Natural Gas Interaction with Wind and Solar Power

Jurisdictional Forum Shopping: Ripples in the Stream

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Gas-Fired Generation Is a Natural Partner for Intermittent Renewables

- Gas combustion turbines can ramp up very quickly.
- Gas-fired plants are inexpensive and easy to site, so they can be in the right place at the right time.
- Air-quality gains from the use of Wind and Solar power can be confirmed and secured when the backup (gas) is also clean.

BUT. . .

You Have to Do it Right, Managing: Impacts on:

- The Gas Fired Generators
- The Pipelines Involved
- Other Customers of the Pipelines
- Optimization of Air Quality

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Gas Plant Utilization Seems to Fall Between Wind and Solar—What's the Difference?

Capacity Factors, 2009

Gas Total	26%
Wind Generation	29%
Solar Generation	18%
Coal Generation	63%

The Difference is that Gas (Actually 43 percent for Combined Cycles and only 9 percent for Peakers) runs when the load needs it.
But Wind and Solar run when the supply is there—regardless of load.

The End Result—Wind and Solar Need Something to Fill in when Supply and Load are not in Synch—Gas Works Well for That

- We know wind and solar vary unpredictably, so the backup generation cannot necessarily be planned and dispatched in advance.
- Gas is best for answering that need, and among fossil fuels emits the least air pollution (including carbon).
- Impacts to Manage:
  - **Gas generation**—If Combined Cycles are used as Peakers instead of Baseload, their Energy Consumption and Emissions increase by almost 50 percent—so the key is to keep them running as Combined Cycles.
  - **Pipelines**—Sudden changes in hourly load can signficantly impair efficient pipeline operations—so the key is to resolve gas-electric interaction issues on pipelines, and to stabilize the load as much as possible.
  - **Customers**—Hourly disruptions in pipeline operations can cause other customers to fail to get the gas they scheduled.
  - **Air Quality**—If the efficiency of Combined Cycles is lost, the air quality benefits of wind and solar can be significantly reduced.

The Impact on Generators—
Keeping Combined Cycles from Becoming Peaking Facilities

		Pounds per MWh				
	Heat Rates	CO2	SO2	Nox	PM10	Hg
Combined Cycle Generation	7,430	869.3	0.007	0.7	0.052	-
Other Gas Generation	10,163	1,189.1	0.010	0.9	0.071	-

By Comparison, Existing Coal Generation Is:

		Pounds per MWh				
	Heat Rates	CO2	SO2	Nox	PM10	Hg
Coal Generation	10,388	2,160.7	26.9	4.7	28.5	0.0002

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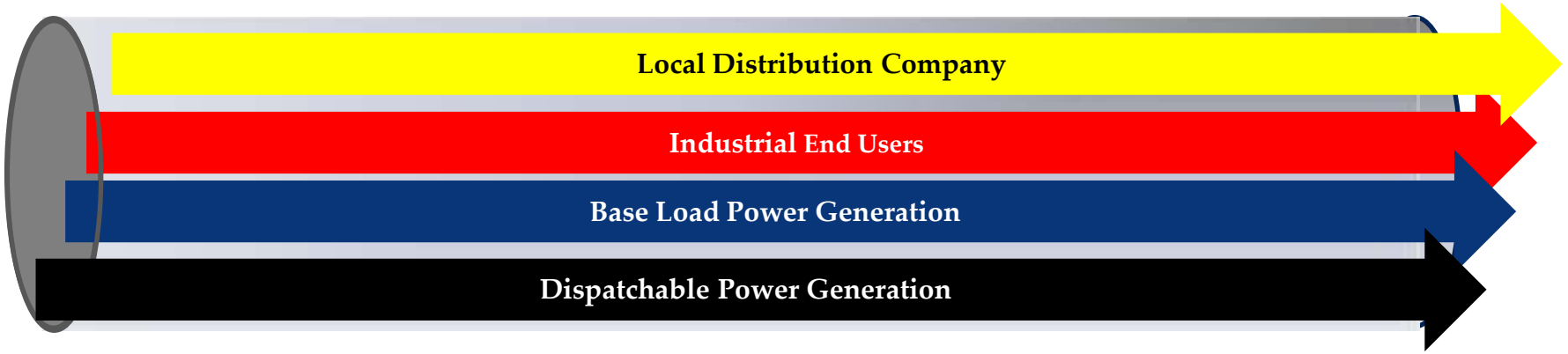
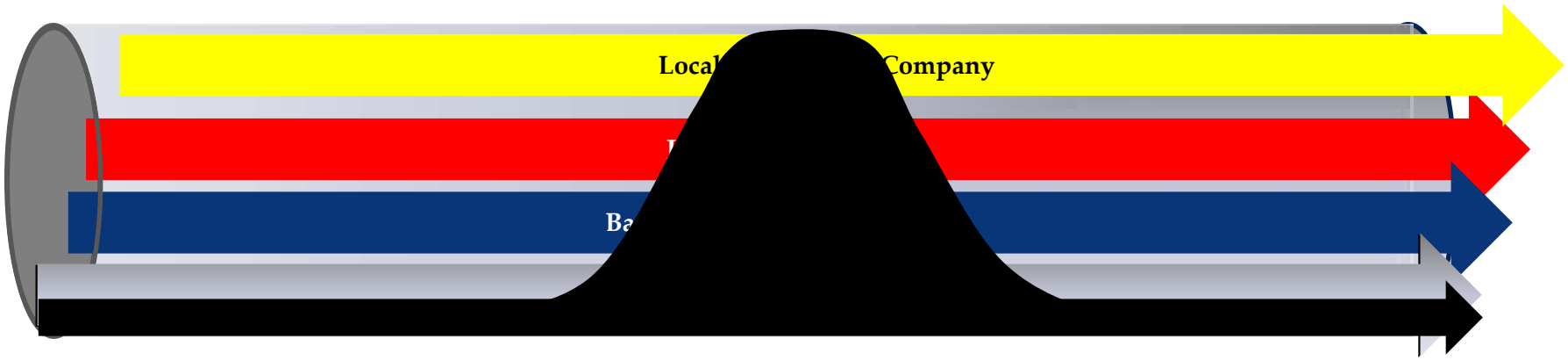
Impact on Pipelines and Their Other Customers

