



 **taigamistral**

# Wind Farm Operators Forum

## Workshop: Cable pooling

**Alberto Orejana  
Paweł Wołczański  
Grzegorz Skarżyński**



**TUNDRA**

10 March 2022

Hybridization potential of an existing wind farm in Poland through cable pooling:

- 1. Spanish case & legislation.**
- 2. Hybrid installation effect based on Polish example.**
- 3. How to implement the cable pooling**

## Cable Pooling

AKA technology hybridization, it consists in installing additional (complementary) generation capacity into an existing power plant, maximizing the use of the interconnection agreement

In the case of Spain, there is a synergic coupling between wind and solar technologies which comes from the seasonality of both resources: yearly (winter/summer) and daily (day/night) seasonality

Wind

28 GW

24%

Solar

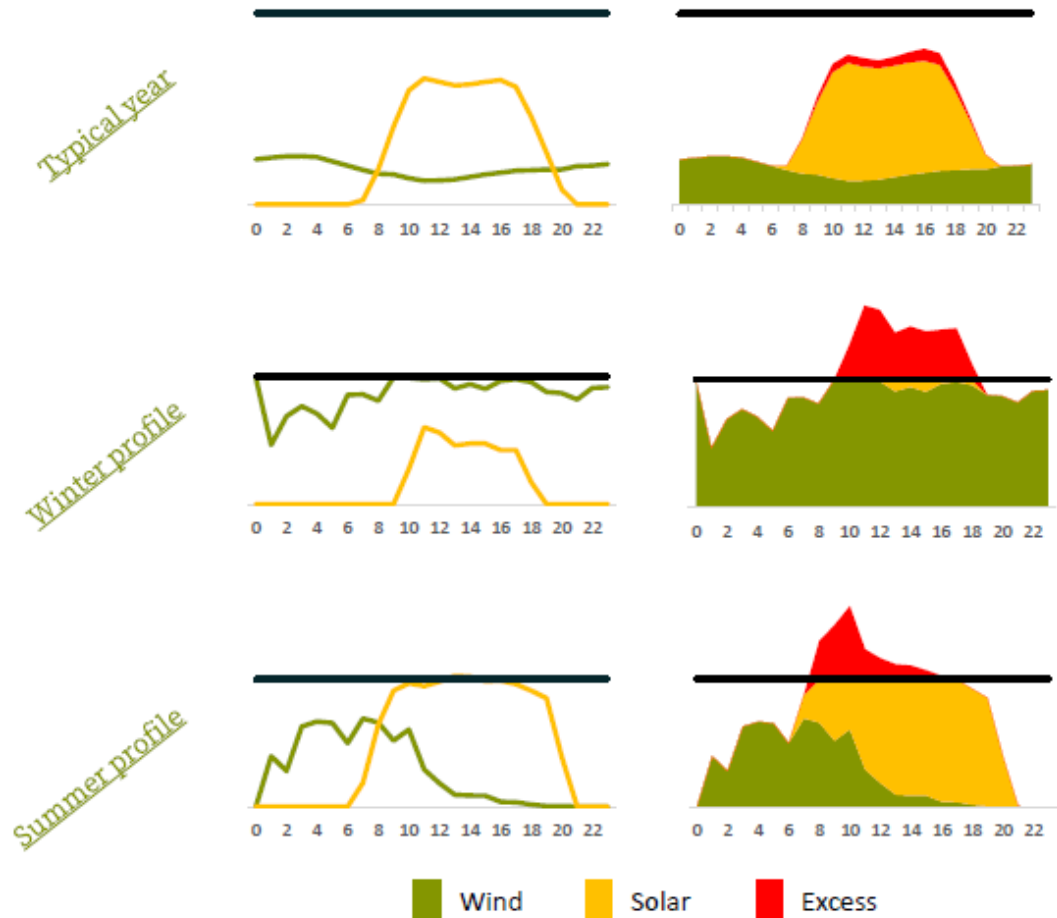
15 GW

19%

Installed

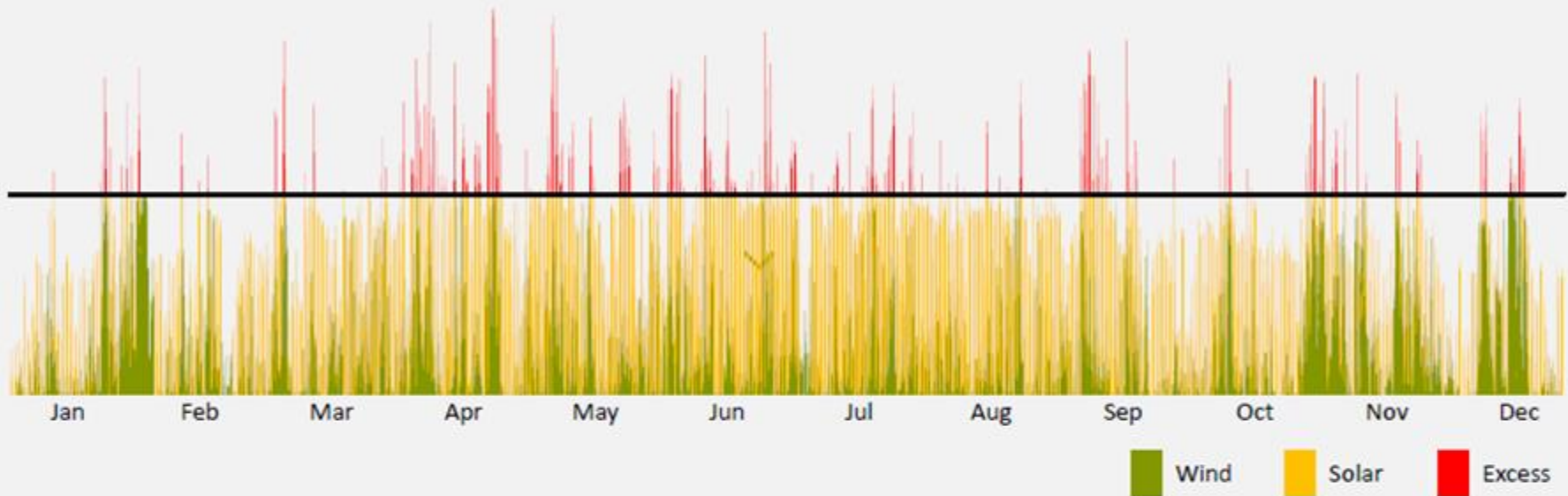
Cap. Factor

Daily load (same size wind&solar)



# 1. Spanish case & legislation (2)

## Full year view



Solar PV pooled to an existing wind farm shows a typical-year total excess <5% (vs. dedicated solar PV interconnection)

## Additional key considerations

### Legislation in Spain

Cable Pooling  
