APREN Associação de Energias Renováveis

2019 PORTUGAL RENEWABLE SUMMIT

Da transição ao compromisso energético

From transition to energy commitment

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Repowering in Germany: the Eckölstadt case

1. Impact of the regulatory framework upon the investment decision

2. Main challenges in the permitting procedure

3. Dismantling, recycling and second-hand markets

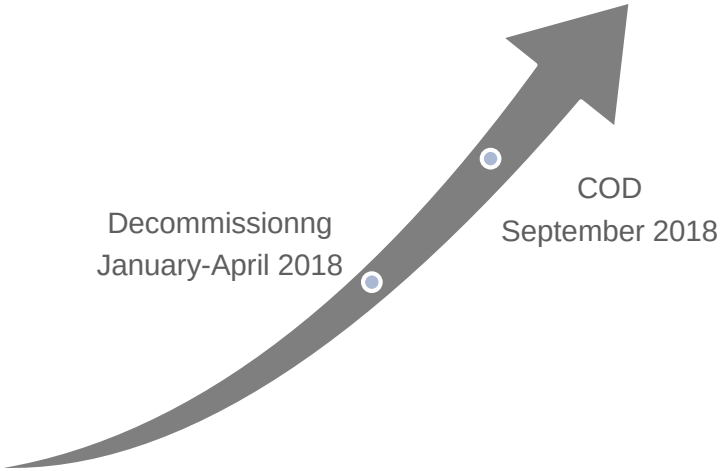
4. Lessons learned and recommendations

5. Repowering potential using the data knowledge to optimize the fleetwide production

Introduction

Eckölstadt is an onshore wind farm developed, built, decommissioned and repowered by EDF EN Deutchland. This is the first repowering of EDF Renewables.

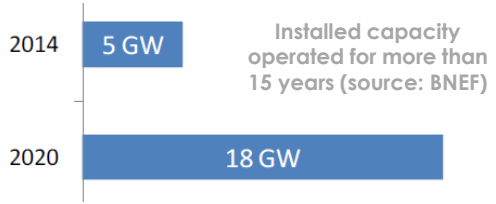
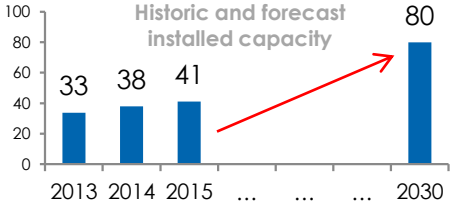
34.5MW = 10 V112 3.45MW HH94m
under a 20 years FIT (72€/ MWh)



14.3 MW =11 Bonus 1.3MW rotor 62m HH68m
under a 20 years FIT since 1999

1. Impact of the regulatory framework upon the investment decision (1/2)

Germany being a leading country in supporting renewables since 1995 through 20 years PPA tariffs now pushes repowering for its aging wind farms.

	Past support reg.	Future support reg.
Rationale	Due to the past strong support policies, the onshore wind installed capacity is significant (51 GW of installed base in 2018, corresponding to 8.5% of the world wind base) with more than 15% of aging wind farms (>15 years of operation).	Onshore wind keeps being pushed by German authorities through high country targets (2.8GW/year for onshore wind auctions, target of 80GW of installed capacity in 2030, not encompassing decommissioning)
Trends		
Impact on repowering	The number of existing projects, along with rampant litigation and permitting issues, results in a lack of eligible sites for new wind farms (and in auction undersubscription).	There is a strong incentive for farms owners / investors to consider repowering for their aging farms to be able participate to next auctions rounds (as this participation requires fully permitted sites).

1. Impact of the regulatory framework upon the investment decision (2/2)

National regulation and power price trends are key factors when deciding end-of-life decisions.

	Offtake reg.	Appeal reg.
In Germany	1 - An auction system was voted in July 2016 with a transitional system (20 years FIT) for projets having received a building permit before end of 2016 and for a COD before end of 2018. 2 - Degressive tariff depending on the COD date (incentive for an early COD)	The right for appeal during 1 months after gaining building permits is linked to comments made during public inquiry. Given the good public acceptance of repowering projects, public inquiries go well, which limits the appeal risk.
Impact on Eckölstadt	Repowering FID while 2 years of the former FIT where remaining, to get a 20 years FIT without having to go through an auction process.	Repowering FID while permits not cleared of any claims based on a positive public inquiry (comments for 2 WTG with a limited appeal risk, none for 10WTG)

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2. Main challenges in the permitting procedure (1/2)

1 **LAND**

Land lease

A repowering usually requires to secure new land plots (or enlarge old land plots), as WTG have larger rotors and an overall bigger capacity to be connected to the grid

2 **PERMITS**

Permitting time

A repowered project requires a full permitting process, exactly like a greenfield project. The average time to get a wind farm permit is now up to 300 days (7 months for Eckölstadt), and applies for a repowering project (source: BWE).

