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Waste2GridS: Triple-mode grid-balancing plant based on biomass gasification and solid-oxide cell stacks

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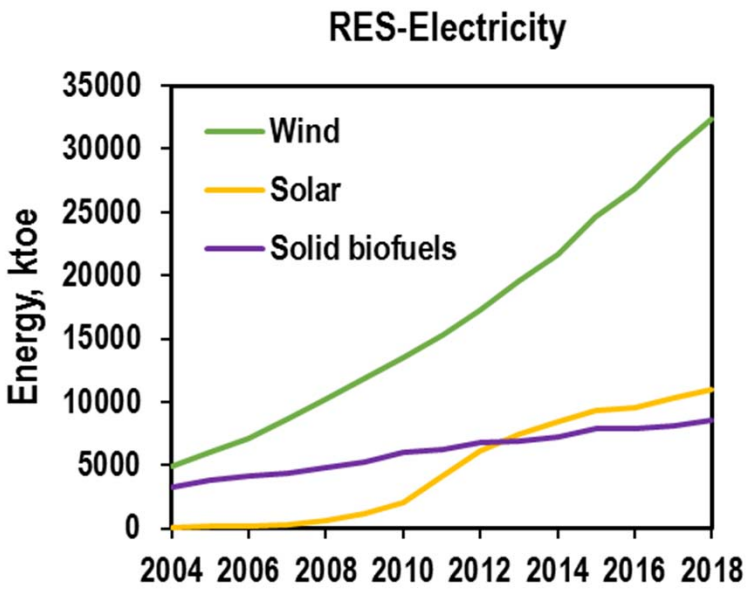
EU-28 waste/biomass utilization

eurostat

2016 **Recovery**

- Recycle 37.8%
- Backfilling 9.9%
- Energy recovery 5.6%

Landfill, incineration without energy recovery 46.7%



High-value waste-to-energy (electricity & bio-fuel)

The role of biomass in electricity sector in future?

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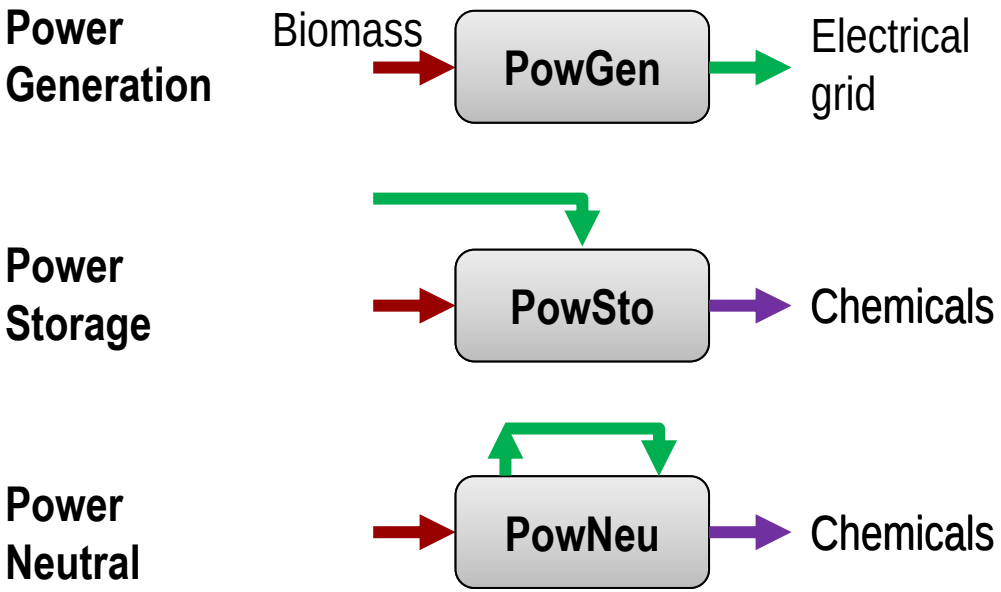
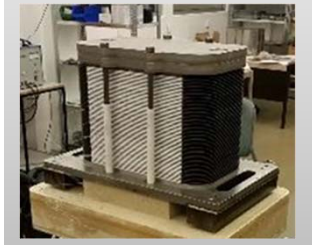
Triple-mode grid balancing plant

