Gas and renewables: Policies, integration, and costs.

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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.

Annual cost, $/MW-year of operating at a given capacity factor

Baseload

Peaker

Peaker cheaper overall for capacity factors lower than threshold

Baseload cheaper overall for capacity factors higher than threshold

0%  Capacity factor  threshold  100%
Economically adapted portfolio with more wind.

Load-duration without wind.

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

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Diagram with labels:
- Load, MW
- Net load, MW
- Duration
- Peaker and Cycling
- Baseload
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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