

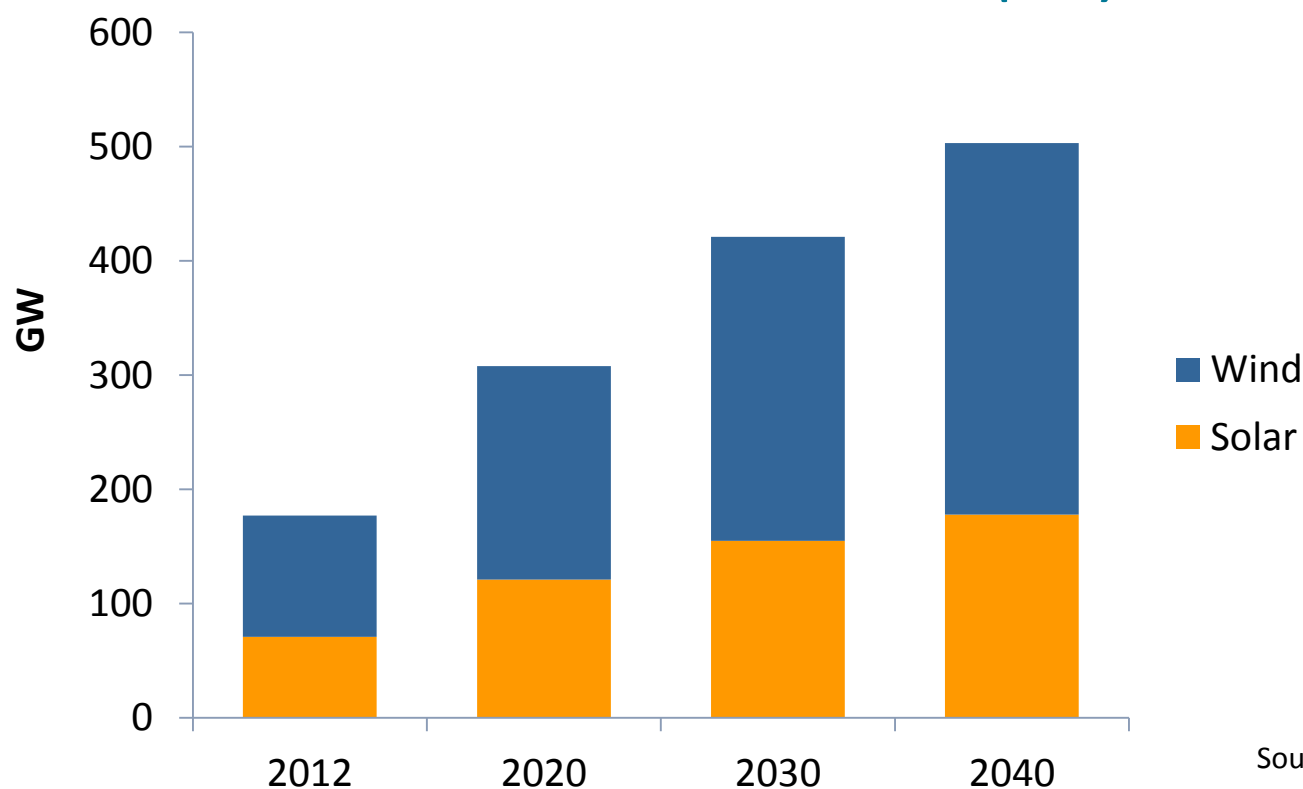
# Does flexibility have a value today and is it correctly priced at its value?

**Manuel Baritaud**  
Senior Energy Analyst, IEA

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# Renewable deployment

*Installed wind and solar capacity in OECD Europe in the WEO New Policies Scenario (NPS)*



