Florida's Energy Future

Efficiency, Solar, Energy Storage & EVs

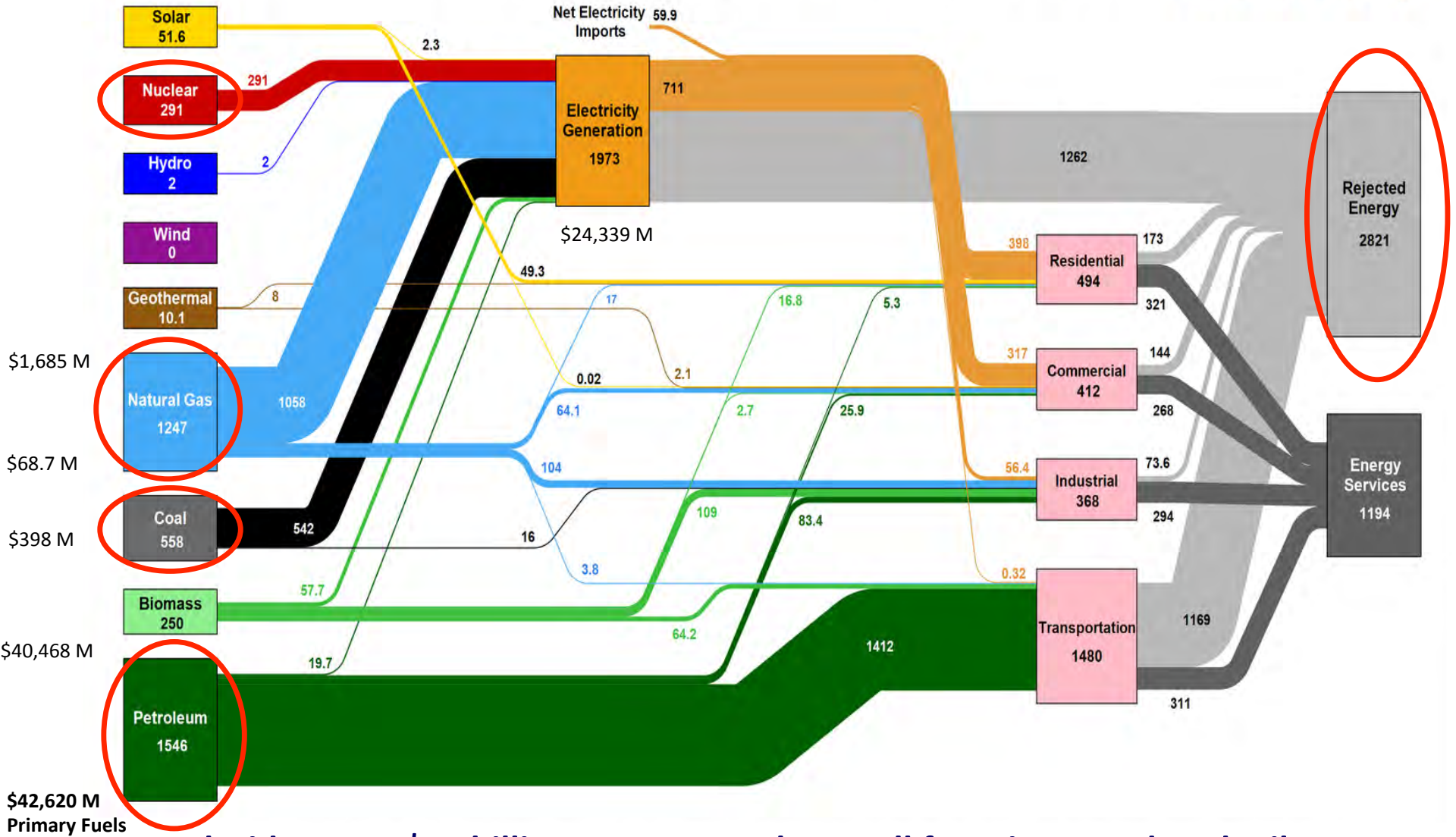
James Fenton, Director

UCF | FSEC Energy Research Center

UNIVERSITY OF CENTRAL FLORIDA

Florida Energy Consumption in 2014: ~ 4015 Trillion BTU

Lawrence Livermore National Laboratory

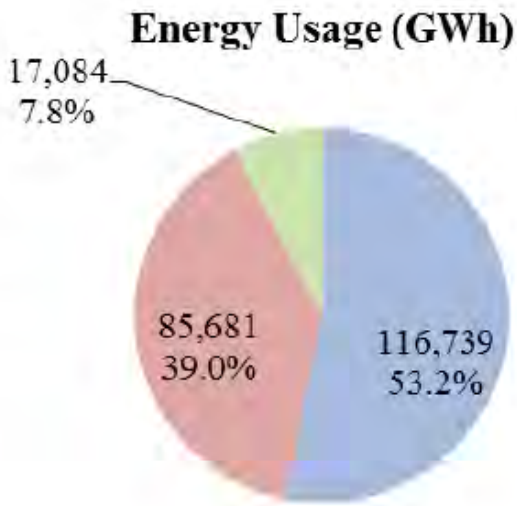


- **Florida spent $67 billion on energy, almost all from imported coal, oil, gas, and nuclear**
- **70% of primary energy is wasted**

*2014 Latest Energy Flow Chart Available from LLNL https://flowcharts.llnl.gov/commodities/energy

UCF

Florida Electric Customer Composition in 2017



>90% in Buildings

Source: FRCC 2018 Load & Resource Plan

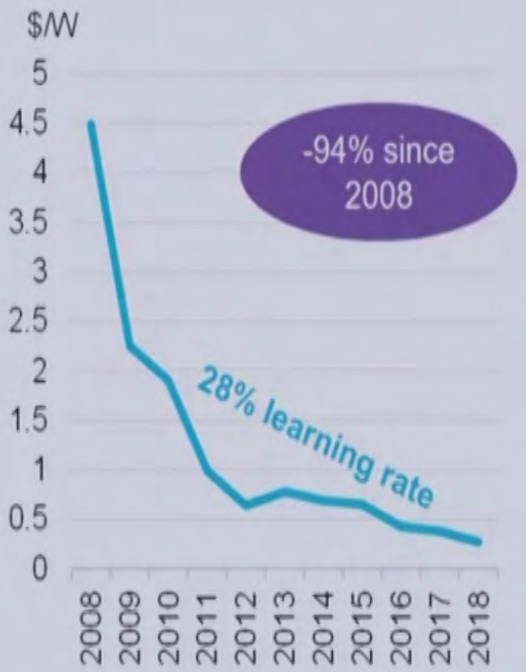
Residential	**13,095 kWh/year**	**=9.4 kW PV**
Commercial	**77,414 kWh/year**	**=55 kW PV**
Industrial	**742,976 kWh/year**	**=531 kW PV**

http://www.psc.state.fl.us/Files/PDF/Utilities/Electricgas/TenYearSitePlans/2018/Review.pdf

BloombergNEF

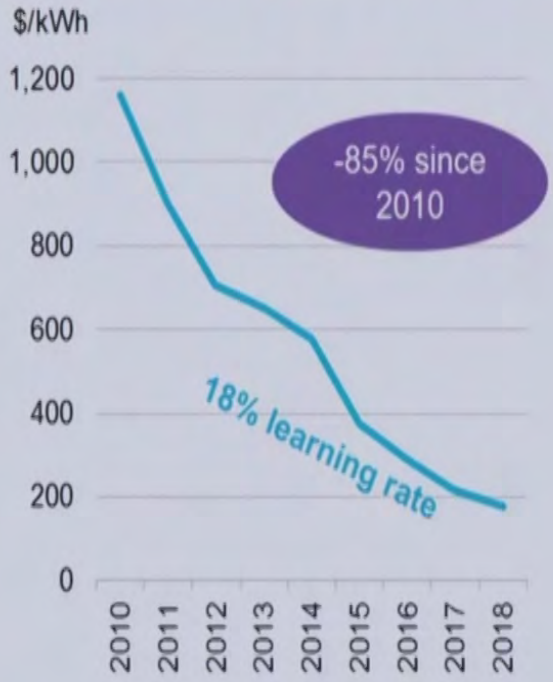
Transitions driven by technology

Solar PV module prices



Onshore wind turbine prices

Lithium-ion battery prices



Source: BloombergNEF.

