Targets and policies to accelerate the growth of wind power in Europe despite resistance and conflicts

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Abstract

Conflicts surrounding the expansion of wind power in Europe are increasing (Diógenes et al. 2020; Lundheim et al. 2022) which has hindered its growth in recent years (Pavlenko and Cherp 2023). However, in the near future, wind power needs to expand much more rapidly to meet the EU's climate and energy security goals (Vinichenko et al. 2023; Pavlenko and Cherp 2023). In fact, meeting the goals for renewable power of the Fit for 55 Package (EC 2021), REPowerEU (EC 2022d) and updated Renewable Energy Directive (EC 2023e) would require faster growth of onshore wind power across the EU compared to what has been observed not only in the EU but even in most individual countries (Vinichenko et al. 2023).

In this paper, we seek to understand whether and how European countries plan to re-accelerate the recently stalling onshore wind power deployment considering the increasing conflicts surrounding this technology. We start with analyzing the current and historical growth patterns and maximum growth rates of onshore wind power in European countries and compare these to a similar analysis completed in 2021 (Cherp et al. 2021). We show that in most European countries (except Finland, Greece, the Netherlands, and Sweden), the growth of wind power is no longer accelerating or is even slowing down.

Subsequently, we look into 17 countries' recently updated National Energy and Climate Plans to identify their national targets for onshore wind power deployment and analyze whether and how these targets would change the historical growth trajectories. We find that eleven countries have set national targets to accelerate the historical growth of wind power, and five countries aim for growth that is faster than ever observed globally. This demonstrates the challenges for policies to overcome the inertia of socio-technical systems surrounding the deployment of wind power.

To investigate whether and how such challenges were addressed historically, the paper reviews cases of re-acceleration of onshore wind power growth in the past. We identify five notable cases of past re-acceleration (Austria, Denmark, Poland, Portugal, and Spain) and show that these have mostly been due to major changes in the national policy environment. We find that historically stalling was induced by halting or significantly reducing subsidies, regulatory uncertainties, and the enaction of policies unfavorable to wind power growth, and re-acceleration was in most cases linked to the increasing of regulatory certainty, re-establishment or increasing of subsidies, and withdrawal of unfavorable policies. This is unlikely to guide the current situation.

We then investigate policies proposed by the European Commission and find that these aim to address administrative, technical, and financial problems rather than social conflicts over land and other issues. Finally, we provide a detailed analysis of Sweden's case of attempting but failing to overcome a recurring onshore wind siting deadlock.

We conclude by pointing out that to meet the onshore wind targets, European countries will likely need to implement different policy measures than what they have applied in the past.

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1 Introduction

1.1 Wind power has been used extensively historically to decarbonize electricity

Over the past several decades, there has been a concerted global effort to reduce greenhouse gas (GHG) emissions. Various policies have been implemented around the world to mitigate GHG emissions, including efforts to decarbonize the energy system and, in particular, electricity generation. Decarbonization of electricity generation is considered an "Achilles' tendon" in the larger effort to combat climate change (IEA 2021). The power sector is a major contributor to greenhouse gas emissions, primarily through the combustion of fossil fuels (coal and gas) for electricity generation. The International Energy Agency (IEA) calculated that developed nations must decarbonize their electricity generation systems by 2035 to limit the global temperature increase to below 1.5°C (IEA 2021; 2023).

Although there are several low-carbon electricity generation technologies, among the modern renewable energy generation technologies onshore wind power stands out as a well-established and most promising option. Commercial deployment of onshore wind technology originated in Denmark during the 1980s, and in the 1990s, it expanded to Germany and Spain, subsequently spreading to other European nations (Cherp et al. 2021). Through decades of historical experience, onshore wind power has evolved into a mature technology, benefitting from years of experience and successful implementation.

1.2 Conflicts are emerging related to wind power siting.

However, conflicts surrounding the expansion of wind power in Europe are increasing (Lundheim et al. 2022; Diógenes et al. 2020), which has hindered its growth in recent years (Pavlenko and Cherp 2023). Denmark - a country historically leading onshore wind deployment - has experienced a decline in public support already in the early 2000s (Johansen 2021). More recently, onshore wind power projects have been halted in both Norway and Sweden. The Norwegian case of the Fosen Wind Farm, which is Europe's largest onshore wind power project in central Norway, comprising six wind farms, with a combined capacity of 1,057 MW, was put on years of standstill following public protests (Klesty and Fouche 2023). The dispute between reindeer herders and wind farm developers was even brought to Norway's supreme court in 2021 (Norwegian National Human Rights Institution 2023). More recently, in December 2023, a partial agreement was reached between the stakeholders for Fosen Wind farm's turbines in Storheia, but not for those in Roan (Buli 2023). In Sweden, where local municipalities have veto power over infrastructure development, including wind farms, within their area, a recent analysis found that 78% of wind turbines were stopped by local councils in 2021 (Westander and Risberg 2022).

1.3 Wind energy in EU plans for renewable energy growth.

The policies that have been recently published by the European Commission (the Fit for 55 Strategy from 2021 (FF55) (EC 2021), the REPowerEU Plan from 2022 (EC 2022d) and the third Renewable Energy Directive (RED III) from 2023 (EC 2023e)) all include goals for further growth of the share of renewables in final energy consumption ranging between 40% (FF55) and 45% (REPowerEU). Onshore wind is to play a significant role in these plans with the required capacity to more than double from the current 187.2 GW (IEA 2022c) to almost 400 GW in 2030[1].

1.4 Research questions

The contradiction between local opposition and European goals has its battlegrounds at the national governments' level. With this research, we aim to uncover if and how the European governments are planning to change the speed and trajectory of onshore wind power deployment in comparison with historical trends, and what challenges they might face, considering recent wind power policy developments in Sweden.

1.5 Structure

This working paper is divided into three main sections. Our research approach section explains our theoretical framework: using S-curves and historical analogies to assess the feasibility of technological growth. It also gives the details of our case selection processes that resulted in the analysis of the plans of 17 EU Member States, an analysis of five episodes

[1] REPowerEU envisioned 510 GW of total wind of which 111 GW offshore (COM(2023) 668 final) and 399 GW onshore.

from history during which onshore wind power deployment re-accelerated, and our single extreme case analysis of recent policy developments in Sweden.

Our results section is divided into four further sub-sections. Section 3.1 discusses onshore wind power targets of EU Member States as defined in their 2023 draft National Energy and Climate Plans (NECPs) and shows that meeting these targets would require most countries to change the course of wind deployment compared to their historic and more recent deployment patterns. Section 3.2 explains that while we have seen five historic cases in which European countries were able to change the pattern of onshore wind power deployment, these episodes were related to the withdrawal of policies unfavorable to onshore wind power. We then, in Section 3.3, investigate policy measures that have emerged in the EU more recently. We show that the European Commission has recently initiated several policies and processes to support the deployment of onshore wind power, yet these address mostly administrative, planning, or financial problems and do not mitigate socio-political issues. Our last section under Results is focused on Sweden's case (Section 3.4). It explains how Sweden's government was planning to overcome problems related to wind farm siting by reducing the window when municipalities have the right to object. After the proposal was rejected by the national parliament, the government seemed to turn its back on wind power and started to pave the way for the expansion of nuclear energy to meet the growing demand for electricity from a low-carbon supply.

Our Discussion section explains that the traditional policy measures focusing on techno-economic aspects of wind power growth as suggested by the European Commission might not be enough to support the unprecedented growth of onshore wind power as planned by countries. Sweden's extreme case shows that socio-political issues, e.g. social acceptance, need to be addressed as well.

2 Research approach

2.1 Conceptual framework

2.1.1 Phases of technology growth.

In this paper, we analyze the speed and trajectory of onshore wind energy growth. Like any emerging technology, wind energy's growth follows a non-linear curve (Griliches 1957; Cherp et al. 2021). This section outlines the phases into which technology growth curves can be divided.

Technology deployment has been shown to go through four phases, see Figure 1. Panel A of the figure shows the cumulative deployment of new technology (e.g. total installed onshore wind capacity), while panel B displays additions of the technology over time (e.g. onshore wind capacity added in each year). Each phase of technology development is colored differently as explained below.

1. In the initial phase of technology development, known as the **formative phase** and represented in grey on the figure, growth is inconsistent. The amount of technology deployed annually fluctuates greatly due to research developments, failures, and adaptation to market conditions, all of which are characteristic of this phase.
2. The second phase, known as the **acceleration phase** (highlighted in green in the figure), commences when the new technology hits the "take-off" point. For onshore wind power, this point is defined as the moment when electricity generated by onshore wind power constitutes 1% of the total electricity supply (Cherp et al. 2021). During this phase on the growth curve, as the driving forces become stronger, the technology's growth rate accelerates, resulting in an increasing number of new installations each year.
3. In the next phase, growth ceases to accelerate and stabilizes, growing linearly. This phase is known as the **stable growth phase** and is depicted in blue in the figure. Growth stabilizes when obstacles to expansion become comparable to the driving forces. For instance, with onshore wind power, the costs of acquiring new land, building transmission lines, or managing permitting procedures become so significant that they offset the decreasing costs of wind turbines, halting the increase in investment profitability.
4. In the fourth phase, there is a deceleration in growth, and in some instances, it may even come to a halt. This phase is represented by the color red in the figure. The growth slows down or **stalls** when the counteracting forces become stronger than the initial drivers. An example of such a countervailing force could be social opposition to wind farms (as discussed in the introduction), which, in this phase, becomes more powerful and pronounced than the drivers that were initially propelling the growth.

The different phases of the S-curve are defined by forces that speed up growth and those that slow it down. Policies[2] driving the growth of the new technology also change along the S-curve (Markard 2018; Breetz, Mildenberger, and Stokes 2018).

Cherp et al. (Cherp et al. 2021) pioneered a methodology involving the fitting of growth model curves to historical data and subsequently calculating key parameters of the fitted curves. This innovative approach allows the identification of the current growth phase of a given technology. In our study, we applied and replicated their method to our dataset, and used maximum growth rate (G) as a key measure in this paper, visually represented by the black arrow in Panel A of Figure 1. In line with Vinichenko et al. (Vinichenko et al. 2023), for countries where the pace of deployment of onshore wind power is still accelerating, we used the most recent empirical growth rate averaged over the last three years (R3) as our key metric.

[2] Beyond policies, there are several other mechanisms driving the energy transitions as explained in (Cherp et al. 2018), however the focus of this paper is on policies and policy-accelerated growth of onshore wind energy.

