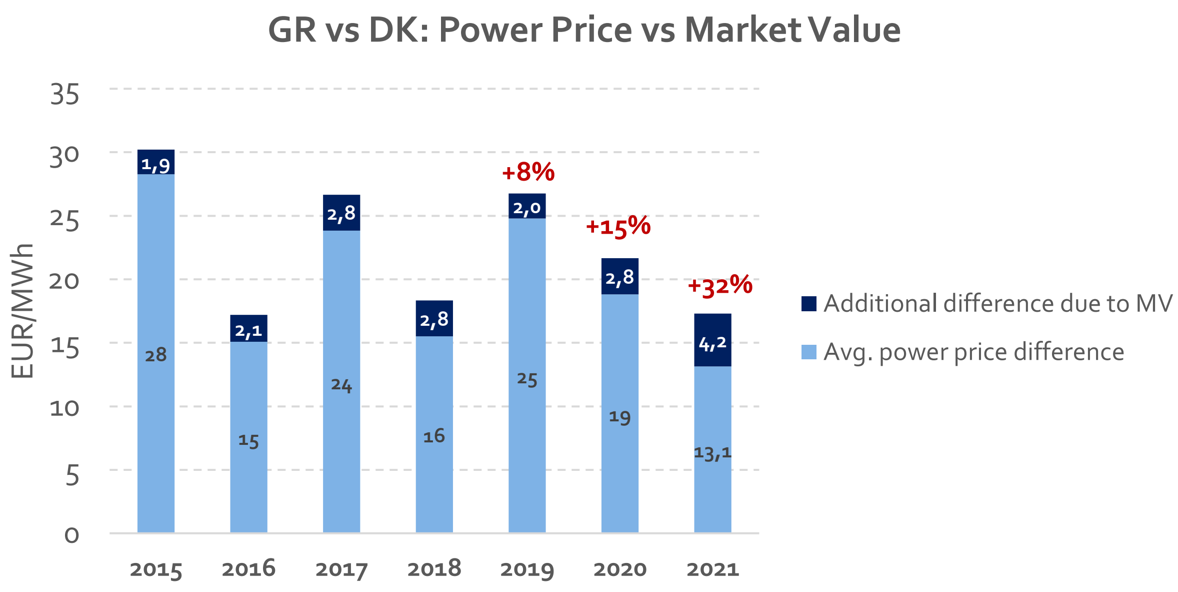
- We have observed that there is a consistent difference in the MV of wind between Northern and Southern Europe
- How much does this difference **depend on power prices**?



Example: Greece vs Denmark

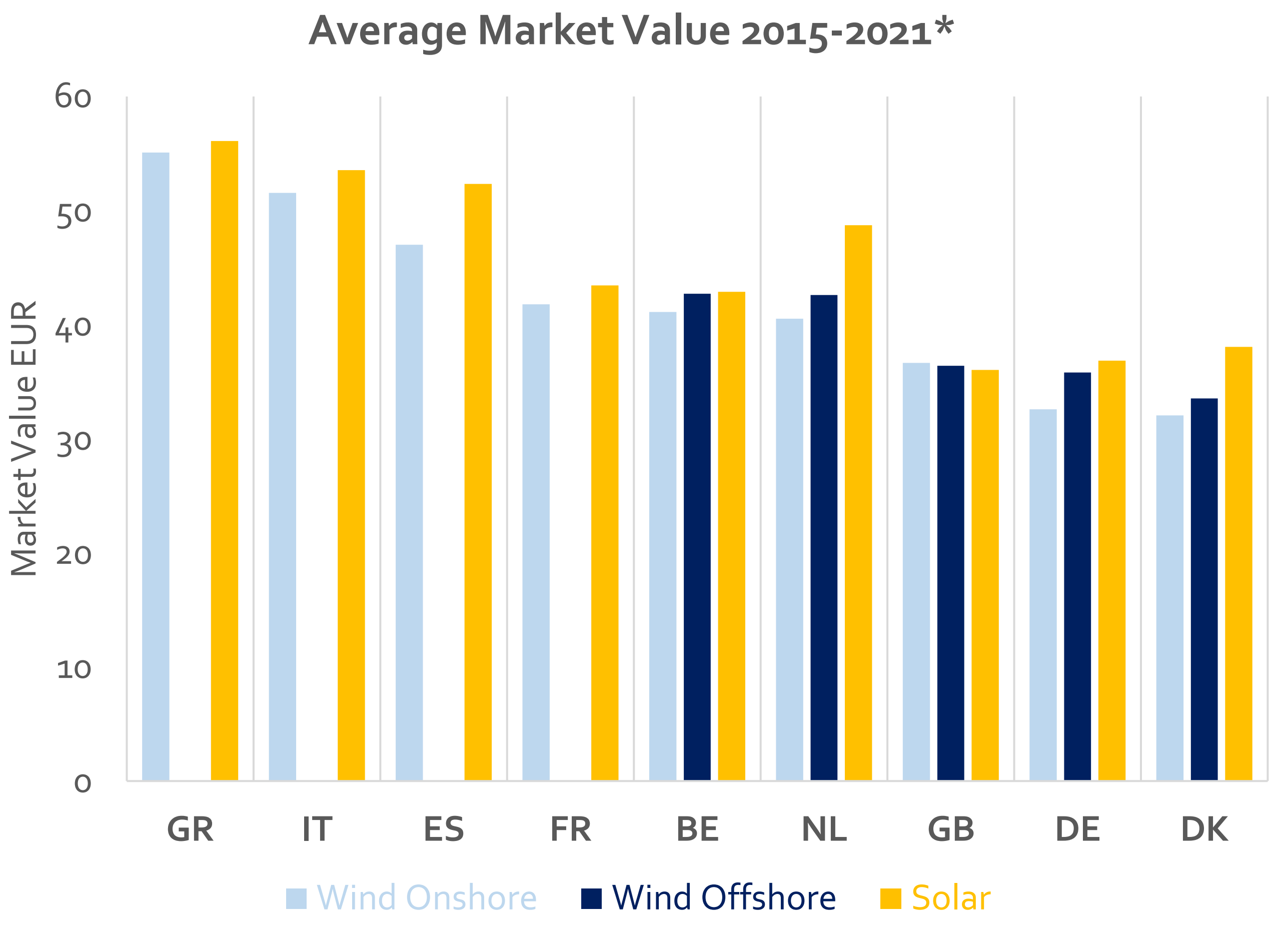
- Greece has higher prices and low wind penetration. Consequently, a high VF
- Conversely, Denmark has lower prices and high wind penetration. Therefore, a relatively lower VF

