



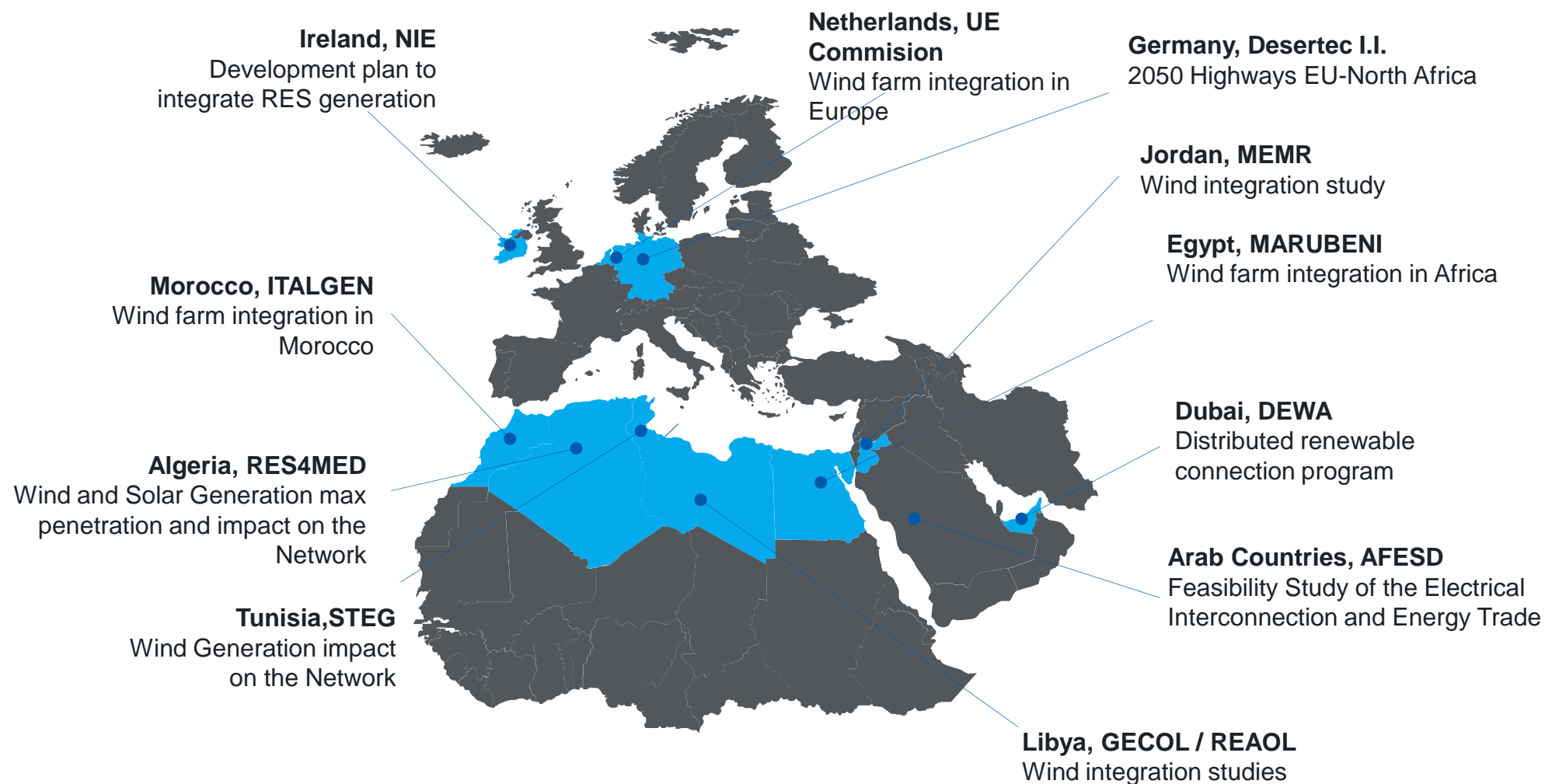
Integration of renewable energy sources in the electricity system: grid connection

Matteo Codazzi, CEO

Rome, 19/05/2016



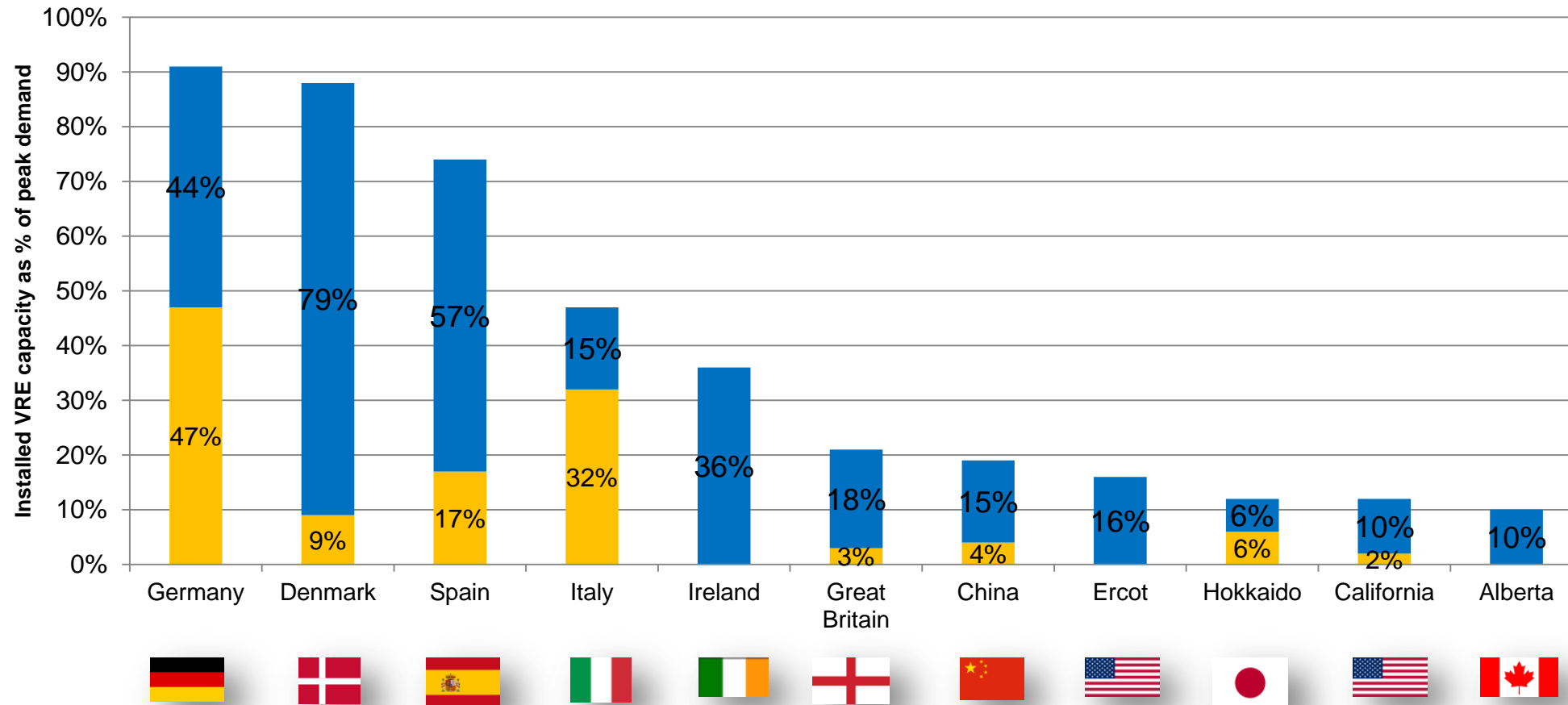
CESI references in max penetration of RES outside Italy