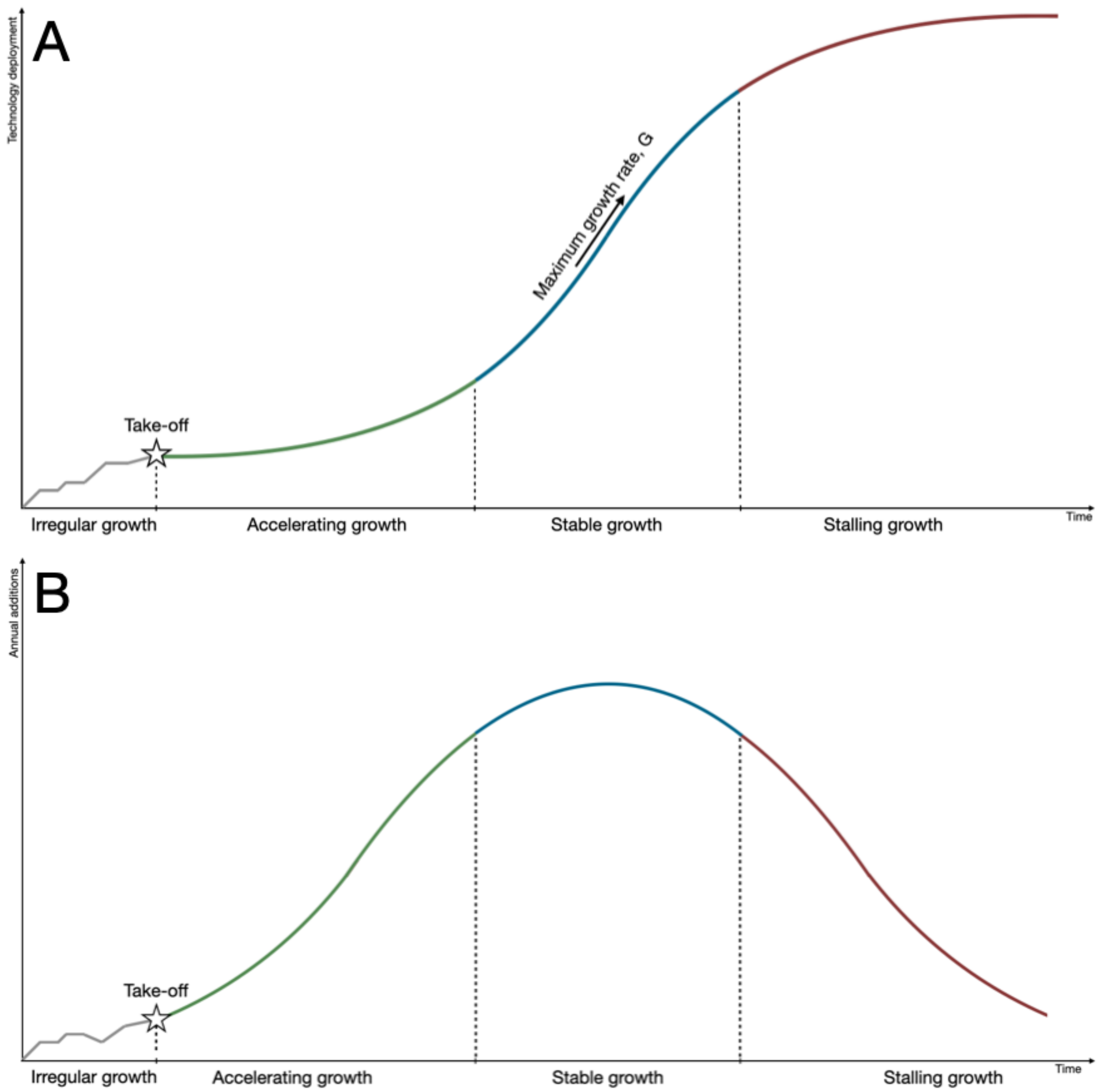

Figure 1: Growth phases (Cherp et al. 2021, Vinichenko et al. 2023)

Notes to Figure 1: **Panel A** illustrates how cumulative deployment evolves, resulting in an S-shaped curve. **Panel B** illustrates how periodical additions change throughout technology growth, resulting in a U-shaped curve. On both panels, the four growth phases (irregular, accelerating, stable, and stalling) are marked with different colors.

2.1.2 The historical analogies method.

While fitting growth models to historical data can allow us to identify the current growth phase of a technology, onshore wind power in the current case, it does not tell us much about changing trajectories or speed of deployment. Thus we draw upon the methodological field of using historical analogies to analyse current and planned changes.

The historical analogies method posits that historical experience can serve as a benchmark for assessing future transitions (Jewell and Cherp 2023). It is an approach that is used in various fields, such as history, political science, and decision-making (Kahneman 1997;

Lovallo and Kahneman 2003), to gain insights into the anticipated challenges and opportunities of current or future large societal transitions, such as transforming energy systems, by drawing comparisons with similar past events.

This method relies on the idea that events of the past that are similar in relevant aspects to the study case(s) (Kahneman and Lovallo 1993) can provide valuable insights to better understand potential outcomes, challenges, or solutions of current or future large societal transitions. The historical analogies method involves identifying similar historical cases as the one being studied (e.g. similar context, actors, sequences of events, phases, or patterns of technology deployment). In our study, we use similarity in the growth phase as an important criterion in drawing parallels between historical episodes and future wind growth trajectories, as discussed in the next section on case selection methods.

2.2 Case selection methods

2.2.1 Scope of the study.

In this study, we focus on onshore wind power development in the European Union's Member States. Onshore wind power is a well-established technology commercially used to generate electricity since the 1980s, and in the EU it has also been deployed widely, in 2023 it produced 17% of the EU's electricity demand (Costanzo and Brindley 2024): except for Malta, all EU Member States generate some electricity with wind turbines and in 23 Member States it is past the take-off point of 1% generation (Cherp et al. 2021), see Figure 2. Wind power is also a major element in countries' efforts to continue decarbonizing their electricity systems.

Our analysis is based on historic growth of onshore wind power and targets for onshore wind power growth in 17 countries EU Member States: Austria (in which 14% of electricity demand was generated by onshore wind power in 2023 (Costanzo and Brindley 2024)), Belgium (8%), Bulgaria (4%), Denmark (32%), Finland (18%), France (11%), Germany (26%), Greece (20%), Hungary (1%), Ireland (36%), Italy (8%), Netherlands (16%), Poland (13%), Portugal (25%), Romania (14%), Spain (27%) and Sweden (26%). From the 27 current EU Member States we excluded the countries whose electricity system size is smaller than 30 TWh in line with (Vinichenko et al. 2023): Croatia, Cyprus, Estonia, Latvia, Lithuania, Luxembourg, Malta, Slovakia, Slovenia, see Figure 2. We also did not include countries that have not passed the take-off point for onshore wind power, i.e. the share of onshore wind energy in total electricity supply is less than 1%: Czechia (0.9%), Slovenia (0.4%), Slovakia (0.1%) and Malta (no onshore wind power).

2.2.2 Identifying historic analogies of re-acceleration.

Historical re-acceleration episodes were identified from historic data on installed wind capacity by systematically analyzing the International Energy Agency's (IEA) and the International Renewable Energy Agency's (IRENA) datasets (see also Section 2.3.1) for stalling periods followed by re-acceleration.

First, we identified stalling periods, which were defined as periods lasting for at least three consecutive years, during which annual additions of onshore wind power capacity fell to nearly zero. Then we analyzed if the stalling periods have been followed by re-acceleration, meaning that the stalling period was followed by years in which annual additions amounted to similar or greater levels than those in the years preceding the stalling. This process identified five historic episodes of re-acceleration, as discussed in detail in Section 3.2.

2.2.3 Extreme-case selection.

We conduct an in-depth analysis of a single extreme case identified through deliberate case selection[3]. We selected the case of onshore wind development in Sweden as our extreme case because the recently observed growth rate of onshore wind power is significantly faster than what (Vinichenko et al. 2023) has observed globally and other European countries' past maximum, as discussed in Section 3.1.

2.3 Sources of data

2.3.1 Historic data.

The main metric we used to analyze onshore wind power growth is the total installed onshore wind power capacity (in MW) which we retrieved from the International Energy Agency's (IEA), the International Renewable Energy Agency's (IRENA) datasets, and Wind Europe's report. IRENA's dataset (IRENA 2023) contains data from 2000 until 2022 and gives annual values of the total installed capacity of onshore wind power for each country included in our analysis. For values of wind energy capacity installed in 2023, we relied on the data published in Wind Europe's report (Costanzo and Brindley 2024). Since onshore wind power was grid-connected and commercially used in some European countries already decades before 2000, we used IEA's dataset (IEA 2022c) to expand our analytical window to years before 2000. IEA's dataset contains data not on onshore wind capacity but on total installed wind capacity. However, because offshore wind power was not playing a major role in Europe before 1990[4] we assume that in years before 2000, all the installed wind was onshore.

In our analysis, we compare the growth rates of onshore wind power in countries that are different from each other in their size. To allow comparison of different system sizes (historically and across countries), we normalized installed wind capacity to total electricity demand (in TWh) in the same year, relying on data given in IEA's database. Since not all countries have given total electricity demand projections along with their targets for renewables, we used total electricity demand in 2022 (last year available in IEA's database) to normalize targets. We use the capacity normalized to total generation (MW/TWh) unit throughout our analysis and figures.

[3] Extreme case sampling is an exploratory qualitative research method, that focuses on selecting cases along the minimum/maximum range along either or both the dependent or the independent variable (Seawright 2016). It is an intentional sampling strategy designed to encompass the entire spectrum of variability present in the data (King, Keohane, and Verba 1994).

[4] Before 2000 there were only two grid-connected offshore wind farms in Denmark, Vindeby and Tuno Knob, with a capacity of 5 MW each (Meyer 2004)

2.3.2 Targets for wind power

We based our analysis of countries' targets on the values for onshore wind power development that the countries have specified in the 2023 updated drafts of their National Climate and Energy Plans (NECPs). For these targets, we searched the European Commission's official website (European Commission 2024) for the latest drafts of the Member States' updated National Energy and Climate Plans (NECPs) submitted by Member States. In the case of Austria and Poland which have not uploaded their NECPs at the time of writing, we identified their draft NECPs on their relevant governmental websites. Bulgaria, which has not shared its NECP at the time of writing, was not included in the analysis of the targets.

In the NECPs, we looked for onshore wind capacity targets and captured these values for all years that were given in the document. For countries that gave onshore wind targets in both capacity and generation (France, Greece, and Italy) we used capacity targets for the calculations. In case countries' targets were given in generation only (Austria and Finland), then these values were converted to capacity using the country's calculated capacity factor of the last three years for which both generation and capacity data were available (2019, 2020, and 2021).

Most countries' draft NECPs give targets not only for 2030 in line with the Regulation (EU)2018/1999, but also for some interim years (e.g. Austria gives values for every year until 2023, and several countries give values for 2025), and years after 2030 (e.g. several countries give 5-yearly targets for the years 2035, 2040, 2045 and 2050). For our calculations of the growth rate required to meet the targets, we calculated growth rates between all the years that were given in the NECP and used the maximum value for each country.

2.3.3 Policies

The main source for both national and the EU-wide renewable energy targets in this paper is the European Commission (EC). In addition to EU Member States' NECPs, which are our main source of information on national wind energy targets, we also turn to other EC policies containing data on wind energy targets or aimed at developing wind energy in the EU. We use the European Wind Power Action Plan (EC 2023b), national wind pledges for 2024-2026 (2023) to which 21 Member States committed in December 2023 as a follow-up on the measures outlined in the Plan (EC 2023b), and the European Wind Charter (2023). The EU-wide targets for wind development were used from the REPowerEU plan and related policies[5] (EC 2022c).

[5] The first draft of the REPowerEU Plan was released in March 2022 (EC 2022a). The final proposal of the Plan (EC 2022d) together with five Communications related to its implementation was released in May 2022 (EC 2022c). To reach the REPowerEU objectives, the Commission has also proposed to update, among other things, Renewable Energy Directive II (RED II) (EC 2018a). The amended Renewable Energy Directive (RED III) came into force in October 2023 (EC 2023e). For brevity, we refer to all the policy documents released together or affected by the REPowerEU Plan as to '*REPowerEU policies*'.

After identifying episodes of stalling and re-acceleration of onshore wind deployment in Europe (see Section 2.2.2), we carried out a review of secondary literature on policies in those countries. We searched the internet for scientific literature, grey literature (e.g. IRENA's reports, IEA's reports, national and European wind associations' reports), and new articles and press releases that described policy changes in the countries before and during stalling growth periods and during the initial years of re-acceleration of wind power deployment.

3 Results

3.1 Re-acceleration of onshore wind power deployment planned in most EU countries.

Most EU countries propose targets that would require them to re-accelerate the speed of onshore wind power deployment from their current stable or stalling growth rates. Let's begin with understanding what growth phase along the S-curve (Figure 1) countries are in.

