THINK BASINS, NOT BORDERS

OFFSHORE WIND FOR THE WIDER BLACK SEA

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CEPS Policy Insights

No 2022-23 / June 2022

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Abstract

Following the outbreak of the energy price crisis in late 2021 and Russia's invasion of Ukraine in 2022, offshore wind has gained strategic importance in the EU as a renewable energy source well suited to substituting natural gas in the mid-term. Offshore wind could have even greater significance for the Black Sea coast, considering the phase-out of carbon-intensive lignite power generation and the need to reconfigure ties with Russia.

Despite offshore wind not enjoying high-profile visibility in the region so far, investment appetite can already be spotted. The first assessments of the region's technical potential for offshore wind are optimistic. Technological advancement of floating offshore wind can further make the case for its competitiveness in the low and medium wind speed areas of the Black Sea.

This study presents an overview of initial assessments of the technical potential in the Black Sea. But just as importantly, it identifies policy-related barriers at the national and regional levels. Its recommendations offer a blueprint of actions policymakers can take to overcome them and boost uptake of offshore wind in Bulgaria and Romania. They point the way towards sound legal frameworks that will underpin investor confidence, cross-border planning and pan-regional cooperation.

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Contents

List of Figures and Tables

1. Introduction

The Russian invasion of Ukraine will accelerate the development of renewable energy coupled with energy efficiency to phase out imports of natural gas. It can be expected that the current geopolitical context will create momentum for political support for renewables in the Black Sea region, where the future of offshore wind has yet to galvanise the higher political level. There is an increasing understanding that the region's long-persistent ties with Russian businesses and the region's dependence on imported Russian energy[1] will be reversed.

Truly living up to the European Green Deal's promises to mitigate climate change, increase energy security and drive low-carbon economic development will require ever more renewable energy (capacity and production) alongside energy efficiency. The European Commission's REPowerEU plan proposes to increase the target of renewables to 45 % by 2030 – compared with a 40 % target tabled in the Fit for 55 package earlier in 2021. This implies an increase of renewables of almost 70 % in power generation by 2030. An additional 200 GW of renewable capacity compared with the Fit for 55 projections will be needed to accelerate the phase-out of imports of Russian fossil fuels.

Offshore wind offers a possible substitute for coal and natural gas. With a capacity factor reaching 40-50 %[2], offshore wind is more suitable than onshore wind for example, as baseload to replace coal and lignite. The higher load factor also makes it a suitable source for renewable hydrogen, for instance to fuel industrial decarbonisation in the region, as well as to provide flexibility in the same manner as natural gas. With the development of an integrated regional market beyond the Black Sea littoral states, offshore wind can contribute to the diversification and decarbonisation of neighbouring landlocked countries. Yet, if the EU Member States seriously plan to develop the Black Sea offshore wind potential, they need first and foremost to build up a credible regulatory framework for offshore wind to bolster investor confidence.

An earlier report by Kustova and Egenhofer (2020) *How Black Sea offshore wind power can deliver a green deal for this EU region* provided a first sketch of the potential contribution of offshore wind technologies to decarbonising the region's economies, accelerating the transition from coal and creating new value chains. This study elaborates further on the existing national and regional barriers and discusses possible steps to advance offshore wind development in the region. It also names a few essential elements of an enabling regional policy framework for offshore wind.

The remainder of the study is structured as follows. Section 2 discusses the existing technological solutions for bottom-fixed and floating offshore wind farms and their applicability to the Black Sea, which is a low and medium wind speed area. It also outlines initial assessments

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[1] For a detailed discussion, see Stefanov and Vladimirov (2020, pp. 39-56).

[2] In 2021, capacity factors for offshore wind were around 35 %, a significant decrease from 42 % in 2020. The decrease is attributed to the geographical concentration of the offshore wind fleet in the North Sea region where abnormal weather conditions were reported throughout 2021. Worth noting, these numbers reflect the performance of the entire offshore wind fleet, including older and less efficient installations (WindEurope, 2022, p. 15).

of the offshore wind technical potential in the region and prospects for cost reductions in bottom-fixed and floating offshore wind technologies. Section 3 reviews the major policy-related impediments to uptake of offshore wind in the region. Section 4 highlights new synergies between offshore wind and other sectors, such as harbour infrastructure, renewable hydrogen production and the oil and gas sector. It outlines the long-term benefits of these synergies for a decarbonised economy of the Black Sea Member States and broader south-east Europe. The report concludes with preliminary 'recommendations for action', including a proposal for a wider regional dialogue on offshore wind.

2. Offshore wind in the Black Sea region: technologies and costs

A scale-up of offshore wind in all EU sea basins is necessitated considering the ambitious targets of the EU's offshore renewable energy strategy and a further increase of the renewable energy target to 45 % recently proposed by the REPowerEU plan. To unlock the potential of these sea basins, offshore wind technologies need to be adapted on a case-by-case basis to local weather and geographical conditions.

As most of the Black Sea is a low and medium wind speed area, certain adjustments, among others to turbine capacity and rotors, may be required. Also, as most of the region's technical potential seems to be in deep-water areas, floating offshore wind is a crucial technology for the region. Its commercialisation and, particularly, adaptation to low and medium wind conditions are therefore particularly important. The steadily decreasing costs of offshore wind technologies will also help.

Initial assessments of the offshore wind technical potential in the Black Sea have been prepared but the official data reported were insufficient, resulting in studies' varying assumptions. The national maritime spatial plans of Bulgaria and Romania, identifying potential areas for offshore wind development, could facilitate more precise estimations.

2.1 Current installation developments in the EU

In the European Commission's estimations, offshore wind is expected to be the fastest growing renewable energy technology[3]. The EU's offshore renewable energy strategy of November 2020 aims at 300 GW of offshore wind by 2050. To reach this target, current EU-wide capacity for offshore wind installation would need to grow by a factor of 20. Annual capacity additions would need to reach around 8-9 GW on average[4]. WindEurope (2022) estimates that capacity additions should reach over 8 GW annually during 2021-2026 to keep EU targets on track. To

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[3] By 2030, the Impact Assessment 'Stepping up Europe's 2030 climate ambition' forecasts a range of between 64 and 79 GW; by mid-century, offshore wind must reach between 270 and 300 GW (European Commission 2020a, p. 59).

[4] In 2021, EU offshore wind capacity amounted to 15.6 GW. So far, annual installations in the EU-27 were 0.997 GW in 2021, and 2.435 GW in 2020 (WindEurope, 2021a, p. 10; WindEurope, 2022, p. 11).

date, annual offshore wind installations are expected to increase from 2 GW in 2022 to 5.8 GW by 2026.

This means that all sea basins across the EU need to be tapped, going beyond the North Sea, which in 2020 accounted for almost 80 % of all offshore wind capacity in Europe[5], followed by the Irish and Baltic Seas (WindEurope, 2021a, p. 14). The Black Sea does not yet play a role. Capacity is highest in Denmark and Germany, with the Netherlands and Belgium catching up[6]. Among the recent large projects in the Baltic Sea, in June 2021 Denmark completed the installation of the Kriegers Flak (604 MW), the first hybrid[7] offshore wind farm in the world – connected to both Denmark and Germany. In May 2022, Belgium, Denmark, Germany and the Netherlands signed a EUR 135 bn offshore wind pact, thereby committing in a joint declaration to install at least 65 GW by 2030. They also plan to focus on hybrid multifunctional energy hubs, i.e. offshore wind farms interconnected among the countries and coupled with, for example, renewable hydrogen production.

On the eastern side of the Baltic Sea, offshore wind development remains embryonic. To advance it, using a EUR 22.5 bn support scheme, Poland plans to award up to 10.9 GW by 2030 in two roll-out phases, with new competitive auctions starting from 2025. In September 2020, Estonia and Latvia signed a memorandum of understanding on ELWIND, a joint hybrid project concept in the Gulf of Riga of up to 1 GW, which is planned to be commissioned by 2030. The pre-feasibility study of ELWIND was commissioned in late 2021, and in May 2022 Estonia adopted a maritime spatial plan, which among others accounted for offshore wind deployment.

While in the North and Baltic Seas most of the installations are bottom-fixed turbines, on the Atlantic coast, offshore wind developers have been exploring floating offshore wind technologies, largely due to the steep coast. The 25 MW Windfloat Atlantic farm, located off the Portuguese shores with a water depth reaching 100 m, is the first operational, floating offshore wind farm and still the largest in the EU[8]. Other pilot offshore wind projects in the region are at the development stage, such as the Groix and Belle-Ile project in France and DemoSATH in Spain.

By contrast, the Black Sea region – along with the Mediterranean Sea[9] – is still largely absent from the EU offshore wind map. The technological pathways best suited for these two basins

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[5] When it comes to the UK, as of end 2021 the country accounted for 12.7 GW of offshore wind capacity, 45% of the European total (WindEurope, 2022).

[6] In the EU, most offshore wind capacities were in Germany (7.7 GW), Denmark (2.3 GW), Belgium (2.26 GW) and the Netherlands (2.98 GW) in 2021. Other Member States' joint capacity reached 0.32 GW (Sweden, Finland, Ireland, Spain, Portugal and France) (WindEurope, 2022, p. 11).

