Italian protocol for massive solar penetration

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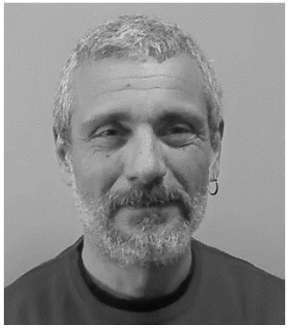
Credits



Marco Pierro

Richard Perez

Marc Perez

David Moser

Matteo Giacomo Prina

Outline

Italian energy outlook

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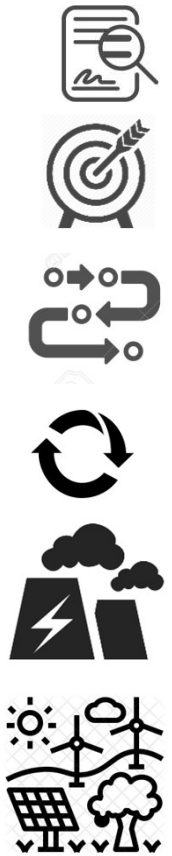
Methodology

Flexible PV concept

Firm PV generation

100% Renewable transition

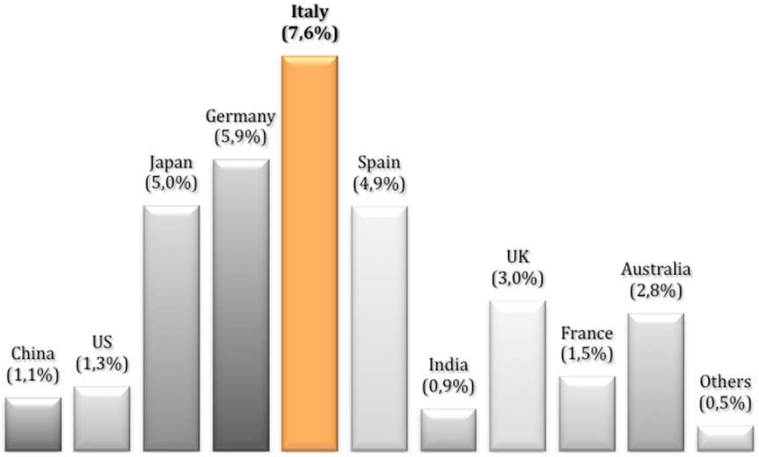


Italian energy outlook

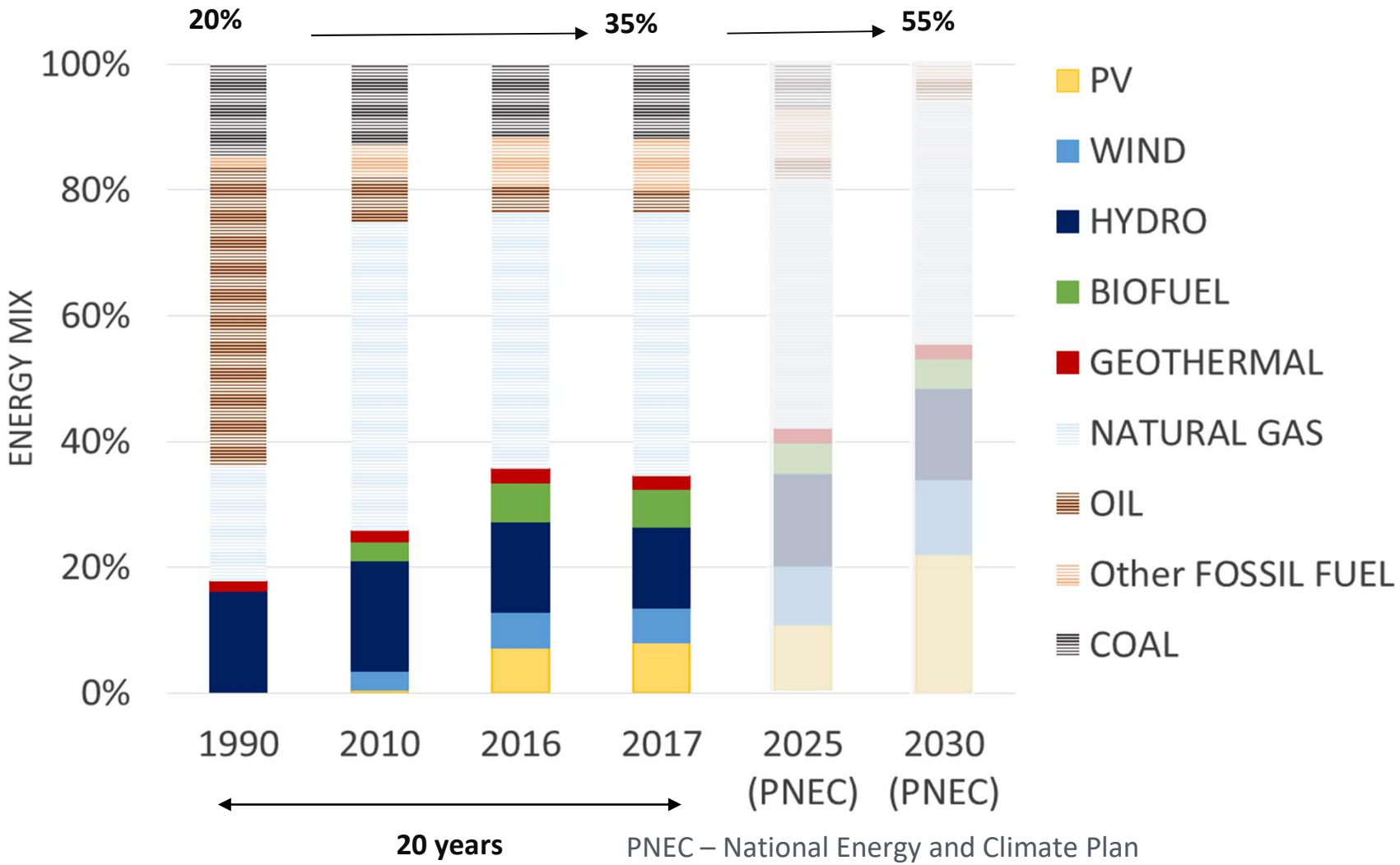
PV generation

PV penetration= PV generation/electric consumption (295.5 TWh)

