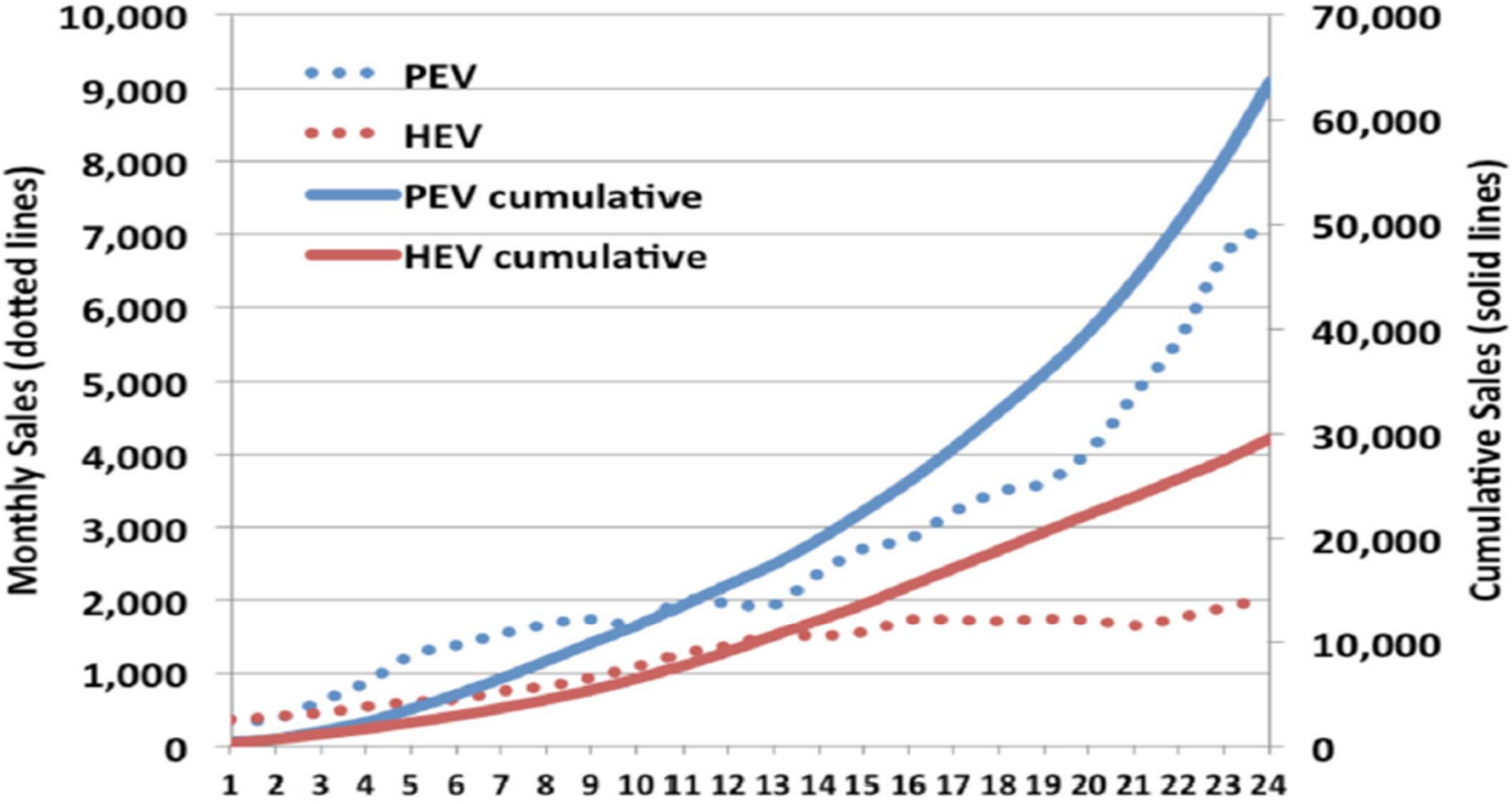
Popular PEV models are outselling more than half of all vehicle models in the U.S. PEV sales are climbing more rapidly than sales of hybrid-electric vehicles when HEVs were first introduced roughly a decade ago

