REPOWERING OF THE INDIAN WIND SECTOR

OPPORTUNITIES AND THE WAY AHEAD

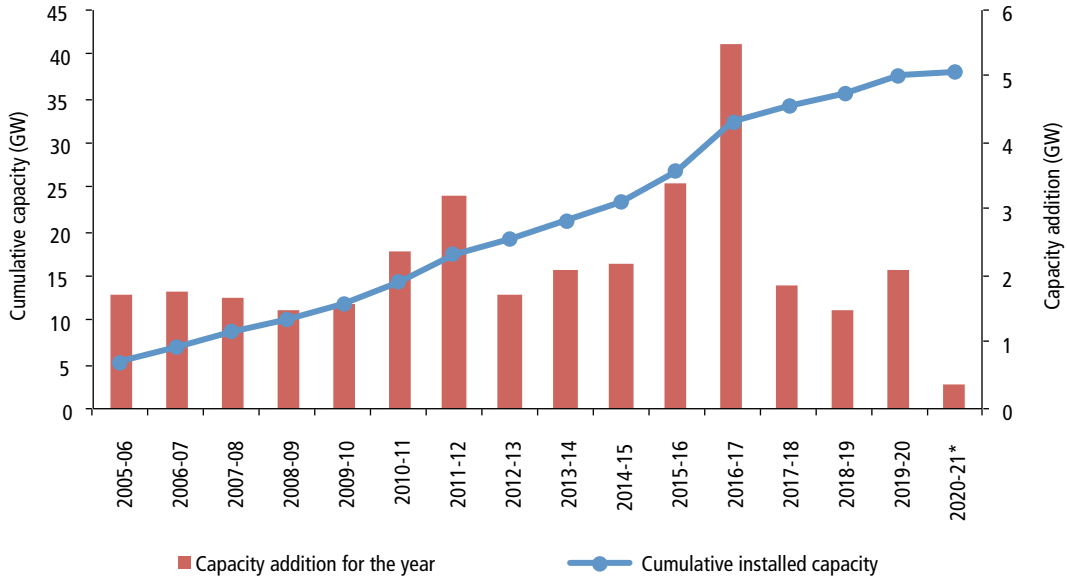
1. According to the Central Electricity Authority (CEA), India's per capita electricity consumption was 1,181 kiloWatt-hour (kWh) in 2018-19[1] as against Vietnam's 2,234, China's 4,475 (2017), South Korea's 9,720 (2016) and the world average of 2,674 units (2016)[2]. India's growing economy and huge population means the country will require a massive addition of new electricity production capacity – ideally, almost all of this capacity addition should preferably happen through clean, non-fossil and renewable sources.

2. Under the Paris Agreement of 2015, as part of its Nationally Determined Contributions (NDC), India has committed that 40 per cent of its total installed capacity will become non-fossil fuel-based by 2030. To meet this target, it has to increase its renewable energy capacity from 87 GW (as on March 2020) to 450 GW by 2030.

3. As per the CEA's January 2020 report on optimal generation capacity mix[3], the installed wind capacity in the country is targeted to increase from 37.7 GW in March 2020 to 140 GW by March 2030; this would require an annual installation of more than 10 GW for the next 10 years. However, annual wind installation in India has crossed the 5-GW mark only once (in 2016-17) – it has been less than 2 GW in all the other years (*see Graph 1*). Given this scenario, how achievable is the target that India has set for itself?

Graph 1: Wind energy capacity in India

The wind sector is struggling to maintain its growth rate



* Till September 2020

Source: Collated from various reports of the Central Electricity Authority and the Union Ministry of New and Renewable Energy

4. Wind resources are site-specific. According to the Chennai-based National Institute of Wind Energy (NIWE), India has exploitable wind potential to the magnitude of 302 GW at 100 metres hub height and 695 GW at 120 metres hub height[4]. But the best class 1 wind sites (with high wind speeds high wind power densities) have already been exhausted during the initial one-and-half decades of development of the sector in the country (1990 onwards).

5. Wind turbines are designed for a lifetime of about 20 years. These are required to be decommissioned on the completion of their designed life; otherwise, they can pose a safety risk. However, there are several old wind farms in India that have completed their designed life of 20 years and continue to run, as they are still profitable to their owners. As per the India Wind Power Directory 2014, over 1 GW of installed capacity with turbine sizes of less than 1 MW has completed 20 years of its designed life[5] (*see Table 1*).

