Process of Waste2GridS project:

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

Ligang Wang, Jan Van herle (EFPL)

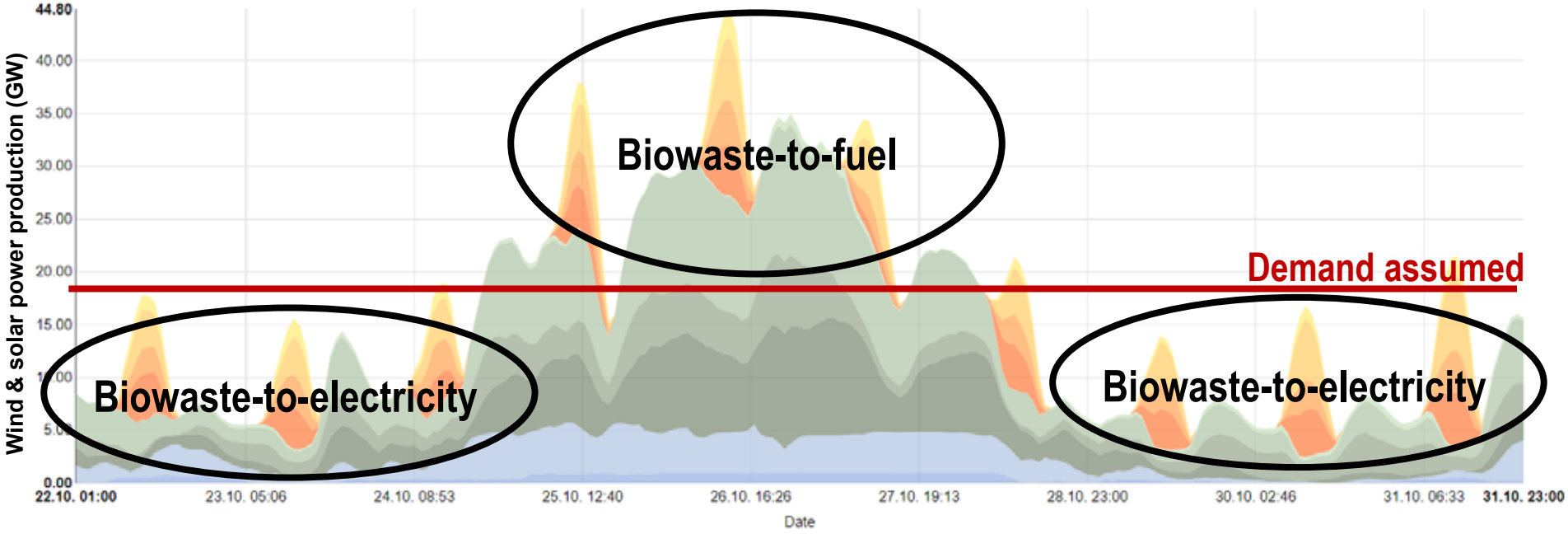
e-EUBCE 2020 *Bioeconomy's role in the post-pandemic economic recovery*

