ARE "WE" ASKING TOO MUCH OF ELECTRICITY MARKETS?

CEE 4th Mid-Year Meeting, June 28, 2016

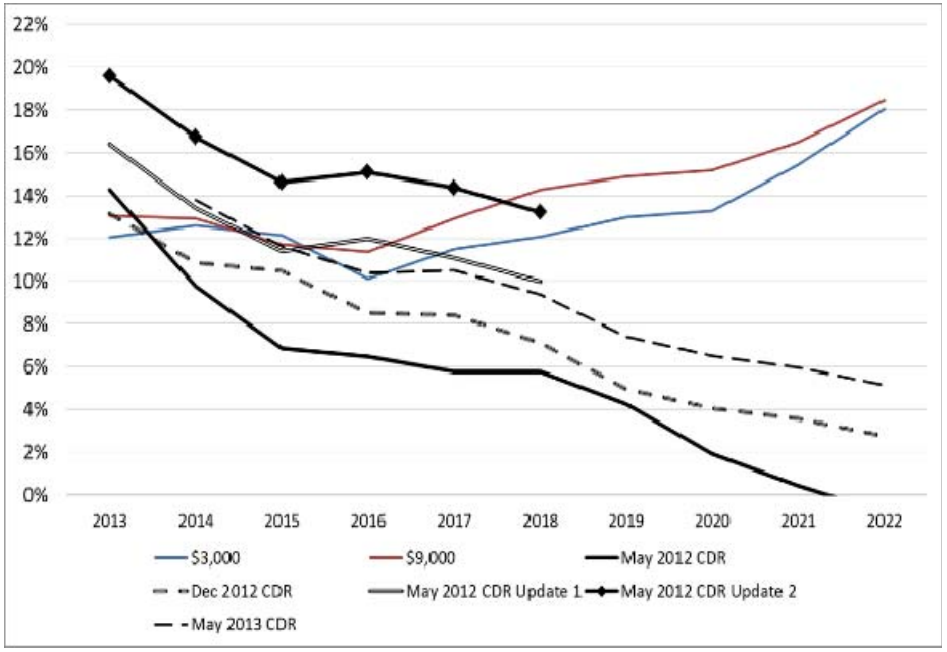
Resource adequacy, capacity expansion optimization, and system costs

Results from Economic Dispatch Modeling, Tsai & Gülen

Partially Sponsored by UT Energy Institute as part of the Full Cost of Electricity (FCe) research program.

Collaborators: Prof. Erich Schneider & Neal Mann, UT Department of Mechanical Engineering; Prof. Jim Dyer, Prof. John Butler & Pedro Cuevas (UT McCombs School of Business); others