- A biomass power plant with power-to-fuel capability



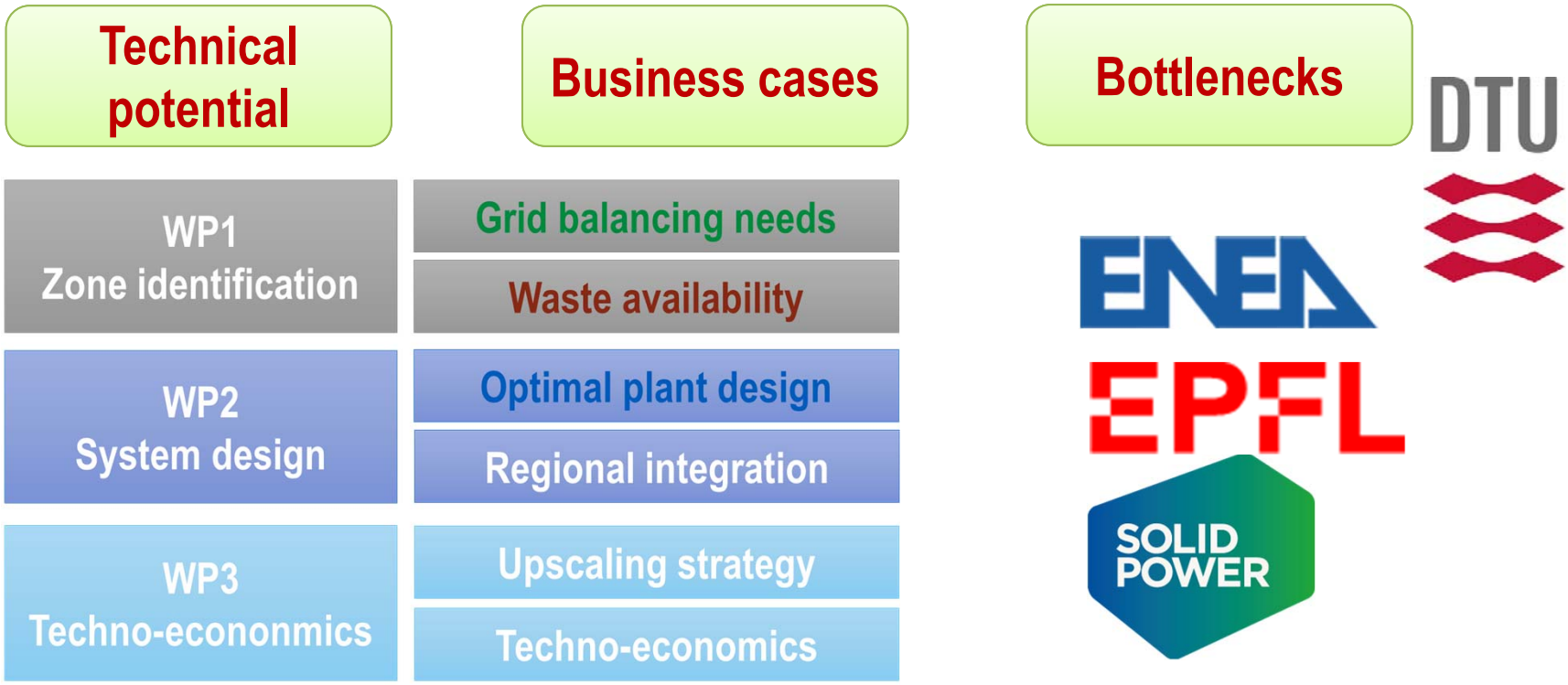
Unique rSOC



- **Reversible operation**
- **High reactant flexibility**

Grid-scale application: Gasification → Syngas → rSOC → End product

Economic feasibility study at 2030



Complex optimization problem: combinatory nature, nonlinear, mixed-integer