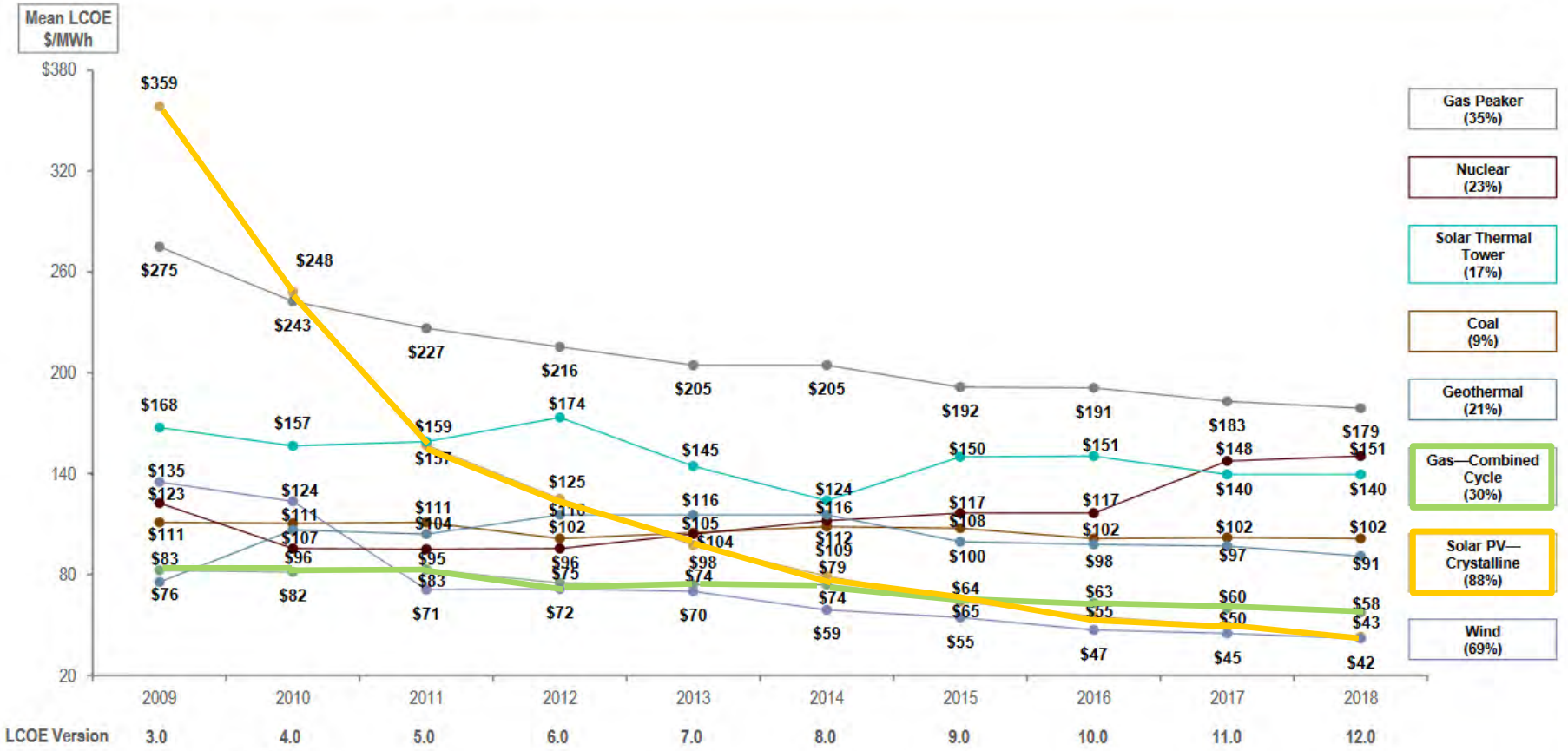
BloombergNEF

Jon Moore, CEO, BloombergNEF: Opportunities in Automotive, Energy and Technology https://about.bnef.com/summit/sanfrancisco/videos/?vid=315275273

Levelized Cost of Energy Comparison—Historical Utility-Scale Generation Comparison

Lazard's unsubsidized LCOE analysis indicates significant historical cost declines for utility-scale Alternative Energy generation technologies driven by, among other factors, decreasing supply chain costs, improving technologies and increased competition

Selected Historical Mean Unsubsidized LCOE Values(1)



Source: Lazard estimates.

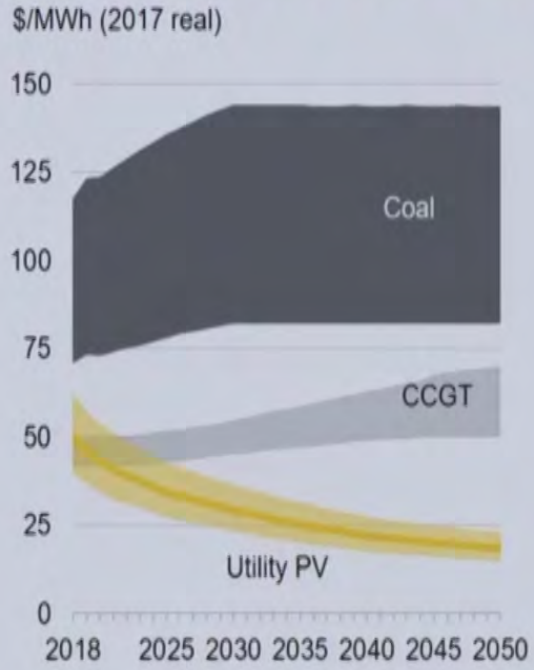
(1) Reflects the average of the high and low LCOE for each respective technology in each respective year. Percentages represent the total decrease in the average LCOE since Lazard's LCOE—Version 3.0.

https://www.lazard.com/media/450784/lazards-levelized-cost-of-energy-version-120-vfinal.pdf

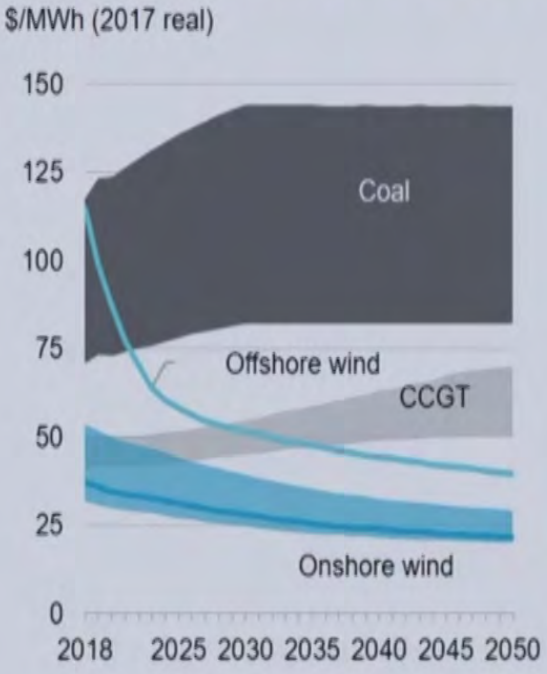
BloombergNEF

Transitions characterized by tipping points

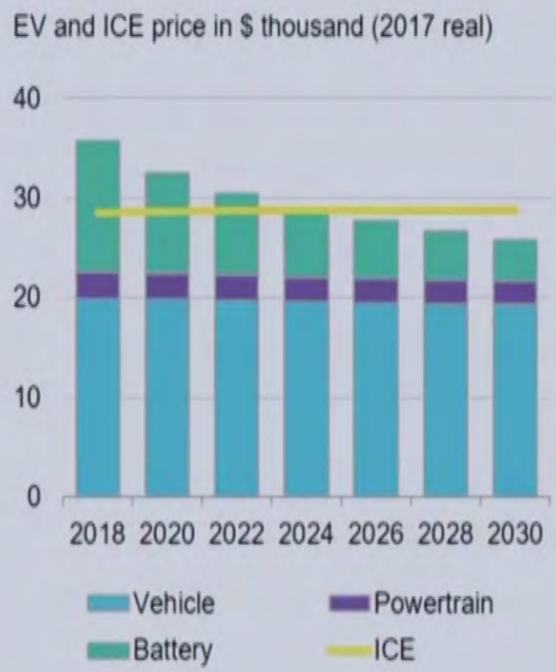
Solar costs vs. coal & gas



Wind costs vs. coal & gas



EV purchase price vs. ICE

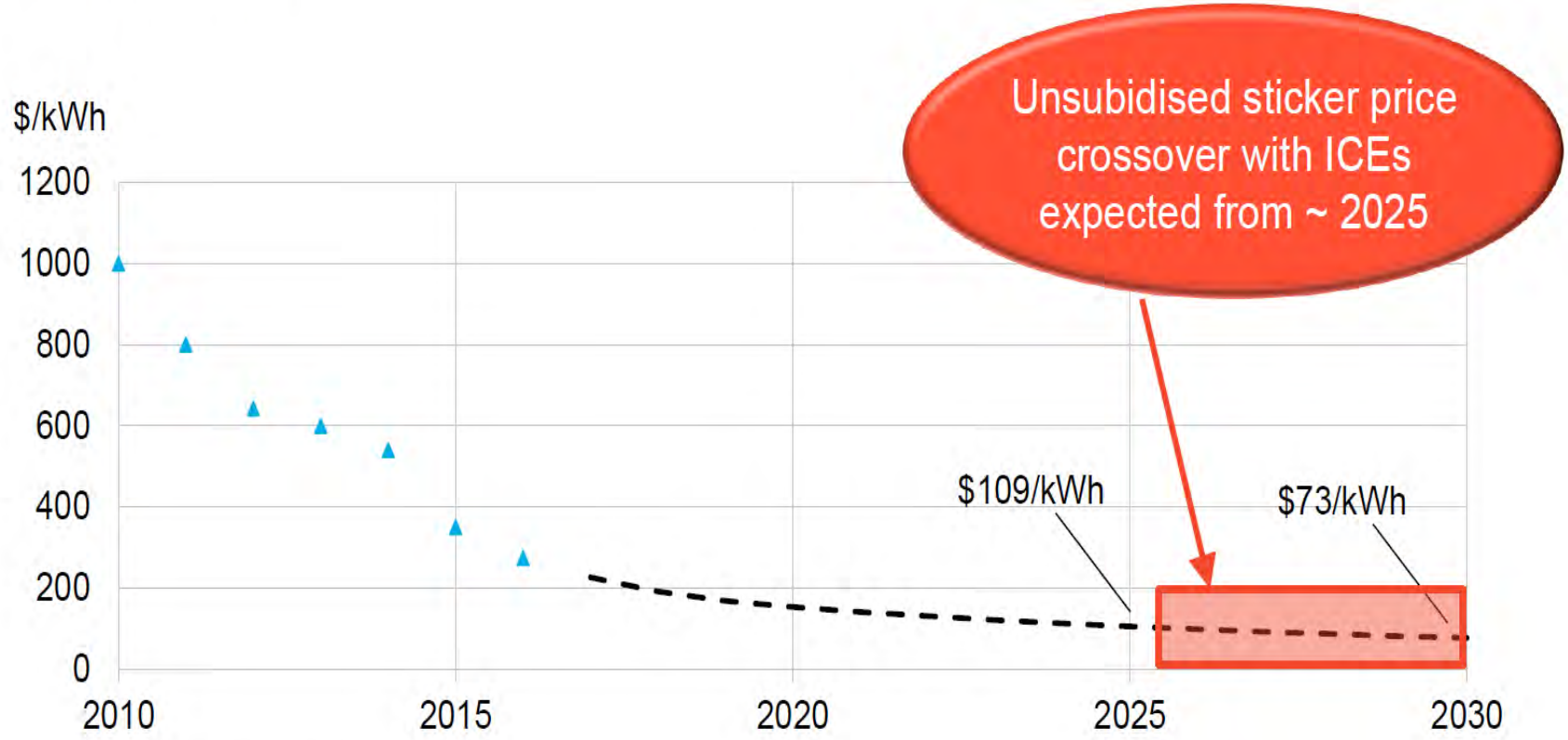


Note: Levelized cost of electricity (solar, wind, gas, coal) calculations are for utility-scale assets in the U.S. and exclude incentives such as the ITC and the PTC. Utility PV assumes tracking. EV price is for a medium segment vehicle in the U.S

