

North American Power

## PJM: Focus on Resource Diversity

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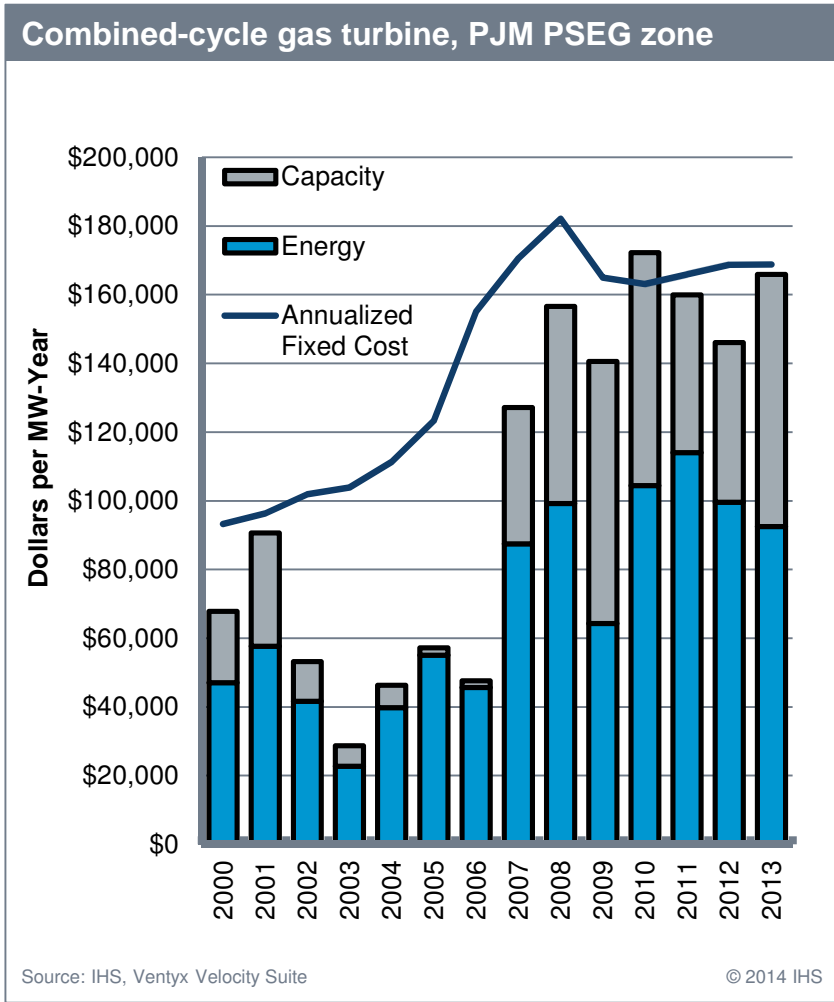
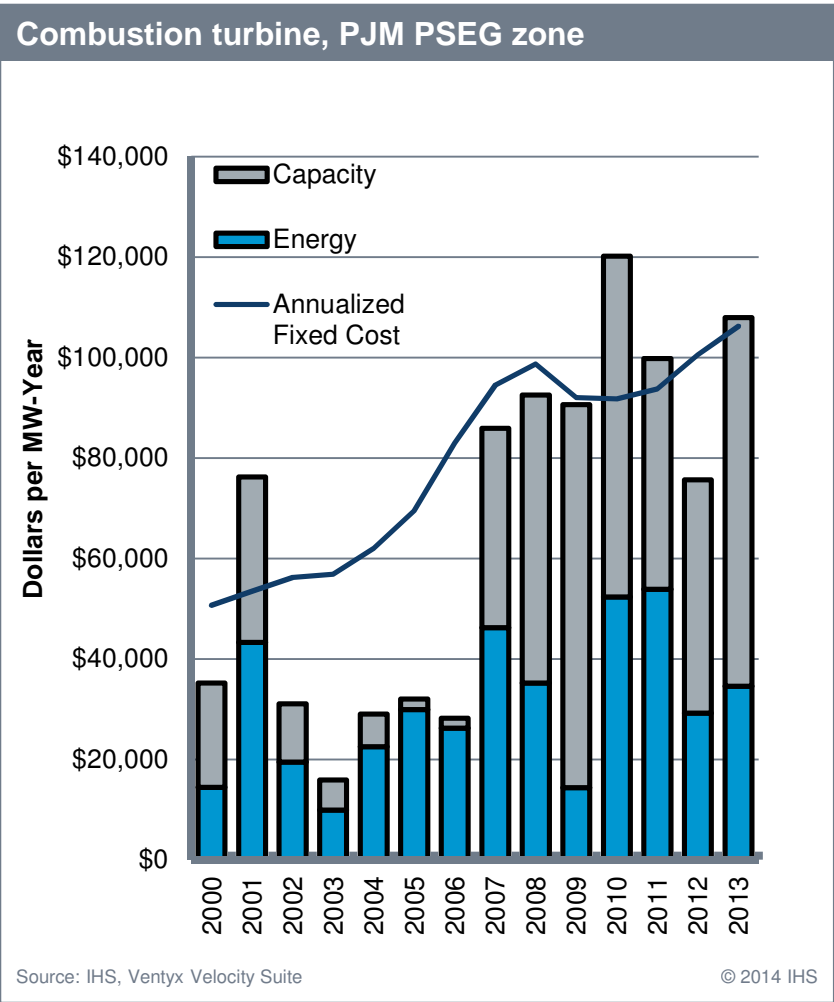
## Reliable and efficient generation mix