[7] Hybrid offshore wind farms are connected to grids of two and more countries, allowing electricity trade in both directions.

[8] The largest floating offshore wind installation in the world is the 50 MW Kincardine in the UK.

[9] One example in the Mediterranean Sea is Beliolico, a 30 MW bottom-fixed offshore wind park, the first in Italy and the Mediterranean. Having been blocked by red tape and opposition from local communities for around a decade, the farm recently received final approvals and construction started.

are yet to be identified in line with the specific geographical conditions of each sea basin. Large parts of the Mediterranean and Black Sea basins are low and medium wind areas with a wind speed of below 7.5 m/s. As wind power grows with the cube of wind speed, existing offshore technological solutions – particularly of wind turbines and balance of plant designed for higher wind speed areas – need to be adapted to low and medium wind areas.

2.2 Offshore wind technologies for the Black Sea

Geographical and weather conditions of each maritime basin imply a need to adapt offshore wind technologies on a case-by-case basis. Offshore wind development in the North Sea has been driven – along with political and economic support – by excellent parameters for offshore wind deployment. In the North Sea basin, rich shallow waters (of up to 50 m deep) with a high wind speed (above 8.5 m/s, Class I and II areas)[10] favoured installations laid on diverse types of foundations[11].

The bottom-fixed technologies currently available on the market are less suitable in areas with a steeper coastline; also, in low and medium wind areas, relatively high wind speeds can more likely be reached mostly in deep-water areas with water depths of over 50-60 m[12]. Thus, in oceanic areas, such as the European Atlantic coast and the west coast of Ireland, wind speed easily exceeds 8 m/s, but seabed depth increases quickly with distance from the coast, which renders bottom-fixed farms installations difficult (WindEnergy Ireland, 2021). Also, in the low and medium wind areas of the Black Sea, most of the identified technical potential is in the deep-water areas with water depths of over 50 m.

Floating offshore wind technologies are deemed to provide a technological breakthrough in deep-water areas. According to the Global Wind Energy Council (GWEC, 2022, p. 13), floating offshore wind holds the most important potential for the industry to adapt to local contexts. Notably, Europe is a global leader in floating offshore wind technologies and accounts for 83 % of the global installed capacity, although at a low base: a total of 62 MW was operational in the EU at the end of 2020. Windfloat Atlantic in Portugal is the first floating offshore wind farm commissioned, while Kincardine (50 MW) off the coast of Scotland, fully operational since 2021, is the largest floating wind farm. Hywind Tampen (88 MW) is under construction in Norway. According to WindEurope (2021a, p. 21), floating offshore wind projects with a

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[10] According to the International Electrotechnical Commission specification, Wind Class I, II and III refer to the areas with annual average wind speed >= 10 m/s; >=8.5 m/s and <=7.5 m/s respectively.

[11] For an average water depth and distance to shore of all offshore wind farms in Europe, see Figure 11 in WindEurope (2021a).

[12] Considering the current stage of offshore wind technology development, bottom-fixed foundations become uneconomic for water depths greater than 50-60 m. The current transition between bottom-fixed and floating foundations lies between 40 to 60 m, but with technological development, this frontier may increase up to 90 m. For monopiles, the current maximum depth is viewed to be 65 m but is limited to 55 m with turbines of 15-20 MW. Jackets are less dependent on water depth, but the concern remains about serial production and transportation and installation, as bigger heavy-lift vessels are needed for deep-water jackets. For a discussion see Paya and Du (2020).

capacity of over 7 GW are currently in the pipeline in Europe for the 2020s, with projects under construction in France, Norway and the UK. Although floating offshore wind has already reached a high technology readiness level (TRL 8-9), the challenge lies in increasing its Commercial Readiness Index from 'commercial trial' to 'commercial scale up'.

The Black Sea basin has been classified as a Class III area characterised by lower wind speed (less than 7.5 m/s) and stormy unstable waters. Given the specific conditions of the Class III areas, such as the Black and Mediterranean Seas, South Korea or India, specific adjustments to the current offshore wind technologies available on the market will be required in terms of the turbine capacity and size of rotor. Although the capacity of offshore wind turbines has been steadily increasing[13], the lower wind conditions could be 'best served by a turbine with a large-diameter rotor matched with a comparatively small generator', de-rated to around the 10 MW level (COWI, Aegir and Pondera, 2021, p. 33).

An assessment of the offshore wind technical potential discussed in Section 2.3 shows that as relatively higher wind speeds can be reached mostly in deep-water areas, floating technologies are likely to be of pivotal importance for the Black Sea basin. Despite progress in pilots of floating offshore wind demonstrators in recent years, most of them have been designed to be deployed in higher wind speed areas (Class I and II). It will need to be demonstrated that the technology can be competitively scaled up for low and medium wind speed areas. So far, floating technologies have been tested in areas with a wind speed above 8-9 m/s, also because of the related economic considerations. A lower TRL of similar offers for low and medium wind areas largely derives from a lack of developer interest. Another reason is that demonstrators often use floaters and turbines already available on the market without undergoing proper optimisation of their operation as a holistic system for low and medium wind areas.

Apart from wind speed, technologies also need to be adapted to other local conditions. Restrictions on minimal water depth and storm conditions can pose further technical challenges for floating technologies and significantly affect the maritime space available for wind farm development. Resilience to storms likewise needs to be advanced for turbines deployed in areas of weather-related risks, such as the western part of the Black Sea (Onea and Rusu, 2017). Specifically, floating installations are more difficult to access and need to be transported to harbour facilities for maintenance, which can be complicated by local weather conditions.

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[13] In 2020, the average rated capacity of a turbine in Europe was 8.2 MW; in 2022, it is expected to reach 10-13 MW. Siemens Gamesa, one of the leading original equipment manufacturers, announced a 15 MW turbine commercially available from 2024 (COWI, Aegir and Pondera, 2021).

2.3 Estimations of the offshore wind technical potential in the Black Sea region

Although the Black Sea region has not been out of the spotlight in discussions about offshore wind, a few recent studies have estimated the offshore wind technical potential[14] for countries of the region. Figure 1 below summarises evidence on offshore wind potential in the Black Sea specifically for Bulgaria, Romania and Turkey.

The World Bank (2020) assesses the Black Sea region's overall technical potential at 435 GW, of which 269 GW is for fixed and 166 GW for floating offshore wind. That said, a significant part of this potential is located outside the EU or Energy Community member states. According to the same estimates, Romania's total fixed and floating offshore wind technical potential is 22 GW and 54 GW, respectively. In Bulgaria, estimates for bottom-fixed offshore wind are more modest (2 GW), while the largest share of the technical potential is for floating (24 GW of the 26 GW).

In the wider Black Sea, the World Bank (2020) deems the highest potential to be in Ukraine (251 GW, of which 183 GW is fixed and 68 GW floating), but the current Russian invasion of the country makes tangible prospects for offshore wind impossible. Turkey is also important for offshore wind deployment in the region, even though most of its offshore wind potential is in the western part of the country, on the Mediterranean coast. The World Bank (2020) estimates the country's offshore wind potential in the Black Sea as 75 GW total.

A study by the Centre for the Study of Democracy in Sofia (Trifonova and Vladimirov, 2021) has modelled promising areas for offshore wind in Bulgarian waters. Accordingly, 26 GW of mature bottom-fixed technologies and 90 GW of floating wind are estimated at 150 m; total offshore wind potential reaches 77.5 GW at 100 m. The study furthermore estimates that around one fourth of these estimations may be economically feasible considering all current regulatory, environmental and maritime limitations. Based on the selected sea-use constraints, economic and environmental protection criteria, the study identifies three areas with the most favourable conditions for bottom-fixed wind: (1) Shabla, with an estimated potential of 4.3-5 GW; (2) Varna with 400-500 MW; (3) Obzor with 1.2-1.5 GW; and (4) an area for floating technologies at the Turkish maritime border of 2-2.5 GW.

According to the Bucharest-based Energy Policy Group (Bălan et al., 2020), Romanian shores can host 94 GW of offshore wind at 100 m, mostly with floating turbines (72 GW). However, only the central part of the country's deep-water sector has more sizeable mean wind speeds (close to 7 m/s), while in the south-eastern part of the Romanian exclusive economic zone the wind speed decreases. Wind speeds depend also on seasonal distribution: in deep-water areas, wind speeds can reach up to 8-9 m/s in winter, while the north-eastern part of the deep waters hardly reaches 7 m/s in summertime.