E&S risk

E&S challenges are more controlled than for a greenfield project as conflicts with rare species would have been identified for the decomissionned farm.

3 **GRID**

Grid connection

In Germany, grid connection is not an issue, as the grid operators (4 TSO and >500 DSO), have the obligation to connect any onshore wind farm to the national grid.

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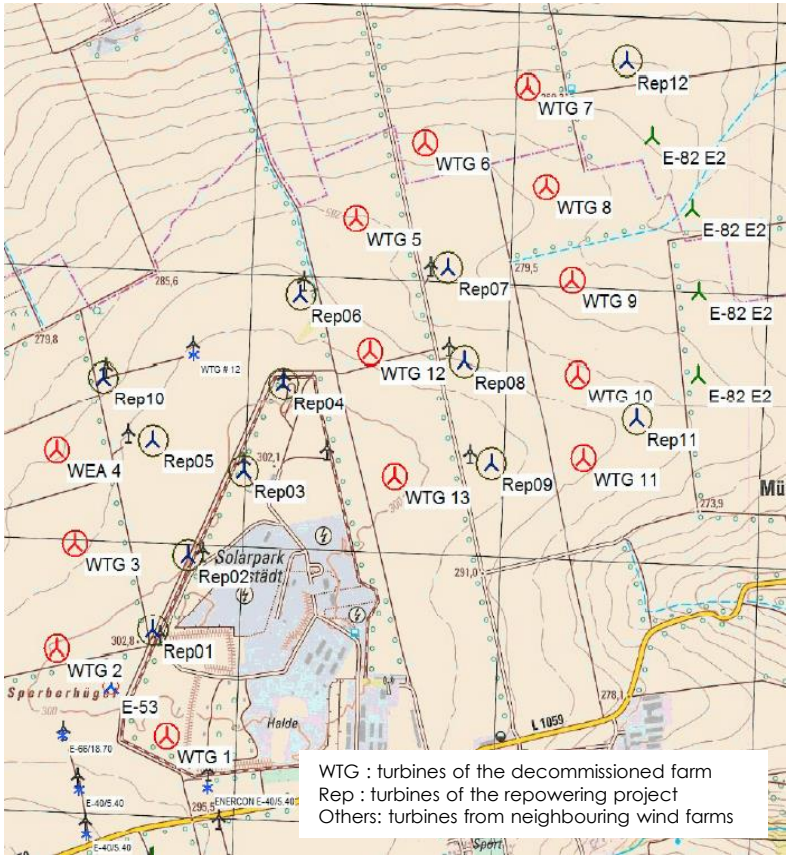
2. Main challenges in the permitting procedure (2/2)

For Eckölstadt, additionnal land had to be secured in order to:

- build a new substation/MV cable route,
- Allow an increase of rotor diamater from 62m to 110m,
- extend on specific locations the existing access roads.

The risk associated to land lease was limited as EDF EN Deutchland (asset manager of the wind farm) knew most of the concerned land owners and municipalities



Map of Eckölstadt repowering

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3. Dismantling, recycling and second-hand markets (1/3)

Eckölstadt is the first repowering project of EDF Renewables:

Timeframe:	2 months for dismantling 11 WTG, 2 months for recycling
Companies:	Reetec (EDF R affiliate) for dismantling, other German contractors for recycling
Old cable:	Stay onground
Existing roads:	Used for the repowering project, with extension on specific locations
2nd-hand market:	Recycling was decided as there was no benefit at the second-hand market for 11 units of BONUS 1.3MW, HH 69m (except for 3 nacelles)
Recycling:	Deconstruction and recycling on site to quickly get the location clean

A disappearing market for second-hand wind WTG:

Platforms are available for spare parts but the market for used full turbines is limited as:

- Market with support schemes for sub 750kW WTG disappeared
- Auctions force developers to choose the most efficient turbine model rather than just the cheapest second-hand model.