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Variable Renewable can cover a significant portion of the demand

VRE penetration – capacity as a percent of peak demand

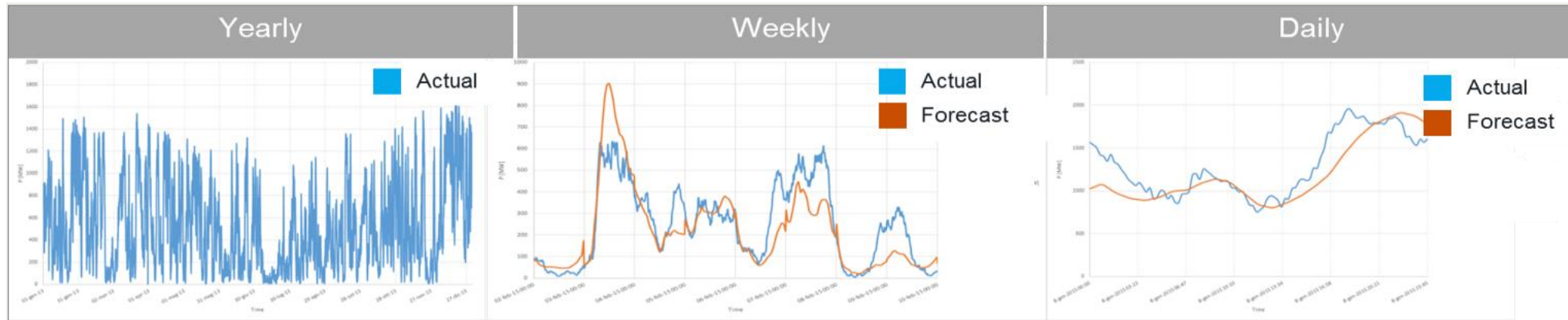


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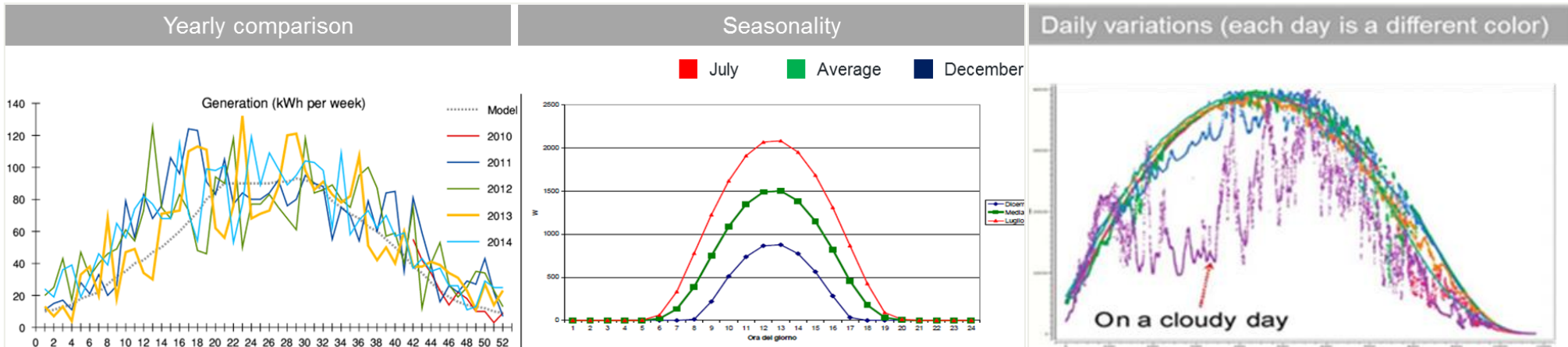
Source: WEC 2015, Mott MacDonald and system operators, 2014

Wind and Solar are Variable and uncertainty

Wind production variability in Ireland



Solar PV production variability in Central Italy



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Source: WEC Ireland, 2013; Italy SunSim, 2013

Variable Renewables: No GRID, No Party!

- 1 Interconnections
- 2 Grid Operations stability and control
- 3 Forecast accuracy