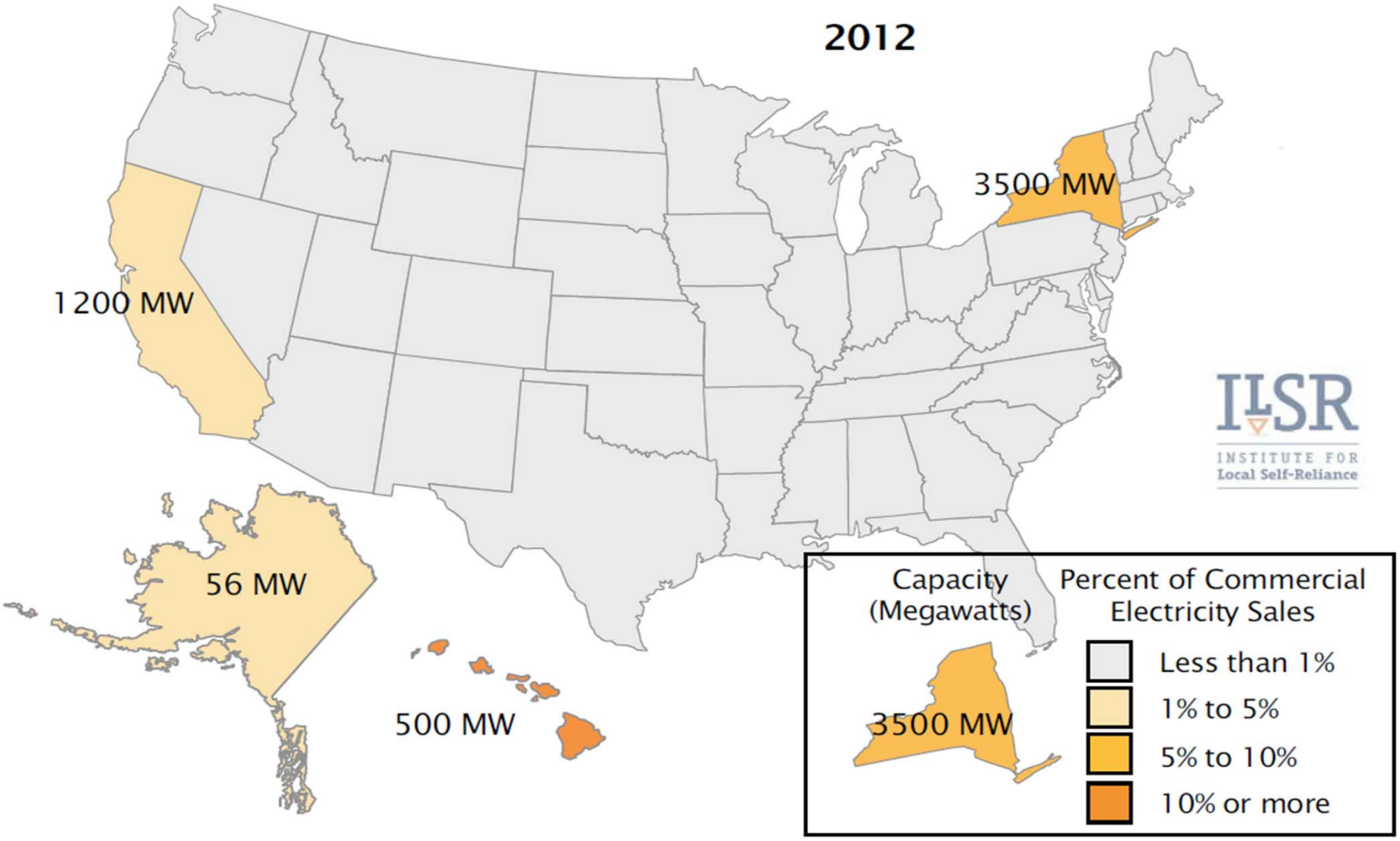


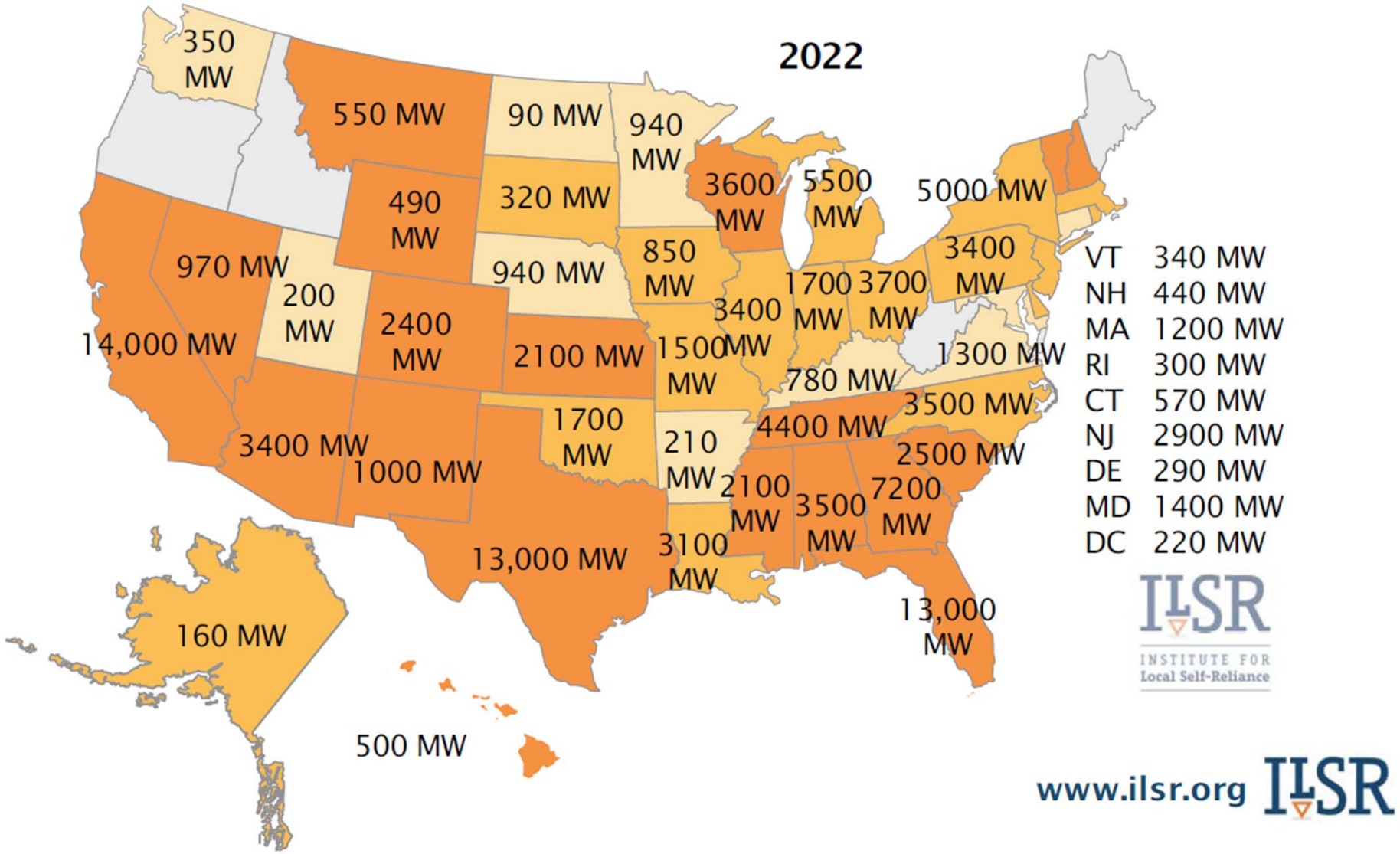
PEV sales 12/2010 through 11/2012, HEV sales 12/1999 through 11/2001

SunSmart Electric Vehicle Program video at http://vimeo.com/59667117

A Decade Spreads Solar Parity Far and Wide

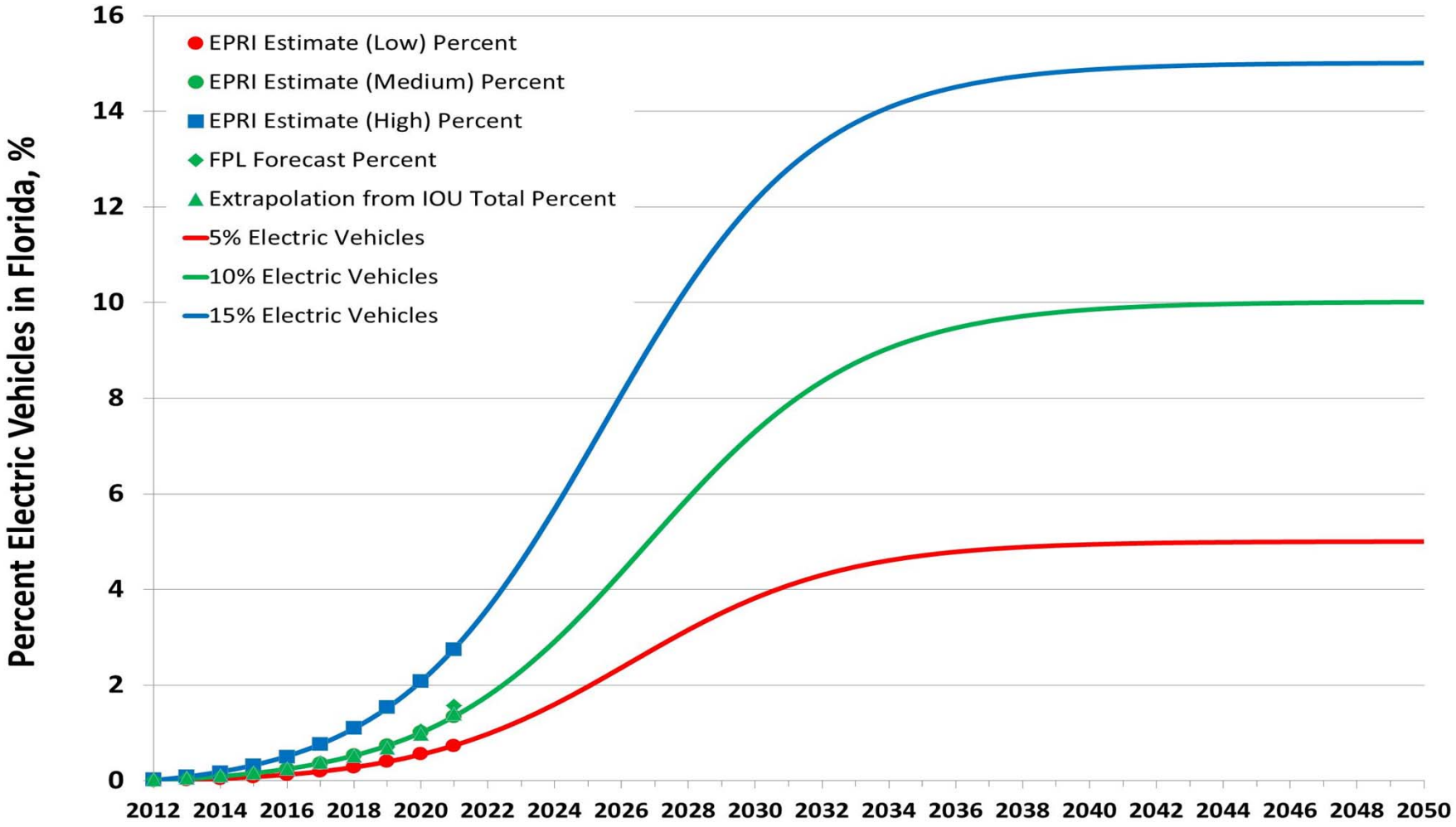
Energy Potential from Unsubsidized $4/W Commercial Solar (Capacity and % of Sales)





By 2021, close to 10% of Florida's electricity will come from rooftop solar power

Electric Vehicle Projections for Florida



300,000 (1.3%) Plug-In Electric Vehicles on Florida's roads in 2021

Electric Vehicle Transportation Center

Electric Vehicle Transportation Center

U. S. Department of Transportation

UCF's FSEC will apply for: Tier 1 UTC

(UCF has Tier 1 Center under Georgia Tech)

Amount: $1.5 M from DOT/year

$1.5 M cost share/year

Proposal Due Date: March 19, 2013

Electric Vehicle Transportation Center

Partner Institutions:

Dr. Willett Kempton	Dr. Sesha Srinivasan	Dr. Rick Rocheleau
University of Delaware	Tuskegee University	University of Hawaii
		Hawaii Natural Energy Inst.