BloombergNEF

Jon Moore, CEO, BloombergNEF: Opportunities in Automotive, Energy and Technology https://about.bnef.com/summit/sanfrancisco/videos/?vid=315275273

Battery pack costs to fall another 70% by 2030



Source: Bloomberg New Energy Finance

Energy is Fungible

- Operate our Buildings with electricity from ***utility and rooftop solar and energy efficiency***
- Drive our ***cars on Florida electricity*** which is cheaper than gasoline today!
- Fossil fuel prices going up, ***solar going down for everyone!***
- Reduce greenhouse gases and NO_x

Jobs and wealth stay in Florida

Vision For Florida

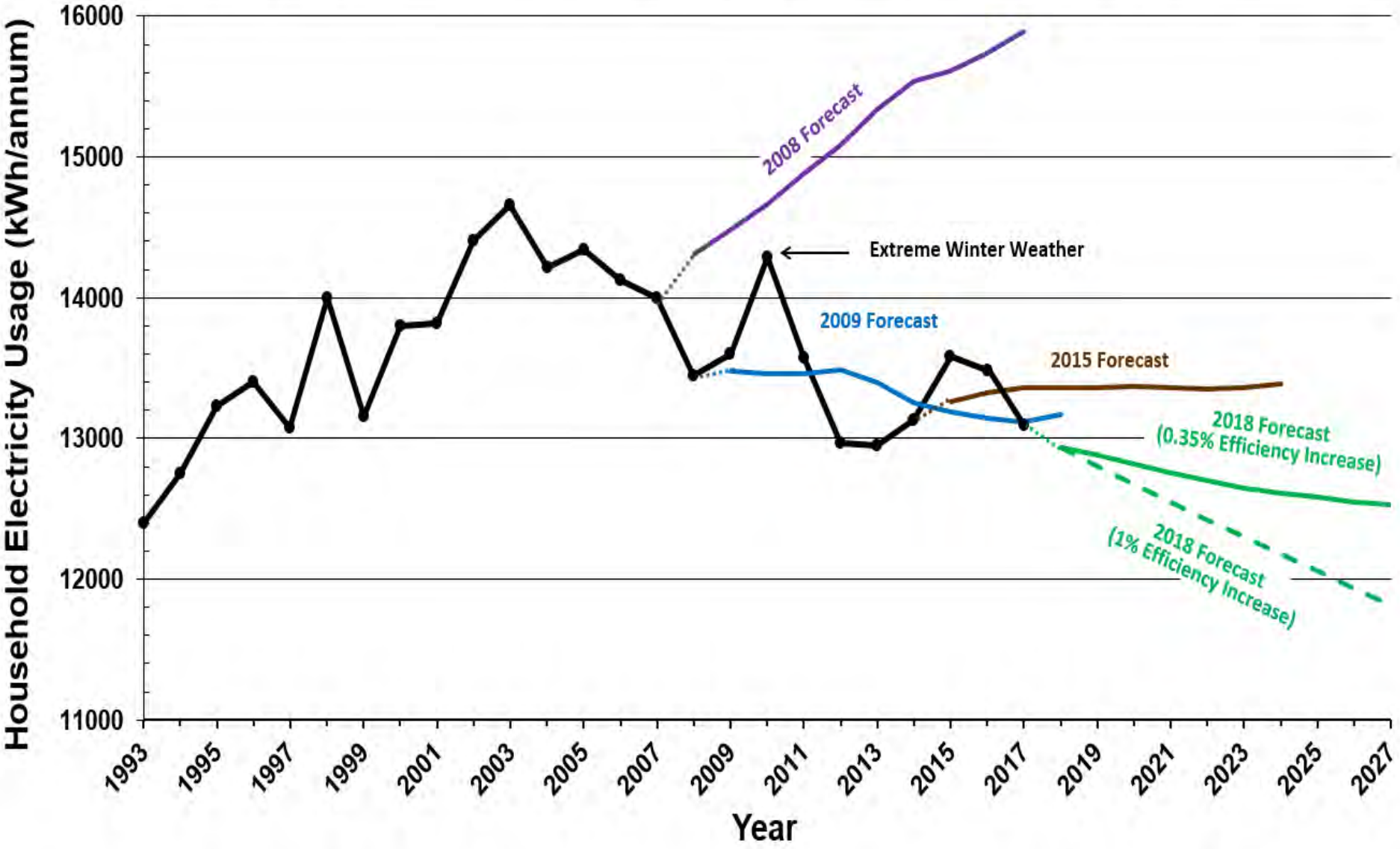
Spend Little to No funds on Imported Primary Fuels

- Utility and rooftop solar, energy storage, smart-charging electric vehicles (V2G), building energy efficiency improvements and demand response all needed to achieve 100% renewables. All at a lower cost then Business-As-Usual.
- A non-optimal path will lead to longer term reliance on fossil fuel backup and oversized renewables capacity.
- Both utilities and customers (those on each side of the electric meter) must be empowered to achieve 100% renewables. Resiliency will then be achieved.

(Planes start to switch from fossil fuels to renewable hydrogen in 2045. Electric high speed trains could displace much of the fossil fuel planes and get you there quicker and cheaper!)

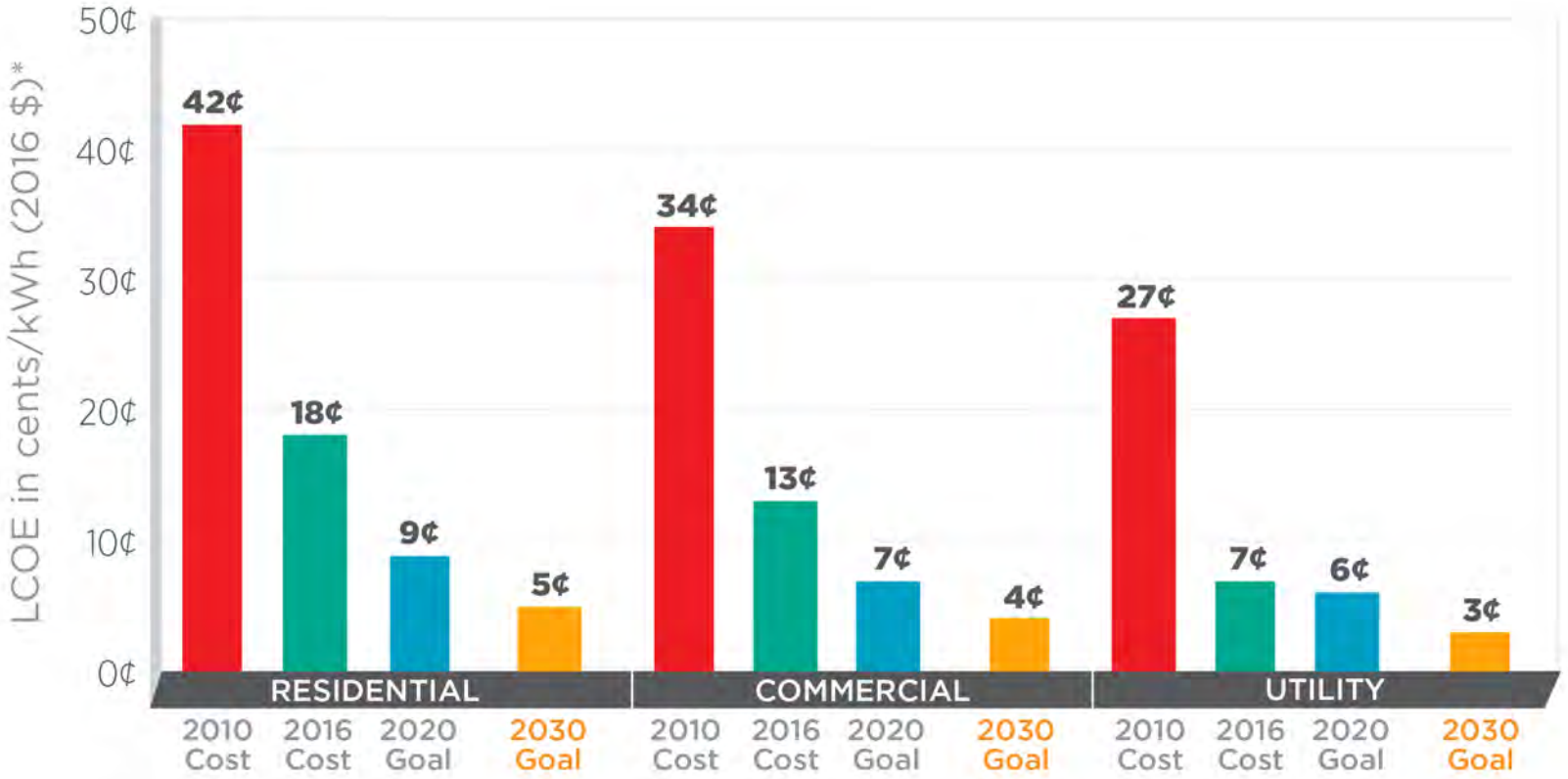
State of Florida: Energy Consumption per Household

(In 2017 8,914,734 Residential Customers used 53.2% of the electricity = 116,739 GWh)