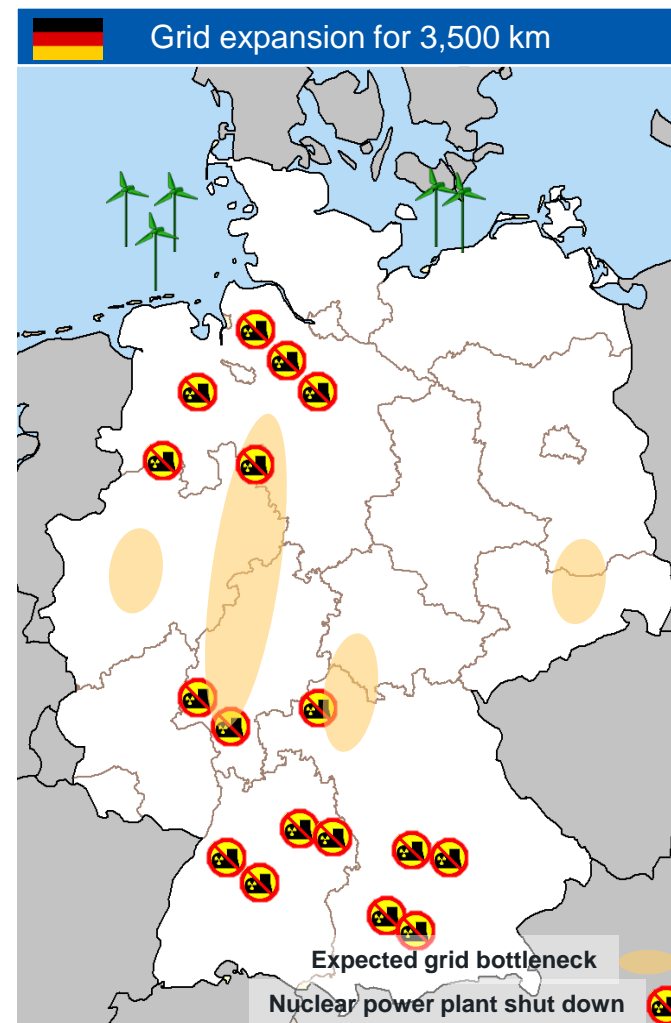
Substantial transformation of the grid



- 4 Supply Aggregation
- 5 Demand Response & Management
- 6 Energy Storage

1

E-NTSO foresees 40,000 km of new lines to accommodate RES with investment worth 80 Billion Euro

