Not All Megawatts Are Created Equal

The implications of CMU research

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March 13, 2012

General observations

- Electricity generation accounts for over 40% of U.S. CO2 emissions, and is growing
- Policy makers began opening generation to competition in 1978, later allowed independent ownership of transmission lines,
  - Non-utility firms owned under 4% of generation in 1977, now own 45%, but:
- There is no evidence that competition has lowered power costs or line losses, or driven up fossil efficiency
- Astonishingly, the U.S. EIA neither tracks delivered efficiency nor reports data needed to determine system efficiency.
- **How can we manage what we do not measure?**

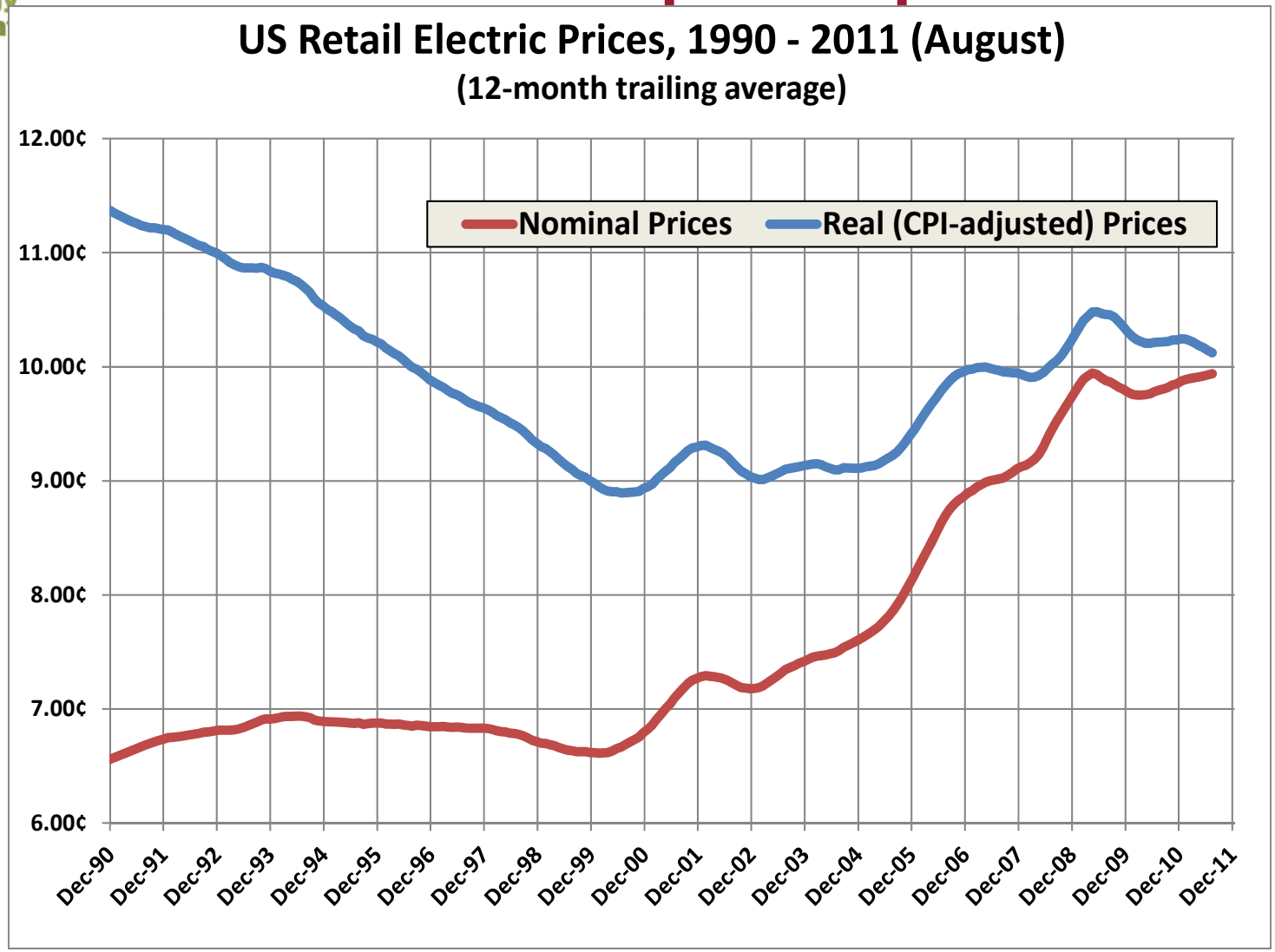
CMU insights abound

- Carnegie Mellon Electric Industry Center has probed industry concerns for more than a decade, documenting ways to optimize the electric system.
- In particular, CEIC scholars have shown strong benefits of deploying more distributed generation, including:
  - DG could provide system reliability with 5% reserve generation and T&D versus 18% reserve margins for central generation (CG)
  - Each strategically placed DG MWh could displace 1.2 to 1.45 CG MWH
  - DG could cut U.S. line losses by 50% or more, which we calculate to be worth nearly $30 billion per year
  - DG could supply balancing reactive power to reduce line losses and improve grid stability.