- Optimize both a “Smart Grid” and a “Smart Transportation Network”
- Use existing Solar Schools Program in Florida adding on PEV Chargers
- PEVs can both use and supply power to the grid
- Study control of Two-Way Chargers and combined PV/Car battery inverters
- Real time two-way communication and data gathering
- Set the stage for EV transition through research, development, demonstration, education and public information

FSEC®

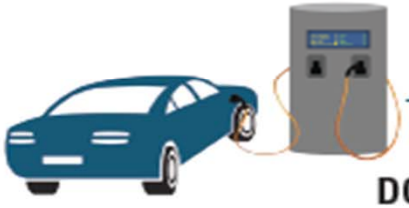
EVTC and the SunSmart Solar Electric Vehicle Program

A Collaboration with Florida Utilities, Automobile and Car Charger Manufactures, FSEC and Florida's K-12 students.

The EV Everywhere Challenge

- Benchmark: 5-passenger vehicle suitable for an average American family
- Majority of vehicle-miles-traveled powered by electricity under standard drive cycles
- 5-year simple payback vs. equivalent gasoline powered vehicle
- Any “vehicle range-charging infrastructure” scenario to be considered must credibly allow for the majority of American consumers to be willing to purchase the PEV as a primary vehicle
- No reduction in grid reliability

Charging Level	Setting	Supply Power	Representative Example	Where Charging Occurs
AC Level 1	Residential/ Parking Lot 5 mi/hour @ 1.7 kW	120vac/20A (16A continuous)		RESIDENTIAL  2/3 of charging
AC Level 2 (minimum)	Residential/ Commercial 10 mi/hour @ 3.4 kW	208/240vac/20A (16A continuous)		
AC Level 2 (maximum)	Commercial (up to) 60 mi/hour @ 19.2 kW	208/240vac/100A (80A continuous)		
DC Level 1	Commercial up to 500v @ 80Adc (up to) 120 mi/hour @ 40 kW	208vac/480vac 3-phase (input current proportional to output power; ~20A-200A AC)		COMMERCIAL  1/3 of charging
DC Level 2	Commercial up to 500v @ 200Adc (up to) 300 mi/hour @ 100 kW	208vac/480vac 3-phase (input current proportional to output power; ~20A-400A AC)		