Table 1: State-wise and turbine size-wise wind installation (prior to March 31, 2000)
This is the wind power capacity that is fit for repowering in the country

States	<=0.5MW	0.5-1.0MW	Total
Tamil Nadu	717.05	37.9	754.95
Gujarat	143.75	1.6	145.35
Andhra Pradesh	84.39		84.39
Maharashtra	63.72	2.25	65.97
Karnataka	24.53		24.53
Madhya Pradesh	21.1		21.1
Rajasthan	2.9		2.9
Total installed capacity	1,057.43	41.75	1,099.18

Source: https://www.indianwindpower.com/pdf/Indian%20Wind%20Power%20Magazine%20-%20Feb.-March%202015%20Issue.pdf, accessed in November 2020

6. The wind power sector in India has been exploring the possibility of repowering older wind farms, a move that can accelerate capacity addition. Repowering – which means deployment of newer and higher capacity turbines in the old wind farms – can either be partial or full. Full repowering involves decommissioning of older wind turbines and installation of new modern wind turbines under a new, optimised micro-siting of the area. In India, the emphasis is on full repowering; the country does not allow partial repowering.

7. The state of Tamil Nadu alone has approximately 800 MW of capacity comprising of less than 1-MW turbines that have completed their designed life. It is important that these are either decommissioned or analysed for any leftover life and certified for their remaining life. According to the NIWE, all windmills with a capacity utilisation factor (CUF) of <15 per cent are technically ready for repowering – their CUF can be at least doubled, or in wind-intensive sites, tripled. The capacity could go up by three to four times. Hence, roughly, the estimated generation at a repowered site could be four-12 times more. The NIWE is now estimating wind energy potential in India at a hub height of 150 m for accommodating future technology in the planning.

A scheme still on paper

There is no regulation in India for older wind turbines regarding their continuation of operation after their service life of 20 years. As per the Union Ministry of New and Renewable Energy's (MNRE) draft Indian wind turbine certification scheme of November 2018, it is mandatory to conduct a safety and performance assessment of all turbines that are connected to the grid and that have been in operation for more than 80 per cent of their designed life. Based on the assessment, the turbine would be allowed to operate for another two years, after which it will be assessed once more. The scheme is yet to be finalised.

8. It is pertinent to note here that these older wind turbines are located in some of the India's best sites in terms of availability of wind (class I sites). But they have very low plant load factors (PLF) of 10-15 per cent, compared to more than 30 per cent PLF of modern wind turbines. If repowered, the project capacity and PLF of the turbines can go up by two-three times – this can translate into annual energy production rising by at least five times. If solar is also added, leading to hybrid renewable energy projects, the annual energy production can go up by more than six times.

9. Wind turbine models currently available in the Indian market are suitable mainly for class III and IV sites; they cannot be used for class I sites of older wind farms. Wind turbine technology has significantly improved since the harnessing of class I sites in early 2000; it is possible now to design a new, more suitable wind turbine model for maximum techno-commercial utilisation.

10. Wind farms with a capacity of 1.67 GW, commissioned before March 2002, will complete 20 years of design very soon; these can be immediately repowered to 5 GW with modern wind turbines. Another 2 GW commissioned between 2002 and 2005 will complete their designed life of 20 years in the next two-five years: these would provide a continuous sizeable volume for repowering. This will require a long-term conducive policy to ensure that the older turbines are retired suitably and regularly, and the available resources are utilised optimally. Most of the repowering opportunities are available in Tamil Nadu and Gujarat (*see Table 2*).