28th European Biomass Conference & Exhibition

VIRTUAL | 6 - 9 July

Biomass/waste-to-energy

- The role of biomass in the future with high vRES share

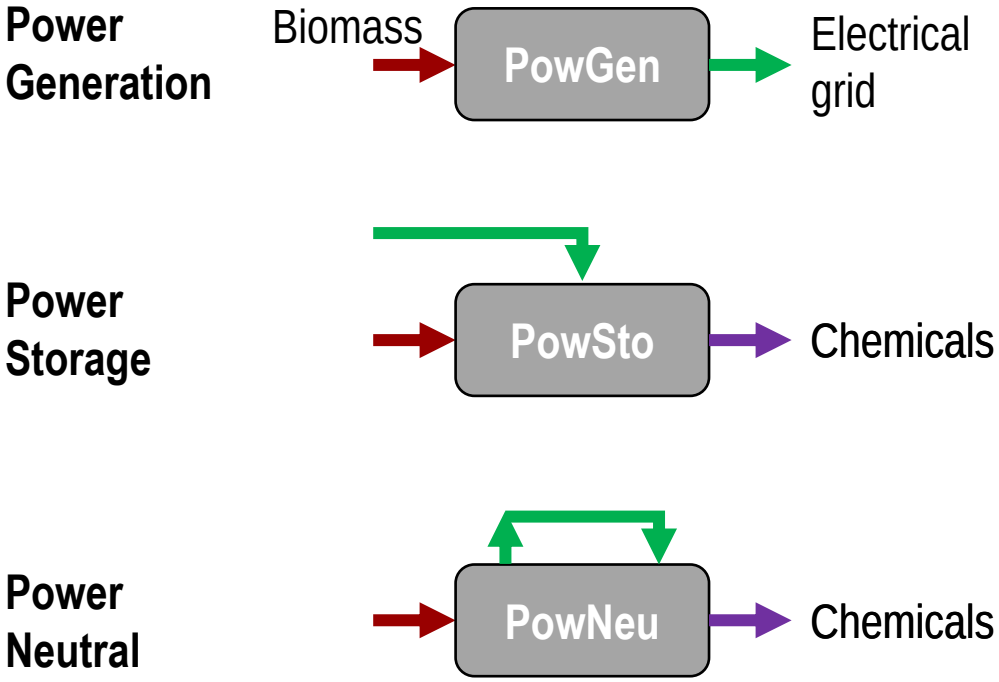


Single-purpose biomass-fed plant will suffer from

- **high OPEX due to biomass collection**
- **low annual operating hours**

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

Triple-mode grid balancing plant



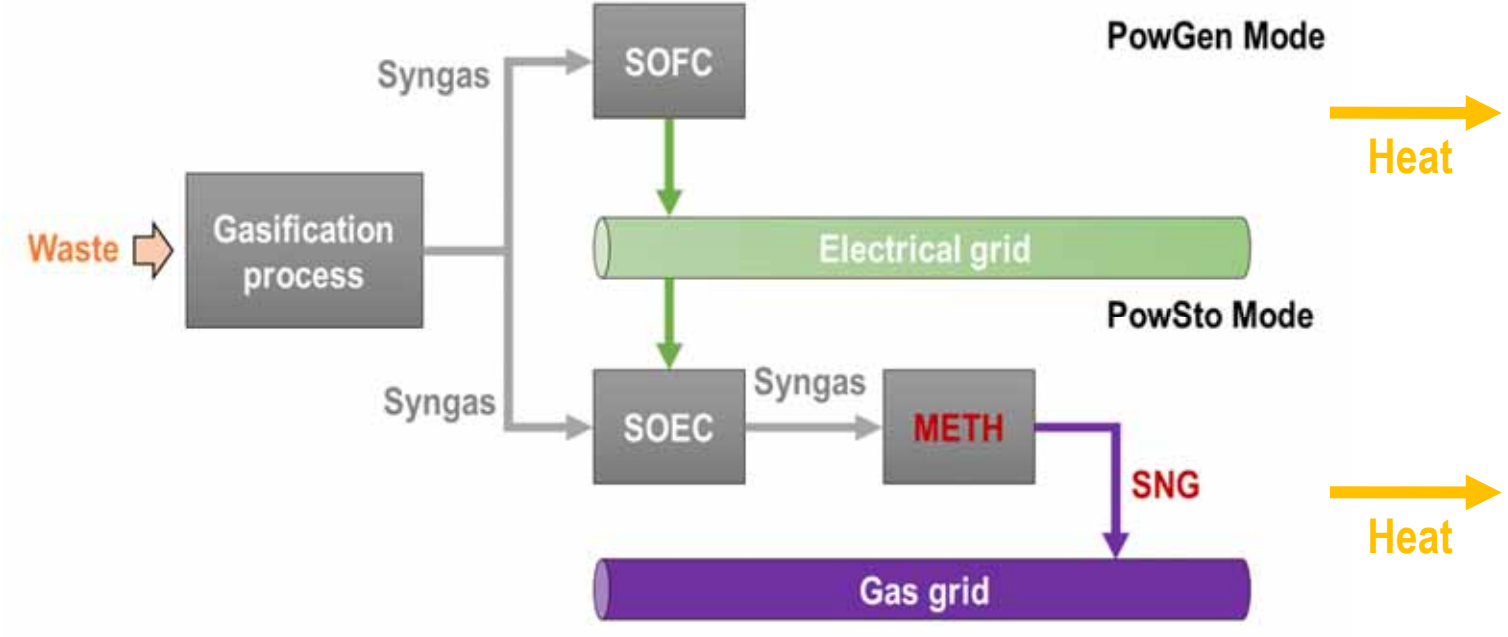
Unique rSOC

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

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

Waste2GridS concept

Three-mode grid-balancing plant with power-to-methane



- Additional profit by grid-balancing services
- Enhanced annual operating hours
- Reduced CAPEX by sharing the stacks & others
- Enhanced balancing capability and capacity
- Unlimited energy storage capacity
- No CO_2 capture needed for waste-to-biofuel

Waste2GridS project (2019—2020)

- **Economic feasibility** study of the plant deployment at **2030**

Technical potential | **Business cases** | **Bottlenecks**

WP1 Zone identification	Grid balancing needs
	Waste availability
WP2 System design	Optimal plant design
	Regional integration
WP3 Techno-econonmics	Upscaling strategy
	Techno-economics

