



RÉPUBLIQUE
FRANÇAISE

*Liberté
Égalité
Fraternité*



Repowering

Strategies for French wind farms and related challenges from a technical, economic, environmental and regulatory point of view



Context and Objectives

Context:

- **French Energy Plan** aims by 2028 : **Double the onshore wind installed capacity** (from 17 GW in 2020 to 34 GW and from 8 000 to around 14 000 turbines)
- More than 7 GW of onshore wind farms will reach the end of their FiT contract by 2028
- Rising opposition in some areas of France: we reach a saturation point and land use should be optimised when possible

Objectives:

- Conduct a **European benchmark** on repowering
- Study the **available options for wind farm managers**
- Analyse the **technical, economic and environmental consequences**
- Determine to what extent can repowering contribute to **reaching the Energy Plan objectives**

Scope and Conditions

Scope:

Commissioning < 2015

- 742 wind farms
- 9,2 GW | 20 TWh/y

Conditions:

- Length of the study: 11 months
- Steering Committee:
 - **ADEME, Everoze, Innosea, Abiès**
 - **CRE** (French Energy Regulatory Commission),
 - **DGEC** and **DGPR** (Energy and Climate & Risk Prevention Departments, Ministry for the Ecological Transition),
 - **SER** (French Renewable Energy Trade Association), **FEE** (France Trade Association for Wind Power)

Types of repowering

Impossible

Critical constraints.

The wind farm will be dismantled at the end of the technical or economic life of the farm.

Example : Houses < 500 m,
Coastal regulation...

Quasi-identical

Some constraints exclude any substantial modification of the wind farm.

The total height cannot be changed but rotor diameters may be increased.

Limited height

Some constraints – for instance, aeronautic – limit the total height. A maximum of 150 m has been set for this study.

Example : Increase of the total height from 125 to 150 m.

Uncapped

No limit for the total height (absence of constraint)

The latest technologies can be used for the repowering.

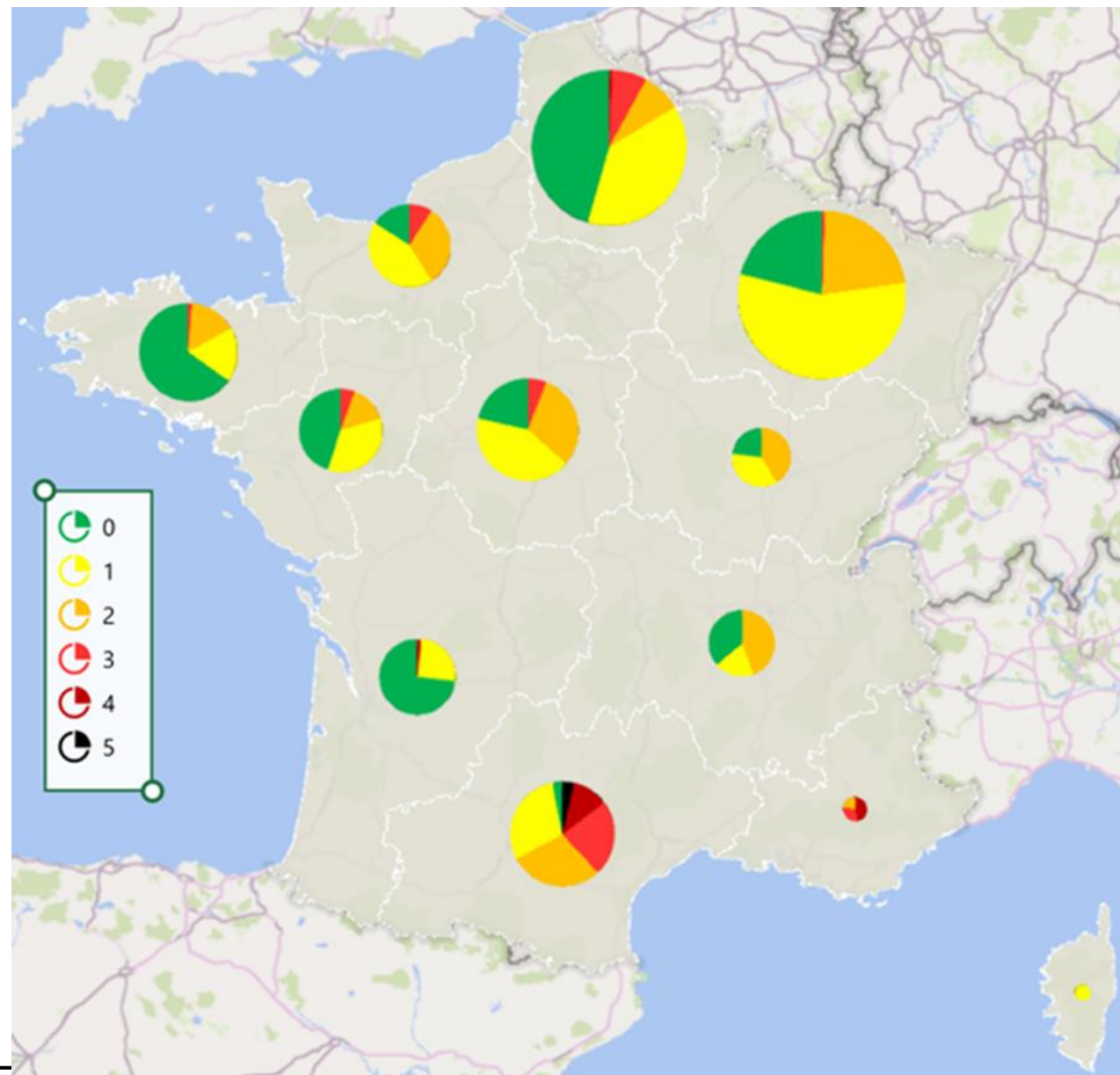
Example : In 2021, a 160 m diameter rotor with a 166 m tower for a 246 m total height.