PV penetration



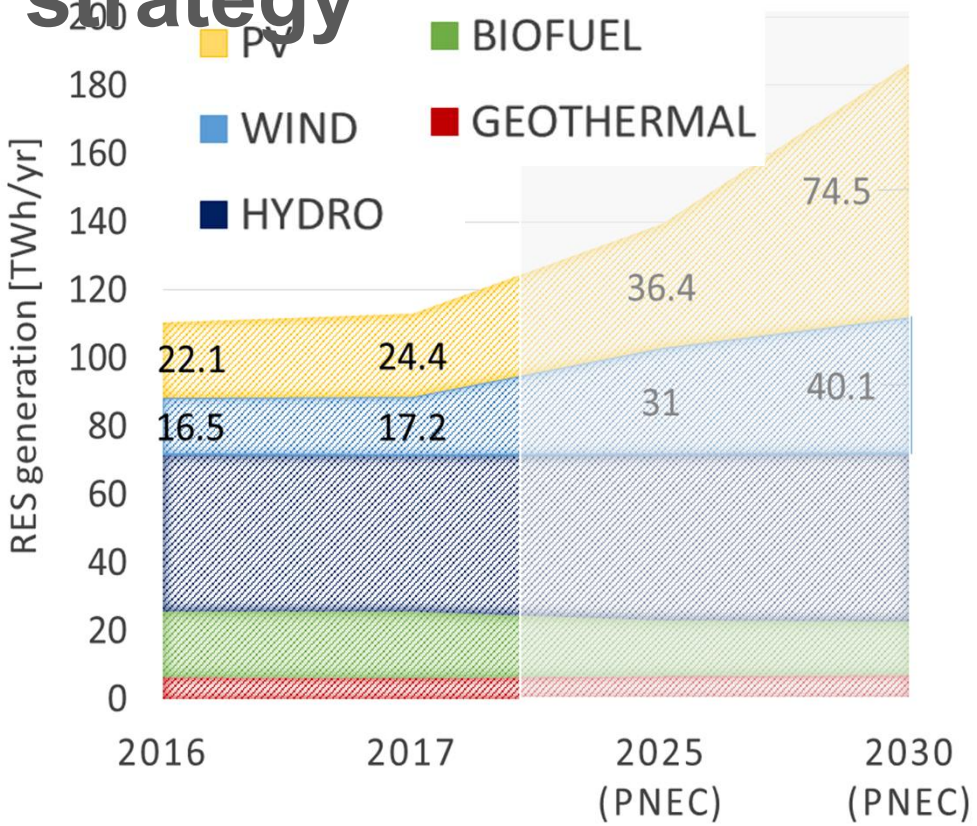
Italian energy outlook



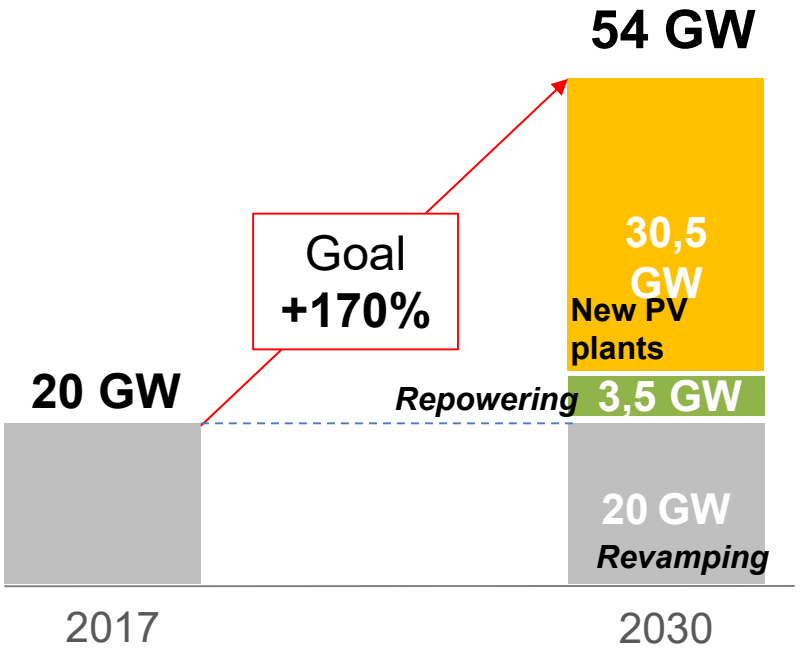
PNEC – National Energy and Climate Plan

Italian energy outlook

European SET Plan → PNEC strategy



Renewable Energy



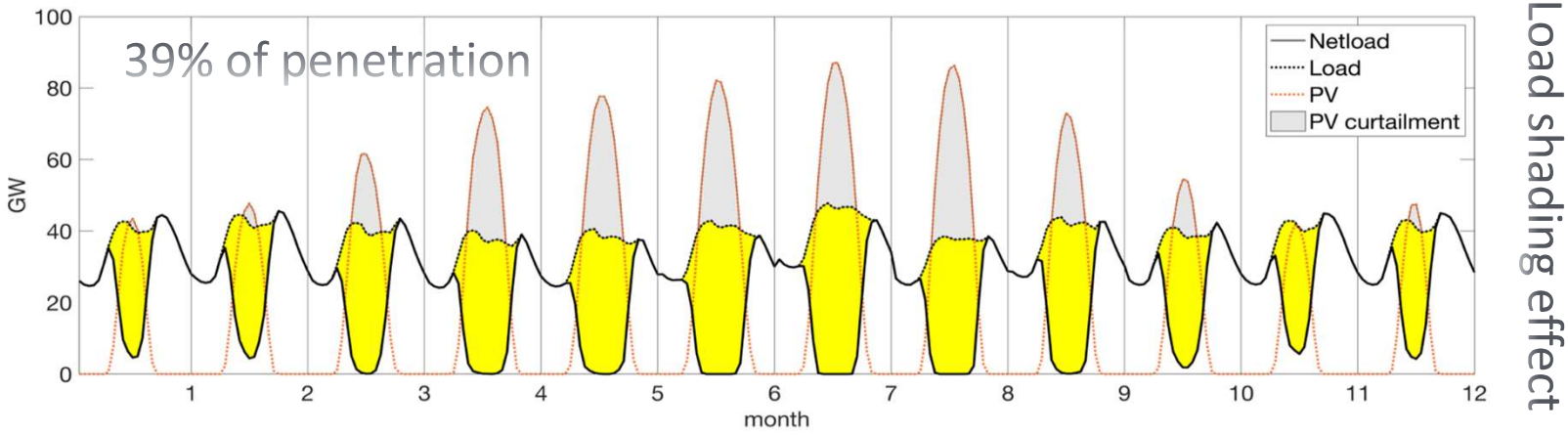
PV Power

Motivation

PV production is:

- **intermittent**

- **difficult to predict**



Load shading effect

Monthly average of the daily profiles

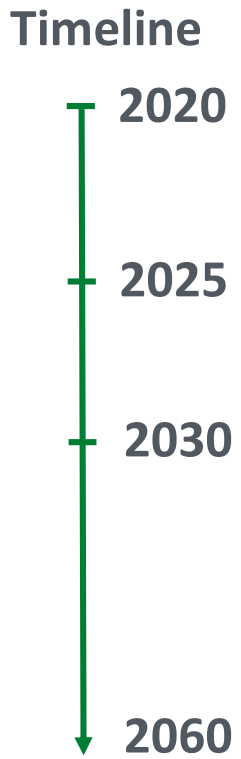
Aim

We suggest a temporal sequence of three **strategies** to allow massive solar penetration in the Italian case study :

1. **Improve the forecast accuracy** and **enlarge the forecast footprint** from the **current six market** zones to the **whole Italy**

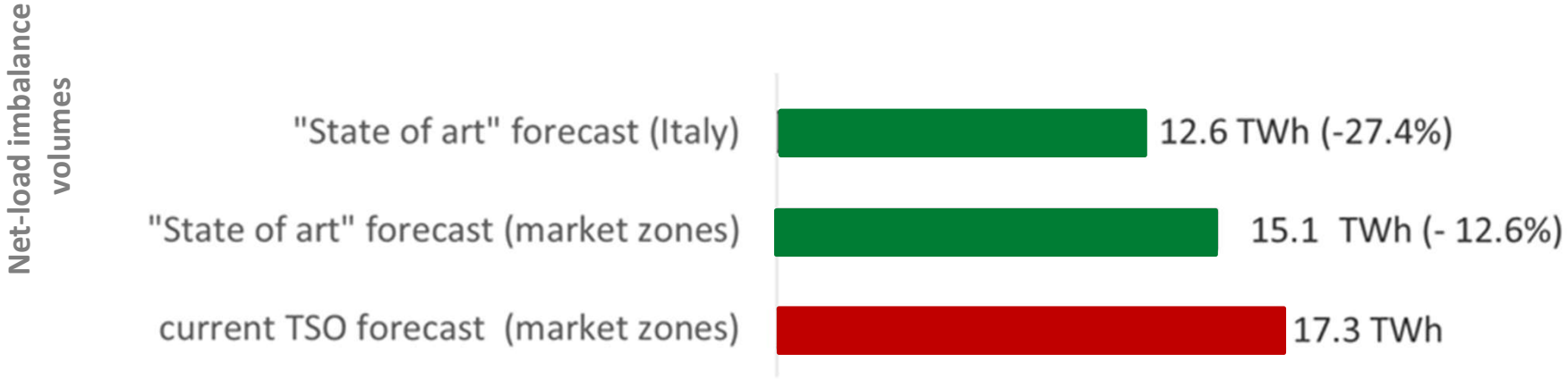
2. Use of **flexible PV plants** for **solar imbalance regulation (perfect forecast)**