MV adds 7-32% to the price difference



Offshore and solar features higher market values than onshore

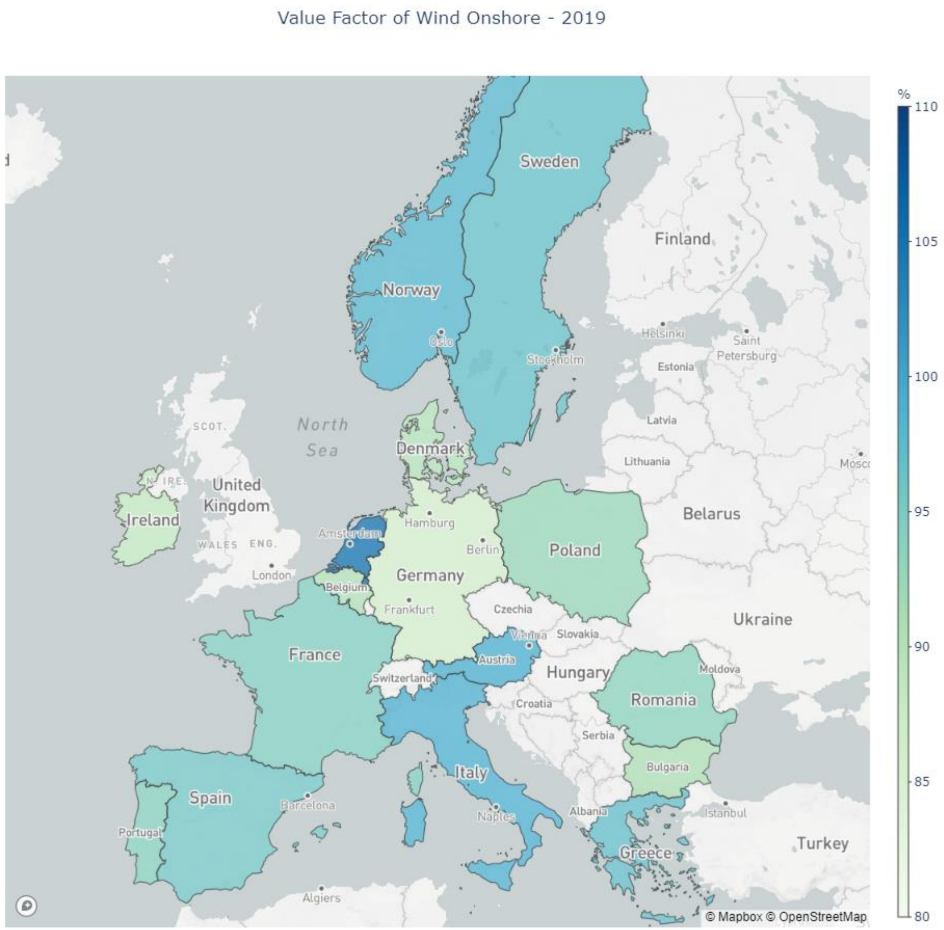
- **Offshore wind shows higher market value** compared to onshore (+5% on average) due to more constant wind
- Great Britain exhibits a different behaviour, with offshore wind value a bit lower than onshore one (large offshore fleet with correlated generation)
- **Solar power** has consistently higher market values compared to both onshore and offshore wind (+11% on average) due to mid-day generation. The market value of solar is highly sensitive to the share of solar