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3. Dismantling, recycling and second-hand markets (2/3)

Recycled part	Process	Cost	Benefit
Towers/ nacelles	• Welded at the WTG locations into 5-6m units • Transported/sold as shell pieces in open containers	390k€	80k€ (3 nacelles)
Rotor Blades	• Cut in 6m parts • Transported/sold as aggregate/ additive for fiber cement for concrete industry		20k€ (concrete) 70k€ (steel) 10k€ (PC components)
Gearboxes	• Dried after having removed the oil out • Welded in pieces on site and metal sold		
Transformers/ external transformer stations	• Complete station lifted on each WTG location • Roof and lift of the transformer unit dismantled • Transformer units transported on trucks to a specialized recycling company • Transformer stations (concrete boxes) cracked on site (separation of steel and concrete) and crushed (then used as recycling gravel for the internal roads)		
Foundations/ reinforcements	• Old foundations cracked by excavators with hydraulic chisel • Dismanted 1.5m deep as per lease agreements (except for 4 WTG close to new locations, requiring a complete decommissionning) • Concrete blocks crushed, used as recycling gravel/road works. • Old reinforcements sorted out by the company who cracked the foundations	120k€	
	Total global cost/WTG	**~30k€/WTG**	

NB: Composites, plastics, gearbox oil, lubricants and cooling liquids are for disposal.

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3. Dismantling, recycling and second-hand markets (3/3)

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4. Lessons learned and recommendations (1/2)

Topic	Recommendation
HSE plan	Ensure the implementation of a strict HSE plan for the decommissioning, to ensure contractors apply good practice for a construction work they have less H&S experience.
WTG energisation	Make sure how to de-energize cable connections between turbines before dismantling. Make sure that the WTGs are energized to get the nacelles in the right position.
Recycling	Make sure how the WTGs should be recycled („second life“ or cut on site). If second life is planned, take care of a just-in-time transport of turbine parts before starting the repowering construction works.
Design	Design the new windfarm layout for civil works and electrical BoP to also accommodate decommissioning and repowering works, to minimise abortive work and cost.
Liabilities	Detail the employer's requirement scope of the decommissioning/repowering works in order to tackle interfaces issues that may occur (for example through an interface matrix).

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4. Lessons learned and recommendations (2/2)

From an investor perspective, repowering an operating farm can make sense

Returns

Revenues

Impact of the regulatory framework: see section 1

LCOE

Resource:
aging wind farms are located at high wind-speed sites

WTG model:
Upgrade inefficient small WTG for modern turbine models

10% increase in capacity factor between old projects and repowered projects (source BNEF Sept.2018)

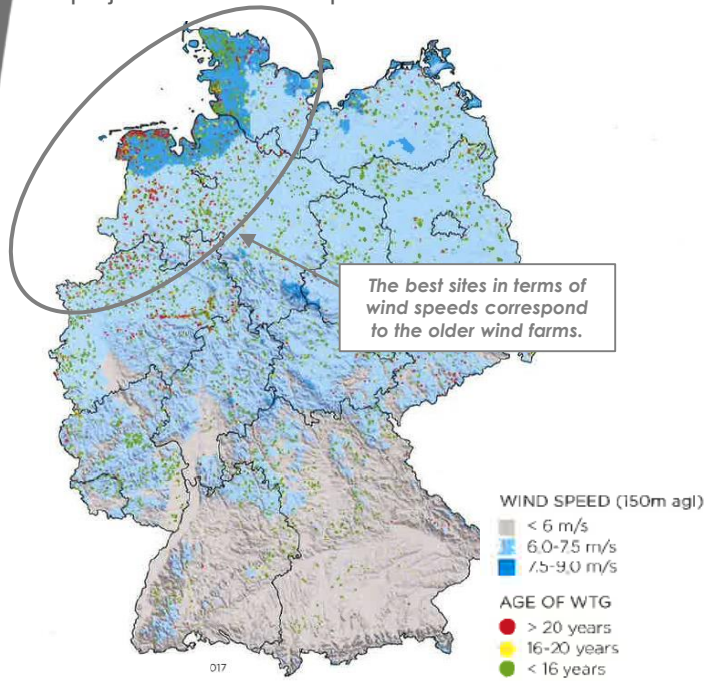
Risks

Resource:
in Germany, farms are developed without wind campaigns which represents a production risk for the sponsor. For a repowering, wind data is available from the past operation years (met mast saving and operational risk reduced)

Development:
Land, permitting and appeal risks are mastered given the knowledge of the site's constraints and stakeholders (higher acceptance as used to onshore wind and given the improvements in noise, shadow flickering and visual impacts)