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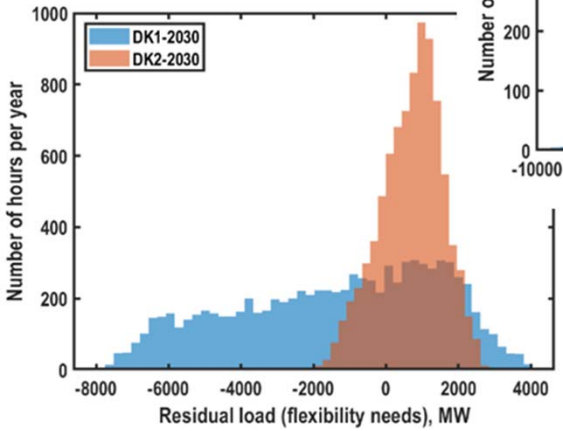
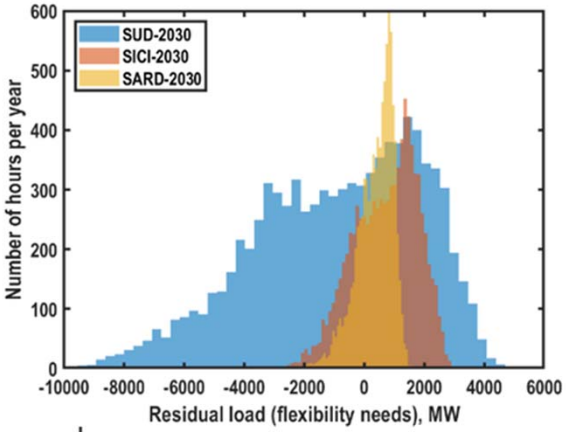
2030 grid flexibility needs of selected RES-dominated zones

Capacity

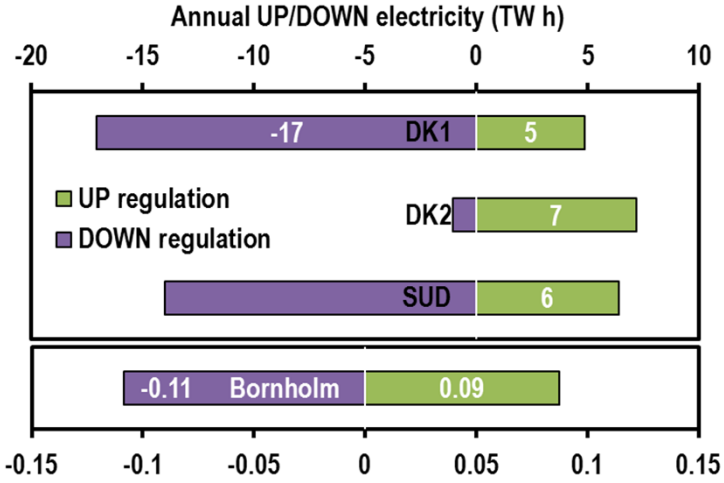
Denmark 2030





Italy 2030

Energy



Large flexibility needs in 2030 both in capacity or energy, however, balancing market…