Decree enacted in  
2020



New (complementary) RES capacity can be added to an existing power plant, up to 60% of the new total capacity:  $B/(A+B) < 0.6$

Limitations



The grid access request must be done by the same project owner. Injection to the grid is limited to its original capacity.

### Grid Operator

Obligation to attend  
the request



The grid operator must concede the interconnection agreement at no cost. Of course, environmental, administrative procedures must follow.

No affection –  
SCADA integration



The operator will monitor the total injected power to the grid, which shall never surpass the original capacity granted.

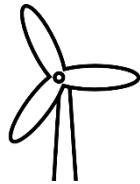
Attractive investment at some -20% CAPEX<sup>1</sup> with just -5% revenues

1. CAPEX considering interconnection costs at 100,000 EUR/MW: 50,000 EUR/MW to DSO/TSO and 50,000 EUR/MW own substation

## 2. Hybrid installation effect (1)

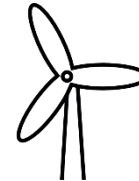
Following installations were taken into consideration once calculating hybrid effect of wind + PV:

### Wind farms:



#### Wind farm 1:

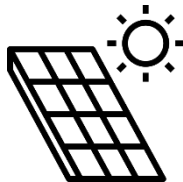
- a) Capacity: ~40 MW
- b) Low productivity: ~2050 nh
- c) Hourly data: 2018 – 2021 (4 years)