** 2021 data covers Jan-Sept.*

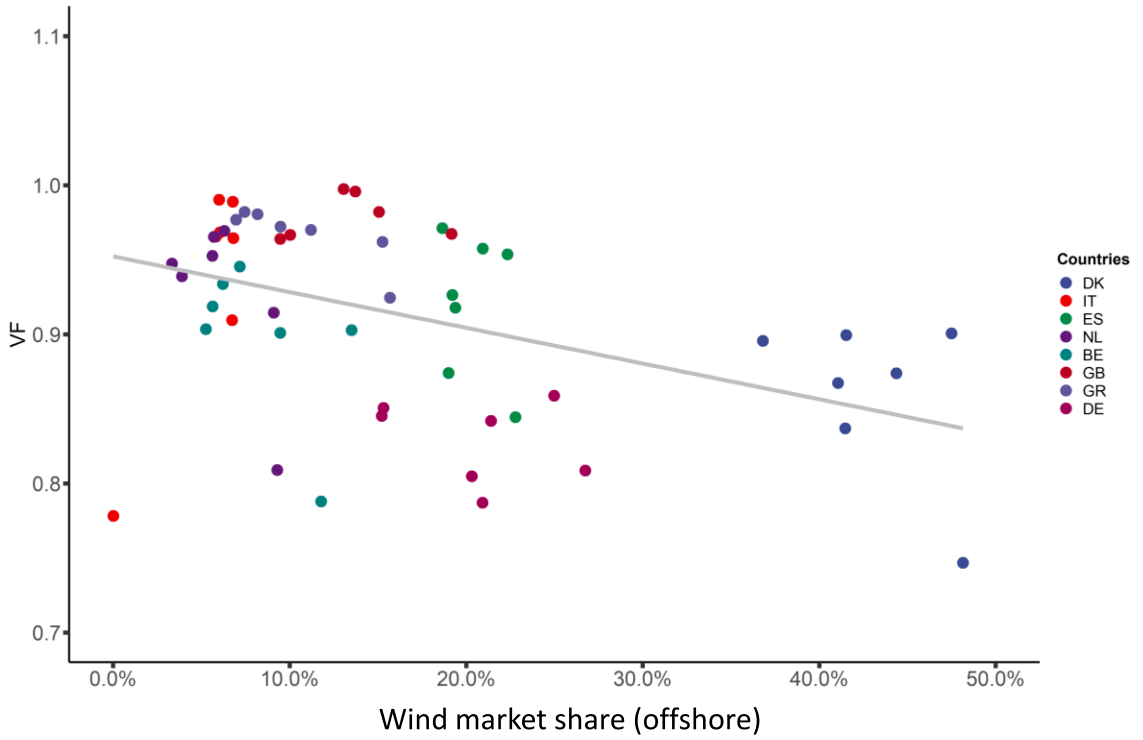
Value factor

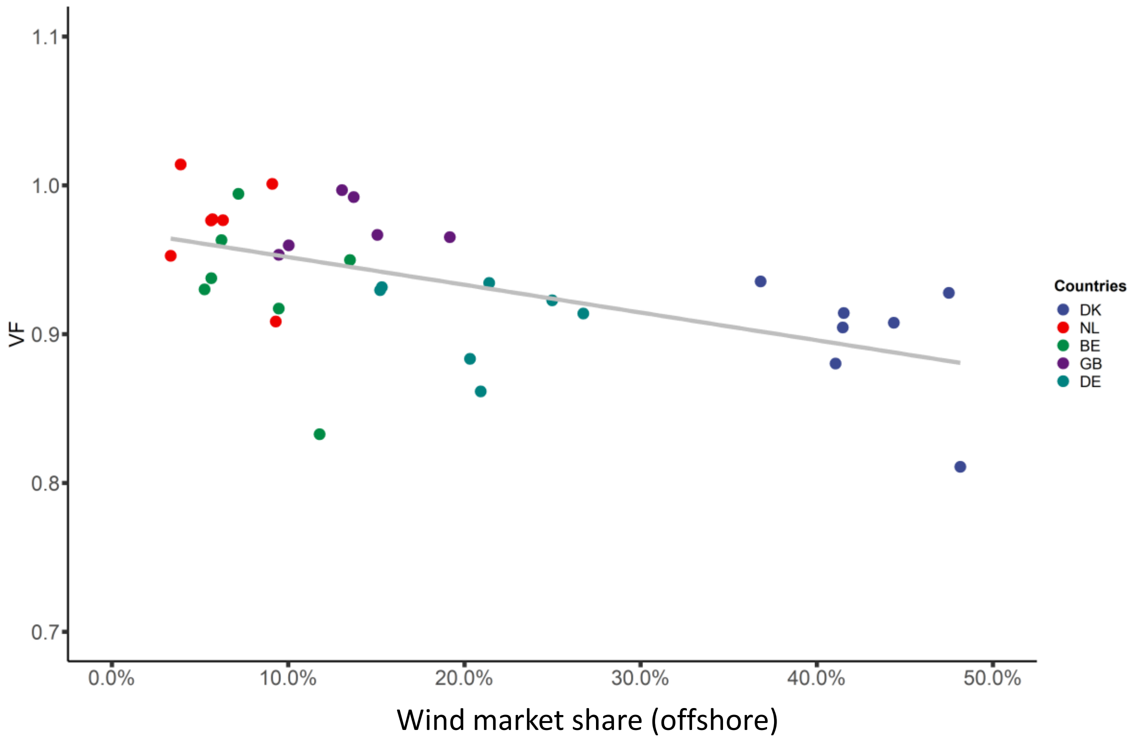
Value factor shows a different picture



- Value factors are lower in countries with larger penetration:
  - Denmark
  - Ireland
  - Germany
- Sweden and Norway have low prices but high value factors. This is the results of large share of hydro power with reservoirs