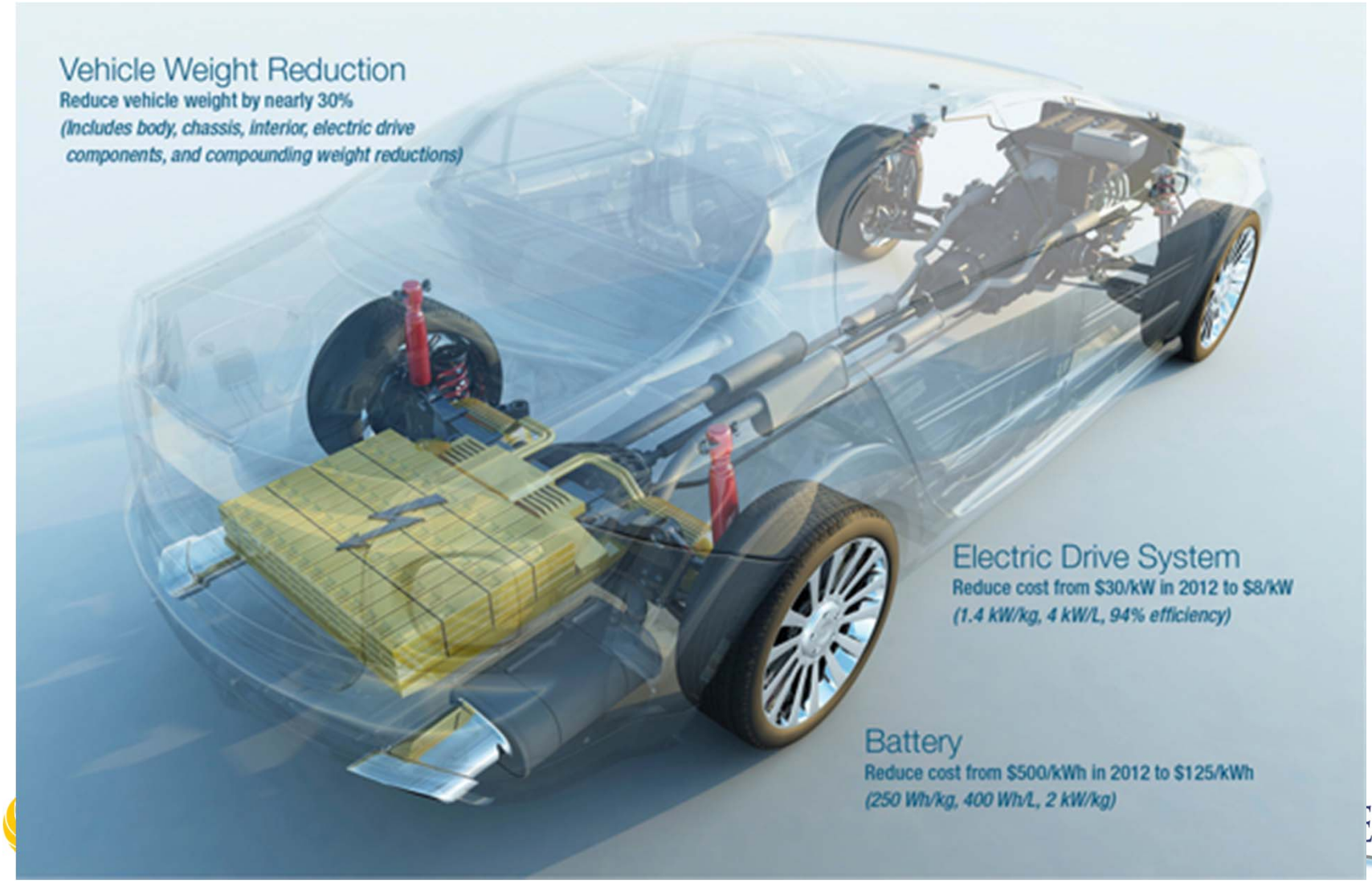


Charging levels and resulting charging times

FL Utilities Add EV Chargers

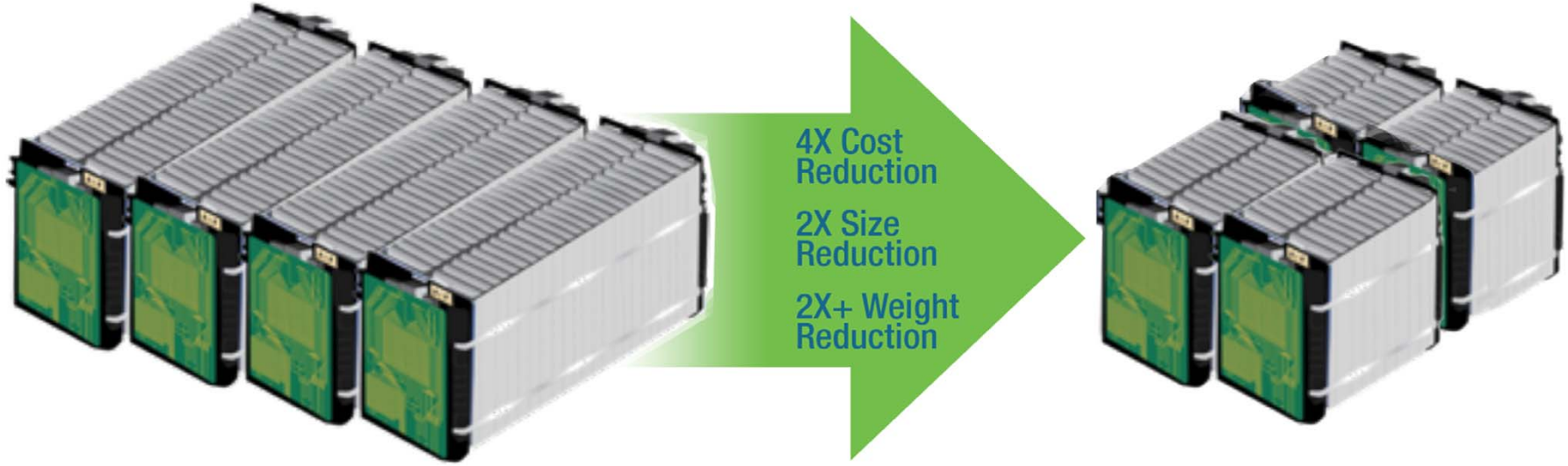
	PV Schools	Sunsmart	E-Shelter	Plus-UP	Totals
Choctawhatchee Electric Cooperative			1		1
City of Leesburg			3		
FP&L	6	6	29		41
Ft. Pierce Utilities Authority			1		1
GRU	3				3
Gulf Power	3		10		13
JEA	5		4		9
Keys Energy			1		1
Kissimmee Utility Authority			2		2
Lakeland Electric	1				1
Lee County Electric Cooperative			1		1
New Smyrna Beach	2				2
Ocala Electric Utility			1		1
Orlando Utilities Commission	1		1		2
Progress Energy	9	10	17	18	54
Sumter Electric Cooperative			1		1
Tallahassee Electric	1				1
Talquin Electric Cooperative, Inc.		2	5		7
TECO	1	2	2	2	7
Tri-County Electric			1		1
West Florida Electric			1		1
Winter Park Utilities (City of)		1			1
Withlacoochee River Electric Cooperative			3		3
TOTALS	32	21	84	20	154

EV Everywhere Grand Challenge: DOE's 10-Year Vision for Plug-in Electric Vehicles



Battery Challenge

Battery advancements needed to enable a large market penetration of PEVs



2012 Battery Technology

$500/kWh, 100 Wh/kg, 200 Wh/l, 400W/kg

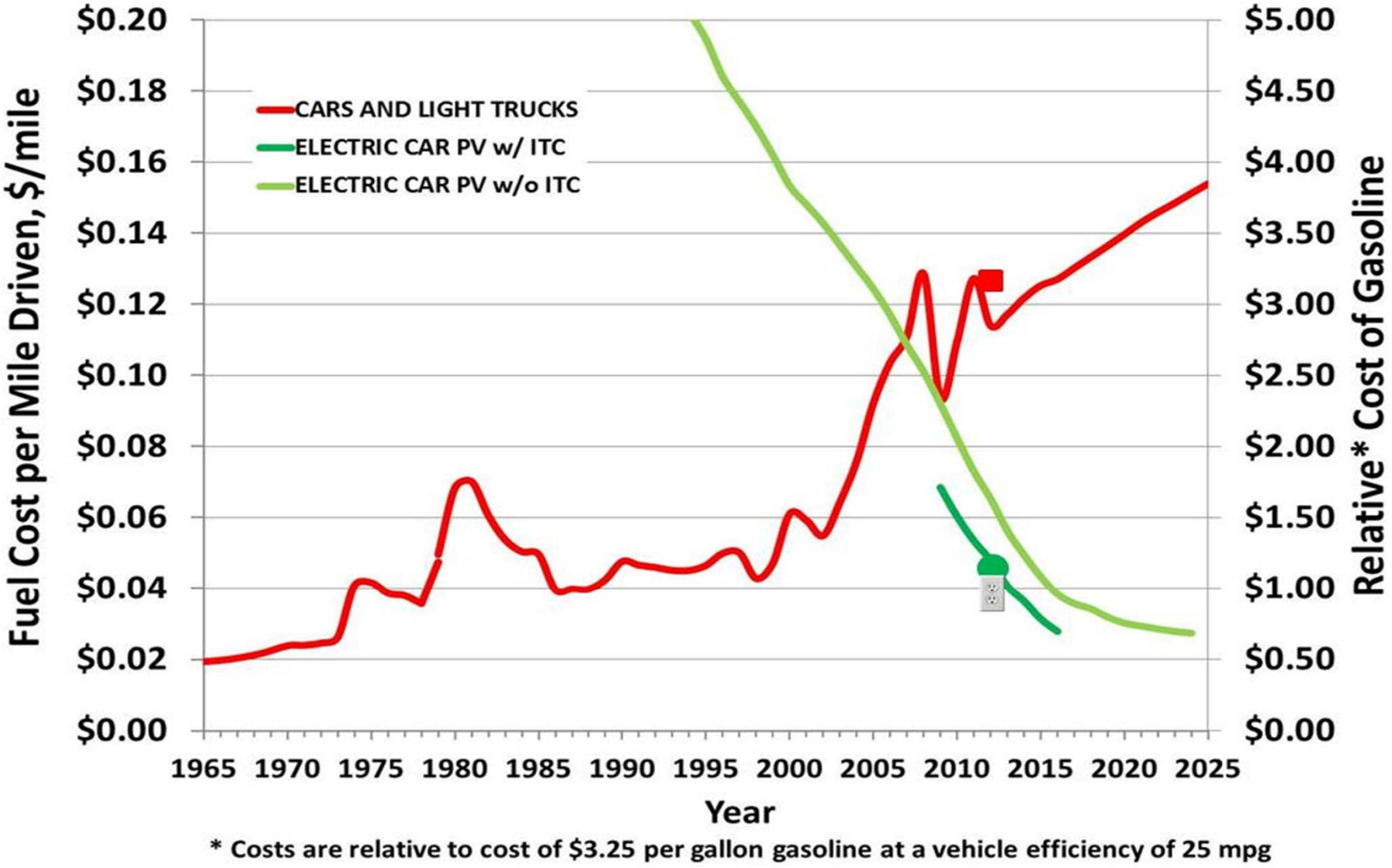
Lithium-ion batteries in today's electric drive vehicles use a combination of positive active materials based on nickel, manganese, or iron; matched with a carbon or graphite negative electrode.

2022 Battery Technology

$125/kWh, 250 Wh/kg, 400 Wh/l, 2000 W/kg

New battery technologies may meet the challenges of *EV Everywhere*. New concepts in lithium-ion technologies have the potential to double the performance and significantly reduce the cost. "Beyond lithium-ion" technologies (lithium metal, lithium-sulfur, and lithium-air) may also meet the challenge.

Will Florida Be Prepared for 60¢ a gallon??



* Costs are relative to cost of $3.25 per gallon gasoline at a vehicle efficiency of 25 mpg

Extra Slides

EV Everywhere Grand Challenge

"Big Hairy Audacious Goal":

Enable U.S. companies to produce plug-in electric vehicles that are as affordable and convenient as today's gas-powered vehicles by 2022