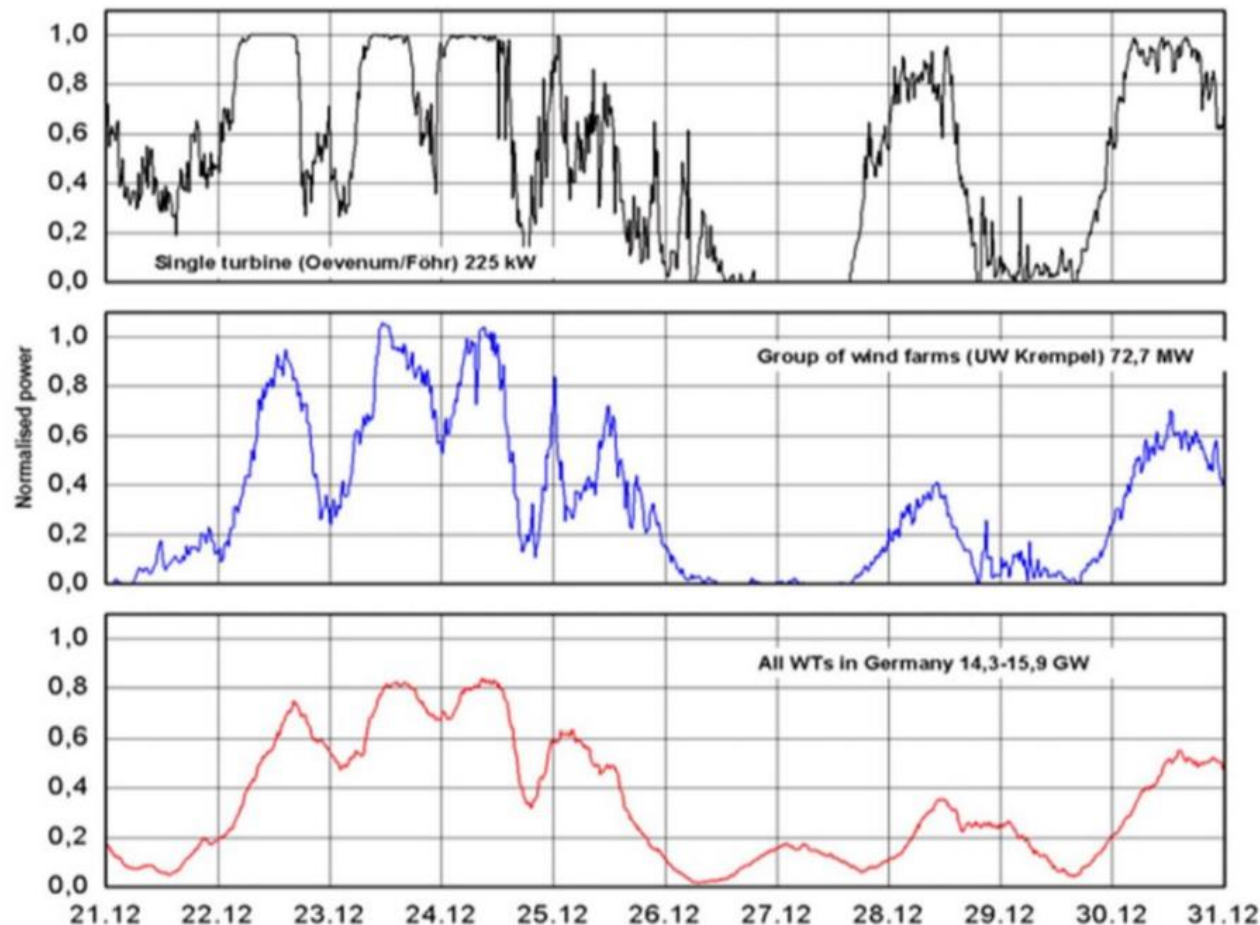


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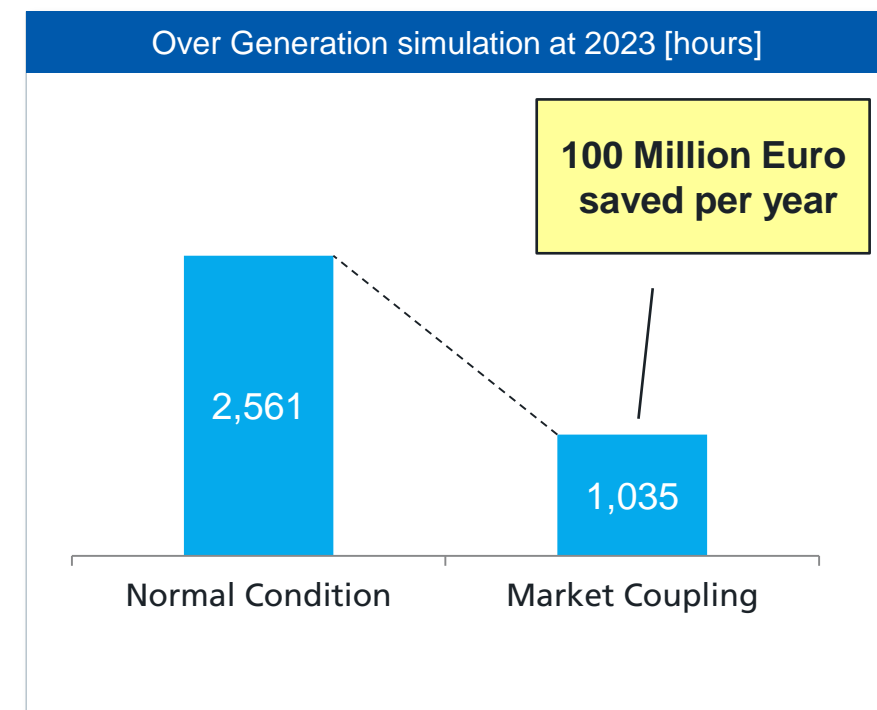
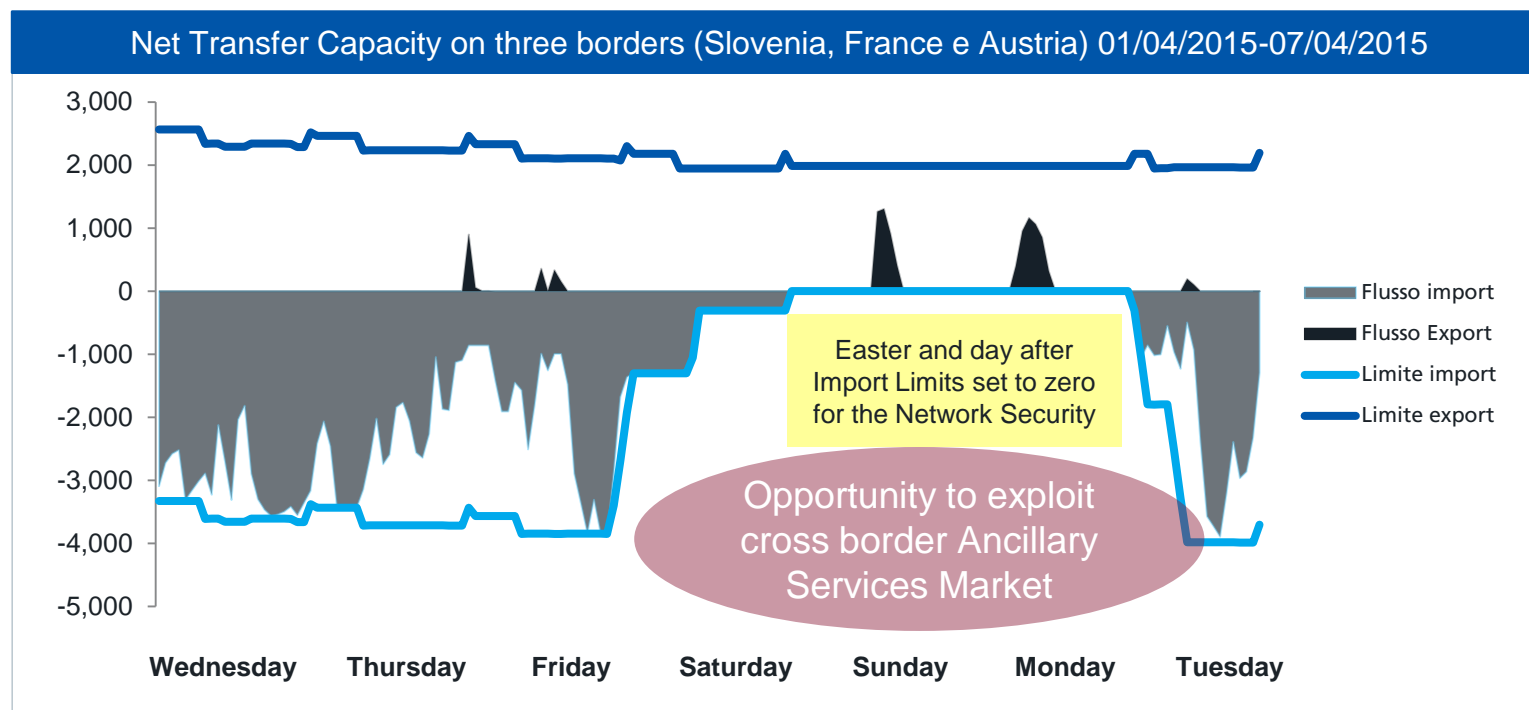
Source: Terna Development Plan, 2014; German Grid Development Plan, 2014

Aggregating VRE over a large geographical area reduces variability

Smoothing by aggregating: Wind in Germany



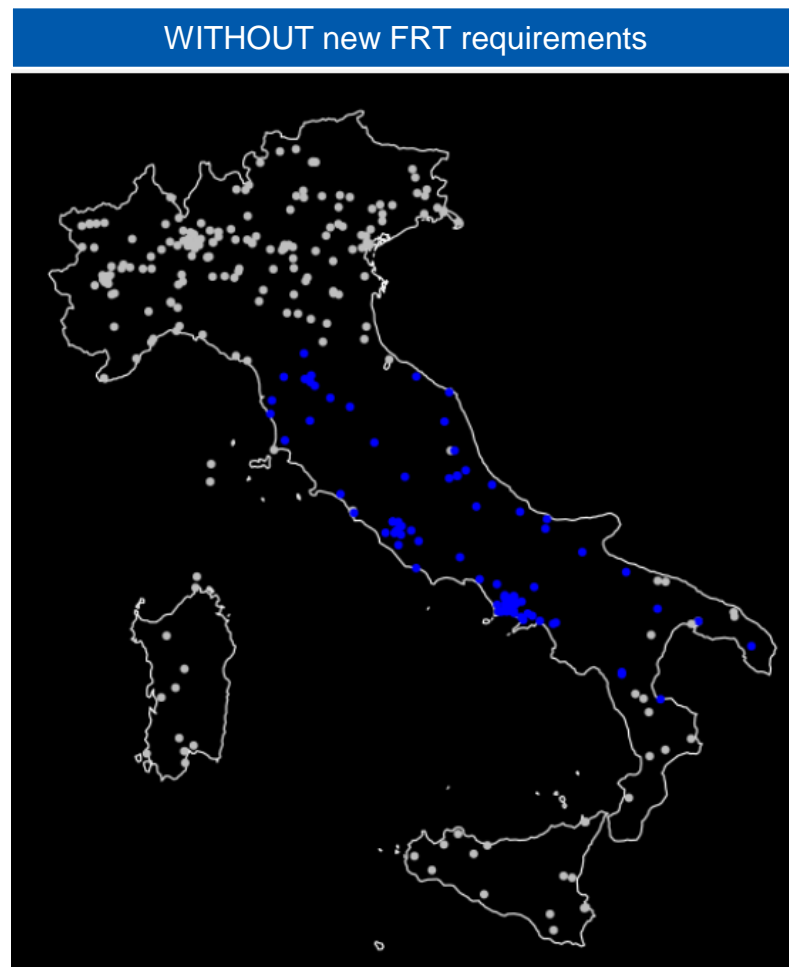
1 Cross-border transfer capacity can provide further flexibility in the ancillary services market to balance RES