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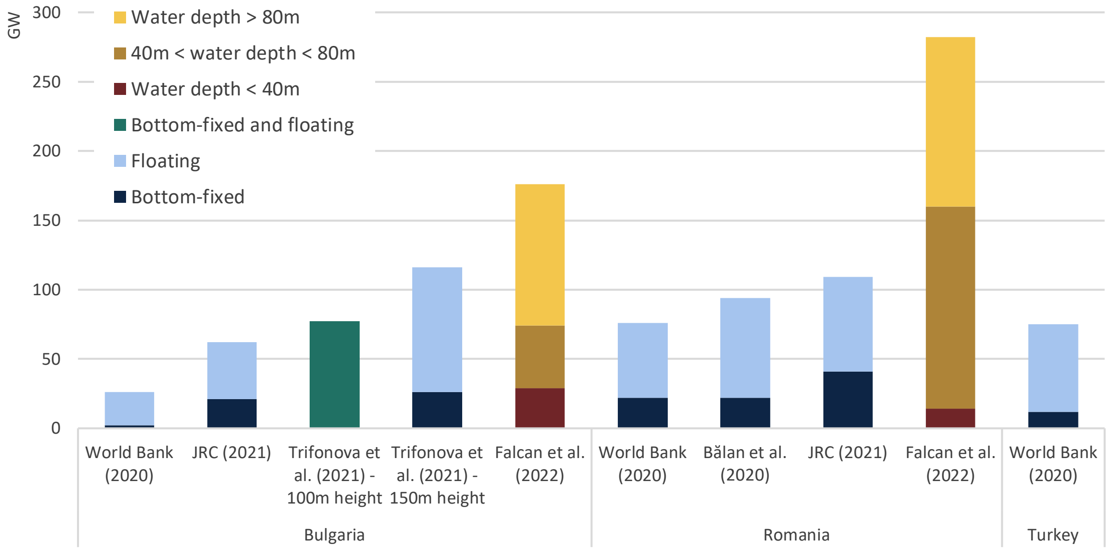
[14] The offshore wind technical potential is an estimate of generation capacity that could be technically feasible considering only wind speed, turbine height and water depth.

The study identifies two potential clusters with the most favourable conditions for a first stage of a bottom-fixed offshore wind uptake in the country. An orange cluster with capacity factors of 33-35 % located 40-60 km from the shore, provides options to boost the output of the Constanta Sud electrical substation and to host cross-border projects with Bulgaria. The proximity of the port of Constanța also facilitates the offshore wind Operations & Maintenance (O&M) activities and potential coupling with renewable hydrogen production. A pink cluster located in the northern part of Romanian waters, with an average capacity factor of 34 %, is identified as the best offshore wind development area. Still, the onshore grid will need to be extended to connect the offshore wind farms through the protected area of the Danube Delta.

Falcan et al. (2022) identify promising areas for offshore wind in the Black Sea, to be located predominately in Romania and Ukraine. Accounting for possible sea-use constraints (such as military zones, nature protection areas and major shipping routes) the study estimates an offshore wind technical potential as high as 176 GW for Bulgaria and 282 GW for Romania. Yet, when only the realisable technical potential is considered, estimates dwindle to only 1 % of all technically available sites, resulting in 1.8 GW for Bulgaria and 2.8 GW for Romania.

The studies briefly sketched above have estimated substantial technical potential that can theoretically be tapped. These estimations show that the Black Sea basin is particularly suitable for floating technologies; however, this does not exclude development of bottom-fixed installations where relevant. So far, the key assumptions still diverge across the studies, and there is a general lack of official raw data for more precise estimations. Overall, more precise assessments would be needed after the national maritime spatial plans are finalised. Once these plans delineate offshore wind development zones, a case-by-case assessment of the maritime areas can be performed.

Figure 1. Offshore wind technical potential in the Black Sea



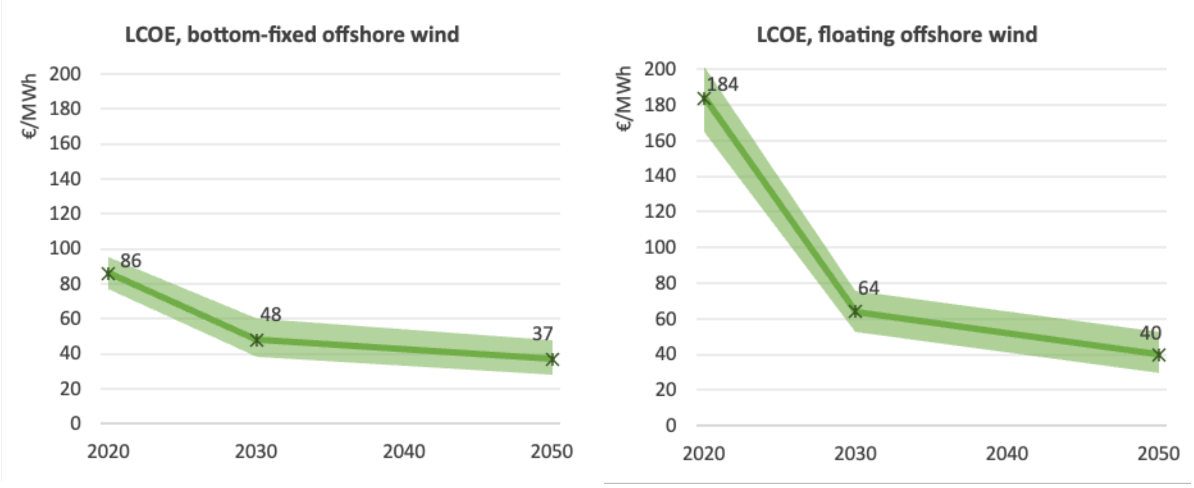
Source: authors' compilation based on World Bank (2020), Bălan et al. (2020), JRC (2021), Trifonova and Vladimirov (2021), Falcan et al. (2022).
Note: JRC (2021) refers to the high scenario (including near shore areas).

2.4 Cost reduction trajectories for offshore wind technologies

Driven by fast-paced technological innovation and economies of scale, offshore wind power costs have rapidly decreased over the last decade and are expected to further drop in the years to come. Between 2010 and 2020, the world-weighted average levelized cost of electricity (LCOE) of (bottom-fixed) offshore wind has almost halved, falling from EUR 150/MWh to EUR 78/MWh (IRENA, 2021). In Europe, costs ranged between EUR 62/MWh and 120/MWh in 2020[15], and the European Commission (2021a) estimates a drop in the range of EUR 30-60/MWh by 2050. The LCOE of floating offshore wind is still substantially higher – between EUR 165 to 202/MWh, mostly due to heavier capital expenditures (CAPEX) (Fraile et al., 2021).

Figure 2 reports the current and projected LCOE of bottom-fixed and floating offshore wind. The figure shows that both technologies are set to experience significant cost reductions over the coming decades, though floating offshore costs are expected to fall much faster. Indeed, while bottom-fixed LCOE is estimated to drop by 45 % from now until 2030, a 65 % cost reduction is envisaged for floating wind technologies over the same period. Looking ahead to 2050, bottom-fixed LCOE is expected to decline by 57 % compared with current levels, whereas floating offshore LCOE might reach a 78 % reduction. At that point, the average LCOE of the two technologies are expected to converge at around EUR 40/MWh[16].

Figure 2. LCOE development of bottom-fixed (left) and floating (right) offshore wind



Source: Adapted from Fraile et al. (2021).

Note: The shaded area represents the LCOE range, while the line represents the LCOE average.

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[15] Weighted average of EUR 77/MWh; both the lower and the upper bounds were recorded in the Netherlands (IRENA, 2021).

[16] Similar LCOE reduction estimates are obtained in an expert elicitation survey carried out by Wiser et al. (2021). For bottom-fixed offshore, the authors estimate 35 % and 49 % LCOE reductions in 2035 and 2050, respectively (median demand scenario); for floating offshore, a 17 % reduction is expected in 2035, and a 40 % reduction is expected in 2050 (both compared with a 2019 bottom-fixed baseline – median demand scenario).

As is typically the case with renewable energy technologies, offshore wind costs are predominantly CAPEX-driven, so the largest contributor in future LCOE reductions will likely be the decrease in overall capital expenditures. This is especially true for floating offshore wind. To date, floating installations' CAPEX can roughly double those of fixed installations, because of significantly larger foundation costs[17]. But industrialisation and large-scale deployment are expected to substantially drive down such costs in the medium term. According to Fraile et al. (2021), decreasing CAPEX alone will lead to a 25 % reduction in bottom-fixed offshore wind LCOE by 2030, whereas for floating technologies the lower CAPEX will be responsible for a 43 % contraction in LCOE. In addition, other substantial contributions to future cost reductions for both technologies will also stem from decreasing O&M costs, extended installation lifetime, expanded capacity factors and falling financing costs.

Looking at innovation-specific impacts on costs, an increase of turbine size could be the largest contribution to reducing offshore wind LCOE up to 2030[18], thanks to both lower construction costs (CAPEX) and operating expenditures (OPEX) according to Valpy et al. (2017). Yet, the authors estimate that larger cost reductions are expected to occur for turbine types suitable for higher wind speed areas (Class I and II). Besides the increasing size, other innovations influencing future costs will be greater material efficiencies, leaner designs and improved installation processes. For floating technologies, optimised manufacturing and assembly and the transition to serial production will be major factors (Fraile et al., 2021).