Table 2: Installed wind capacity completing 20 to 10 years of designed life by 2022

A long-term continuous repowering programme can help utilise resources optimally

State	Tamil Nadu	Andhra Pradesh	Gujarat	Karna-taka	Kerala	Madhya Pradesh	Rajast-han	West Bengal	Mahar-ashtra	Others	Total
Up to March 2002	877.0	93.2	181.4	69.3	2.0	23.2	16.1	1.1	400.3	3.2	1,666.8
2002-03	133.6	0.0	6.2	55.6	0.0	0.0	44.6	0.0	2.0	0.0	242.0
2003-04	371.2	6.2	28.9	84.9	0.0	0.0	117.8	0.0	6.2	0.0	615.2
2004-05	675.5	21.8	51.5	201.5	0.0	6.3	106.3	0.0	48.8	0.0	1,111.7
2005-06	857.55	0.45	84.60	143.80	0.0	11.40	73.27	0.0	545.10	0.0	1,7161.17
2006-07	577.90	0.80	283.95	265.95	0.0	16.40	111.90	0.0	485.30	0.0	1,742.05
2007-08	380.67	0.0	616.36	190.30	8.50	130.39	68.95	0.0	268.15	0.0	1,663.32
2008-09	431.1	0.0	313.6	316.0	16.5	25.1	199.6	0.0	183.0	0.0	1,484.9
2009-10	602.2	13.6	197.1	145.4	0.8	16.6	350.0	0.0	138.9	0.0	1,564.6
2010-11	997.4	55.4	312.8	254.1	7.4	46.5	436.7	0.0	239.1	0.0	2,349.2
2011-12	1,083.5	54.1	789.9	206.7	0.0	100.5	545.7	0.0	416.5	0.0	3,196.7
Total	6,987.6	245.5	2,966.3	1,933.5	35.1	376.40	2070.7	1.1	2,733.3	3.2	17,351.5

Source: https://niwe.res.in/information_isw.php, accessed in November 2020

11. A Right to Information (RTI) query addressed to the Indian Renewable Energy Development Agency (IREDA), a government body entrusted with financing repowering projects, has revealed that not a single project has availed an additional interest rate rebate for wind repowering under the policy of 'Repowering of Wind Power Projects 2016' between 2016 and 2020. This clearly indicates the lack of interest in such projects among developers under the current policy regime.

Policies on repowering

The MNRE released its Repowering Policy in August 2016. The policy allowed repowering for wind turbine generators (WTG) of 1 MW and less. It offered the following provisions:

- **The IREDA will provide an additional interest rate rebate of 0.25 per cent.**
- **Any augmentation of transmission system from pooling station onwards would be carried out by respective state transmission utilities.**
- **In case of power being procured by state discoms through power purchase agreements (PPA), the power generated corresponding to the average of last three years' generation prior to repowering would continue to be procured on the terms of the PPA in force; the remaining additional generation would either be purchased by discoms at feed-in-tariffs applicable in the state at the time of commissioning of the repowering project, and/or allowed for third party sale.**
- **A wind farm/turbine undergoing repowering would be exempted from not honouring the PPA for the non-availability of generation during the period of execution of repowering. Similarly, in case of repowering by a captive user, they will be allowed to purchase power from the grid during the period of execution of repowering, on payment of charges as determined by the regulator.**

Two states — Tamil Nadu and Gujarat, which have the highest potential for repowering — have made some progress with respect to their own state policies.

TAMIL NADU

The Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO) has sought approval from the Tamil Nadu Electricity Regulatory Commission (TNERC) for the procedure to be adopted for repowering of existing wind farms within the state, as well as for the tariff proposed for the repowered wind farms. The commission's response is awaited.

TANGEDCO has proposed the following for repowering:

- **The feed-in-tariff of Rs 2.80 per unit or the latest tender discovered rate at the time of commissioning of the repowered wind farm, whichever is less.**
- **For wind farms under wheeling agreement, banking of one month with encashment of unutilised energy at 75 per cent of the tariff at the end of the month.**
- **Developers to erect/augment transmission infrastructure up to TANGEDCO sub-stations at their own cost.**

GUJARAT

Till March 2017, Gujarat had 1,494 MW of wind capacity with turbine sizes of less than 1 MW; out of this, 894 MW was under PPP model and the remaining 600 MW was under wheeling mode (captive/third party). In May 2018, the state released its policy on repowering of wind projects. It has the following provisions:

- **Any augmentation in transmission system up to a Gujarat Energy Transmission Company (GETCO) sub-station would be undertaken by the developer.**
- **The average generation during the last three years prior to repowering would be continued to be paid as per the existing PPA. The additional generation shall be procured by the state discom, taking into account the renewable purchase obligation (RPO) requirements and tariffs discovered through a competitive bidding process. However, it is not binding on state discoms to purchase additional power.**
- **In case of wheeling agreement, the wheeling charges would be applicable on the entire repowered capacity.**