Missing: Extrapolations to policy and system-wide implications

- The CMU papers, aimed at electrical engineering peers, have not, to date, changed the way the world makes power, to the detriment of humanity.
- It is difficult to extrapolate system-wide implications within the bounds of academic rigor, given lack of practical experience of the scholars with the electric system.
- CEIC has collaborated with the power industry, but that industry is deeply vested in the central generation approach.
- The question is not whether the world will of should move to distributed generation, but how soon.

Industry competition has not reduced power prices

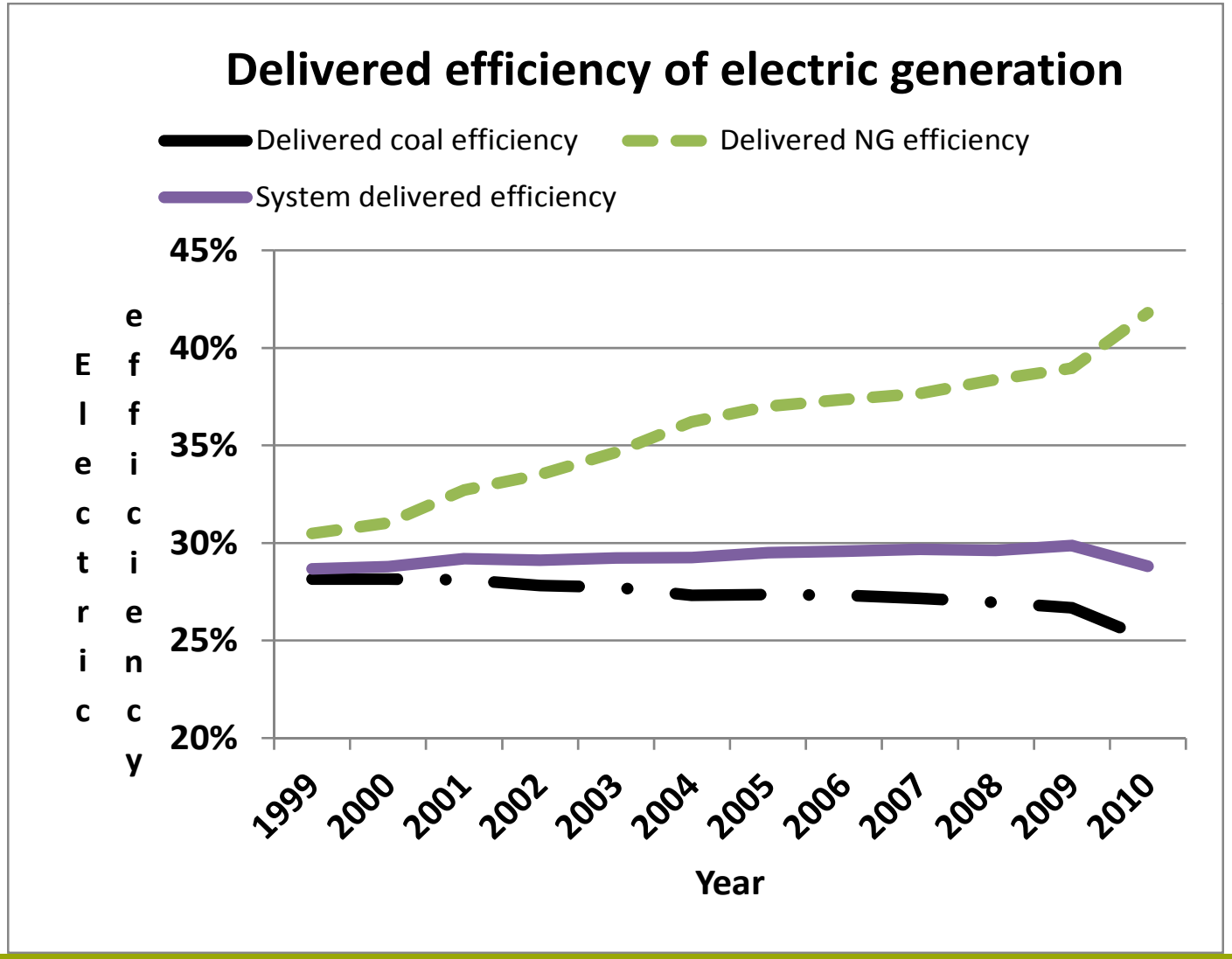


Fuel price change impacts

Changes in Real Prices Since 2000				
	Units	Dec-00	Aug-11	Change
Coal	MMBtu	$ 1.58	$ 2.40	52%
Natural Gas	MMBtu	$ 5.72	$ 4.92	-14%
Retail Electricity	kWh	8.9 cents	10.2 cents	15%
Prices above are 12 month trailing average				

- Markets responded, coal generation down from 51% to 44% of total in 2011, under 40% in November & December 2011
- CG natural gas generation beginning to replace coal
- CHP droppws as percentage of fossil fuel burned from 6.1% in 1999 to 5.2% in 2010, as old contracts expired.

Delivered efficiency is stagnant



Problem: All megawatts are not equal

- DG megawatts have more value than CG megawatts:
  - First, DG megawatts usually flow directly to users, bypassing long wires and associated line losses.
  - Second, by reducing the power flowing through the wires, DG also reduces line losses on all remaining centrally generated power.
  - Third, DG greatly eases the need for new transmission.
  - Fourth, DG enables use of normally wasted thermal energy to displace boiler fuel by combining heat and power generation.
  - Finally, DG decreases the grid's vulnerability to extreme weather, terrorism and blackouts.

Extrapolation of Dr. Ilic and colleagues' studies

- Each MWh of DG could displace 1.2 to 1.45 MWh of CG, providing 20 to 45% benefit.
- DG supplying 10% of peak load – 80,000 MW could:
  - Cut peak U.S. generation and transmission requirements by 100 to 120 gigawatts.
  - Reduce U.S. CO_2 emissions by roughly 290 million tons, 4.4% of U.S. CO2 equivalent emissions in 2009.
  - Avoid $95 to $260 billion of net capital investment to supply next 10% of U.S. load growth. ($160 to $240 million of DG capital for 80 GW vs. $335 to $420 billion on 96 to 120 GE of new CG and T&D capacity

