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Special Report

GERMAN OFFSHORE EXPANSION SCENARIOS

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Introduction

Since the initial deliberations on expanding wind energy at sea, different scenarios have existed which represent a potential development of installed offshore capacity for Germany. This article provides an overview of the different early and current scenarios, and enables classification of the scenarios and estimation of the future development of offshore wind energy in Germany on the basis of the current expansion status and the existing project pipeline.

Previous expansion scenarios

The two grid studies by dena are amongst the initial expansion scenarios worthy of mention. These made, for the first time, forecasts on the expansion of offshore wind energy, with different studies and energy concepts on behalf of the Federal Government following later. Essentially, all earlier scenarios overestimated offshore expansion to varying degrees (see Figure 1). The reasons for this lie with the starting difficulties of the entire offshore industry, triggered for example by delays in grid connections, technical and logistical problems, and a lack of economic and political framework conditions in the initial years.

dena I (2005). The scope of the dena I grid study was to determine the required grid expansion and expansion costs as a consequence of increased wind energy expansion. The lower expansion path of the dena I scenario is based upon an analysis by DEWI on offshore wind farm planning status in place in 2004 as regards realization capability. Potential restrictions and delays are taken into account with a flat-rate reduction of 20%. The top expansion path results from taking into account the planning of regional governments of coastal states for the respective grid connection points. This leads to a slightly raised offshore capacity in 2007 and 2010. From 2015, the two paths again form a common scenario [1]. .

dena II (2010). As a follow-on study of dena I, the dena II grid study expects a "development of the offshore wind energy expansion highlighted, delayed by five years" due to capacity bottlenecks in the younger years of the wind energy industry. The updated dena II scenario takes into account the delays, as well as the modified legal and economic framework conditions, and the planning and approval status at that time. A modified forecast reduces the figures for 2015, 2020 and 2025 by about 12.5% - as a consequence of criticism on the too optimistic expansion expectation of the first path by the federal environment ministry [2].

National action plan for renewable energy (2010). The "national action plan for renewable energy" represents the development of renewable energy expansion in Germany expected by the Federal Government. It includes measures in place at the time of publication, and planned measures, with which this goal is to be achieved in implementing the EU specification (renewables to represent 18% by 2020). Under the assumptions that "further installations will run relatively speedily" and "usage relevant to the energy sector starts promptly", the action plan forecasts an installed offshore capacity of 10 GW by 2020. However, the expansion stated is only possible given expansion of the necessary grid infrastructure in time, and represents a relatively optimistic estimation [3].

Energy scenarios (2010). The "Energy scenarios for an energy concept from the Federal Government", authored by Prognos, GWS and EWI, form the basis for the energy concept of the Federal Government from 2010. A fundamental assumption in the study is adherence to the specifications for reducing greenhouse gas emissions by 2050. Ways to prolong the service lives of nuclear power plants is investigated in four scenarios. The renewable energy expansion goals are met in all scenarios. 10 GW and 7.6 GW of installed offshore capacity by 2020 are assumed in scenarios I-III and IV respectively [4].

EWEA (2011). EWEA publishes expansion scenarios for wind energy in Europe as part of the "Pure Power" reports. These scenarios set out forecasts for the whole of Europe and show onshore and offshore capacities for individual countries. In its 2011 report, EWEA differentiates between two scenarios anticipating 8 and 10 GW of installed offshore capacity for Germany by 2020 [7].

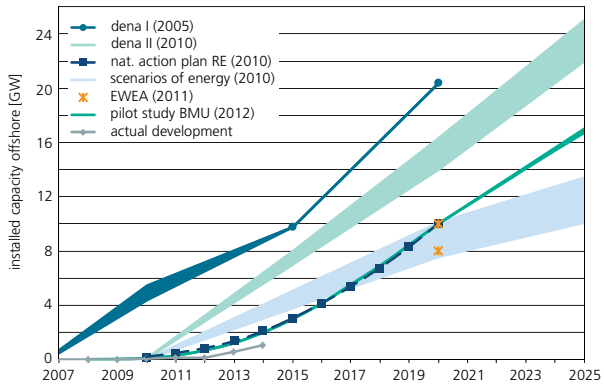

Figure 1: Comparison of early expansion scenarios for offshore wind energy in Germany