#### Wind farm 2:

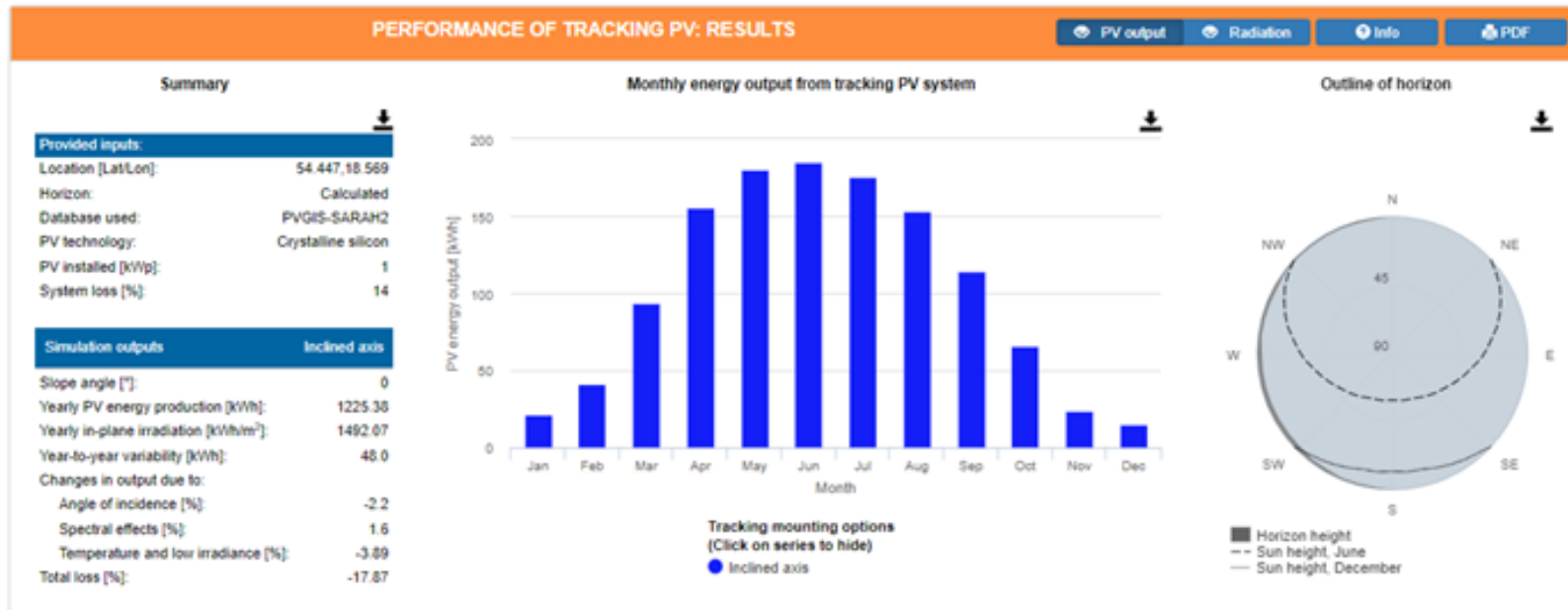
- a) Capacity: ~40 MW
- b) High productivity : ~3500 nh
- c) Hourly data: 2018 – 2021 (4 years)

### PV potential installation:



#### PV:

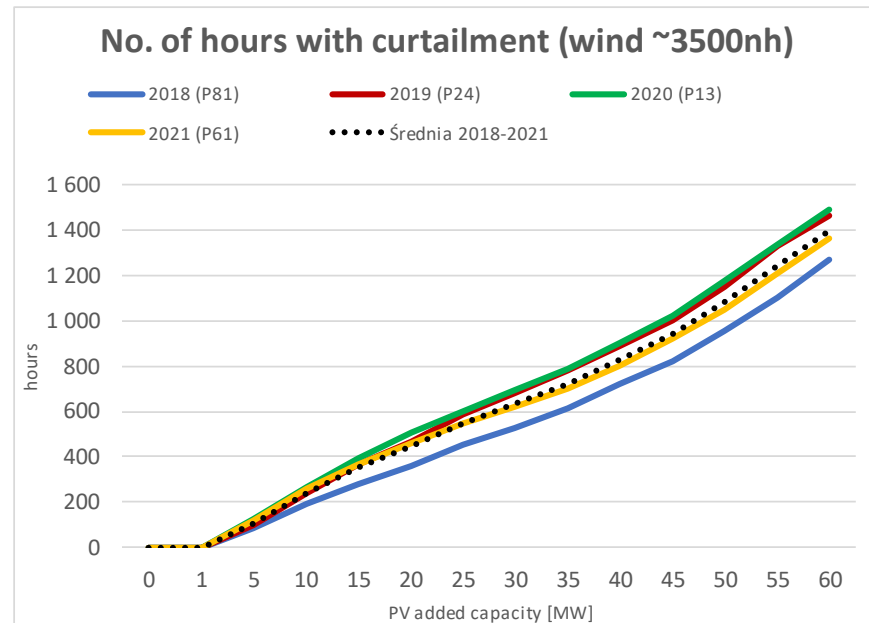
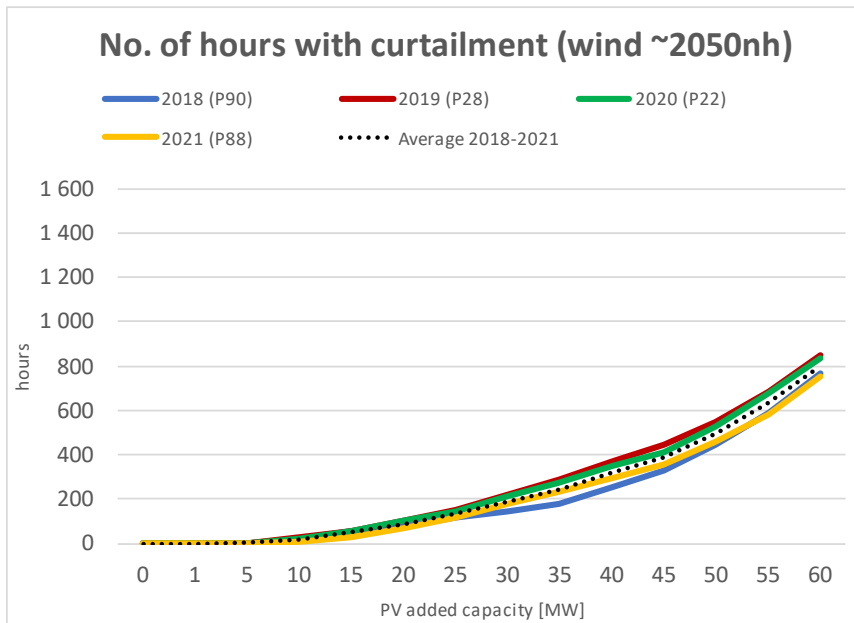
- a) Capacity: multiple of 5 MW between 0 to 60 MW.
- b) Medium productivity: 1225 nh (north Poland)
- c) Hourly data: based on data published by PSE for total PV generation in Poland.