3.1.1 Wind energy growth is no longer accelerating in Europe.

We fitted S-curves (logistic growth model) to the countries' historic data of normalized onshore wind capacity up to 2023. This analysis aimed to assess their present growth phase (Figure 1) and determine their highest growth rates. The characteristics of the fitted S-curves indicate that in the majority of EU Member States onshore wind power growth is either in the stable growth phase (five countries: Austria, Belgium, France, Germany, Ireland) or has already stalled (eight countries: Bulgaria, Denmark, Hungary, Italy, Poland, Portugal, Romania, Spain). Notably, only four European countries—Finland, Greece, Netherlands, and Sweden— are accelerating the pace of their onshore wind capacity growth, as illustrated in Figure 2.

We calculated the fastest growth along the S-curve (G) for all countries past the acceleration phase (Figure 1), and the average growth rate of the recent three years (R3) for all countries that are still accelerating, in line with (Vinichenko et al. 2023) (Table 1). We found that the fastest growth rate was observed in Portugal during the late 2000s, which had a G value of 11 MW/TWh/year, which is in line with (Cherp et al. 2021). This means that during its fastest, stable, growth period, Portugal added 11 MW of onshore wind power for every TWh of total electricity used in the country. Sweden and Finland, two countries currently accelerating growth of onshore wind power, experienced recently an even faster growth, adding respectively an average of 15.5 and 17.2 MW/TWh/year wind power to their system in the last three years (R3).

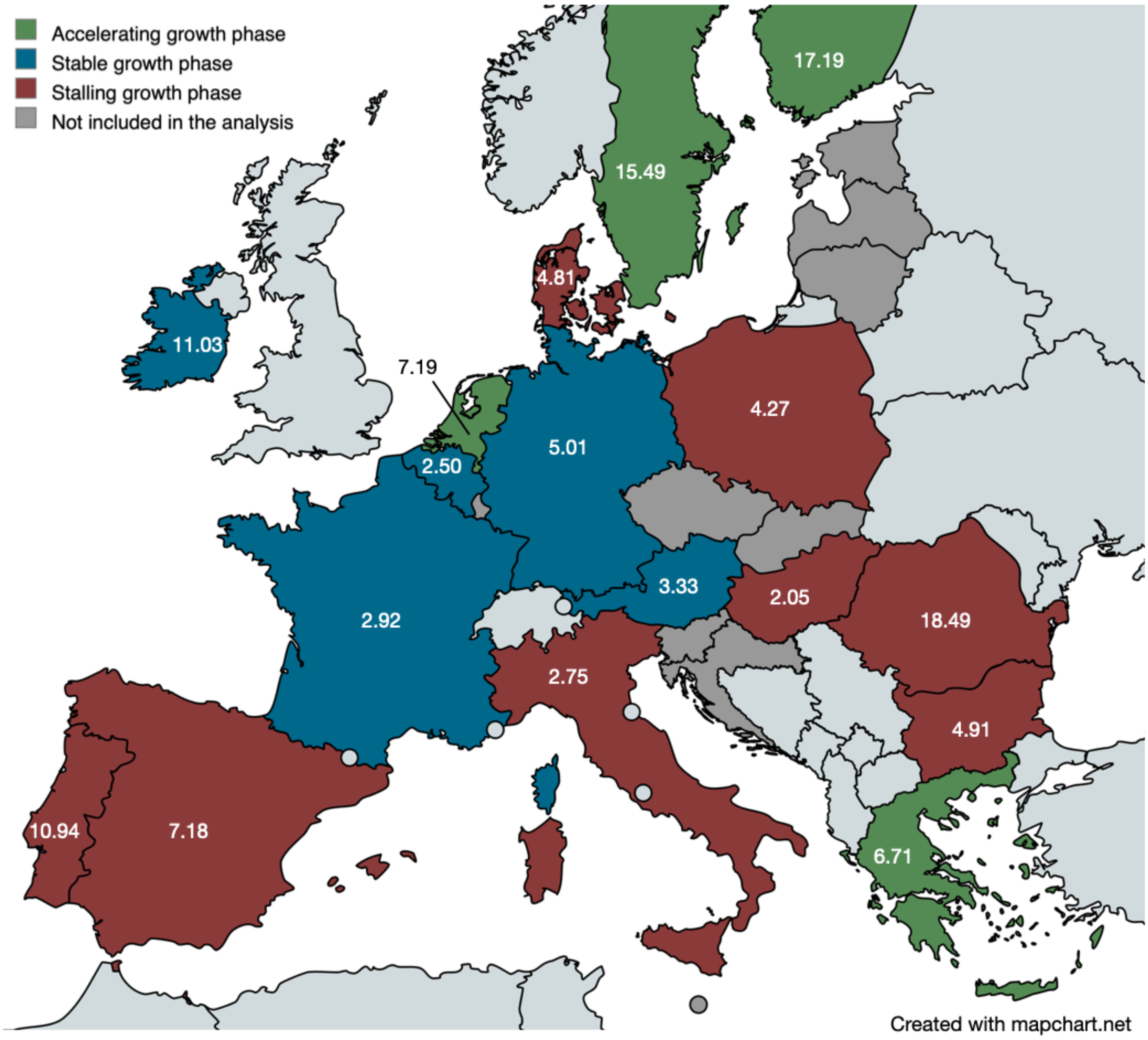

Figure 2: Growth phases of onshore wind deployment in EU Member States.

Notes to Figure 2: The colors indicate the current growth phase of a county. Countries in the accelerating growth phase are colored green, those in stable growth phase are colored blue and counties where the growth of wind energy has stalled are colored red. The numbers indicate the fastest growth of wind capacity in the country along the S-curve (G) or the average of the recent three years' growth (R3) in MW/TWh/year, see also Methodology.

Table 1: Countries' historic growth rates, growth rates required to meet their draft NECP target(s)

Country	Current growth phase	Year of maximum growth rate	Historic growth rate G and (R3) MW/TWh/year	(Re)accelerating in the target?	Maximum growth rate required to meet the target(s) MW/TWh/year	Growth-to-target compared to… maximum historic growth (G) %	recent 3 years' growth (R3) %	Finland's recent growth %
Austria	stable	2015	3.33 (3.04)	Accelerating beyond past maximum growth	17.37	522%	572%	101%
Germany	stable	2012	5.01 (4.05)	Accelerating beyond past maximum growth	16.18	323%	399%	94%
Spain	stalling	2007	7.18 (4.71)	Accelerating beyond past maximum growth	21.68	302%	460%	126%
Belgium	stable	2018	2.50 (3.14)	Accelerating beyond past maximum growth	6.71	269%	215%	39%
Italy	stalling	2010	2.75 (1.50)	Accelerating beyond past maximum growth	7.18	261%	479%	42%
Hungary	stalling	2008	2.05 (0.04)	Accelerating beyond past maximum growth	3.41	166%	>1000%	20%
Ireland	stable	2016	11.03 (5.03)	Accelerating beyond past maximum growth	18.04	164%	359%	105%
France	stable	2017	2.92 (3.06)	Accelerating beyond past maximum growth	4.12	141%	135%	24%
Portugal	stalling	2008	10.94 (4.37)	Accelerating beyond past maximum growth	14.75	135%	337%	86%
Romania	stalling	2012	18.49 (0.51)	Re-accelerating compared to recent growth, but to a level lower than past maximum growth	16.85	91%	>1000%	98%
Poland	stalling	2015	4.27 (45.94)	No planned acceleration	3.56	83%	60%	21%
Denmark	stalling	2005	4.81 (3.19)	Re-accelerating compared to recent growth, but to a level lower than past maximum growth	3.91	81%	123%	23%
Greece	accelerating	In the future	(6.71)	Accelerating beyond past maximum growth	17.30		258%	101%
Sweden	accelerating	In the future	(15.49)	No planned acceleration	10.01		65%	58%
Finland	accelerating	In the future	(17.19)	No planned acceleration	4.24		25%	25%
Netherlands	accelerating	In the future	(7.19)	No planned acceleration	0.79		11%	5%
Bulgaria	stalling	2009	4.91 (0.04)	No draft NECP				

Notes to Table 1: The countries are ordered according to the 7th column: the ratio of countries' required speed of growth to meet their NECP target compared to their historic maximum growth rate, G or R3.

3.1.2 NECP targets require acceleration from the current slow growth.

As this analysis has shown, in the majority of European Member States the growth of onshore wind power is in the stable growth phase, or its growth has already stalled. In the stable growth phase, the forces driving deployment and those slowing it down are in balance, until the opposing forces put a halt on deployment and growth stalls (Cherp et al. 2021). Yet, the targets recently set by the countries in their draft NECPs show that most countries plan to re-accelerate wind growth, and several countries' targets would require growth rates that are greater than what they have reached historically, see Table 1.

Austria, Germany, and Spain would need to deploy onshore wind power at a pace more than three times their historically observed maximum growth rate, while Belgium's and Italy's targets would require re-acceleration to more than twice their historical maximum. Austria[6], Greece, Ireland, and Spain would need to exceed Finland's recently observed record-high growth rate to meet their NECP targets, see also Figure 3.

We compared countries' maximum historical growth to that required to meet their NECP target, as shown in Figure 3 and Table 1. Figure 3 displays countries' maximum observed growth rate on the x-axis, and the maximum growth required to meet their targets on the y-axis. If a country were on the 45° grey line, it would mean that their planned growth rate is the same as their historical maximum. Countries above the line plan to accelerate, and those below the line have targets that require growth slower than their observed maximum. The horizontal grey band is the interquartile range (IQR) of global historic wind growth, 2.7 MW/TWh - 7.7 MW/TWh, calculated from (Vinichenko et al. 2023). Countries above the global IQR range announced targets with fewer precedents.

We can identify four groups of countries in Figure 3:

1. Seven countries with growth-to-target rates higher than both their historical maximum and higher than global IQR (i.e. those that are above the 45° line and the grey band): Austria, Germany, Spain, Greece, Ireland, Portugal, and Romania. They are highlighted with the green shaded area on the figure.
2. Four countries have set targets that require growth rates higher than their historical maximum, but within global IQR (i.e. those that are about the 45° line and within or just under the grey band): Belgium, France, Hungary, and Italy. They are highlighted with the blue shaded area on the figure.
3. Four countries whose target rates are lower than historical and within or below the global IQR are Denmark, Finland, Netherlands, and Poland. They are highlighted with the red shaded area on the figure.
4. One country with a target rate that is lower than historical, but still higher than the global IQR: Sweden (which will be discussed further in Section 3.4)

[6] While other countries have targets for 5-yearly leaps (i.e. 2025, 2030, 2035, 2040), Austria gives annual targets in its NECP. Our calculations show that the fastest deployment in Austria is required from 2023 to 2024 (17.37 MW/TWh/year). In case only its targets given for 2025, 2030, 2035, 2040 are considered, its growth rate slightly decreases to 11.88 MW/TWh/year.