While the above projections indicate how technology improvements might affect offshore wind costs in the medium to long term, project-specific costs will ultimately depend on region-specific factors. It also remains difficult to estimate with precision cost dynamics for bottom-fixed and, particularly, floating technology projects in the low and medium wind speed areas. For the Black Sea, Trifonova and Vladimirov (2021) estimate the LCOE of offshore wind in the four most favourable areas off the Bulgarian shore[19] to potentially range around EUR 62-90/MWh for bottom-fixed technologies[20] and EUR 20-158/MWh for floating ones[21]. With such cost ranges, bottom-fixed installations would already be competitive with current market prices, while floating offshore wind costs would likely be too high to be attractive. Yet, with floating installation costs rapidly declining in the years leading to 2030 and further technological adaptation to low and medium wind areas, several areas located at higher water depths along the Bulgarian and Romanian shores might prove commercially viable for offshore wind developers.

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[17] Foundation costs represent the largest component of floating offshore CAPEX (36 % of the total).

[18] According to the authors, a 15 % LCOE reduction will be realised due to larger turbine size by 2030, with a total of 36 % expected. Such an impact stems from the transition from a wind farm using 6 MW-size turbines and a final investment decision in 2017 to a wind farm using 10 MW-size turbines and a final investment decision in 2030.

[19] See Section 2.3.

[20] EUR 62-81/MWh for 45 % capacity factor, EUR 79-91/MWh for 40 % capacity factor.

[21] EUR 110-133/MWh for 45 % capacity factor, EUR 124-150/MWh for 40 % capacity factor.

3. Key barriers to offshore wind in the region

The deployment of both solar PV and wind installations across the EU has been performed in a 'stop and go' manner, often being blocked, slowed down or hindered by various barriers. Several studies have recently identified the chief ones. Yet, at the same time, there is investor interest. According to RES Simplify (2022)[22], various administrative barriers have been the core obstacle to renewable energy installations. These barriers include complex and lengthy permitting processes, conflicting public goods related to the environment, non-energy use of land and water, and grid connection for new renewable energy installations.

Another study (Banasiak et al. 2022) published a Barrier Index, ranking Member States on the level of impediments to wind and solar PV[23]. Various Member States scored at the top of the ranking in either some areas or in specific renewable energy technologies. Romania and Bulgaria, together with Hungary[24], were among the top with severe barriers identified across almost all areas analysed (Table 1).

Table 1. The Barrier Index

Barriers	Bulgaria	Romania
Overall Barrier Index	**0.87 (7th place)**	**0.87 (5th place)**
Political and economic framework	0.95 (4th)	0.99 (2nd)
Markets	0.77 (6th)	0.88 (2nd)
Administrative processes	0.84 (24th)	0.88 (12th)
Grid regulation and infrastructure	0.95 (3rd)	0.77 (14th)
Other	0.77 (9th)	0.77 (10th)
Offshore wind (overall)	0.76	0.83
Offshore wind (political and economic framework)	0.95	0.95
Offshore wind (markets)	0.63	
Offshore wind (grid regulation and infrastructure)	0.63	
Offshore wind (other)		0.53

Source: Authors' compilation based on Banasiak et al. (2022).

Note: Impact on renewable energy deployment: 1.0 – Crucial; 0.90-<1.0 – Severe; 0.80-0.90 – High; 0.60-<0.80 – Moderate; 0.30-<0.60 – Low; <0.30 – Minimal.

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[22] RES Simplify (2022) has been prepared for the European Commission and published together with the Commission's proposal for speeding up permitting processes (Proposal for a Directive of the European Parliament and of the Council amending Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources, Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency, Brussels, 18.5.2022 COM(2022) 222 final, 2022/0160 (COD)).

[23] The barriers were assessed in four key areas: political and economic frameworks, markets, administrative processes, and grid regulation and infrastructure.

[24] Hungary was ranked first among Member States, with crucial barriers (0.99-1.0) in the political and economic framework, administrative processes, grid regulation and infrastructure, and an overall Barrier Index of 0.94.

In the Black Sea region, offshore wind is non-existent and has not been at the centre of political debates at either the EU or national levels for a long time. The barriers to offshore wind identified by Banasiak et al. (2022) for Bulgaria and Romania relate primarily to political and economic frameworks. Both Bulgaria and Romania score high (0.95) in this category, which indicates severe impediments to offshore wind development.

At the same time, investor appetite has already been spotted in the region. In 2020, Hidroelectrica, a Romanian power generation company, announced an intention to invest in 600 MW of wind power in Romania by 2026, of which 300 MW is envisaged offshore. Recently, wpd offshore, a German renewable-energy project developer, became the first company to officially apply in Romania for the development of two offshore wind projects, totalling 1.9 GW.

For further stimulating investor interest, barriers will need to be addressed. First, as discussed in Section 2, the technologies available on the market, such as the existing offers of turbines, need to be adapted to the maritime and wind conditions of the Black Sea. The TRL for floating offshore wind technologies that are best suited to low and medium wind areas in the region can be advanced through R&D and demonstration projects.

The principal regional barriers, however, remain socio-political. Offshore wind is still outside the national political priorities and long-term targets in both Bulgaria and Romania. Adding to that, the current political debate in both countries substantially overlooks offshore wind as a viable solution for an energy mix. The national legal frameworks for offshore wind are still embryonic in Bulgaria and Romania, perpetuating a regulatory vacuum for investors. All this further stagnates a regional approach and cross-border joint planning, which are of paramount importance for offshore wind. As renewable energy in general faces substantial obstacles in terms of permitting processes in Bulgaria and Romania, facilitating offshore wind will become an additional challenge. Then, preparations of national maritime spatial plans are experiencing delays, and offshore wind still needs to be properly accounted for within these plans. Finally, lack of expertise in offshore wind among the national authorities, which are also substantially understaffed, exacerbates the already-listed hurdles.

3.1 Insufficient policy priority given to offshore wind development

In terms of political and regulatory frameworks, Bulgaria and Romania were among the top five in the Barrier Index ranking (Banasiak et al., 2022). In both countries, a consistent lack of reliability in the renewable energy strategies has been coupled with a lack of priority and insufficient regulatory frameworks, including support schemes. The renewables support frameworks in the countries were subject to either frequent regulatory amendments or a lack of transparency.

In addition to overall low reliability, the national renewable energy strategies of Bulgaria and Romania do not include prospects for offshore wind technologies. Although the countries in the region have been slowly incorporating the EU carbon-neutrality objectives in their domestic policies, offshore wind has remained absent from projections in their national energy and climate plans (NECPs). Offshore wind specifically lacks policy incentives and regulations in place to drive offshore wind development in the region (see Trifonova and Vladimirov, 2021; Bălan et al., 2020).

Responding to a recommendation by the European Commission on Bulgaria's NECP, Bulgaria raised its 2030 target for the share of renewable energy in final energy consumption from 25 % to 27.09 % (European Commission, 2020b). However, the expansion of renewable energy in the updated NECP remained associated primarily with the growth of biomass in heating (CSD, 2020, p. 3). Almost all the projected increase in installed power-generating capacity (2.645 GW by 2030) is expected to be covered by solar PV (2.174 GW). Only 249 MW from onshore wind farms were projected (NECP Bulgaria, 2021, p. 61). Also, according to the RES Policy Monitoring Database, the plan does not provide a clear strategy on how these targets will be achieved. To some extent, a limited focus on wind energy may be explained by restrictions to the construction of wind farms in protected sites established within the Natura 2000 network[25].

In Bulgaria, the current regulatory setup does not provide a legal basis for offshore wind deployment, including guidelines on co-existence with other activities in the Black Sea, such as possible conflicts with concession holders, environmental protection or military zones. A law on offshore wind has still not been adopted, though is reported to be at an advanced stage. During the hearing of the Energy Committee of the Bulgarian Parliament in March 2022, a rare consensus was reached as part of a general commitment from all political parties to develop a regulatory framework for offshore wind. As has been reported in interviews with regional stakeholders, vested interests continue to persist in the energy sector, but more stakeholders are demonstrating genuine interest and readiness to discuss offshore wind. Security of supply concerns and rapidly declining costs of this technology arguably contribute to raising the attractiveness of offshore wind in the country.

In a similar vein, when incorporating the Commission's recommendations, Romania increased the target in its revised NECP for the share of renewable energy in final energy consumption from 27.9 % to 30.7 % (European Commission 2020c). The projections for 2030 estimate an increase of up to 5.255 GW in wind capacities and of approximately 5.054 GW in solar PV (NECP Romania, 2020). The new proposed renewable-energy target was tabled by the government in February 2020, updating the earlier targets but remaining below the recommendations made by the EU of 34 %.

Some progress for offshore wind can be observed, however, as Romania submitted a draft Offshore Wind Bill to its Senate in July 2020. As mentioned by several stakeholders interviewed, this fast-track submission was arguably motivated by the then ongoing discussions on the European Commission's offshore renewable energy strategy. This initiative certainly became a

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[25] In line with Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora and Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds. Protected areas cover 41 053.2 km^2 or almost 40 % of Bulgaria's territory, among which an area of 2 821.35 km^2 in Bulgaria's marine territory (NECP Bulgaria, 2021, p. 59).

'first mover' in the region; nevertheless, it also received criticism for lacking insufficient preparation and crucial elements (see Bălan et al., 2020). Despite the initial urgency and fast-tracking (the bill went to the Senate without any prior public discussion or public consultation), the draft bill has been inactive since then.