Two challenges to reliable and efficient generation mixes

- Wholesale power prices are chronically too low and cause too few new power plants to get built and too many existing power plants to retire.
- Energy policy is misaligned with power engineering and economics.

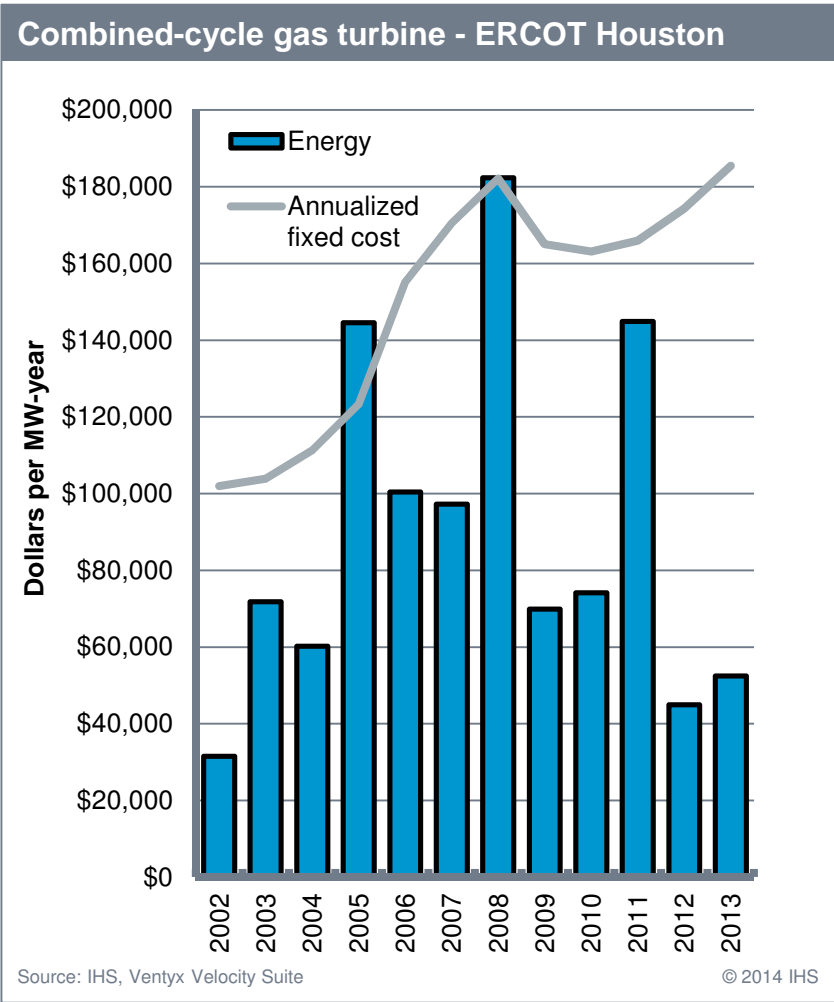
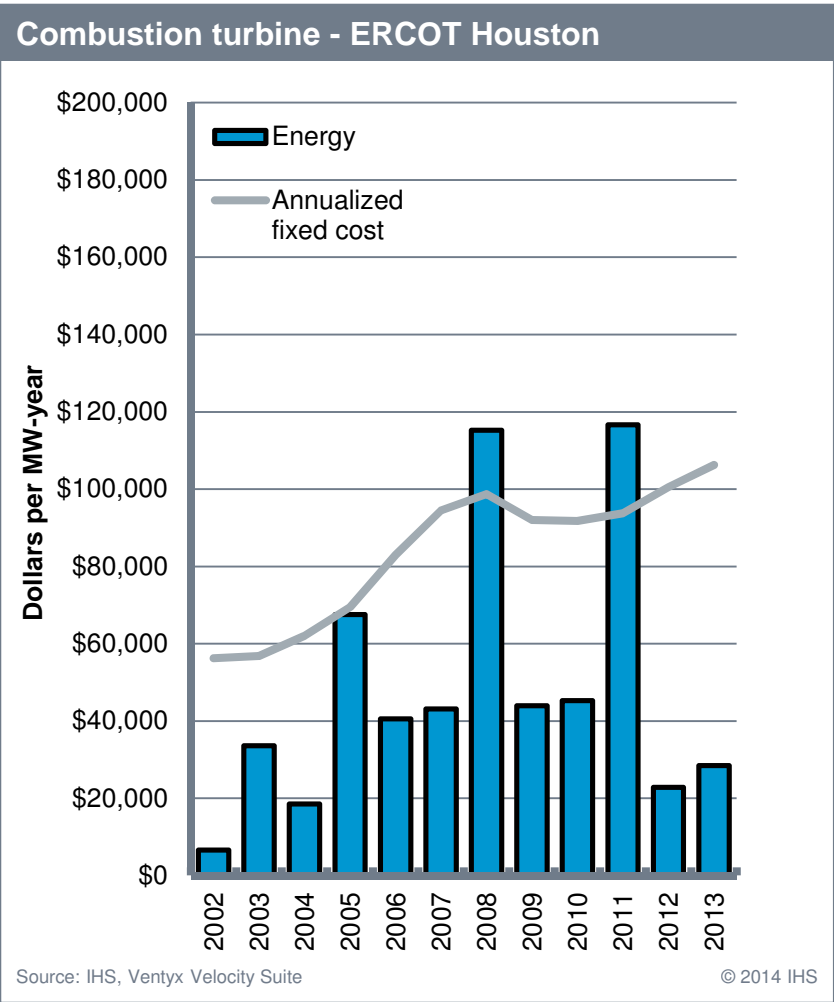