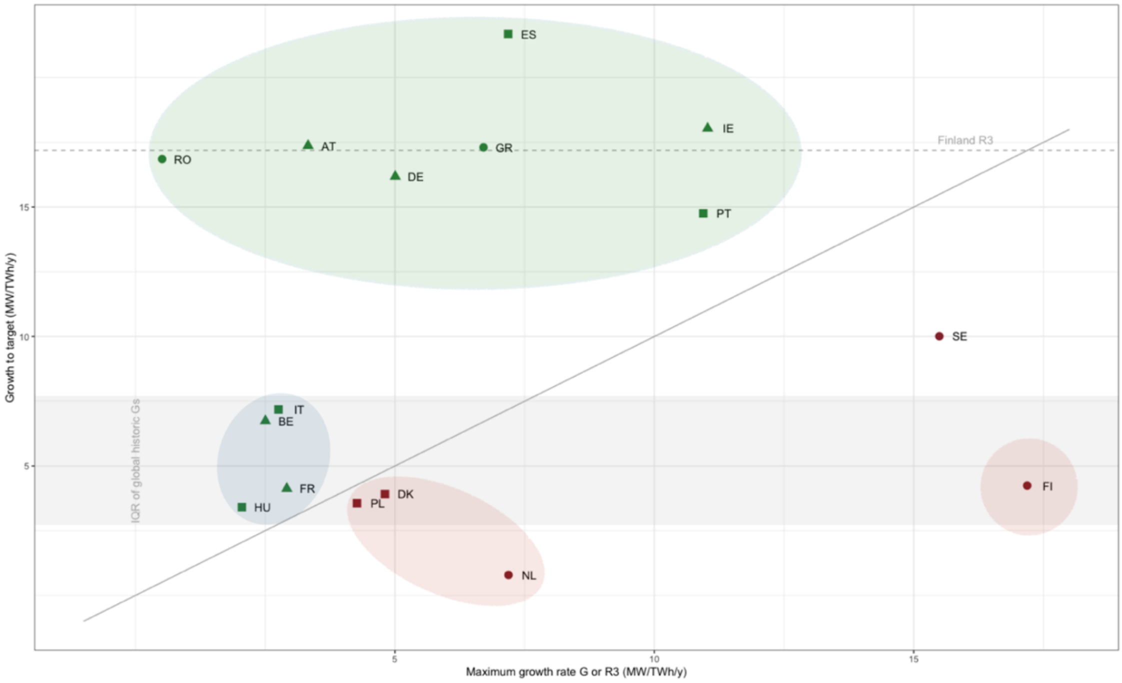

Figure 3: Historic maximum growth compared to growth required to meet the NECP target

Notes to Figure 3: Countries are labeled with their ISO2 country codes. The shape of the node of each country indicates its current growth phase. A circle indicates that a country is in the accelerating growth phase, a triangle indicates a stable growth phase and a square indicates stalling growth. The oval-form color-shaded areas indicate the groups of countries as discussed in the text. The horizontal grey band is the interquartile range (IQR) of global historic wind growth from (Vinichenko et al. 2023).

The analysis of historic growth rates and NECP targets showed that eleven countries are planning to re-accelerate wind deployment from the current slow deployment rate they have experienced recently to growth rates beyond their historical maximum. In the next section, we discuss when and where re-acceleration of onshore wind deployment has been observed historically, and what was the driver of these episodes.

3.2 Historic cases of re-acceleration of onshore wind power deployment in EU countries.

We analyzed historic wind deployment in European countries to identify if re-acceleration from stalling growth has ever been observed. We defined historic re-acceleration episodes as a stalling period of at least three consecutive years during which annual capacity additions fall to zero or almost zero, which was followed by re-acceleration during which period annual additions rose to a level similar (or greater) than those in the years preceding the stalling.

We have identified five countries that have experienced a period of stalling wind power growth followed by re-acceleration of wind deployment. The stalling periods were the following: in Austria from 2007 to 2010, in Denmark from 2003 to 2007, in Poland from 2016 to 2019, in Portugal from 2016 to 2020, and in Spain from 2012 to 2018, see Figure 4.

The black bars in Figure 4 show how much onshore wind capacity has been added to the system in each year from 1995 to 2023. As we can see during the stalling periods, which are highlighted by the red-shaded areas, the annual additions fell to nearly zero. Since annual additions can vary greatly from year to year, the blue line shows the three-year moving mean of annual additions. During the episodes of stalling growth, the three-year moving mean also reached zero.

Important to note that historically only Austria demonstrated a second growth pulse that was higher than the first one, while recently eleven EU Member States have set targets that would require them to accelerate wind deployment to a pace greater than their historically observed maximum (Figure 3).

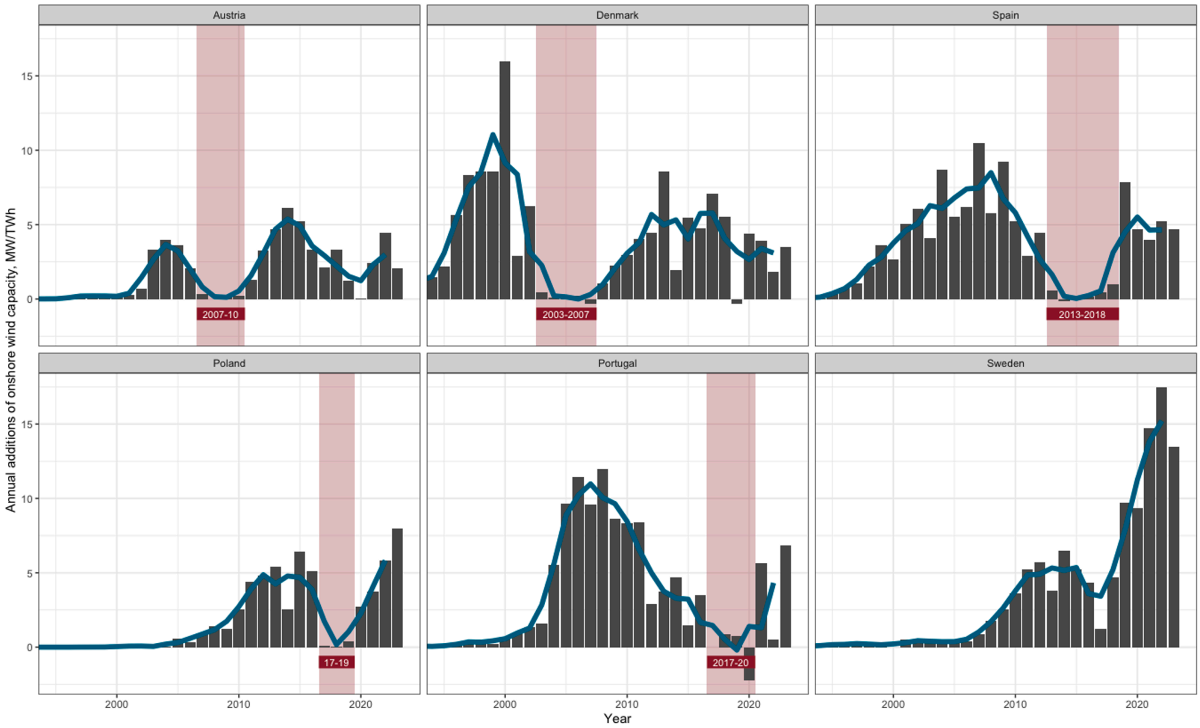

Figure 4: Episodes of stalling wind power growth.

Notes to Figure 4: The black bars show annual capacity additions of onshore wind power normalized to total electricity demand from 1995 to 2023.; the blue line shows the three-year moving mean of annual additions; the red shaded areas indicate years that were defined as stalling periods, see Methodology.

To understand what led to these stalling and re-acceleration episodes, we looked at the countries' policies before, during, and after stalling. We found that historically stalling was induced by halting or significantly reducing subsidies, regulatory uncertainties, and the enaction of policies unfavorable to wind power growth, and re-acceleration was in most cases linked to the increasing of regulatory certainty, re-establishment, or increasing of subsidies, and withdrawal of unfavorable policies, see Table 2.

Table 2: Overview of policy changes inducing stalling and re-acceleration.

Policies leading to stalling of growth	Policies enabling re-acceleration of deployment
Austria	
2007 to 2010	From 2011
2004: halting feed-in tariffs to new (and not already approved) renewables capacity	2009: introducing a new feed-in tariff system
2004: regulatory uncertainties after the amendments to the Green Electricity Act failed to be passed by parliament 2006: capping funds available to support new plants	2012: adopting a new Act, setting targets for renewable electricity growth, increasing the amount of funds available for new plants, and simplifying the authorization procedure
Denmark	
2003 to 2007	From 2008
1999: regulatory uncertainties after the planned switch from feed-in-tariffs to a renewable portfolio standard mechanism failed to be passed by parliament 2003: introducing the new feed-in premium system with insufficient funds	2008: adopting the new Renewable Energy Act, which combines all renewables-related regulations under a single piece of legislation and setting medium-term targets for renewables 2009: doubling the amount of financial support given under the feed-in premium support scheme
	2008: introducing four different compensation measures in the new Act to give financial compensation to individuals and communities hosting wind farms
Poland	
2016 to 2019	From 2020
2015: changing from a green certificate system to auctioning scheme, however the auctioning system was dysfunctional	2018: modifying the auction system, and largest-ever auctions in 2018 and 2019
2017: increasing real estate tax on wind farms	2018: removing the increased real estate tax
Mid-2000s: oversupply in green certificates leading to reduced profitability	From 2018: increasing green certificate prices
2016: excluding 99.72% of Poland's land area from wind development	2024: the rule adopted in 2016 is still in place; some modifications are planned for 2024 to ease restrictions
Portugal	
2016 to 2020	From 2021
2014: changing the feed-in tariff system, halting support to new renewables capacity not already approved	2024: no financial support scheme is in place. Wholesale market price gives income to wind farm operators.
Spain	
2012 to 2018	From 2019
2013: regulatory uncertainties after the planned amendments to legislation faced delays in parliament	2013: passing the new Electricity Sector Act
2012: moratorium on new renewables 2013: halting feed-in tariffs to new (and not already approved) renewables capacity 2014: changing to auctioning scheme, however auctions not starting until 2017	2017: starting the auctions 2019: 28 onshore projects reached final investment decision, which accounted for over 20% of all such decision in the EU.

3.2.1 Austria

Austria experienced a period from 2007 to 2010 during which wind power growth stalled, and the slowing down of wind deployment was experienced already in 2006. In 2004 the government halted subsidies (feed-in tariffs[7]) to all wind farms that were not already earlier approved (IG Windkraft 2005). The financial support system was only re-introduced five years later in 2009 (IG Windkraft 2017).

There were also regulatory changes that contributed to the stalling of wind growth. In 2004 the reform to the country's Green Electricity Act (Ökostromgesetz) did not pass the parliament, which led to regulatory uncertainties for investors. The amendments adopted in 2006 to the Act, which defined an annual cap on funds available to new plants which meant there were "extremely low feed-in tariffs" (IG Windkraft 2017) "almost brought the expansion of wind power to a standstill for a whole four years" (IG Windkraft 2018).

Until finally the new 2012 Green Electricity Act (Ökostromgesetz (Nationalrat 2012)) was adopted. The new Act defined expansion targets, which created long-term certainty for renewable electricity generation (IG Windkraft 2017). It also re-confirmed the feed-in tariff system and increased the amount of funds available for new plants' feed-in tariff agreements (from EUR 21 to 50 million per year), furthermore, under these funds it defined a special pot for wind power (EUR 11.5 million/year) (IG Windkraft 2017). The 2012 Act also simplified the authorization procedures (IG Windkraft 2017).

In its re-acceleration period in 2013-2015, Austria managed to deploy wind power at a faster pace than before stalling growth (Figure 4). This pattern of driving acceleration to a deployment pace that is faster than the previously experienced maximum speed of growth is what several European countries (including Austria itself) are planning to do in their NECP targets, as discussed earlier in Section 3.1.

3.2.2 Denmark

Denmark's wind power deployment stalled between 2003 and 2007. In the early 2000s, there were regulatory uncertainties in Denmark. Denmark planned a change in the financing mechanisms in 1999 from feed-in-tariffs to a renewable portfolio standard mechanism[8] with a system of tradable green certificates[9] (Meyer 2004), but the supporting legislation failed to be passed by parliament (IRENA 2013). The planned but not implemented change "introduced so much uncertainty for private wind power investors that installation of new land-based capacity dropped" (Meyer 2004, 668). In 2003 Denmark introduced a feed-in

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[7] Feed-in tariffs (FITs) are guaranteed payments through long-term contracts. The contracts guarantee a price for the electricity from renewable sources fed into the grid.

