European Commission

Clean energy for EU islands

Future-proofing electricity systems: Wind electricity on non-interconnected islands

Nicolas Meerts

Clean energy for EU islands
www.euislands.eu | info@euislands.eu

#CleanEnergyIslands

Resource diversification and complementarity

Can diversification play a role on non-interconnected island systems?

Off-the-shelf solutions

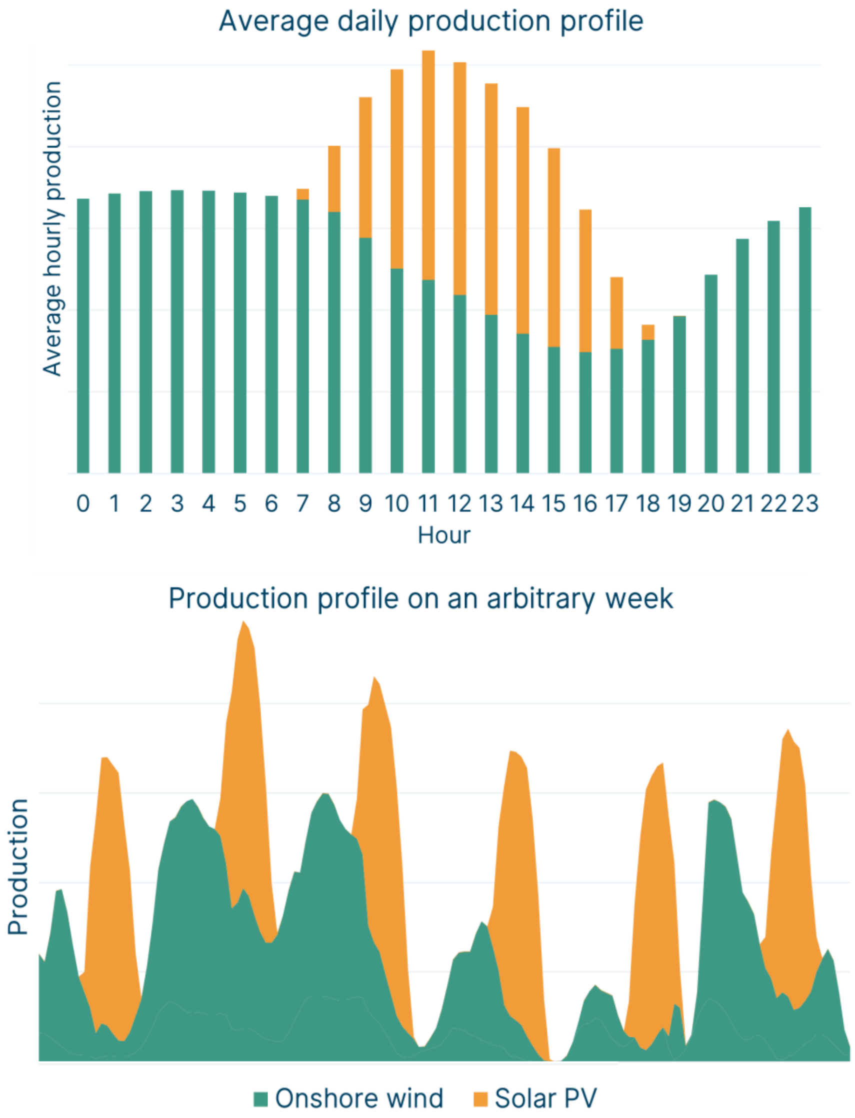
Standard solutions offered by turbine OEMs to comply with continental grid codes and support weak systems

Resource diversification and complementarity

Can diversification play a role on non-interconnected island systems?