3. Use of flexible PV plants for **firm PV generation**

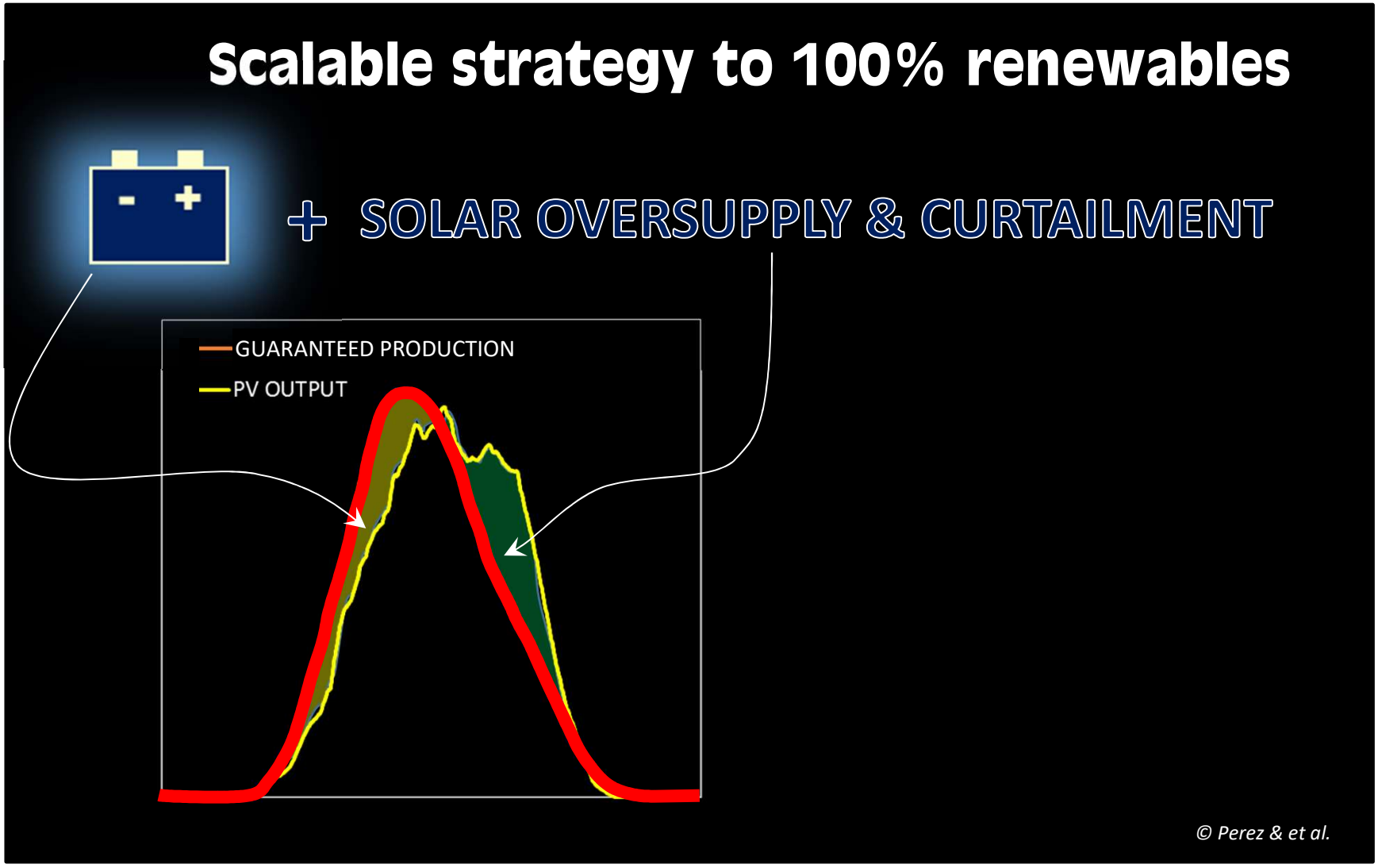


Forecast accuracy

-27.4 %



Flexible PV plant concept



Perfect forecast

“state of the art” forecast

Solar regulation

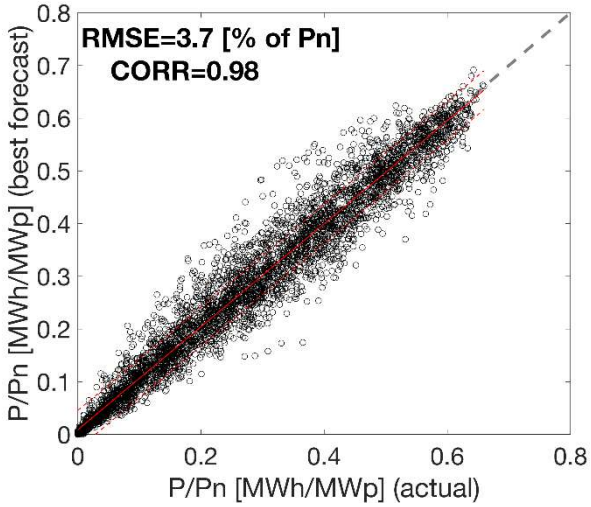
0.25 kWh/kWp

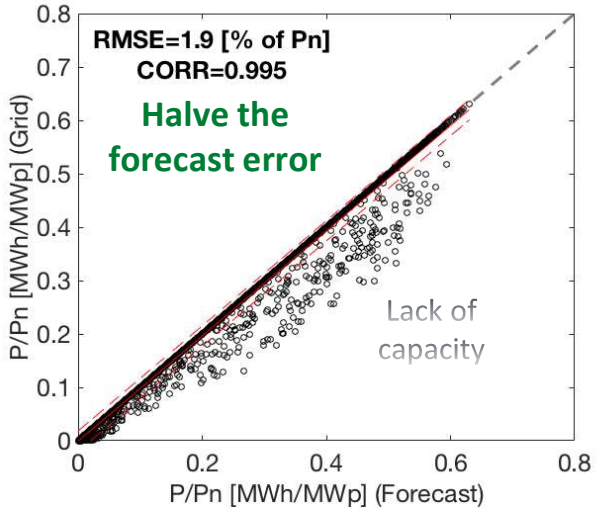
3.8% of PV generation

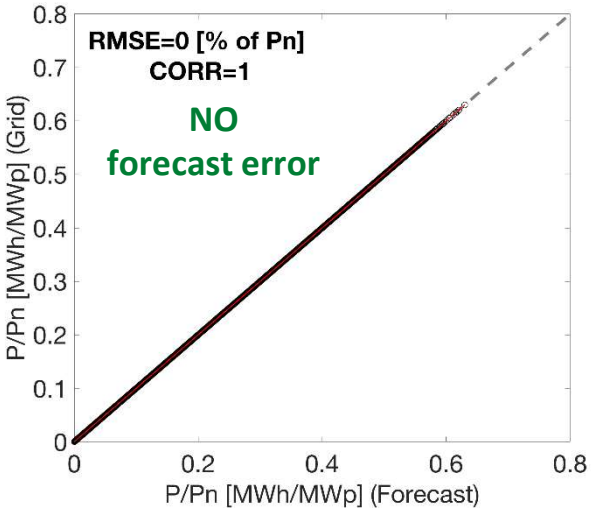
Perfect forecast

1.4 kWh/kWp

3.8% of PV generation

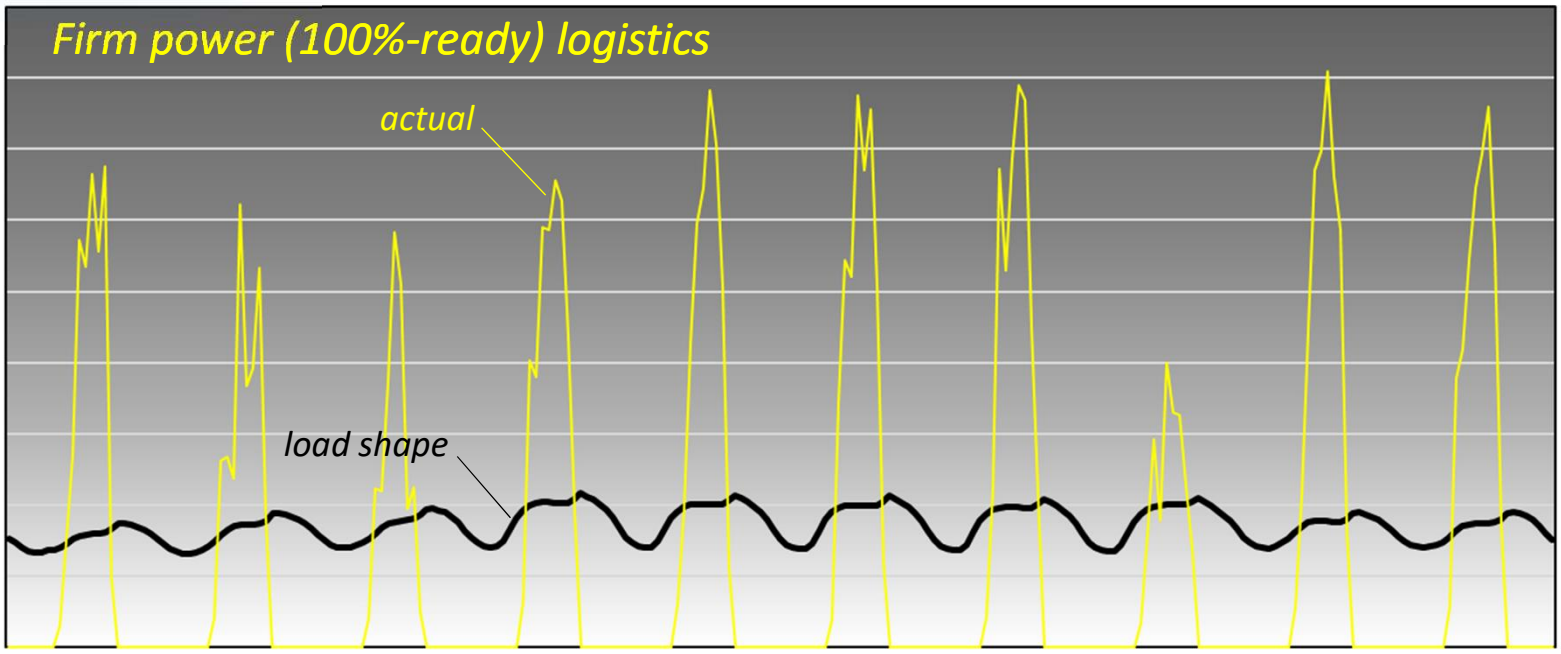






Firm PV generation

+ SOLAR OVERSUPPLY & CURTAILMENT



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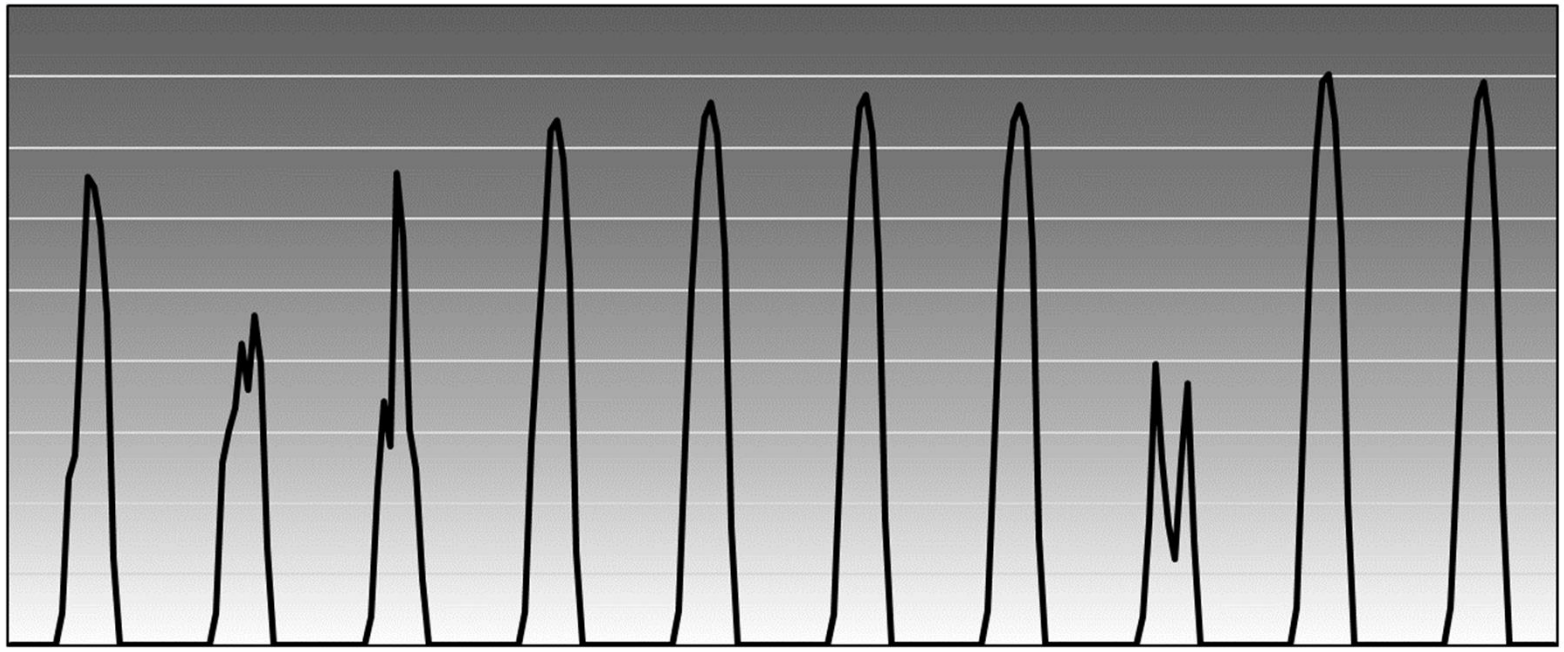

