

Integrating Renewables into Power Systems

**ENARD/IEA Grid Policy Workshop:
Electricity Grids - a key enabler in the
delivery of a sustainable energy policy**

**April 28, 2010
Paris, France**

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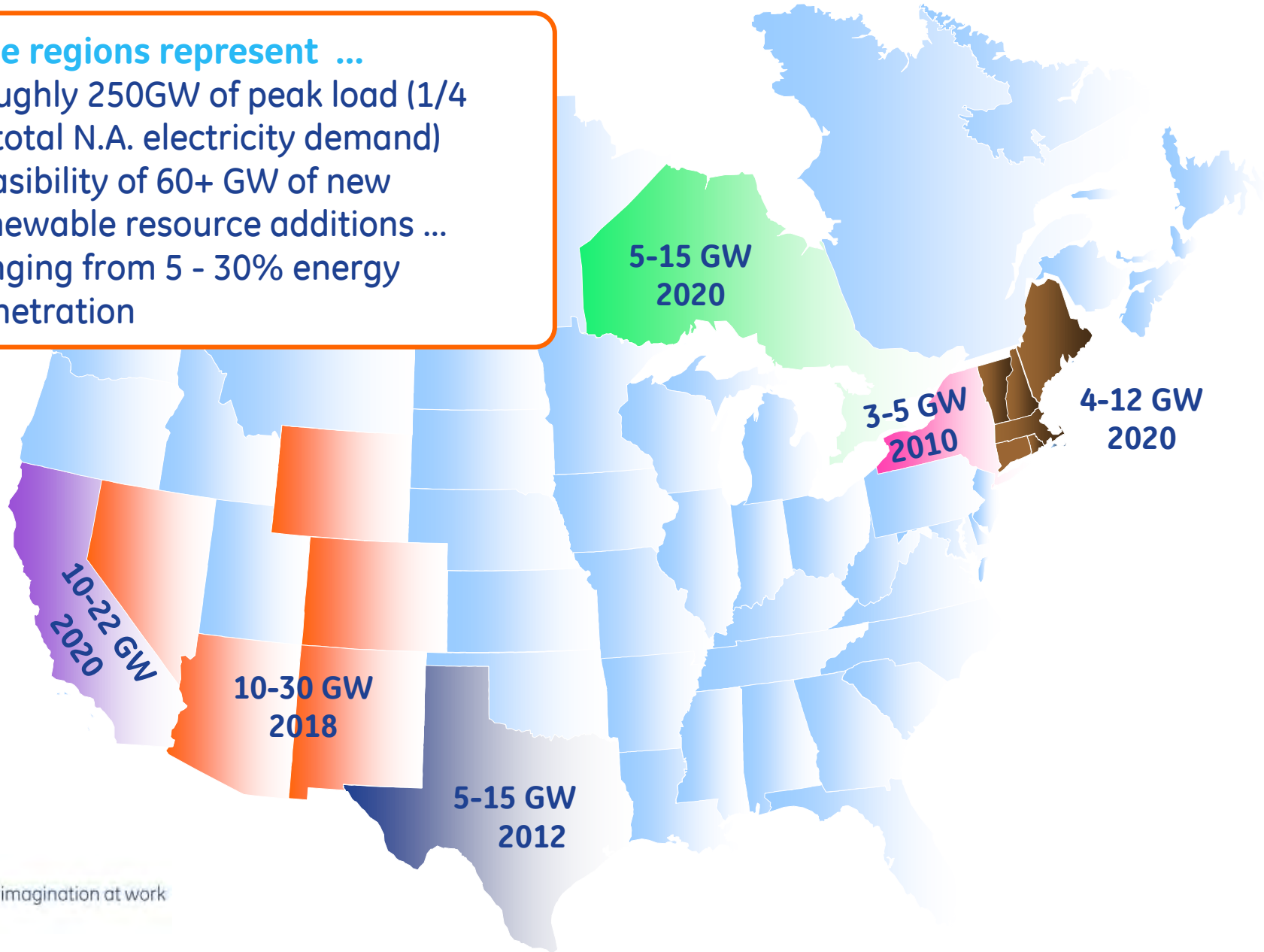


GE imagination at work

Our experience ... large scale renewable studies (N.A.)