3.2 Limited policy discussion

For long time, Black Sea offshore wind had only arisen in various policy discussions with no policy or investment follow-up. The process seemed to too slow compared with the overall discussion in the region about how to source carbon-neutral electricity. Stepping stones have gradually been reached in recent years. In 2018, Eurelectric and WindEurope organised the workshop affiliated with the Central and South Eastern Europe energy connectivity (CESEC) group's ministerial meeting. The following conclusions during this meeting resulted in arguably the first original statement that offshore wind should be part of renewable energy considerations in the Black Sea. Only in 2020 did the World Bank propose a general assessment of the technical potential in the Black Sea (World Bank, 2020). Following the European Commission's offshore renewable strategy, which recognised the importance of the Black Sea basin, two initial studies were conducted in 2020-2021 by the Romanian Energy Policy Group (Bălan et al., 2020) and the Bulgarian Centre for the Study of Democracy (Trifonova and Vladimirov, 2021).

According to discussions with regional stakeholders, relatively strong resistance to offshore wind by stakeholders lies not only in their vested economic or political interests but also in a lack of knowledge about these technologies. Misconceptions and misinformation about allegedly negative effects of offshore wind on the maritime space amplify it. There is widespread opinion that offshore wind should be developed only at a much later stage, after 2030, when floating installations will have hopefully proven their effectiveness. Resistance on the part of local experts to offshore wind energy is still present; but, some are starting to understand the prospects of this technology, which indicates a slow shift in the discourse on offshore wind.

3.3 Lack of a regional dialogue and cross-border joint planning

Offshore wind development necessitates cooperation on issues ranging from wind risk-assessment maps and identification of marine ecosystem areas to market integration. Cooperation needs to extend to other issues, such as the planning of interconnection between offshore farms and onshore grids. Best practices can be drawn from the experience of the North Seas Energy Cooperation, through which governments and stakeholders, including electricity generators, grid companies and project developers, have taken up initiatives that go beyond national regulatory frameworks.

Currently, in the region, there are neither joint approaches to maritime spatial planning, nor joint planning for offshore wind and related development of grids and dispatching. A CESEC high-level working group is serving as a platform for the discussion of offshore wind. Among the issues discussed during its meetings are how to unlock offshore renewable capacity in the Black Sea basin and identify major offshore renewable energy projects (European Commission, 2021b).

Communication with local stakeholders revealed growing interest from landlocked countries in the region and Energy Community countries located next to the Black Sea. There is also interest in some countries in engaging via the Black Sea Economic Cooperation, part of the wider cooperation frameworks in the Black Sea area. Turkey is increasingly interested in exploring offshore wind, having led the creation of the Black Sea Offshore Wind Federation in 2019[26]. Ideally, market integration would contribute to offshore wind development and to its bigger role in decarbonised power supply across the region. Yet, there is no clarity at this stage about broader electricity cooperation in the region, which would be highly beneficial for offshore wind. Overall, discussions about any cooperation on offshore wind remain over-general, without clear outlooks and timelines.

3.4 Lengthy administrative processes

Lengthy permitting processes, including a high degree of complexity, long duration and low transparency of administrative procedures, have been reported as one of the key bottlenecks of renewable energy and offshore wind projects in the EU. That is the case despite a dedicated Article 15 in the Renewable Energy Directive II (Directive 2018/2001/EC) requiring Member States to create a one-stop shop to authorise renewable power installations. Lengthy permitting can severely affect the costs of offshore wind projects, especially at the initial stage of the development; a substantial time lag between the initial investments and the operational phase often results in abandoned projects (Hüffmeier and Goldberg, 2019, p. 50).

Although the key barriers for offshore wind – like other renewables – remain connected to bureaucratic issues, RES Simplify (2022, p. 46) views project implementation processes for offshore wind on the existing markets of northern Europe as ‘relatively easy and unproblematic’. Surprisingly enough, offshore wind-related barriers were in general deemed less severe than for onshore wind. As pointed by RES Simplify (2022, p. 46), ‘the administrative process for offshore wind was designated from scratch and could benefit from experience with offshore wind’[27].

In Romania, the currently inconsistent licensing procedures and long administrative procedure have been reported as the main impediments to onshore wind and solar PV ground-mounted (Banasiak et al., 2022). Administrative procedures to obtain all the necessary permits and

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[26] Bulgaria, Ukraine and Georgia have already joined the Federation.

[27] Among the notable barriers identified were the numerous permits required with little legal coherence between them in Sweden; the numerous comprehensive expert reports requested in Germany, affecting costs and the completion schedules of offshore wind projects; and the lack of a sufficient legal framework in Belgium, Germany and Ireland.

environmental authorisations remain extremely complex, with a kaleidoscope of required permits and time limits across jurisdictions, according to the RES Policy Monitoring Database. Inevitably, all the complexities and inconsistencies of administrative procedures inflate the time allocated for administrative procedures, thus increasing the CAPEX of projects and deterring project developers.

An analogous situation is observed in Bulgaria, where non-harmonised and non-standardised permitting procedures present a big challenge for renewable energy projects. As mentioned by the RES Policy Monitoring Database, a lack of information exchange between the different national and local authorities and difficulties experienced in understanding and applying the rules even by the relevant public officers at the municipal level constitute an additional burden for renewable energy developers. Among others, delays with approvals of environmental impact assessments are ranked within overall top five key barriers in Bulgaria (Banasiak et al., 2022). Another critical impediment in Bulgaria is complicated access to public information about the site selection process. It is particularly difficult to obtain information about the renewable energy potential, existing capacities and generation; the entire process is associated with 'personal connections, trial-and-fail attempts in communication, pulling strings'. When provided, information from different institutions can be conflicting. All this further complicates preliminary assessments at the initial stages of a project, as assessments of its compliance with all the requirements and restrictions of all the public authorities are made on a trial-and-error basis.

Regarding offshore wind, in addition to all these restrictive practices, the local context, including weather conditions, might also require even more time and expertise for permitting than in the northern part of Europe. As reported by the stakeholders interviewed, at the domestic level, the internal capacities of the relevant ministries in Bulgaria and Romania remain essentially limited, in terms of both the required staff and expertise.

3.5 Offshore wind in national maritime spatial plans

Under the framework of the Maritime Spatial Planning Directive 2014/89/EU, all coastal Member States were to draw up maritime spatial plans no later than 31 March 2021. Both Bulgaria and Romania were preparing national maritime spatial plans, but missed the March 2021 deadline[28].

In Bulgaria, a draft maritime spatial plan for the period 2021-2035 was presented to the European Commission in March 2021 and is in the final approval stage. Still, offshore wind development is not currently being considered in the draft. A new regulation on navigation routes is also expected to be adopted this year; tourist zones have not been finally adapted. On 19 May 2022, the European Commission launched an infringement proceeding against

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[28] Certain support in delivering maritime spatial plans was offered to both countries via an EU-funded MARSPLAN-BS Project; however, offshore wind was not part of the scope of the project.

Bulgaria for failure to properly implement maritime spatial planning (INFR(2022)2025). Bulgaria will have two months to respond to the letter and address the shortcomings identified by the Commission.

In Romania, with a one-year delay, a draft maritime spatial plan was published for public consultation in March 2022 (MSP RO, 2022). Repeating the World Bank (2020) assessments of offshore wind technical potential and reinstating the importance of objectives for the EU offshore renewable energy strategy, the draft plan envisages bottom-fixed installations as the first to be installed from a cost-effectiveness point of view.

The draft plan also specifies two potential clusters that have in mind the installation of fixed turbines. The first cluster has a capacity factor of 33-35 %, at depths below 50 m and at 40-60 km from the shore (with reference to the city of Constanța). It is in an area that achieves the right balance between wind resources and the costs of the necessary offshore network, considering injection of the energy produced in the Constanța Sud power station near the Port of Constanța. The second cluster has moderately better wind resources, but the existing electricity transmission line is much more substantial on land, and the connection network should be extended through the Danube Delta, which is a protected area.

The draft plan outlines the future value chains and infrastructure that would be required for both bottom-fixed and floating installations. For floating turbines, certain infrastructure would be required for ports, as the components are generally assembled on land and then towed to the site. For bottom-fixed installations, the foundations, platforms or substations required for wind farms are manufactured directly at the nearest port, where operation and maintenance activities also take place. A plan for grid connection, submarine cables and transformer stations needs to be envisaged as well (MSP RO, 2022, pp. 71-73).

3.6 Grid development and integration of offshore wind

The uptake of renewables will need to be complemented with grid development, its reinforcement, expansion and optimisation. Grid development has been widely recognised as a future bottleneck of offshore wind development. To a considerable extent, insufficient grid infrastructure has resulted from consistent under-investment[29], substantial delays and low social acceptance of new grid infrastructure. As Banasiak et al. (2022, p. 43) summarise, 'overall, the problem is well understood, but expanding grid capacities has remained painstakingly slow'. As more renewable energy projects need to apply for a grid connection, this becomes a serious burden for project developers, especially in the wind energy sector.