DTU

ENEA

EPFL

SOLID POWER

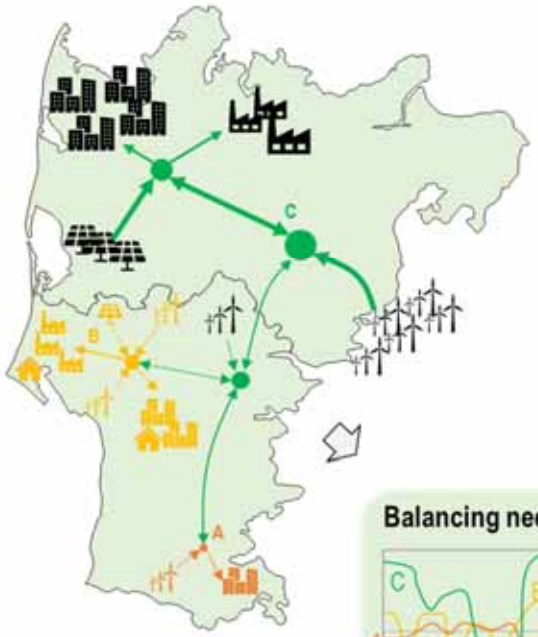
Overall implementation and timeline

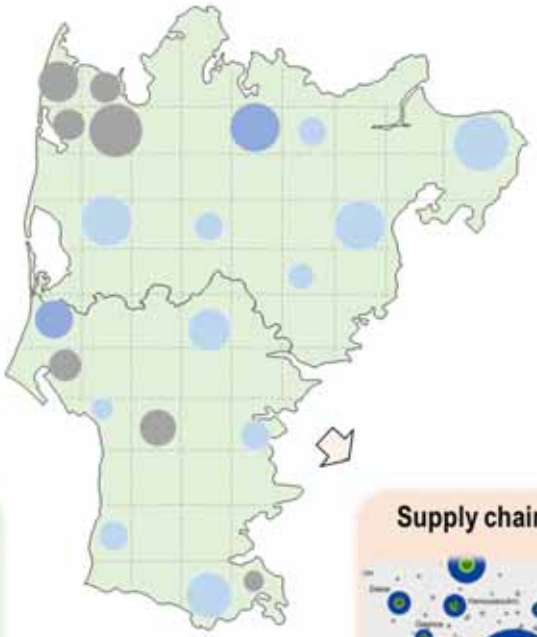
2019.01 **Technical potential** M18 **Business cases** 2020.12

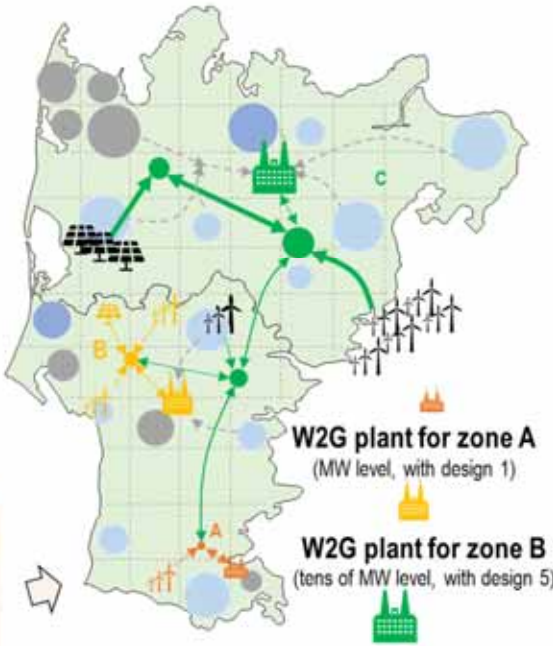
RES-dominated power generation zones
(solid lines: electricity transmission or distribution lines)

Waste availability
(grey: MSW; blue: commercial; light blue: agri&forest)

Case studies
(grey dashed curves: waste supply)





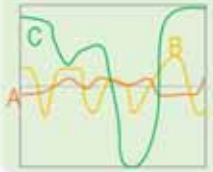


W2G plant for zone A
(MW level, with design 1)

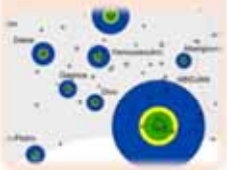
W2G plant for zone B
(tens of MW level, with design 5)

W2G plant for zone C
(100 MW to 1 GW level, with design n)