[8] The Renewable Portfolio Standard (RPS) policy requires electricity retailers to include a certain amount of electricity from renewable resources (e.g. wind, solar, hydro, biomass) in their resource portfolio. This can be done by owning a renewable energy facility or purchasing power from another producer.

[9] Tradable green certificates (TGC) are a market-based trading tool supporting the RPS scheme. They allow power providers to confirm the ownership of a specific amount of renewable energy (e.g. 1 MWh) that they have generated. After the energy is fed into the grid, these certificates can be sold on the open market as an energy commodity. Other entities that are polluting can buy these certificates as a carbon credit to offset their emissions.

premium system with a maximum cap for support[10] (this cap was later removed in 2005) (IEA 2006), which was still "considered unsatisfactory by investors (Meyer 2004, 668), and thus wind power growth stalled (IRENA 2013).

In 2008 a new Renewable Energy Act (Lov om fremme af vedvarende energi, (Klima- Energi- og Forsyningsministeriet 2008)) was passed, which put an end to regulatory uncertainties, furthermore it combined all renewables-related regulations under a single piece of legislation (IRENA 2013). Under the Act from 2009, the amount of subsidy given as a feed-in premium was raised to double its previous amount (Meyer 2004; IEA 2013). Denmark also set a medium-term goal for increasing the share of renewables to 30% of final energy consumption by 2025 (Skjærseth et al. 2023).

Another non-policy-driven process that possibly contributed to the slow down of deployment was increasing public opposition to wind farms. Public opposition developed in the early 2000s in Denmark, and the bottom-up wind farm cooperatives dwindled with the advancement of industrial-scale wind farms (Johansen 2021). The new Act (Klima- Energi- og Forsyningsministeriet 2008) introduced four different compensation measures to give financial compensation to individuals and communities hosting wind farms, to countervail the emerging public opposition against wind power (IRENA 2013).

3.2.3 Poland

Poland experienced multiple policy changes that affected the financing of onshore wind projects and contributed to a halt in wind energy deployment from 2016 to 2019, see Table 2.

1. Firstly, the Renewable Energy Act (Ustawa z dnia 20 lutego 2015 r. o odnawialnych źródłach energii, (Sejm 2015)) introduced an auctioning scheme[11]. However, the scheme was dysfunctional (IEA 2020) until an amendment passed in June 2018 "modified the auction system and in effect unblocked it" (IEA 2020). Afterwards in 2018 and 2019, Poland had its largest-ever auctions (Polish Wind Energy Association 2020).
2. Secondly, in 2017 Poland increased the real estate tax on wind farms (Gnatowska and Moryń-Kucharczyk 2019). Just one year later, in 2018, the tax was removed (IEA 2022a).
3. Thirdly, in the mid-2000s there was an oversupply of green certificates, which resulted in reduced profitability for investors (Polish Wind Energy Association 2020). However, by "mid-2018 […] green certificate prices also increased, improving the financial standing of wind energy investments" (Polish Wind Energy Association 2020).

[10] Under this scheme wind farm operators received a "premium" on top of the market price (IEA 2013); however, there was a limit placed on this additional premium, establishing a maximum price that wind producers could obtain (IRENA 2013).

[11] Auctions are competitive bidding processes for renewable energy. The government invites project developers to participate by issuing a call for tenders to procure a certain capacity or generation of renewables-based electricity. During the auction, project developers submit a bid with a price per unit of electricity at which they are able to realize the project.

Contradicting the re-acceleration phase, the same Act in 2016 excluded 99.72% of the country's land area from wind development (IEA 2022a; Czyzak 2022). This rule is still in place, though modifications are planned for 2024 to ease restrictions (Reuters 2023).

3.2.4 Portugal

Portugal experienced very limited deployment of onshore wind capacity from 2016 to 2020 compared to earlier years. However, the drivers leading to stalling and re-acceleration of growth are much less clear than in the other cases discussed in this paper.

In 2014, like Austria, Denmark, and Spain, Portugal suspended subsidies for new wind capacity additions (Andreas, Burns, and Touza 2019). Even today Portugal does not provide subsidies for wind, it is only the wholesale market price that gives income to wind farm operators in the country (Lexology 2021). However, despite the lack of re-introducing some type of financial support mechanism, in 2021 and 2023 onshore wind capacity added to its system was similar to the amounts before the 4-years of stalling growth (see Figure 4).

Also, contrary to the other countries covered in this paper, Portugal introduced and ratcheted up its medium-term targets just before the period when its wind power growth stalled. In 2015, one year after feed-in tariffs were suspended, Portugal set a new renewable target of 40% share in final energy consumption (Conselho de Ministros 2015), and then in 2018 raised it to 47% in its NECP. In the case of Austria and Denmark, targets were set as part of the policies driving re-acceleration and not during stalling.

Thus it is likely that in Portugal's case, other processes had a stronger impact on the stalling and growth of wind power, than in the cases of the other countries described in this paper.

3.2.5 Spain

Changes in regulation, financing mechanisms, and halting subsidies to wind power contributed to Spain's stalling growth period from 2013 to 2018. Regulatory uncertainties developed after Spain planned to introduce multiple amendments to its legislative framework in 2013 (Red Electrica de Espana 2014), but faced delays in adopting legislation (IRENA 2013). Furthermore, the new 24/2013 Electricity Sector Act overwrote several aspects of the electricity system regulatory framework (Ciarreta, Pizarro-Irizar, and Zarraga 2020).

In the same year, in 2013, Spain halted subsidies (feed-in tariffs) to all new renewables capacity not already approved earlier to tackle its growing feed-in deficit (Araoz & Rueda 2014). Later, in 2014, the country changed to an auction-based support scheme (Ollier, Melliger, and Metz 2023; Castro-Rodríguez and Miles-Touya 2023), but "without commitment by the Government on the number of MW or when these bid processes will be called" (Araoz & Rueda 2014, 3). Auctions did not start for three years, until 2017 (Gürtler, Postpischil, and Quitzow 2019). Then two years later, in 2019, Spain financed the most wind energy among European countries, both in terms of capacity financed and amount invested: 28 onshore projects received final investment decision (Wind Europe Business Intelligence and Brindley 2020).

Parallel to changes in the policy environment there was a reduction in total electricity demand in Spain following the economic crisis: from 301 TWh in 2010 (100%) to 286 TWh in 2013, and 274 TWh in 2018 (95% and 91%, respectively) (IEA 2022b). This decreased electricity wholesale prices and thus led to declining revenues of producers, including wind farm operators and investors, and possibly contributed to slowing down deployment (Gürtler, Postpischil, and Quitzow 2019). On the other hand, the shrinking of electricity demand in Spain continued until 2020, even after wind energy deployment started to grow again (IEA 2022b).

3.2.6 Summary

As we have seen five European countries have experienced episodes of stalling wind capacity growth followed by re-acceleration. We also showed that except for the case of Austria, in all other countries the second wave, the re-acceleration, only reached lower annual growth levels than before stalling, Figure 4. We also discussed in detail that the historic stalling and re-acceleration episodes were induced by policy changes.

Currently, as described in Section 3.1, eleven European countries are planning to replicate the re-acceleration of wind deployment that Austria, Denmark, Poland, Portugal, and Spain have experienced. However, the current targets would raise countries' deployment pace to a level much higher than their previous maximum growth speed, which has only been seen in the Austrian re-acceleration case.

However, the current policy environment is different from the historic episodes: policies in place now in most countries are supporting - at least in principle - wind growth. The EU and its Member States need to develop and implement new policies to support the re-acceleration of the growth of onshore wind power in Europe. The next section investigates the key policy documents that have been proposed by the European Commission, each outlining multiple measures to enhance the pace of deployment.

3.3 Emerging policy measures in Europe

In the last years, especially following the energy security crisis following Russia's war on Ukraine, the European institutions (the European Commission, the European Council, and the European Parliament) have adopted different policy documents that spell out policy measures they see necessary and are ready to implement to support the acceleration of renewable energy sources, including onshore wind power (Pavlenko and Cherp 2023).

3.3.1 REPowerEU Plan and Emergency Regulation on Permitting.

REPowerEU is a communication from the European Commission that was published in May 2022 (EC 2022d) during the culmination of the energy security crisis following the start of the Russian war on Ukraine. The document's main aim is to reduce energy dependence, as it explains that "REPowerEU is about rapidly reducing our dependence on Russian fossil fuels by fast-forwarding the clean transition and joining forces to achieve a more resilient energy system and a true Energy Union" (EC 2022d).

REPowerEU suggested, among other things, to significantly increase the EU's target for a share of renewable energy in final energy consumption from 40% in 2030 decided in the 'Fit for 55' Package to 45% in 2030 in the REPowerEU Plan (Pavlenko and Cherp 2023), classify renewables projects as falling under overriding public interest, speeding-up permitting, and identifying renewables go-to areas where a simplified permitting procedure would suffice (EC 2022d).

A subsequent emergency regulation on permitting adopted in December 2022 (that was initially to be applied until 30 June 2024 but was recently extended until 30 June 2025) (EC 2022b; 2024) aimed to unblock projects "stuck in permitting procedures across Europe" (Wind Europe 2022).

3.3.2 Renewable Energy Directive.

The revised Renewable Energy Directive (also known as RED III) formally entered into force on 21 November 2023 (EC 2023e). Its provisions need to be transposed into national legislation of Member States, which is expected to happen by the first half of 2025. The key policy measures, relevant to onshore wind power, introduced in RED III are:

- Increased targets from 40% to 42.5% for the share of renewables in total energy use in 2030, including onshore wind generation.
- Simplifying the permitting procedures
  - The total time for all relevant permits, including grid concessions, should not exceed 24 months.
  - There should be a single point of contact for applicants in the Member States throughout the permitting process.
- Member States should identify "renewables acceleration areas" in which sites the projects go through simplified and expedited permitting processes. Within the acceleration areas, the projects will be exempt from carrying out an environmental impact assessment and/or an assessment of their implications for Natura 2000 sites. Furthermore, the applications within the "renewables acceleration areas" should be authorized from an environmental perspective without requiring any express decision from the competent authority.
- Renewable energy development should be recognized as a superior public interest, thus the grounds for legal objections to new installations shall be reduced.
- Administrative improvements, such as streamlining of administrative processes, adequate resources to competent authorities, and digitalization of permit-granting procedures.

3.3.3 Wind Power Action Plan.

On 24 October 2023, the European Commission published a communication, widely known as the European Wind Power Action Plan (EC 2023b). The Wind Power Action Plan spells out "measures that should be urgently taken" for the EU to be able to meet its targets. The Action Plan proposes 15 concrete Actions that fall into six main themes: (1) increasing predictability

of the market and faster permitting, (2) improving auction design, (3) easier access to financial support, (4) ensuring a fair and competitive international environment that allows European wind industry actors to compete and invest in foreign markets, (5) supporting skills development for the renewable energy sector, and (6) defining Member States' voluntary short term wind deployment commitments as part of a Wind Charter (2023).
Member States have shared their voluntary short-term wind deployment plans in the "Wind Pledges" document in December 2023 (EC 2023d).

3.3.4 Summary

These policy documents do not exist in a vacuum, but build upon one another (and previously adopted EU policies), thus it is natural that they share several policy measures, while modifying some aspects e.g. the change of the numeric value of the renewable energy target from 45% in REPowerEU to 42.5% in the legally binding RED III, change in language from "overriding public interest" to "superior public interest" or from "renewable go-to areas" to "renewables acceleration areas" in REPowerEU and RED III respectively and moving from medium-term targets defining the share of renewables (RED III) to concrete capacities planned to be deployed (Wind Pledges under the Wind Power Action Plan).
Taking a step back from these details, at the more general level all three EU policy documents focus on four policy problems: politically prioritizing renewables growth, defining targets (medium- and short-term targets), addressing administrative issues relating to permitting, auctioning, and accessing financial support, and aiming to ease siting of onshore wind. Historically, as discussed in the previous section, further to the policy problems addressed by the EU documents financial support mechanisms and managing social opposition also contributed to the re-acceleration of wind.
Managing social opposition could be a vital milestone in meeting the targets. In the next section, we analyze Sweden's recent attempts to manage local opposition to the siting of wind farms to support the expansion of wind.