Source: WEO 2014

***Wind and solar will reach 36% to 40% of installed capacity by 2040 in the NPS and 450 ppm scenarios, respectively***

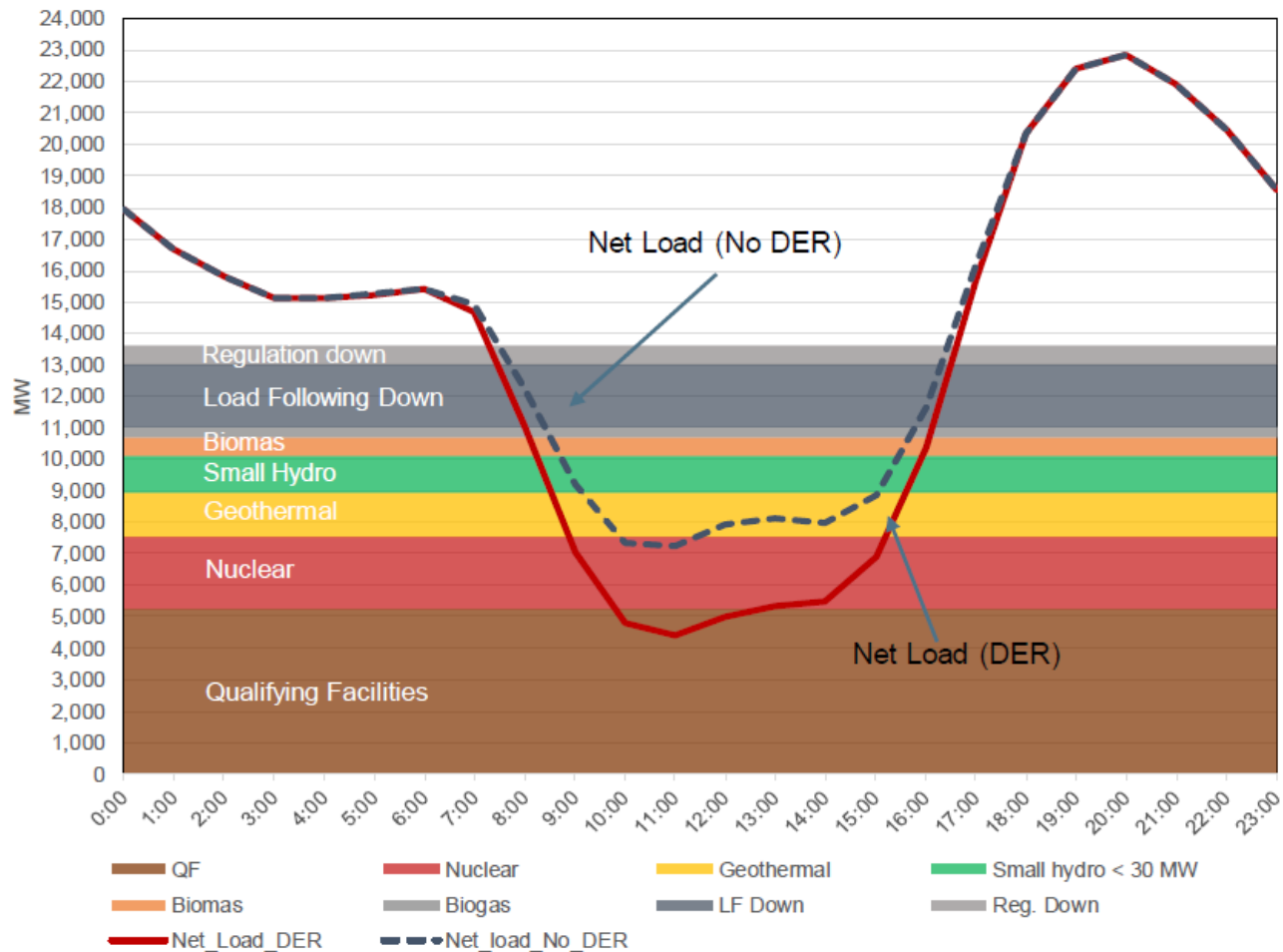
## Grid integration of renewables: three main results

1. Very high shares of variable renewables are technically possible
2. No problems at low shares, if ...
3. Reaching high shares cost-effectively calls for system-wide transformation



