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
- 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
- Subject to inter-temporal generating unit constraints

Capital costs, Fuel costs, Future demand, Govt. policies

**Chronological demand is rearranged in order of magnitude**

Load Duration Curve (LDC)

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 CO₂ emissions

Generation portfolios from long-term Portfolio Planning Model

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
• 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

Rerun candidate portfolios through a year of sequential 30-minute constrained dispatch
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/tCO₂ carbon price

- 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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