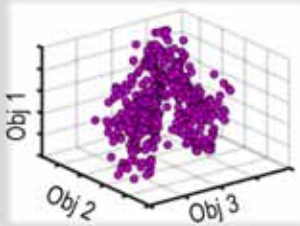
Balancing needs



Supply chain



Plant design pool

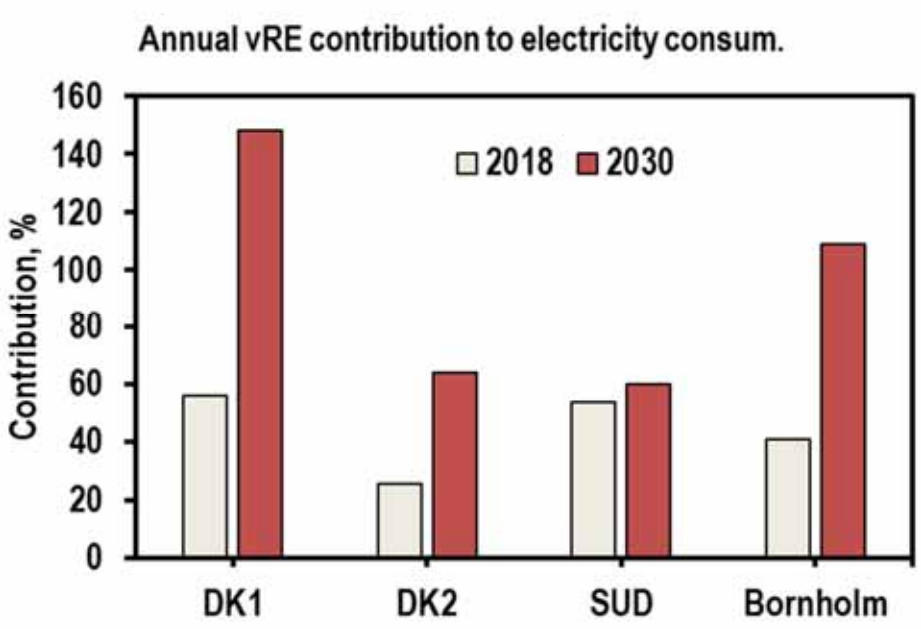


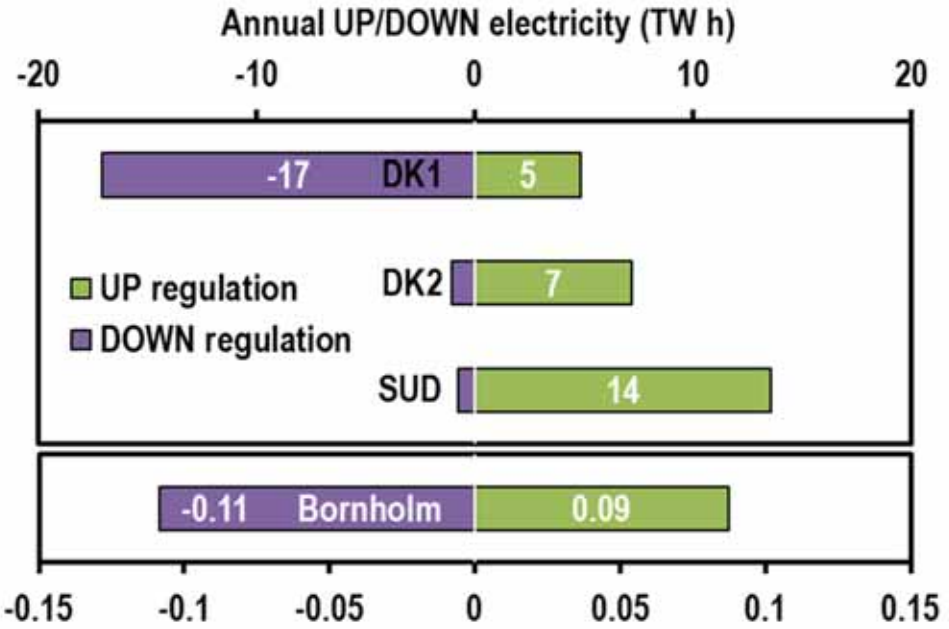
Optimal plant design
with technology superstructure
(various technologies considered)

Optimal design selection, plant sizing & scheduling

Progress – Grid flexibility needs

- vRES-dominated zones for 2030





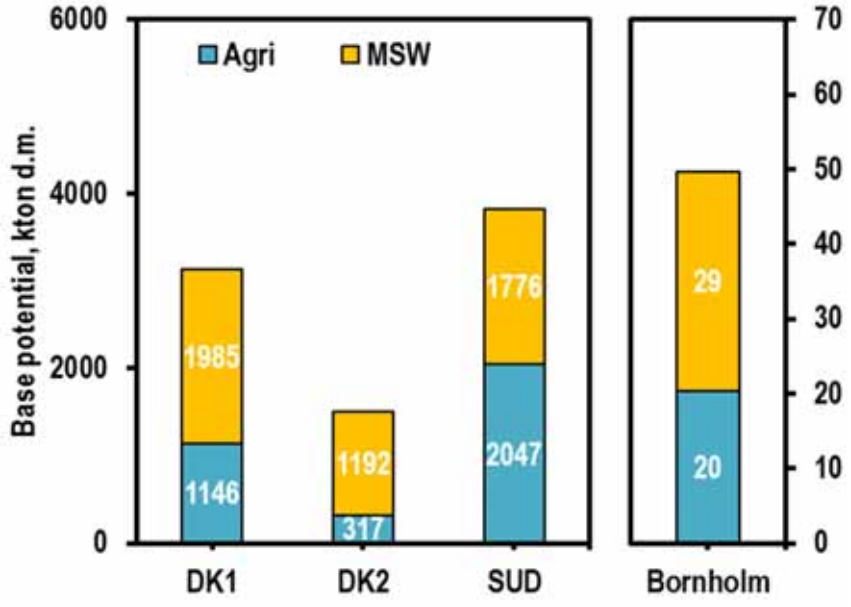
- VERY high vRE share (>100%) to have big DOWN need: DK1 and Bornholm
- Several to several tens of TW h (2-8 GW) for large market: DK1, DK2, SUD
- Tens to hundreds of GW h (40-100 MW) for Bornholm