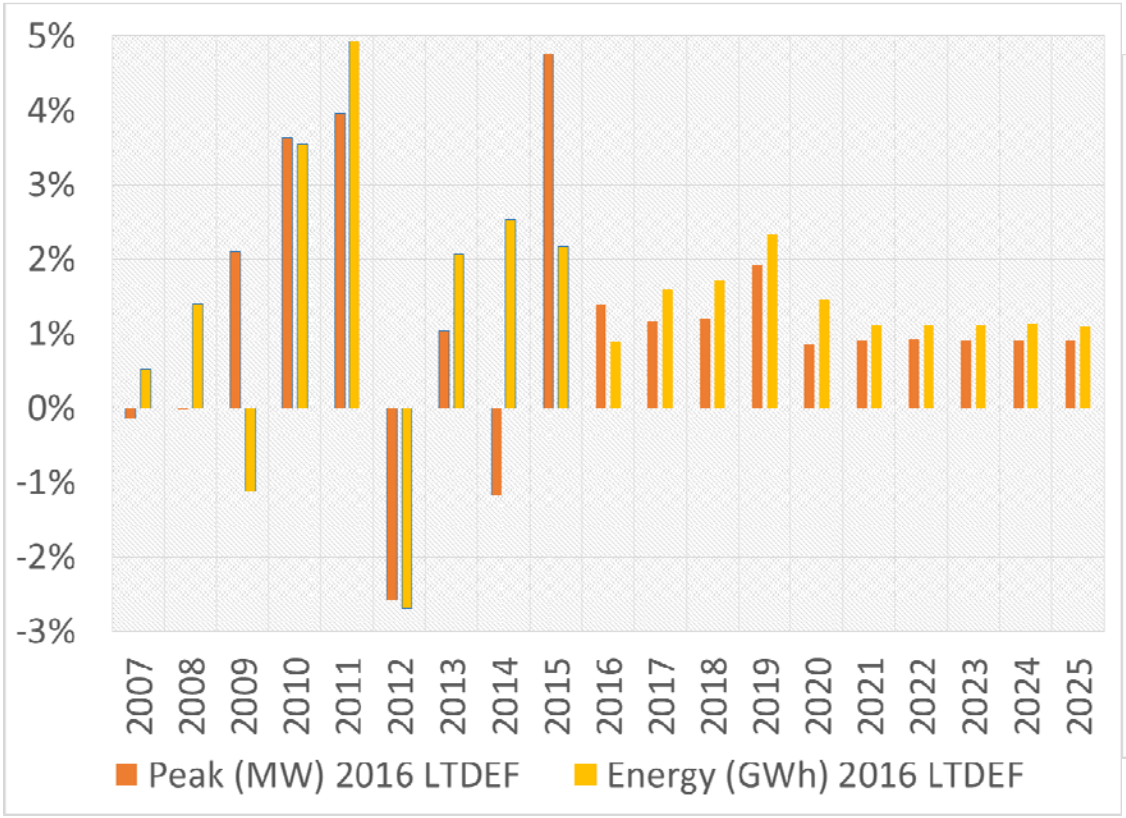
ERCOT Resource Adequacy: Higher Price Cap Should Increase Reserve Margin (2013 Analysis)

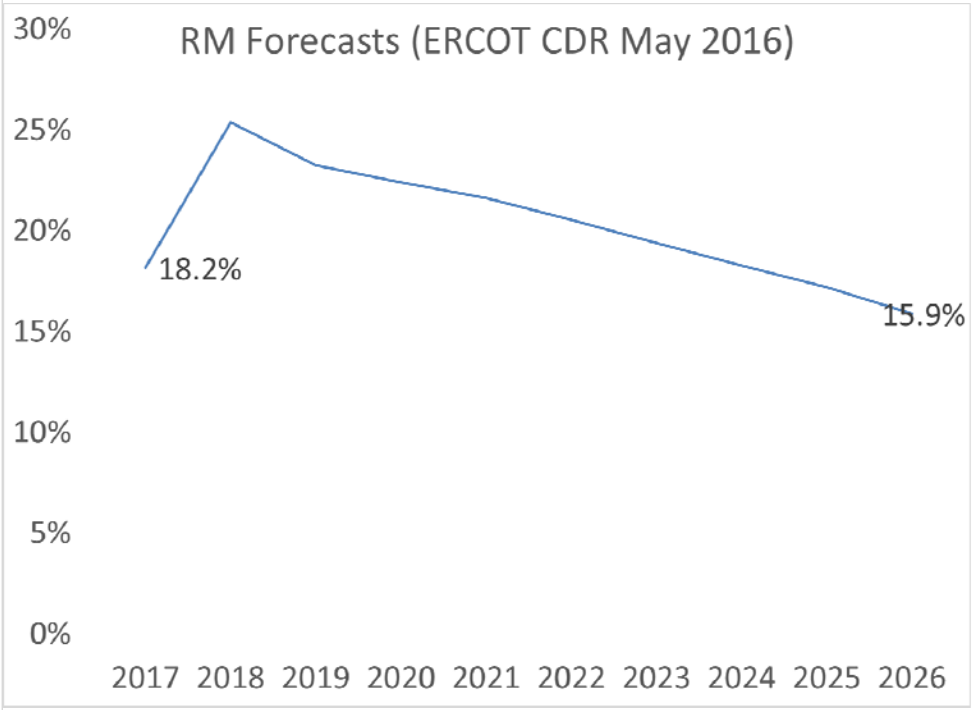


- ERCOT is an energy-only market
- Low electricity prices since 2010 (except for August 2011)
- Price cap increase should help
  - But, reserve margins also depend on environmental regulations, share of renewables, price of natural gas