Resource complementarity

- Coastal areas often have a daily pattern in wind speed
- Partial ressource complementarity often exists between solar and wind on the daily and seasonal scales
- While the profile can be optimised in average, the variability remains



Resource complementarity

- Optimal zonal and resource mixes can be found
- The gain in baseload often comes at an increased levelized cost of electricity

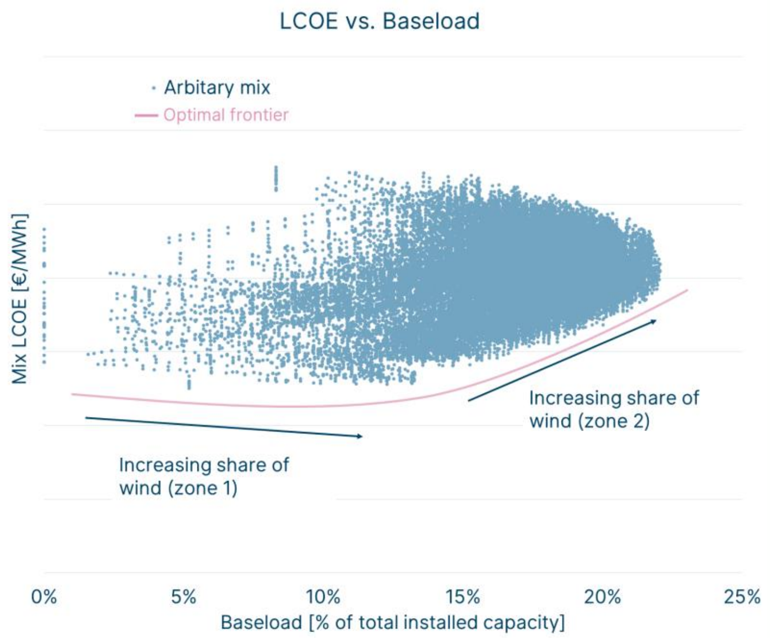


Figure: Evolution of LCOE with changing renewable mix

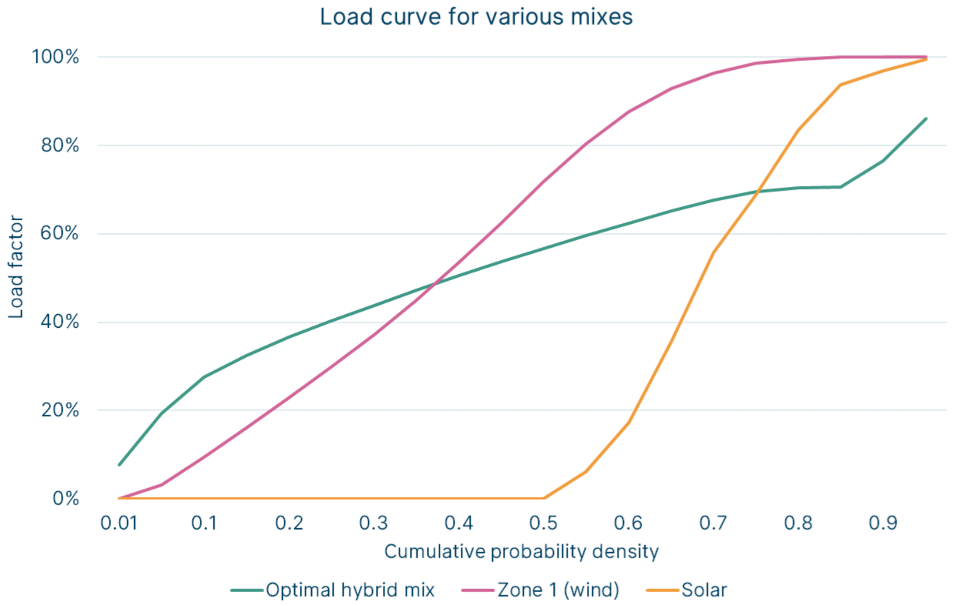


Figure: Gain in baseload due to technological diversification (green line)

Geographical diversification

- Complex island can benefit from surprisingly large geographical diversification effects over short distances