These regions represent ...

- Roughly 250GW of peak load (1/4 of total N.A. electricity demand)
- Feasibility of 60+ GW of new renewable resource additions ... ranging from 5 - 30% energy penetration



Variability and uncertainty

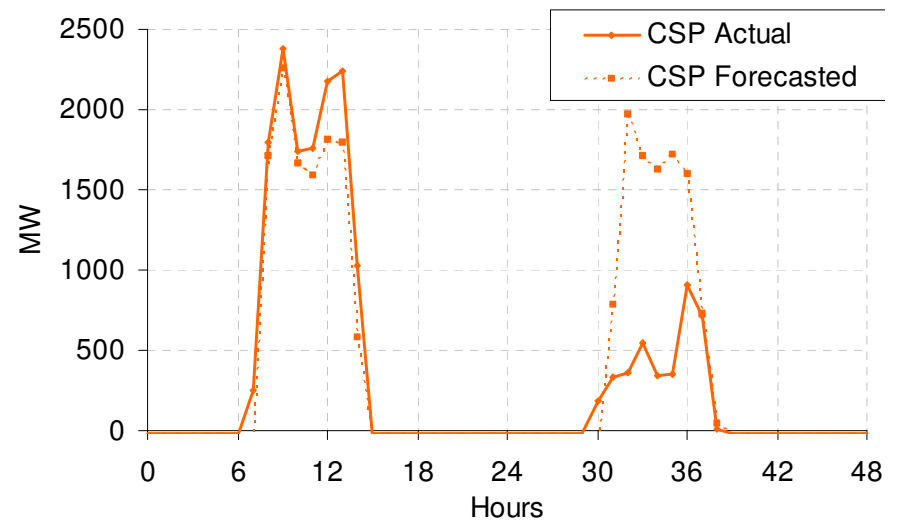
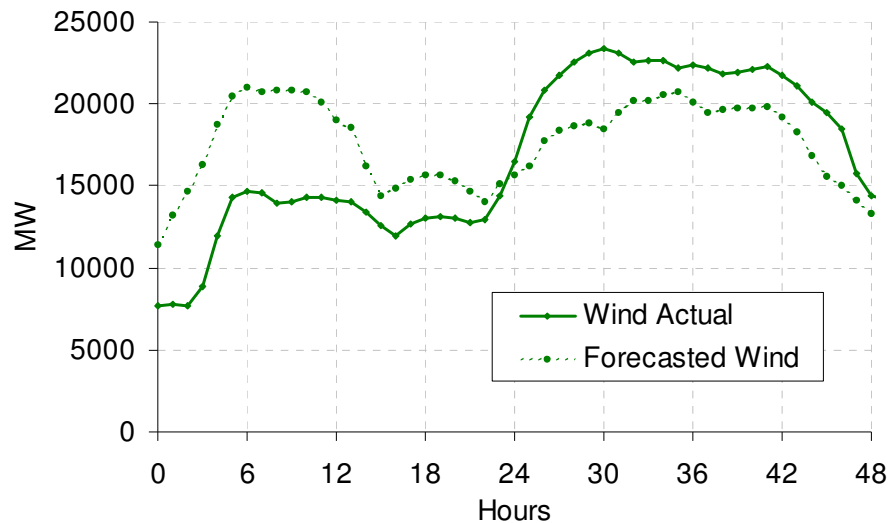
Variability: Wind and solar generator outputs vary as the intensity of their energy sources (wind and sun)

- Several timescales: minute (regulation), hour (ramping), diurnal, seasonal

Uncertainty: Wind and solar generation are similar to “load”