# Potential over-generation

## California ISO Long-Term Procurement Proceeding Scenario 24 March 2024



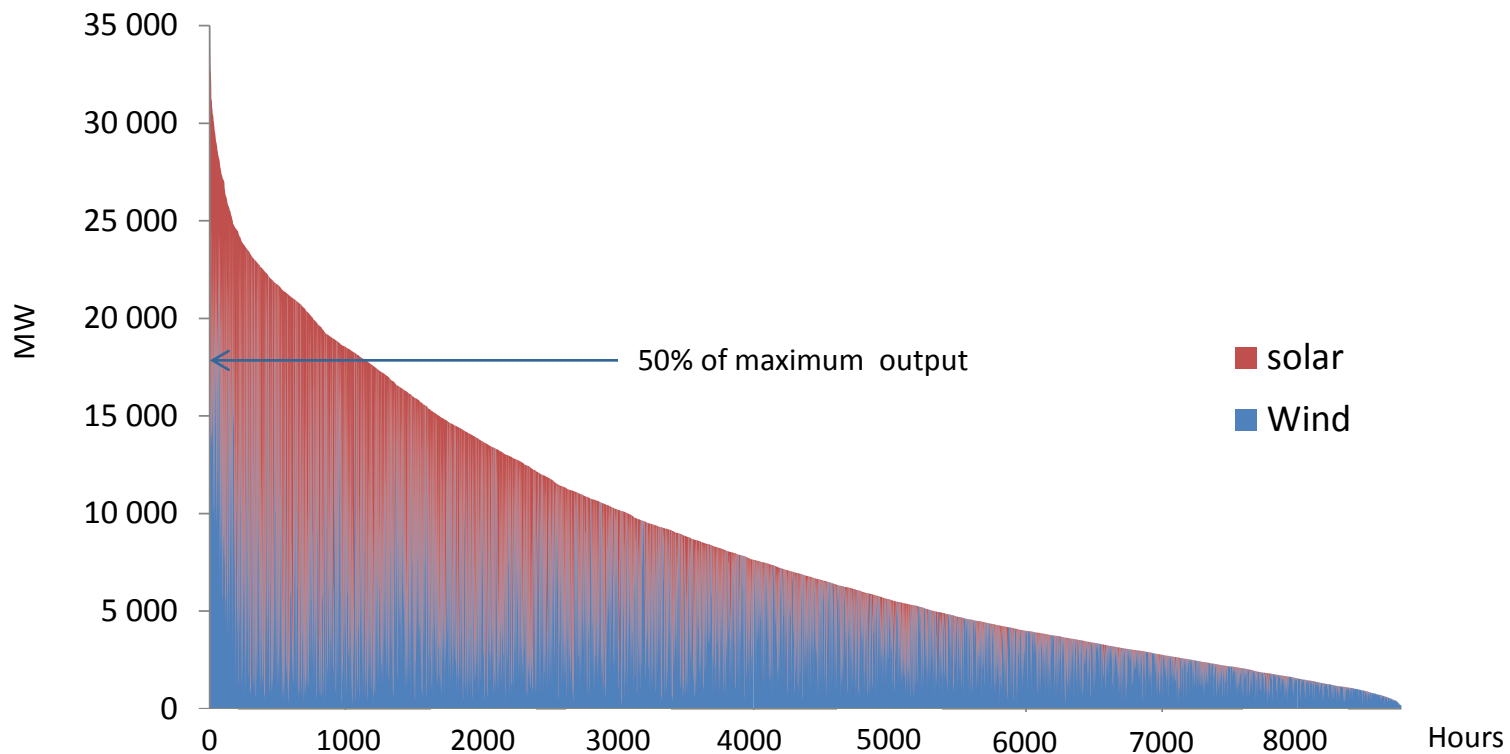
Source: CAISO

# Three pillars of system transformation

1. **Let wind and solar power play their part**
2. **Improve system and market operations**
3. **Ensure long-term system transformation**

# Variable renewables (VRE) generation is peaky

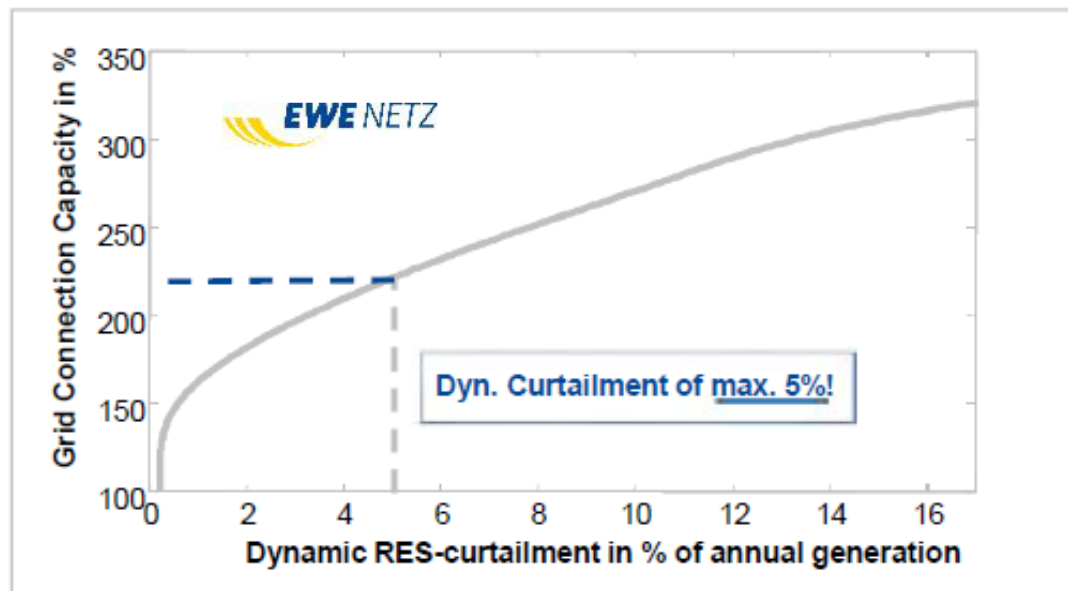
*Load-duration curve of wind and solar generation in Germany, 2014*