# Fixed cost recovery: PJM PSEG zone



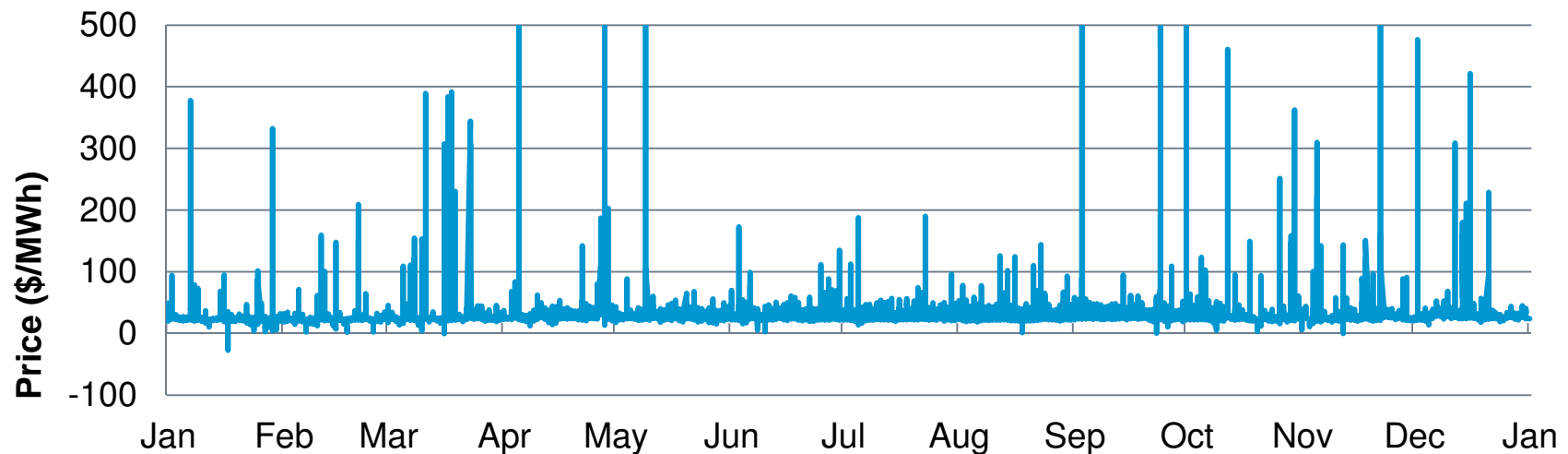


# Fixed cost recovery: ERCOT Houston



# ERCOT-Houston hourly prices, 2013

## ERCOT-Houston hourly prices, 2013



### Hourly ERCOT-Houston power prices, 2013

Maximum	Minimum	Negative Hours
\$2315.00	-\$27.57	3
On-peak average	Off-peak average	All-hours average
\$36.29	\$28.07	\$31.50