3.4 Swedish wind power - blown with the wind?

During the last three years, Sweden has deployed onshore wind at a very fast pace adding 15.5 MW/TWh on average each year (see Table 1 and Figure 4). Currently, 26% of its total electricity demand is generated by onshore wind farms, which is amongst the highest share of wind energy in electricity among European countries (Costanzo and Brindley 2024). While the country is committed to meeting its expanding electricity demand from low-carbon sources, two forces are playing against each other: the national government's target for low-carbon electricity growth and the local communities' opposition to wind power development within their municipalities' boundaries.

3.4.1 The government's commitment to double low-carbon electricity.

With projections showing significant growth in electricity demand and the national commitment to 100% low-carbon electricity (Klimat- och näringslivsdepartementet 2023b), Sweden projects that it will need to more than double its electricity production from low-carbon sources by 2045 (Energimyndigheten 2022). The Swedish Energy Agency calculated earlier that all of this expansion could be met by onshore wind energy until 2035 (Energimyndigheten 2022).

The past and the future projections point in different directions whether Sweden is on track to this. On the one hand, Sweden has recently seen one of the fastest expansions of wind energy in the world, as shown previously. On the other hand, wind turbine sales peaked in 2021 and the pipeline of new projects drops after 2023, according to the Swedish Wind Energy Association's forecasts (Almqvist 2023). One reason for the slowdown is associated with municipalities' right to block wind farms' permits.

3.4.2 Municipalities veto the majority of applications.

In 2009 Sweden changed its procedures for permitting onshore wind farms, aiming to streamline the permitting process. Instead of having to apply for dual permits under both the Planning and Building Act (Plan- och bygglag (2010:900), (Sveriges riksdag 2010)) and the Environmental Code (Miljöbalk (1998:808), (Sveriges riksdag 1998)), since 2009 onshore wind farms are only assessed under the Environmental Code. However, at the same time, the Environmental Code was also changed, and a provision on municipal opinions (known more commonly as municipal veto) was introduced.

The municipal veto allows municipalities to block permits for wind farms, and other large infrastructure projects, at any time during the permitting procedure without even providing any justification for their decision, furthermore the municipalities may change their decision after previously approving an area for development (Swedish Climate Policy Council 2022). On the other hand, the applicant cannot appeal against the municipality's decision (Swedish Climate Policy Council 2022). According to a report ordered by the Swedish Wind Energy Association, 78% of wind turbines were affected by the municipal veto in 2021 (Westander and Risberg 2022), and a report claims the rejection rate has increased significantly recently (Johnsson et al. 2023).

3.4.3 National and local forces toggle each other.

The government has launched two attempts to overcome the deadlock caused by the municipal veto but failed. In October 2020 the Swedish government set up a commission to develop options to change the municipal veto in the case of onshore wind farms and thus make wind farm project permitting processes shorter and more predictable (Nordin, Vestling, and Pile 2021). The commission presented its proposals in 2022 (Miljödepartementet 2022). It suggested limiting municipal vetoes on wind power projects by setting a fixed time frame for when a municipal decision must be delivered. Under the proposal, municipalities would have to respond to a request within nine months, and the municipality's decision would be legally binding for five years. The municipality would not be able to grant partial approval or set conditions for its approval (Miljödepartementet 2022). However, the proposal to change the municipal veto was voted down by the parliament soon afterward, in June 2022 (Wickström 2022).

Following this failed attempt to limit the municipal veto for onshore wind turbines, a new inquiry process was launched in June 2022 to identify ways of creating fiscal incentives for municipalities to accept wind power projects. The suggestions for compensation measures were published a year ago (Klimat- och näringslivsdepartementet 2023c), and suggest that every house within 1 km of a turbine receives a share of the spot market revenue over electricity generated by the turbine. The compensation levels are determined in such a way that in case a household is within 1 km of two turbines their electricity costs would be fully compensated (Lundin 2023). From the state, there is no compensation paid, the costs are borne by the turbine operators (Badman 2023). While the compensation report suggested that the measures should be implemented by 31 May 2023, the government did not yet act on these recommendations.

Whether causation or simply coincidental, at the end of 2023, the Swedish government announced that they plan to pave the way for a massive expansion of nuclear power until 2045. The plan is to develop the equivalent of ten large nuclear reactors by 2045 and the equivalent of two large-scale reactors by 2035 (Klimat- och näringslivsdepartementet 2023a). This signals a turn away from wind power, which was seen even earlier in that year as the technically and economically feasible option to supply the growing electricity demand (Energimyndigheten 2022).

3.4.4 Summary

As our analysis showed Sweden's onshore wind deployment is in the acceleration phase, and one would expect its deployment rate to grow further in the next years. However, the scenarios presented by the government in the Swedish NECP, and the forecasts of the Swedish Wind Energy Association paint a bleaker picture, with wind deployment declining over the next years. The growing social opposition and failed governmental attempts to deal with it could be contributing to the slowdown of wind deployment. However, this is one point that the EU policy measures are also missing, which could lead to challenges for the EU Member States in meeting their targets.

4 Discussion

4.1 Wind power growth no longer accelerating

According to the S-curve theory, the growth of a new technology goes through four distinct phases. In the beginning, a technology experiences erratic growth with high year-to-year variations in capacity additions due to experimentation, failures, learning, and unsteady policy support. For onshore wind energy, this phase ends when the share of wind energy in total electricity demand reaches 1% (Vinichenko et al. 2023; Cherp et al. 2021). Currently, all EU Member States are past this phase, except for Czechia (0.9%), Slovenia (0.4%), Slovakia (0.1%), and Malta (no wind power) (Costanzo and Brindley 2024).

The next phase is the acceleration phase of technology development. This is a period where the rate of growth increases year after year. The growth acceleration of onshore wind power is driven by favorable market conditions and supportive policies such as feed-in-tariffs, feed-in-premiums, and green certificate schemes (IRENA 2013). Currently, four European countries (Finland, Greece, the Netherlands, and Sweden) are experiencing an acceleration of the speed of wind power growth. Recently, both Finland and Sweden have added more onshore wind capacity for each TWh of electricity demand than ever seen in any other country, with Finland adding 17.19 MW/TWh/year and Sweden adding 15.49 MW/TWh/year. However, most EU countries are no longer in the accelerating growth phase.

In the third growth phase, the deployment rate of a new technology stabilizes, with year-on-year additions remaining consistent. This is currently being observed in Austria, Belgium, France, Germany, and Ireland. During the stable growth phase, market and policy drivers, as well as counteracting factors like problems with siting and grid integration, balance each other out.

Eight EU Member States are even past the stable growth phase along the S-curve and have experienced a halt in their growth with none or very limited capacity added to the system each year. The growth of wind capacity is close to stalling or has already stalled in eight countries including Bulgaria, Denmark, Hungary, Italy, Poland, Portugal, Romania, and Spain. These countries have experienced a halt in their growth with limited capacity added to the system every year. According to the S-curve theory (Cherp et al. 2021), this is the stage in which the new technology has saturated, filled its niche, and is unlikely to continue to grow under the same circumstances.

After analyzing the historical growth curves of onshore wind power in Europe, we can conclude that in most parts of the continent, wind power has already reached its maximum growth speed. Without changes in the wider circumstances, it is unlikely to further accelerate.

4.2 Unprecedented growth in the plans

The European Union since 2018 has been increasing its targets for the share of energy generated through renewables (Pavlenko and Cherp 2023). The Member States' recently submitted draft National Energy and Climate Plans reflect these increased ambitions. By analyzing the targets for onshore wind energy in the NECPs we have shown that all countries plan to add wind capacity to their system. Eleven countries have set targets that would require them to accelerate the growth of wind power to speeds greater than what they have experienced historically.

There is a group of four countries (Belgium, France, Hungary, Italy) that plan for the acceleration of wind energy to levels within the IQR of historic global growth rates. France and Hungary plan to accelerate to a speed close to their own historical maximum growth rates. The targets in the NECPs of Belgium and Italy would require them to exceed their historic levels while staying within the IQR of other countries' maximum growth speed.

We also identified a group of seven EU Member States (Austria, Germany, Spain, Greece, Ireland, Portugal, Romania) that not only plan to exceed their own historical maximum growth rates but also to deploy onshore wind energy at levels rarely precedented globally. To meet their NECP targets, Austria, Greece, and Romania would need to install wind power at the speed that has only been achieved by Finland in the last three years. While Spain and Ireland have set targets that would require these countries to deploy wind power at even faster rates than ever seen before.

The further five countries included in our analysis (Denmark, Finland, Netherlands, Poland, and Sweden) also plan to increase the installed capacity of onshore wind energy. Their targets would not require them to accelerate beyond their historic maximum growth rates. Yet in the case of Sweden, even this level would mean a growth rate greater than IQR of global maximum growth rates.

As we have seen most European countries are no longer in the accelerating growth phase. In fact, except for Greece, all countries that plan to increase their growth rates from their historical maximum, plan to do so from the current stable growth phase or stalling growth phase. What this means is that these countries would need to "re-bend" the S-curve of onshore wind capacity and create a second growth pulse. This, according to the S-curve theory, is unlikely to happen without changes in the wider system that has led to its saturation.

4.3 Unprecedented policy challenge

We identified historic precedents of double-peaked S-curves in Austria, Denmark, Poland, Portugal, and Spain. These countries have previously experienced the stalling of wind growth for at least three years, during which very limited wind capacity was added to their system. However, they were then able to re-start wind deployment after the stalling episodes.

We analysed changes in the historic policy environment in these countries: both before and during the stalling of growth, to understand what could have been policy drivers of stalling and re-acceleration, as summarized in Table 2. We discovered that when growth slowed down, it was often because they stopped or greatly cut back on subsidies, there was uncertainty in the regulations, and/or they put in place policies that were unfavorable to wind power growth. On the other hand, re-acceleration in most cases began after there was more certainty in the regulations, subsidies were brought back or increased, and the countries withdrew the restrictive policies.

We also highlighted that some non-policy-driven factors also contributed to the slow-down, such as increasing public resistance in Denmark (Johansen 2021) and decreasing electricity demand in Spain (Gürtler, Postpischil, and Quitzow 2019). We also noted that setting higher targets for renewables is not enough to overcome stalling, as we saw in the case of Portugal which increased its national targets (Conselho de Ministros 2015), yet had very limited capacity added to its system for three years.

Our analysis has also shown that in these historic pulsing episodes, only Austria experienced a second pulse that had a faster deployment pace than its first pulse. Yet that is exactly what eleven EU Member States are planning to do in the next years.

Thus, we can conclude that while historical precedents can help us understand factors that can contribute to the slow-down and re-acceleration of wind deployment, these are unlikely to serve as guidance to the current situation. While we have seen five cases of re-accelerating wind power deployment from stalling growth in Europe, the policy environment in those periods was very different from what countries have now. Currently, the stalling of wind power deployment (in most EU Member States) is not associated with unfavorable financing or regulatory conditions. Most countries have set policies that - at least in principle - support wind power deployment.

Furthermore, except for the case of Austria, none of the historic stalling and re-acceleration episodes led to faster growth in the second wave than before the halting of deployment. However, EU Member States are now planning to make the second wave of deployment faster than the first, which is unlikely to happen by itself, and will require strong policy support.