***During extreme VRE generation hours,  
half of the maximum capacity generates only 5% of the energy***

# System-friendly renewable deployment

*Grid connection capacity under new network access conditions and planning methods*



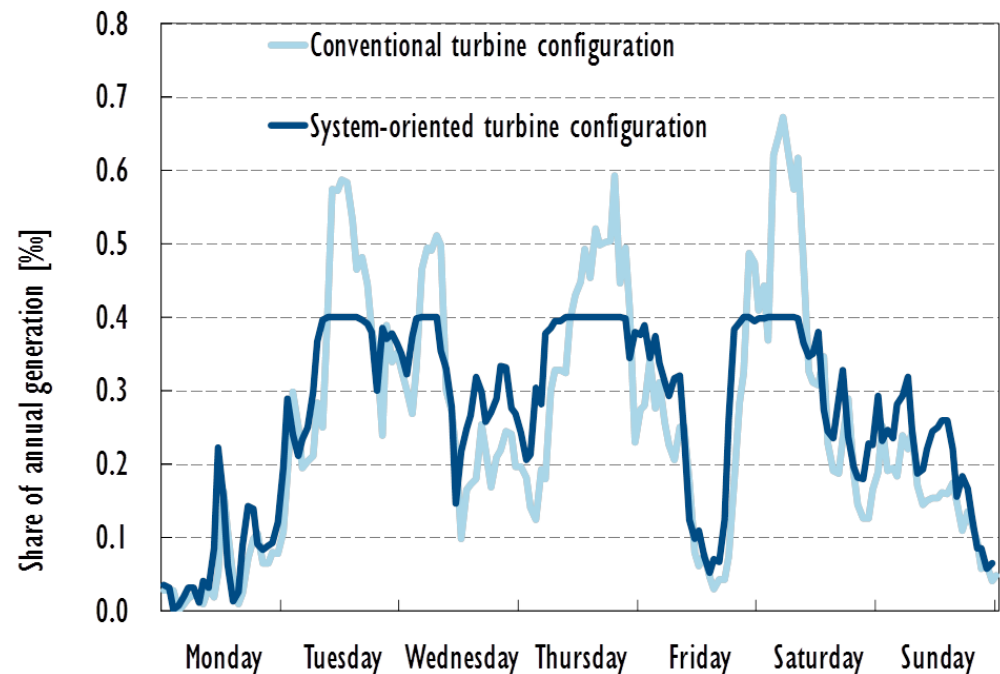
Source: ERDF, Based on EWE Netz

***Grid connection capacity for VRE at distribution level  
can be doubled with a curtailment of only 5%***

# System-friendly renewable deployment (cont. )

- Wind and solar PV can contribute to grid integration...
- but only if they are allowed and asked to do so!