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Firm PV generation

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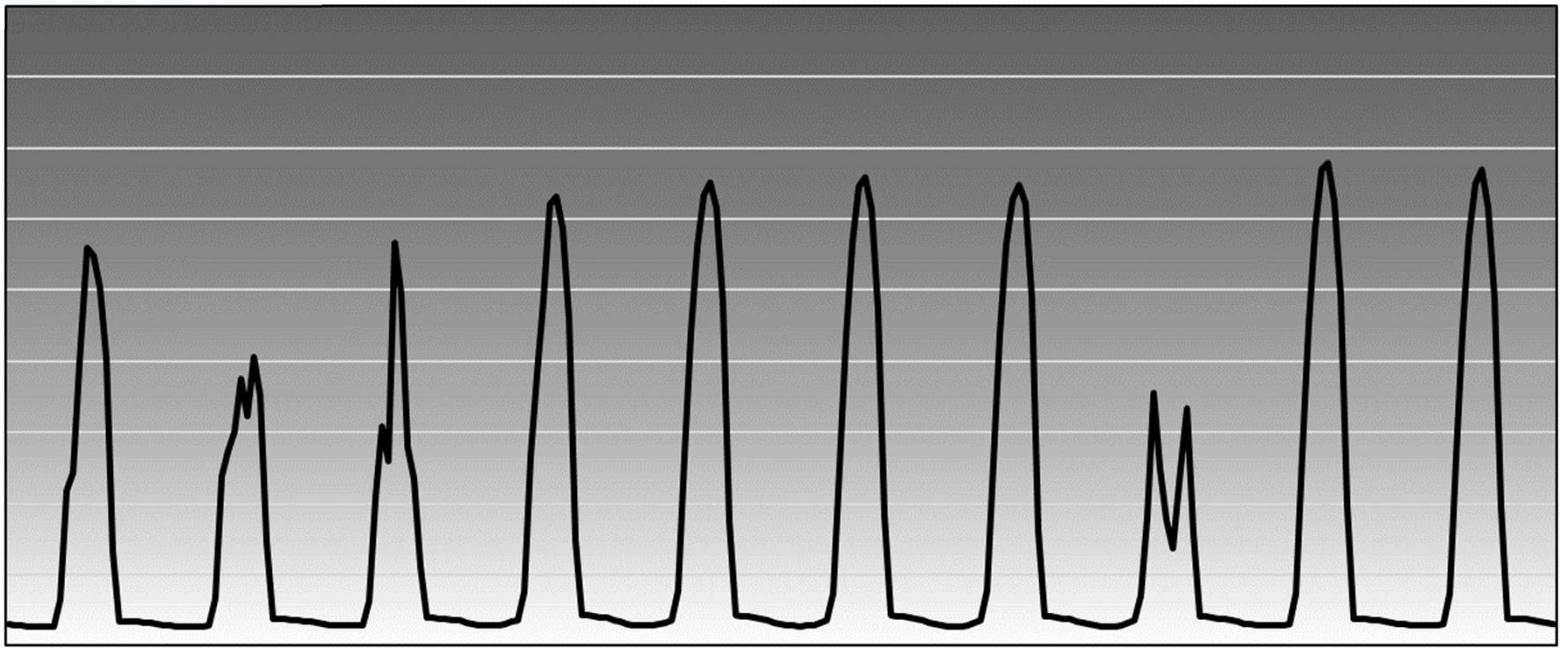

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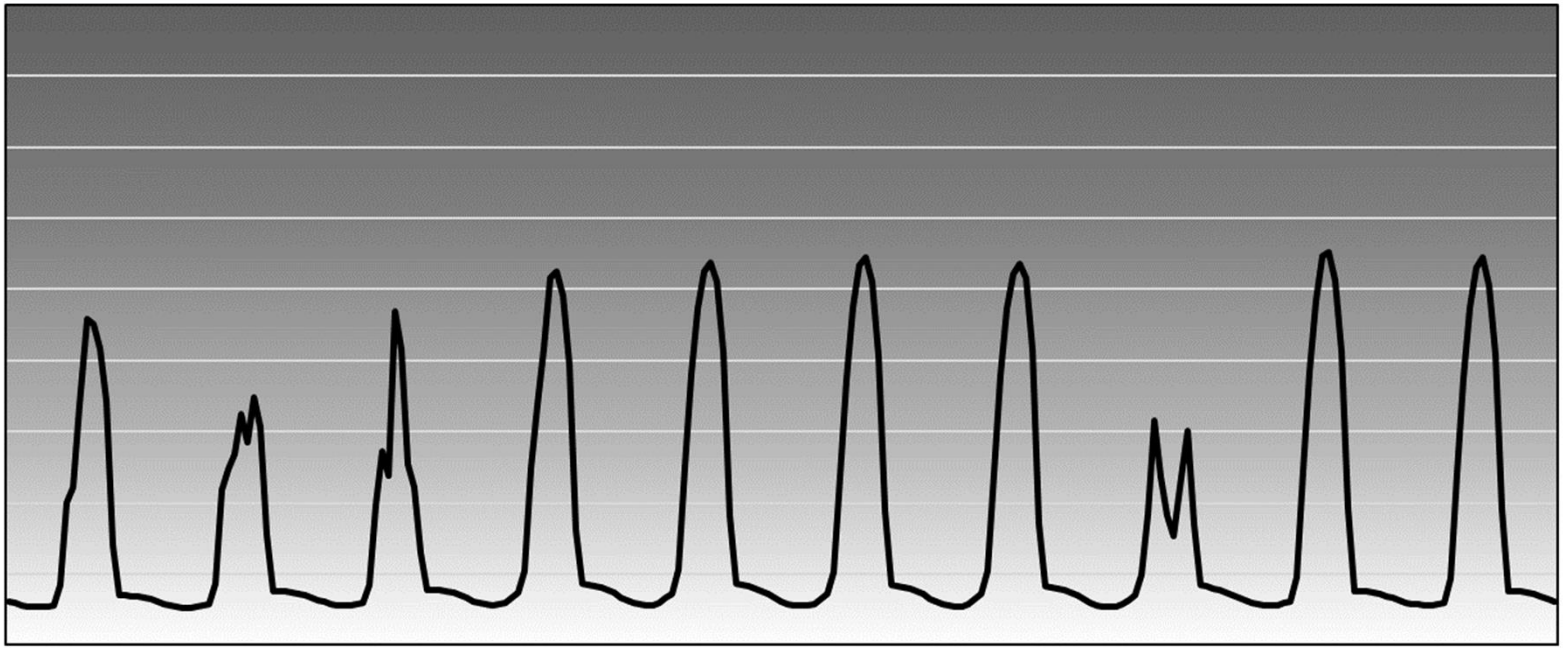

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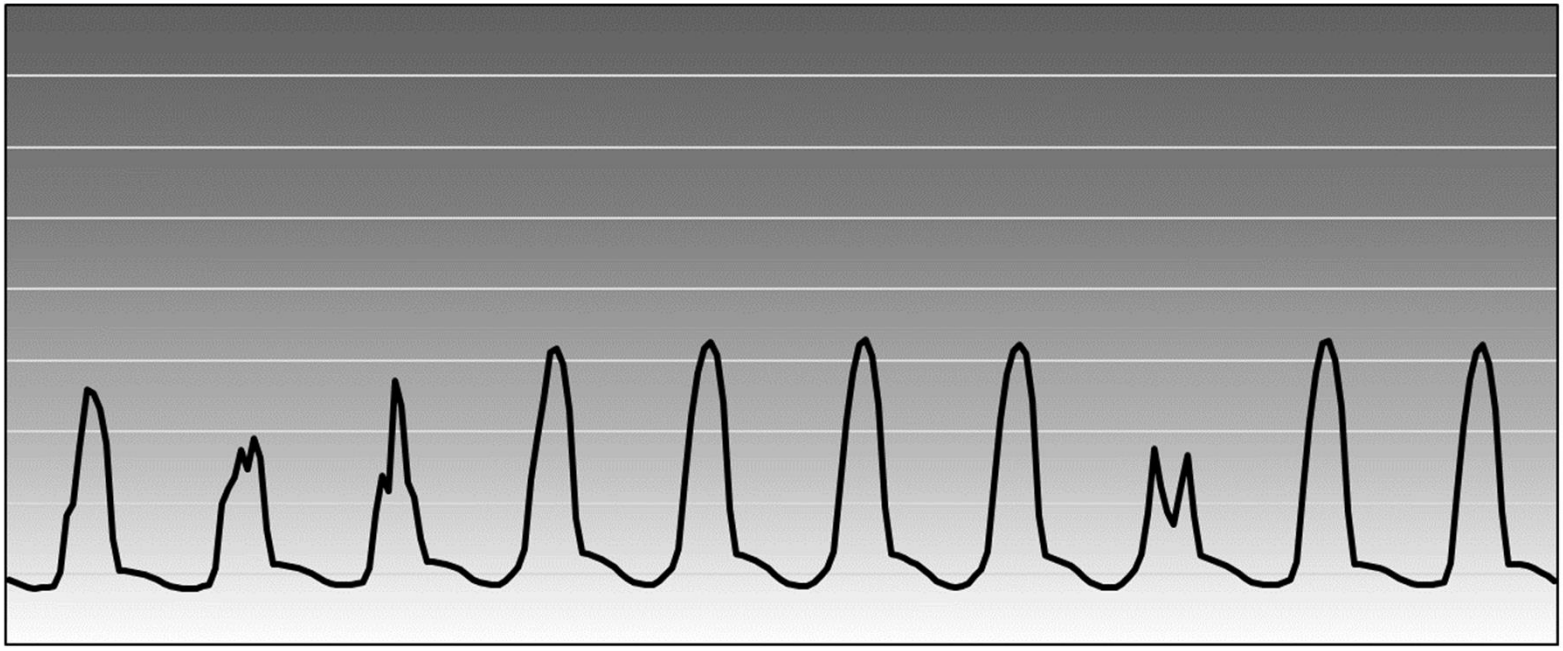