Value factor is decreasing with penetration

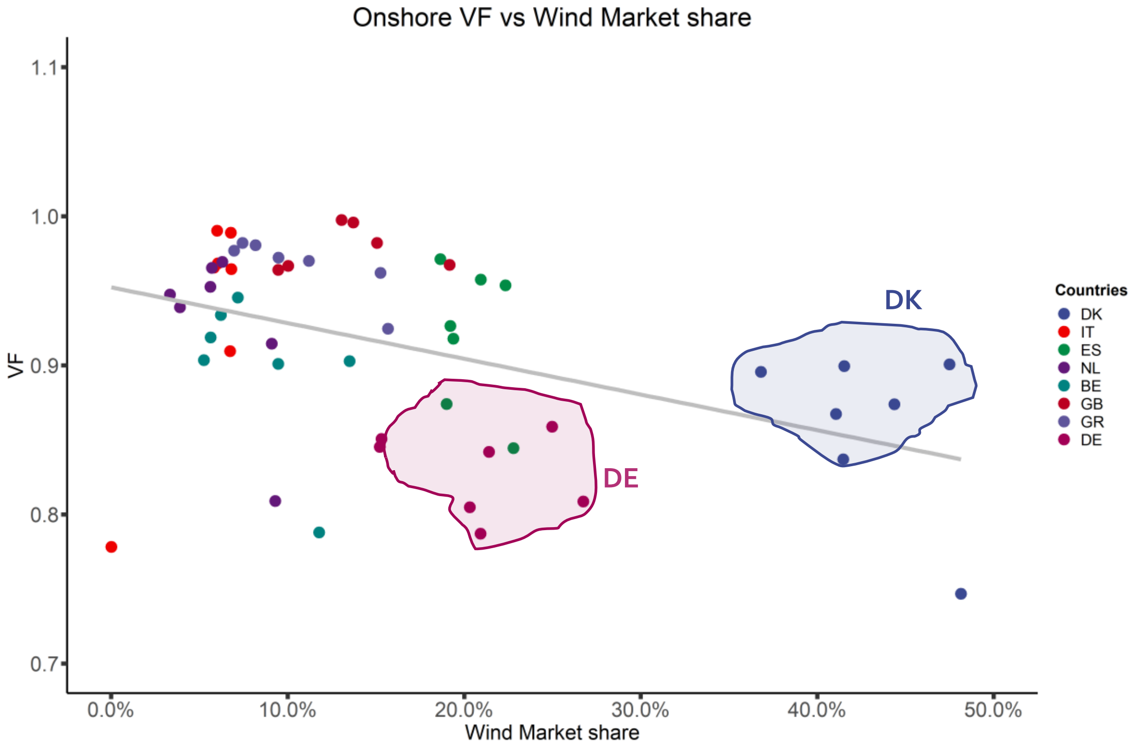




- Decreasing VF with penetration

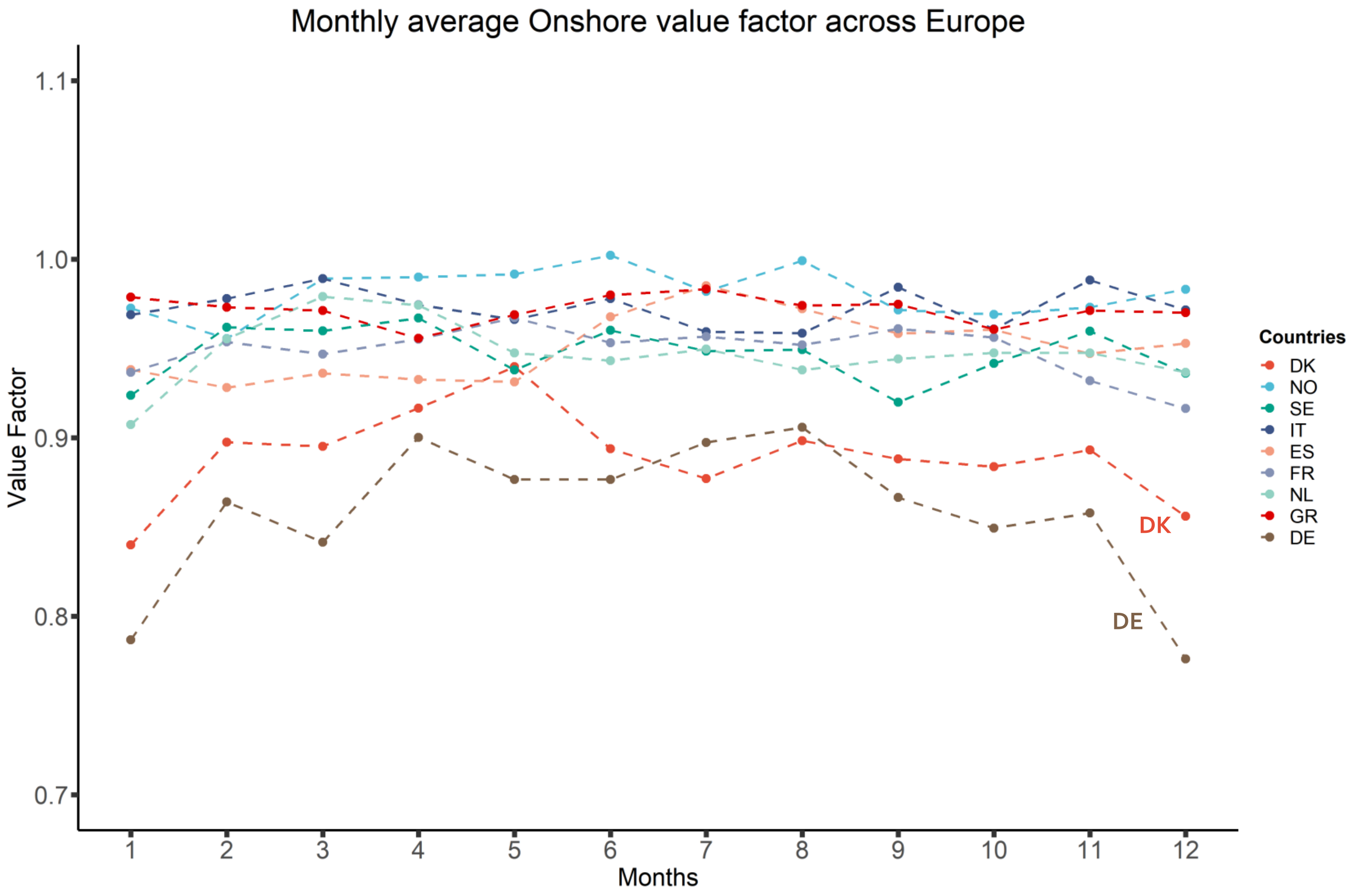
- Offshore VF is relatively higher than Onshore VF
- Onshore VF decreases at a faster rate in comparison to offshore

Value factor is decreasing with penetration, but with a catch!



- As already observed in literature, **decreasing value factor with increasing penetration**
  - More wind means more price pressure and more challenging integration
- Two "**integration pathways**": DK vs DE
  - Denmark is well interconnected, can get access to hydro in Norway and Sweden, has had high focus on flexibility in power plants. Higher average full load hours for wind power
  - Germany faces more challenges due to lower flexibility in the market and a larger share of low-marginal cost base load and less flexible power plants (nuclear and lignite)

Integration of wind in winter may be more challenging



- For most countries, there is low seasonal variation in the VF
- However, for Denmark and Germany, high wind penetrations lead to a clearer **seasonal pattern**
- In Germany, VF **dips below 0.8** in Dec-Jan
- One possible explanation is the relatively higher wind speed, which coincide with **low demand** (Christmas)