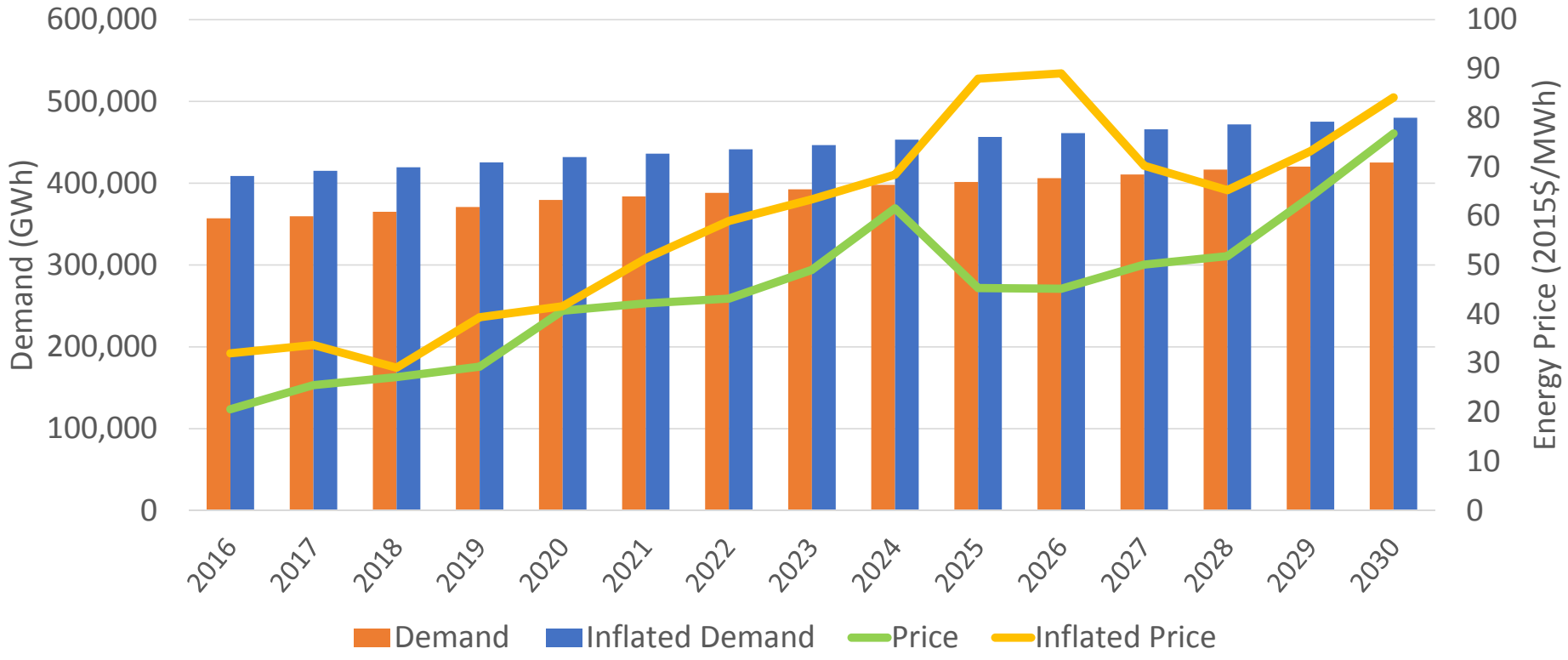
Gülen & Soni, "The Impacts of Raising the Energy Price Cap in ERCOT." The Electricity Journal, 26(7), 43-54.