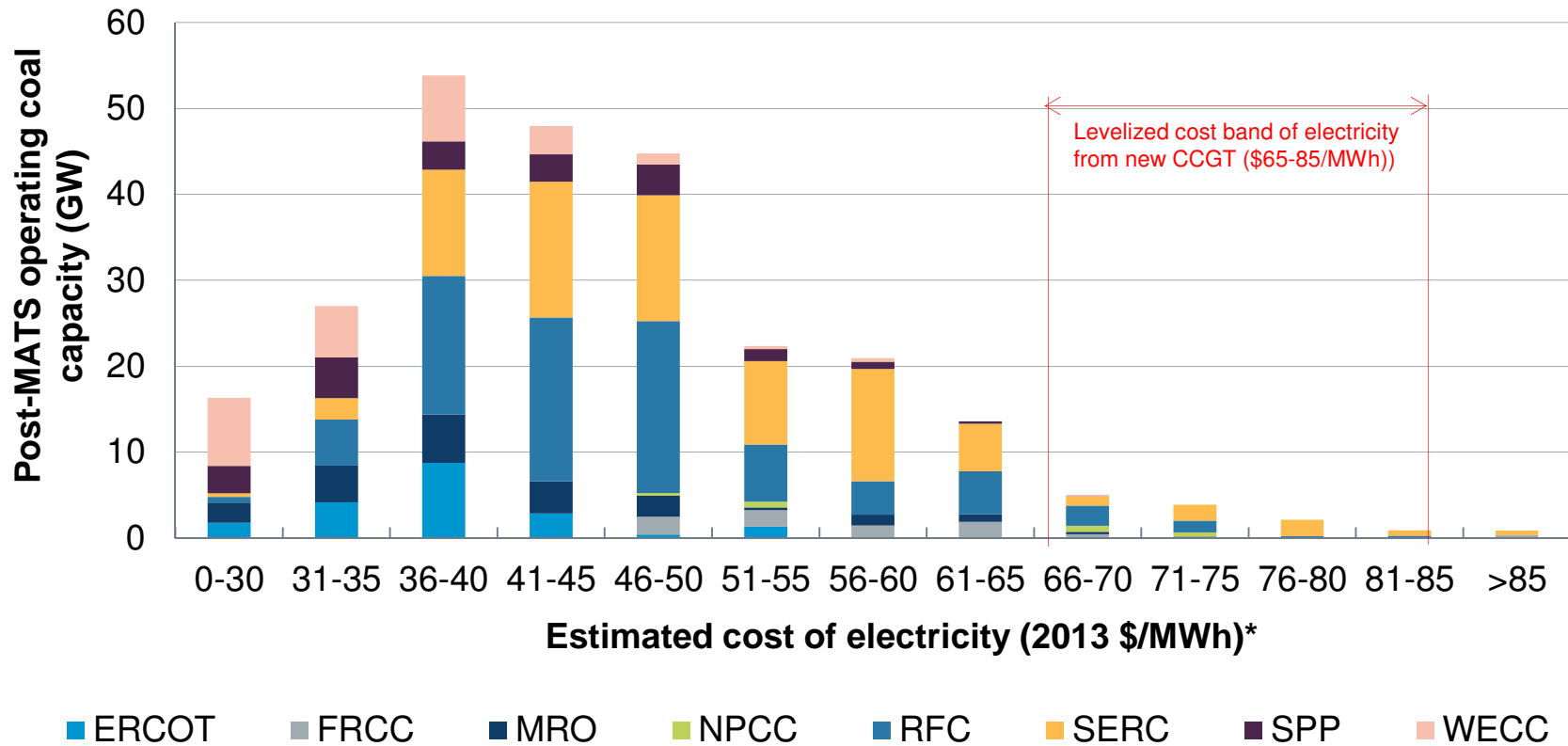
Source: IHS, Ventyx Velocity Suite

Notes: Scale maximum does not show price maximum

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