Applied Energy 264 (2020) 114702

Progress – Technical waste potential

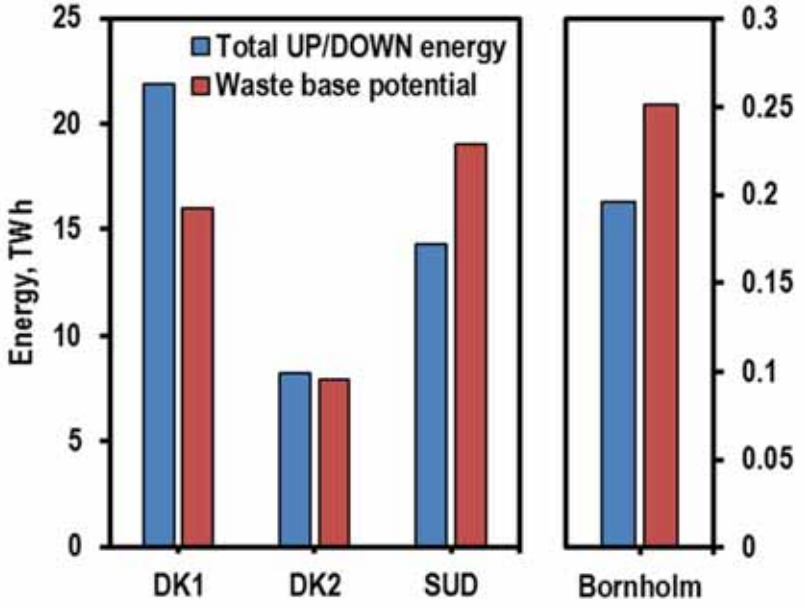
- Local waste availability predicted for 2030