Various barriers related to high connection and grid development costs, delayed access and grid saturation have been reported across the EU. Grid saturation has been a pressing problem in both Bulgaria and Romania, and particularly in Hungary where no concrete plans for grid

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[29] One in three grid infrastructure investments have been delayed or rescheduled according to Kreusel, Timbus and Oudalov (2022).

expansion have been developed so far. In Romania, renewable energy projects are often abandoned in the first 2 to 3 years of the project's lifespan because of problems at the grid connection stage. As a result, by 2021, certain regions, such as Dobrogea, had become almost unavailable for grid connection despite their suitability for renewables. Dobrogea, among others, is viewed as the primary region for offshore wind and potential coupling activities, such as renewable hydrogen (Bălan et al., 2020).

In Bulgaria, renewable energy is curtailed first by situations in which the electricity grid is congested; an unpredictable grid-connection process may also result in extended timelines for grid connection. Transparency of connection procedures is another obstacle. In Bulgaria, there are no harmonised grid-connection requirements. Additionally, the transmission system operator does not disclose information about the available network capacities. In many cases, project developers need to access the electricity system operator (ESO) on a case-by-case basis to receive confirmation on whether the location has available capacities. This 'trial and error method' can incur additional costs and become time consuming, as once the ESO rejects the location, the entire process must restart.

3.6.1 Cross-border cooperation through priority offshore grid corridors

For offshore wind, the need for coordination of activities in open sea by several governments imposes further challenges. Installation of offshore wind generation capacity requires new offshore underwater cables, installation of substations for electricity transmission and dispatching centres to control electricity flows and losses. All this infrastructure is more complex to install in maritime zones, whereas operation and maintenance costs can increase with harsh weather conditions.

Steps to facilitate cross-border network cooperation and unlock offshore grids are envisaged in the Regulation (EU) 2022/869 on *guidelines for trans-European energy infrastructure* (TEN-E Regulation), which was adopted by the Council on 16 May 2022 and has subsequently entered into force. The revisions aim to align the TEN-E Regulation with the objectives stipulated in the European Green Deal and consequent legislation (see an overview in Wilson, 2021). Among others, Chapter V focuses on offshore electricity grids. It includes provisions for long-term offshore grid planning for each sea basin. Member States are expected to generally set out and agree to cooperate on the volumes of offshore renewable generation to be deployed. In addition, the European Network of Electricity Transmission System Operators (ENTSO-e) will be required to prepare plans to develop an integrated offshore network starting from the 2050 objectives, with intermediate steps for 2030 and 2040. The implementation is expected to be smoothed out through the introduction of offshore one-stop shops for project permits and work along five priority offshore grid corridors[30] that have been identified around Europe's sea basins.

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[30] Priority offshore grid corridors include North Seas offshore grids (Belgium, Denmark, Germany, Ireland, France, Luxembourg, Netherlands and Sweden)); Baltic Energy Market Interconnection Plan offshore grids (Denmark,

4. From brown to green: towards a low-carbon economy

South-eastern Europe depends on coal power generation, which will have to be promptly phased out as part of EU climate targets. Bulgaria and Romania have set up the coal exit by 2038-2040 and 2030 respectively[31]. Decarbonisation of carbon-intensive power generation in the region is an immediate target that offshore wind can contribute to. However, phasing out coal from power generation and abandoning coal-mining activities have often been socially and politically sensitive. Coal-mining closures have been constrained by perceived negative social impacts from job losses and a consequent rise in wholesale electricity prices. Government attempts to reform a generously subsidised coal industry have often resulted in nationwide social protests. At the same time, if the coal lock-in remains unchanged, policies on coal subsidies will continue exposing the governments to even more sizeable financial losses[32]. As the carbon price[33] will further reinforce the disincentive effect of carbon-intensive production, in both power generation and industry (Elkerbout, 2021), the economic rationale for replacing carbon-intensive coal and lignite power plants will consequently strengthen (Agora Energiewende, 2020).

Debates on offshore wind, however, transcend direct decarbonisation of the power mix and offer a long-term vision for industrial development. The economies of the region – willingly or not – will need to adapt to the low-carbon development shaped by the EU climate targets, and globally, the Paris Agreement. Ever more affected by their carbon intensity, economies in south-east Europe will need to embark on the energy transition. First and foremost, this would require switching from the 'compensation' discourse prevalent in the region's transition discussions to a discourse focused on the opportunities arising through, for example, low-carbon value chains. Instead of relying on increasingly unprofitable sectors, a renewed economic model for countries in the region will need to explore incentives for low-carbon socioeconomic models (CSD, 2022; Covatariu et al., 2021).

Germany, Estonia, Latvia, Lithuania, Poland, Finland and Sweden); South and West offshore grids (Greece, Spain, France, Italy, Malta and Portugal); South and East offshore grids (Bulgaria, Croatia, Greece, Italy, Cyprus, Romania and Slovenia); and Atlantic offshore grids (Ireland, Spain, France and Portugal).

[31] Romania moved the deadline from 2032 (as stipulated in the national recovery and resilience plan submitted in September 2021) to 2030 in an emergency law adopted in June 2022. Bulgaria committed to a coal phase-out from electricity generation by 2040 as submitted in its national recovery and resilience plan in October 2021. However, to be line with the Paris Agreement, the EU Member States need to exit coal by 2030 at the latest.

[32] According to the study by SE3T.net (2020, p. 40), a platform that comprises several region-based institutions and think tanks, to fulfil the criteria of the Industrial Emission Directive, lignite power plants in the region would require substantial modernisation that would cost up to EUR 1 billion.

[33] Even though the European Commission estimated in the impact assessment for the 55 % target an increase of the carbon price up to EUR 65 per tonne CO_2 only by 2030, the current peak pushed the ETS price up to almost EUR 90 per tonne CO_2 well before the end of 2021. Since the beginning of 2022, the ETS price has rarely fallen below EUR 70 per tonne CO_2; it peaked at EUR 96.93 per tonne CO_2 on 8 February (as of 30 June 2022). See Ember, 'Daily carbon prices'.

Until recently, natural gas has been viewed in the region as a viable mid-term transition fuel from coal to renewables. Yet, price spikes observed since autumn 2021 and Gazprom's decision to cut supplies to Bulgaria in April 2022 have confirmed that natural gas is neither always a competitive nor secure option, unless it is available domestically as in Romania. A need to urgently source alternatives to Russian natural gas supplies at higher prices and probably smaller volumes – also via a rapidly completed Interconnector Greece-Bulgaria – clearly shows that the best solution for energy security might be increasing domestic self-sufficiency. In addition, with the EU strategy to reduce methane emissions adopted in 2020, natural gas can hardly be considered a key transition fuel for the mid-term.

Offshore wind could become part of the solution, offering a decarbonisation possibility to the power sector and providing an impetus to modernise coastal areas and harbours and a longer-term stimulus for industry. Among others, offshore wind development can refresh the regional market for high-skilled jobs and local port economies. As a labour-intensive industry, offshore wind demands a substantial workforce for construction, maintenance and operation of the installation sites. It also enables establishment of new local supply chains, such as renewable hydrogen production. Hydrogen production coupled with offshore wind could in turn create new business opportunities for energy storage, bunkering and transport.

4.1 Creating synergies with local industries

Offshore wind can drive the creation of new synergies with local industries. The literature is rich in making cases for local value chains and opportunities for coastal areas once offshore wind is taken up in the area (IRENA, 2018; European Commission, 2022; ORE Catapult, 2018). Offshore wind development is labour-intensive: the industry requires a diversified portfolio of expertise including regulatory, energy engineering, financial and management expertise, a workforce involved in logistics, naval activities, physicists and weather data experts.

According to IRENA (2018), a 500 MW offshore wind park generates 2.1 million person-days, which only accounts for direct jobs. 59 % of the required workforce is involved in manufacturing and procurement, 24 % in operation and maintenance, 11 % in installation and grid connection, and 5 % in decommissioning. Administration, project management, project planning and transport make up the rest 1%. ORE Catapult (2018, p. 16), in its study on the UK job market generated by offshore wind, emphasises that offshore wind industry 'provides a golden opportunity to align national skills development with local skill development'. Among others, an increase of graduates in mechanical engineering by 1 000 between 2011 and 2015 was directly stimulated by the offshore wind installations and related activities across the UK coast.

Offshore wind stimulates not only new jobs but also value creation through economic activities – the procurement of materials, the installation of bottom-fixed turbines on site or the assembly of floating turbines in ports and related O&M activities. For offshore wind, turbines constitute 66-84 % of the offshore wind farms' total cost, as additional costs are incurred for balance of plant, power substations and operations in the maritime environment[34]. Manufacturing relevant equipment, notably turbines and balance of plant including cables, foundations, onshore and offshore substations on site, would provide new economic activities for the coastal areas of Bulgaria and Romania.

4.2 Harbour infrastructure and coastal areas

Offshore wind creates local added value in terms of new skill development and the organisation of a local supply chain around the ports from which the assembly of installations is coordinated. Ports become the immediate beneficiaries of offshore wind development since a large part of organisational and managerial activities are concentrated in harbours and adjacent areas. Offshore wind can also contribute to the regeneration of declining coastal communities (Glasson et al., 2022).