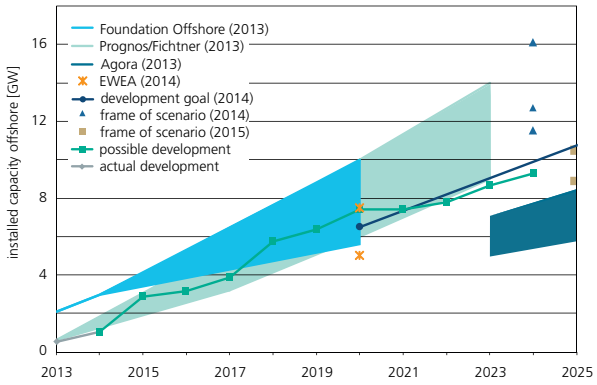

Figure 2: Comparison of current expansion scenarios for offshore wind energy in Germany

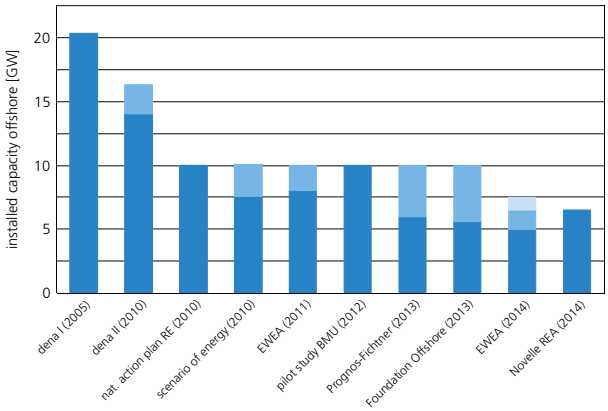

Figure 3: Comparison of expansion paths of installed offshore capacity for 2020

Federal environment ministry „Leitstudie" (2012). The "Long-term scenarios and strategies for renewable energy expansion in Germany", known as the federal environment ministry pilot study, was authored by DLR, IWES and IFNE and contains three long-term scenarios to 2050. Every scenario is based around the reduction of greenhouse gas emissions to 2050 by 80% as compared to 1990 [5]. The scenarios differ primarily in the transport sector, meaning they run identically to 2020 as with regards to offshore wind energy (10 GW), and there is only a minimum discrepancy of less than 3% up to 2030 [6].

Current expansion scenarios

Other scenarios and expansion goals for offshore wind energy have been published since 2013. Many studies dispense with specifying annual expansion, others use a time horizon of 10 years, whilst others use year 2020 as the forecast time. The following studies take into consideration the delays which have already occurred in offshore expansion, and so lie closer together. Refer to "Outlook" for a more detailed explanation of the potential expansion path.

Prognos/Fichtner (2013). The scenario is from the study "Cost reduction potential for offshore wind energy in Germany". It describes a lower expansion path up to the year 2023 with moderate expansion within a market environment stable over the long term, and an optimistic upper path, the basis of which is represented by an optimum market environment and adherence to the then political goals (10 GW to 2020 [5]). The more probable lower expansion path according to the authors achieves 6 GW in 2020 and 10 GW by 2023 [8].

Stiftung Offshore (2013). Two expansion paths were developed based upon other expansion scenarios in a study into the opportunities and challenges of the maritime industry. In the "ambitious", first expansion path, the expansion goal of 10 GW to 2020 [5] is achieved with relatively constant expansion. The second expansion path factors in more unfavorable framework conditions, grid connection delay problems existing

at the time of publication, and only offshore wind farms with secure grid connections, corresponding to a capacity of 5.6 GW by 2020 [9].

Agora (2013). In the Agora study into renewable energy expansion at optimal cost, two alternative expansion paths are investigated on the basis of the pilot scenario of GDP 2013. Both alternatives place the focus on onshore wind energy as the cheapest form of renewable energy. Resulting from this is a reduced offshore expansion corridor in range 5 – 7 GW in 2023 and 9 – 14 GW by 2033. Used as the basis for the upper corridor is the notion of concentrated renewable energy expansion at optimal locations. The lower threshold implies on the other hand generation located closely to consumption, and load-oriented renewable energy expansion [10].

EWEA (2014). 2014 sees an updated estimation following the EWEA scenario in 2011. It contains adaptations to modified political and economic framework conditions, and factors in the offshore delays. Three sub-scenarios give a forecast of installed wind energy capacity in 2020. The central scenario corresponds to the expansion goals of the Federal Government, 6.5 GW (see below). The two other sub-scenarios forecast 5 and 7.5 GW for Germany [11].

Expansion goal (2014). The Federal Government has revised its offshore expansion goals with the 2014 REA amendment. The previous goal of 10 GW by 2020 was reduced to 6.5 GW, whilst 15 GW instead of the original 25 GW is to be reached by 2030 (see § 3 REA) [12].