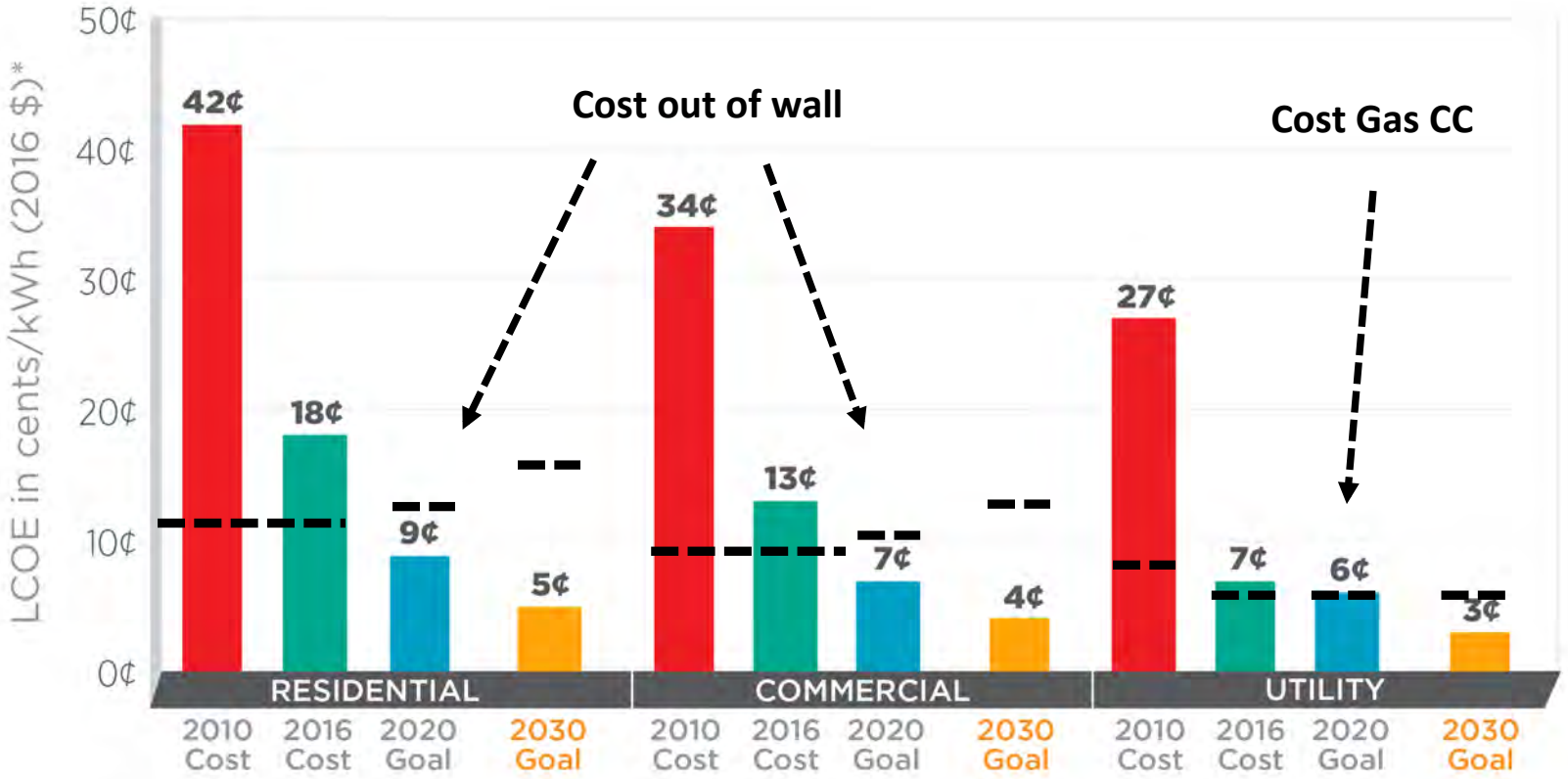
http://www.psc.state.fl.us/ElectricNaturalGas/TenYearSitePlans

SunShot Progress and Goals



*Levelized cost of electricity (LCOE) progress and targets are calculated based on average U.S. climate and without the ITC or state/local incentives. Utility-scale PV uses one-axis tracking.

SunShot Progress and Goals



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SunShot Progress and Goals

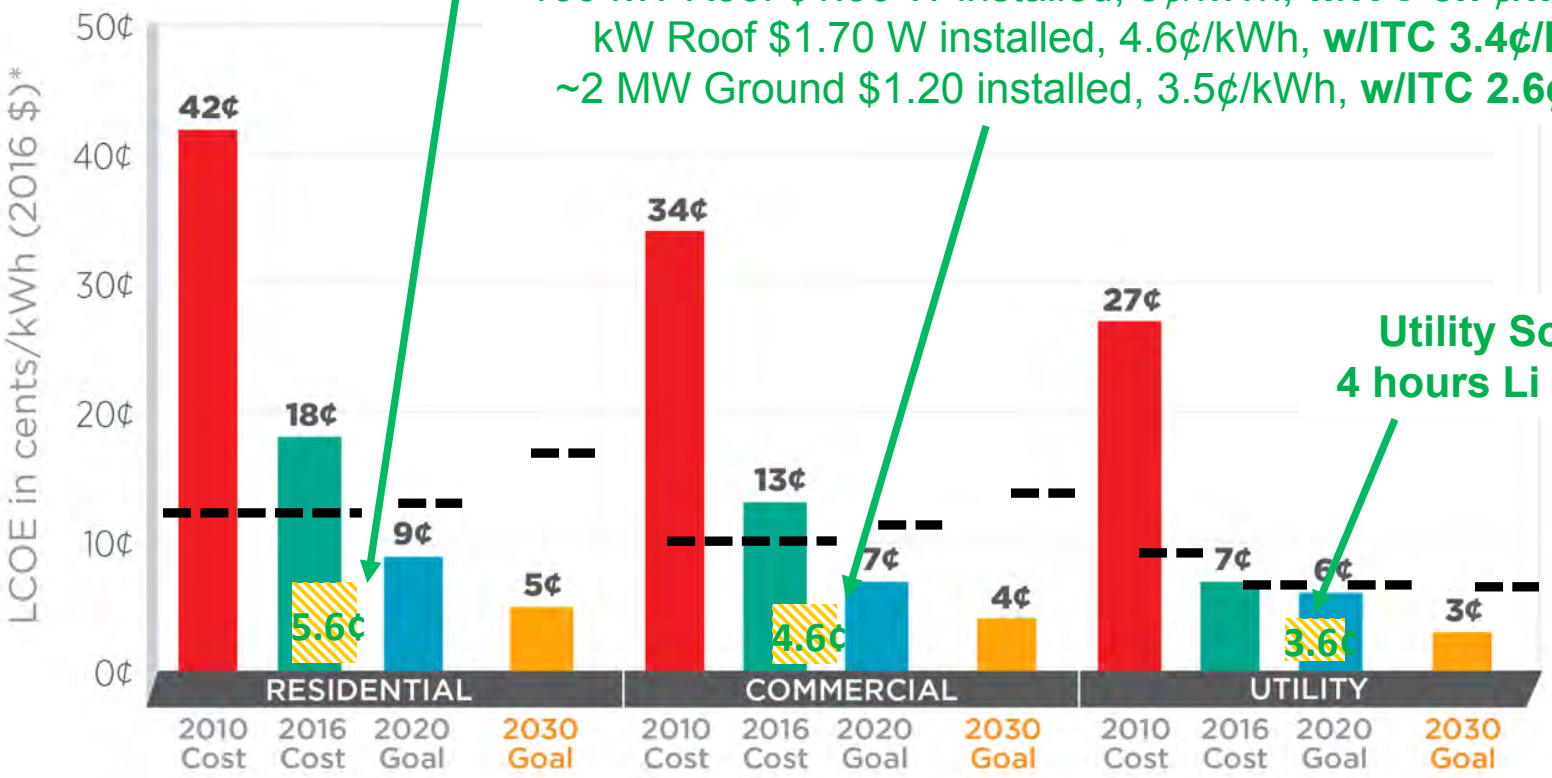
TODAYS Florida Solar Co-ops <15 kW

$2.00 W installed, 5.6¢/kWh, **w/ITC 4¢/kWh**

Florida Commercial Solar

~100 kW Roof $1.90 W installed, 5¢/kWh, **w/ITC 3.7¢/kWh** ~500 kW Roof $1.70 W installed, 4.6¢/kWh, **w/ITC 3.4¢/kWh**
~2 MW Ground $1.20 installed, 3.5¢/kWh, **w/ITC 2.6¢/kWh**

Utility Solar & 4 hours Li Battery



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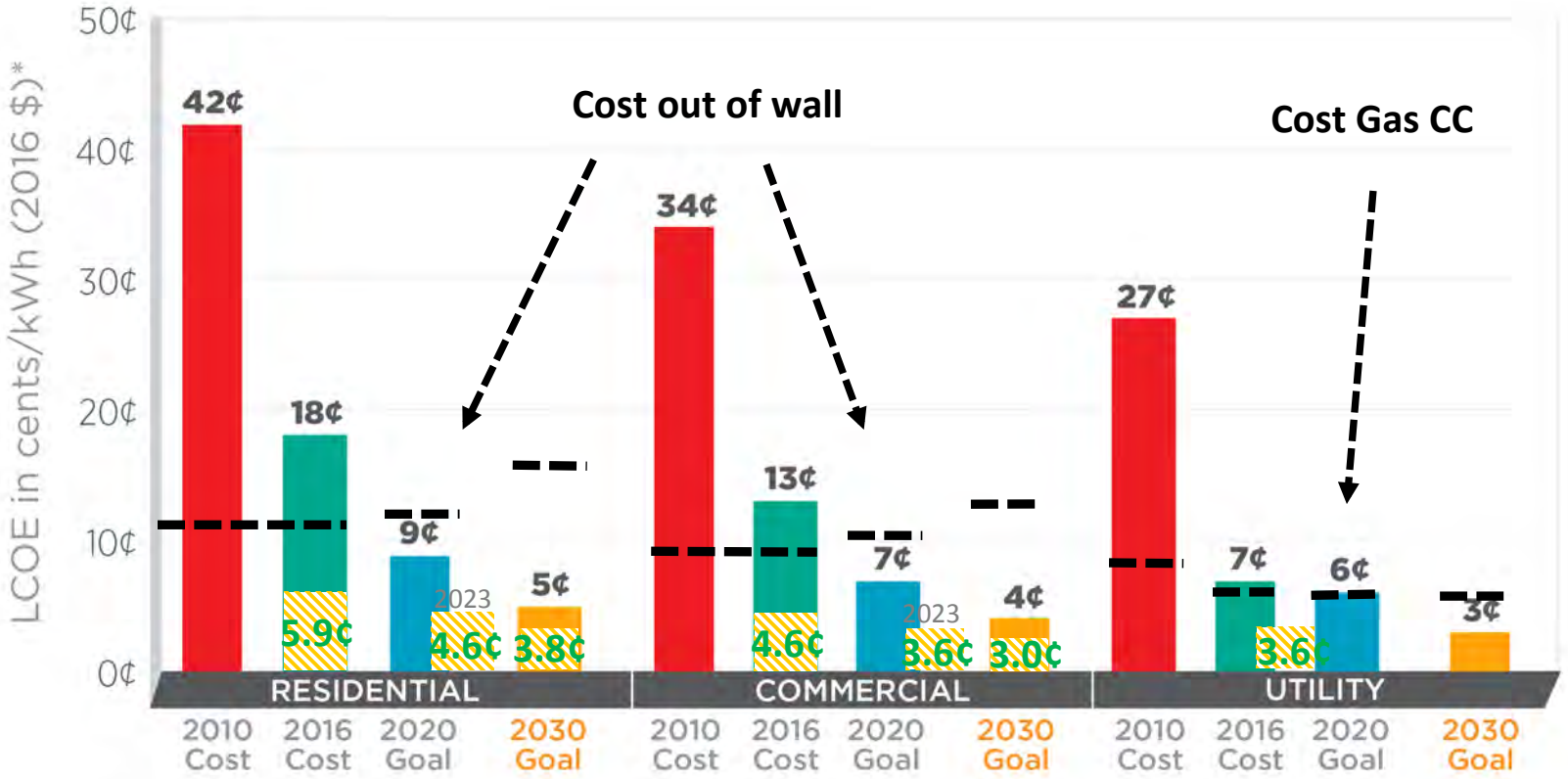