3.
Further Perspectives

COVID-19 has virtually increased wind penetrations

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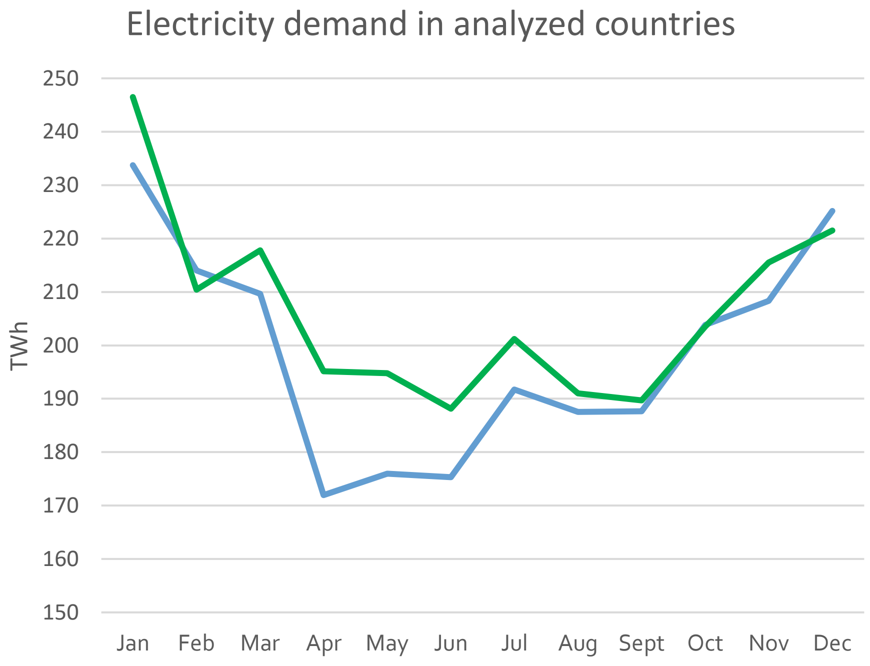
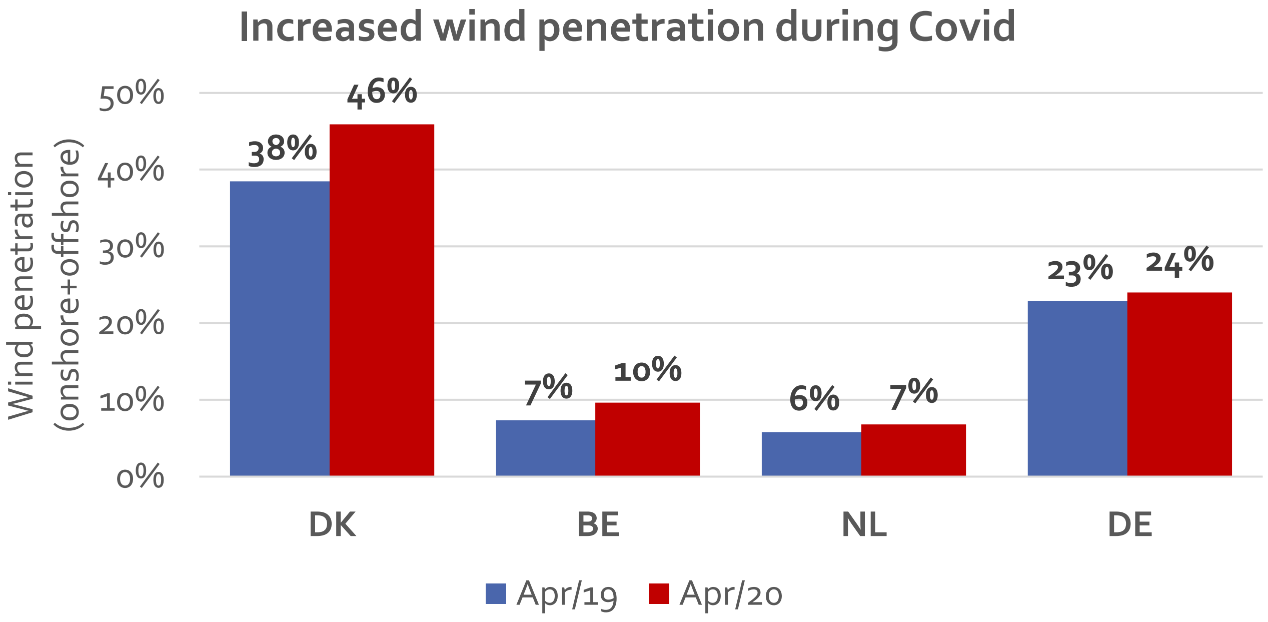
Power demand reduction compared to 2019 was **strongest in April 2020**, with some countries down around **-20% YoY**.





Very low value factors during period Covid19

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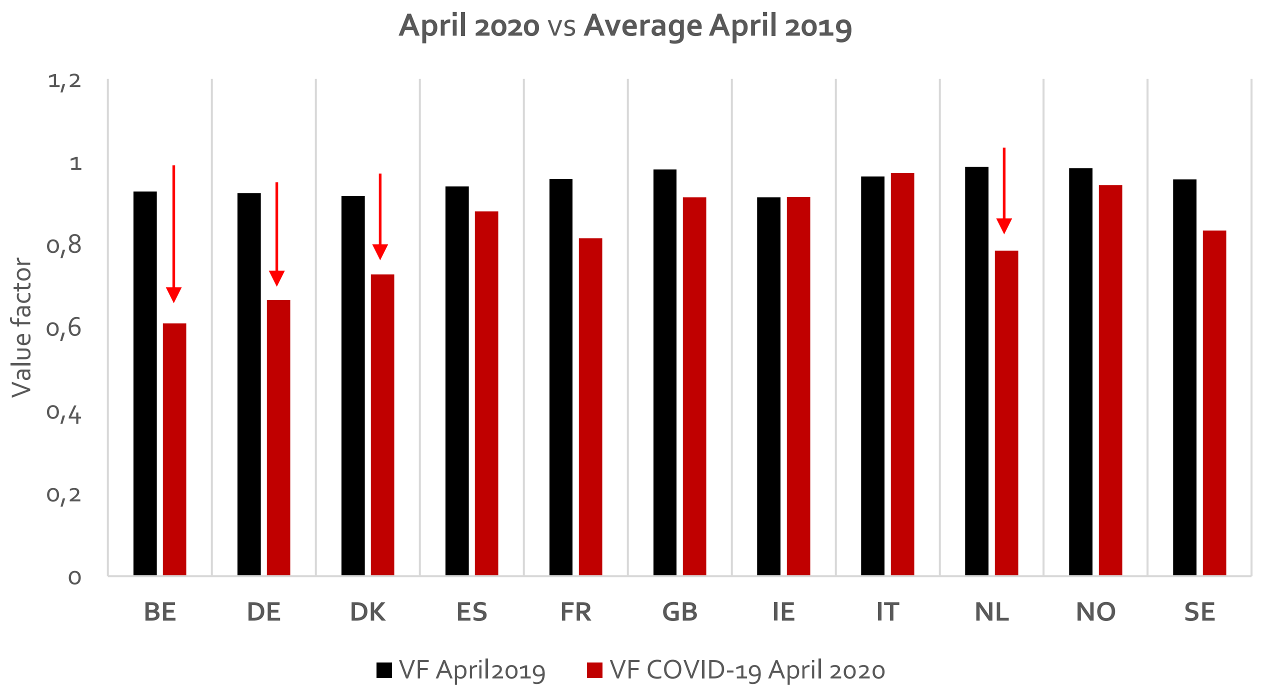
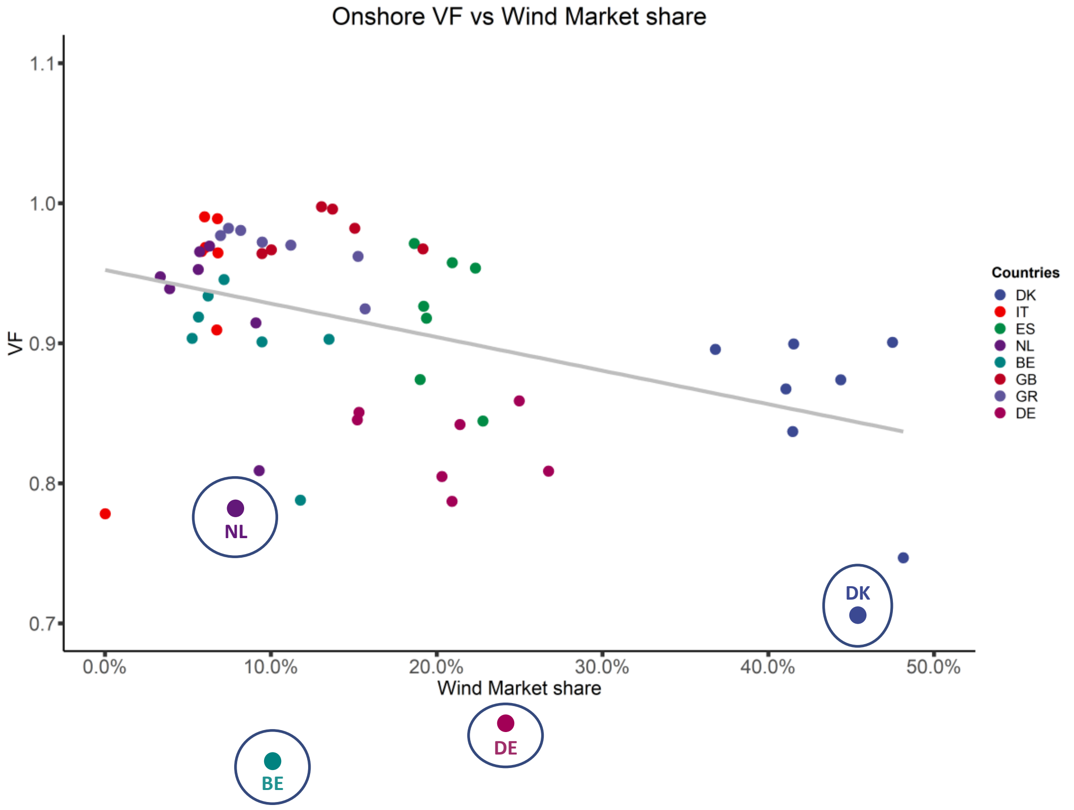
Value factor down to 0.6-0.7 in several countries in April 2020, the month with the largest reduction in power demand.



