15th SE Europe Energy Dialogue, Thessaloniki, 19-20 June 2024

H2 as energy storage for RES: Planning, optimization and integration in energy ecosystems

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Space for optimization in RES-produced power

RES curtailments are here to stay

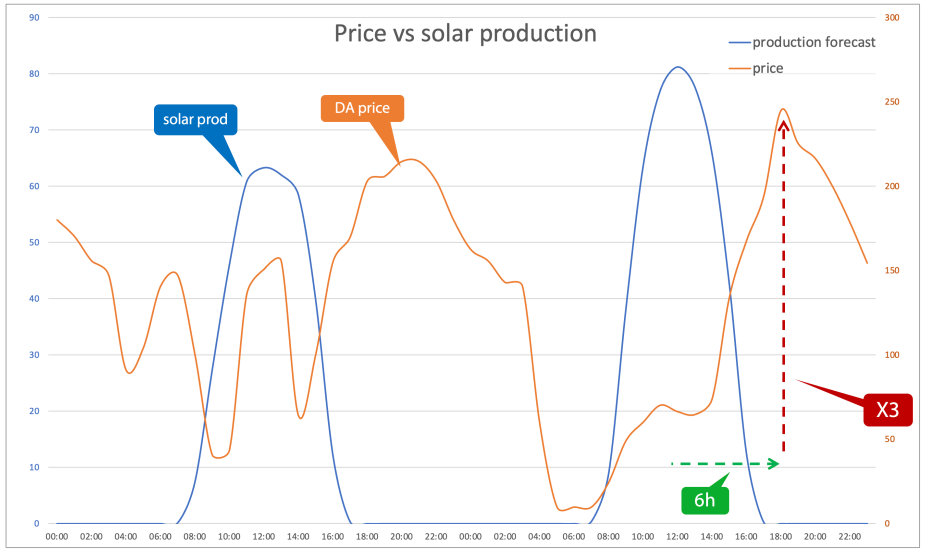
- Technical and market reasons

Prices vs solar production: bad timing

- BESS: High efficiency, expensive
- H2: Low round-trip efficiency (PH2P), low price

Can we optimize revenue & minimize rejected RES power by using H2 as energy storage?

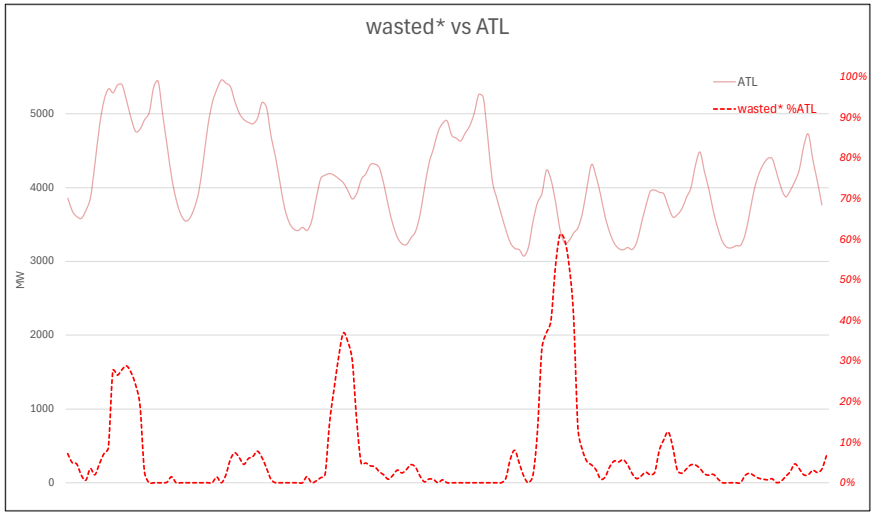
- RES CAPEX amortization
- Ground for new H2 business and strategy

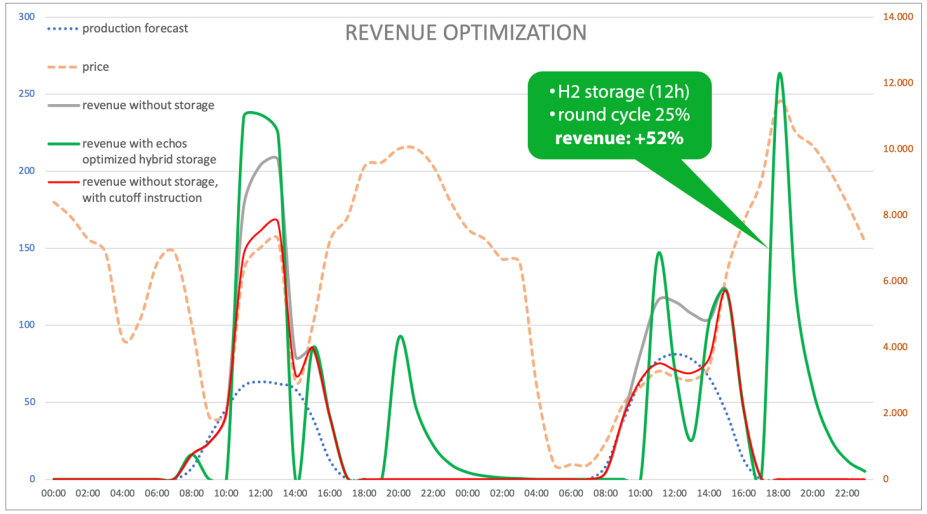


A Brief Independent Study on RES-Rejections in Greece

Thanos Natsikas
Power Systems & Data Engineer
1 article ✓ Following
April 5, 2024