2



Voltage fault ride-through (FRT) capabilities for PV units reduced the risk in case of voltage dip in the grid



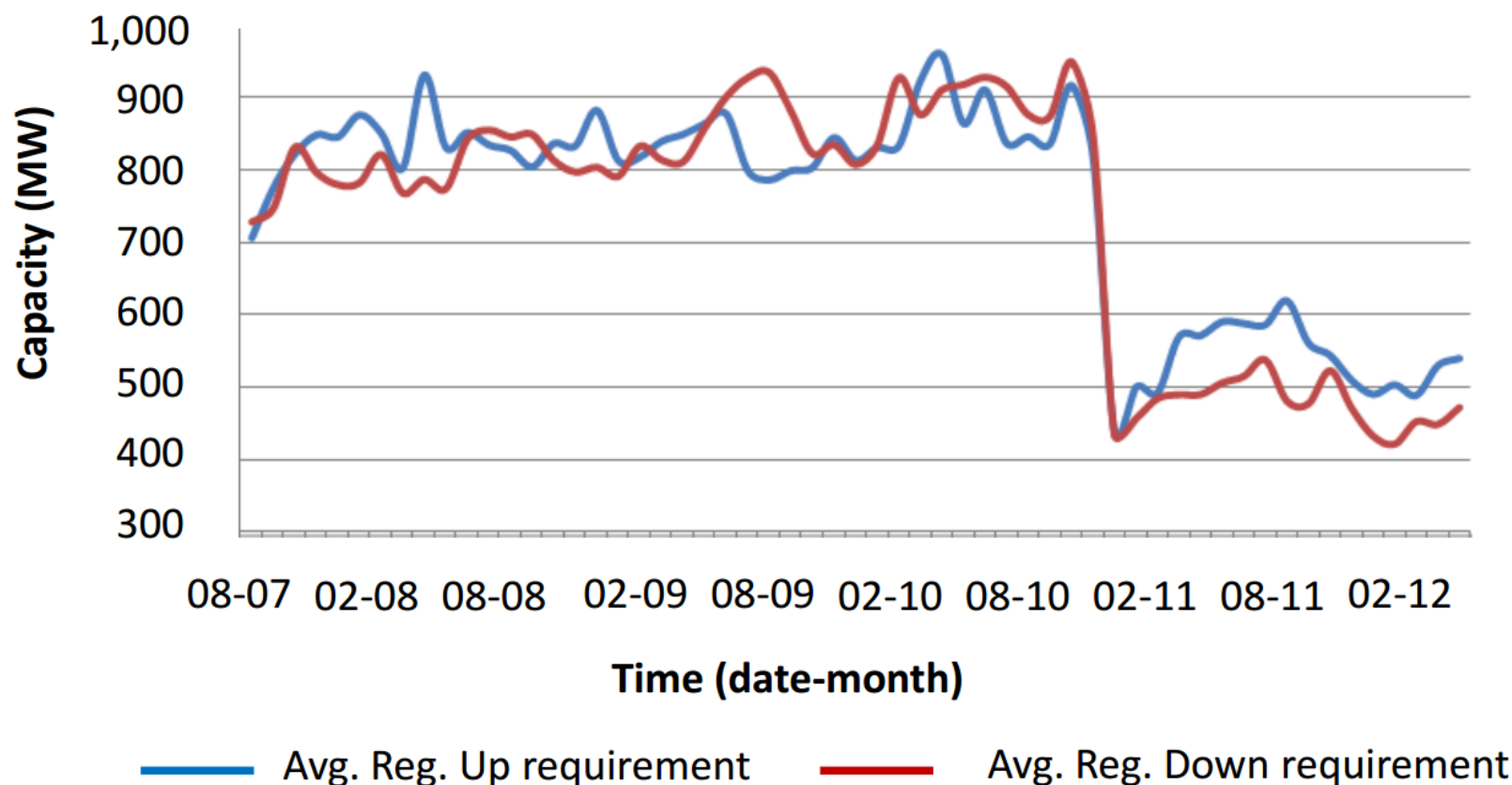
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Source: Terna, AEEGSI