ERCOT demand growth forecasts lower now than in the past

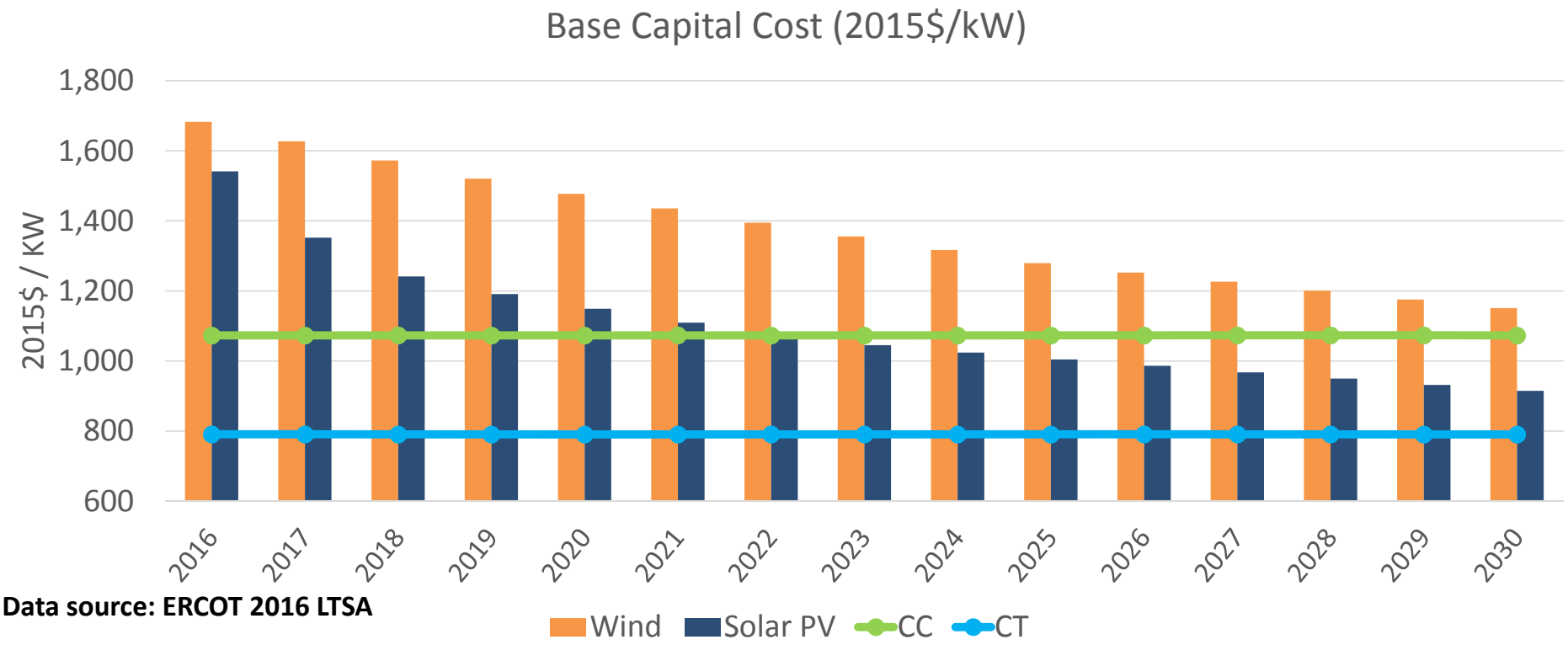




Small changes in demand growth leads to potentially significant changes in prices and price volatility



Generation cost trends by technology: significant declines in solar PV and wind, constant for gas



Data source: ERCOT 2016 LTSA

Rapid expansion of renewable energy in near term (2016-2020)