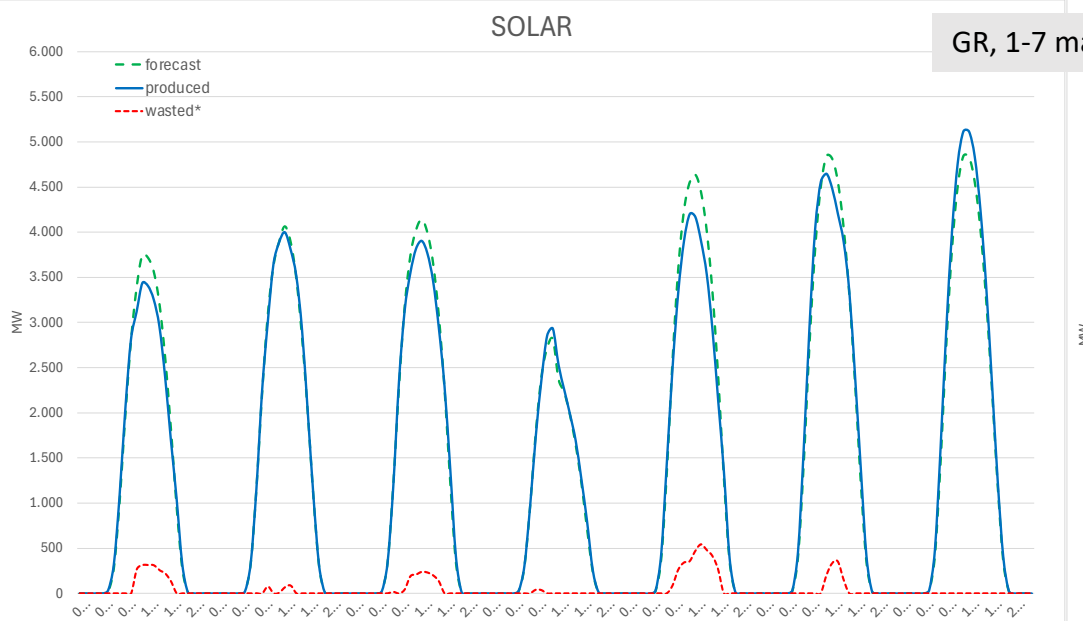
- **Market-related RES-rejections are a fact**, and can become quite severe amid low-demand & high-res conditions.
- In some cases, they have accounted for more than 70% of the total RES-Rejections in Greece: Out of the total of 2468 MW of total RES-Rejections that took place on **Sunday, 24th of March, 2024** at **12:00 CET** (taking into account only the already mentioned market stages), the study found that **more than 70% (1770 MW) took place in the DAM.** This number is considered to be, if anything a lower-ceiling of the Market-related RES-Rejections.