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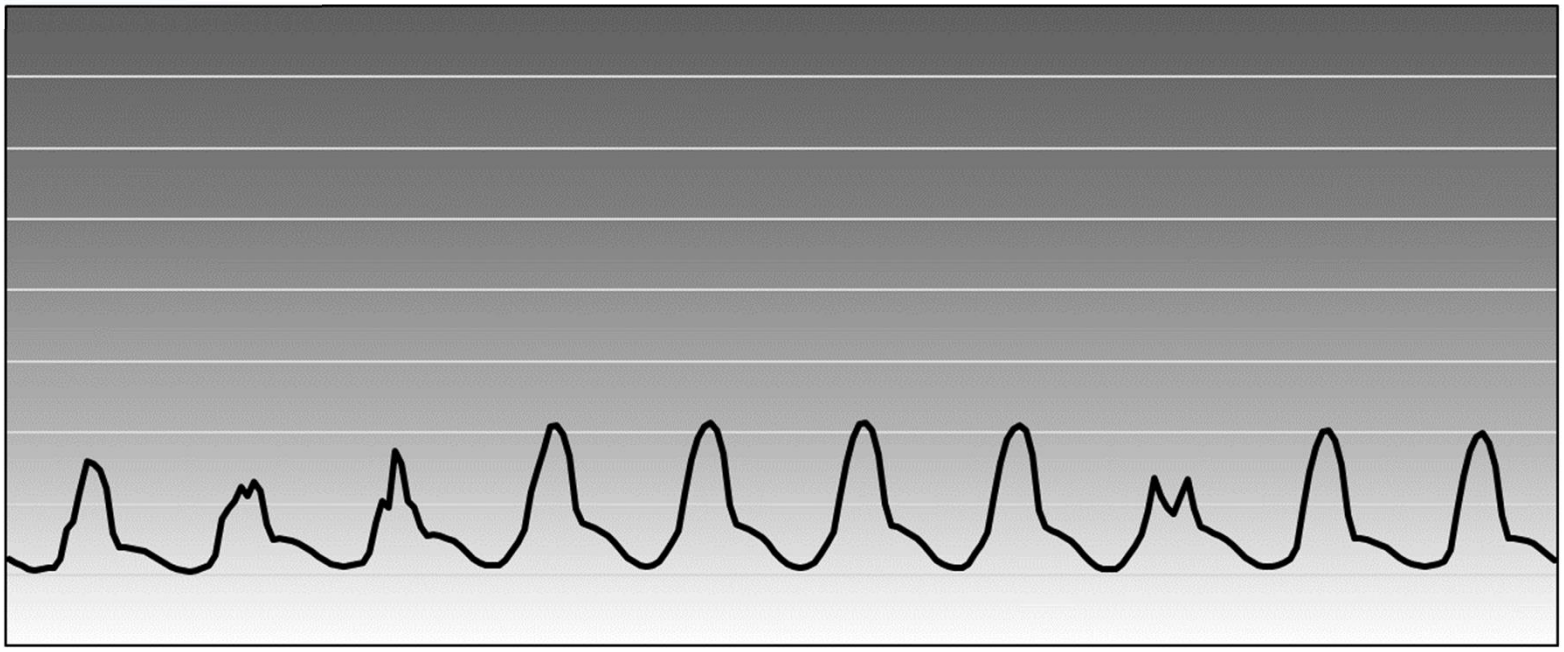

Firm PV generation

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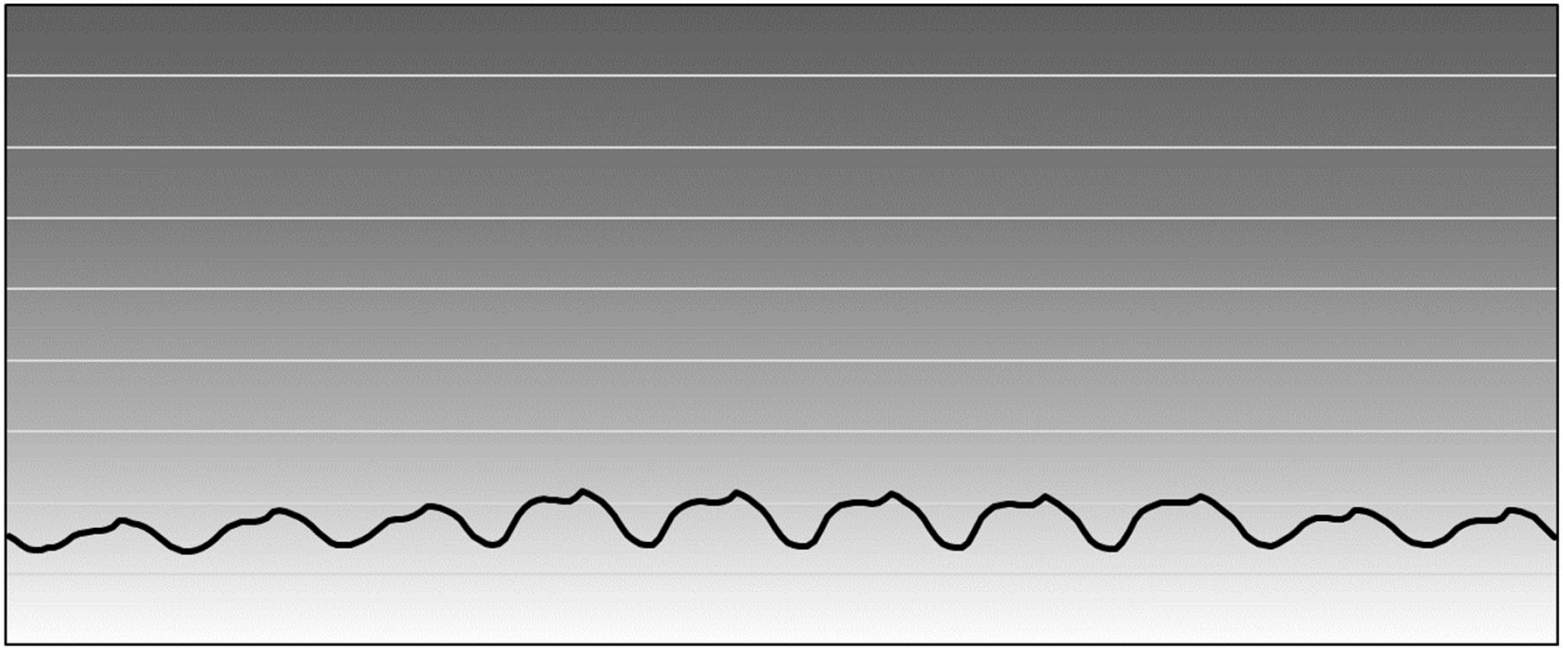