# Going-forward costs of the existing coal fleet

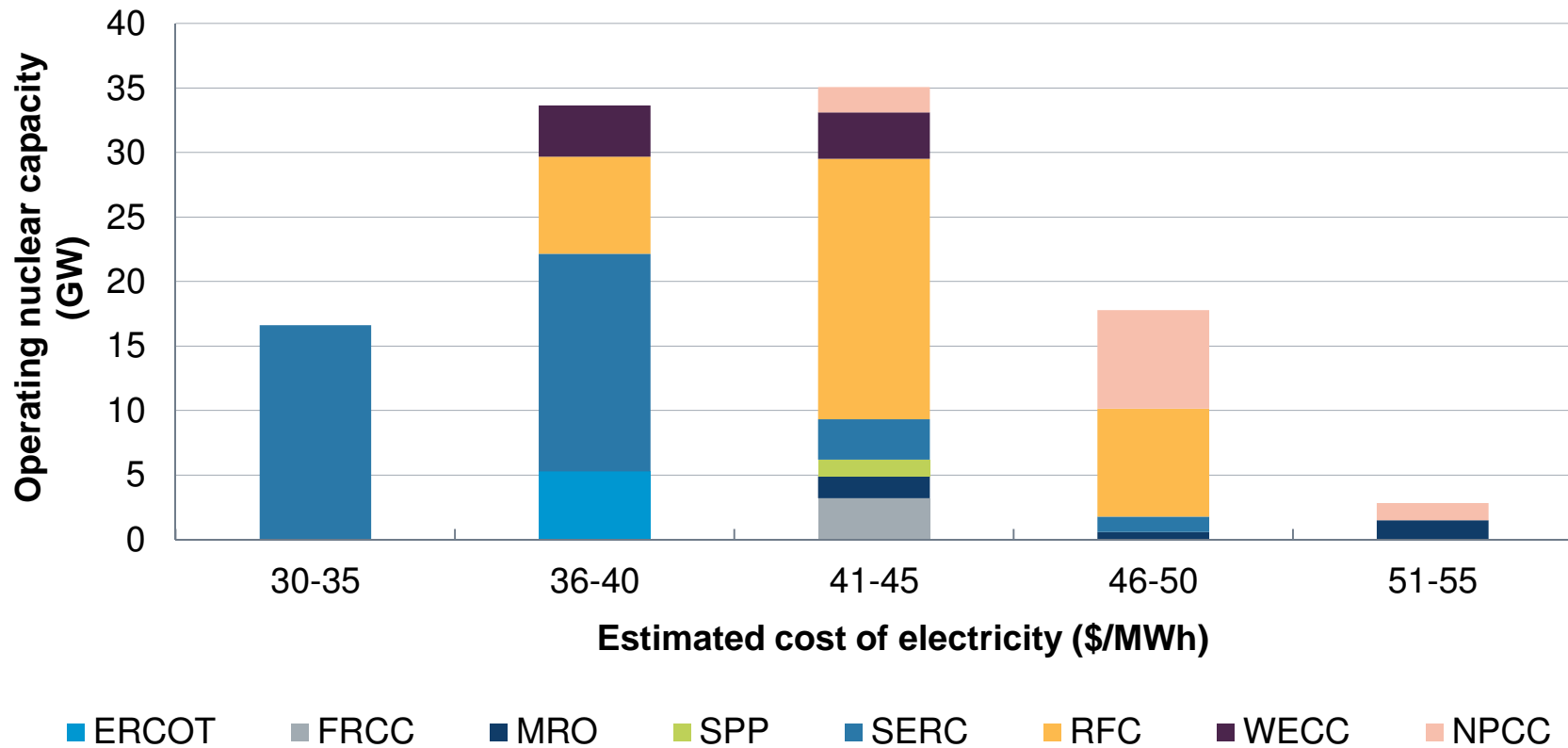
## Going-forward costs of the existing coal fleet