In Bulgaria, there are seven major ports. Bourgas and Varna, as the largest, consolidate most of the shipping and maritime activities of the country. A maritime zone close to Varna has been identified as one of the most feasible areas for bottom-fixed offshore wind in the study by Trifonova and Vladimirov (2021), discussed in Section 2. In Romania, there are four large ports, with Constanța and Mangalia the most important. The latter is mainly used as Constanța's shipyard; hence, Constanța remains the largest hub for maritime activities in Romania, and the largest port on the Black Sea coast.

It remains premature to estimate the exact economic and labour development in the Black Sea ports that could be stimulated by the development of offshore wind parks. Still, it could be expected that Constanța would easily become an offshore wind hub in Romania steering innovative activities around the Black Sea's largest port.

In Bulgaria, Varna and Bourgas are the biggest ones, but smaller ports are located nearby. As international experience shows, adjacent ports can benefit in terms of skill development, logistics and local manufacturing as well. To host an assembly of offshore wind turbines, an upgrade of port infrastructure would be required.

Apart from economic activities, other incremental advantages of offshore wind energy for ports would include a reduction of air pollution in the port areas due to clean energy generated by offshore wind parks. For example, Constanța remains one of the most polluted ports in the region partly because of the transit activities in the harbour. Air pollution remains a substantial problem because of significant emissions of nitrogen oxides (NOx) and volatile organic Compounds (VOCs). Further, a reduction of coastal pollution in Constanța would contribute to an improvement in quality of life and business (Raileanu et al., 2020).

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[34] This breakdown of the costs of an offshore windfarm in Scotland in 2020 (500 MW, jacket foundation, 8 MW turbines) shows that O&M is on top of costs (40 %), turbines account for 25 % and 17 % goes for balance of plant (IRENA, 2018).

4.3 Oil & gas sector: new synergies with conventional energies

Synergies between the oil & gas sector and the offshore wind industry have been actively explored by oil and gas majors, which have viewed offshore wind as an opportunity to transition their business from fossil fuels. Total Energies, bp, Shell, Equinor and Ørsted, among others, have used decades of experience in offshore engineering to diversify their portfolios. They relatively quickly adapted their specialised skills, equipment and services to the offshore wind industry[35]. Arguably, energy majors may be viewed as among those spurring interest also in coupling renewable hydrogen with offshore wind, aiming at a shift in their portfolios towards production and trade of renewable fuels. New supply chain opportunities have been used by oil service companies such as Schlumberger and Baker Hughes, which have increasingly engaged their engineering capacity in offshore wind. Service operation vessels have been expanding their portfolio to support those for offshore wind farms.

Coupling early industry development with oil & gas decarbonisation could become a solution for commercialisation of floating offshore wind technologies (Quinn, 2021)[36]. Oil majors could provide early market development opportunities for offshore wind capacity, which could be used as a step towards decarbonisation of the industry, as currently they mainly use diesel generators with heavy-carbon components. The use of diesel and gas as a fuel for power generation produces leaks and increases emissions. In this context, offshore wind could reduce the carbon intensity of the oil and gas production in deep waters.

From the short- and mid-term perspectives, floating offshore wind installations could supply off-grid offshore oil and gas platforms. In the longer term, offshore reservoirs could serve as carbon storage locations, and then offshore wind power would be necessary to provide electricity for carbon capture, utilisation and storage activities. Additionally, rich oil & gas expertise, products and services could be further adapted for offshore wind and offshore aquaculture, among others.

Despite a clear synergy with offshore oil and gas platforms to host floating offshore wind demonstration projects, several challenges persist. First, in an isolated system of an oil or gas platform, during high winds the turbines will produce excessive power, which cannot be used without a storage system. Battery storage of excess power can be used but at the current stage it is deemed to be too expensive, as calculated by Quinn (2021). Additionally, some oil & gas production units require not only electric power but also mechanical power or steam

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[35] Technology overlap is noticeable in the maritime and subsea areas, in the safety of electricity supply particularly for floating platforms in deep waters and in maritime planning.

[36] For their commercialisation, several medium-scale parks are to be developed by the 2030s, as current demonstration projects need to scale up to over 500 MW after 2030. Floating offshore wind that currently provides power at higher prices than from bottom-fixed projects could be competitive once offshore oil and gas operators decide that they are willing to pay these energy prices. Oil and gas operators can cover the cost of energy offshore, as well as provide their extensive operational experience in offshore areas.

generation, which is not readily electrified. The electrification of power systems away from diesel generators would require a separate supply of heat to be installed and powered.

Coupling floating offshore wind pilots with offshore oil and gas operations could be of relevance for both Romania and Bulgaria, as both countries have operating offshore platforms. Romania is the third-largest EU oil producer with about 72 000 barrels per day of oil production in 2020. Bulgaria's production is significantly smaller, yet the country keeps an eye on new offshore oil and natural gas exploration in the Black Sea.

4.4 Hydrogen industry

The EU hydrogen strategy identifies hydrogen as the pivotal solution for sectors where full electrification would be either technologically impossible or too costly, including hard-to-abate sectors (such as the ammonia, chemicals and refining industries, and primary steel production) and some segments of the transport sector (particularly maritime and long-haul aviation). Compressed hydrogen can be also stored in fuel cells to provide power on demand, along with heat and power via combined heat and power systems, among others.

From a longer-term perspective, offshore wind could offer sufficient capacity levels to scale up and commercialise hydrogen production, thus building an economic rationale for renewable hydrogen. At present, cost reductions for renewable hydrogen, i.e. hydrogen produced from water electrolysis using renewable electricity, is the core challenge. So far, electrolysis-based hydrogen production is still minimal in terms of volume and, because of high costs, cannot provide necessary economies of scale. A report published by Cătuți et al. (2021) shows costs of electrolysis remain elevated and vary with the capacity factor of the generator used to produce hydrogen. As stated in the report, a sufficiently high load factor for electrolysers – between 3 000 and 6 000 hours per year – can reduce the impact of the capital expenditure on hydrogen production costs. For instance, when the capacity factor is close to or above 50 %, capital expenditure on hydrogen production costs will be less visible.

Coupling offshore wind and hydrogen production is already considered a viable and cost-effective option in the North Sea, where several projects at a pilot or demonstration phase are currently in the pipeline[37]. Hybrid and meshed offshore wind grids, such as those planned by countries in northern Europe, would interconnect multiple wind farms of larger capacity. Hydrogen production hubs could become adjacent to these meshed grids. Once a further decline in LCOE for offshore wind is obtained, coupling with hydrogen production could become even more feasible. As reported by the IEA (2021), the use offshore of wind leads to the lowest hydrogen production costs among renewables (the electricity price being equal).

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[37] In the Netherlands, the NorthH2 project targets 4 GW of renewable hydrogen production through offshore wind power by 2030, and 10 GW by 2040; similarly, the German project AquaVentus aims to reach 10 GW through offshore electrolysis. In Denmark, the Oyster project is currently developing compact electrolyser systems suited for offshore production.

Such a combination would also address the challenges often attributed to offshore wind. As part of the power-to-X solutions, hydrogen production would help reduce curtailments by transforming excess generation into hydrogen, thus further improving flexibility to meet demand. This can reduce constraints often faced by offshore wind farms, such as long distances to the shore, limited interconnection points and onshore grid constraints. At least conceptually, it may also provide solutions for long-term energy storage in the future: hydrogen-for-storage should enable back-up for periods of non-operation of offshore wind. New technologies for small-scale storage and shipment of compressed hydrogen can provide further necessary flexibility. From an economic point of view, coupling offshore wind and hydrogen production can also help stabilise offshore wind revenues (CEEP, 2021) and mitigate renewable electricity price risk (Aarnes and Alvik, 2022).

In general, the ideal conditions for the coupling of offshore wind and hydrogen production are short value chains, with wind turbines located relatively close to shore and a direct integration of electrolyser output with hydrogen demand (e.g. on industrial sites) (Aarnes and Alvik, 2022). Offshore wind power should be solely used to supply electrolysers, to allow for electric infrastructure optimisation and potentially lowering infrastructure costs[38]. However, this could give rise to an issue related to the availability of sufficient renewable capacity, and competition with the electricity sector (Cătuți et al., 2021). Sufficient hydrogen demand could be guaranteed by the proximity of offshore wind parks to industrial ecosystems, usually well integrated at ports (WindEurope, 2021b). In the event of successful penetration of hydrogen into industrial applications, the need for continuous supply would require a sufficient level of local hydrogen storage, or access to alternative hydrogen sources (Aarnes and Alvik, 2022).

Among the initial assessments of the Black Sea region, a study by the Energy Policy Group (Bălan et al., 2020) estimates that offshore wind can directly serve the industrial Dobrogea region in Romania to first create a decarbonised local economy and then expand it beyond this industrial area. According to the initial estimates, if Romania makes a successful case for obtaining and efficiently using EU financial instruments for offshore wind and hydrogen, the country could become a premier producer of renewable hydrogen in south-eastern Europe. Moreover, cooperation between Bulgaria and Romania on renewable hydrogen would provide a new basis for industrial decarbonisation that could further spill over in the region. This way, offshore wind could become one of the key drivers in stimulating carbon-neutral economic development in south-east Europe.