Firm PV generation

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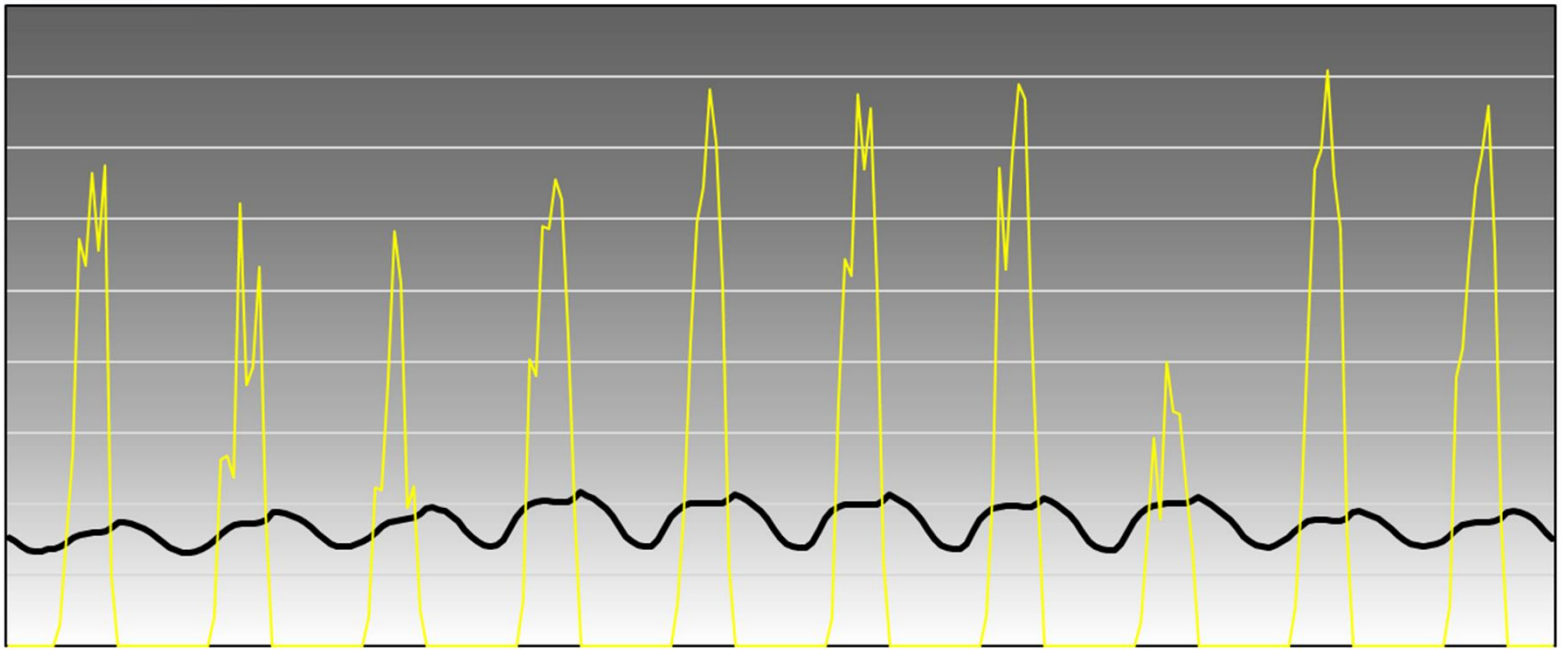
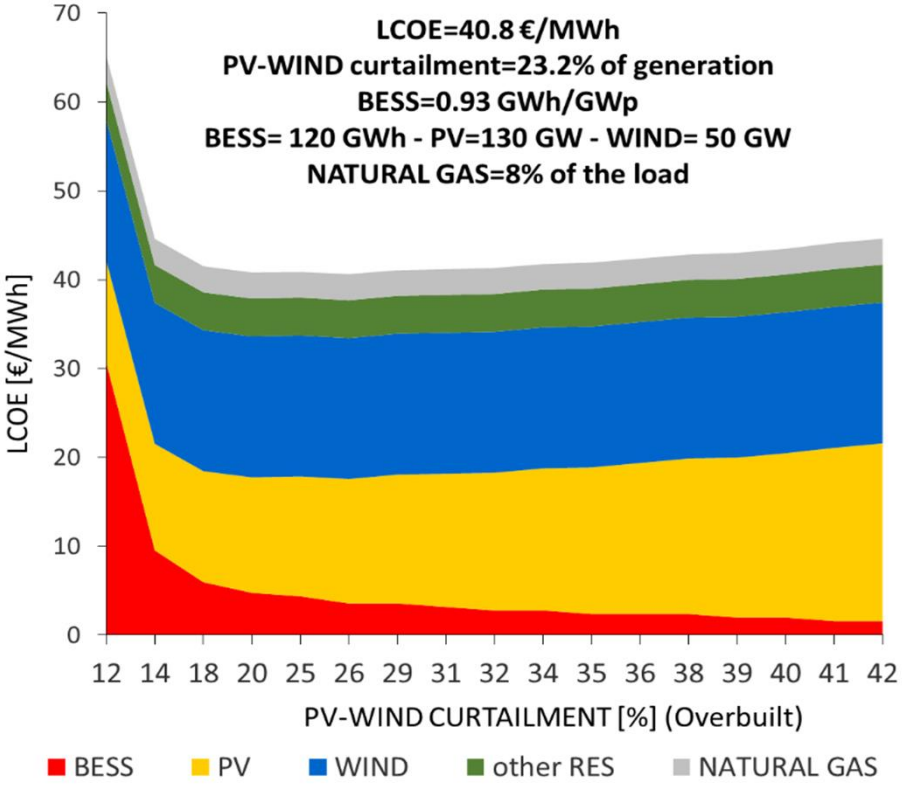


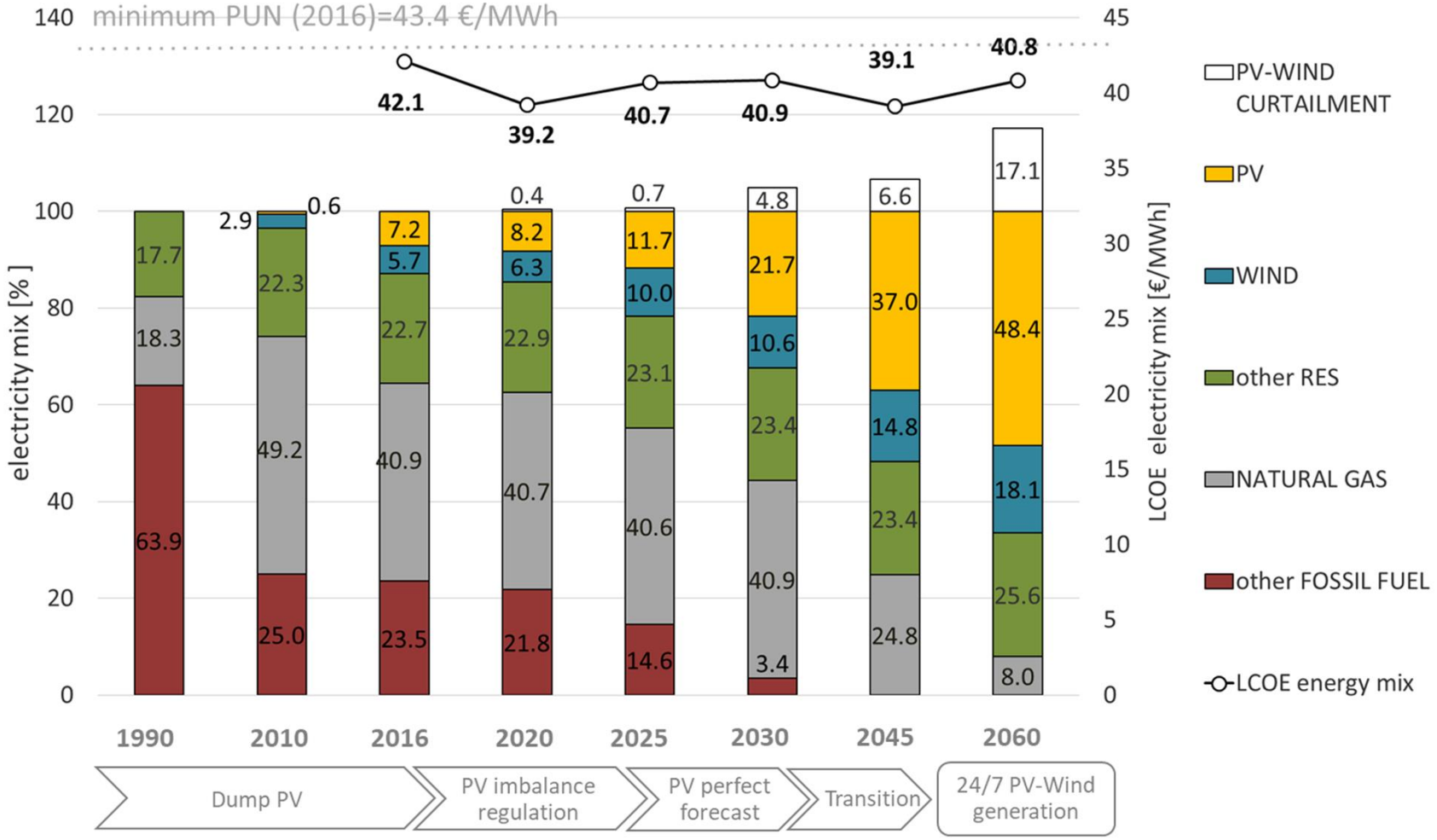
Firm PV generation

By 2060, turnkey utility-scale PV costs are expected to be at € 350 and batteries at € 90 per kWh. At this point, applying flexible PV and wind plants for firm 24/365 power generation will be economically attractive.

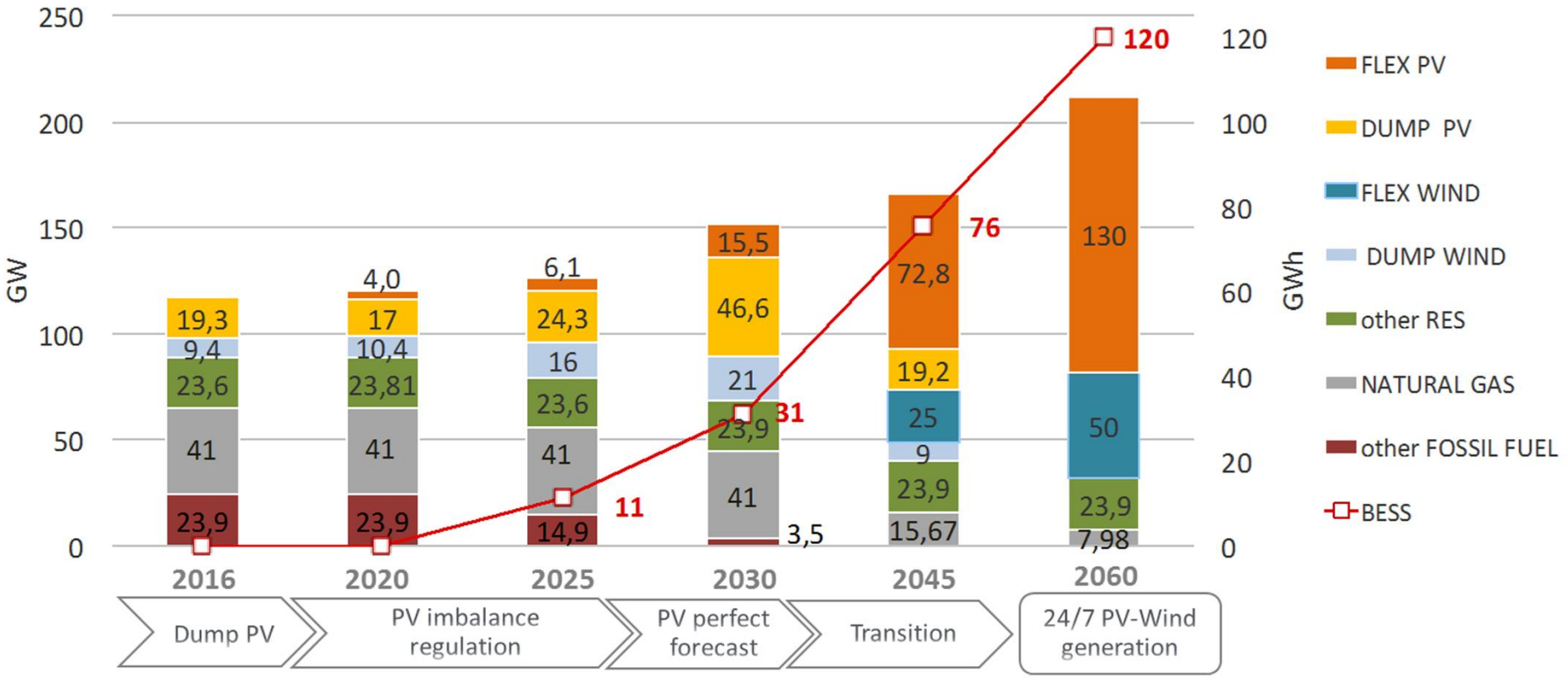


To reach least-cost production, an optimal balancing between solar and wind overbuild/curtailment and storage must be determined. A small residual use of natural gas could also be considered to further minimize costs and maximize flexibility.