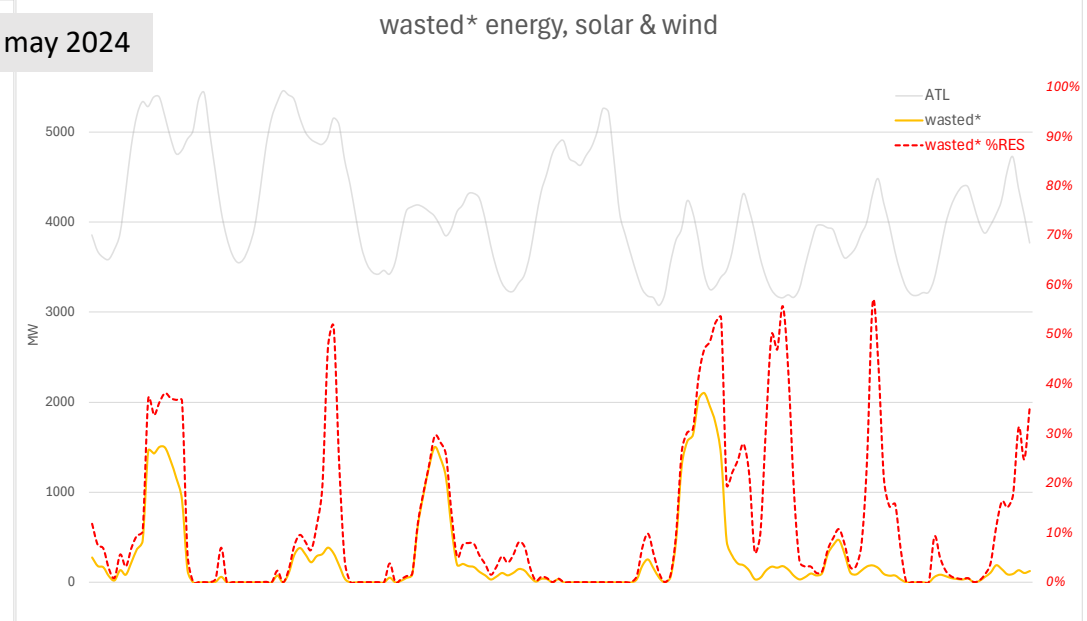


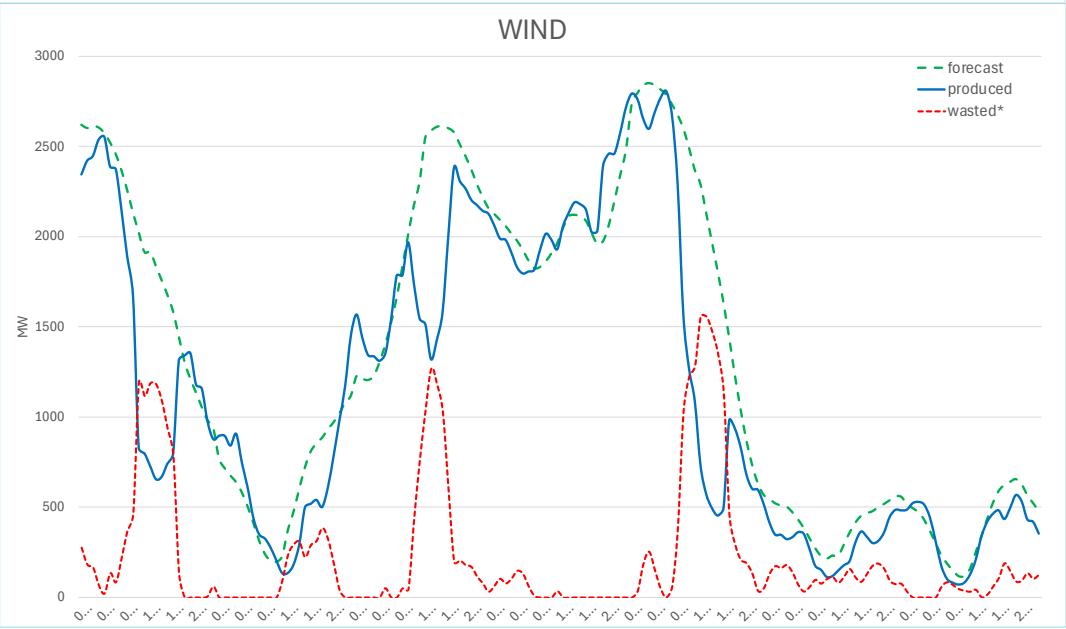


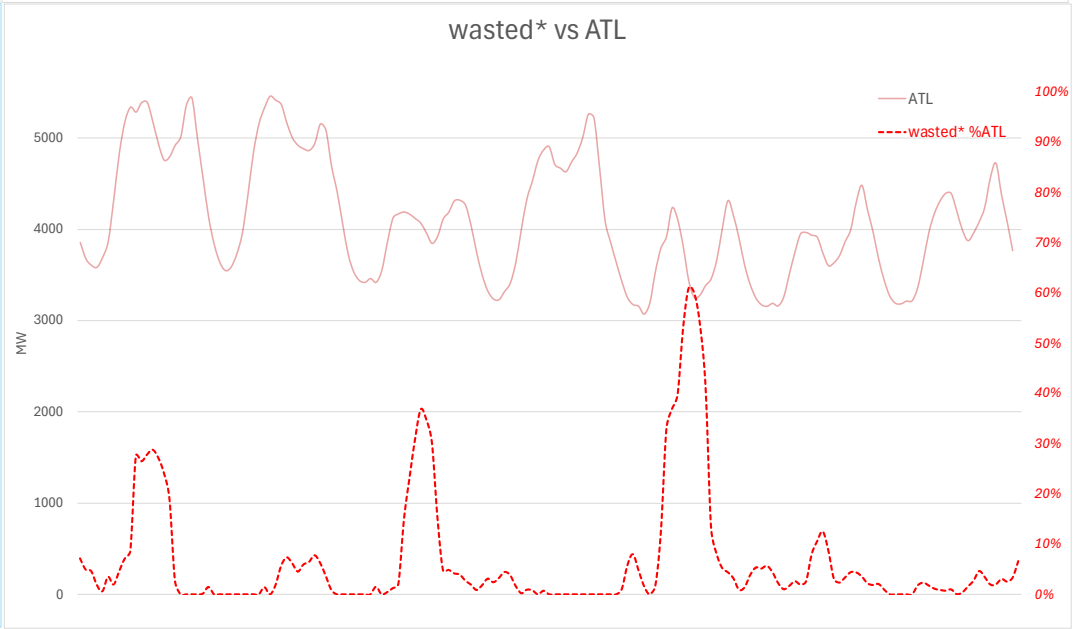
Can we afford not-to-procuce energy we can produce?