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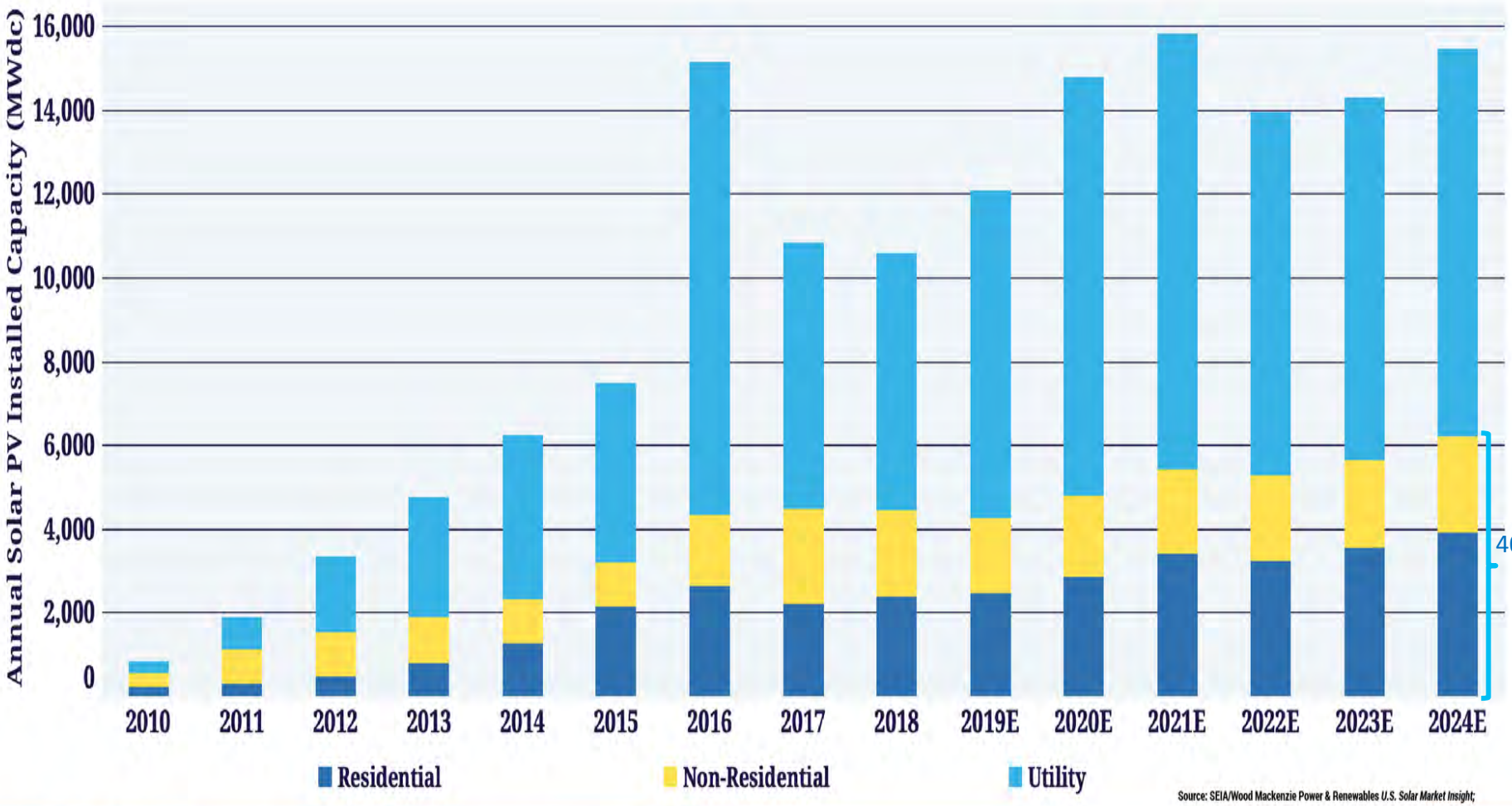
U.S. Solar PV Deployment Forecast