REASONS FOR STATUS QUO

The repowering policy has not made any impact in terms of enabling repowering of older wind farms. Despite the low PLF of the wind farms and their having completed 20 years of designed life, there is a status quo. The reasons for it, as per CSE's analysis, are as follows:

- In Tamil Nadu, no time limit has been mentioned in the earlier PPA and hence, wind farms can continue to provide power beyond 20 years. In Gujarat, the PPA has a provision of multiple extensions.
- The earlier wind turbine models had high design margins (meaning having a design acceptability which is more than the value prescribed in operation). The renewable energy sector in the country is of the opinion that the relatively benign environmental conditions in India allows many of the older wind turbines to operate even after 20 years of service.
- Old wind farms have minimal O&M (operation and maintenance) requirements. Given the tariff of Rs 2.75 or Rs 2.90 before 2009 in Tamil Nadu, running older wind farms, therefore, has been profitable with minimum interventions.
- Around 90 per cent of the older wind farms in Tamil Nadu have been under a captive scheme, where banking of power is allowed for a period of 12 months. However, for repowered wind farms, the banking facility is provided only for one month.

CASE STUDY: Repowering the Ananthpur BHEL 6.5-MW Wind Power Project

- **Historic capacity utilisation factor (CUF): 8.5 per cent**
- **Land available: 220 acres**
- **Repowered with 16 MW of new wind capacity and an additional 25 MW of solar capacity at the cost of Rs 2.5-3 crore/MW and Rs 5-5.5 crore/MW, respectively**
- **Post-repowering CUF: 35 per cent**
- **Post-repowering capacity: 41 MW**

INFERENCE: With an investment of Rs 143 crore, the generation increased by almost 10 times from the same natural resources.

REPOWERING CHALLENGES

Repowering has its own unique challenges:

- **Fragmented ownership:** Repowering will reduce the number of wind turbines; individual owners may be left with even one turbine per head. In such a case, a consortium of owners can undertake repowering and share the equity.
- **Land ownership:** The new micro-siting would require few turbines at new locations. This would require selling of older wind turbine footprints and acquisition of new land. This will pose a challenge.
- Power evacuation facilities: Most of the old wind turbines are connected to distribution sub-stations which are already overloaded. Additional evacuation infrastructure has to be developed for additional power.
- **Power purchase agreements (PPA):** The previous PPAs were signed at marginally high tariffs and the wheeling and banking conditions were more favourable. However, now the distribution companies are committed to buy power at a cheaper price, which is a challenge for the wind sector. In the current situation, with exchanges trading green energy, the sector is expected to revive significantly.
- **Disposal of old turbines:** A lack of policy and absence of any guidelines regarding disposal pose an environmental challenge.