4.4 Policies for acceleration after take-off or policies for re-acceleration from stalling

Several policy documents relating to renewables and more specifically wind energy have been published and adopted by EU institutions and Member States in the last three years, some of which will need to be transposed to national legislation by the countries. The policy measures proposed at the European level set targets, and aim to tackle mainly administrative (e.g. shortening the permit lead time, simplifying the permitting procedure, improving auction design), spatial planning (identifying areas for renewables), and financial issues (paving the way for easier access to finances). These types of policy problems, along with technical problems, are characteristic of the acceleration phase of renewable technologies (Breetz, Mildenberger, and Stokes 2018).

One can argue that because the EU is aiming for the re-acceleration of the growth pace of onshore wind energy, its policy measures are naturally similar to those that support acceleration. However, we should not forget that the forces in the acceleration phase on the S-curve of the technology and those in the stable and stalling phases are very different (Cherp et al. 2021). Thus policies for acceleration after take-off (second phase) and policies for re-acceleration (beyond the third and fourth phases) also have to be different (Markard 2018).

A major policy issue in the later stages of onshore wind energy deployment is the management of social opposition. Our research has indicated that increased social opposition to onshore wind farm siting caused a slowdown in wind energy development in Denmark during the early 2000s (Johansen 2021). This was resolved in 2008 with the introduction of compensation measures (IRENA 2013). Additionally, we have highlighted the case of Sweden, where local municipalities stopped 78% of wind turbine planning applications in 2021 (Westander and Risberg 2022). After the government failed to manage the emerging social opposition, it seems to be changing priorities of low-carbon electricity supply from wind energy to nuclear energy (Klimat- och näringslivsdepartementet 2023a).

Yet, neither RED III nor the Wind Power Action Plan mentions or addresses socio-political *opposition* and other emerging phenomena in socio-technical systems. The barriers are viewed as mostly purely administrative or economic. In RED III, the only measure proposed to the Member States to *enhance public acceptance* is "direct and indirect participation of local communities in those [renewable energy] projects" (Article 15d). Participation might not be enough to manage social opposition. Yet social acceptance might be equally relevant, yet more challenging to deal with, as the growth of onshore wind continues in Europe. It is yet to be seen if the theories that claim that new policy measures will be needed to create a second wave of wind energy deployment are supported or refuted by practice.

5 Conclusions

Onshore wind energy deployment is no longer accelerating in Europe. Except in four countries, onshore wind power deployment is currently growing at a stable pace or has already slowed down or even stalled in most European countries. Most EU Member States have recently set new targets for onshore wind power deployment in their draft updated National Energy and Climate Plans. These targets imply a departure from historical growth trends for most European countries: eleven countries would need to re-accelerate wind power deployment from currently stalling or stable growth to a pace that exceeds their national historical maximum growth speed. For several countries meeting their targets would require accelerating to a globally unprecedented speed of growth.

After concluding that European Members States are planning to change the speed and trajectory of onshore wind power deployment in comparison with historical trends, we asked the question of what challenges they might face, and how could they overcome these. We looked for historical precedents of re-acceleration, to understand if there is a potential for policy learning from those experiences. We identified five historic episodes in European countries during which there was a halt in wind power deployment that was followed by re-acceleration. We investigated the policy environment that the countries had during those episodes and concluded that the policy environment was substantially different in those episodes than what is required from countries currently. Historically, re-acceleration phases were driven by increasing regulatory certainty, re-establishment or increasing of subsidies, and withdrawal of restrictive policies; while currently, most EU Member States do not have policies that hinder wind deployment.

We turned to current policies and case studies to further explore challenges and solutions to changing the growth trajectory of onshore wind energy. We found that the recently set targets are (going to be) supported by EU-level and national policies. We explain that the EU policies mainly address policy problems relating to administrative, financial, and siting issues. However, through the case of Sweden, a country in Europe currently championing onshore wind power deployment, we show that managing social opposition cannot be avoided. Yet the policies proposed at the European level turn a blind eye to socio-political problems that might emerge. It is yet to be seen what policy measures the Member States plan to implement to accelerate onshore wind growth and how successful those will be.

Based on our study looking at historical growth trajectories of onshore wind energy in Europe and the Member States' targets for its future growth we can conclude that countries are planning to make the second wave of deployment faster than the first, which is unlikely to happen by itself, and will require strong policy support.

A future study should look into the final versions of the National Energy and Climate Plans and the targets on those since there could still be changes made to these plans following input from the European Commission. One should also analyze what national-level policies countries adopt to support the growth of onshore wind power. In the long term: one should analyse if there will be an observed change in the growth rate of onshore wind power deployment in the decades between today and 2030-40.

References

Almqvist, Erik. 2023. "Statistics and Forecast – Q3 2023." Stockholm: Swedish Wind Energy Association. https://swedishwindenergy.com/wp-content/uploads/2023/11/Statistics-and-forecast-Q3-2023_final-1.pdf.

Andreas, Jan-Justus, Charlotte Burns, and Julia Touza. 2019. "Portugal under Austerity: From Financial to Renewable Crisis?" Environmental Research Communications 1 (9): 091005. https://doi.org/10.1088/2515-7620/ab3cb0.

Araoz & Rueda. 2014. "New Regulatory Framework for Renewables in Spain." Madrid: Araoz & Rueda. https://www.araozyrueda.com/wp-content/uploads/2016/08/New-regulatory-framework-for-renewables-in-Spain.pdf.

Badman, Daniel. 2023. Swedish wind industry calls for new incentivesRenewable Energy News. https://renews.biz/87572/swedish-wind-industry-calls-for-new-incentives/.

Breetz, Hanna, Matto Mildenberger, and Leah Stokes. 2018. "The Political Logics of Clean Energy Transitions." Business and Politics 20 (4): 492–522. https://doi.org/10.1017/bap.2018.14.

Buli, Nora. 2023. Review of Dispute over Norway Wind Farm Continues despite Partial Deal, by Terje Solsvik. Reuters, 2023. https://www.reuters.com/business/energy/dispute-over-norway-wind-farm-continues-despite-partial-deal-2023-12-19/.

Castro-Rodríguez, Fidel, and Daniel Miles-Touya. 2023. "Impact of Spanish Renewable Support Scheme Reforms on the Revenues of Photovoltaic Power Plants." Utilities Policy 80: 101476. https://doi.org/10.1016/j.jup.2022.101476.

Cherp, Aleh, Vadim Vinichenko, Jessica Jewell, Elina Brutschin, and Benjamin K Sovacool. 2018. "Integrating Techno-Economic, Socio-Technical and Political Perspectives on National Energy Transitions: A Meta-Theoretical Framework." Energy Research & Social Science 37: 175–90. https://doi.org/10.1016/j.erss.2017.09.015.

Cherp, Aleh, Vadim Vinichenko, Jale Tosun, Joel A. Gordon, and Jessica Jewell. 2021. "National Growth Dynamics of Wind and Solar Power Compared to the Growth Required for Global Climate Targets." Nature Energy 6 (7): 742–54. https://doi.org/10.1038/s41560-021-00863-0.

Ciarreta, Aitor, Cristina Pizarro-Irizar, and Ainhoa Zarraga. 2020. "Renewable Energy Regulation and Structural Breaks: An Empirical Analysis of Spanish Electricity Price Volatility." Energy Economics 88: 104749. https://doi.org/10.1016/j.eneco.2020.104749.

Conselho de Ministros. 2015. Programa Nacional Para as Alterações Climáticas 2020/2030 (PNAC 2020/2030) | Resolução Do Conselho de Ministros n.º 56/2015. https://files.diariodarepublica.pt/1s/2015/07/14700/0511405168.pdf.

Costanzo, Giuseppe, and Guy Brindley. 2024. "Wind Energy in Europe 2023 - Statistics and the Outlook for 2024-2030." Brussels: Wind Europe. https://proceedings.windeurope.org/biplatform/rails/active_storage/blobs/redirect/eyJfcmFpbHMiOnsibWVzc2FnZSI6IkJBaHBBcFVGIiwiZXhwIjpudWxsLCJwdXIiOiJibG9iX2IkIn19--99818f702274525917e03ce9dc6a162227802a1f/WindEurope%20-%20Wind%20energy%20in%20Europe%20-%202023.pdf.

Czyzak, Pawel. 2022. "Change Is in the Wind." London: EMBER. https://ember-climate.org/insights/research/change-is-in-the-wind/.

Diógenes, Jamil Ramsi Farkat, João Claro, José Coelho Rodrigues, and Manuel Valentim Loureiro. 2020. "Barriers to Onshore Wind Energy Implementation: A Systematic Review." Energy Research & Social Science 60: 101337. https://doi.org/10.1016/j.erss.2019.101337.

EC. 2018a. "Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the Promotion of the Use of Energy from Renewable Sources (Recast) (Text with EEA Relevance.) PE/48/2018/REV/1." https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32018L2001.

———. 2018b. "Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, Amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and Repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council." https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.328.01.0001.01.ENG&toc=OJ:L:2018:328:TOC.

———. 2021. "Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions 'Fit for 55': Delivering the EU's 2030 Climate Target on the Way to Climate Neutrality. COM/2021/550 Final of 14.7.2021." https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021DC0550.

———. 2022a. "Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions REPowerEU: Joint European Action for More Affordable, Secure and Sustainable Energy. COM(2022) 108 Final of 8.3.2022." https://eur-lex.europa.eu/resource.html?uri=cellar:71767319-9f0a-11ec-83e1-01aa75ed71a1.0001.02/DOC_1&format=PDF.

———. 2022b. Council Regulation (EU) 2022/2577 of 22 December 2022 Laying down a Framework to Accelerate the Deployment of Renewable Energy. https://eur-lex.europa.eu/eli/reg/2022/2577/oj.

———. 2022c. "Key Documents: REPowerEU." 2022. https://commission.europa.eu/publications/key-documents-repowereu_en.

———. 2022d. "Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions REPowerEU Plan. COM(2022) 230 Final of 18.05.2022." https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A230%3AFIN.

———. 2023a. "Communication from the Commission to the European Parliament, the Council, the European Economic And Social Committee and the Committee of the Regions Delivering on the EU Offshore Renewable Energy Ambitions. COM(2023) 668 Final of 24.10.2023." https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0668&qid=1702455230867.

———. 2023b. "Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions European Wind Power Action Plan. COM(2023) 669 Final of 24.10.2023." https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0669&qid=1702455143415#footnote2.

———. 2023c. "European Wind Charter." https://energy.ec.europa.eu/document/download/c302f43f-2592-455e-99e2-e14aed3dd871_en?filename=European%20Wind%20Charter%20signed%20without%20logos.pdf.

———. 2023d. "Wind Pledges - European Wind Power Action." https://energy.ec.europa.eu/document/download/ff9911eb-4f53-497b-a6a6-

84a64feeea60_en?filename=Wind%20Pledges%20MS%2019%20Dec_FINAL%20FINAL_0.pdf.

———. 2023e. "Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 October 2023 Amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as Regards the Promotion of Energy from Renewable Sources, and Repealing Council Directive (EU) 2015/652 PE/36/2023/REV/2." https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023L2413&qid=1699364355105.

———. 2024. "Council Regulation (EU) 2024/223 of 22 December 2023 Amending Regulation (EU) 2022/2577 Laying down a Framework to Accelerate the Deployment of Renewable Energy." http://data.europa.eu/eli/reg/2024/223/oj.

Energimyndigheten. 2022. "Myndighetsgemensam Uppföljning Av Samhällets Elektrifiering - ER 2023:2." Energimyndigheten. https://energimyndigheten.a-w2m.se/Home.mvc?ResourceId=212470.

European Commission. 2024. "National Energy and Climate Plans." 2024. https://commission.europa.eu/energy-climate-change-environment/implementation-eu-countries/energy-and-climate-governance-and-reporting/national-energy-and-climate-plans_en.