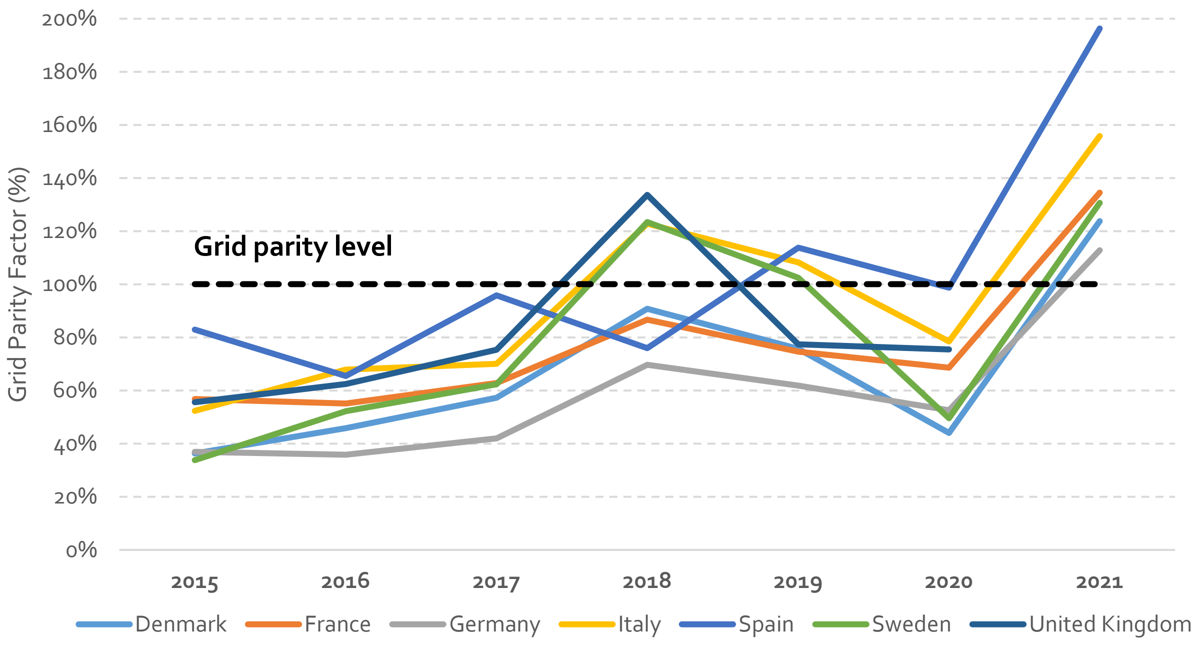


** Circled data points correspond to VF vs. Market Share in April 2020*

Grid parity is virtually achieved in 2021 in most of EU countries

The **levelized cost of electricity** (LCOE) metric, expressed in €/MWh, indicates the average cost of generation for a certain power source over its lifetime. It is a simple metric that indicates how expensive is the MWh generated from a particular source.

As reported and studied yearly by IRENA, over the last decade the LCOE of renewable energy technologies like wind and solar has been dramatically decreasing. Across the main European countries, LCOE of onshore wind power has been **decreasing by an average of 55% between 2010 and 2020.** IRENA calculates the LCOE based on project-specific installed costs and capacity factors, as well as O&M costs.