President Obama announced the EV Everywhere Challenge on March 7, 2012

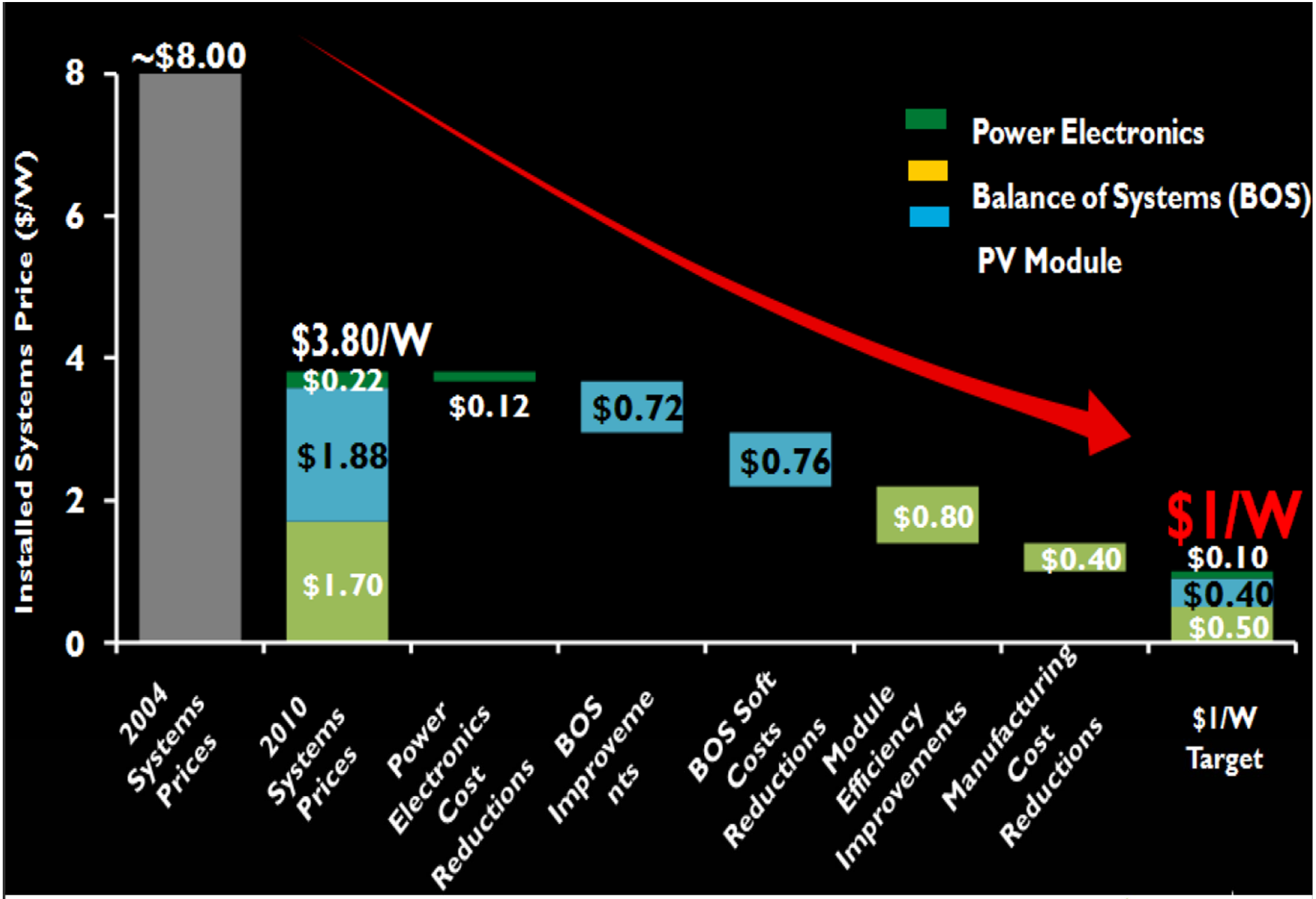
SunShot Grand Challenge

"Big Hairy Audacious Goal"

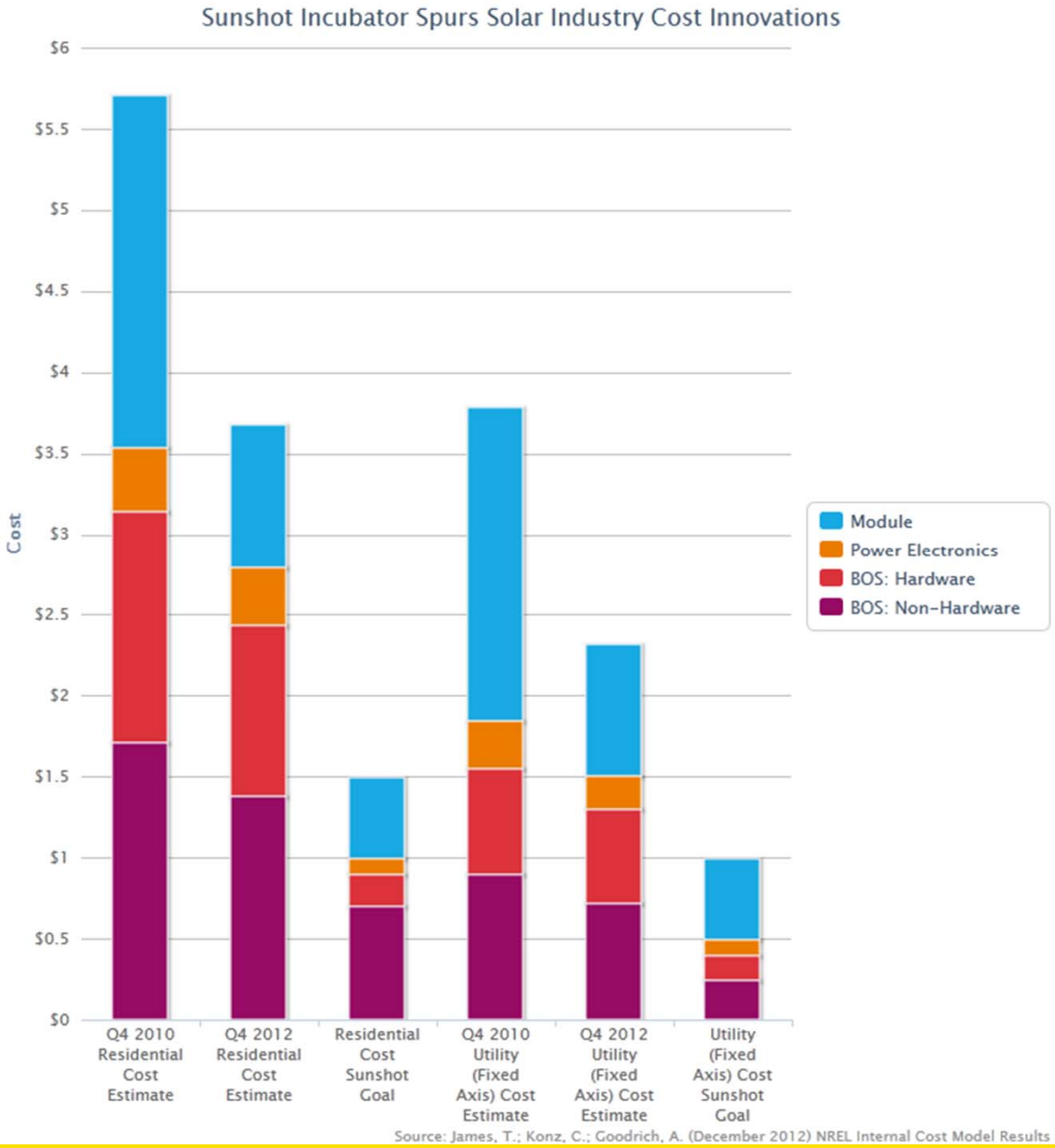
To achieve unsubsidized cost parity for solar power with traditional sources of electricity by 2020

Far Reaching Impacts of SunShot
- 2 years later -

- ✓ Set very aggressive goals for module and BOS costs that have spurred innovation at all companies.
- ✓ Recognized importance of reducing BOS and soft costs.
- ✓ Recognized the importance of understanding grid impacts at high penetration.


Installed Systems Price ($/W)
8
6
4
2
0
~$8.00
$3.80/W
$0.22
$1.88
$1.70
$0.12
$0.72
$0.76
$0.80
$0.40
$1/W
$0.10
$0.40
$0.50
Power Electronics
Balance of Systems (BOS)
PV Module
2004 Systems Prices
2010 Systems Prices
Power Electronics Cost Reductions
BOS Improvements
BOS Soft Costs Reductions
Module Efficiency Improvements
Manufacturing Cost Reductions
$1/W Target

January 16, 2013 - 12:43pm



Source: James, T.; Konz, C.; Goodrich, A. (December 2012) NREL Internal Cost Model Results

"Game Changers"
The New Electric Cars

- 80% of VMT is less than 40 miles per day
- 26% of Florida vehicles are small cars
- 4,000 kWh/yr for 12,000 miles
- **If all small cars electric**
  - 1.4 billion gallons of gasoline saved per year
  - $2.6 billion net cost savings per year if PV electric
  - 15 TWh (billion kWh) additional energy needs per year (4 MORE LARGE POWER PLANTS)!