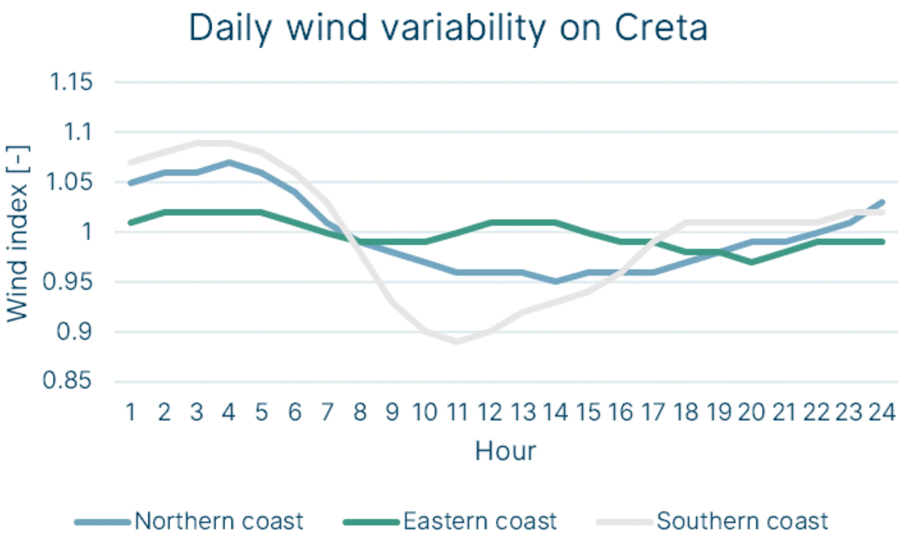


Figure: Diurnal variability on a selection of three sites around the coastline of Creta

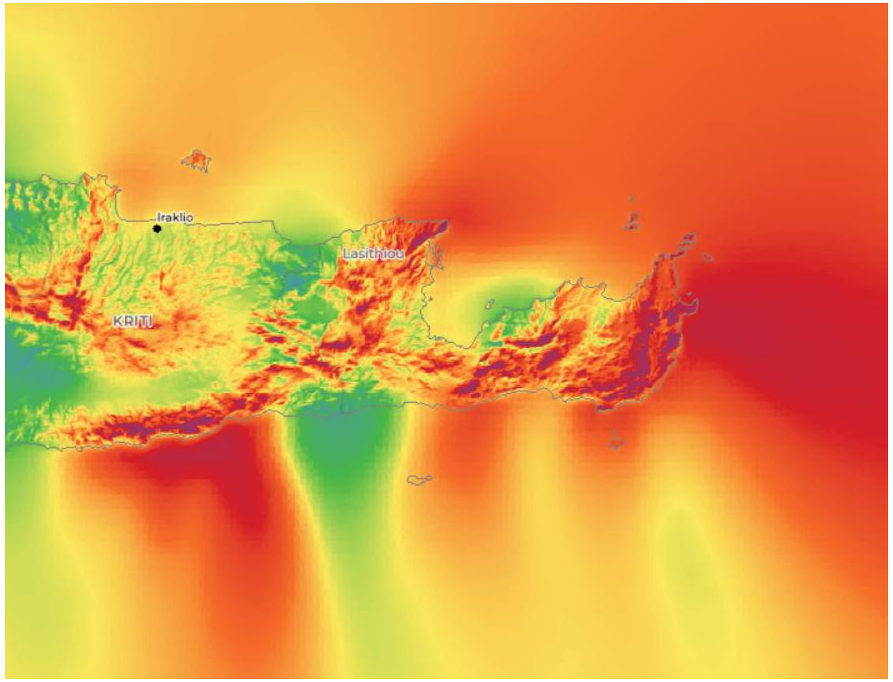


Figure: Average wind speed over the Eastern side of Creta (source: Global wind atlas)

Off-the-shelf solutions

Standard solutions offered by turbine OEMs to comply with continental grid codes and support weak systems

Reactive power capability

- Wind turbines are increasingly full-converter designs, which are more flexible
- The reactive power capability generally exceed continental grid code requirements
- STATCOM options often allows no-load reactive power provision