** 2021 data covers Jan-Sept.; in the LCOE calculation the following country-specific capacity factor averages are assumed by IRENA: DK: 39%, FR: 32%, DE: 34%5, IT: 33%, ES: 38%, SE:38%, UK: 37%*

***Sources:** IRENA (2021), Wind Task 26 (2021), World Bank (2021), Wind Power Monthly (2021)*

To compare the cost perspective given by the LCOE and the revenue perspective embodied by the market value of wind, we introduce a metric called **Grid Parity Factor (GPF)**. The grid parity factor is calculated as the ratio between the Market value of wind and the Levelized cost of electricity and is expressed in relative terms (percentage). A grid parity factor of 100% indicates that the revenues from the day-ahead market (MV) fully cover the cost of generation (LCOE) and therefore grid parity is achieved.

$$GPF = \frac{MV}{LCOE}$$

MV: market value in €/MWh
LCOE: levelized cost of electricity in €/MWh

The Grid Parity Factor indicates how far a wind project is to break even in terms of revenue (market value) vs cost (levelized cost of electricity).

Looking at the resulting GPFs for a selected number of European countries, a **clear trend toward grid parity emerges**. The GPFs went from values of around 40-80% in 2015 to values of 113-196% in 2021. This is the combined result of declining LCOEs and increasing MV of onshore wind in the analysed countries. Even though 2021 is a quite particular year, with record-high electricity prices, the trend towards higher GPF is clear and consistent.

The country with a consistently higher GPF is Spain, that experience both very good wind sites which LCOE can go down to 30 €/MWh and lower (as indicated by latest auctions in the country) and higher-than-average market values typical of Southern Europe. Conversely, countries like Sweden, Germany and Denmark, despite having amongst the lowest LCOEs, exhibit a lower GPF due to the low market values in the countries, as a combined effect of lower day-ahead prices and lower value factors.

Concluding remarks

- Based on publicly available data from ENTSO-E's transparency platform, the present analysis has gathered insights on the evolution of market value and value factor of wind in a selected group of European countries
- Countries in the sample were Austria, Belgium, Bulgaria, Germany, Denmark, Spain, France, the United Kingdom, Greece, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Romania and Sweden
- The data used had daily frequency, but was aggregated and averaged in different ways, such that monthly and yearly observations could be analyzed
- One of the most relevant, yet obvious, conclusions is that the main driver behind the market value of wind remains the market price in the given electricity market
- However, each market is characterized by its own energy mix, which ultimately determines the typical merit order.
- In countries with thermal generation and relatively low market shares, market value is higher. Conversely, countries with relatively higher market shares that are hydro-dominated, market value tends to be lower
- Given the higher wind penetration, countries like Denmark, Ireland and Germany display relatively lower value factors than countries at the south, such as Greece, Spain and Italy.
- Our data analysis has also been able to shed light on the impact of COVID-19 on wind market values. It becomes clear that electricity demand has been dragged downwards, virtually pushing up wind penetrations up. As a result, the value factor has decreased to levels below 0.7
- Similarly, our data analysis reveals how the price surge has led to a substantial increase in the market value of wind.

Appendix

References

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Our methodology

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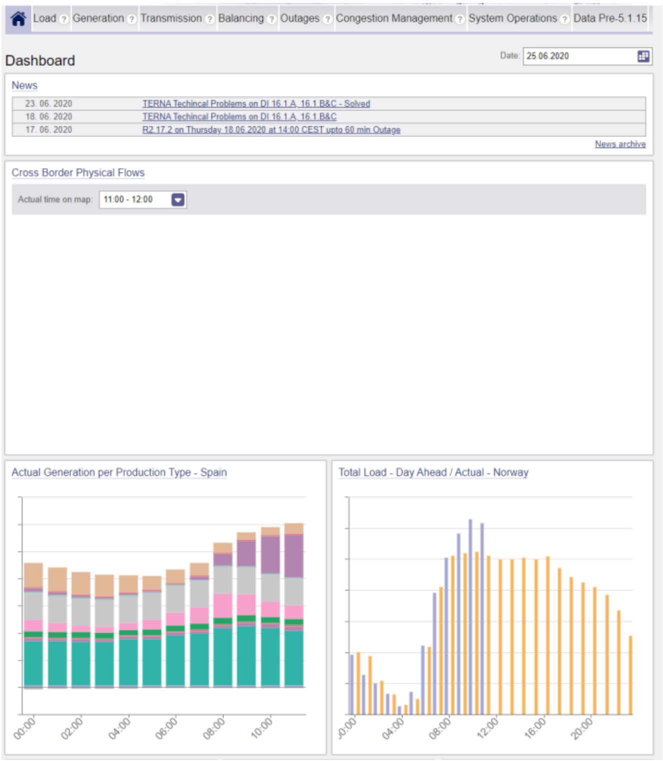
Transparency Platform



- API Entsoe transparency platform
- Download all data until September 2021
- Data cleaning
(some corrections still pending)
- Data processing

We can look at **MV and VF** for most of EU countries **monthly and yearly** in the period **2015-2020**

Literature review

iea wind

Author	Year	Results
Brown and O'Sullivan	2019	Compared to capacity-factor optimized fixed-tilt arrays, orientation optimization increases revenues by 1%~20%, 1-axis tracking increases 1%~ 32%, and curtailment increases revenues by 1%~9%. California in 2017 prices showed the highest increases in the market values.
Chudinzo et al.	2019	Relative to the conventional PV systems, the vertical bifacial PV plants showed slightly higher value factors (0.5~1%) in recent years in the selected European countries
E3	2018	The simulated results for different solar penetration scenarios showed that the downward dispatchable PV increase the average solar value increase by 1%~35%
Denholm et al.	2017	In the empirical (past) and simulated results (future) for different solar penetration level in the California, the benefit-cost ratio of solar + PV is from 1.2 to 1.85 while standalone solar is from 0.7 to 1.45
Bogenrieder et al.	2016	The newly installed PV plants in 2014 faced towards east or west could profit from higher spot market prices in the morning and afternoon, which changes revenue by from –1% to 5%.
Alexander Zipp	2015	Adopting market value optimized orientation, the relative market values of the location Stötten for 2011 till 2013 increased by 1%~6%.
Hartner et al.	2015	The simulated results for different solar penetration scenarios showed that the value maximizing tilt and azimuth can increase the market value of solar by 0~20%.
Rhodes et al.	2014	Percent change in the value of energy generated from value maximizing orientation as compared to a South facing array for an entire year was 0.71 considering Austin's TOU rate
Hummon et al.	2013	Adopting market value optimized orientation, the relative market values of the various states in the U.S increased by 1%~8%
Rudolf et al.	2013	The differences in NPV by adding battery on the existing PV system after 25years of operation is minus 12.62MEuro.