*Example: System-friendly design of wind turbines reduces variability*



Source: adapted from Agora, 2013

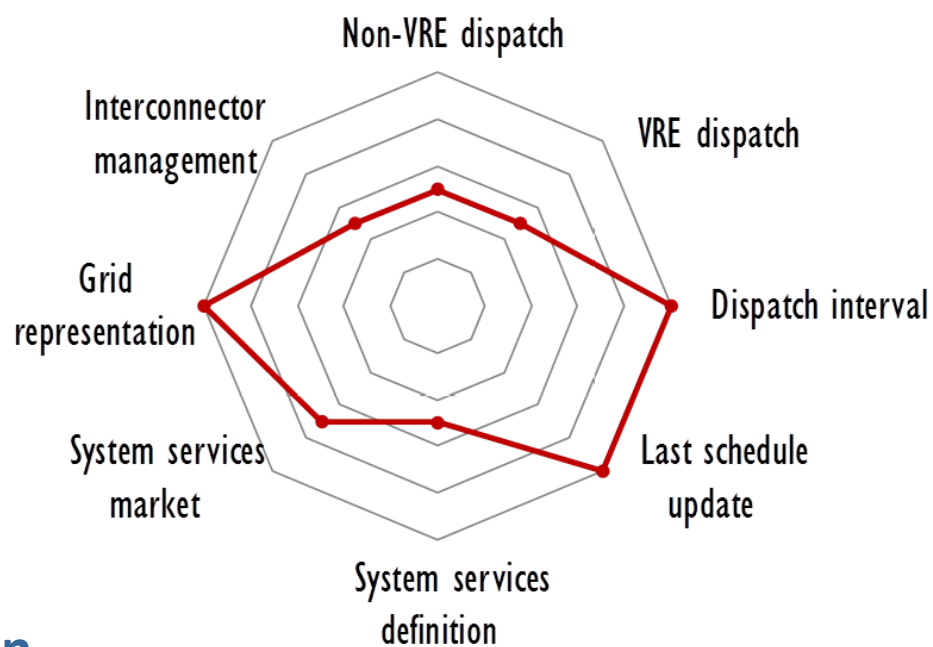
***Market integration of renewables will send the signals to develop system-friendly solutions***



# Better system and market operations

- VRE forecasting
- Better market operations:
  - Fast trading  
*Best practice: US (Texas) – 5 minutes*
  - Price depending on location  
*Best practice: US – Locational Marginal Prices*
  - Better flexibility markets  
*Example: New ramping product*
- Align system and market operation

## Example: ERCOT market design

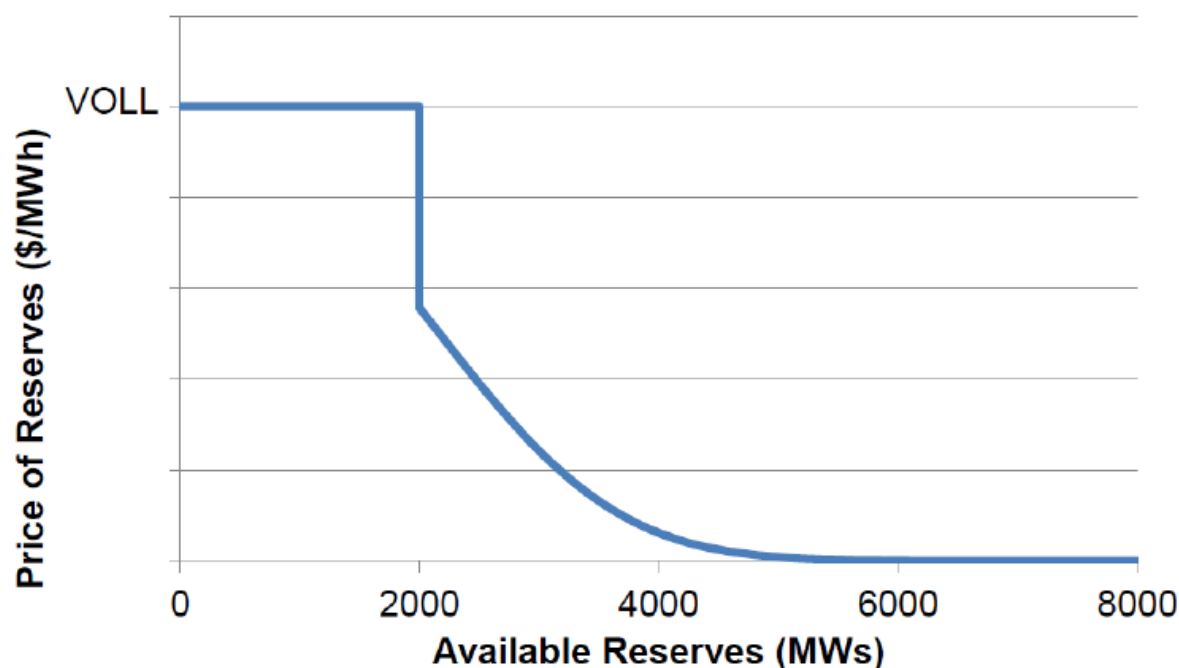


Source: IEA (2014) The Power of Transformation

***Make better use of what you have already!***

# Scarcity pricing

*Operating Reserve Demand Curve in Ercot*



Source: Potomac Economics

***Price during scarcity can take the form of administrative scarcity pricing, mitigating market power and leading to accurate prices***

# Demand Response

Demand Response can ...