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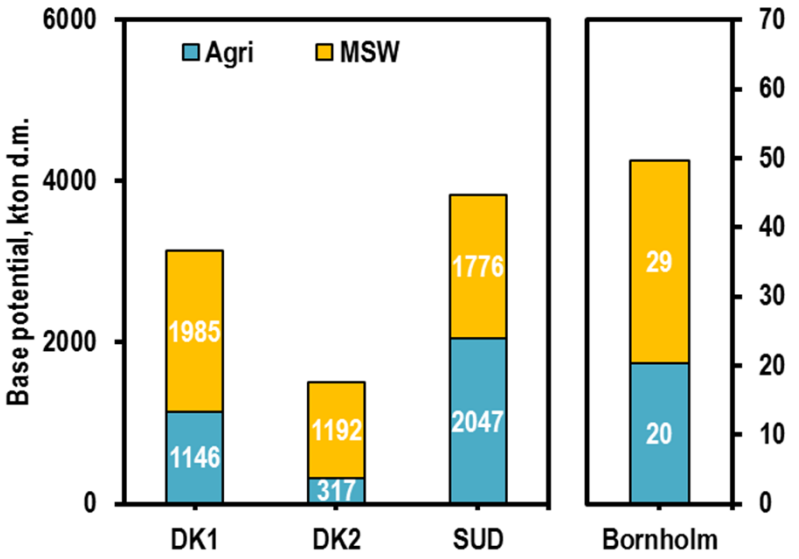
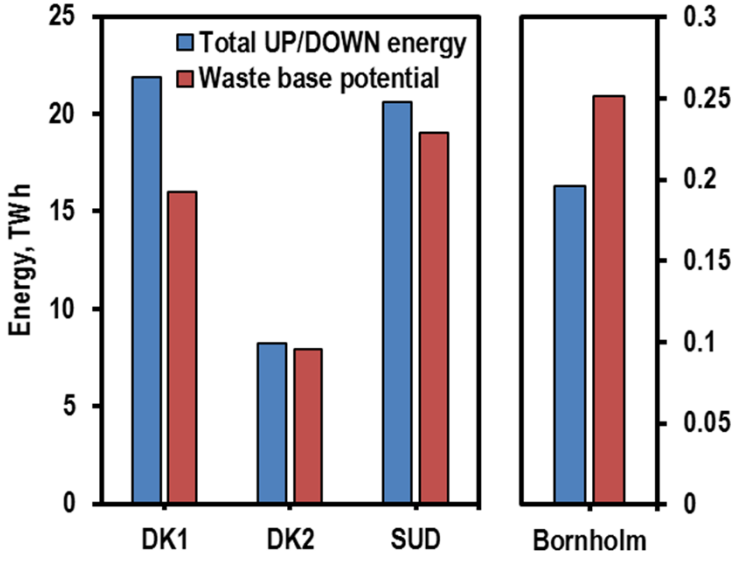
2030 local waste availability

Local exploitable wastes (Agri, MSW)



Waste energy v.s. flexibility needs



Local exploitable wastes enough to contribute significantly to local grid balancing.

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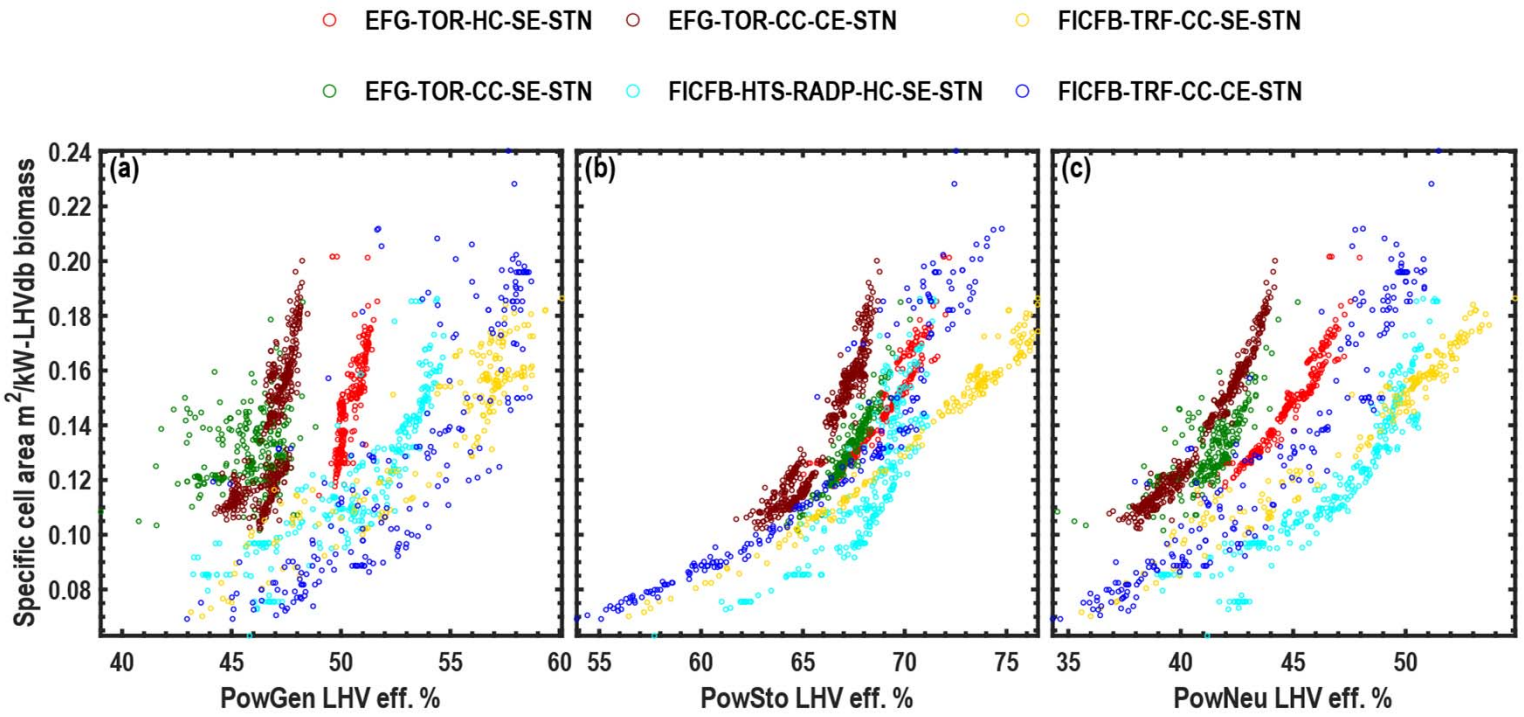
Pool of optimal plant design