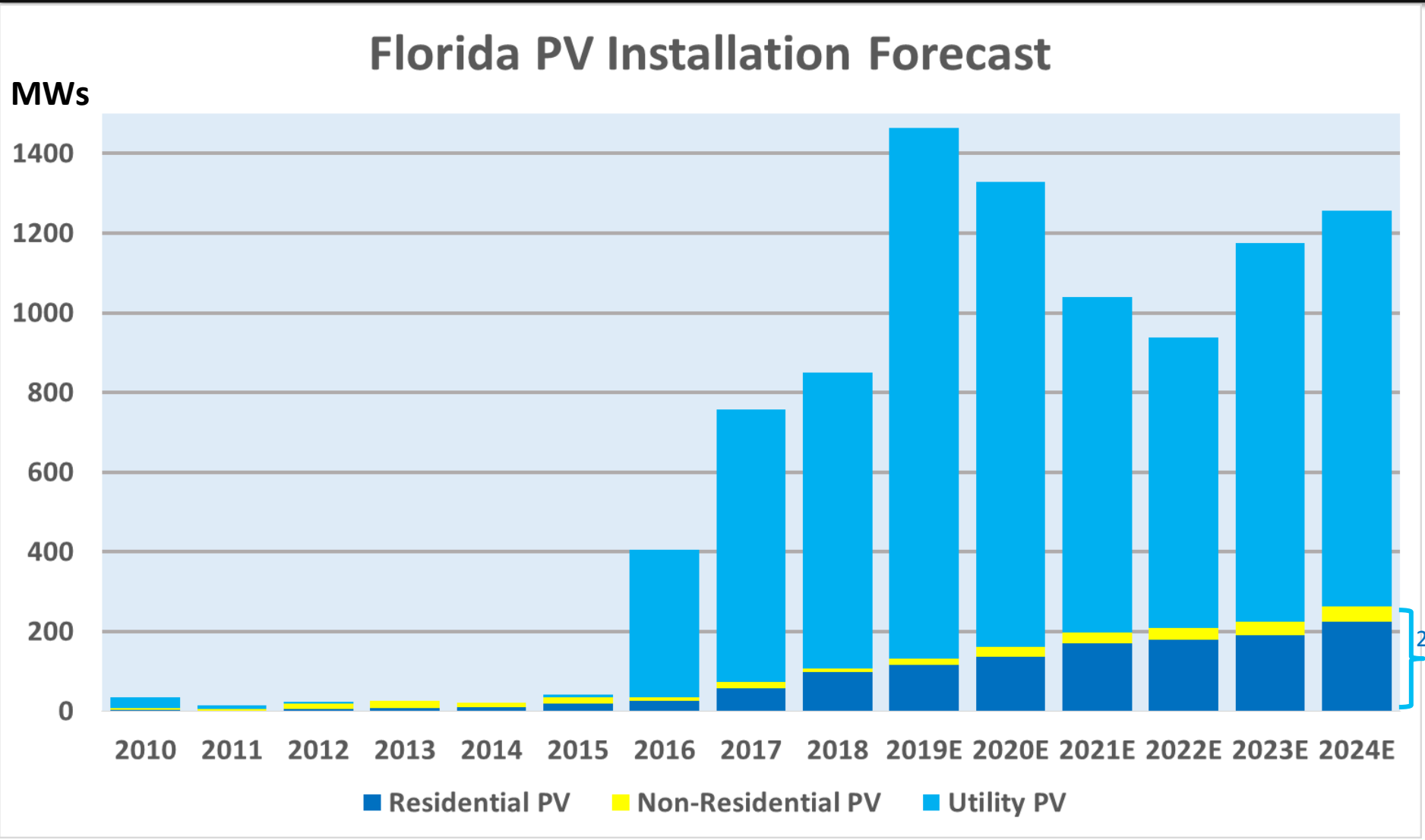


Source: SEIA/Wood Mackenzie Power & Renewables *U.S. Solar Market Insight;*

Wood Mackenzie POWER & RENEWABLES

SEIA Solar Energy Industries Association®

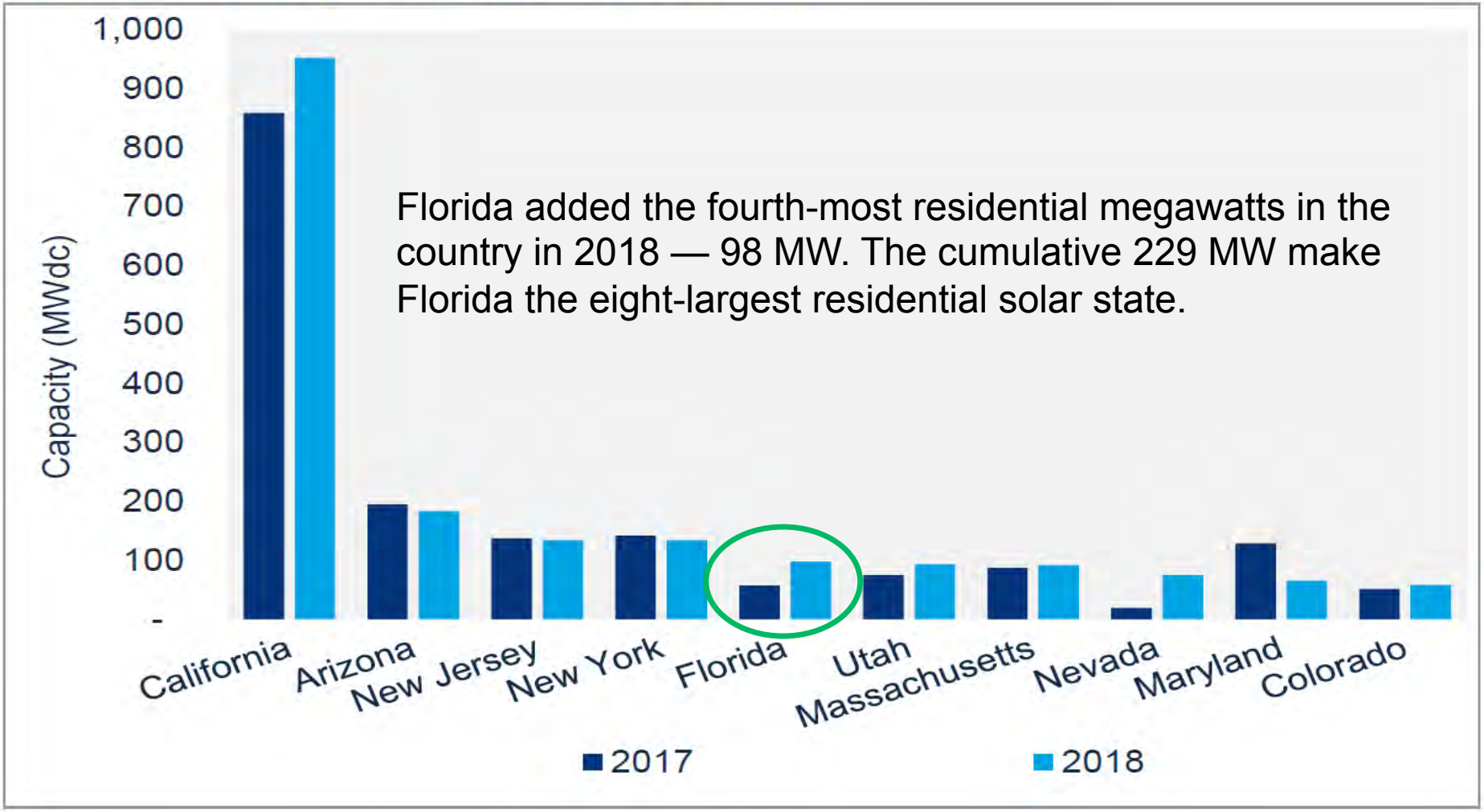
Florida PV Installation Forecast



The CAGR from 2018 to 2024 is **15% for residential installations**, **29% for non-residential installations** and 5% per year for utility installations. In 2035, costumer owned installations in MWs will be equal to those installed by Utilities (50% of total solar deployment, ~1,400 MW each annually).

Residential Solar

Figure 2.2 Top 10 state markets, 2017 vs. 2018



Florida added the fourth-most residential megawatts in the country in 2018 — 98 MW. The cumulative 229 MW make Florida the eight-largest residential solar state.

Source: Wood Mackenzie Power & Renewables

PV Installer Fasting Growing Job

United States

- PV installer fastest growing occupation* 2016 to 2026 (105%)
- 2017 Median Pay of $39,490

Florida

- 10,528 State Solar Jobs, 1st New Solar Jobs (1,769), 20.6% Growth Rate
- 7,445 Installation Jobs, 2nd in Nation
  - 6,539 Residential jobs
  - 817 Non-Residential jobs
  - 89 Utility-scale jobs
- 991 Manufacturing Jobs, 9th in Nation
- Future Florida Job growth is on the Roof and Manufacturing floor

*Bureau of Labor Statistics, US Department of Labor

https://solarstates.org/#state/florida/counties/solar-jobs/2018

Solar, Efficiency, Energy Storage & EV Job Growth is Just Starting

TOP 10 STATES FOR CLEAN ENERGY JOBS

RANK	STATE	TOTAL*	SOLAR	WIND	ENERGY EFFICIENCY	CLEAN VEHICLES
1	California	512,934	126,507	5,785	318,542	22,389
2	Texas	233,447	11,433	25,386	162,816	17,800
3	Florida	158,652	10,528	4,461	118,412	9,360
4	New York	156,059	11,603	3,491	123,292	8,624
5	Michigan	126,081	5,419	4,783	85,061	25,304
6	Illinois	123,247	5,341	8,706	89,469	10,417
7	Massachusetts	116,491	16,527	1,983	86,473	3,184
8	Ohio	112,486	8,108	1,080	81,676	16,646
9	North Carolina	110,913	8,912	908	86,559	7,280
10	Virginia	95,158	4,241	1,628	78,670	5,436

https://www.e2.org/reports/clean-jobs-america-2019/

* Total includes renewable energy, energy efficiency, clean vehicles, battery storage, advanced biofuels, low-impact hydro and other sectors.

CLEAN ENERGY GROWTH IN PERSPECTIVE

110,000

Clean energy jobs grew 3.6 percent in 2018, adding jobs in nearly every state and combining to add over 110,000 net new clean energy jobs nationally.

12

Number of states that have or are considering policies that get 100 percent of their electricity from clean energy sources.

3X

Clean energy jobs outnumbered fossil fuel jobs nearly 3 to 1 in 2018.

10

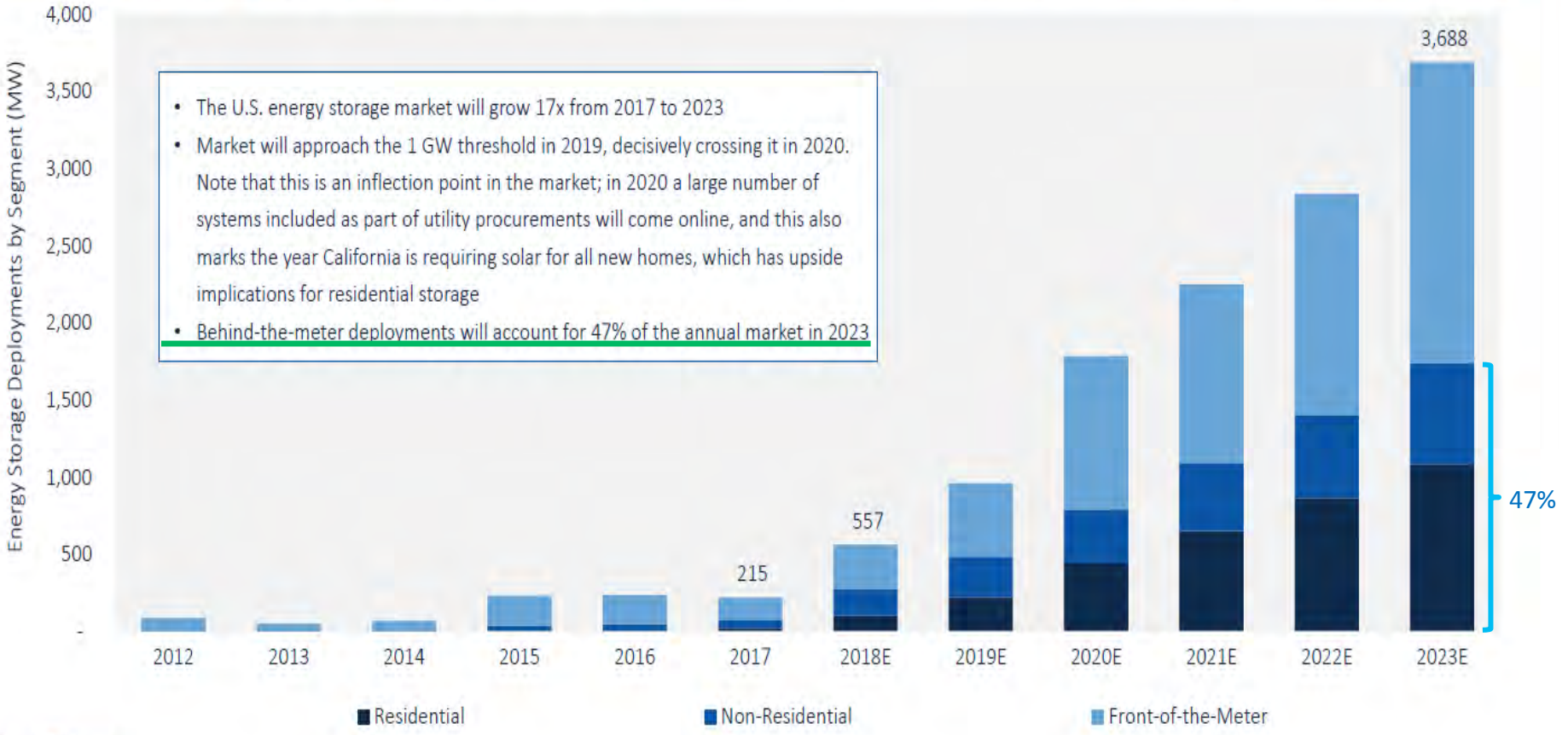
The number of states that generate more than 20 percent of their electricity from wind and solar–Kansas, Iowa, Oklahoma, North Dakota, South Dakota, Vermont, California, Maine, Colorado, and Minnesota.[3]

156 GW

Combined capacity of installed solar and wind surpassed 150GW in 2018. Wind energy is the largest source of renewable generating capacity. A new solar project is installed in America every two minutes.[4,5]