Case study: Lime kiln waste energy recycling DG

- Use exhaust from lime kilns to boil water & produce 8.7 MW of fuel-free power.
  - $20 million investment faces mill risks, needs $80 to $90 per MWh to be economic
  - No incremental fuel or incremental CO_2
  - Assume each DG MW displaces 1.3 MW of CG.

	Cost / MWh	% of CG cost
Societal cost, equivalent CG	$100.50	100%
Typical DG offer	$57.00	56.7%
Theoretical societal savings from DG	$43.50	43.3%
Actual societal savings	0	0
Give DG 80% of value it creates	$80.40	80%
Actual Societal Savings / DG MWh	$20.10	20%

This DG plant will not be built

- Regulators, treating all MW as equal, approve Power Purchase Agreements with avoided CG cost of only 1 MWh per DG MWh
  - Also assume capital avoidance is 1 MW CG per 1 MW DG, at best
  - No assumption of the DG meeting system growth, so no credit for avoiding T&D capital or avoiding the added reserve generation to cover line losses.
- Acknowledging and rewarding DG added value would enable competition to work and produce societal benefits

DG cuts utility profits, due to regulatory paradigm

- Utility rates give electric consumers 100% of savings from all efficiency gains, utilities 0% of savings, so DG does nothing to increase utility profits, but:
  - DG cuts need for utility investment in rate based assets, which cuts utility profits.
  - If DG plant sells power directly to the user, utility sales drop, further reducing profits.
- Consequently, utility managers erect every possible hurdle to DG deployment.
- Society needs regulatory changes that give utilities reasons to support DG.

Conclusions

- DG is a key component of a sustainable energy system. Besides avoiding line losses and enhancing grid stability, DG
  - Reduces fossil fuel use and greenhouse-gas emissions.
  - Improves the economy by lowering the cost of power, making local manufacturing more competitive and thus preserving jobs.
  - Is less vulnerable to extreme weather and terrorism than the current system of a few large remote stations.

Recommendations

- CMU get your message out in language policy makers can grasp
- Goal is for policymakers to recognize the differential economic and environmental value of megawatts from strategically placed distributed generation, and to then share those benefits among DG developers, electric utilities and end users.