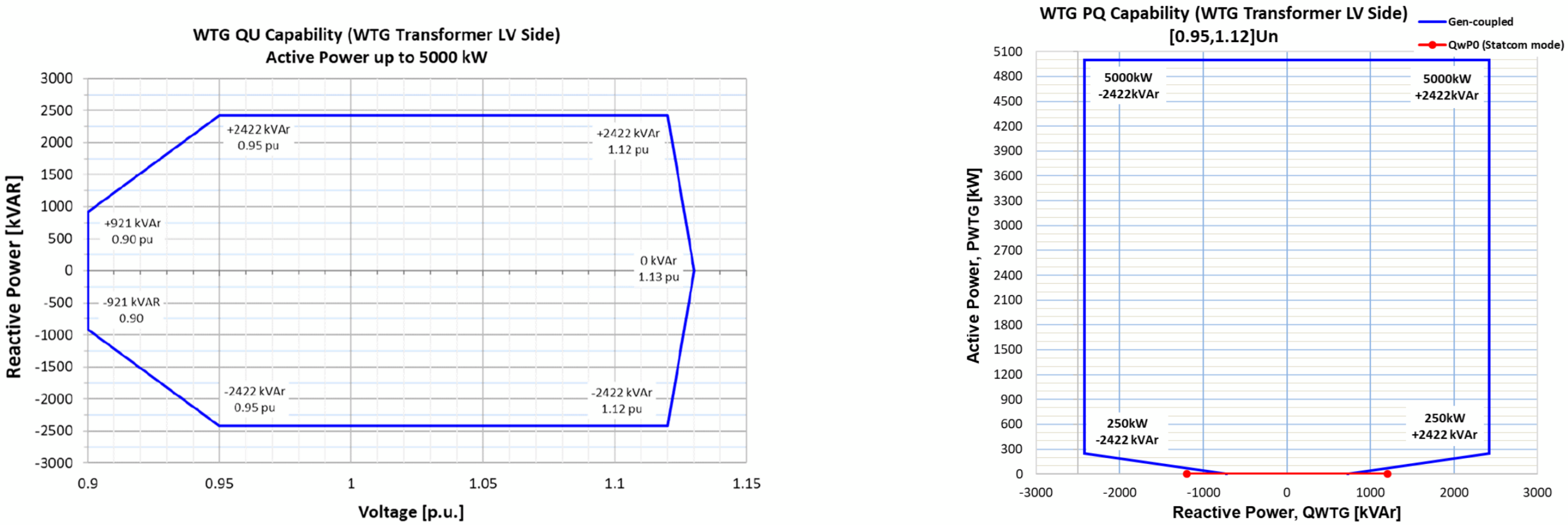


Figure: Standard reactive power capability of a Siemens-Gamesa turbine

Low voltage ride-through

- If reactive power provision is insufficient to support voltage, turbines need to provide LVRT as per grid code requirements
- Capabilities depend on generator and controller design and vary widely (e.g. Enercon vs. Siemens Gamesa)