U.S. Energy Storage Annual Deployments Will Reach 3.7 GW by 2023

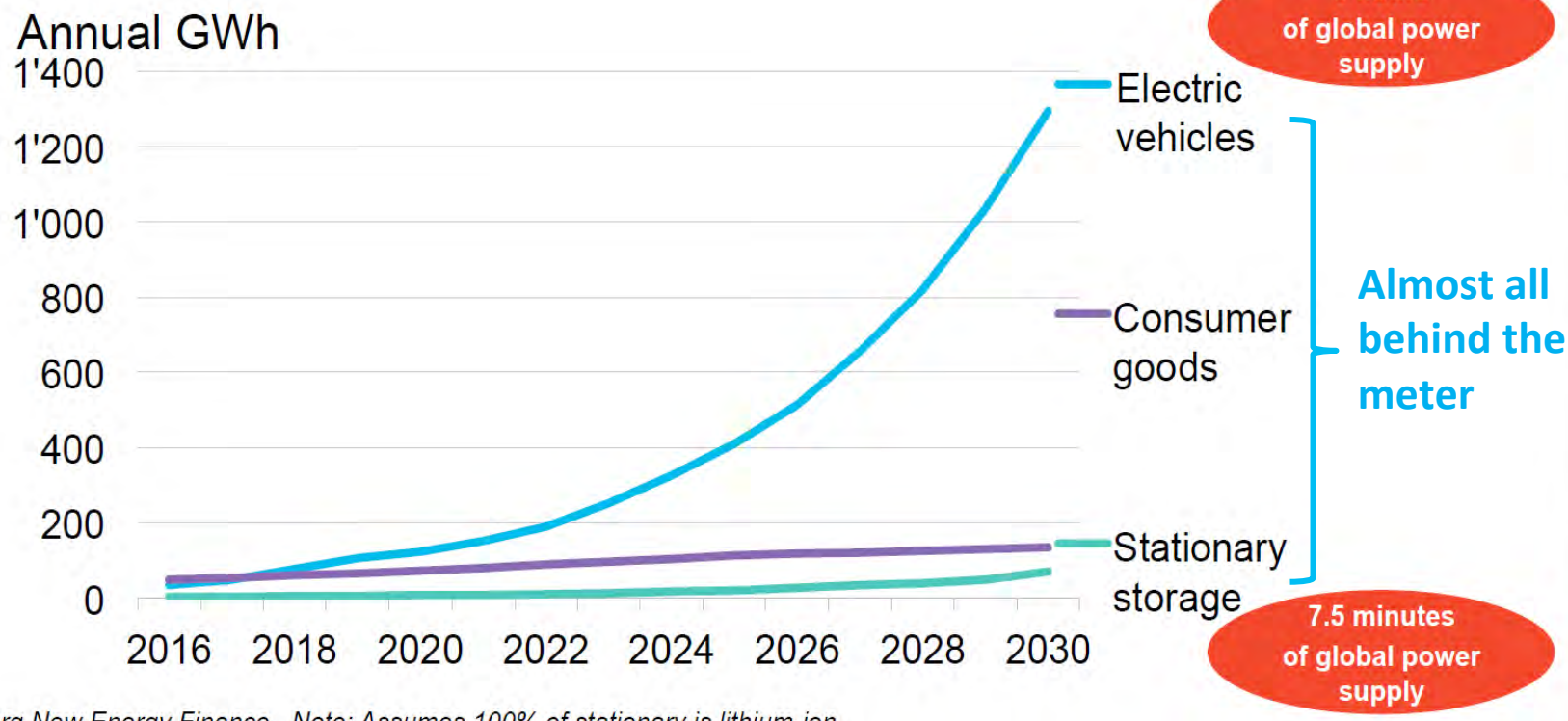
U.S. Annual Energy Storage Deployment Forecast, 2012-2023E (MW)



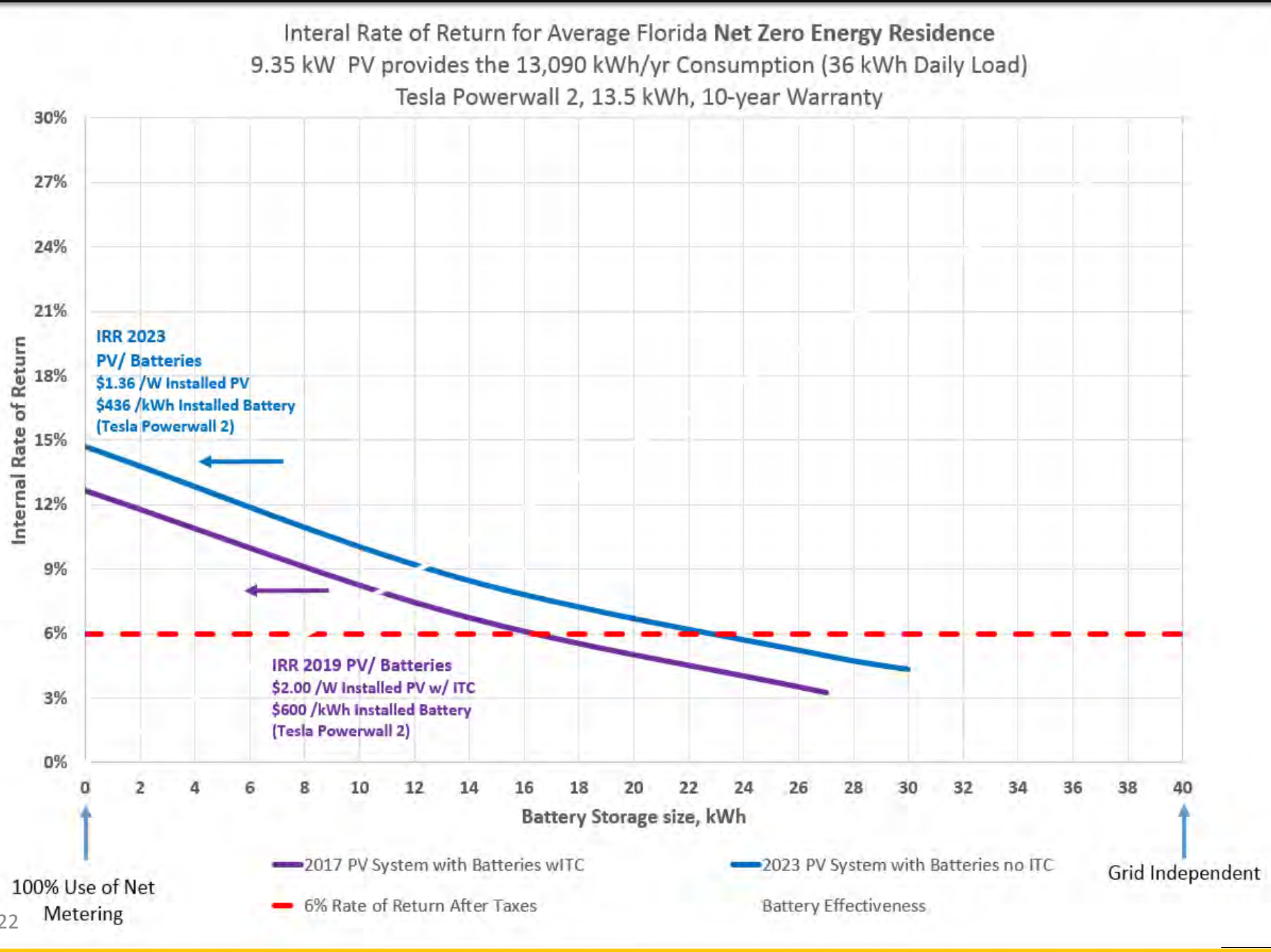
Source: GTM Research

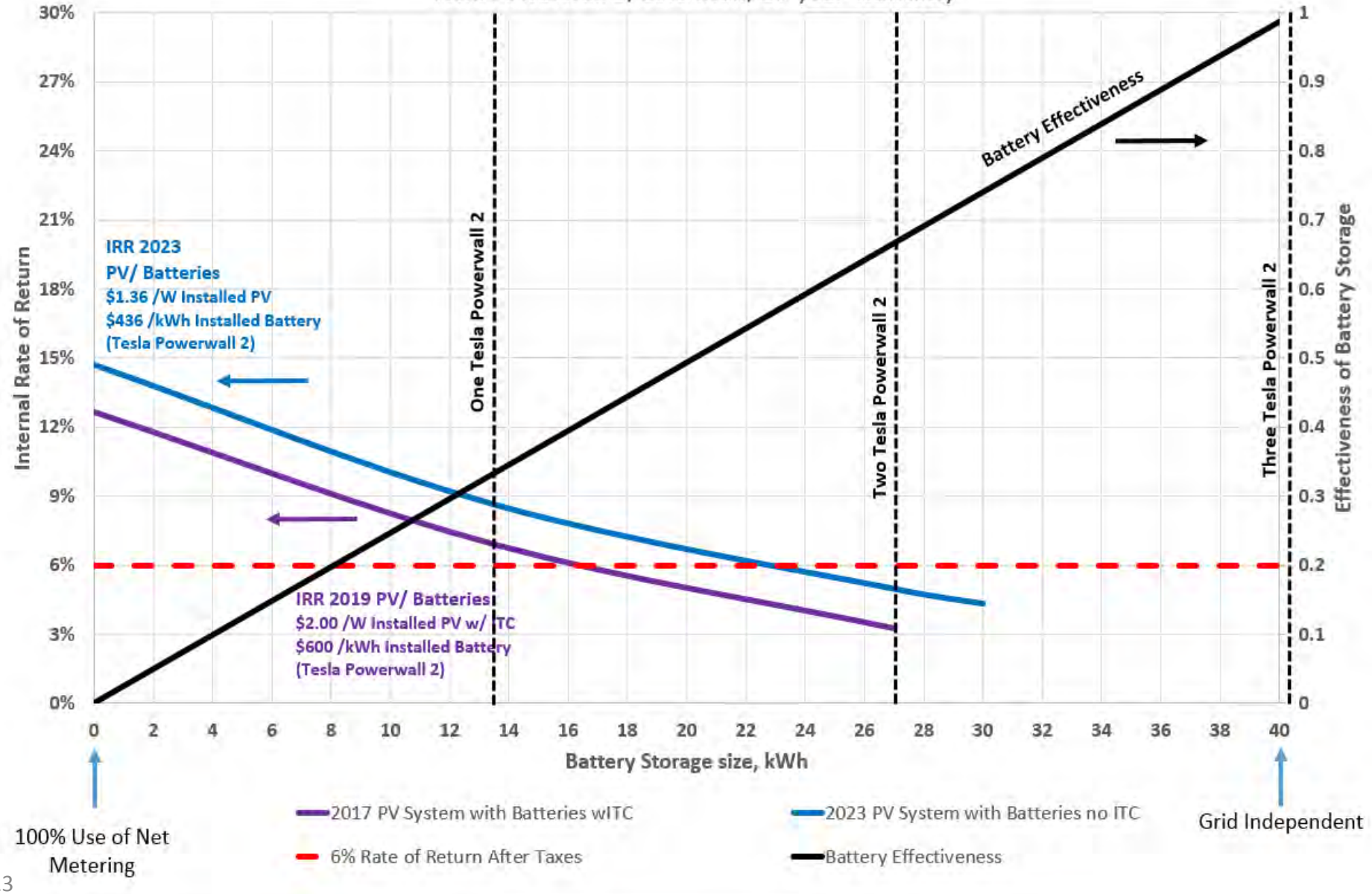
V2G – Where the Batteries Are

Global lithium-ion demand by market segment



Source: Bloomberg New Energy Finance. Note: Assumes 100% of stationary is lithium-ion.