Nissan Leaf (all electric)

Chevy Volt (plug-in hybrids)

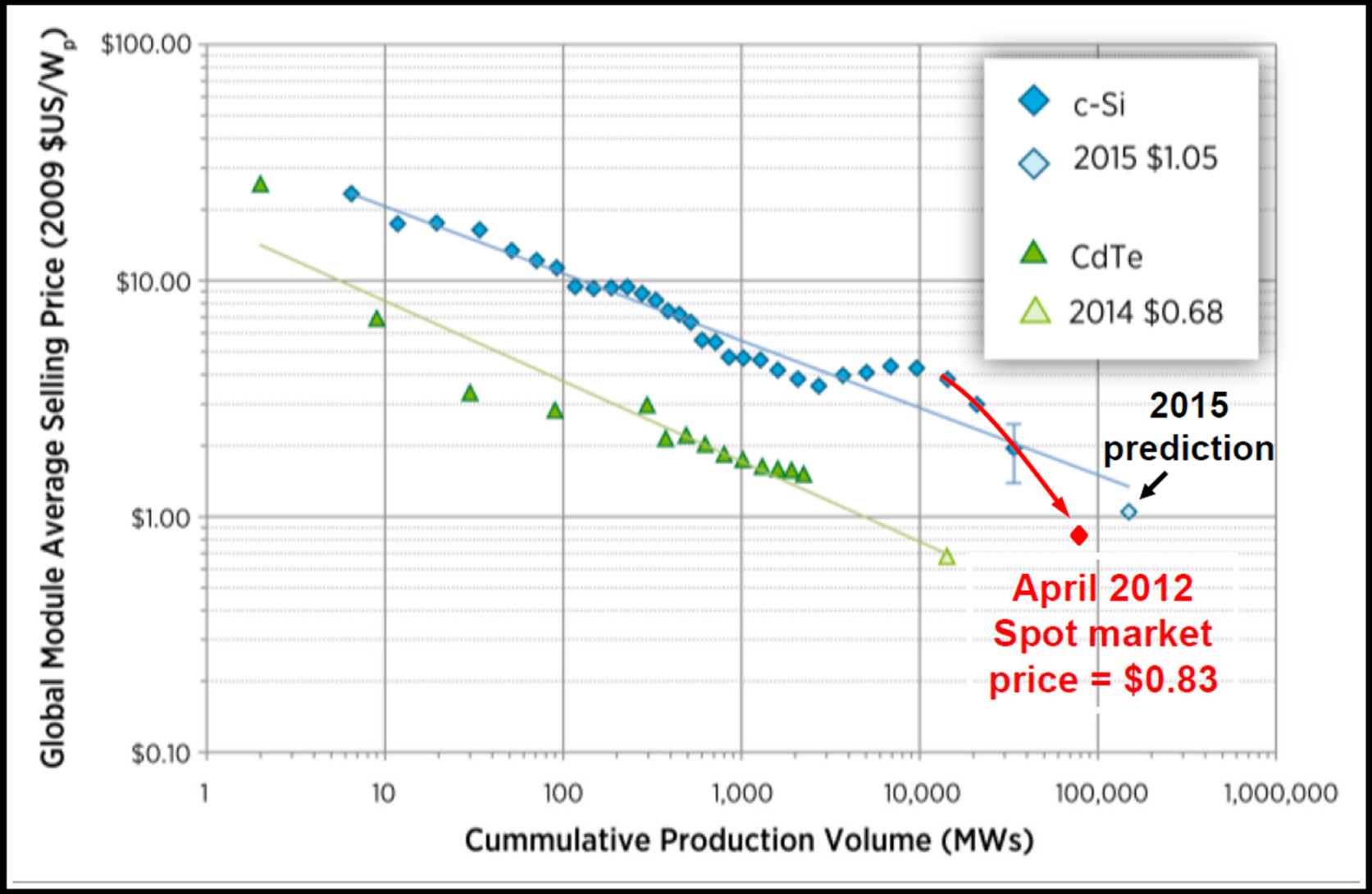
Total Cost of Electric Car ~ Cost of Gasoline Car at the end of 5 years

Residential Photovoltaic Power is Equivalent to $1.08 Per Gallon Gasoline

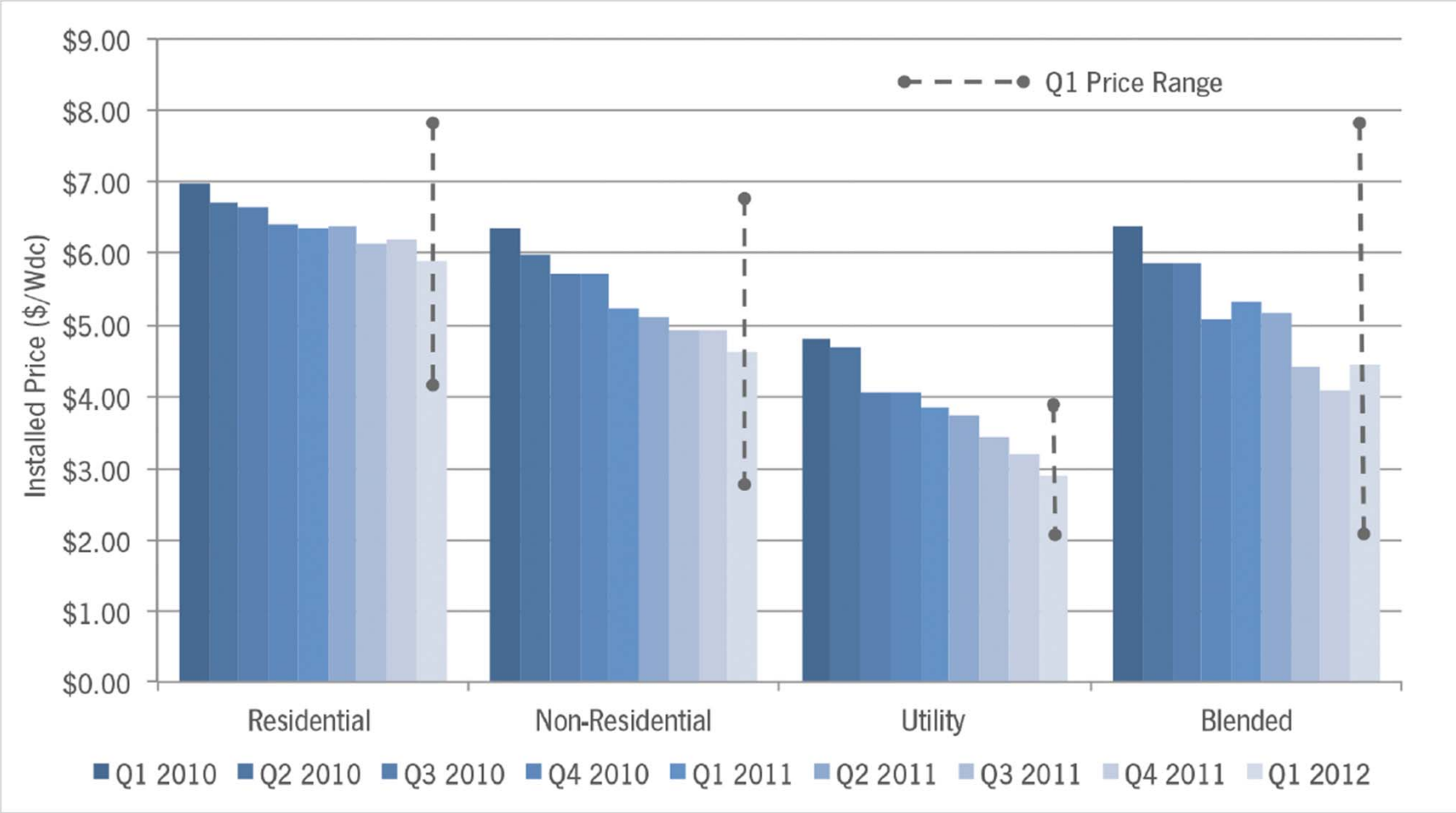
	Fuel Efficiency	Fuel Price	Cost per Mile	Cost per 12,000 Miles
	25 mpg	$3.25 per gal	13¢ per mile	$1,560
	3 miles per kWh	13 ¢/kWh ($1.08 per gal equiv.)	4.3¢ per mile	$520