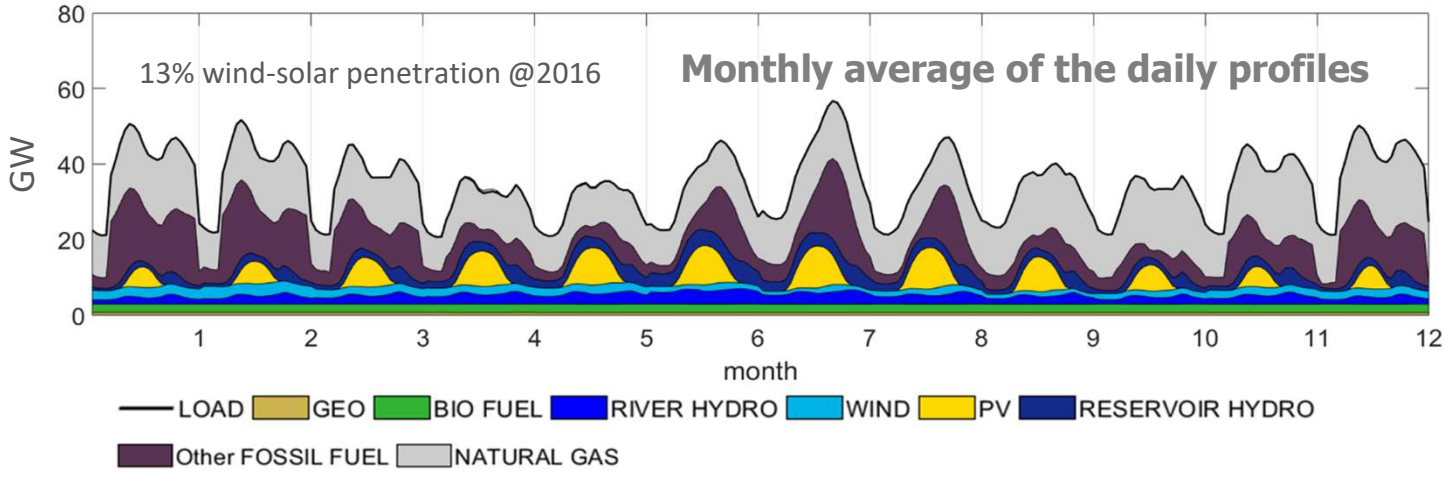
100% Renewable transition

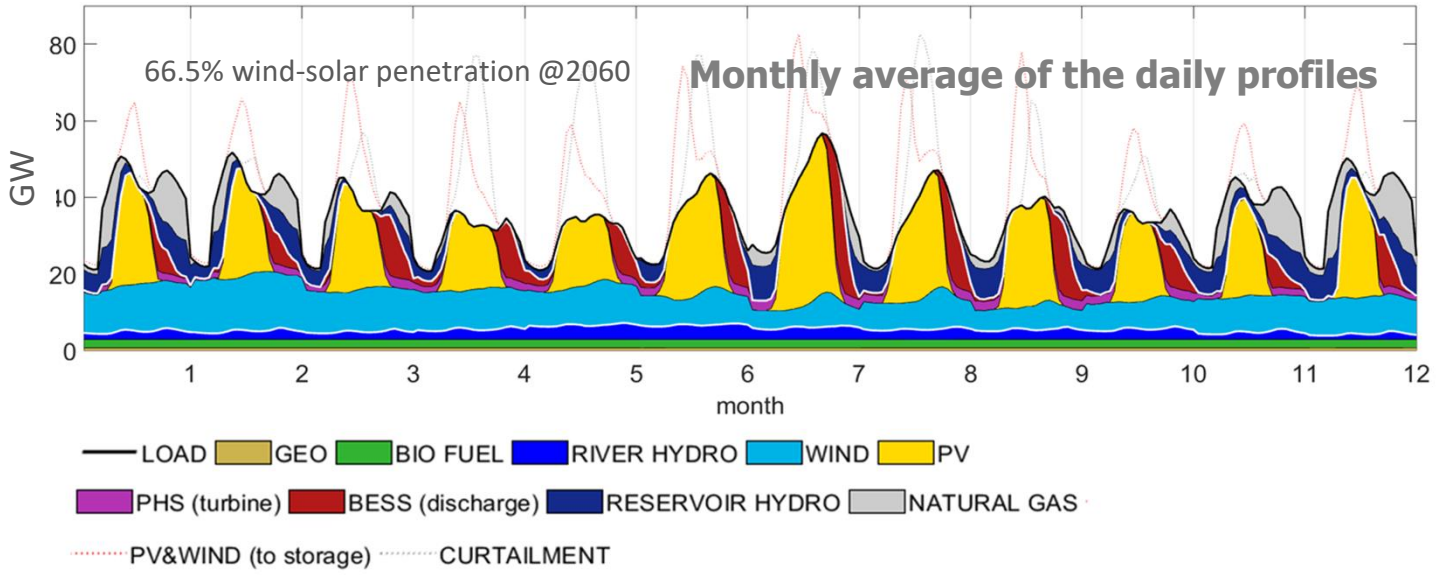


100% Renewable transition



100% Renewable transition

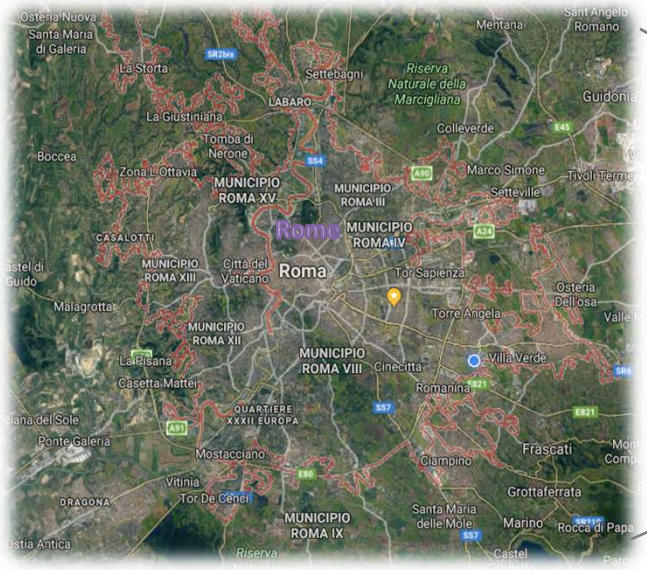




92% RES transition

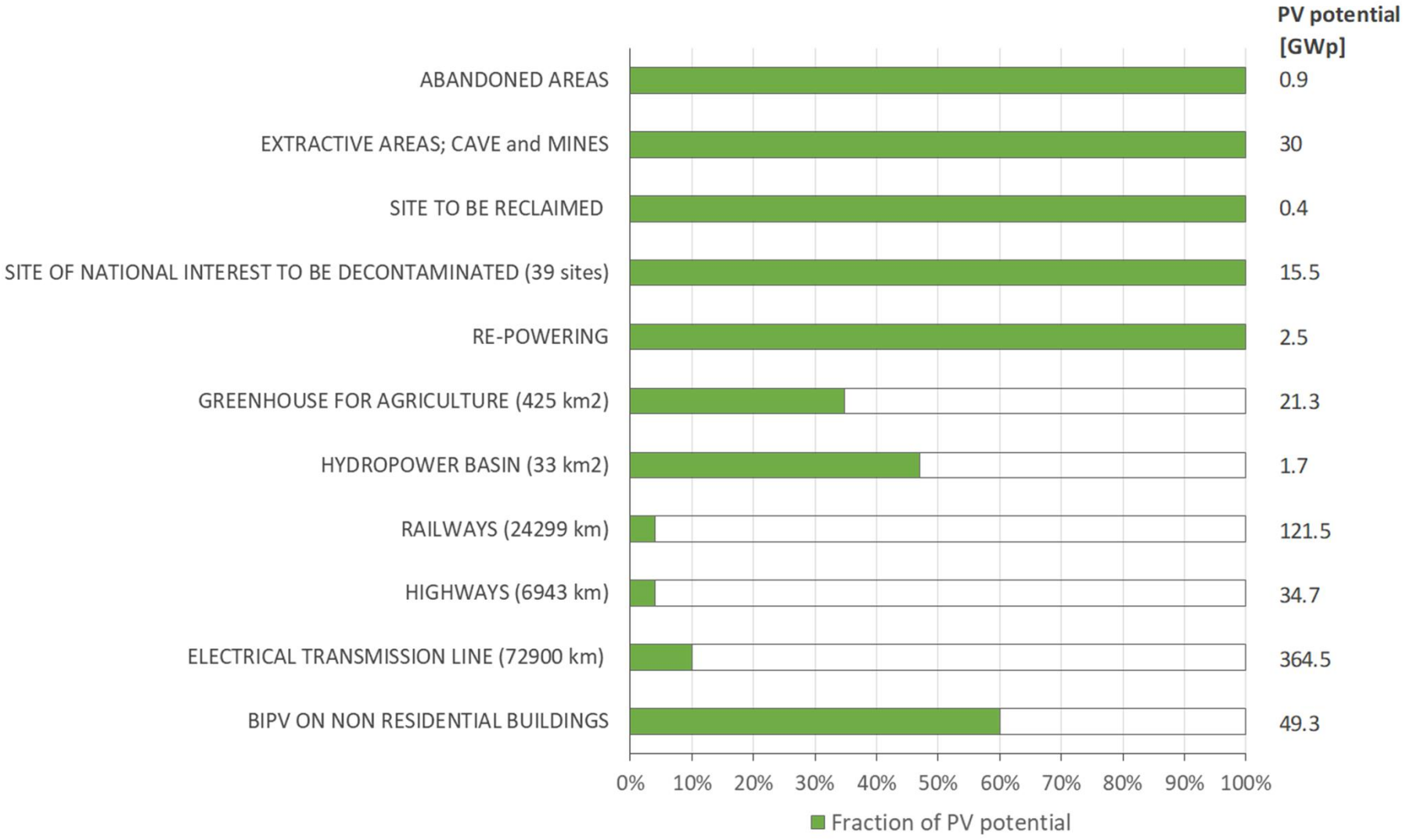
Where to install?