SUCCESS STORIES

Germany

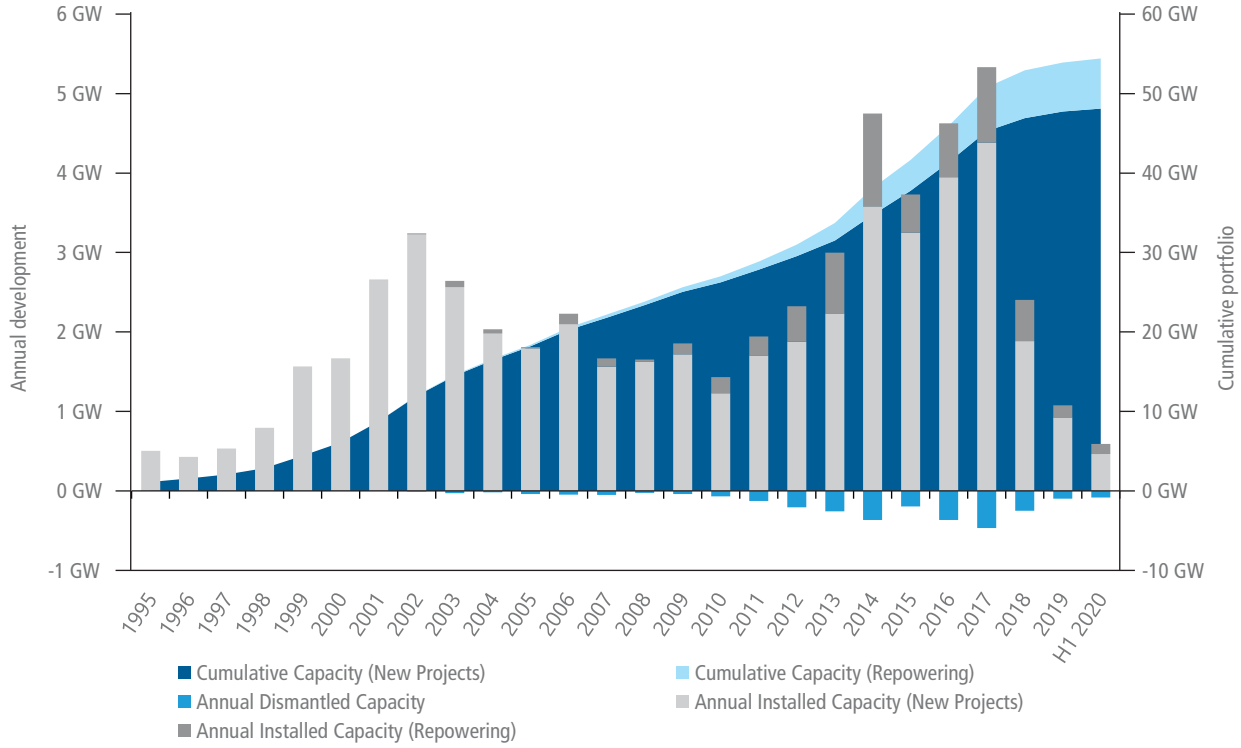
The Renewable Energy Act (EEG) is the key legislation responsible for wind turbine development in Germany. It was enacted in 2000 and subsequently amended in 2004, 2009, 2012, 2014 and 2017. The Act of 2000 provisioned for subsidies for 20 years in the form of feed-in-tariffs (FiTs); a higher tariff indirectly supported repowering of older turbines. The 2004 amendment first offered an incentive for repowering installed before 2015 and for new capacity of at least three times the older capacity. However, the stringent requirements on height limits and spacing made it almost impossible to fulfil all the criteria to receive the incentive.

The 2009 amendment increased the repowering incentive and relaxed the criteria where it required for the replaced turbines to have at least twice the original turbine capacity. The amendment in 2014 was the last one that continued to provide the financial incentive for repowering. The 2017 amendment moved to public tender procedures where the price would be decided through public auctions. Today, repowering – which had started in Germany in early 2000 – constitutes a sizeable portion of the new capacity addition (*see Graph 2*).

After repowering, the new capacity is more than three times its older counterpart. The repowering share crossed more than 25 per cent in 2014 and more than 20 per cent in 2017 (when repowering incentive was discontinued) (*see Graph 3*).