Decrease of the conflicts intensity: spatial or environmental challenges and constraints

Constraints

Radar / Aeronautic / Natura 2000 / Environmental regulations / Landscape

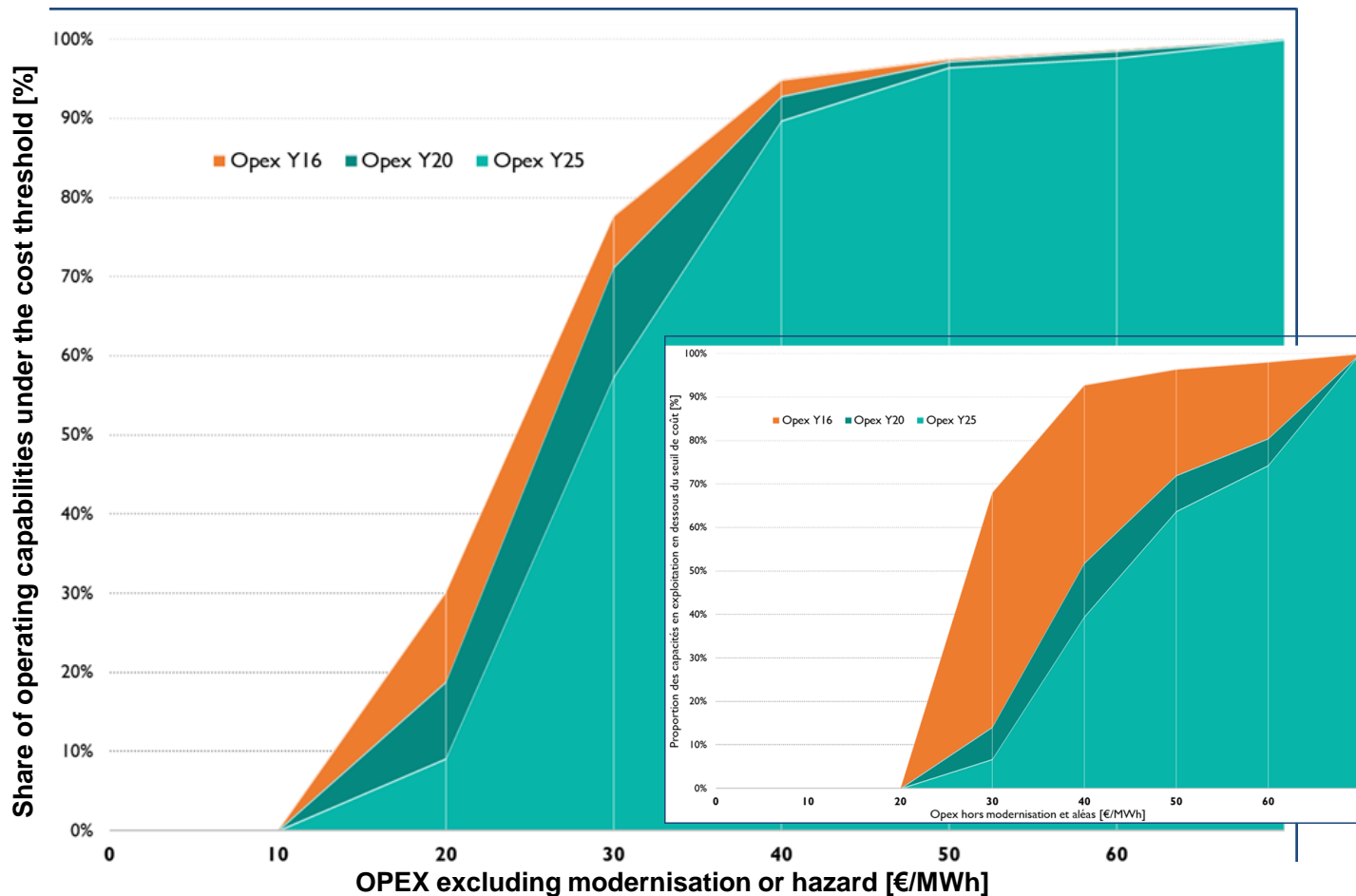
- Old wind farms are the most affected ones:
 - 65% of wind farms commissioned before 2015 are affected by at least one constraint
 - 30% by at least 2 constraints
- Independently of the 11 July 2018 Circular, some farms could be definitively dismantled.
- This risk concerns 700 - 1000 MW, 8 - 11% of the studied wind farms.



