Gas and renewables: Policies, integration, and costs.

Ross Baldick
Department of Electrical
and Computer Engineering
The University of Texas at Austin

Outline

- Given policy of promoting intermittent renewables, what are implications for:
  - Technical grid integration of renewables,
  - Portfolio of thermal resources,
  - Storage.
- Does policy of promoting renewables make sense:
  - Cost and benefit estimates for new wind in ERCOT,
  - Re-evaluation of policies.

Technical aspects of integration of intermittent renewables.

- Wind is variable (cannot be bidden) and intermittent (cannot be *fully* predicted) at various timescales:
  – Improved forecasting continues to reduce lack of predictability,
  – “Residual” thermal generation for “net load” must provide increased “reserves” to compensate for (among other things) intermittency:
    - Thermal resources generate less energy on average,
    - Requires nearly as much residual thermal capacity as without wind.

Technical aspects of integration of intermittent renewables, contd.

- On-shore North American wind resources are typically far from demand centers:
  - Transmission system requires significant augmentation to deliver wind power,
  - Intermittent resources at far end of transmission system pose “stability” problems.

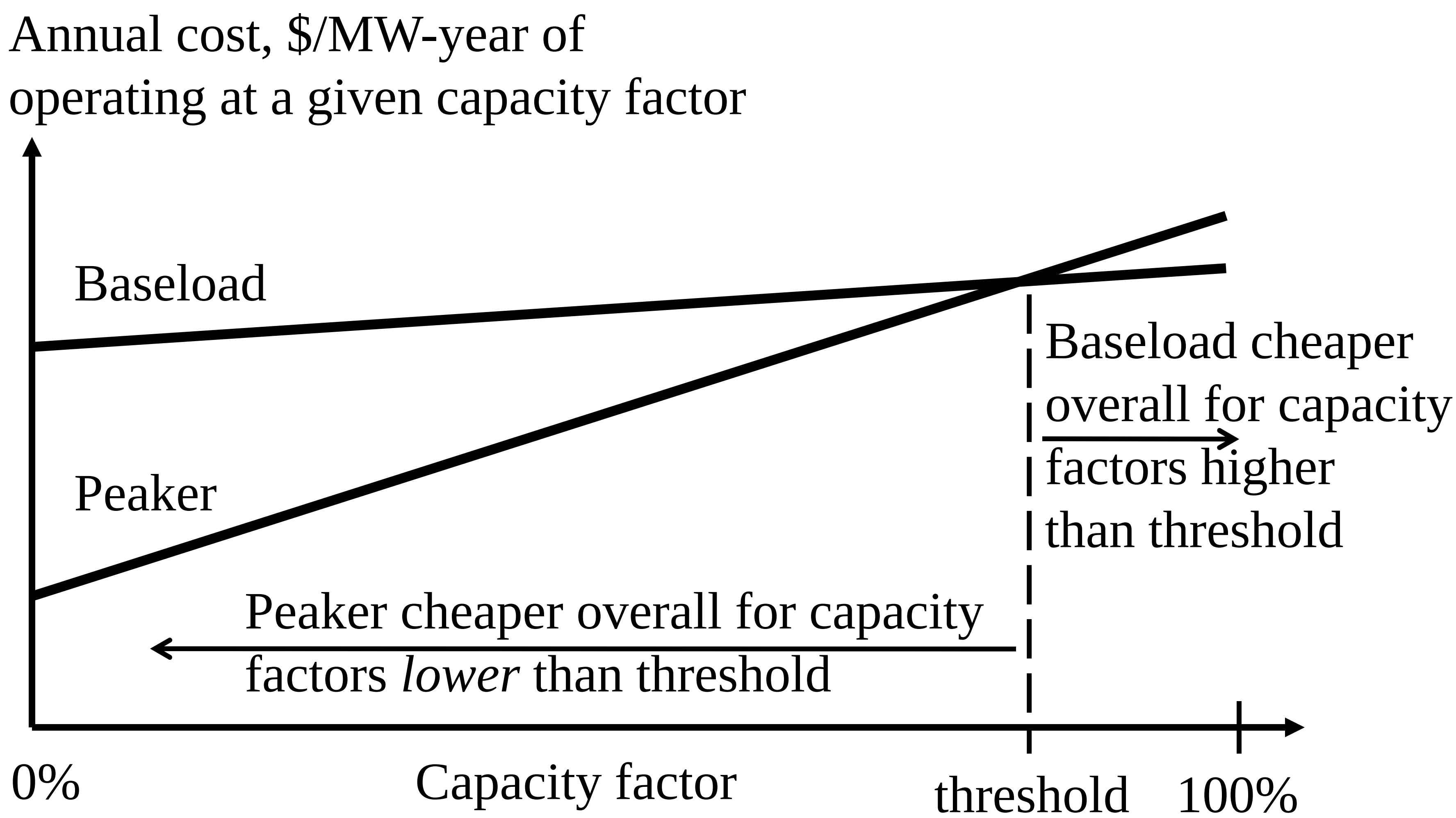
Technical aspects of integration of intermittent renewables, contd.