GR, 1-7 may 2024









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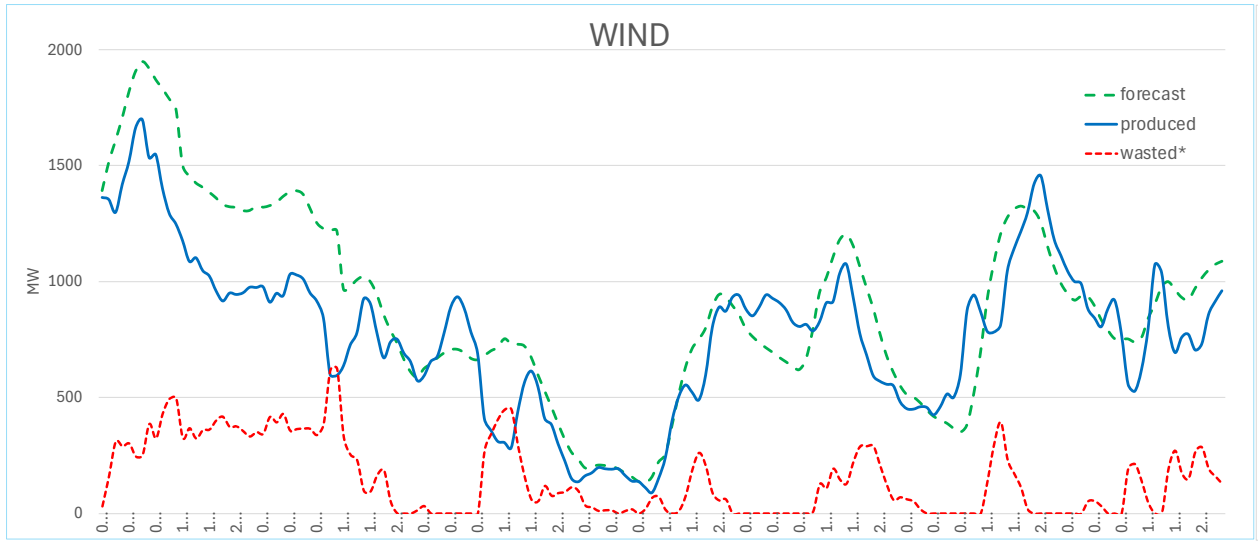
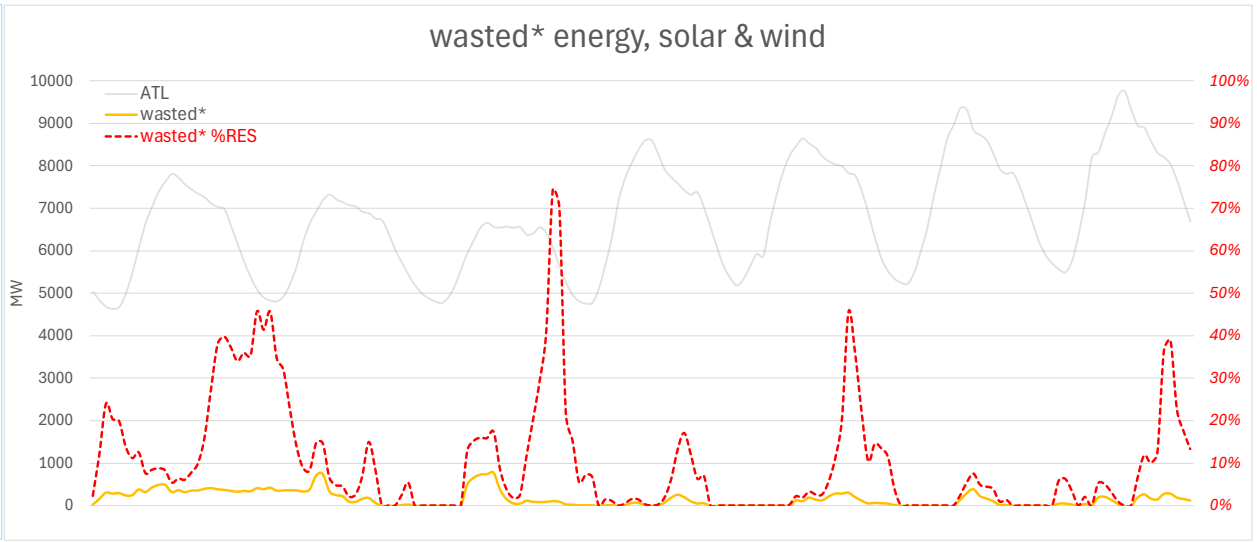
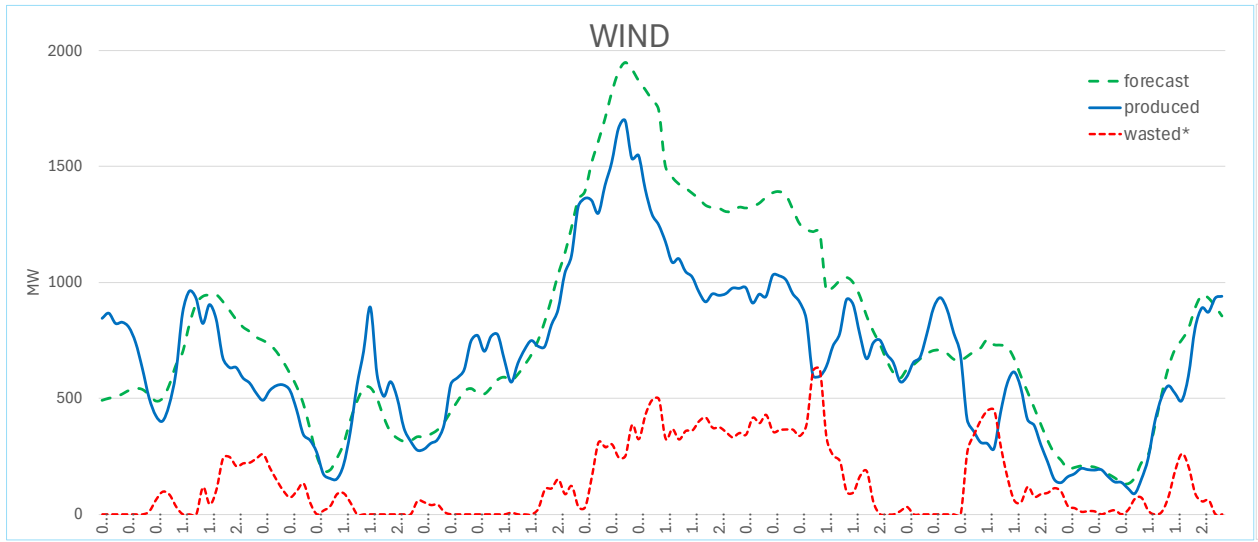
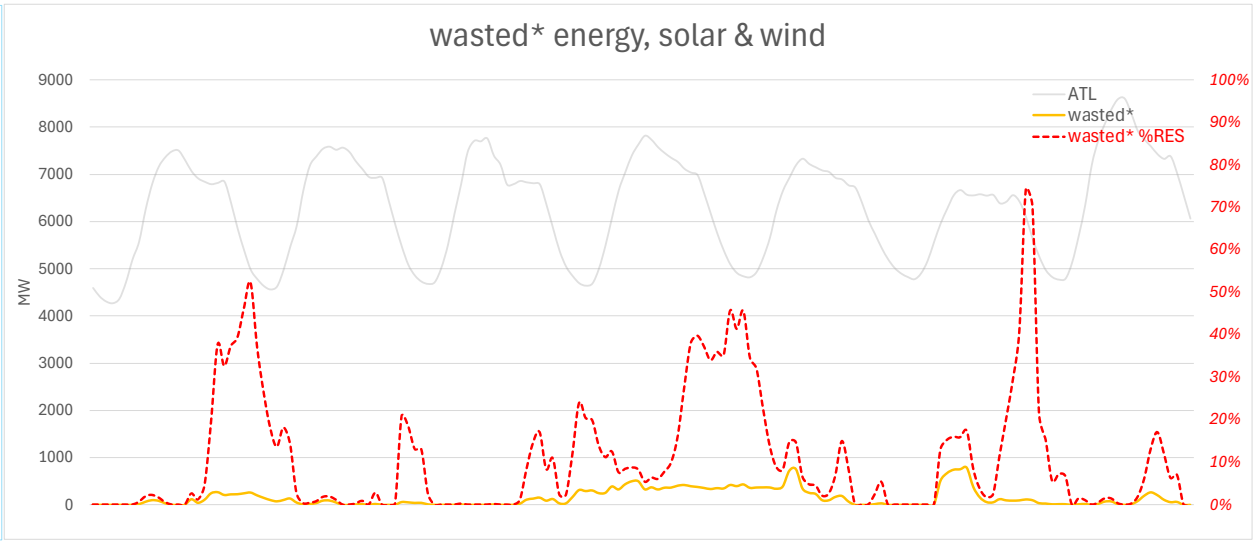