Characterics of the French onshore wind farms

	Before 2005				2005 - 2009						2010 - 2014					
Category	Cat 1		Cat 2		Cat 3		Cat 4		Cat 5		Cat 6		Cat 7		Cat 8	
Rotor diameter	43-52		58-80		43-52		58-77		80-100		48-77		80-97		100-114	
Nb of farms	26		19		31		100		201		65		230		70	
Total MW	149		185		151		1110		2853		641		2999		1101	
Main models	N43, G47/52, V52, NM52		N60, MD77, V66, GE1.5		E44/48/53, G52/58, V52		SWT-1.3-62, GE1.5, MD77, ECO74/80, E70		MM82/92, V80/90, N80/90		E70		MM82/92, V80/90, E82		V100/112, N100, SWT101, GE2.5xl	
Typical farm	8 x N43 or G47 4,6 MW		6 x N60 or V66 5,1 MW		5 x E44 4,5 MW		6 x E70 12 MW		5 x N90 11,5 MW		5 x E70 11,5 MW		4 x V90 10 MW		5 x V100 10 MW	
Main constraints	Number	MW	Number	MW	Number	MW	Number	MW	Number	MW	Number	MW	Number	MW	Number	MW
2 or more	15	91	12	98	16	78	39	466	63	1043	21	242	41	484	7	90
Radar	2	12	1	38	5	20	11	248	36	506	12	120	50	739	15	343
Aeronautical	3	8			3	13	7	49	31	415	5	35	22	293	12	193
Other	4	32	2	15	4	22	14	115	6	67	8	77	13	164	5	53
None	2	6	4	34	3	18	29	232	65	822	19	167	104	1319	31	422
Analysis	Highly impacted by 2-3 constraints				No major constraint on most projects or 1 height constraint						No major constraint on most projects or 1 height constraint					