- Current Trends (projects under construction)
  - 4,413 MW wind
  - 642 MW solar
- Aggressive Renewables (projects announced, in early or advanced stage of development)
  - 13,546 MW wind
  - 2,162 MW of solar

Data source: ERCOT GIS report; CDR report; and SNL

Environmental regulations

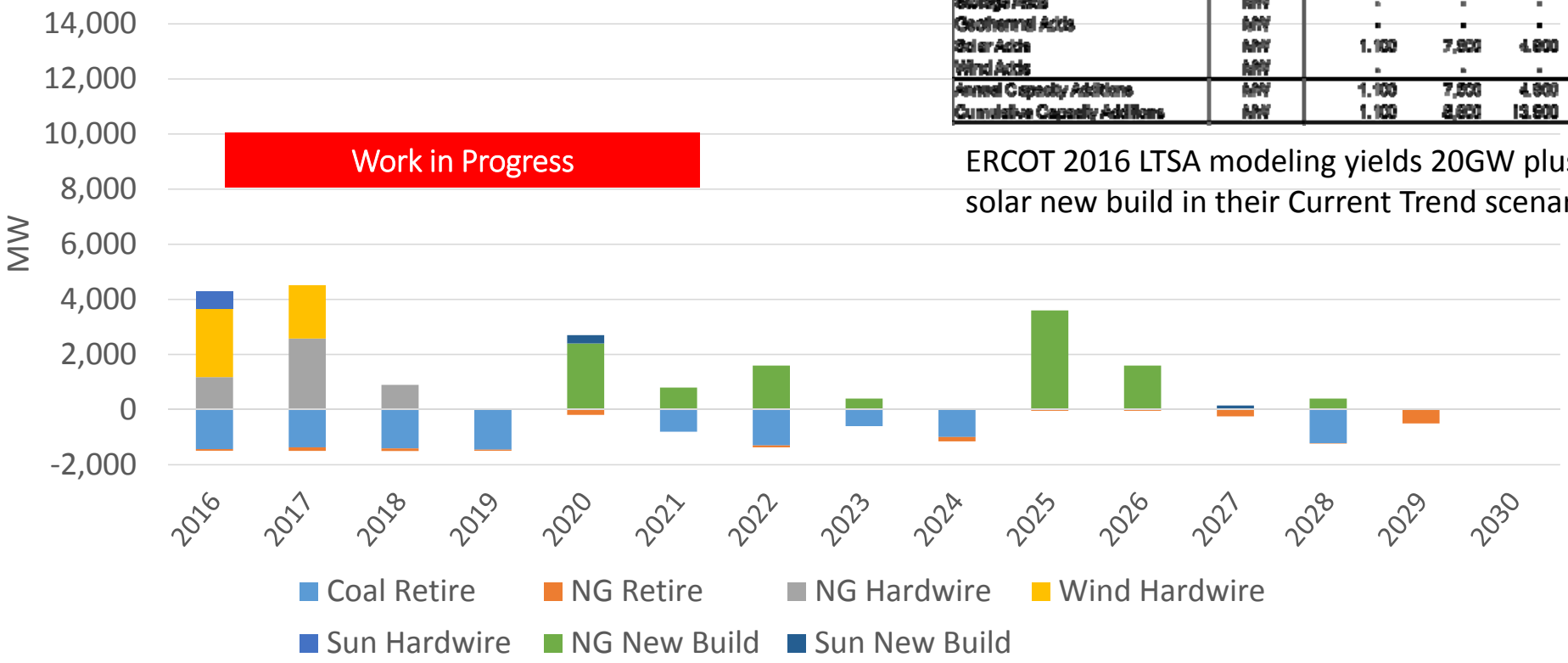
- Environmental regulation compliance costs
  - Mostly for coal units
  - Range from $50 to $700/KW for potential retrofit costs