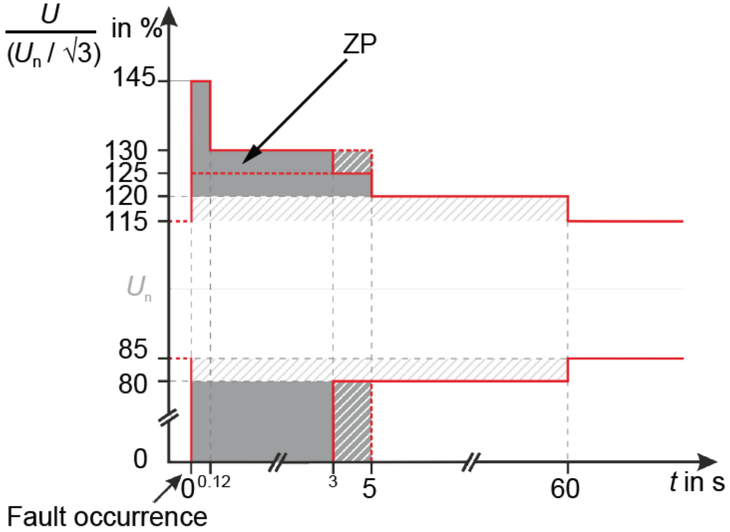


Figure: Enercon turbine

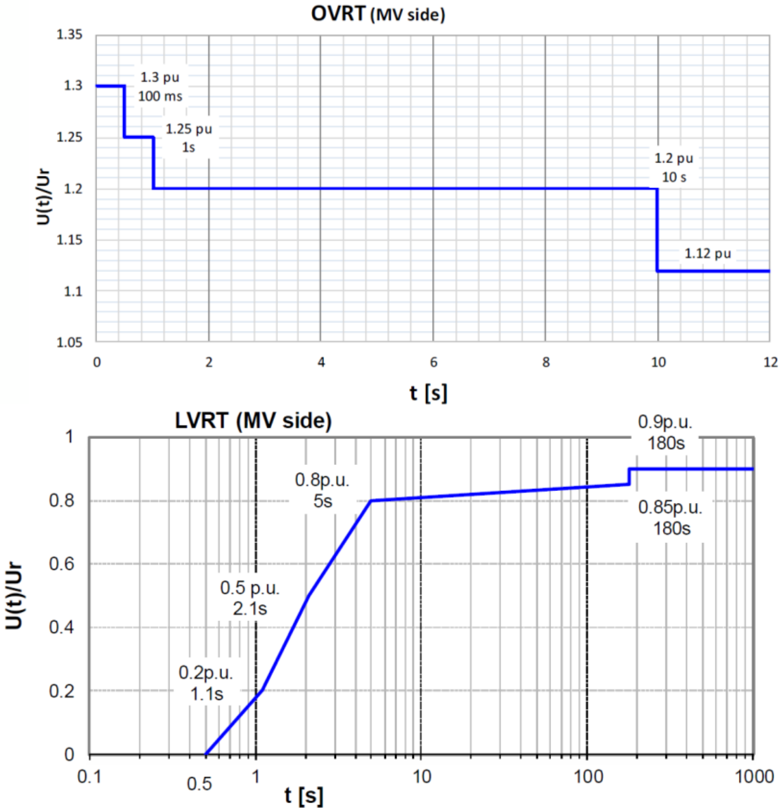


Figure: Siemens-Gamesa turbine

Bidirectional frequency control

- Wind turbines are increasingly full-converter designs, which are more flexible
- The reactive power capability generally exceed continental grid code requirements
- STATCOM options often allows no-load reactive power provision