Scenario framework (2014). The scenario framework forms the basis for the annual O-GDP, which determines the necessary expansion requirement for the offshore transmission grid. Scenario A shows 11.5 GW for year 2024, corresponding to the capacity of all offshore wind farms approved by the BSH by the end of 2013. The assumption of 12.7 GW in pilot scenario B is based upon the federal environment ministry pilot study with a delay addition of two years. Scenario C is derived from the total expansion goals of the coastal populations of Mecklenburg-Western Pomerania (2.9 GW), Schleswig-Holstein (3 GW) and Lower Saxony (10.2 GW), so 16.1 GW of offshore capacity in total [13].

Scenario framework (2015). In January 2015 the BNetzA approved the updated scenario framework of TSOs for O-GDP 2015. This takes into consideration the modified goals of the REA amendment. Scenario A satisfies the goals set for 2025 (renewables making up 40% of gross electricity consumption - see § 1 REA) with an anticipated offshore expansion level of 8.9 GW, whilst the other scenarios reach a figure of 45% with 10.5 GW of installed offshore capacity [14].

Goals to 2020

The comparison of expansion scenarios for 2020 in Figure 3 shows the development of expansion paths over time. Whilst the dena I scenario in 2005 assumed over 20 GW of installed capacity, the dena II estimation five years later was between 14 GW and 16.3 GW. The expansion goal of the Federal Government from 2010 amounting to 10 GW [5] turned out in subsequent years to be simply an upper threshold for the scenarios. With the exception of the federal environment ministry Leitstudie, a downward tendency of the lower expansion paths was identifiable in all scenarios following 2010. These reduce from over 7.5 GW to 5 - 6 GW in the most recent publications. The new goal of the Federal Government, of 6.5 GW by 2020 [12], ultimately fits in with this downward trend.

Current situation and outlook

Expansion status. Table 1 shows that 1044 MW from the German North and Baltic Seas was connected at the end of 2014. A further 1309 MW were installed but not connected to the grid. This capacity is likely to come online during 2015. Four offshore wind farms were under construction in 2014, and the start of construction of four more with final investment decisions in place is scheduled for 2015. Approved by the BSH in 2014 were an additional 23 offshore wind farms with a capacity of just under 7 GW. Efforts are underway to seek final investment decisions and assignments of grid connection capacities. Another 49 offshore wind farms with a capacity of

status	no. of offshore wind farms	capacity [MW]
operating	5	1,044*
installed	4	1,309*
in construction	4	923
financed	4	1,220
approved	23	6,978
submitted	49	18,264
planed	45	14,549

** Capacity is accurate down to the last installation and so contains wind turbines from farms partially installed / in use*

Table 1: Project status of offshore wind farms / offshore capacities in the German North and Baltic Seas

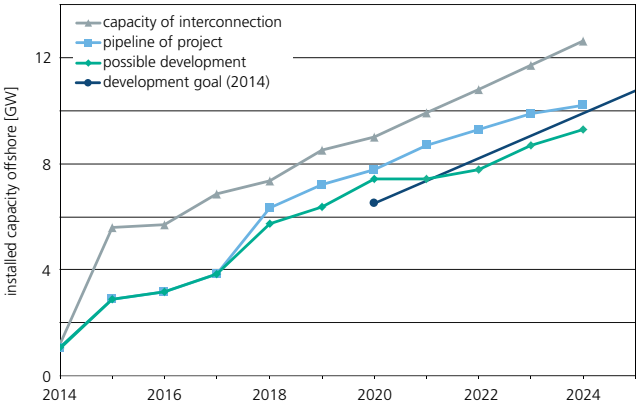

Figure 4: Potential expansion path for offshore wind energy in Germany

around 18 GW are at the BSH seeking approval, whilst another 45 offshore wind farms with a capacity of 14.5 GW are in the early planning phase. The capacity figures for future farms are approximate in line with the current planning status. Also, some of the offshore wind farms in the application and planning processes are assigned dual allocation of areas, meaning not all offshore wind farms mentioned can be realized..

Outlook. Figure 4 shows growth potential up to year 2024 based upon the current development status. The upper threshold of the offshore expansion represents the grid connection capacity, installed by TSOs over the upcoming years. Without the BorWin 4 grid connection which the BNetzA would like to drop according to the current planning status [15], the grid connection capacity will reach 12.6 GW in 2024 [13].

One potential expansion path can be depicted using an approximation of the respective project stages, making use of previous empirical values and various assumptions. The framework conditions form the scheduled year of entering service for the relevant grid connections and the maximum assignable grid connection capacity to EnWG (Energy Industry Act). § 17d Section 3 of EnWG states that assignment of 6.5 GW of grid connection capacity by the end of 2020 with subsequent annual increases of capacity by 800 MW is possible. In terms of transition, 7.7 GW can be assigned up to the end of 2017 according to § 118 Section 14 EnWG [16]. .