Data source: SNL, ERCOT analyses

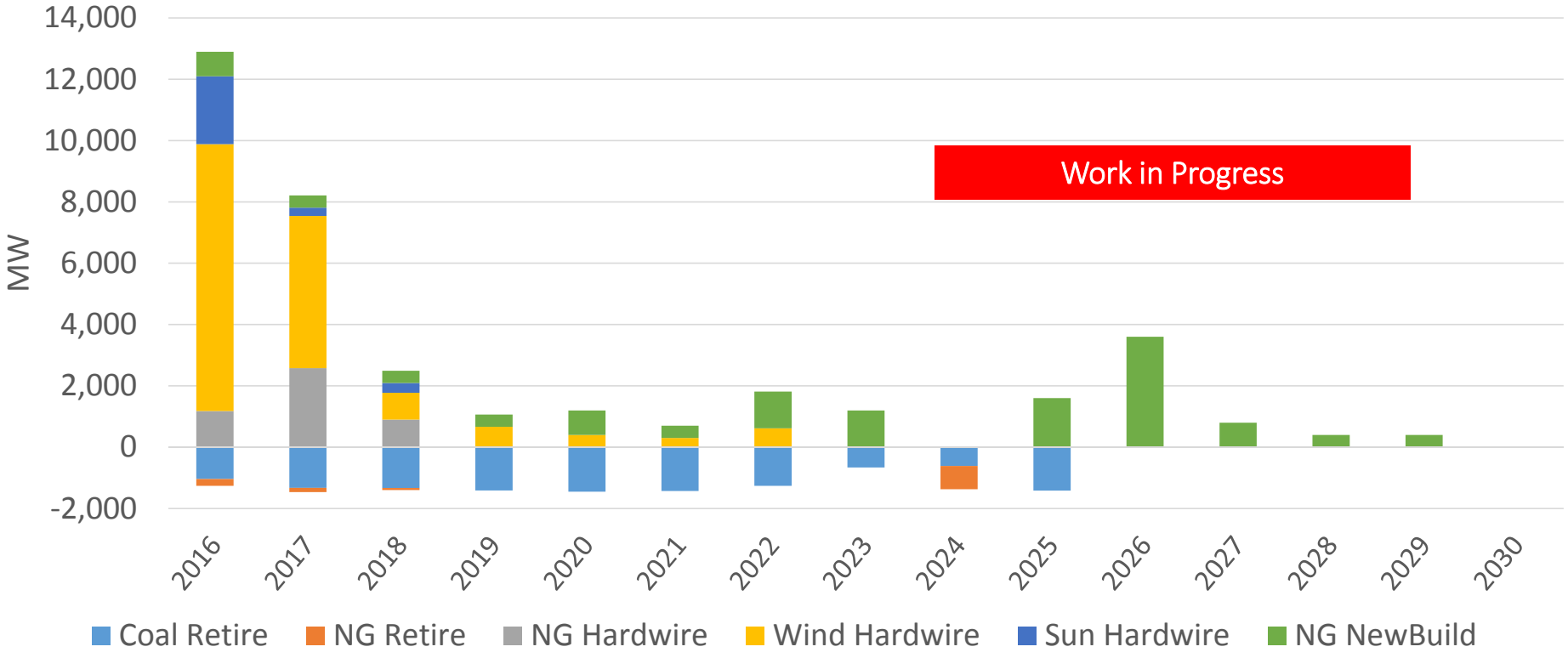
Current Trends
resource expansion/retirement

Description	Units	2017	2022	2026	2031
CC Adds	MW	-		-	-
CT Adds	MW	-	-	-	-
Coal Adds	MW	-	-	-	-
Nuclear Adds	MW	-	-	-	-
Storage Adds	MW	-	-	-	-
Geothermal Adds	MW	-	-	-	-
Solar Adds	MW	1,100	7,800	4,800	6,700
Wind Adds	MW	-	-	-	-
Annual Capacity Additions	MW	1,100	7,800	4,800	6,700
Cumulative Capacity Additions	MW	1,100	8,800	13,600	20,200