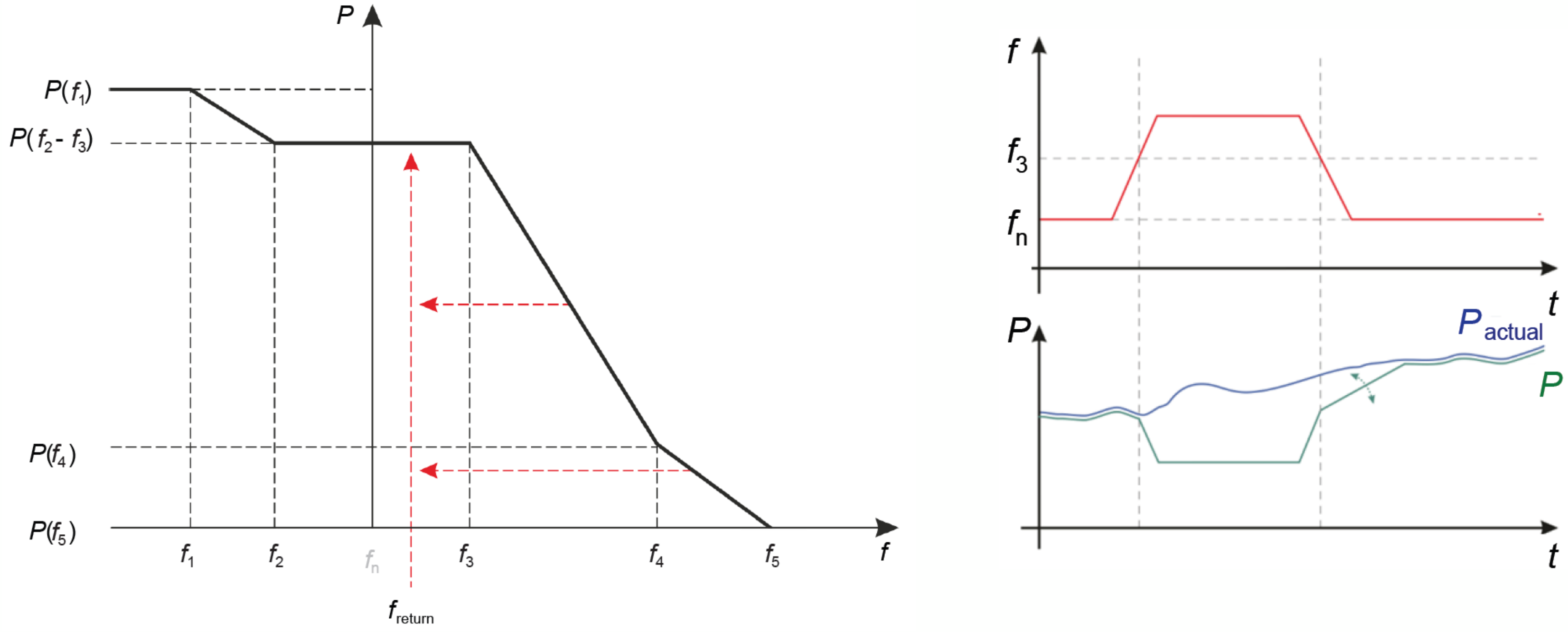


Figure: Static frequency characteristics of an Enercon turbine

High wind ride-through

- Sudden loss of injection is especially dangerous for small networks
- Generally, turbines stop suddenly at the cut-out wind speed to avoid excessive loading
- Especially relevant for island climates
- Most turbine OEM now offer high-wind options avoiding sudden and simultaneous stops