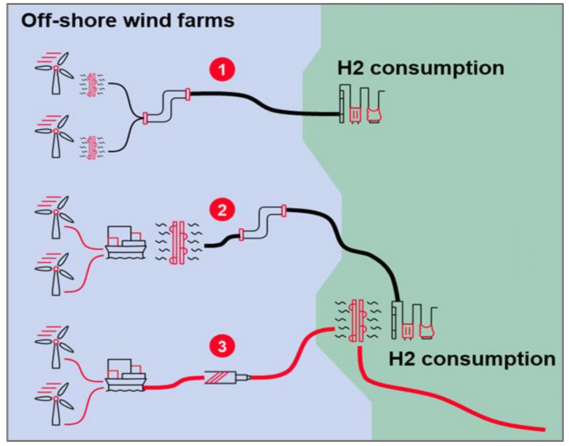


H2 for energy storage and more…

H2 can be produced from RES-produced power

- to be consumed to H2 pipelines etc facilities
- to be transformed back to electricity
- electrolyzers can be on-the-spot or away via PPAs*

Is this economicaly viable?



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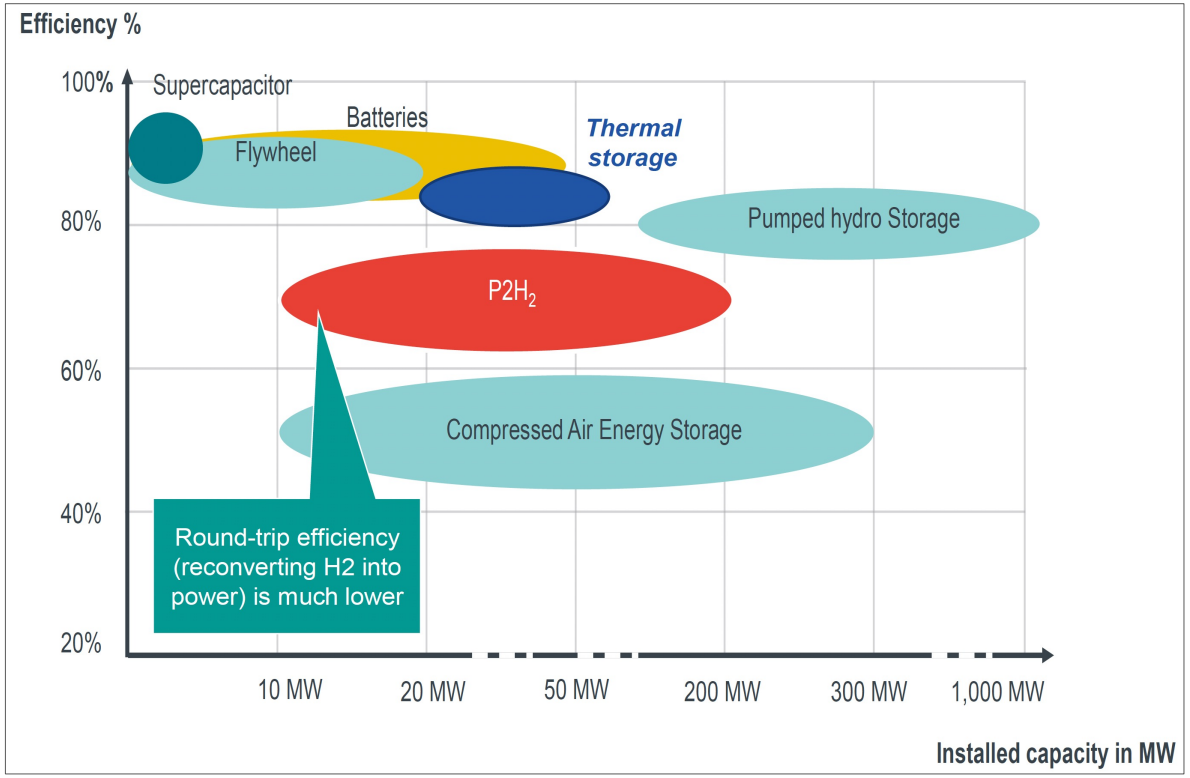
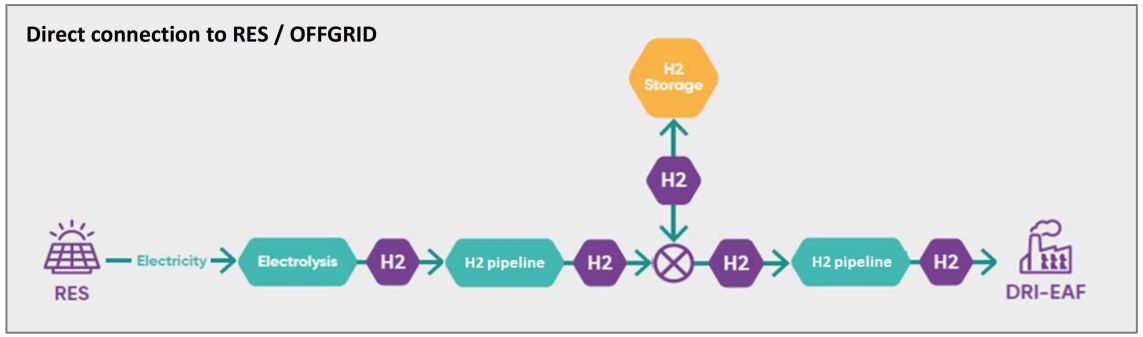
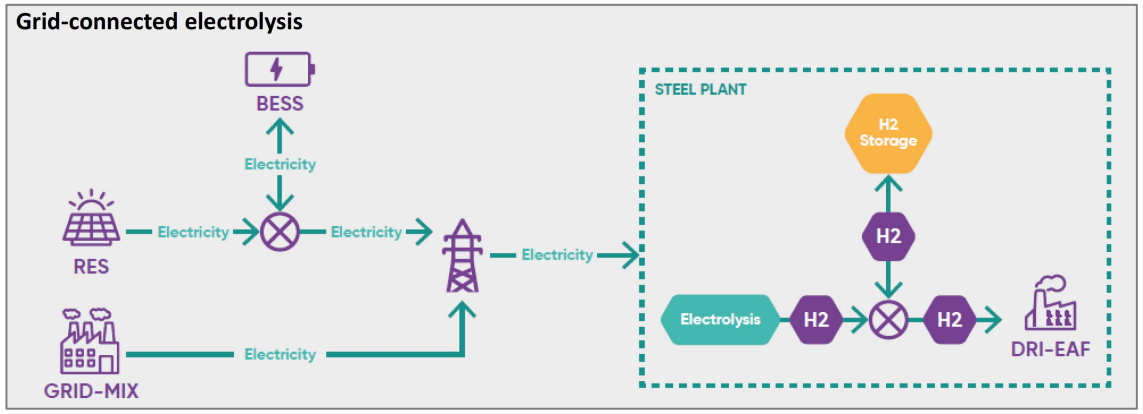