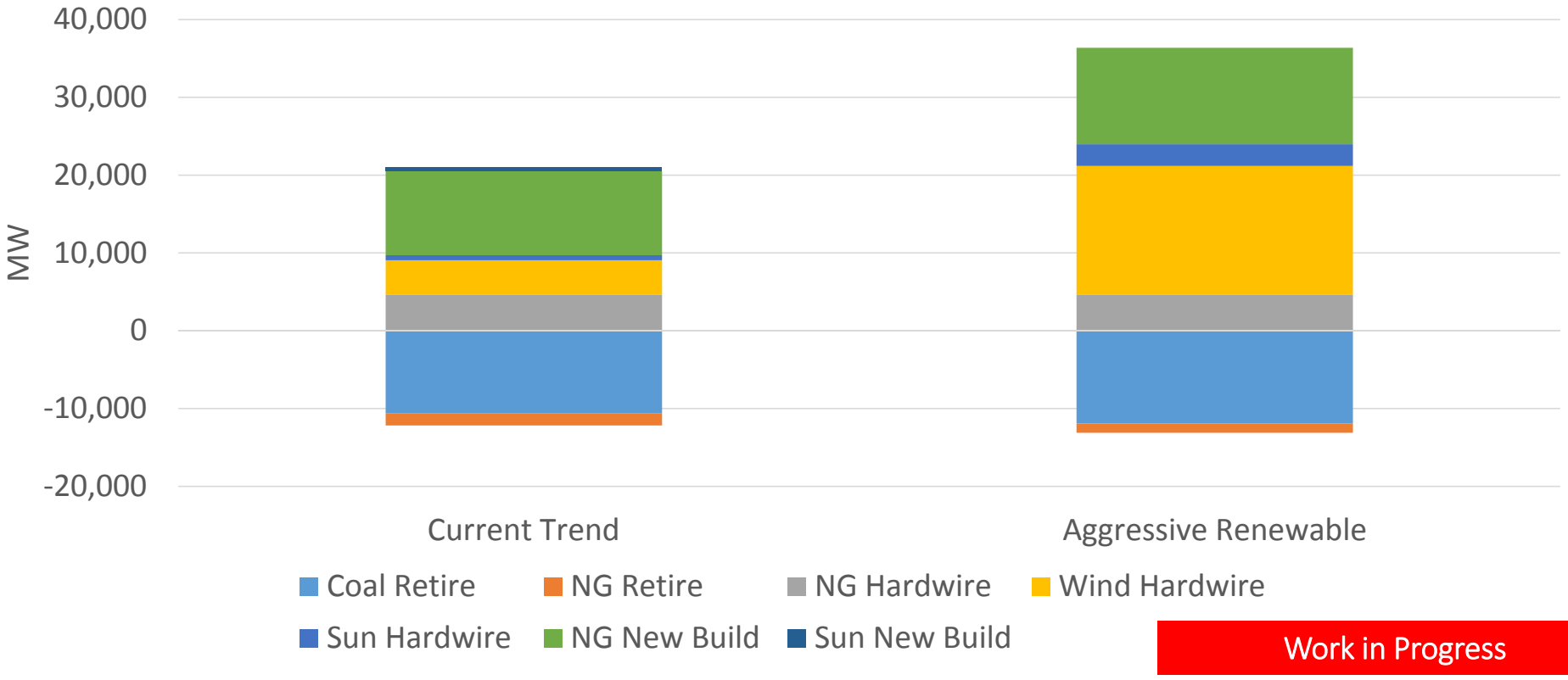
ERCOT 2016 LTSA modeling yields 20GW plus solar new build in their Current Trend scenario.



