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Impacts of Generation-Cycling Costs on Future Electricity Generation Portfolio Investment

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Context

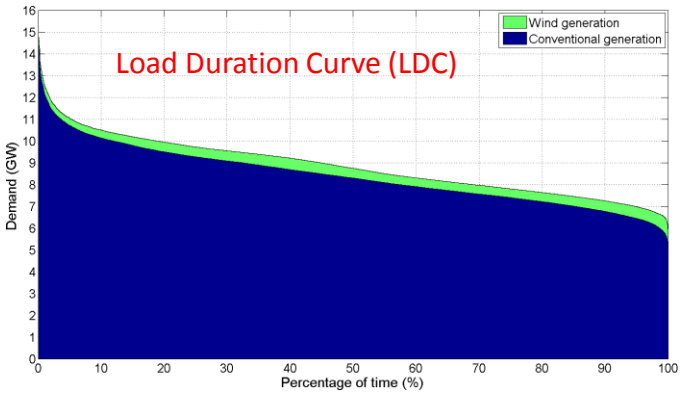
- Long-term (LT) generation planning and investment models often ignore short-term (ST) operational aspects

LT Generation planning and investment decisions

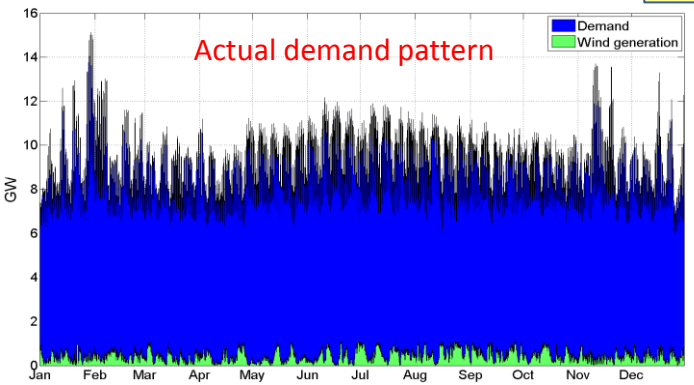
- Long planning horizon (5 years+)
- When, how much, types of generation capacity to build — *Capital costs, Fuel costs, Future demand, Govt. policies*
- Ignore operating constraints & chronological demand variability

Short-term electricity industry operation decisions

- Short timeframe (minutes to hours)
- Amount and which generators to dispatch to meet varying demand — *Constrained dispatch*
- Subject to inter-temporal generating unit constraints — *Min. Gen, Ramp rates, Startup time*



Chronological demand is rearranged in order of magnitude

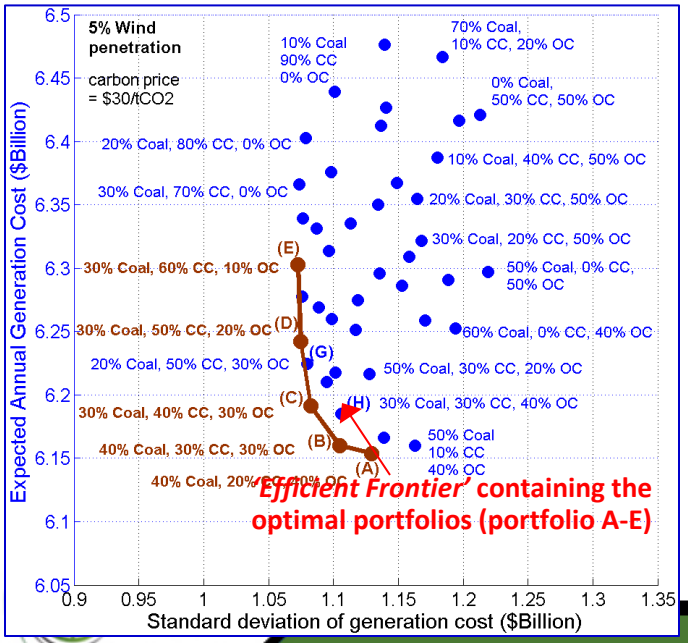


ST operational criteria might have implications for future generation portfolios (technical viability, additional costs)

Objectives and methodology

- Assess the impact of ST operating criteria on optimal portfolios obtained from LT portfolio planning model
  - Operational viability – number of starts/stops, ramp rates
  - Economic impacts – changes in overall costs (e.g. from startup costs)
  - Emissions impacts – changes in annual CO_2 emissions

Generation portfolios from long-term Portfolio Planning Model



***'Efficient Frontier'* containing the optimal portfolios (portfolio A-E)**

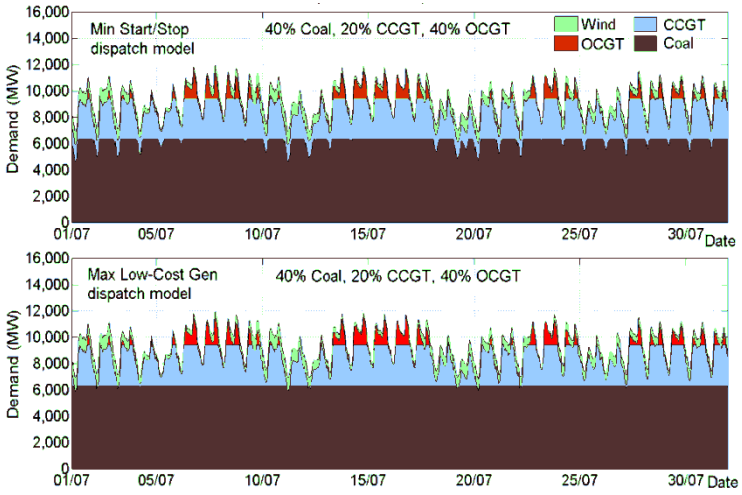
Rerun candidate portfolios through a year of *sequential 30-minute constrained dispatch*