Notes: Only includes those coal units that are forecasted to operate beyond 2020 in our reference case scenario. These coal units are retrofitted  
 Source: IHS © 2014 IHS

# Going-forward costs of the existing nuclear fleet

Going-forward costs of the existing nuclear fleet



Source: IHS

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## 2008 EU objectives for 20/20/20 targets in 2020

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“To develop a broader growth strategy to boost international competitiveness and create jobs by making a decisive transition to a smarter and sustainable low carbon economy.”

—European climate and energy package, released 23 January 2008, adopted 12 December 2008



## German utility transition

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- One-quarter of global installed solar PV is in Germany providing 5 percent of generation along with 9 percent from wind
- Nuclear generation declined from 30% of power supply in 2000 to 7% in 2012 and is scheduled for elimination by 2022.
- German real power prices increased 10% per year since 2000 and reduced economic competitiveness and delayed economic recovery.
- Intermittent generation integration challenges drove construction of coal-fired power plants
- German CO2 emissions began increasing
- Political backlash challenged cost recovery and destroyed utility valuations

## Four building blocks underpin EPA's definition of BSER

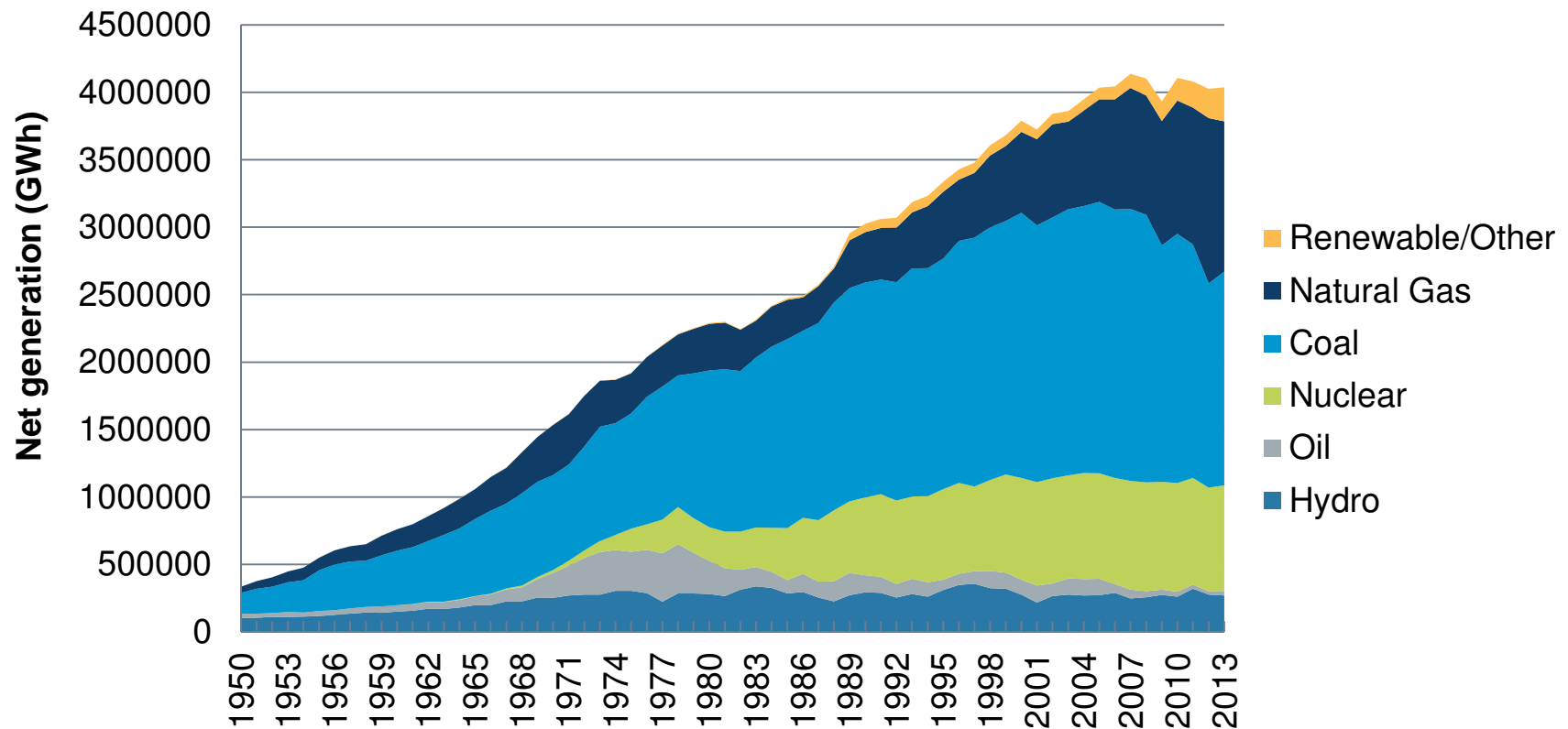
- State-adjusted, CO<sub>2</sub> emission rate goals (lb/MWh) for affected units based on the level of reduction below 2012 that can be achieved over 2020–29 and 2030+:\*
  1. **Heat rate improvements**—6% on steam coal, assuming best practices and equipment upgrades
  2. **Redispatch**—increase CCGT utilization to 70% at the expense of steam coal and steam oil/gas
  3. **Expanded use of renewables and nuclear**—Meet EPA-derived regional nonhydro renewable target, prevent the retirement of “at risk” nuclear capacity and promote the completion of nuclear capacity already under construction
  4. **Expanded use of demand-side energy efficiency**—scale to achieve a 1.5% of prior year sales annual savings rate
  
- Formula for calculating a state's adjusted CO<sub>2</sub> emission rate goal:

$$\equiv \frac{\text{CO}_2 \text{ emissions from affected existing fossil gen. (lb)}}{\text{affected existing fossil gen.} + \text{nuclear gen.}_{ar+uc} + \text{non-hydro renewable gen.} + \text{incred. efficiency (MWh)}}$$

\*Affected units consist of fossil plants that were in operation or that commenced construction prior to 1/8/14, are greater than roughly 25 MW and that supply more than one-third of their potential electrical output to the grid, assessed on a three-year rolling average basis. Note: CCGT=combined-cycle gas turbine; ar = at risk, uc = under construction