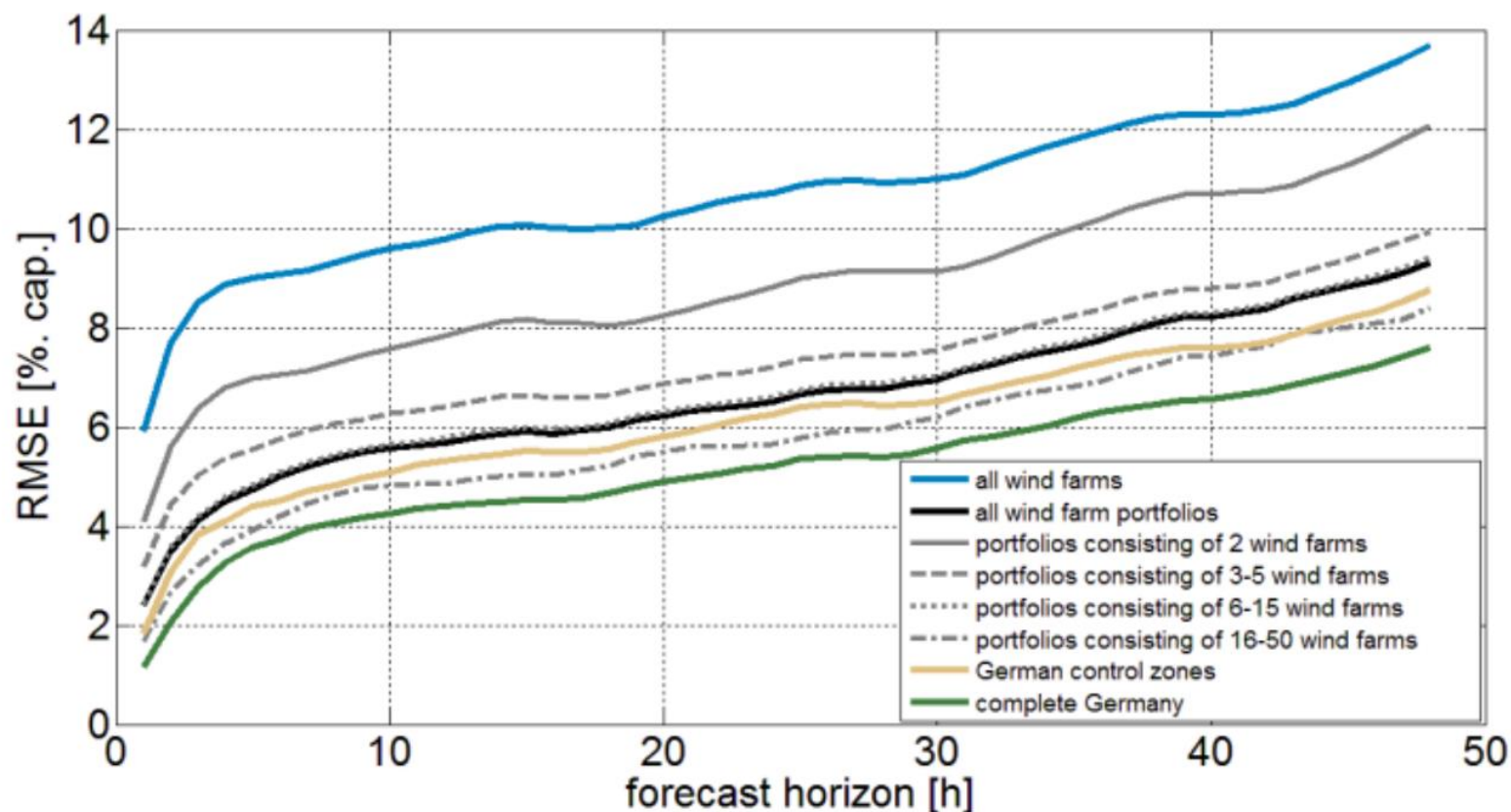
Shortening dispatch times from 15 to 5 minutes can significantly reduce the amount of regulation reserve to manage imbalances

Regulating reserve requirement in ERCOT

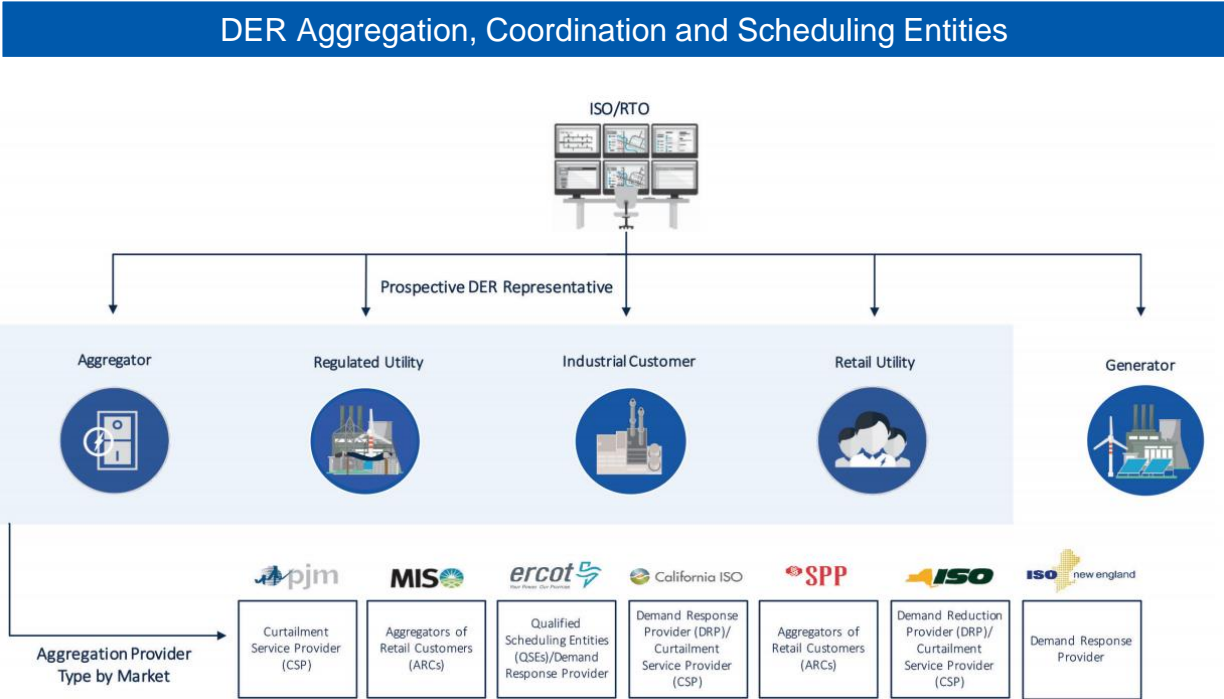
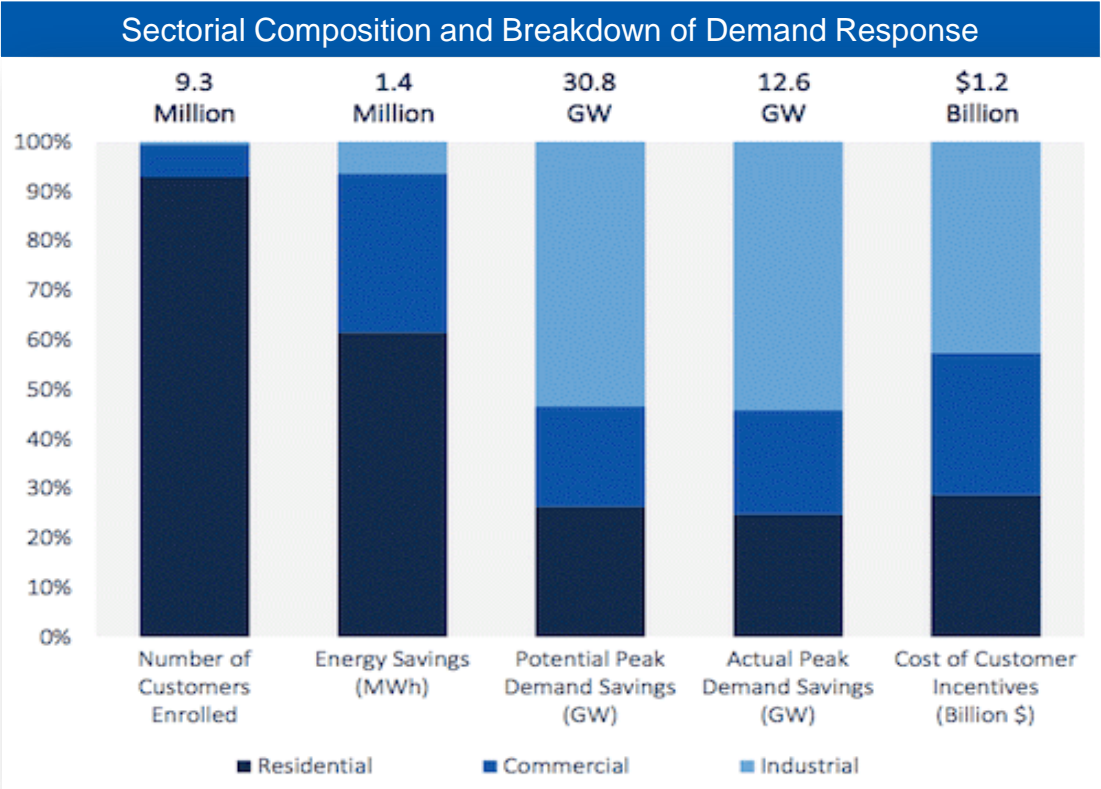