Local exploitable waste excluding competing use



- MSW & Agri amount comparable

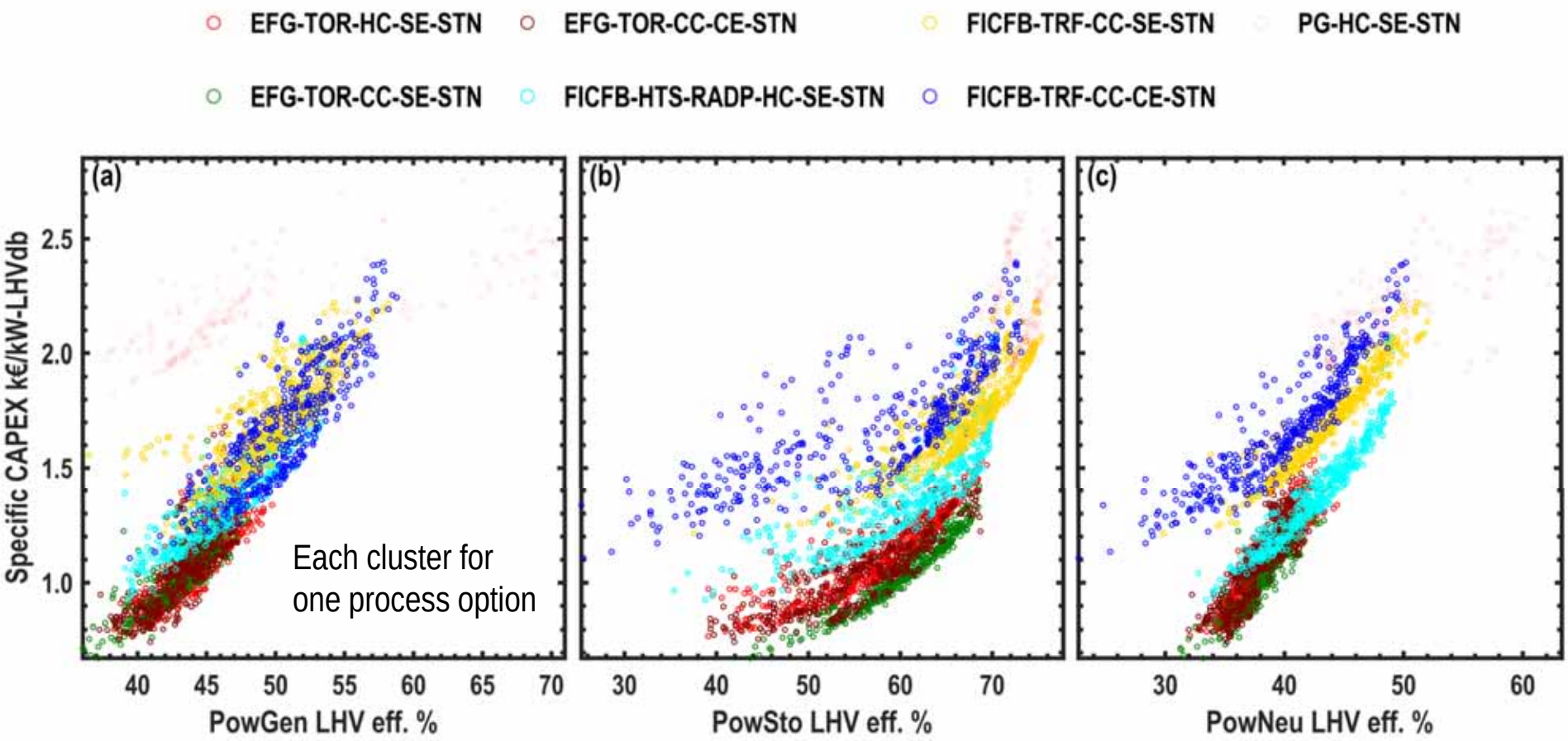
Energy comparison



- Balancing energy & waste potential at the same magnitude

Progress – Optimal plant concept design

- **Design pool**

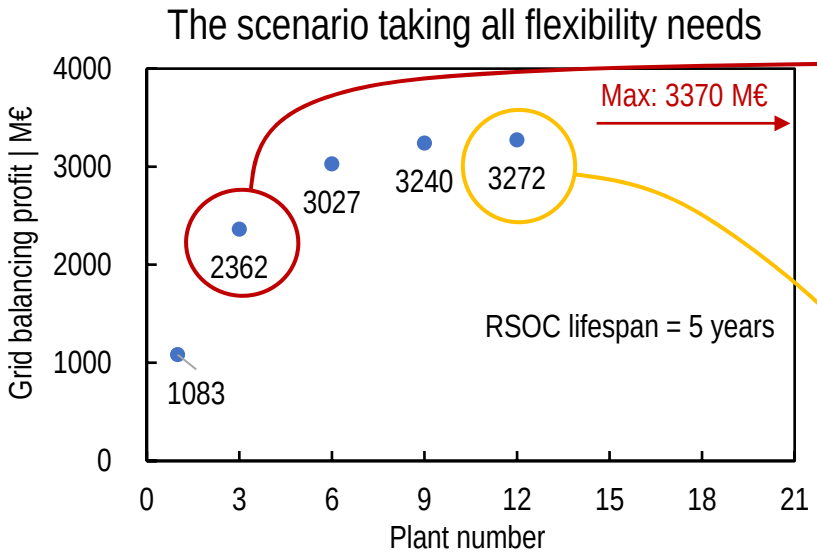


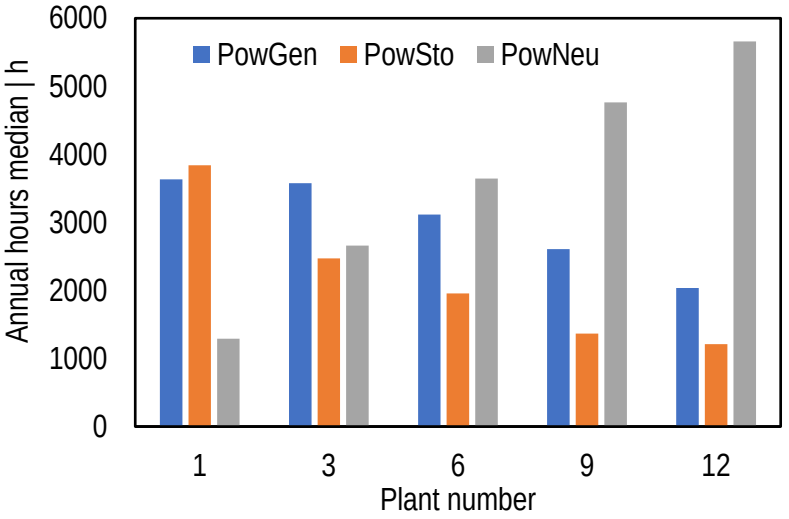
- **A variety of plant designs with a wide range of efficiency**
- **Eff. of PowGen (36-70%), PowSto (40-76%) and PowNeu (32-62%), much higher than exiting Biomass-to-Power or -Fuel plants**

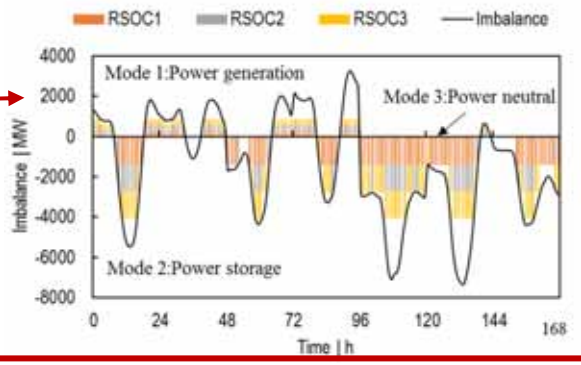
Wang, 2020 (Applied Energy)

Progress – Grid integration

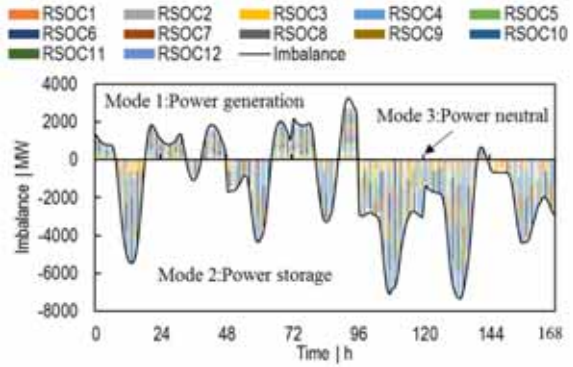
- **Modified Dispa-SET platform for multiple scenarios**