Interal Rate of Return for Average Florida Net Zero Energy Residence
9.35 kW PV provides the 13,090 kWh/yr Consumption (36 kWh Daily Load)
Tesla Powerwall 2, 13.5 kWh, 10-year Warranty
Internal Rate of Return
30%
27%
24%
21%
18%
15%
12%
9%
6%
3%
0%
IRR 2023
PV/ Batteries
$1.36 /W Installed PV
$436 /kWh Installed Battery
(Tesla Powerwall 2)
IRR 2019 PV/ Batteries
$2.00 /W Installed PV w/ ITC
$600 /kWh Installed Battery
(Tesla Powerwall 2)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
Battery Storage size, kWh
100% Use of Net Metering
Grid Independent
2017 PV System with Batteries wITC
2023 PV System with Batteries no ITC
6% Rate of Return After Taxes
Battery Effectiveness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Effectiveness of Battery Storage
Battery Storage size, kWh
IRR 2023
PV/ Batteries
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$436 /kWh Installed Battery
(Tesla Powerwall 2)
IRR 2019 PV/ Batteries
$2.00 /W Installed PV w/ ITC
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One Tesla Powerwall 2
Two Tesla Powerwall 2
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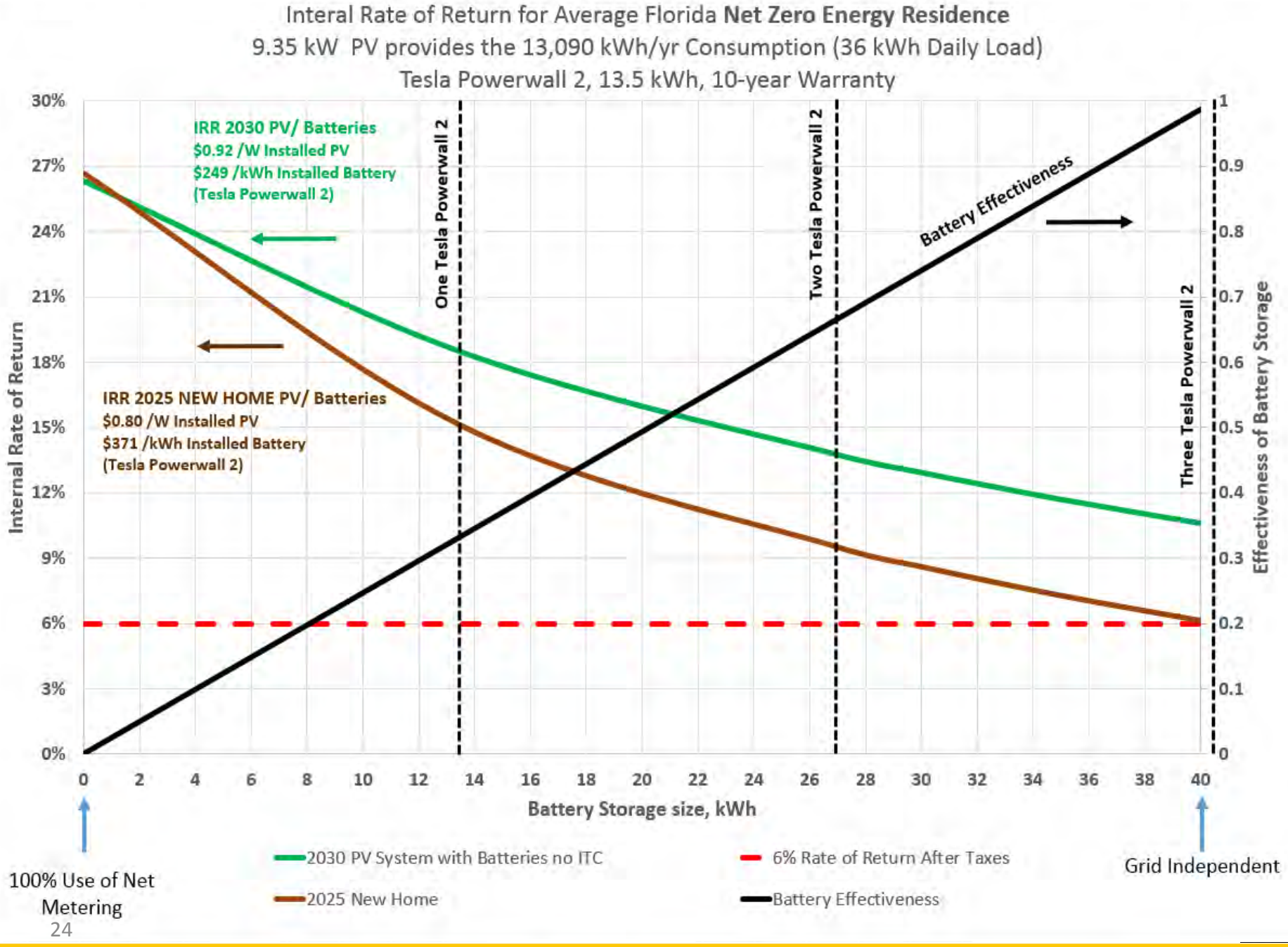
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Tesla Powerwall 2, 13.5 kWh, 10-year Warranty
IRR 2030 PV/ Batteries
$0.92 /W Installed PV
$249 /kWh Installed Battery
(Tesla Powerwall 2)
IRR 2025 NEW HOME PV/ Batteries
$0.80 /W Installed PV
$371 /kWh Installed Battery
(Tesla Powerwall 2)
One Tesla Powerwall 2
Two Tesla Powerwall 2
Three Tesla Powerwall 2
Battery Effectiveness
Internal Rate of Return
Effectiveness of Battery Storage
Battery Storage size, kWh
30%
27%
24%
21%
18%
15%
12%
9%
6%
3%
0%
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
100% Use of Net Metering
Grid Independent
2030 PV System with Batteries no ITC
6% Rate of Return After Taxes
2025 New Home
Battery Effectiveness

Florida Today

- New Net-Zero Energy Homes are more cost-effective than code homes
- Older homes can be retrofitted cost-effectively to net-zero-ready
- Rooftop PV today is less than half the cost out of the wall (***4.7¢ per kWh*** *versus 11.7¢ per kWh from the utility)* with a 12.7% internal rate of return.
- An EV in your garage uses this rooftop solar at the equivalent of $0.32 per gal.

Florida 2025 to 2030

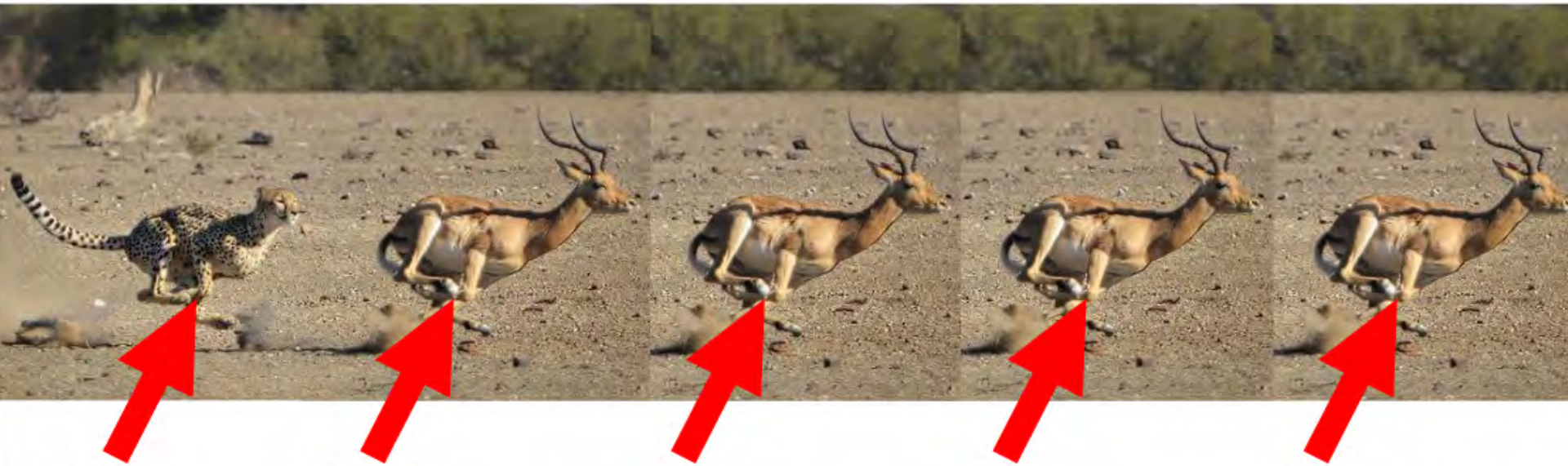
- By 2025 U.S. customer owned PV installations and energy storage both in MWs will be equal to those installed by Utilities (50% of total deployment). Florida will reach 50% customer owned by 2035 under BAU.
- In 2030 a Florida retrofit home with 9.25 kW PV and 40 kWh Li battery will have a 10.6% internal rate of return. ***A net-zero resilient home!***
- The unsubsidized EV sticker price crossover with Internal Combustion Engine (ICE) vehicles expected shortly after 2025.
- By 2030 EVs will have 24 times the GWh of storage as stationary storage

Florida 2025 to 2030

- Employees will charge their EVs using peak solar at work and then drive home, plug-in and use the EV battery to handle the evening residential demand.
- Utilities will be more concerned about managing electricity then making electricity as every "electron" will need to have a "bit" with it.

In partnership, owners of PV, EVs and storage WIN!
Jobs and Wealth Stay in Florida

"The gazelle does not have to outrun the cheetah It has to outrun the slowest gazelle"



Utility Solar, Bldg. EE inside, Rooftop Solar, Storage (EV and wall)

Coal

Oil Sands

Oil

Natural Gas

Adapted from Bloomberg New Energy Finance presentation in London of October 2015

Questions?