Viability of existing farms post-FiT



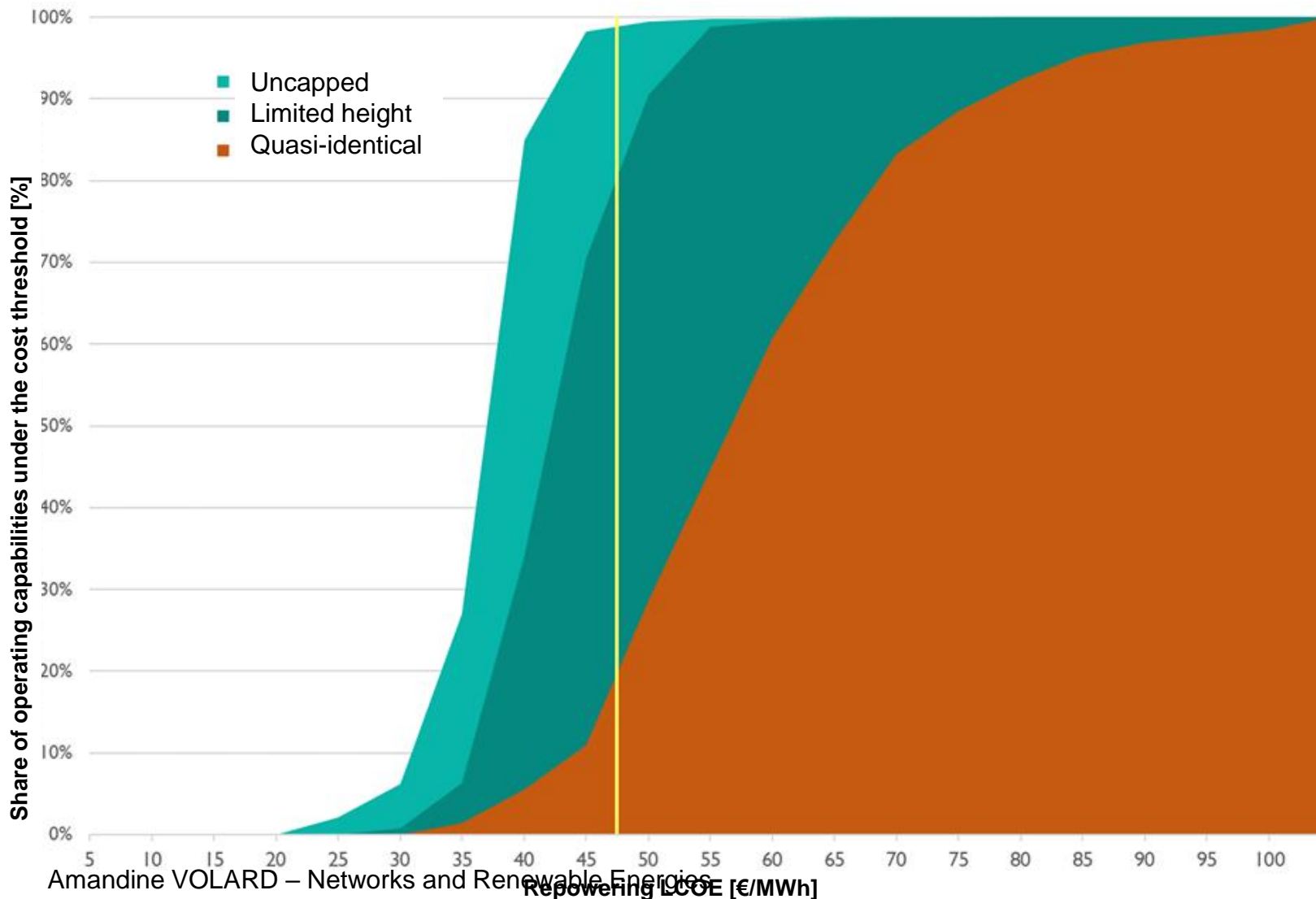
OPEX after the end of FiT contract terms should remain below 40 €/MWh in most cases (cat. 1-8, main figure)

50% of the capabilities for which the term of the FiT contract has already been reached (cat. 1&2, small figure) should remain below 47 €/MWh until 25 years of operation.

Legend :

- Main figure: OPEX for all categories of farms (1-8) after the end of the FiT contract term
- Small figure: OPEX for categories 1-2 of farms after the end of the FiT contract term

Cost of repowering /LCOE [€/MWh in 2020]



LCOE of repowered wind farms with no major constraint shall remain below 50 €/MWh.

LCOE of quasi-identical repowered wind farms shall remain below 70 €/MWh for 75% of them.

Identical repowering could be prohibitive for 10 to 20 % of installed capacities (70- 75 €/MWh).