Pipelines Get Nominated, Confirmed, and Scheduled to Fill the Pipe and Operate at Fairly Constant Rates through the Day



Impact on Pipelines and Their Other Customers

If One Shipper Can Unexpectedly Swing Up, It Interrupts the Day's Flow for the Other Shippers



Local Distribution Companies Can Have This Kind of Load, but They Buy Expensive No-Notice Service, Supported by Storage

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How Can Sudden Load Variation Be Addressed?

This is a generic gas-electric issue, not at all unique to renewables.

- The Gas and Power industries have worked for over a decade to resolve the interaction of power loads and pipeline operation.
- The North American Energy Standards Board addressed in 2007, and isolated policy issues for FERC to resolve.
- A primary key is intelligence and communication, allowing pipeline operators to know when and how a gas generation load will appear or disappear.
  - Ongoing planning communication between grid operators, generators, and pipelines have helped.
  - With foreknowledge, the pipeline can pack and draft to handle load surges.
  - This is more difficult with wind and solar backup, since the variability is driven by weather, not grid operation.
- Meanwhile, larger, more stable gas baseload allows these surges to fit better within the pipeline's operating flexibility.

What About the Firmness of Capacity for Generators?

Another Generic Gas-Electric Issue is the Commitment to Firm Pipeline Capacity—Its Need, and its Cost

- A baseload generator is in a better position to commit to firm capacity, to spread the cost of that capacity over enough MwH of generation.
- For a peaker, this is a real problem, though, since a year's worth of firm reservation charges may have to be charged over a 10 percent capacity factor.
- Some markets require a must-run generator to hold firm delivery capacity—but some do not.
- Meanwhile, providing firm capacity to all gas-fired generation, both existing and new, would require substantial expansion of pipelines (see, e.g., the INGAA Foundation study released March 16, 2011).
- Determining the true need for firmness, market alternatives (e.g., through capacity release), and developing innovative rate schedules will all help address the high cost of firm pipeline capacity for low capacity-factor generators.
- The best answer for economic efficiency is to match firm pipeline capacity with high load-factor utilization, whether through baseload of the generator or through aggressive off-peak capacity release.

In Energy and Air Quality Terms, Managing the "Partnership" is Important

The Air Benefits of Wind and Solar can Vary Greatly Depending on What Other Generation Continues to Run

- Natural Gas emits 46 percent less CO2 per MMBtu of Energy than does Coal.

- But a Natural Gas Combined Cycle plant emits 62 percent less CO2 per MWh than does the average Coal plant.

So the Way Gas Plants Back Up Wind and Solar Makes a Difference. . .

2009 Actuals---Total US	Capacity MW	Pct. Of Total Capacity	Generation 1,000 MWh	Pct. Of Total Gen.
Other Gas Generation	209,338	20%	168,091	4.3%
Combined Cycle Generation	200,380	19%	752,706	19.1%
Coal Generation	316,941	31%	1,755,904	44.5%
Wind Generation	29,504	3%	73,886	1.9%
Solar Generation	577	0%	891	0.1%
Other Generation	278,557	27%	1,198,216	30.3%

Now Let's Bring Wind and Solar Combined, to 20 percent of Total Capacity

	Reduction from 2009 Business as Usual				
	CO2	SO2	Nox	Particulates	Mercury
Displace CC first, Converting some CCs to Peakers	8%	0%	3%	0%	0%
Displace CC and Coal Ratably	17%	18%	18%	18%	18%
Displace Coal First	21%	26%	24%	26%	26%

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The Bottom Line: Just Assuming Gas will Back Up New Wind and Solar Is Not the Best Answer

- There has to be an integrated approach, to see that the right plants are in the right places.
- A choice should be made (in such places as state Integrated Resource Plans) as to how the total generation portfolio will be managed to achieve the best energy and pollution benefits.
- Equal or more gas baseload, rather than less, is critical to optimizing the air quality benefits.
- Meanwhile, lingering issues of gas-electric interaction on the gas grid have to be resolved, and continuing industry and regulatory priority for that is important.