Industrial decarbonisation, however, is not a fast-track process. Some energy-intensive industries, such as fertiliser producers, will need time either to shift away from hydrocarbons or to replace feedstock with renewable hydrogen. Also, a stepwise approach in applying steady targets will help heavy industries to adapt to new realities. At the same time, clear policy priorities for renewable solutions, once set by Member States, would send a necessary long-

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[38] Aarnes and Alvik (2022) estimate that lack of connection to the public grid would lower wind farm infrastructure costs by 10 %, due to technical and legislative simplifications.

term signal to investors and stakeholders in the region. Such long-term vision, if implemented, would ideally result in replicating new value chains in the region. The simultaneous development of offshore wind and a hydrogen economy should be seen as part of the overall solution instead of being viewed as *the only* silver bullet for decarbonisation in the region.

5. Enabling offshore wind opportunities in the Black Sea: immediate steps

Several tangible actions could be implemented at the national, regional and EU levels to launch and then accelerate offshore wind development in the region. To start with, Member States should establish long-term targets for offshore wind. This should be accompanied by the creation of a suitable national regulatory framework, including the identification of offshore wind deployment areas in national maritime spatial plans. This would constitute credible commitments to develop offshore renewable energy. Efforts to develop projects will require the gradual availability of funding opportunities, possibly including from the national recovery and resilience plans.

At the regional level, offshore wind will require cooperation between the EU Member States of south-eastern Europe and possibly the Energy Community countries and beyond. The wider Black Sea thus would cover countries like non-EU Western Balkan countries, Turkey and Ukraine. Existing frameworks, dialogues and discussion platforms, such as CESEC or the Black Sea Economic Cooperation, could be used to formulate and possibly implement cross-border cooperation. Where gaps appear, new frameworks and dialogues could be envisaged.

If successful in developing cross-border offshore wind programmes, the steps taken by the EU Black Sea coastal states could become a blueprint for other states in the Black Sea and further in the Caspian Sea where the appetite for offshore wind is growing. Joint action could even help reduce neighbourhood rivalries.

At the EU level, the European Commission could further steer the debate in the region to advance the targets in the offshore renewable energy strategy. This already entails a dialogue under the Governance Regulation and the policy frameworks aimed at enabling regional cooperation on offshore grids, envisaged in the updated TEN-E Regulation.

To address permitting-related issues, the European Commission introduced an additional proposal under the REPowerEU plan in May 2022, in the ongoing amendment of the EU Renewable Energy Directive (RED II). Among others, the REPowerEU action plan underlines the need to accelerate permitting for wind energy projects. The proposal suggests enshrining the principle that renewable energy installations constitute ‘overriding public interest’, and thus should be prioritised and streamlined on a case-by-case basis. Therefore, ‘renewables go-to areas’ should be designated – Member States are expected to identify such areas after undertaking the strategic environmental assessment. Tighter permitting deadlines – one year for projects in ‘renewables go-to areas’, and six months for repowered projects and several other types of installations located in ‘renewables-to-go areas’ – would be introduced[39].

Along with these proposals, the European Commission also published an EU recommendation and guidance on good practices to improve permit-granting procedures for renewable energy projects and to facilitate power purchase agreements. The guidance document aims to provide instructions on timeframes for completion of the permit-granting process in various renewable energy technologies, establishment of a contact point and notification procedures. Possibly, the EU guidelines could positively affect the general approach to granting permits for renewable energies to the benefit of offshore wind projects in the Black Sea.

5.1 Developing an appropriate legislative and regulatory framework

After initial steps towards offshore wind deployment, Bulgaria and Romania could take the measures outlined below.

- *Set explicit and feasible national targets for offshore wind development.* There is already a possibility to introduce updates in national energy and climate plans (NECPs) for 2023 as part of the biennial updating procedure of the NECPs specified in Governance Regulation 2018/1999. This procedure also allows the European Commission to monitor the Member States’ level of ambition towards offshore wind and nudge them to increase their commitments, if needed. Bulgaria and Romania’s declared *commitments for phasing out coal* by 2038 and 2030[40] respectively should not be diverted.
- *National policy and regulatory frameworks for offshore wind* should be finalised to provide clear and transparent procedures for licensing and support schemes that investors can trust. Among others, it would be essential to acknowledge the need for offshore wind development and further to promote a simultaneous uptake of offshore wind with other renewable energies, i.e. solar PV and onshore wind, to stimulate a diversified and decarbonised electricity generation portfolio. Other sustainability-related issues around wind power development should be acknowledged, including repowering and waste treatment of end-of-life wind farms, and marine and biodiversity protection.
- The implementation of policy and regulatory frameworks would benefit from an open *public dialogue with stakeholders* and *capacity-building of relevant domestic institutions* to overcome the barriers of limited budget resources and low institutional and expert capacities of relevant national authorities. For example, tailored study programmes may help government officials learn from experience of offshore wind development in key offshore wind markets, such as Denmark, the Netherlands or the UK.

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[39] With the possibility of a justified extension on the grounds of extraordinary circumstances by up to three months.

[40] As stipulated in the national draft emergency law for the phase-out of coal by 2030 adopted in June 2022, two years before the initially established date (2032) in the NRRP.

- Use of best practices, information exchange and well-conducted public consultations will most likely lead to more public support and carefully crafted regulatory mechanisms to support offshore wind. The Commission's recommendation and guidance on good practices to improve permit-granting procedures and to facilitate power purchase agreements published in May 2022 can be used in identifying and lifting national regulatory barriers stemming from misinterpretation or inadequate implementation of EU legislation.

5.2 Cross-border cooperation and joint maritime spatial planning

- *Finalising and adopting the national maritime spatial plans* that were due in March 2021 remain major 'homework' for Bulgaria and Romania. The plans should identify the maritime areas suitable for the development of offshore wind energy and align with the NECPs.
- *Cross-border joint planning is essential* to identify the most optimal areas and offshore grid development. Joint planning across littoral states can ensure efficient use of the limited maritime space and more effective protection of the environment and biodiversity. Aligning national maritime spatial plans could help reduce potential spatial tensions between the neighbouring countries. It may also require the development of a common strategy for maritime spatial planning for cross-border areas, including a mechanism for Black Sea basin cross-border cooperation. Cooperation can also be incentivised by available funding from, for example, CINEA (the Climate Infrastructure and Environment Executive Agency) for cross-border projects, which can be used by Bulgarian and Romanian authorities to further include offshore wind in their maritime spatial plans.

5.3 A pan-regional dialogue beyond the coastal Member States

Offshore wind development, as a complex technological and economic process, entails regional cooperation beyond national planning. In the current geopolitical context, the Black Sea is a hotspot but can also provide a window of opportunities for unlocking political support for offshore wind.

- *Joint pilot projects for offshore wind* can be envisaged through cross-border maritime cooperation. The European Commission's proposal for amending RED II includes joint planning and target setting per sea basin, as well as measures to facilitate the permitting of cross-border offshore renewable projects. Even though the proposal may not be adopted before the end of 2022, it indicates a policy trend in improving cross-border cooperation on renewable energies. Dialogue can be fostered through the South and East offshore grids (SE offshore) corridor envisaged under the updated TEN-E Regulation, which includes Bulgaria and Romania. Bulgaria and Romania are reported to have started discussions on the construction of a joint offshore wind park in the Black Sea, near the northern coastal town of Shabla in Bulgaria. Also, the substantial technical potential in the 'orange cluster' in Romania identified by Bălan et al. (2020) may be discussed. In this regard, more cooperation between Bulgarian and Romanian TSOs is needed to facilitate grid connectivity and feed offshore wind farms into the power markets of both countries.

- Having an effective regional electricity market would also allow offshore wind to participate in the pool. Electricity trade would enable landlocked countries, such as Hungary, Serbia or Moldova, to receive low-carbon electricity from offshore wind via regional trading mechanisms. Although current estimations of the technical potential of offshore wind in the region vary, it is generally deemed that offshore wind can theoretically provide power generation far beyond the demand of the coastal states. Landlocked states of the region may be willing to contribute to offshore wind development by providing demand-related incentives for offshore wind electricity. The regional cooperation could be further incentivised by the European Commission and streamlined at the EU level. Employing various instruments, including funding opportunities under EU frameworks and regional cross-border cooperation as indicated in the TEN-E Regulation, could uplift new generation capacity and interconnect more electricity markets. This would benefit not only the Black Sea coastal states but also nearby landlocked countries.
- The EU's regional approach could also give way to *a more flexible regional framework for cooperation* or dialogue involving non-EU states. Among others, the Energy Community offers a legal basis for extending EU energy market integration to south-east Europe, Georgia and Ukraine. A 'looser' framework gathering various activities in central and south-eastern Europe energy connectivity and probably, the Black Sea Economic Cooperation, may steer the interested parties and facilitate dialogue more efficiently. Finally, involving Turkey is essential, as the country is key in the region's grid development and balancing.
- If Bulgaria and Romania become success stories for offshore wind in the region, the EU could lead by example through offering *region-based tailored solutions* for decarbonising other countries in the wider Black Sea region. This would create incentives for the development of engineering schools and training in the region, with opportunities for Member States to become 'expertise exporters' for the rest of the Black Sea basin and further beyond to the Caspian Sea.

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