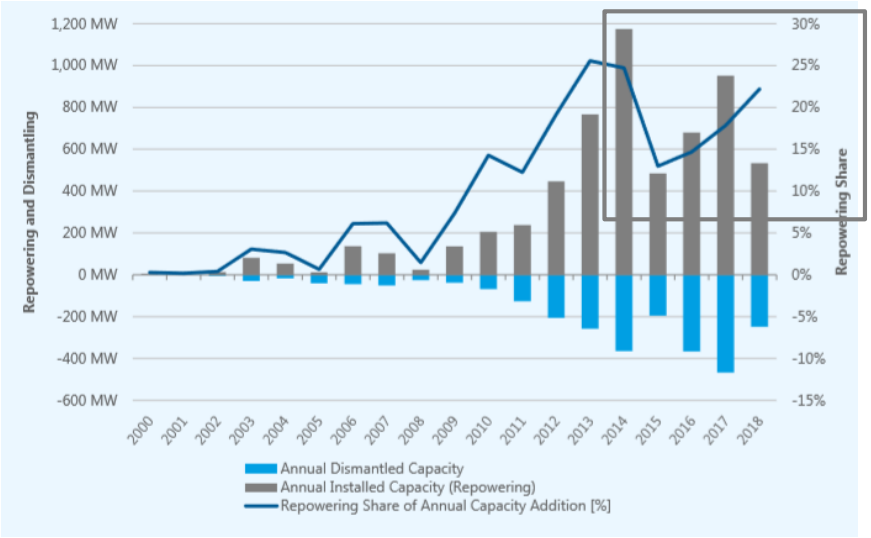
5. Repowering potential using the data knowledge to optimize the fleetwide production (1/3)

Due to both the scarcity of new site and the good resource quality of old wind farm sites, repowering projects will be developed for next auctions rounds.



Age of WTG and wind speeds
(source: Rambol, 2017)

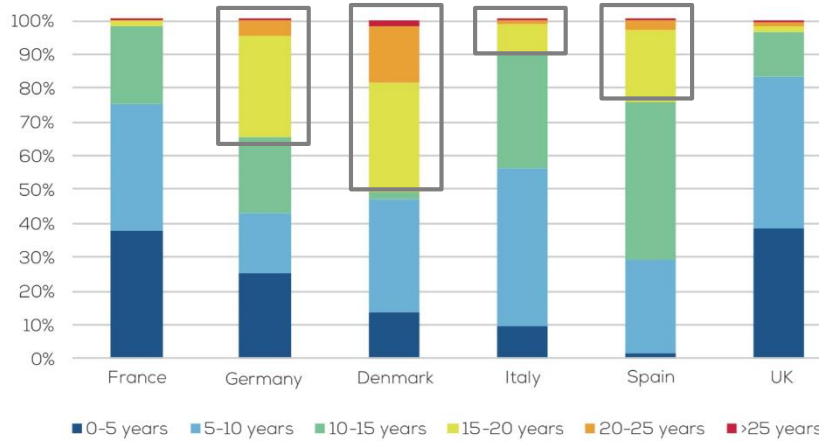
With the increased annual dismantled capacity, the repowering projects' share of annual capacity addition is going to increase (more than 20% in 2018), even without repowering support.



Repowering share, annual installed repowering capacity and dismantled capacity
(source: Deutsche wind guard, 2018)

5. Repowering potential using the data knowledge to optimize the fleetwide production (2/3)

After Germany, who has been amongst the first European countries supporting wind, every country short of good wind-speed sites will consider repowering projects.



Age of wind installed capacity per country
(source: WindEurope, 2018)

More than **21GW** of installed European capacity **is over 15 years** old, representing opportunities to re-evaluate good wind sites for repowering (source: BNEF, September 2017).

5. Repowering potential using the data knowledge to optimize the fleetwide production (3/3)

Which are the alternatives to extend a project lifetime, based on EDF R experience in Germany?

1 REPOWERING (full replacement of the farm)

- Site opportunity for auctions (high revenues)
- Competitive LCOE (use of existing infrastructures, increased capacity, usually high wind and low BOP, etc.)
- Less risks (available data for E&S and wind, ppublic acceptance)

- Same permitting process than greenfield projects
- More stringent regulations (E&S constraints, etc.)

2 RUN-TO-FAIL (replacement of critical components)

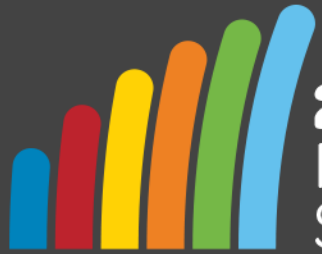
- Cheap maintenance & repair
- Sometimes the only way to optimise returns if repowering is not possible

- No lifetime target
- Grid compliance to the current grid code (required certification)
- Market risk and low revenues

3 LIFETIME EXTENSION (replacement of all required components)

- Potential bridge to repowering
- Up to 10 years lifetime extension
- Sometimes the only way to optimise returns if repowering is not possible

- Expensive MCR
- Grid compliance to the current grid code (required certification)
- Market risk and low revenues



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