**BE A RESPONSE  
TO PRICES**

**Electricity  
Markets**

**BE TREATED AS  
A GENERATION RESOURCE**

Reduced capacity  
requirements

**Capacity**

Participation as a resource  
in capacity markets

Time-of-Use /  
Dynamic Pricing

**Energy**

Participation as a resource  
in energy markets

-

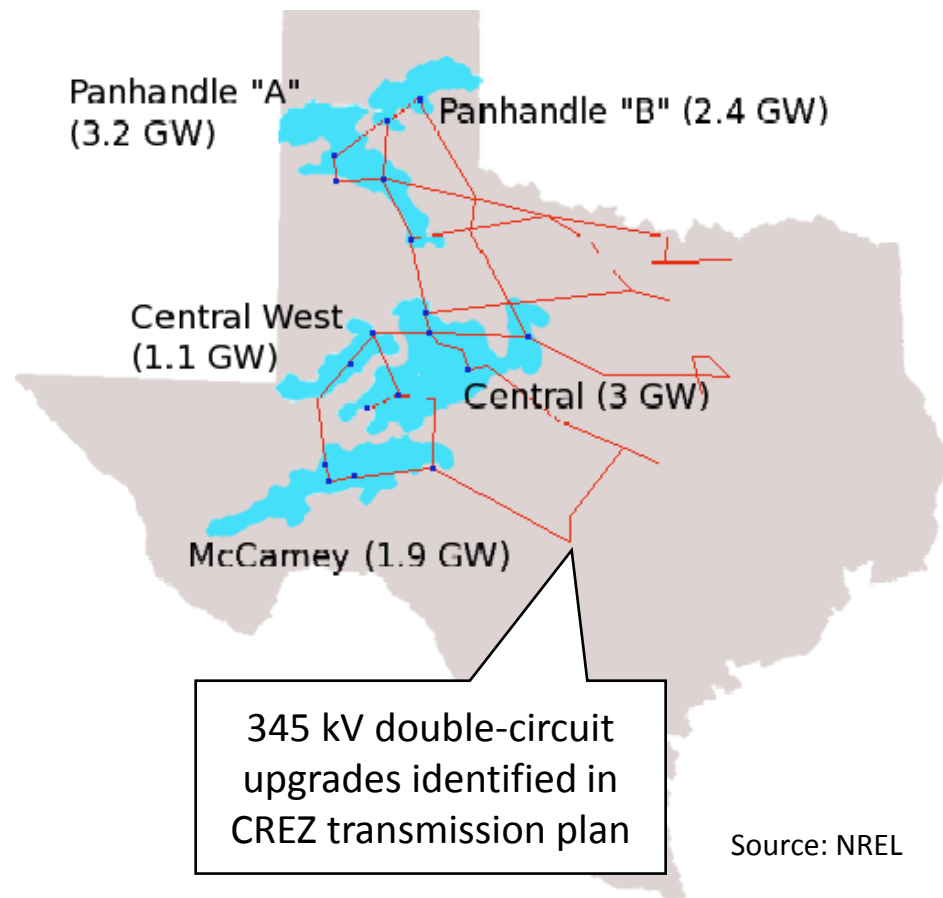
**Operating reserves**

Ancillary Services  
open to demand

# Wind in Texas – Operational issues

## *Texas Competitive Renewable Energy Zones*

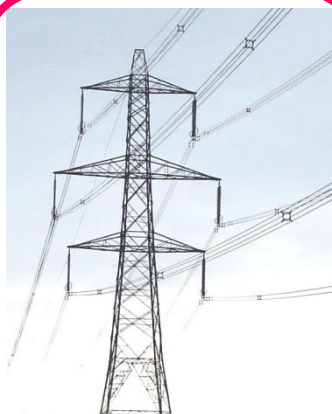
- **Curtailment: 17% in 2009**
- **Curtailment reduced to 1.6% in 2013 after implementing locational pricing and grid expansion**





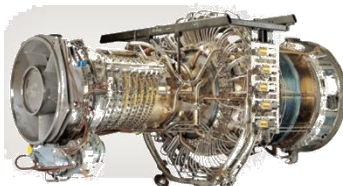
# Long-term system transformation: re-optimising

## Grid infrastructure



- Coordination of investments with VRE

## Dispatchable generation



- Less baseload
- System friendly renewables

## Storage



- Pumped hydro
- Batteries

## Demand Response



- Smart meters
- Automation

***Replacement of ageing capacity is an opportunity to transform the electricity sector in order to reach decarbonisation cost-effectively***

# Thank you

<http://www.iea.org/topics/electricity/>