130 GW → 0.4% of the Italian surface area



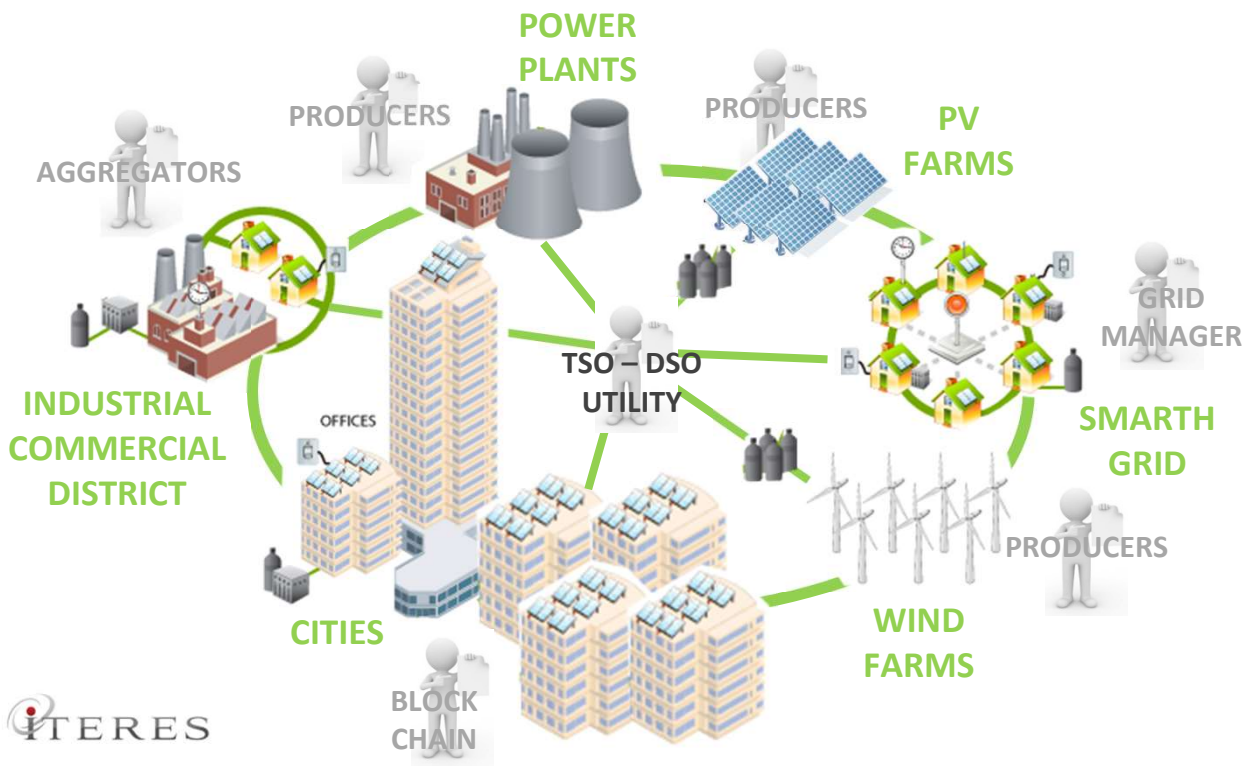
1.3×10^3 km^2

Where to install?



A change of paradigm

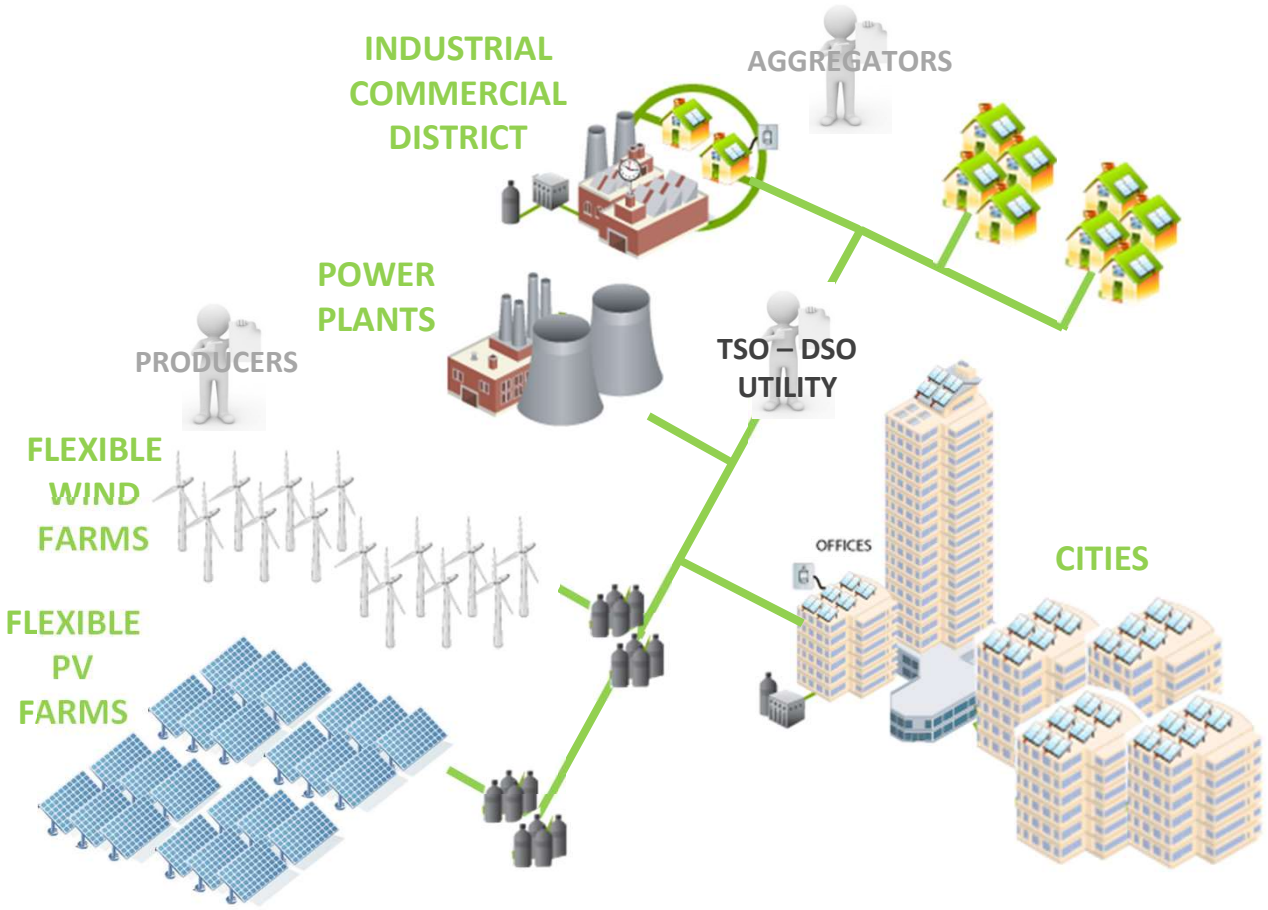
DISTRIBUTED GENERATION



- ✓ **High solar integration**
- ✓ **Low distribution loss**
- ✓ **Difficulties in O&M**
- ✓ **Complex system with many actors**
- ✓ **Intermittent PV generation**
- ✓ **Grid management problems for TSO-DSO**
- ✓ **Not enough space for massive solar generation in cities**
- ✓ **High PV costs (not for all)**

A change of paradigm

CENTRALIZED MASSIVE SOLAR & WIND GENERATION



- ✓ **High solar visual impact**
- ✓ **High distribution loss**
- ✓ **Optimal performance and O&M**
- ✓ **Simple system with few actors**
- ✓ **Centralize TSO-DSO Grid management and no radical grid change**
- ✓ **Very low PV and storage costs**
- ✓ **Solar availability for all**

Reference

Renewable Energy 169 (2021) 425–436

Contents lists available at ScienceDirect

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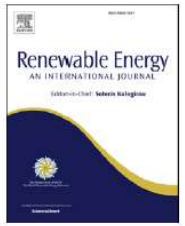

Italian protocol for massive solar integration: From solar imbalance regulation to firm 24/365 solar generation

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Yes, we can!