Need for models and tools to support decisions

Can we optimize revenue & minimize curtailed RES power by using H2 as energy storage?

- RES CAPEX amortization
- Ground for new H2 business and strategy

Informed decisions need quantitative analyses

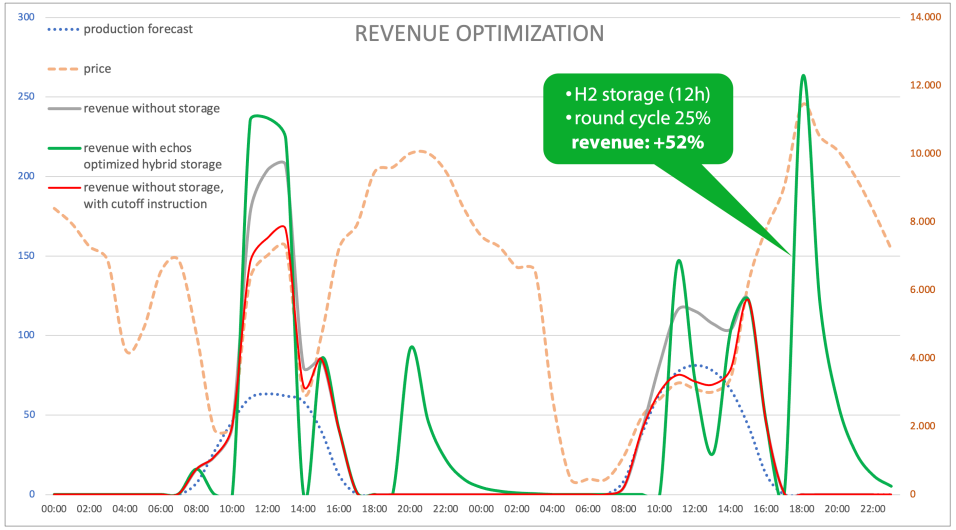
- Long-term planning of RES & H2 infrastructure development
- New incentives for business development in RES & H2
- Policy and regulatory aspects for the energy market as a whole
- Efficient planning and operation of RES with hybrid (BESS & H2) storage

Quantitative analyses require specialized tools for multiple parameters

- Production scenarios, incl. long-term licensing deployment of new RES
- Price scenarios for electricity, H2, gas markets
- CAPEX & OPEX of BESS and H2-related equipment

NTUA provides advanced know-how and tools for the energy sector

- Collaborates with major players
- Develops cross-discipline know-how and services



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Can we optimize revenue & minimize curtailed RES power by using H2 as energy storage?

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ECHOS (Energy Clean Hybrid-storage Optimization Service):
Customizable scenario analyzer and optimizer service for RES with hybrid (BESS, H2) storage

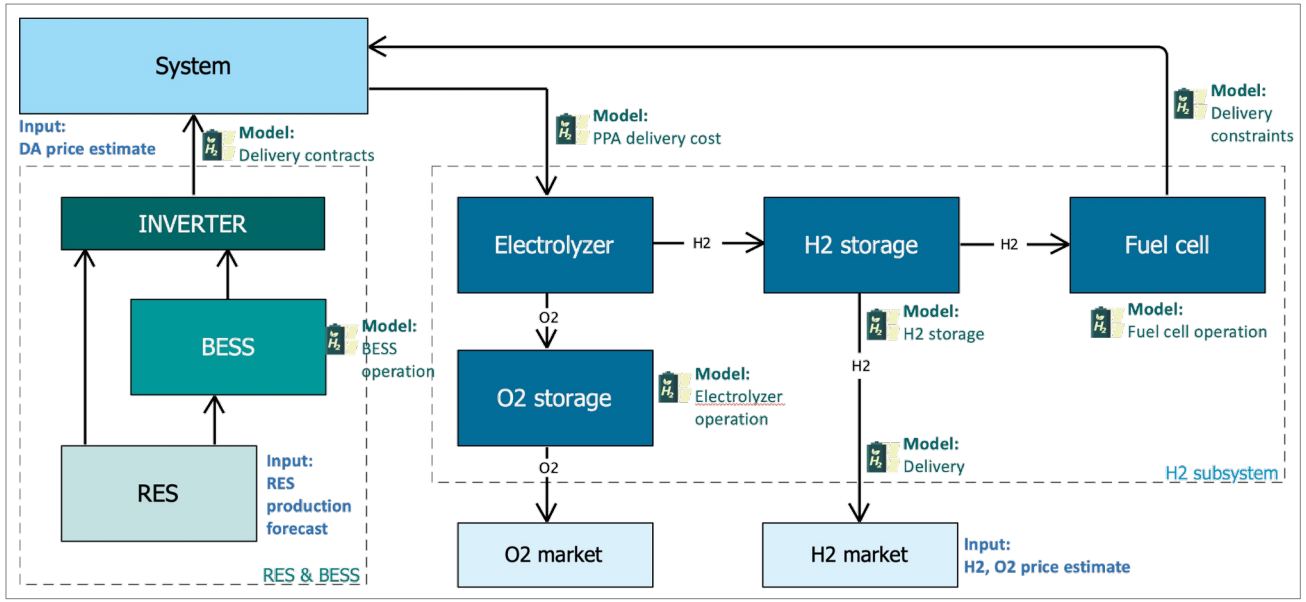
- Addressed to policy makers, regulators, investors, operators
- Decision support in planning and operation