(1) High efficiency. (2) Mode efficiencies and grid-interaction characteristics vary among plant designs with different process options. (3) Design alternatives for different balancing profiles.

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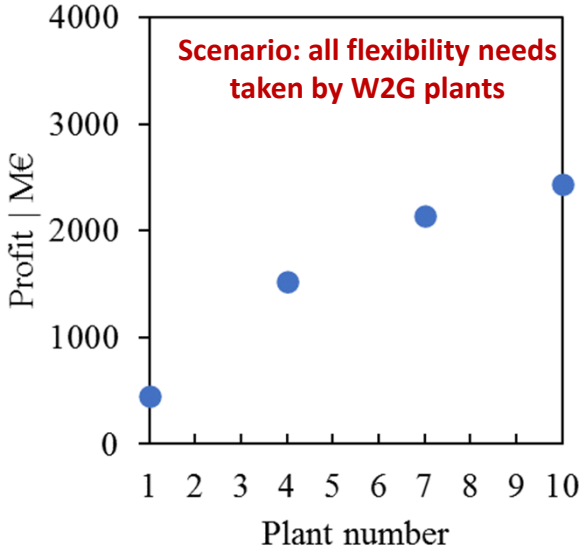
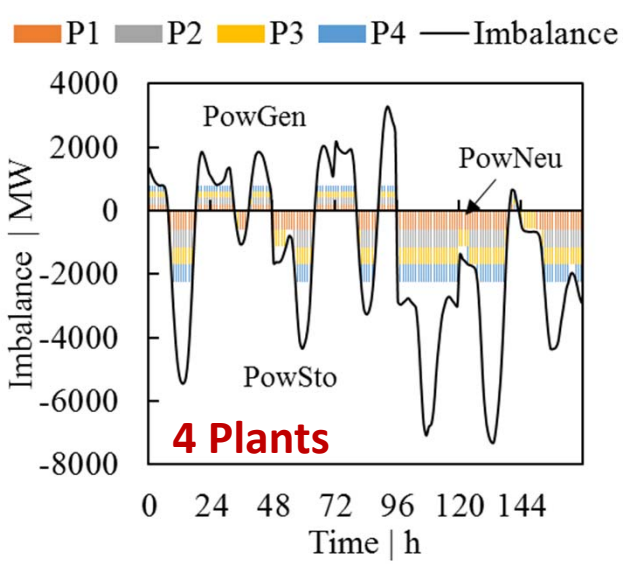
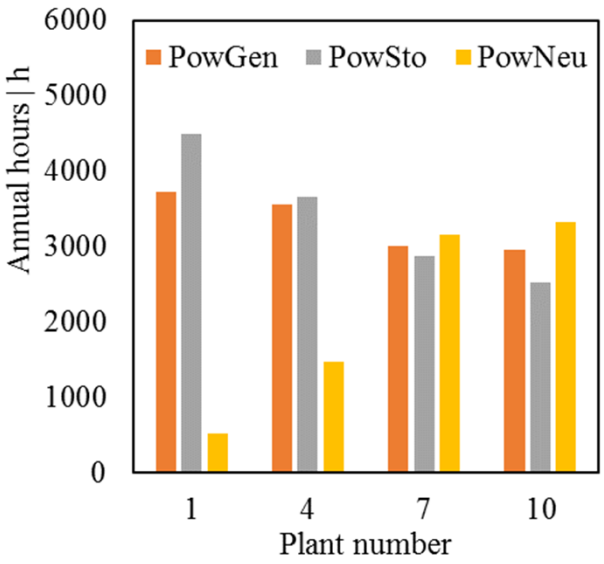
Grid integration to maximize balancing service gain (SUD, IT)