Reducing gate closure times is equivalent to increasing wind forecast accuracy

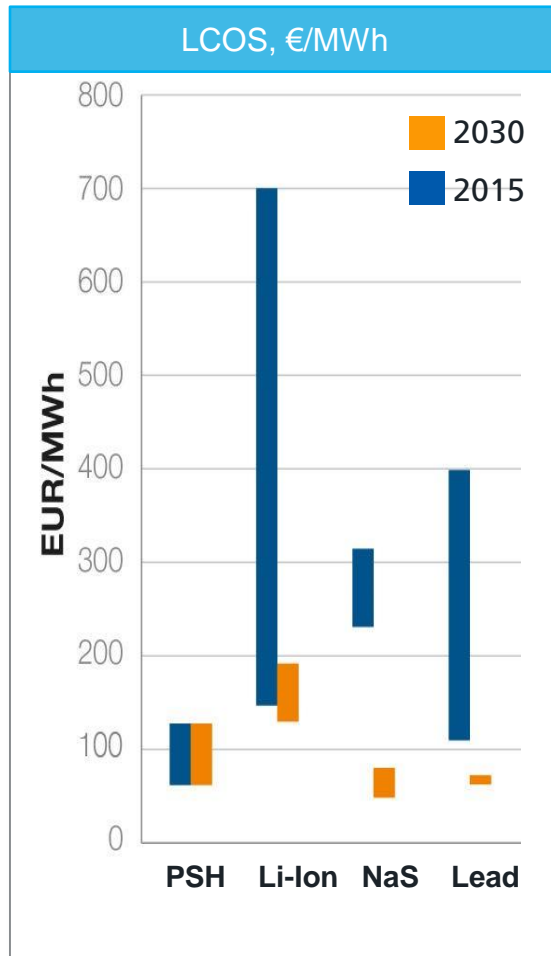
Average error is increasing as the time horizon to forecast is increasing



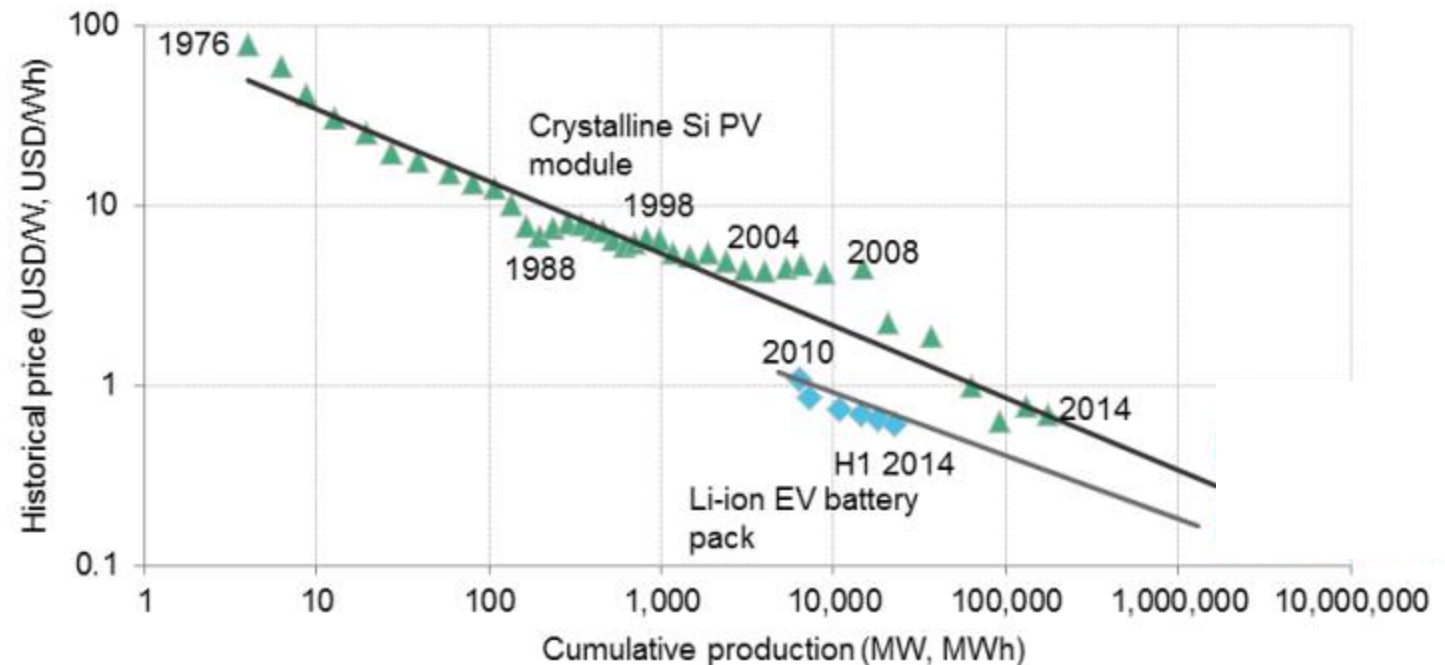
9.3 Million U.S. Customers are Enrolled in Demand Response