Parameter and timeseries analyzed

- Production scenarios for current and future RES
- Price scenarios for electricity, H2, O2 and gas markets
- CAPEX & OPEX of BESS and H2-related equipment
- Dimensions and analysis time windows

Optimized quantities

- Minimize curtailed RES
- Maximize H2 production
- Maximize revenue
- CAPEX amortization



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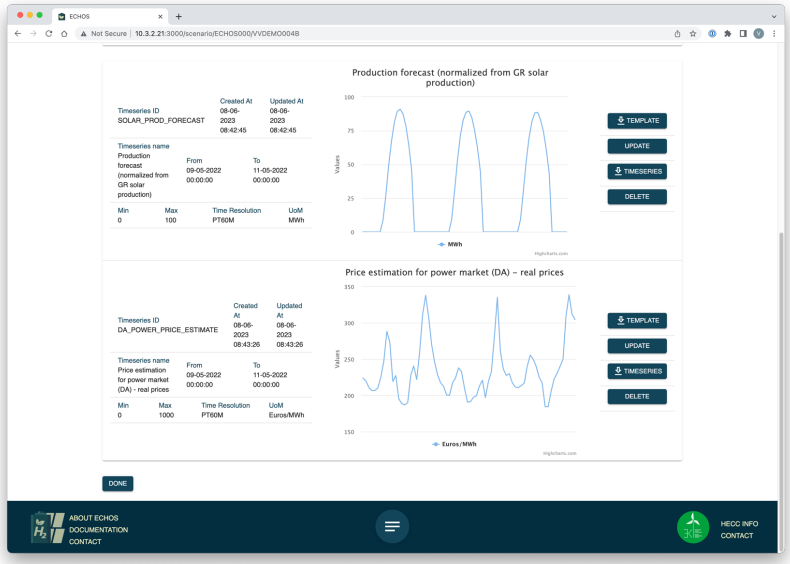

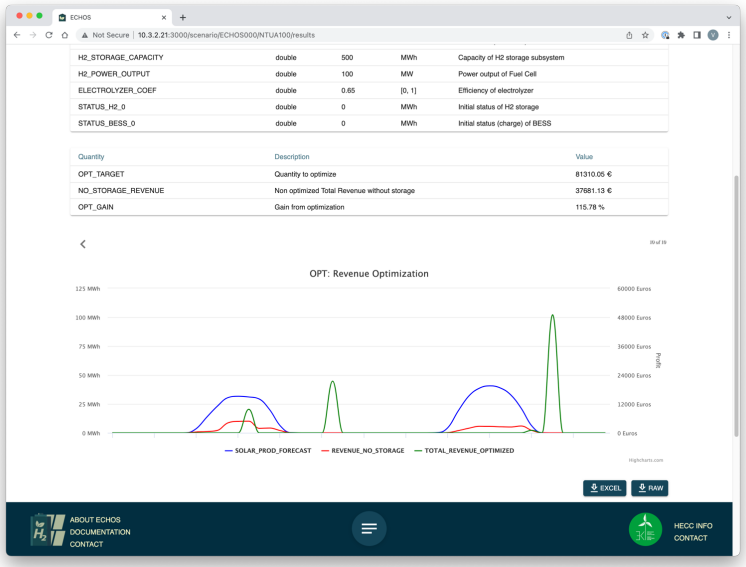

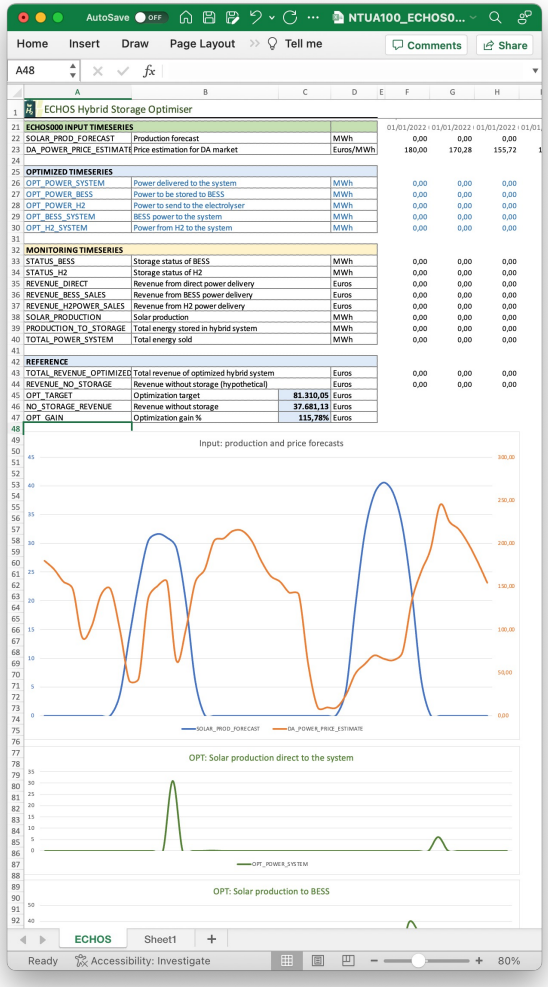

Optimization in RES-produced power

Informed decisions need quantitative analyses with multiple parameters

- Long-term planning, new incentives for business development
- Policy and regulatory aspects, efficient planning and operation of RES
- Production scenarios, incl. long-term licensing deployment of new RES
- Price scenarios, CAPEX & OPEX of relevant equipment