- Considering only ***energy balancing*** *(40 €/MWh), no capacity reserves*
- Design selection, plant number, sizing & scheduling







- More plants installed with optimal sizes, the profit increases but the increment decreases.
- **More plants coordinated to operate under PowNeu mode (not preferable mode)**.

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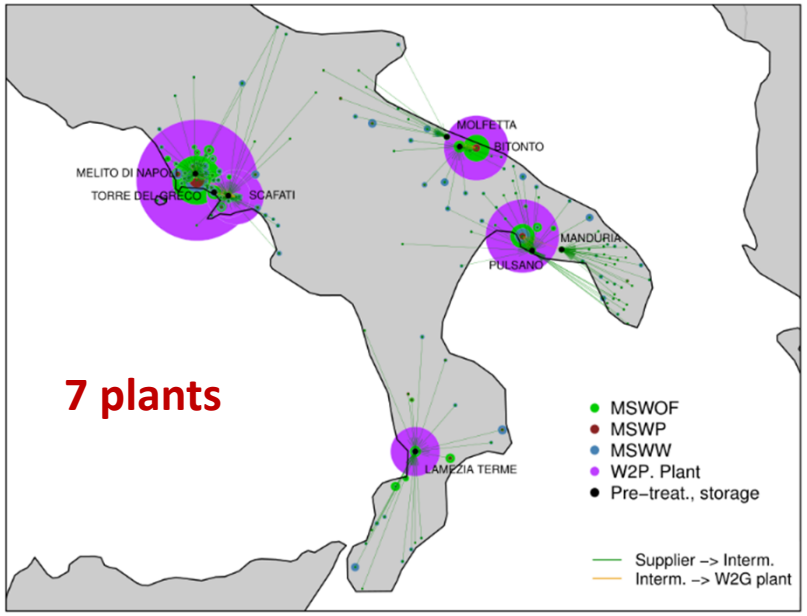
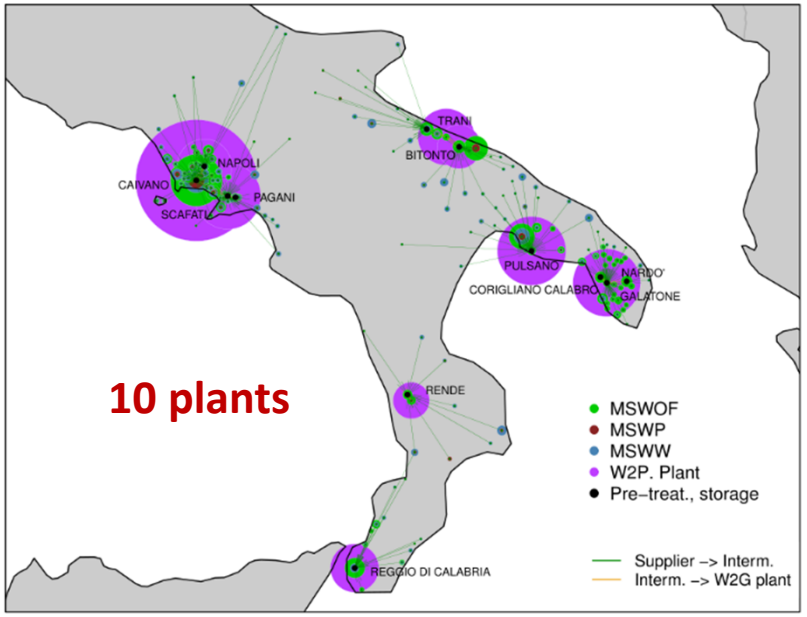
Biomass supply chain optimization (SUD, IT)