Costs of PV modules are dropping below the power law experience curves

Sources: (CdTe) First Solar Earnings Presentation, SEC Filings;
(c-Si) Navigant, Bloomberg NEF, NREL internal cost models

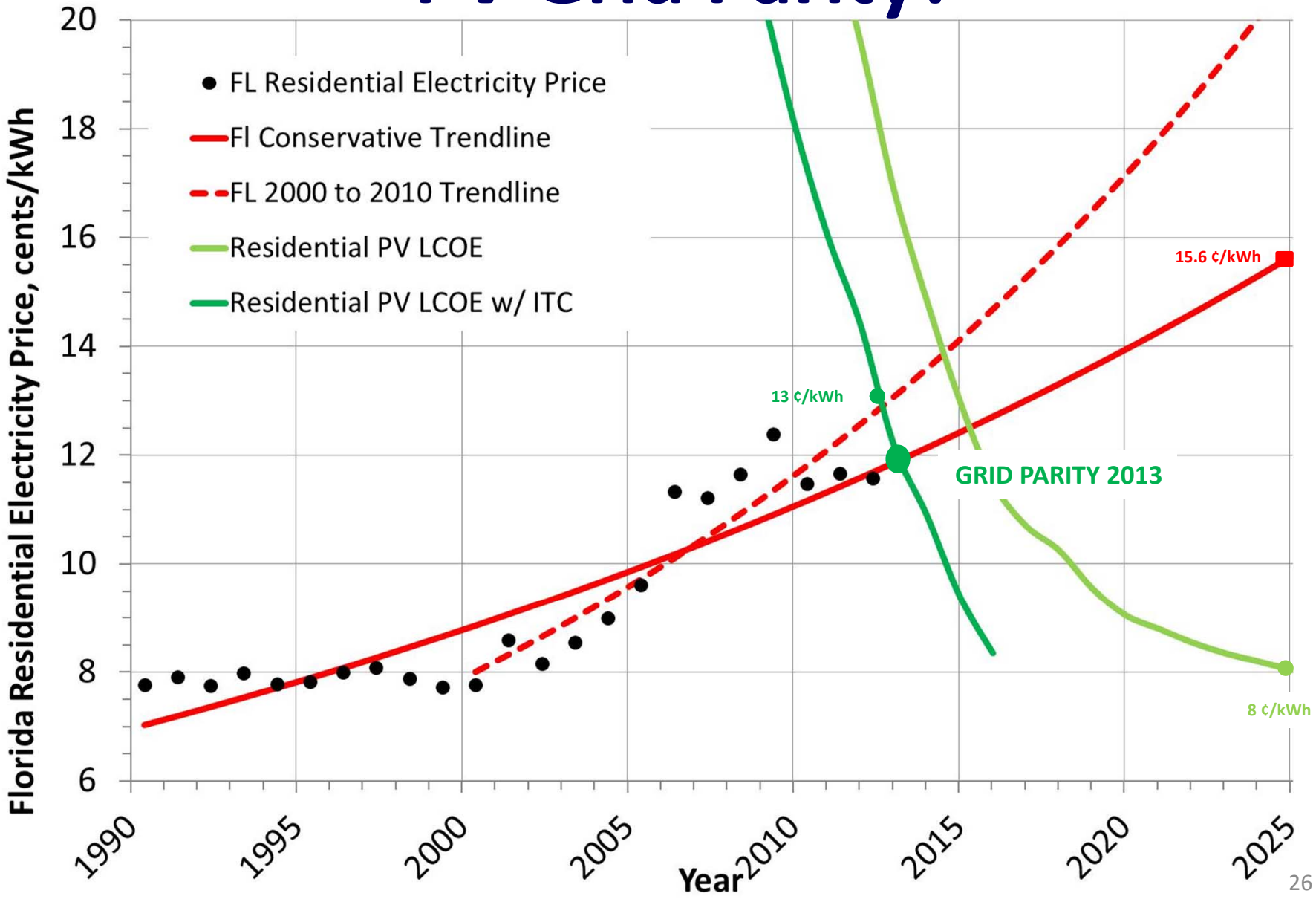


Installed Price of PV

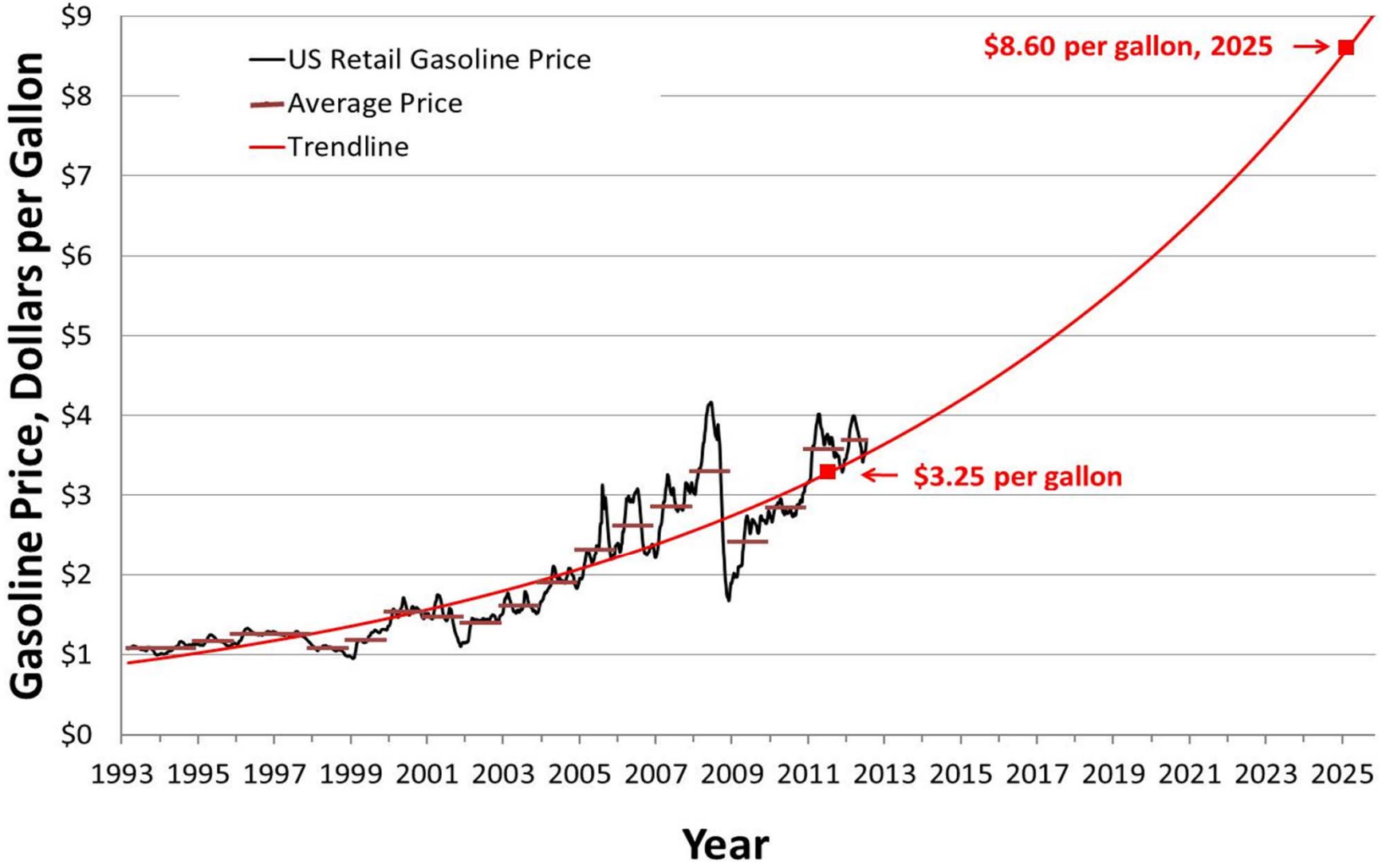


National Weighted Average System Prices, 2010 –Q1 2012

PV Grid Parity?