- 1) Source: EU PVGIS Photovoltaic Geographical Information System
- 2) Icons have been designed using resources from Flaticon.com

## 2. Hybrid installation effect (2)

As within cable pooling, total generation of hybrid installation (both wind + PV) cannot exceed the already granted interconnection capacity, then number of hours with active curtailment were calculated. Results are presented below with the breakdown into individual PV capacity for given year.



### For low wind productivity:

- 1) up to 50% of added PV capacity, the curtailment appears only up to ~90 hours (in other words - up to 2 hours per week),
- 2) once similar PV installation installed, then curtailment of generation takes places proportionally up to ~320 hours (in other words – in 1 hour a day).

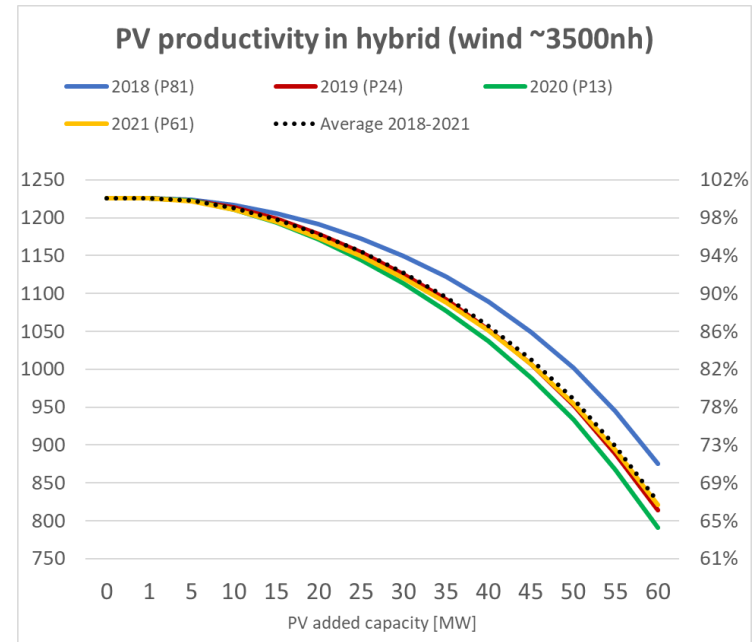
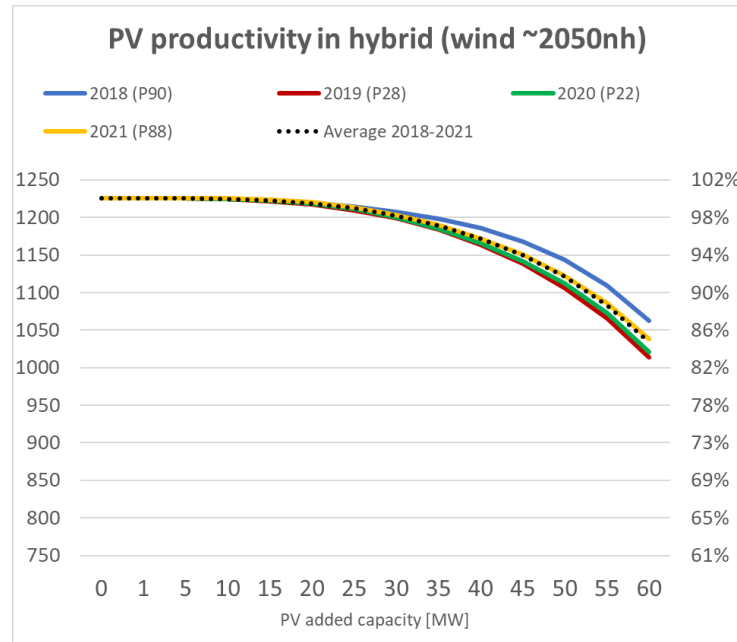
### For high wind productivity:

- 1) situation changes and hours with curtailment appears already with few additional MW installed growing linearly.

## 2. Hybrid installation effect (3)

Number of hours when total generation exceeds granted interconnection capacity does not reflect the real effect of curtailment. Therefore, lost (curtailed) production from added PV installation (with wind generation kept unchanged) is presented on graphs below.

Productivity in different years varied significantly (between ~P15 and P90).



### For low wind productivity:

- 1) hybrid installations with even 75% of added PV capacity have very limited impact (up to 2%) of PV generation. With higher capacity of new PV (50% more than installed as possible in Spain) the PV curtailed generation would be even up to ~17%.

### For high wind productivity:

- 2) curtailed PV generation is low only with small added PV installation (up to 25% with losses of 2%), whereas the curtailment increases exponentially.



### 3. How to implement the *cable pooling* within the current regulatory framework

1. *Cable pooling* means increasing potential of electricity generation, without increasing the interconnection capacity (more energy exported to the grid through the existing interconnection point).
2. *Cable pooling* does not mean any increase of the interconnection capacity for individual installation, therefore should not be treated in the same way as the application for the grid connection capacity for the new projects – this is not the same procedure.
3. It is possible to implement the *cable pooling* by amending actual interconnection agreement at the individual investor request – new installation has to be harmonized with the existing one (integrated communication system, emergency shutdown, new equipment to be install etc.).
4. Similarities to the self generation facilities (companies planning to build its own generating facilities), prosumers (only notification needed for installation energy generating facilities within the max capacity granted by interconnection agreement).
5. RES installations operating under the „green certificates” scheme could implement *cable pooling* without losing this support (electricity generation is measured on the turbines), while the auction projects will not be allowed to participate (energy measured at interconnection point).

### 3. How to implement the *cable pooling* – suggested regulatory changes



1. In order to streamline the process of acceptance *cable pooling* by DSOs as well as to avoid potential disputes between investors and DSOs, it would be advisable to introduce following provisions:
  - a) DSO obligation to positively accept *cable pooling* up to the max capacity (similar to the Spanish regulations), unless it could significantly negatively impact the grid (justified evidence has to be provided when application was rejected).
  - b) under paying deposit fee, such acceptance has to be granted for max 4 years to give time for permitting the additional installation; within this 4 years period investor can sign amended connection agreement; deposit is returnable after construction of the new installation or resignation from construction.
  
2. It could be also recommended to widely allow the proportional measurement at the interconnection point (currently it is applicable only to hybrid projects) to include the „auction projects” to use in the *cable pooling* model (energy generated by the new installation will not be counted for the auction scheme).

### 3. How to implement the *cable pooling* – final remarks

1. Taking into consideration findings from our calculations, application of the *cable pooling* model for all wind farms operated under the green certificate scheme with accepted loss of 5% of the new PV generation, may allow to build up to 87% new PV capacity (6 400 MW in wind – 5 600 MW in PV), which may increase the electricity generation by max 42% (15 440 GWh in wind – 6 517 GWh in new PV). In reality it will be lower numbers, as such new PV installation could not be developed for all wind park locations.
2. If we add also „auction projects” this additional PV capacity may increase further, however less than for the „old” wind portfolio (the higher wind productivity, the lower new PV capacity).
3. It has to be considered to extend the *cable pooling* concept by including granting grid capacity for new installations connected in the new interconnection points under the acceptance of the obligatory curtailment not compensated by DSO (the max curtailment ratio will be calculated taking into consideration operating installations located in the neighboring area); it will allow to built new installations by new investors in the new locations, not necessarily connected to the existing interconnection points.



**TUNDRA**

*We make your projects grow*

Tundra Advisory Sp. zo.o.  
ul. Do Studzienki 63, lok. 115  
80-227 Gdańsk  
NIP 527-255-24-72

+48 58 580 17 89  
[tundra@tundraadvisory.com](mailto:tundra@tundraadvisory.com)