- Minimize biomass supply chain cost for given plant number and sizes
- With plant locations determined





Even over 25% of the revenue of the balancing services

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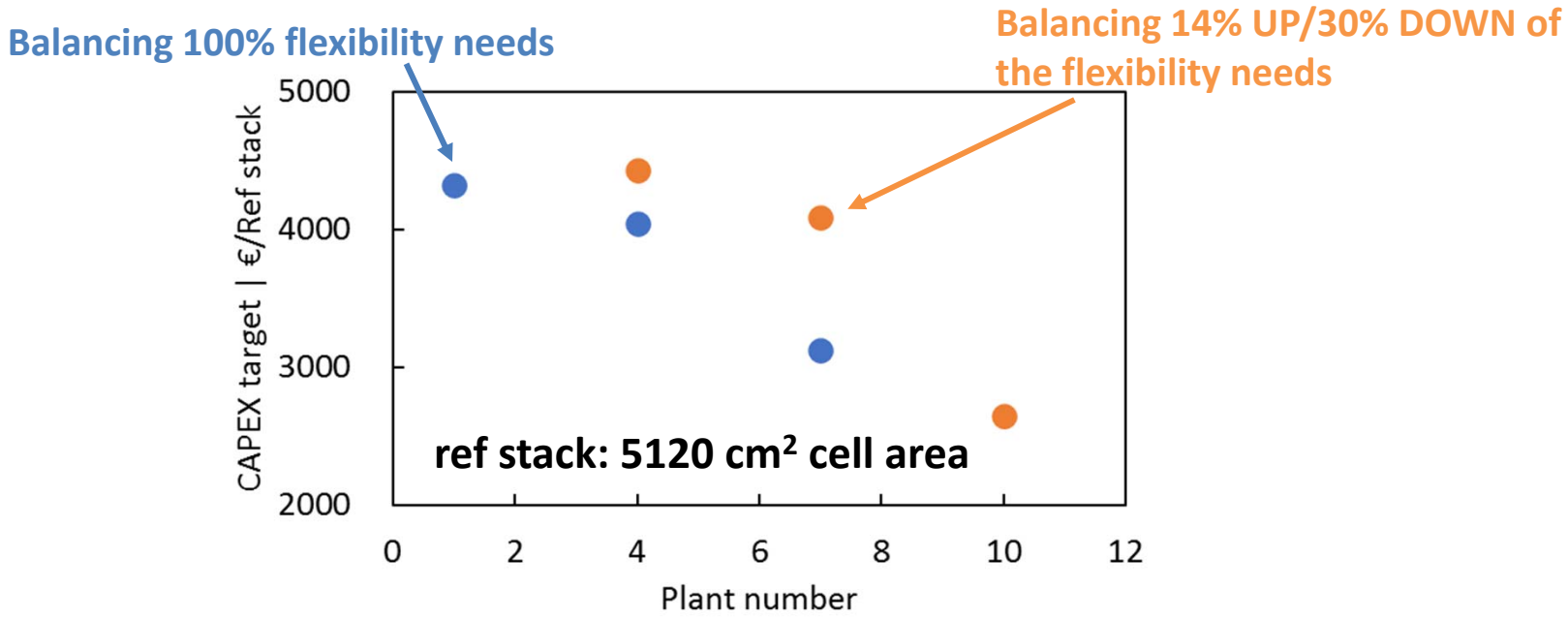
Plant CAPEX target for balancing price 40 €/MWh (SUD, IT)

- It is possible to have revenue only when real CAPEX is below the target



- More plants, more difficult to earn revenue due to increased use of PowNeu mode.
- Plant CAPEX target 2500 – 4500 €/ref stack, **compared to 4000 €/ref stack SNG CHP**.

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Conclusions

- A new triple-mode grid-balancing technology based on gasification and solid-oxide technology
- Large flexibility needs in 2030 and local wastes could potentially support all real balancing needs
- Multiple plant designs available with high efficiency
- When coping with specific balancing profile, the more plants installed to reduce imbalance, the more difficult to gain revenue.
- Plant CAPEX target 2500 – 4500 €/ref stack (5120 cm^2). Strong needs to further reduce CAPEX of key components.

Calculation for other cases are ongoing, conclusions will be updated accordingly.

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