ECHOS - a customizable scenario analyzer and optimizer service for hybrid storage

- Addressed to policy makers, regulators, investors, operators
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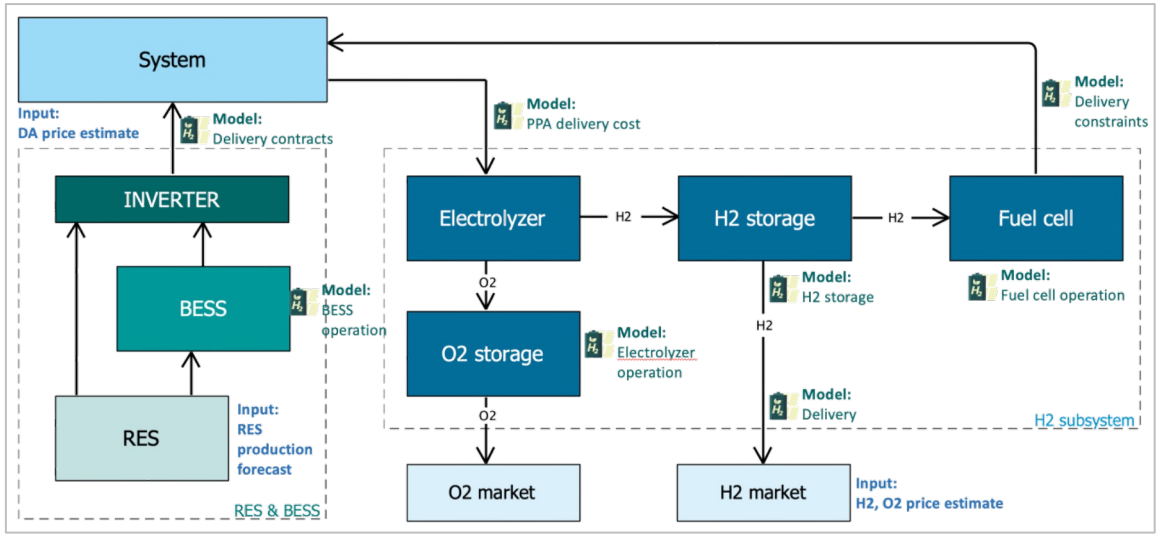

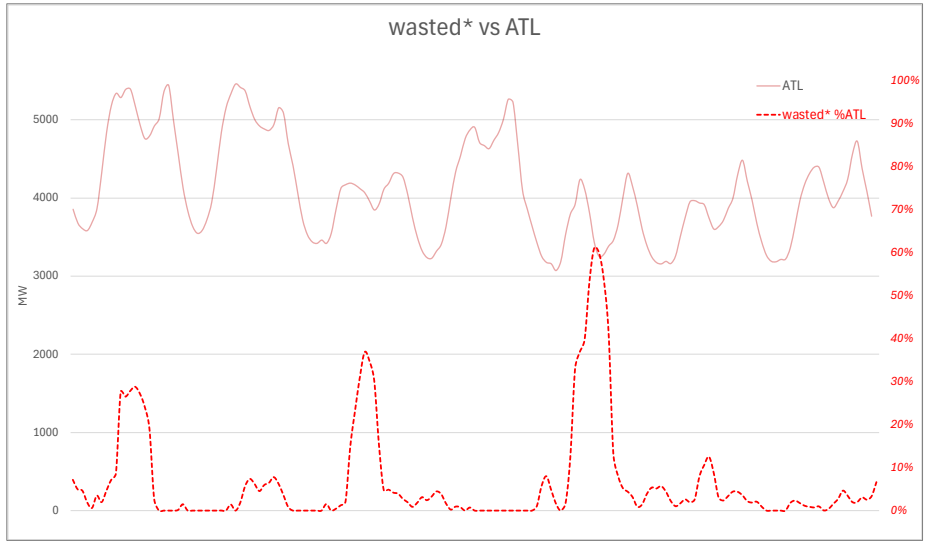

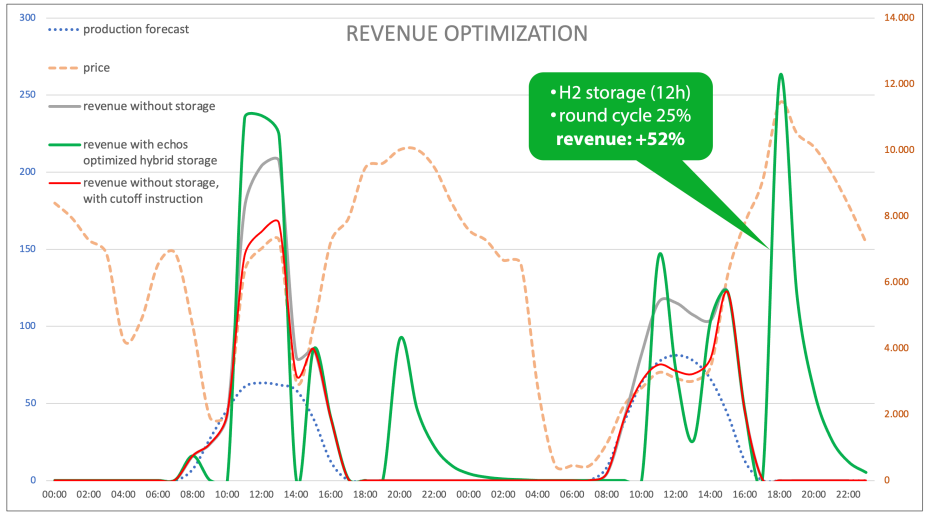

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