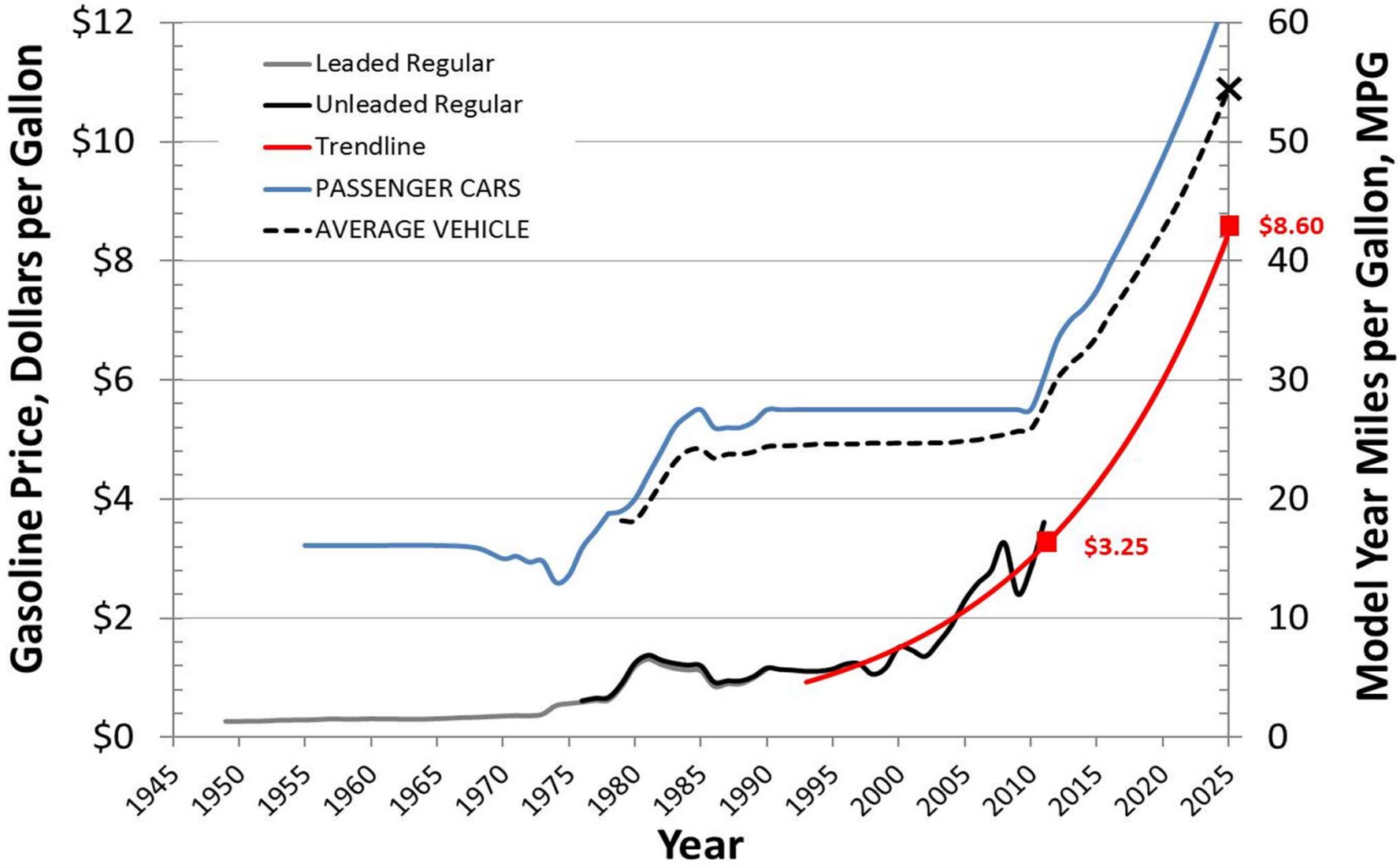


Future Price of Gasoline?

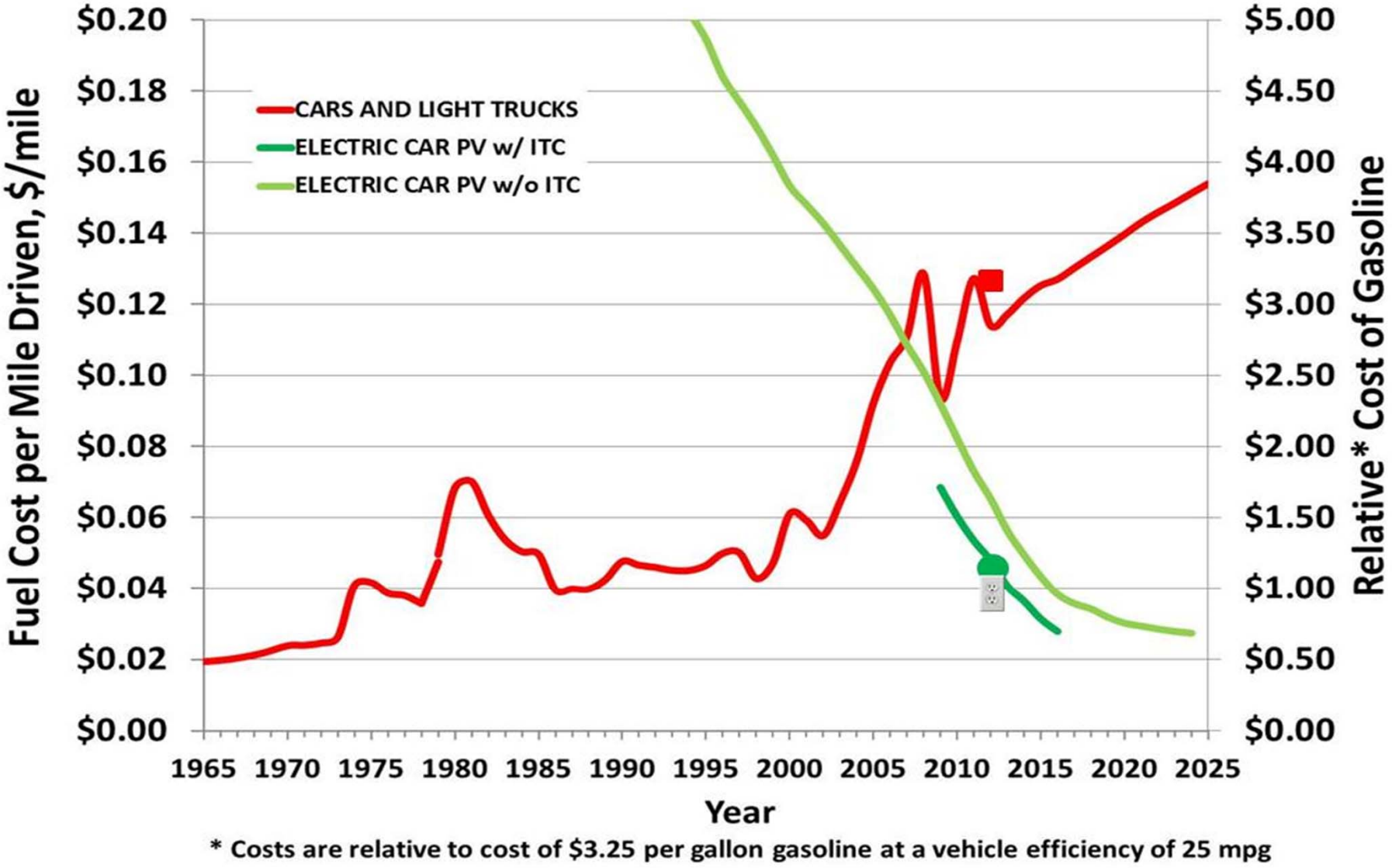


Price of Gasoline?

LIGHT-DUTY VEHICLE FUEL ECONOMY STANDARDS, 1955-2025



PV $1.08 a gallon today less than a $1 tomorrow



* Costs are relative to cost of $3.25 per gallon gasoline at a vehicle efficiency of 25 mpg

Residential Electricity is Equivalent to $0.99 Per Gallon Gasoline

	Fuel Efficiency	Fuel Price	Cost per Mile	Cost per 12,000 Miles
 Gasoline Car	25 mpg	$3.25 per gal	13¢ per mile	$1,560
Electric Car 	3 miles per kWh	12 ¢/kWh ($0.99 per gal equiv.)	4¢ per mile	$480 (~$466, Drive for Free)