Batteries will become competitive



Lithium-ion EV Battery experience curve compared with solar PV experience curve

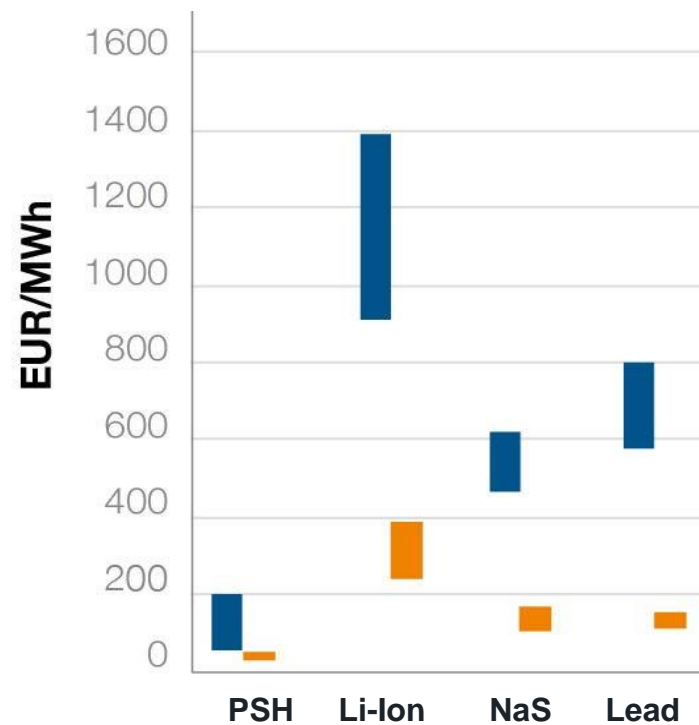
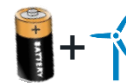
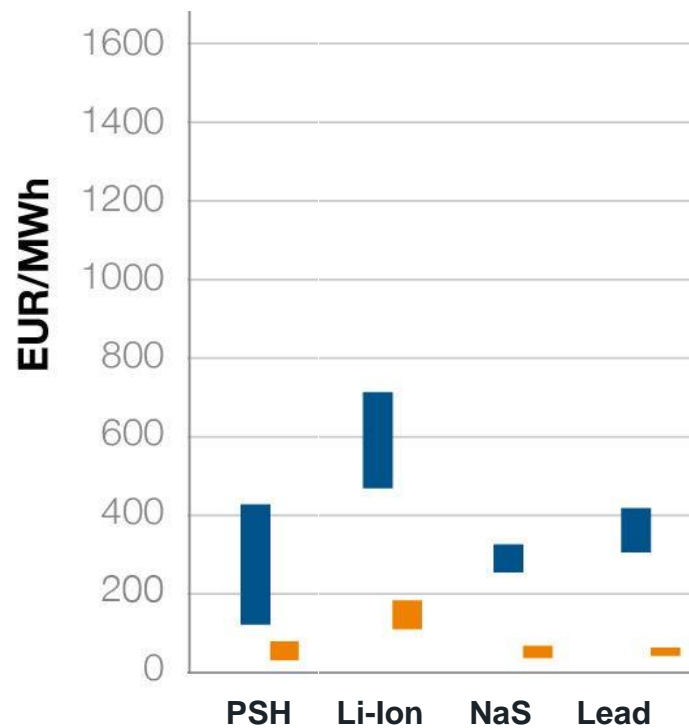


6

Comparing levelised cost of storage co-located

for 2015 and 2030

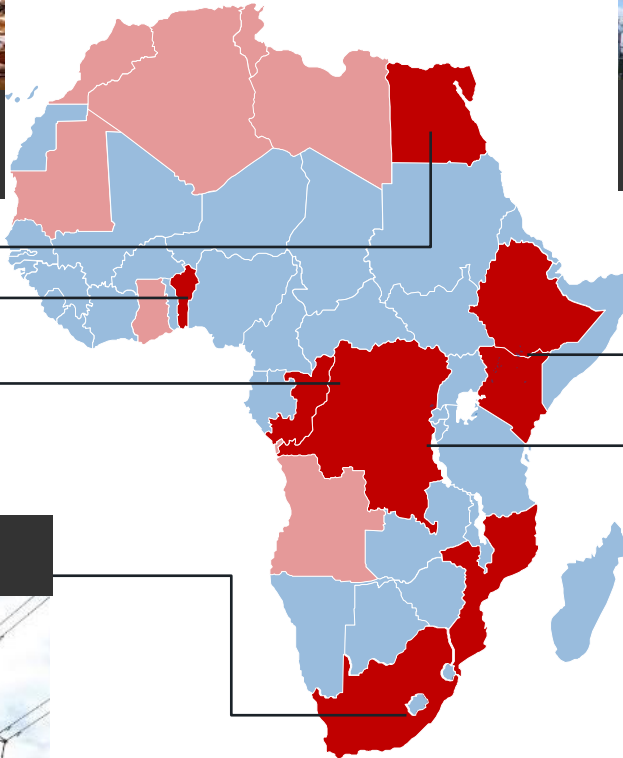
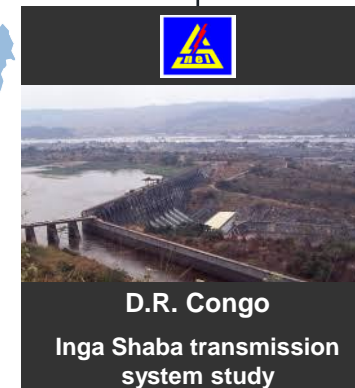
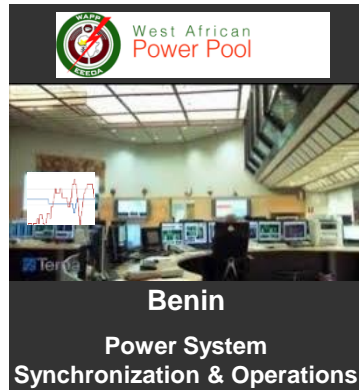
2030 2015



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Source: WEC 2016, Euro_2014

A few selected example of CESI reference in Africa



■ Country with Reference

19/05/2016



Thank you