Aggressive Renewables resource expansion/retirement

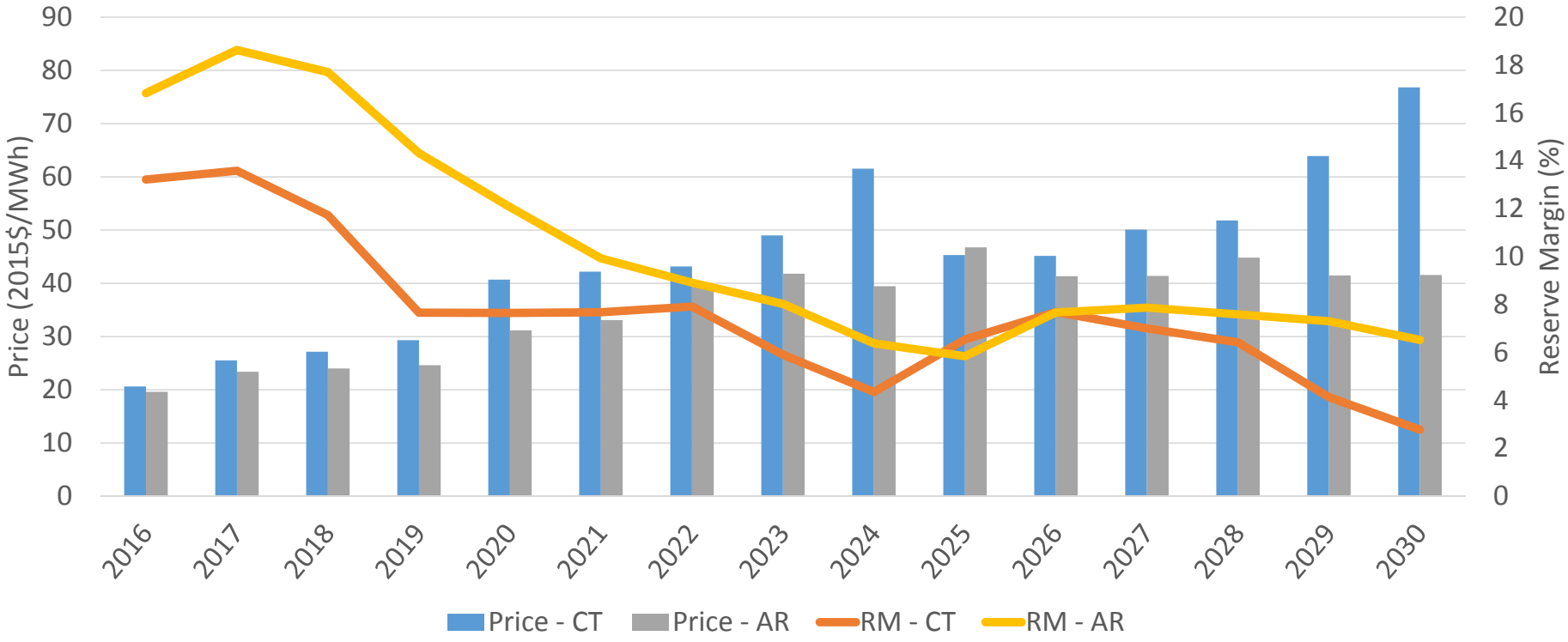


Additional 13GW+ hard-wired wind capacity does not reduce new NG builds



Work in Progress

Energy Price and Reserve Margin



Work in Progress

LACE Incorporates Portfolio Mix (If LACE>LCOE, "economic") – ERCOT Scenarios (2016-2030)

	LACE ($2015/MWh)*		LCOE (2013$/MWh)**
	Current Trends	Aggressive Renewables	
Wind	34.05	24.68	73.6
Solar	66.78	49.62	125.3
Gas – Non-Cycling	164.56	118.80	72.6 – 141.5
Gas – Peaking	1209.52	818.04	
Coal	73.16	53.88	95.1
Note: * Based on FCe results; ** US EIA Annual Energy Outlook 2015, estimated for new generations resources in 2020			

Work in Progress