- On shore North American wind resources produce on average as much or more off-peak as on-peak:
  - Off-peak wind generation often results in residual thermal generation operating at technical or economic minimum off-peak, (and lower operating efficiencies),
  - Residual thermal system must meet larger morning ramp-ups and evening ramp-downs of net load and may necessitate more “ramping reserves.”

Portfolio of thermal resources.

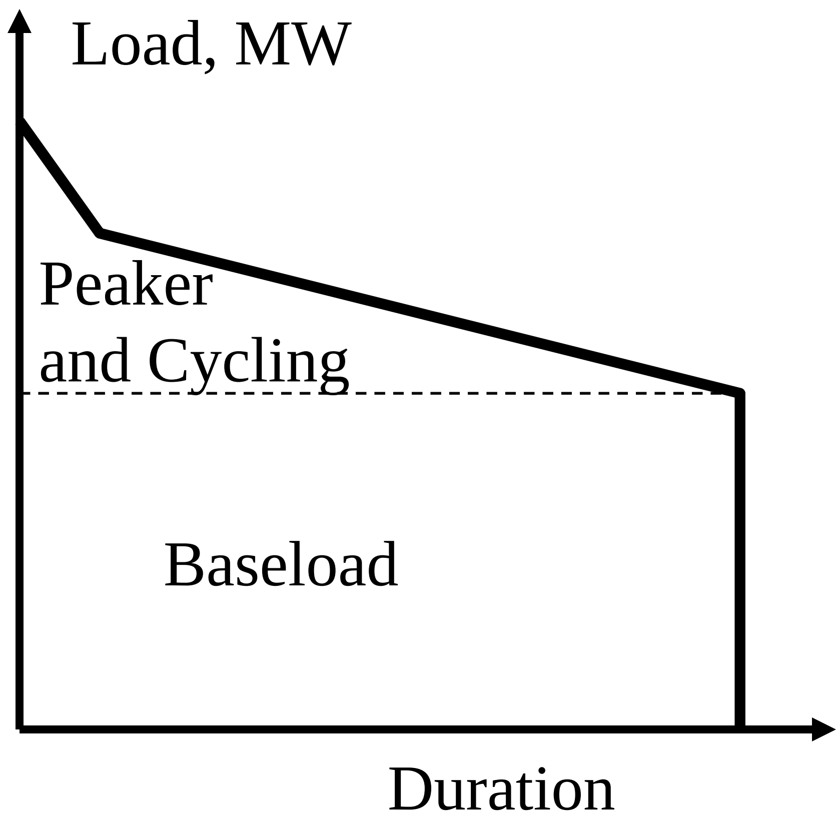
- In short-term, existing thermal will run at a lower capacity factor and off-peak prices will be lower (even negative):
  - Coal or wind setting price off-peak instead of gas,
  - Already see this in ERCOT.
- In longer-term, “economically adapted” generation portfolio would have increased fraction of peaker and cycling capacity:
  - Net load-duration issues,
  - Need to provide more reserves.

Portfolio costs: Notional annualized operating costs versus capacity factor.