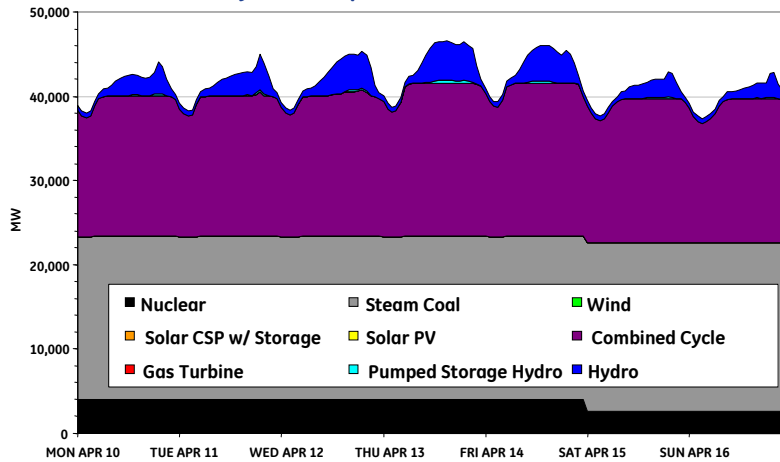
- Not dispatchable – output is predicted by a forecast
- Actual power output is different that forecast output