Gnatowska, Renata, and Elżbieta Moryń-Kucharczyk. 2019. "Current Status of Wind Energy Policy in Poland." Renewable Energy 135: 232–37. https://doi.org/10.1016/j.renene.2018.12.015.

Griliches, Zvi. 1957. "Hybrid Corn: An Exploration in the Economics of Technological Change." Econometrica 25 (4): 501. https://doi.org/10.2307/1905380.

Gürtler, Konrad, Rafael Postpischil, and Rainer Quitzow. 2019. "The Dismantling of Renewable Energy Policies: The Cases of Spain and the Czech Republic." Energy Policy 133: 110881. https://doi.org/10.1016/j.enpol.2019.110881.

IEA. 2006. "Denmark 2006 Review." Paris: International Energy Agency (IEA). https://iea.blob.core.windows.net/assets/99013ffc-5611-48d1-9b65-c11d37a0f264/EnergyPoliciesofIEACountriesDenmark2006.pdf.

———. 2013. "Feed-in Premium Tariffs for Renewable Power (Promotion of Renewable Energy Act)." 2013. https://www.iea.org/policies/4888-feed-in-premium-tariffs-for-renewable-power-promotion-of-renewable-energy-act.

———. 2020. "Renewable Energy Act of Poland (Amended)." 2020. https://www.iea.org/policies/5737-renewable-energy-act-of-poland-amended.

———. 2021. "Net Zero by 2050 - A Roadmap for the Global Energy Sector." https://iea.blob.core.windows.net/assets/beceb956-0dcf-4d73-89fe-1310e3046d68/NetZeroby2050-ARoadmapfortheGlobalEnergySector_CORR.pdf.

———. 2022a. "Poland 2022 Energy Policy Review." IEA Energy Policy Reviews.

———. 2022b. "Spain." 2022. https://www.iea.org/countries/spain/electricity.

———. 2022c. “World Energy Balances.” IEA World Energy Statistics and Balances (Database). https://doi.org/10.1787/data-00512-en.

———. 2023. “Net Zero Roadmap: A Global Pathway to Keep the 1.5 °C Goal in Reach, 2023 Update.” Paris; France: IEA. https://www.iea.org/reports/net-zero-roadmap-a-global-pathway-to-keep-the-15-0c-goal-in-reach.

IG Windkraft. 2005. “Wind Energy in Austria.” 2005. https://www.igwindkraft.at/?mdoc_id=1000741.

———. 2017. “Historie Des Ökostromgesetzes Im Kurzüberblick.” 2017. https://www.igwindkraft.at/?mdoc_id=1014570.

———. 2018. “Mehr Als 20 Jahre Rasante Entwicklung Der Windkraft in Österreich.”

IRENA. 2013. “30 Years of Policies for Wind Energy | Lessons from 12 Wind Energy Markets.” https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2013/GWEC_WindReport_All_web-display.pdf.

———. 2023. “IRENA Data and Statistics.” 2023. https://www.irena.org/Statistics.

Jewell, Jessica, and Aleh Cherp. 2023. “The Feasibility of Climate Action: Bridging the inside and the Outside View through Feasibility Spaces.” WIREs Climate Change 14 (5). https://doi.org/10.1002/wcc.838.

Johansen, Katinka. 2021. “Wind Energy in Denmark.” IEEE Power and Energy Magazine 19 (3): 94–102. https://doi.org/10.1109/mpe.2021.3057973.

Johnsson, Filip, Jessica Henryson, Henrik Westander, and David Magnusson. 2023. “Kommunala Vetot – Landbaserad Vindkraft.” Gothenburg: Chalmers University of Technology. https://research.chalmers.se/publication/537949/file/537949_Fulltext.pdf.

Kahneman, Daniel. 1997. “New Challenges to the Rationality Assumption.” Legal Theory 3 (2): 105–24. https://doi.org/10.1017/s1352325200000689.

Kahneman, Daniel, and Dan Lovallo. 1993. “Timid Choices and Bold Forecasts: A Cognitive Perspective on Risk Taking.” Management Science 39 (1): 17–31. https://doi.org/10.1287/mnsc.39.1.17.

King, Gary, Robert O. Keohane, and Sidney Verba. 1994. Scientific Inference in Qualitative Research. Princeton: Princeton University Press. https://doi.org/10.1515/9781400821211.

Klesty, Victoria, and Gwladys Fouche. 2023. “Thunberg, Indigenous Protesters Block Norway Energy Ministry over Wind Farms | Reuters.” Reuters, 2023. https://www.reuters.com/business/environment/thunberg-other-protesters-block-norway-energy-ministry-over-wind-farms-2023-02-27/.

Klima- Energi- og Forsyningsministeriet. 2008. Lov Om Fremme Af Vedvarende Energi LOV Nr 1392 Af 27/12/2008. https://www.retsinformation.dk/eli/lta/2008/1392.

Klimat- och näringslivsdepartementet. 2023a. “Regeringen Tillsätter Utredning Om Ny Kärnkraft – Ett Andra Steg.” 2023. https://www.regeringen.se/pressmeddelanden/2023/11/regeringen-tillsatter-utredning-om-ny-karnkraft--ett-andra-steg/.

———. 2023b. “Sweden’s Draft Integrated National Energy and Climate Plan.” https://www.government.se/contentassets/e731726022cd4e0b8ffa0f8229893115/swedens-draft-integrated-national-energy-and-climate-plan/.

———. 2023c. “Värdet Av Vinden Kompensation, Incitament Och Planering För En Hållbar Fortsatt Utbyggnad Av Vindkraften SOU 2023:18.” https://www.regeringen.se/rattsliga-dokument/statens-offentliga-utredningar/2023/04/sou-202318/.

Lexology. 2021. “Q&A: The Legal Framework for Renewable Energy in Portugal.” 2021. https://www.lexology.com/library/detail.aspx?g=605178dc-d029-403b-94cd-6ee97e8acfd1.

Lovallo, Dan, and Daniel Kahneman. 2003. “Delusions of Success. How Optimism Undermines Executives’ Decisions.” Harvard Business Review 81 (7): 56–63, 117.

Lundheim, Sigurd Hilmo, Giuseppe Pellegrini-Masini, Christian A. Klöckner, and Stefan Geiss. 2022. “Developing a Theoretical Framework to Explain the Social Acceptability of Wind Energy.” Energies 15 (14): 4934. https://doi.org/10.3390/en15144934.

Lundin, Erik. 2023. “Wind Power and the Cost of Local Compensation Schemes: A Swedish Revenue Sharing Policy Simulation.” IFN Working Paper No. 1467. IFN. https://www.ifn.se/media/11kbi1km/wp1467.pdf.

Markard, Jochen. 2018. “The next Phase of the Energy Transition and Its Implications for Research and Policy.” Nature Energy 3 (8): 628–33. https://doi.org/10.1038/s41560-018-0171-7.

Meyer, Niels I. 2004. “Development of Danish Wind Power Market.” Energy & Environment 15 (4): 657–73. https://www.jstor.org/stable/43734674?seq=9.

Miljödepartementet. 2022. “Tidigt Kommunalt Ställningstagande till Vindkraft.” https://perma.cc/ZCR3-FBD6.

Nationalrat. 2012. Bundesgesetz Über Die Förderung Der Elektrizitätserzeugung Aus Erneuerbaren Energieträgern (Ökostromgesetz 2012 – ÖSG 2012) BGBl. I Nr. 75/2011. https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20007386.

Nordin, Lise, Filip Vestling, and Claes Pile. 2021. “En Rättssäker Vindkraftsprövning SOU 2021:53.” Stockholm: Statens Ofentliga Utredningar. https://perma.cc/6BAA-PCE6.

Norwegian National Human Rights Institution. 2023. “About the Wind Farms on Fosen and the Supreme Court Judgment.” 2023. https://www.nhri.no/en/2023/about-the-wind-farms-on-fosen-and-the-supreme-court-judgment/.

Ollier, Lana, Marc Melliger, and Florence Metz. 2023. “How Do Governments’ Policy Priorities Change as the Energy Transition Progresses? A Cross-Country Comparison.”

Journal of Comparative Policy Analysis: Research and Practice ahead-of-print (ahead-of-print): 1–15. https://doi.org/10.1080/13876988.2023.2280270.

Pavlenko, Anastasia, and Aleh Cherp. 2023. "When Is It Feasible for Policies to Accelerate Energy Transitions? The Case of REPowerEU." Paper Presented at ECPR General Conference 2023, September.

Polish Wind Energy Association. 2020. "Wind of Hope for Poland's Green Deal." 2020. http://psew.pl/en/2020/08/25/wind-of-hope-for-polands-green-deal/.

Red Electrica de Espana. 2014. "The Spanish Electricity System 2013." Madrid: RED ELÉCTRICA DE ESPAÑA. https://www.ree.es/sites/default/files/downloadable/the_spanish_electricity_system_2013.pdf.

Reuters. 2023. "Poland to Ease Wind Farm Rules, Freeze Energy Prices," 2023. https://www.reuters.com/business/energy/poland-ease-wind-farm-rules-freeze-energy-prices-2023-11-29/.

Seawright, Jason. 2016. "The Case for Selecting Cases That Are Deviant or Extreme on the Independent Variable." Sociological Methods & Research 45 (3): 493–525. https://doi.org/10.1177/0049124116643556.

Sejm. 2015. USTAWA z Dnia 20 Lutego 2015 r. o Odnawialnych Źródłach Energii. https://orka.sejm.gov.pl/proc7.nsf/ustawy/2604_u.htm.

Skjærseth, Jon Birger, Teis Hansen, Jakob Donner-Amnell, Jens Hanson, Tor Håkon Jackson Inderberg, Helle Ørsted Nielsen, Birgitte Nygaard, and Markus Steen. 2023. Wind Power Policies and Diffusion in the Nordic Countries, Comparative Patterns. https://doi.org/10.1007/978-3-031-34186-1.

Sveriges riksdag. 1998. Miljöbalk (1998:808). https://www.riksdagen.se/sv/dokument-och-lagar/dokument/svensk-forfattningssamling/miljobalk-1998808_sfs-1998-808/.

———. 2010. Plan- Och Bygglag (2010:900). https://www.riksdagen.se/sv/dokument-och-lagar/dokument/svensk-forfattningssamling/plan-och-bygglag-2010900_sfs-2010-900/.

Swedish Climate Policy Council. 2022. "2022 Report of the Swedish Climate Policy Council." Annual Report. Stockholm: Swedish Climate Policy Council. https://www.klimatpolitiskaradet.se/wp-content/uploads/2022/05/kprreport2022.pdf.

Vinichenko, Vadim, Jessica Jewell, Johan Jacobsson, and Aleh Cherp. 2023. "Historical Diffusion of Nuclear, Wind and Solar Power in Different National Contexts: Implications for Climate Mitigation Pathways." Environmental Research Letters 18. https://doi.org/10.1088/1748-9326/acf47a.

Westander, Henrik, and Jacob Risberg. 2022. "Kommunala vetot 2020–2021." Westander Klimat och Energi. https://svenskvindenergi.org/wp-content/uploads/2022/03/Kommunala-vetot-2020-och-2021-2022-03-18-slutversion.pdf.

Wickström, Johan. 2022. "Ingen Ändring Av Kommunala Vetot Mot Vindkraft – Trots Allt Färre Tillstånd." Tidningen Energi, 2022. https://www.energi.se/artiklar/2022/juni-2022/ingen-andring-av-kommunala-vetot-mot-vindkraft-trots-allt-farre-tillstand/.

Wind Europe. 2022. "EU Energy Ministers Adopt Emergency Measures on Permitting," 2022. https://windeurope.org/newsroom/news/eu-energy-ministers-adopt-emergency-measures-on-permitting/.

Wind Europe Business Intelligence, and Guy Brindley. 2020. "Financing and Investment Trends - The European Wind Industry in 2019." Brussels: Wind Europe.