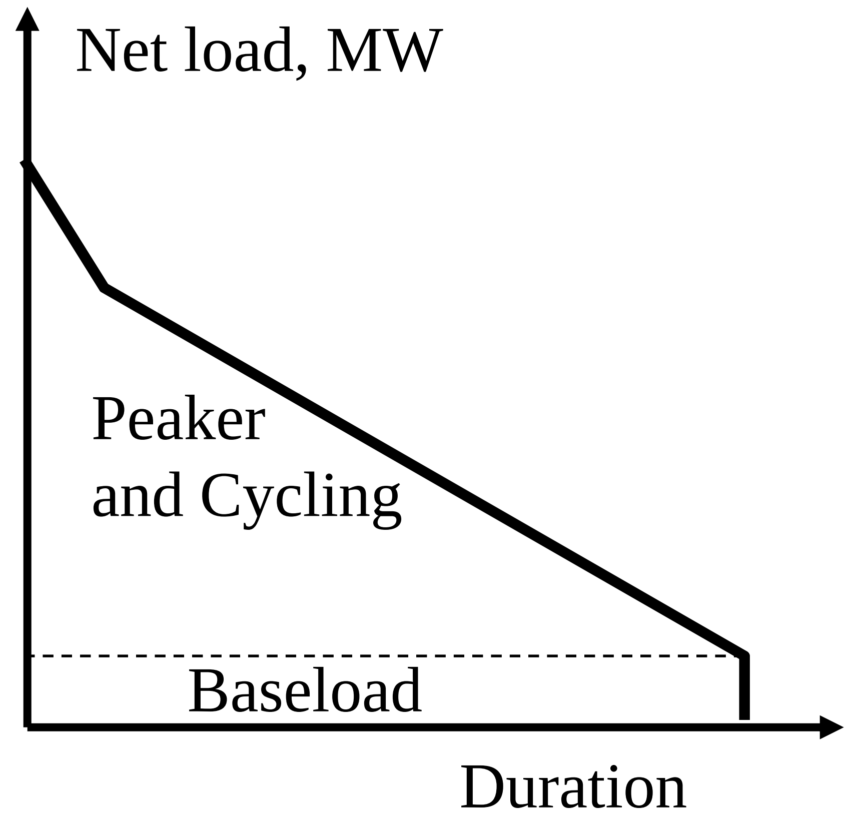


Economically adapted portfolio with more wind.

Load-duration without wind.



Net Load-duration with wind.
Net load = load minus wind.



Incentives for the right portfolio to match wind.

- Current market prices and expectations of forward prices in ERCOT do not support new peaker entry:
  – Prices not high enough on average under tight supply conditions for profitable peaker entry,
- Some baseload projects are apparently going ahead in ERCOT and in Midwest.
- We might not be getting the right types of capacity built to match the wind, even if total capacity is apparently adequate in coming years.

Storage.

- Typical storage capacity costs are currently well over $1000/kW and range up to $4000/kW:
  - Greatly exceeds cost of peaking gas fired generation,
  - Dedicated storage unlikely to be competitive against peaker capacity until costs of storage reduced significantly.
  - “Free” storage such as plug-in hybrids, charged during high wind, have potential economic role.

Cost and benefit estimates for new wind in ERCOT.

- ERCOT is embarking on large expansion in transmission capacity to allow for 11 GW expansion in wind:
  - “competitive renewable energy zone” transmission at cost of around $5 billion,
  - Approximately $20/MWh average cost of transmission resources for wind.

Cost and benefit estimates for new wind in ERCOT.

- Typical unsubsidized cost of wind energy is around US$80/MWh,
- Assume US$20/MWh incremental transmission for wind in ERCOT,
- Assume US$5/MWh to US$10/MWh proxy to cost of intermittency,
- Total is about US$105/MWh to US$110/MWh.
- Average balancing energy market price in ERCOT is around US$50/MWh to $60/MWh.
- New wind adds about US$50/MWh to costs.

Cost and benefit estimates for new wind in ERCOT.

- US Congressional Budget Office estimates $15 per metric ton of CO_2 emissions ($13-14 per US ton) as initial price under House Bill 2454.
- Ceilings discussed at $30 to $35/US ton.
- Assuming 10,000 Btu/kWh heat rate, a little over 1US ton of CO_2 is produced per MWh of coal-fired electricity production, less for gas:
  - Around at most $15 to $35 of CO_2 is produced per MWh, given House Bill 2454 valuations.

Cost and benefit estimates for new wind in ERCOT.

- Wind is often touted as having various benefits, but is not worthwhile for greenhouse benefits alone.
- Suggests need to re-evaluate policies that directly promote renewables versus policies that aim to reduce greenhouse emissions.

Summary

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