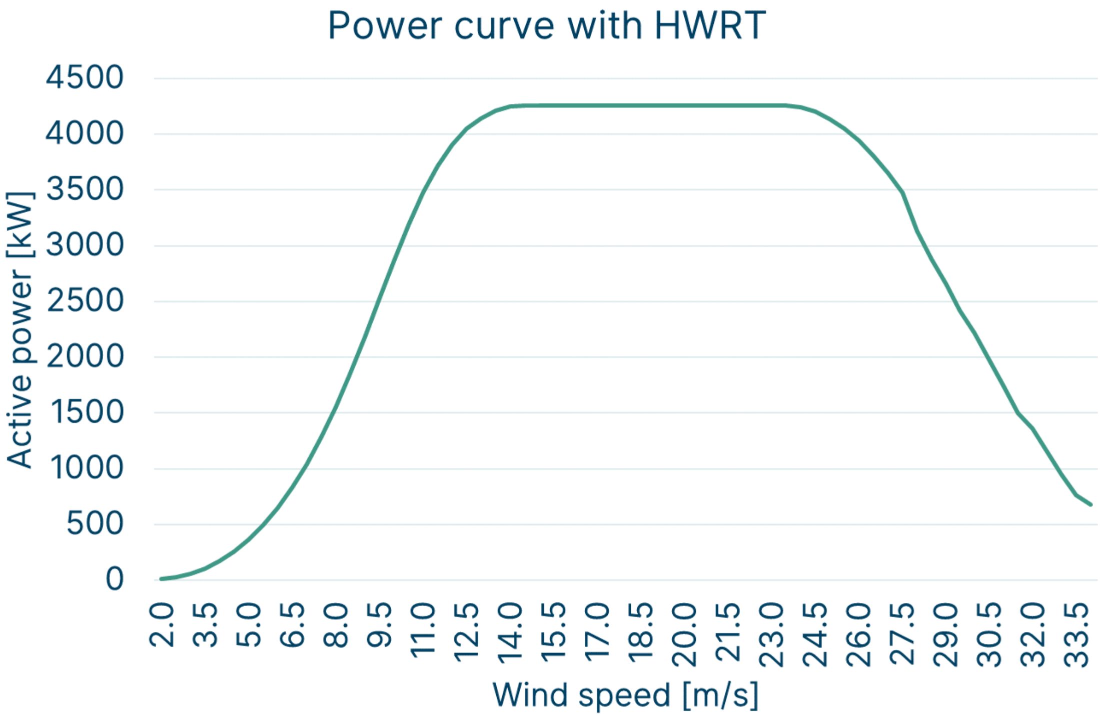


Figure: Power curve of an Enercon turbine with HWRT option

High temperature ride-through

- High-temperatures yield derating to protect electrical components
- The derating is progressive until the operating limit is reached
- OEM often propose options for higher temperature operation, and for temporary

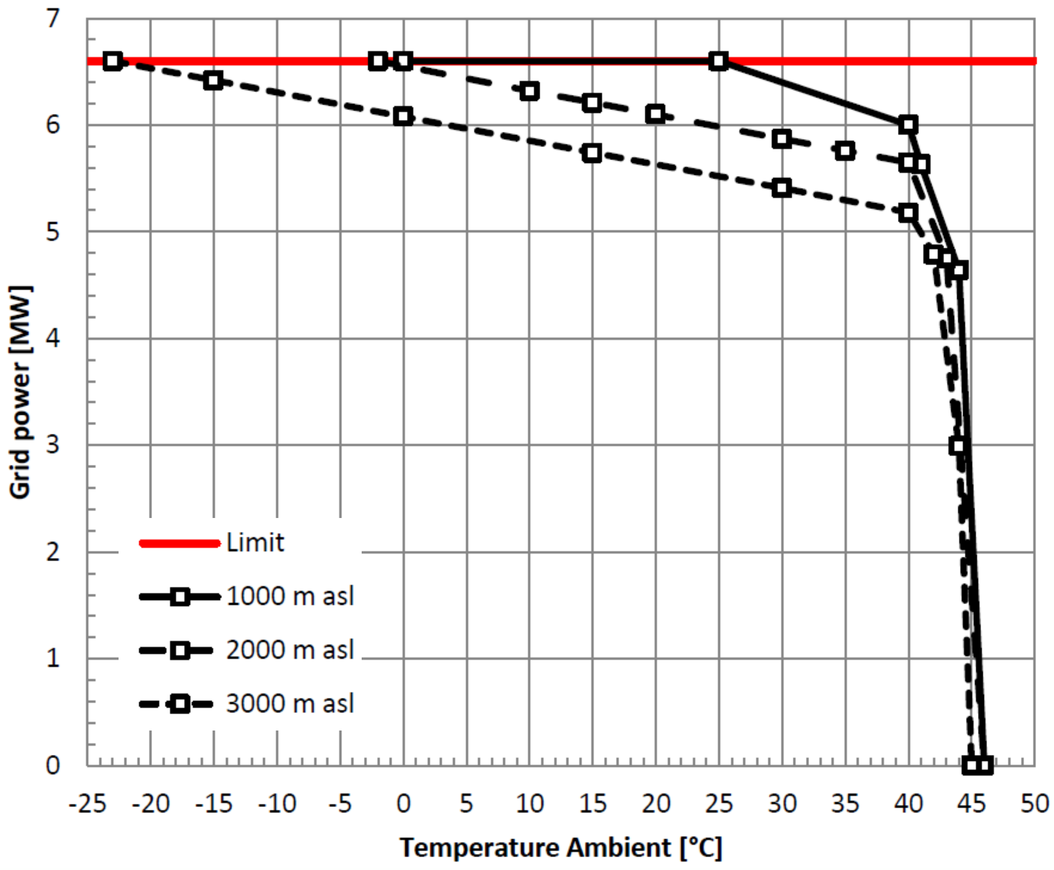


Figure: Temperature derating on a Siemens-Gamesa turbine

Other ancillary services

- Ramp-up/down limitations (1 kW/s to 1500 kW/s)
- Black-start capability with grid-forming inverters
- Physical and synthetic inertia

Thank you!

nme@3e.eu

Belgium, Kalkkaai 6 1000 Brussels

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For your texts, figures, tables, accents

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