3 plants

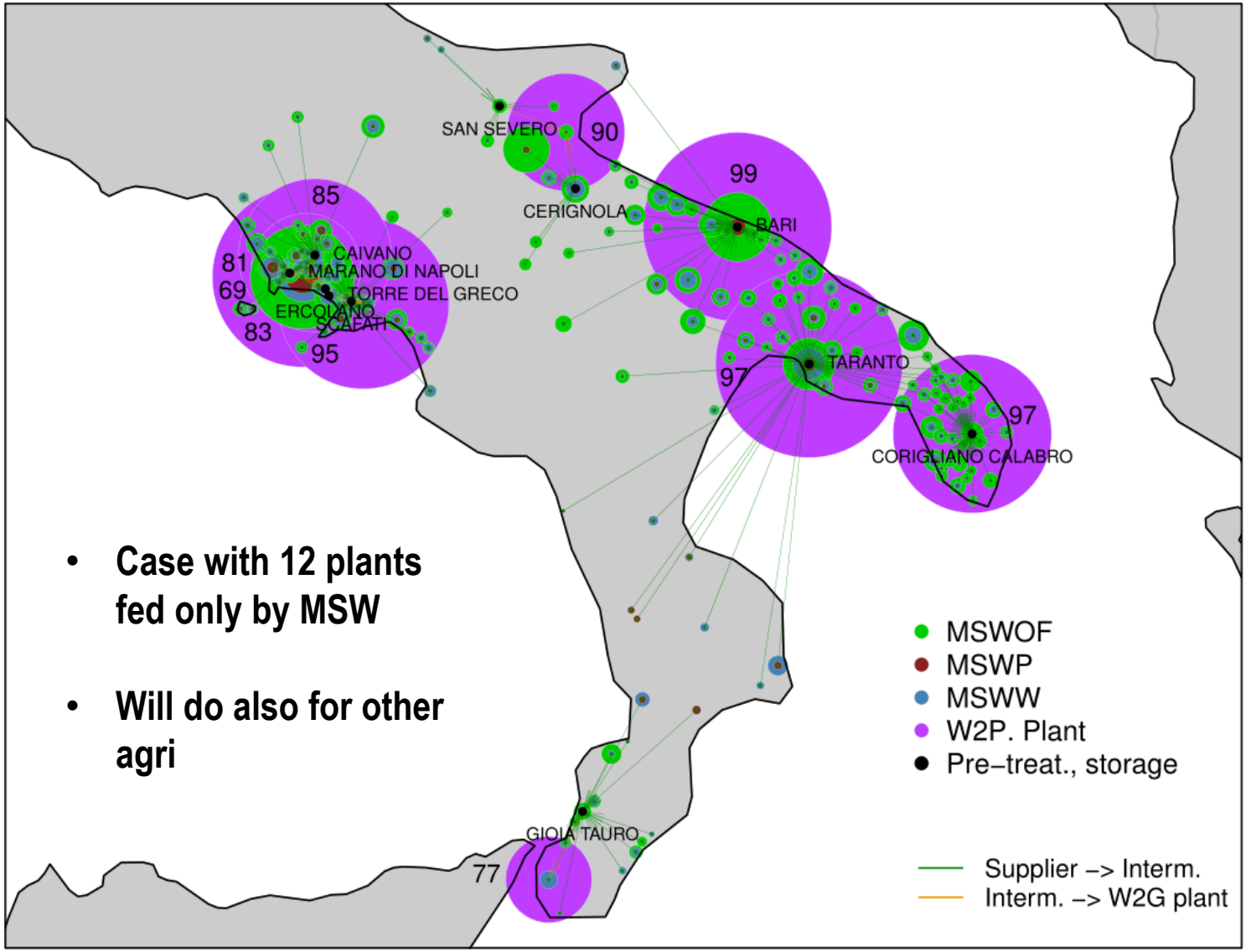


12 plants

- Critical information provided for economic evaluation
  - Plant number & sizes
  - Plant scheduling and auxiliary requirement
- **PowNeu mode might have large operation share!**