A perfect forecast eliminates uncertainty, but there is still variability

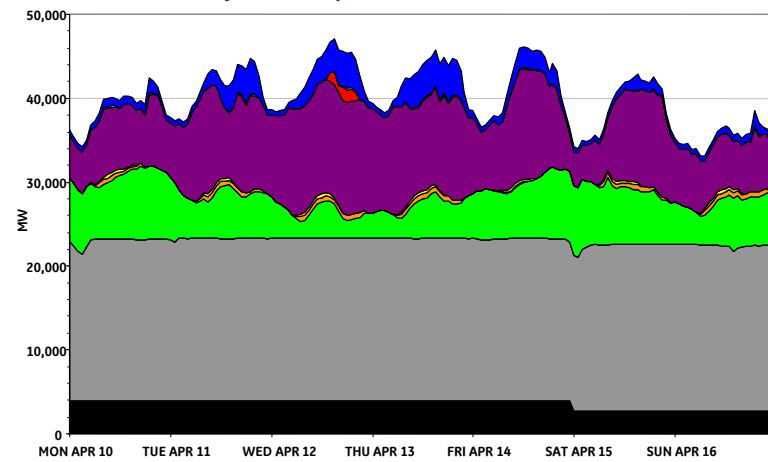


Operational flexibility ... Western US grid

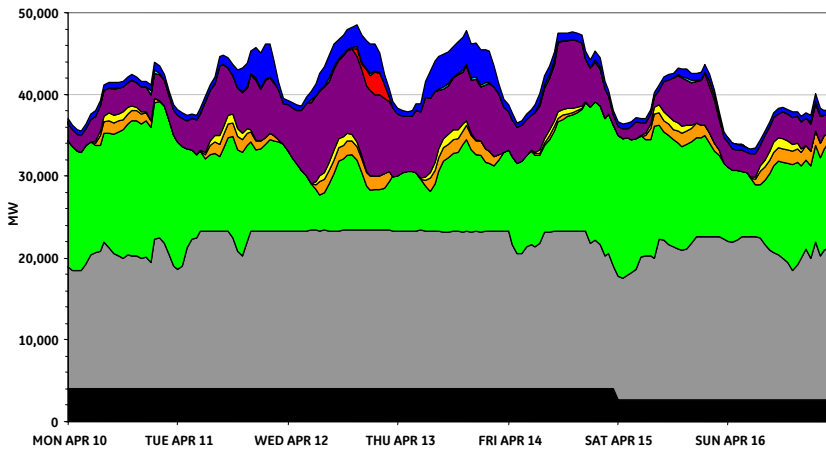
Study Area Dispatch - No Renewables



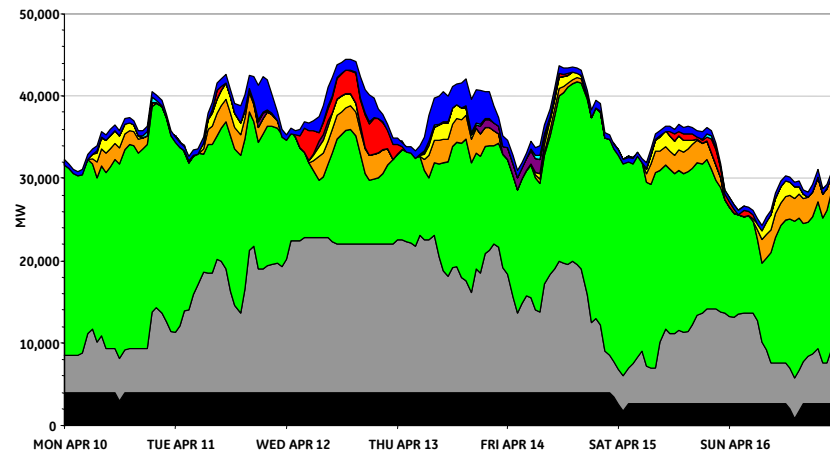
Study Area Dispatch - 10% Renewables



Study Area Dispatch - 20% Renewables



Study Area Dispatch - 30% Renewables



Week of April 10, 2006

Source: NREL Western Wind & Solar Integration Study

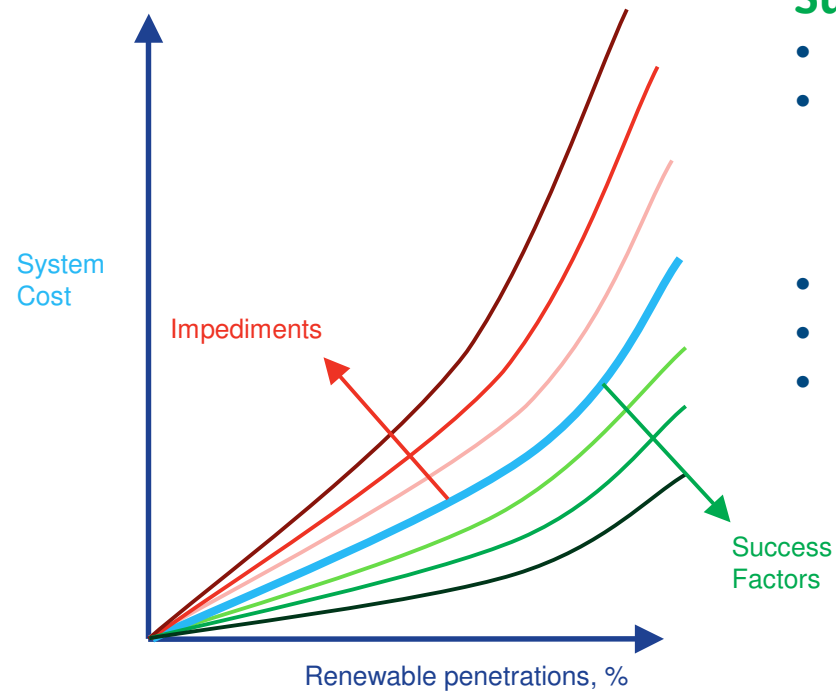
Lessons Learned ...

Impediments

- Lack of transmission
- Lack of control area cooperation
- Inflexibility due to market rules and contracts
- Unobservable DGs
- Inflexible operation strategies during light load & high risk periods

System cost

- Unserved Energy
- RPS miss
- Higher COE
- Higher Emission
- Higher O&M



Success factors

- Forecasting
- Thermal fleet
 - Higher quick starts
 - Deeper turn-down
 - Faster ramps
- More spatial diversity
- Renewable + DG + Demand A/S
- Grid-friendly renewables

GE Energy

Thank you!



imagination at work