Graph 2: Development of repowering in Germany

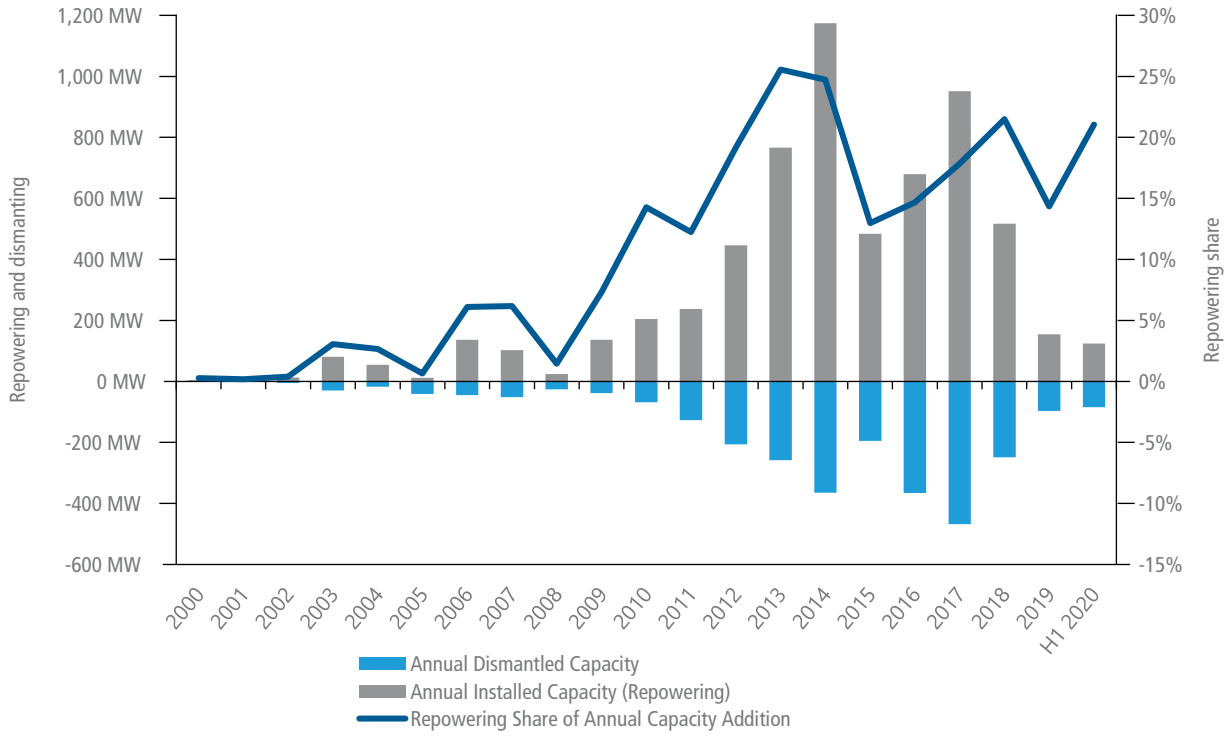
Significant repowered capacity added in the last 10 years



Source: Deutsche WindGuard 2020, Status of Onshore Wind Energy Development in Germany First Half of 2020

Graph 3: Repowered and dismantled capacity of old wind farms

Share of repowering in total wind installations remains almost over 15 per cent for the last decade



Source: Deutsche WindGuard 2020, Status of Onshore Wind Energy Development in Germany First Half of 2020

Repowering is currently tendered in Germany through reverse bidding. The recently commissioned Beckum Wind Farm was repowered with two turbines of 4.5 MW each by replacing six turbines of total 5.2 MW capacity. In a recent tender (June 2020), for repowering of Krusemark Wind Farm, 15 older turbines will be replaced with six N-131 models of 3.3 MW each. Vestas, the Denmark-based wind turbine manufacturer, will be repowering the Brest Wind Farm by replacing 11 old Nordex turbines (with a cumulative capacity of 14.30 MW) with five turbines of V150-5.6 MW to take the capacity to 28 MW.)

It should be noted that the federal incentives for the first batch of wind farms of 4,000 MW, developed with 20 years of FiT under EEG 2000, are ending this year. Around 16 GW of wind power capacity will lose the support of federal incentives by 2025, after 20 years of FiT provision. Hence, from 2021 and onwards, Germany will see massive large-scale dismantling and replacement of old turbines as these would not be sustainable without a subsidy.

The German government is yet to come up with a suitable policy. This means the government will need to have a balance between continuation of existing wind farms based on their residual life, and making the best use of land and wind resources by repowering as a way to achieve its goal of 65 per cent of power consumption through renewables by 2030.