Literature review

Title	Year	Authors	Type of Publication	Small Abstract - Details
The market value and impact of offshore wind on the electricity spot market: Evidence from Germany	2015	Nikolaus Ederer	Literature review	Market value of offshore wind based on feed-in and weather data is assessed. Merit order effect caused by wind energy is simulated for 2006–2014. Steadier wind resource offshore imposes less variability on market price
The market value of variable renewables. The effect of solar wind power variability on their relative price	2013	L. Hirth	Literature review +Modeling European Electricity model EMMA	Wind value factor, the merit-order effect depresses the electricity price whenever these generators produce electricity. This implies that the per MWh value of VRE decreases as more capacity is intergrated. Analysis only profile cost, mention for the need of balancing and grid realting costs
The benefits of flexibility: The value of wind energy with hydropower	2016	L. Hirth	Literature review +Modelling with EMMA again	Adding more information regarding the importance of flexible production units, e.g. Hydropower thermal. It is likely that the optimal hydro station configuration moves towards higher installed capacity per annual energy output if variable renewables are considered.
Future wind and solar power market values in Germany — Evidence of spatial and technological dependencies	2020	Eising Manuel	Extended Literature review +Modeling with ELTRAMOD	really nice ideas a well developed literature review provide information about a lot of factors. For more information look inside.
Optimal siting of wind farms in wind energy dominated power systems	2018	Becker, Raik	Little literature review + Nice fast modelling	Ideas about the spatial location of the wind farms - how support scheme affect the location. Main idea, it is assumed that investors will pick a site that minimizes the normalized sum of wind power correlations and the normalized installed capacity at these sites meanwhile fulfilling a minimum wind yield. Not a lot information how the wind value will be affected by location
Strategies to mitigate declines in the economic value of wind and solar at high penetration in California	2015	AD Mills	Little literature review + modelling	Geographic diversity leads to the largest increase in the value of wind, California study. (be aware US wholesale market is little bit dif than EL-Spot)
Perfect competition vs. strategic behaviour models to derive electricity prices and the influence of renewables on market power	2016	Koschker, Susanne	Little literature review + economical models (i.e. Cournot and Bilevel)	Comparison of model prices to prices in a perfect competition model and real market prices show that there is a significant price overestimation in most hours of the year. and the author state that for real world applications, well-founded perfect competition models (with a well-prepared set of input data) perform best to explain electricity prices.
The market value of renewable electricity – Which factors really matter	2016	Jenny Winkler	Little literature review + regression analysis , assesing importance of factors affectin market value of RENE	CO2 prices, conventional capacitymix, and fuel prices were identified as the most important factors for market value development at low to medium technologyspecific market shares.
How to estimate wind-turbine infeed with incomplete stock data: A general framework with an application to turbine-specificmarket values in Germany	2018	Thorsten Engelhorn	Little literature review + modelling	Interesting paper, The question remains, to what extent is the fleet's value representative of an individual turbine? Different idea, modeling individual performance of the wind turbine. Bottom up techniques, As more and more advanced turbines enter themarket, we expect relative performance of older turbine generations to drop further. At the same time, the comparative advantage of newly built turbines (i.e. built between 2013 and 2015) over the fleet's market value will probably decrease since beating the fleet will become more ambitious.
2018 Wind Technologies Market Report FINAL	2018	U.S. Department of Energy - RH Wiser	Literature review and Data analysis	Figure 60 ustrates the variability that exists in market value within each region, with areas facing transmission congestion and high wind penetrations experiencing lower market value. Higher market value estimates are found in uncongested areas, areas with higher average wholesale prices, and areas where wind output profiles are more-correlated with electricity demand.
Impacts of wind and solar spatial diversification on its market value: A case study of the Chilean electricity market	2019	Rodrigo Pérez Odeh,	Literature review + modelling	Policy analysis to intergrate VRE into the system. Importance of Hydro into the system. The importance of a spatial diversed portofolio. Also mention forecasted error, are important during modelling , underestimating or overestimating the production may have significant effects - such as unit commitment decision and long term run hydor generations
System-friendly wind power. How advanced wind turbine design can increase the economic value of electricity generated through wind power	2016	L. Hirth	Literature review + modelling	different type of parameters affecting the performance of wind turbines and thus the wind value. The increased value of advanced wind turbines depends on the penetration level of wind power. At low penetration rates, thebmost economic choice is classical wind turbine design. However, above a certain penetration threshold, this is no longer the case. This underlines the need to provide investors with clear visibility on the long-term deployment trajectory and appropriately designed support policies in order to make the right investment choices during rapid scale-up of wind power and avoid lock-in.
Intergrating Solar PV in utility Systems Operations				Big report for the stats
The cannibalization effect of wind and solar in the Californiawholesale electricity market	2019	Javier López Prola,	Literature review + modelling	Nice paper, and aproach. Lot of calculation projections and historical prices. Nice conclusions. Canibalism effect among the technologies e.g. Solar vs Wind
The merit-order effect in the Italian power market The impact of solar and wind generation on natioanl wholesale electricity prices	2016	Stefano Clò		
The dark side of the sun How solar power production affects the market value of solar	2015	Stefano Clò		
The hidden value of large-rotor,tall-tower wind turbines in the United States	2020	Ryan Wiser	Literature review and modelling of market value	Recent paper provide information, regarding the effect of low speed windturbines so called advanced, and their impact to the market value.
The impact of wind power support schemes on technology choices	2017	Nils May	Literature review + modelling	Provide information for low speed wind turbines, how they affect the systems and what should be the support scheme to advance investement. Also from market value perspective how big is the increase into the market value with the low speed wind turbines. Input data from ERA
Value of wind power e Implications from specific power	2017	V. Johansson	Literature review + modelling	Uses two different aproaches to model the Market value. One using power curve model, and one using Electricity system model. The dispatch model is not very popular. Simple linear optimization. Input data from Merra
Opportunities for and challenges to further reductions in the specific power rating of wind turbines installed in the United states	2020	Mark Bolinger	Literature review and modelling of market value	A good literature review. Same inshitfull comments like, SP should help to mitigate the high penetration and drop of market value.
Market value of solar power: Is photovoltaics costcompetitive?	2014	Lion Hirth		