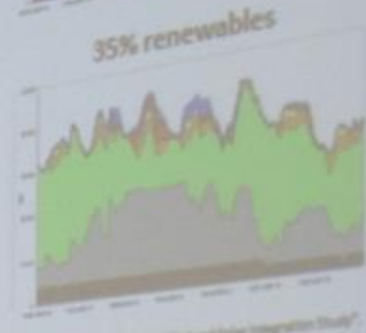
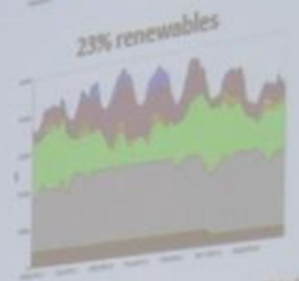








Smart behaviors



Lee et al. "How do Wind and Solar Power Affect Grid Operations: The Western Wind and Solar Integration Study". National Renewable Energy Laboratory. September 2009. p. 9.

- Data (over a week) from US Western Electricity Coordinating Council.
- At 35% (wind) renewables (green): combined cycle units are off, gas turbine (red) output has increased, coal plants (grey) are cycling, total generation drops because imports are reduced with increased renewables.





- Data (ov
- At 35% (red) out drops be



- Data
- At 3
- (red)
- drop

Some lessons from complex systems

Keep multiple possibilities viable.

- In complex systems, elements compete to see which best meets the real need.
- Prematurely focusing on one most efficient option leads to catastrophes.

Presume a system is complex unless proven otherwise.

- Identify relevant risks.

Think "evolve" not "design".

- Complex systems are not created from scratch; rather, they evolve using working pieces of other systems.

- Coordination should be performed on a big enough scale to perform the task, but not so big that you damage the independence of small-scale elements, which provides robustness.



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