Environmental Impacts

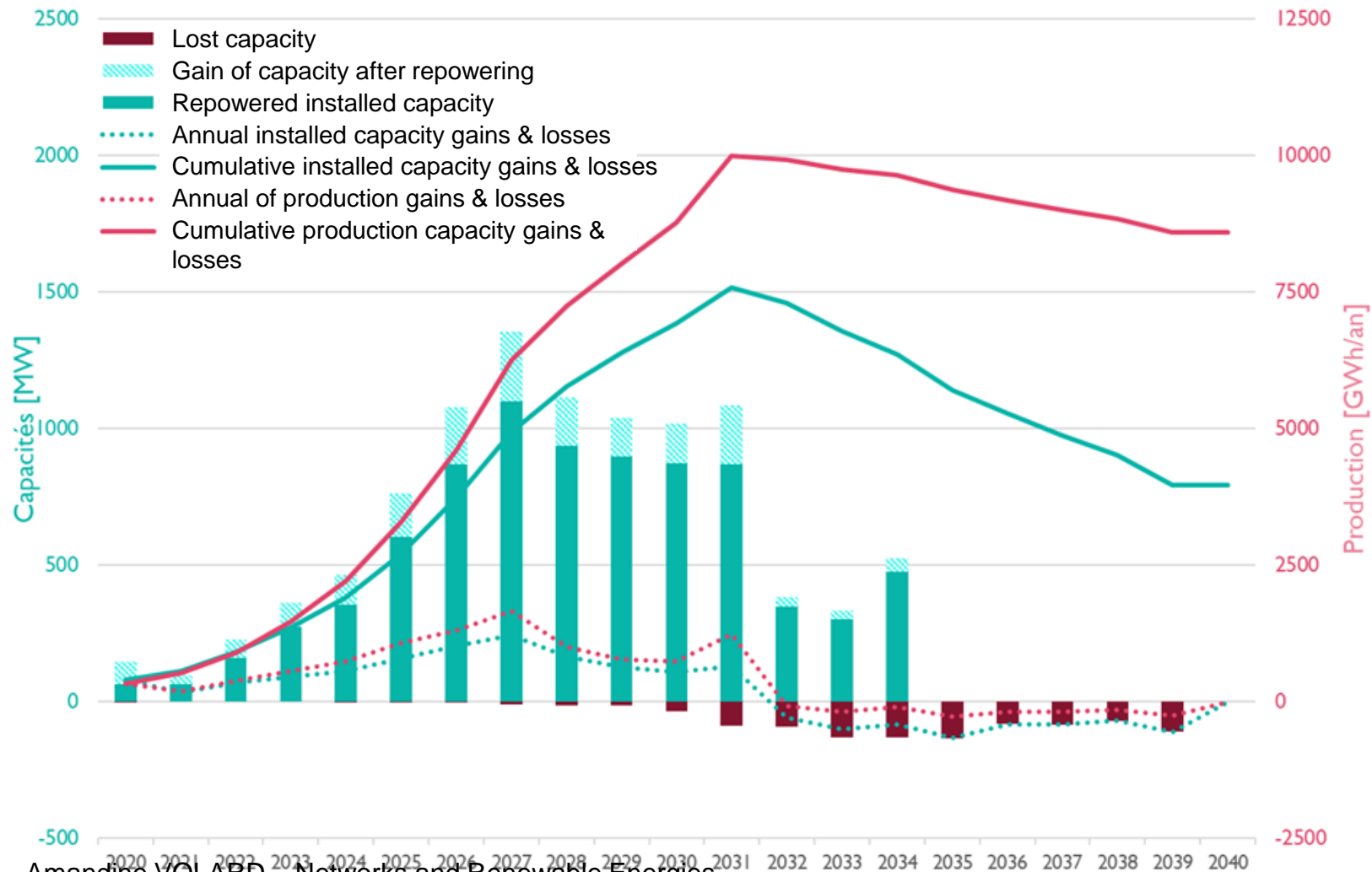
3 main environmental impacts: Noise, landscape management, impacts on bats and birds.

- Less turbines which perform well = **less noise** ;
- **Limited or positive impact on landscape**, higher but less turbines, removal of the most impacting turbines ;
- Impacts on **biodiversity** (fauna, mainly birds and bats) :
 1. Territory loss, mainly for fearful species: low sensitivity to the turbines height, depending mainly on the number (which is decreasing).
 2. Death by collision or barotrauma: lower impact because fewer turbines and removal of the most impacting ones, speed limitation, automatic stops and frightening measures.

Regarding wind farms Life Cycle Assessments, lifespan increase and the improvement of turbines reliability should allow to improve the main indicators.

Analysis

Capacity and production losses and gains [MW and GWh/y] – Base Case



Gains of capacity and production linked to repowering of 1.5 GW and 10 TWh/y can be expected towards 2031 for the 742 farms studies (Current capacity and production : 9.2 GW; 20 TWh/y).

In 2030 and beyond, if the lifespan of the farms is extended to 25 years – The first dismantling operations could reduce these gains of 0.7 - 1 GW and 1.5 - 2 TWh/y

Conclusions and Perspectives

- **Windfarms can be operated for 25 years** with OPEX comprised in majority between **20-30 €/MWh** in the years 15-25.
- **25 - 40% of repowered capacities (2 - 4 GW)**, would be **quasi-identical**
- **LCOE for quasi-identical repowering** will be **15-20 €/MWh** more expensive than the other types of repowering
- **Risk of permanent dismantling: 0,7 - 1 GW (8 - 11% of the studied wind farms), 1,5 - 2 TWh/y**

- **Uncapped repowering should be encouraged, as they are a significant lever to reach the French Energy Plan objectives**
- **The regulatory framework should be clarified** (11 July 2018 Circular)
- **Constraints should be lightened** when possible in order to encourage and facilitate repowering when relevant (ongoing work at a national level)



RÉPUBLIQUE FRANÇAISE

*Liberté
Égalité
Fraternité*

Amandine VOLARD
Renewable Energies Engineer
ADEME - Networks & Renewable Energies Department

amandine.volard@ademe.fr