Denmark

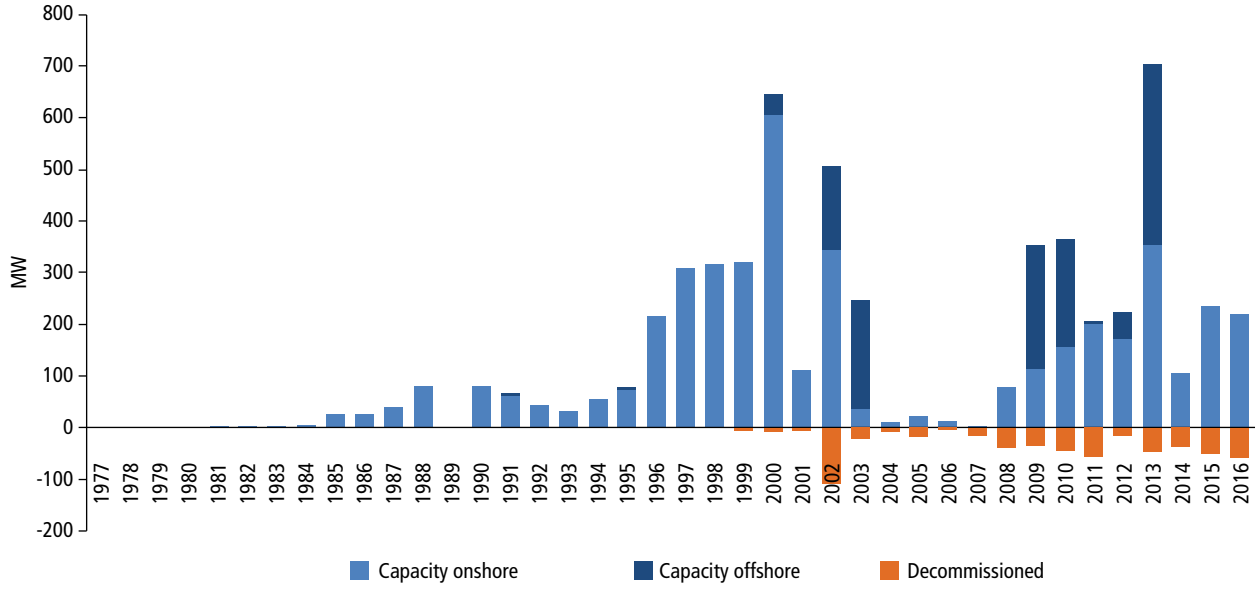
Wind turbine installation in Denmark started before 1980 – by the year 2000, almost 2,500 MW capacity was installed, accounting for 12 per cent of the total electricity generation (*see Graph 4*). Repowering of older turbines also started before 2000.

Two repowering schemes have been implemented in Denmark. The first one is for wind turbines with capacities up to 150 kW, decommissioned during the period from March 3, 1999 to December 31, 2003. The second scheme is for wind turbines with capacities up to 450 kW, decommissioned during the period from December 15, 2004 to December 15, 2011.

Wind turbine owners with repowering certificates have the right to receive a price supplement. Under the first repowering scheme, turbine owners were entitled to receive the price supplement for triple the decommissioned capacity if decommissioned wind turbines had an installed capacity of less than 100 kW. The capacity constraint was removed in the second repowering scheme, and the owners could receive the price supplement for double the decommissioned capacity.

Graph 4: Development of the wind energy sector in Denmark

Wind energy constitutes a major part of the energy mix



Source: World Wind Energy Association Policy Paper Series, Denmark, April 2018

THE WAY FORWARD

Repowering in India should be seen as a process for suitable retiring of older wind turbines and optimal use of existing resources. As mentioned above, repowering has the potential to increase energy generation by more than six times by using modern wind turbines and including solar to make the best use of natural resources as well as the power evacuation system.

To make optimum use of the best sites available for repowering, it is necessary to design a new wind turbines. Given the current repowering market size of around 5 GW and the similar size of market available on a rolling basis, it entails a long-term policy and roadmap for the investment and design of large-sized wind turbine models and improvement in infrastructure. The government should undertake a massive augmentation of transmission facilities. This should encompass repowering projects to meet the target of 140 GW of wind capacity by 2030.

Some policy recommendations

- **Considering the complications and challenges, repowering development in India may be initiated through an original equipment manufacturer (OEM)-driven business model.**
- **Under the Wind Parks/Wind-Solar Hybrid Park Development Scheme, the government can identify few tranches for repowering and should develop/enhance transmission infrastructures.**
- **In parts of the country where wind power projects have been built on revenue land, states can take up repowering on their own as there is no uniformity among the projects or their sites. In Maharashtra and Karnataka, PPAs are signed for only 13 years. Hence, it is possible to take up repowering early in the life cycle of the projects without impacting the contracts and adding complexities.**
- **States should facilitate easy termination of PPAs without penalties.**

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