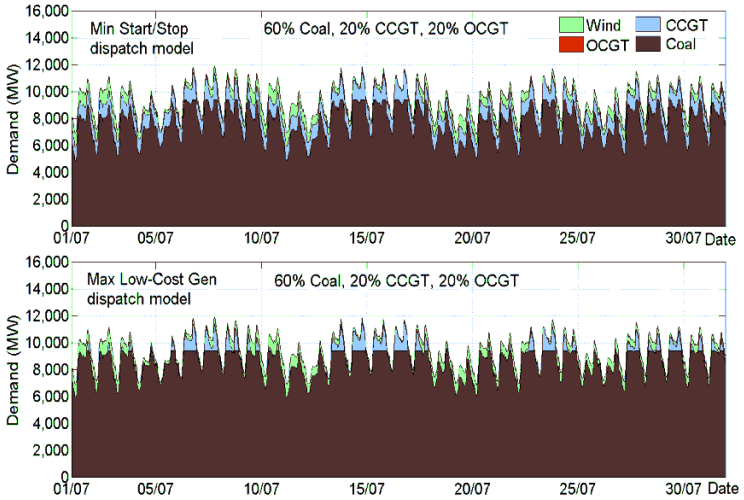
Generation dispatch Strategies

Minimize unit startup/shutdown	Maximize outputs from low running-cost units
• Dispatch low cost units at part-load to allow other units to remain online	• Dispatch the lowest cost technology as close to its maximum capacity
• Startups/shutdowns only occur when online units cannot increase or reduce their outputs any further	• Shutdowns occur if outputs of the lowest cost units would otherwise have to be reduced

Impacts of ST operational constraints

- A case study of generation portfolios with coal, CCGT, OCGT and wind generation in SE Australia
  - 5% wind penetration and a \$30/tCO_2 carbon price





Merit order

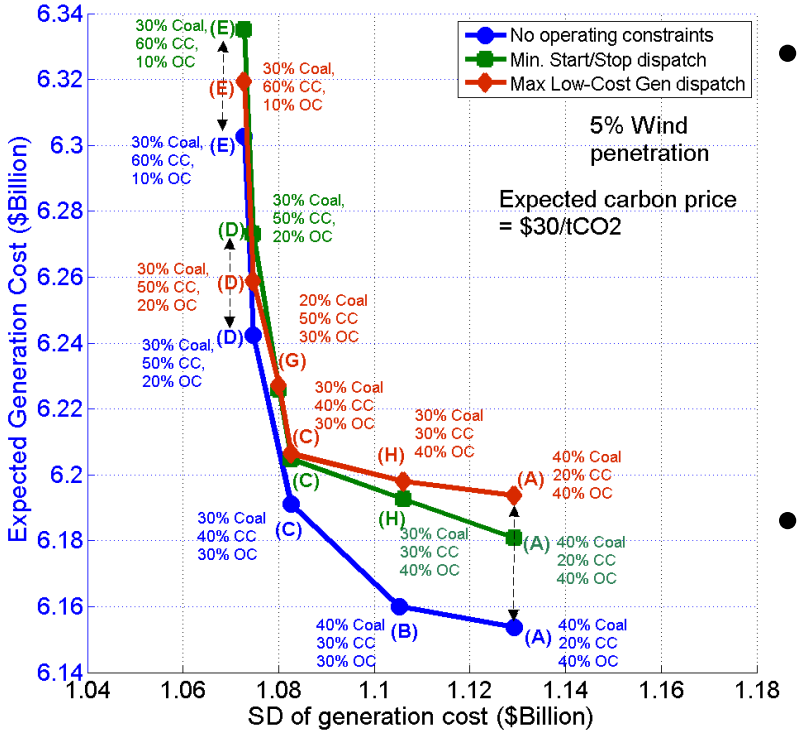
- Peaking: OCGTs

- Intermediate: CCGTs

- Baseload: Coal

- **Operational impacts**
  - All portfolios were able to meet maximum 30-minute ramps
  - CCGTs incurs nearly daily starts/stops but still within design limits
  - Baseload coal units rarely shutdown, but still needed to vary outputs

Impacts of ST operational constraints



- **Economic impacts**
  - Increase overall costs obtained under long-term planning model (additional startup and running costs)
  - May change in the optimal portfolios on the *Efficient Frontier*
- **Emission impacts**
  - Reductions in emissions for a certain generation dispatch strategy

- **When carbon price is high and greater RE penetrations**
  - Changes in merit order between coal and CCGT.
  - Coal units will incur frequent starts/stops, resulting in higher costs.

Conclusions

- ST constraints have moderate impacts on the appropriate generation portfolios obtained under the long-term portfolio planning framework (*for modest RE penetrations and carbon prices*).
- Dispatch strategies associated with startup/shutdown of generating units can influence cycling operation.
- This study did not consider full unit commitment problems.
- Implications of high renewables and carbon price to be further explored.

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