Progress – Biomass supply chain

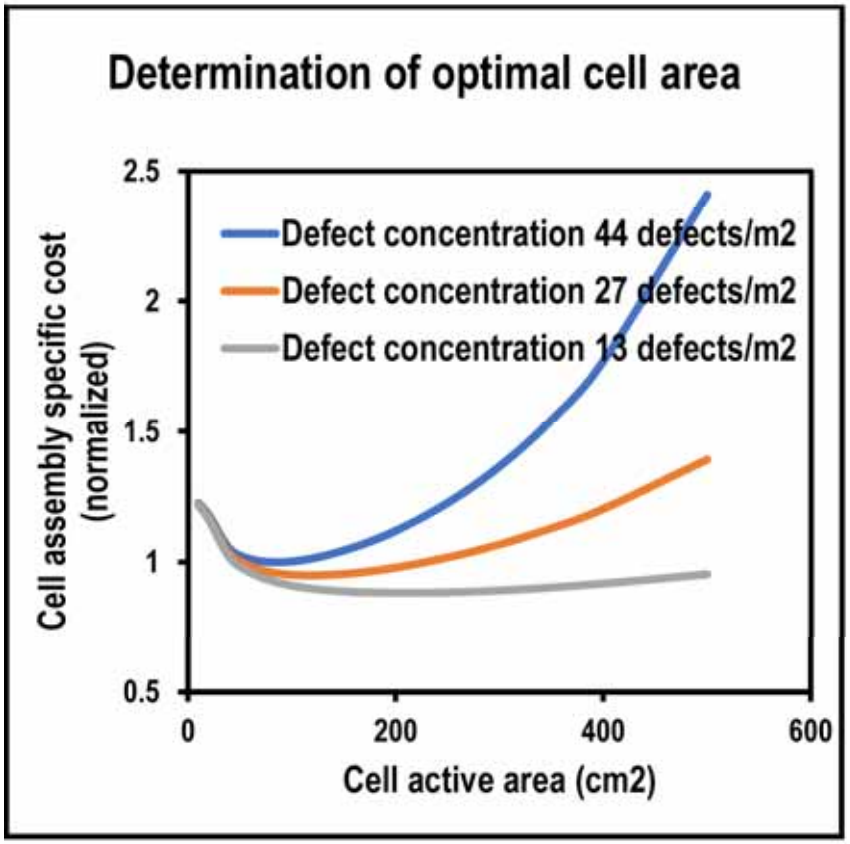
- **Create supply chain for the plants expected**

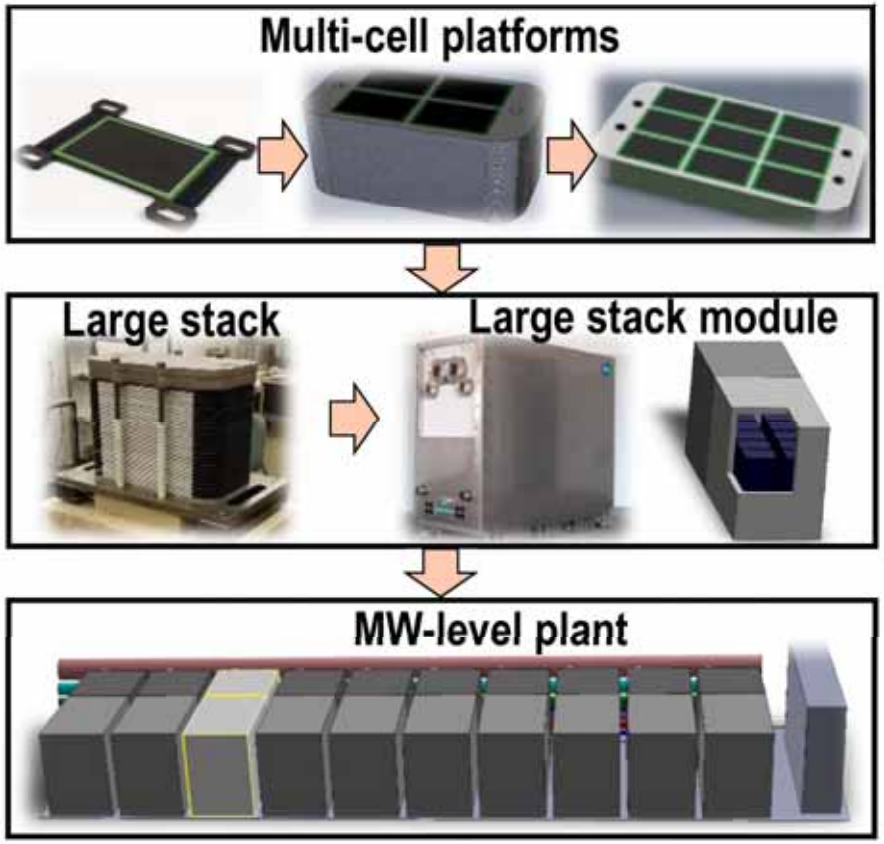


- **Case with 12 plants fed only by MSW**
- **Will do also for other agri**

Progress – Upscale strategy

How to scale up from kW-level stack to MW-level plant?





Summary

- Potential way of biomass utilization for grid balancing
  - Efficiency, flexibility, possibly economic, new service
- An optimization methodology for optimal plant deployment
- Large grid flexibility needs exist for DK1, Bornholm (>100% vRES / electricity consumption); hardly be coped with a specific technology.
- Local waste supply within the same order of magnitude as flexibility needs
- Upscaling strategy of SOC to MW level developed

- Grid integration & supply chain design ready
- Specific business cases in DK and IT will be delivered in next half year

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