# US power generation: Net generation, 1950-2013

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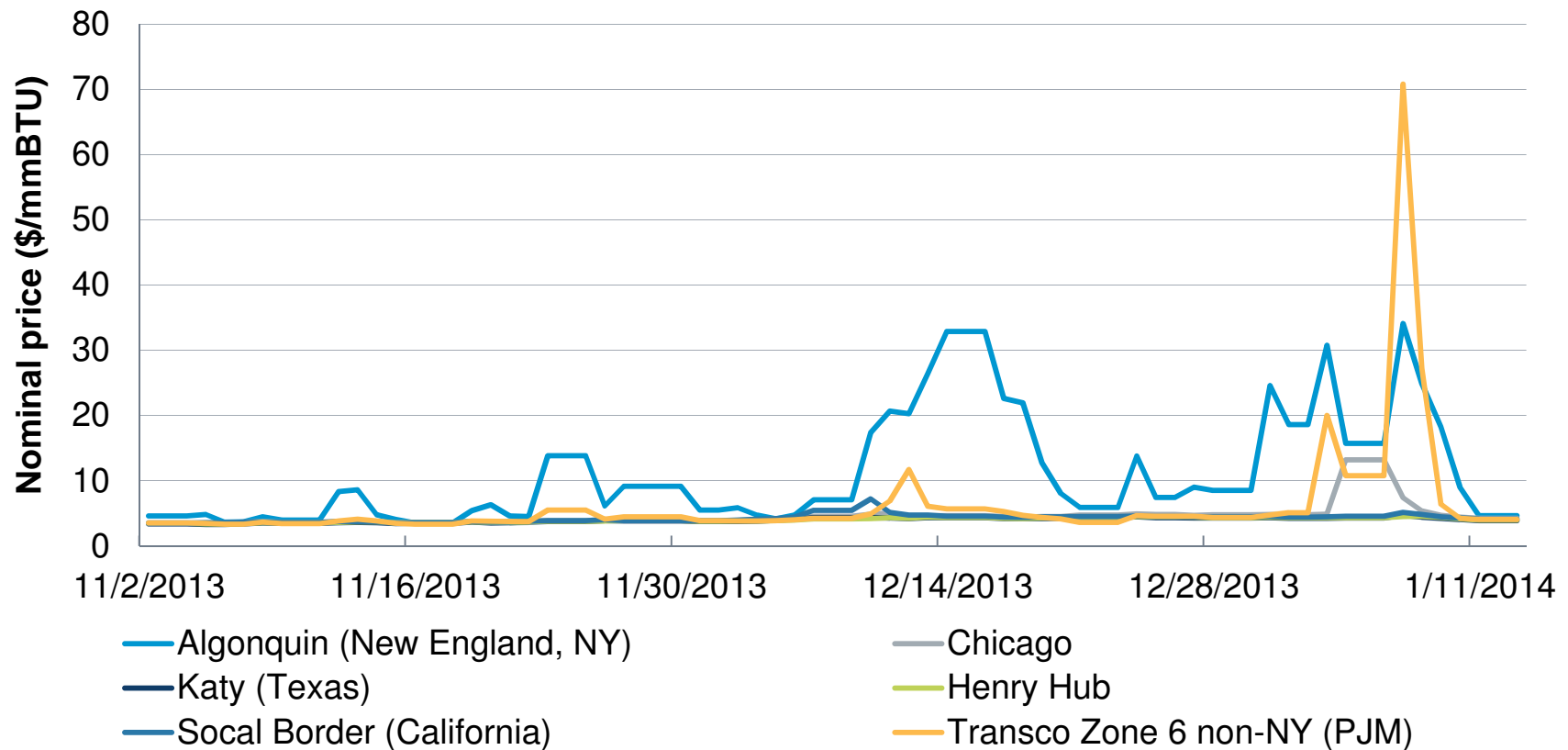


Source: IHS, US Energy Information Administration

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# Delivered gas prices during winter 2013-14

## Delivered daily gas prices, November 2013 - January 2014



Source: IHS, Ventyx Velocity Suite

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