Up to 2014, about 3.8 years on average passed following the final investment decision, and following construction start, about 2.3 years on average until an offshore wind farm finally begins operation. These values are used to forecast the time required for farms which were in the construction phase in 2014, or for which a final investment decision was in place, will come online. Four offshore wind farms with a capacity of around 1240 MW must verify their financing by 01/07/2015, and construction start by 01/07/2016, otherwise the BNetzA should retract its commitment to the grid connection (§ 17d Section 6 EnWG). On-time financing as well as construction start on the due dates are assumed for these wind farms.

The depiction of a potential development beyond the previous assumptions is associated with great insecurity because the other approved farms are in uncertain project phases and some have no grid connection commitment. Observance of § 17d Section 6 EnWG is assumed for these offshore wind farms, meaning construction is to start no later than 12 months prior to the scheduled start of operation of the respective grid connection. The farms in Cluster 3 with the DolWin 2 grid connection represent a special case. Due to the restricted capacity of 1302 MW approved, only a maximum of 900 MW will be able to go online in this cluster.

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The project pipeline includes all farms approved in 2014 which were able to enter service without delay on completion of their corresponding grid connection lines and consideration of their maximum capacity. Also, it is assumed that construction progress of all farms not yet financed is aligned to the completion date of the relevant grid connection in due consideration of the minimum project term. The assignment of grid connection capacity and the "expansion cap" to §§ 17d and 118 EnWG remain unconsidered, meaning this expansion path represents a purely theoretical option from 2020 onwards.

Achieving the expansion goal of the Federal Government by 2020 under the assumptions given appears to be possible if no delays postpone expansion and, as a minimum, framework conditions remain unchanged. Accordingly, approximately 9.3 GW of installed capacity can be anticipated by 2024.

List of references

[1] Deutsche Energie-Agentur GmbH, "dena network study: Energiewirtschaftliche Planung für die Netzintegration von Windenergie in Deutschland an Land und Offshore bis zum Jahr 2020," Cologne, Feb. 2005.

[2] Deutsche Energie-Agentur GmbH, "dena network study II: Integration erneuerbarer Energien in die deutsche Stromversorgung im Zeitraum 2015-2020 mit Ausblick 2025," Berlin, Nov. 2010.

[3] German Federal Government, "Nationaler Aktionsplan für erneuerbare Energie gemäß der Richtlinie 2009/28/EG zur Förderung der Nutzung von Energie aus erneuerbaren Quellen," Berlin, 2010.

[4] Prognos AG, EWI und GWS, "Energieszenarien für ein Energiekonzept der Bundesregierung," Basel/Cologne/Osnabrück, Aug. 2010.

[5] German Federal Government, "Energiekonzept für eine umweltschonende, zuverlässige und bezahlbare Energieversorgung," Berlin, Sep. 2010.

[6] DLR, Fraunhofer IWES and IFNE, "Langfristszenarien und Strategien für den Ausbau der erneuerbaren Energien in Deutschland bei Berücksichtigung der Entwicklung in Europa und global," March 2012.

[7] European Wind Energy Association, "Pure Power: Wind energy targets for 2020 and 2030," Jul. 2011.

[8] Prognos AG and Fichtner Group, "Kostensenkungspotenziale der Offshore-Windenergie in Deutschland," Berlin, Aug. 2013.

[9] Stiftung OFFSHORE-WINDENERGIE, "Herausarbeitung von Chancen und Herausforderungen für die Hafen- und Werftwirtschaft im Zuge der Offshore-Windenergieentwicklung," Jan. 2013.

[10] Agora Energiewende, „Kostenoptimaler Ausbau der Erneuerbaren Energien in Deutschland: Ein Vergleich möglicher Strategien für den Ausbau von Wind- und Solarenergie in Deutschland bis 2033," May 2013.

[11] European Wind Energy Association, "Wind energy scenarios for 2020," Jul. 2014.

[12] Expansion of renewable energy law: REA 2014, 2014.

[13] 50Hertz Transmission GmbH, Amprion GmbH, TenneT TSO GmbH and TransnetBW GmbH, „Netzentwicklungsplan Strom: Offshore-Netzentwicklungsplan 2014, 2. Entwurf," Nov. 2014.

[14] Federal Network Agency, "Genehmigung des Szenariorahmens 2025 für die Netzentwicklungsplanung und Offshore-Netzentwicklungsplanung," Dec. 2014.

[15] Regional appeal court of Düsseldorf, Federal Network Agency looking to do without electricity cables - offshore wind farm operators fearing profit setbacks. Düsseldorf, 2014.

[16] Electricity and Gas Supply Law: EnWG, 2014