IMO Presentation February 2010

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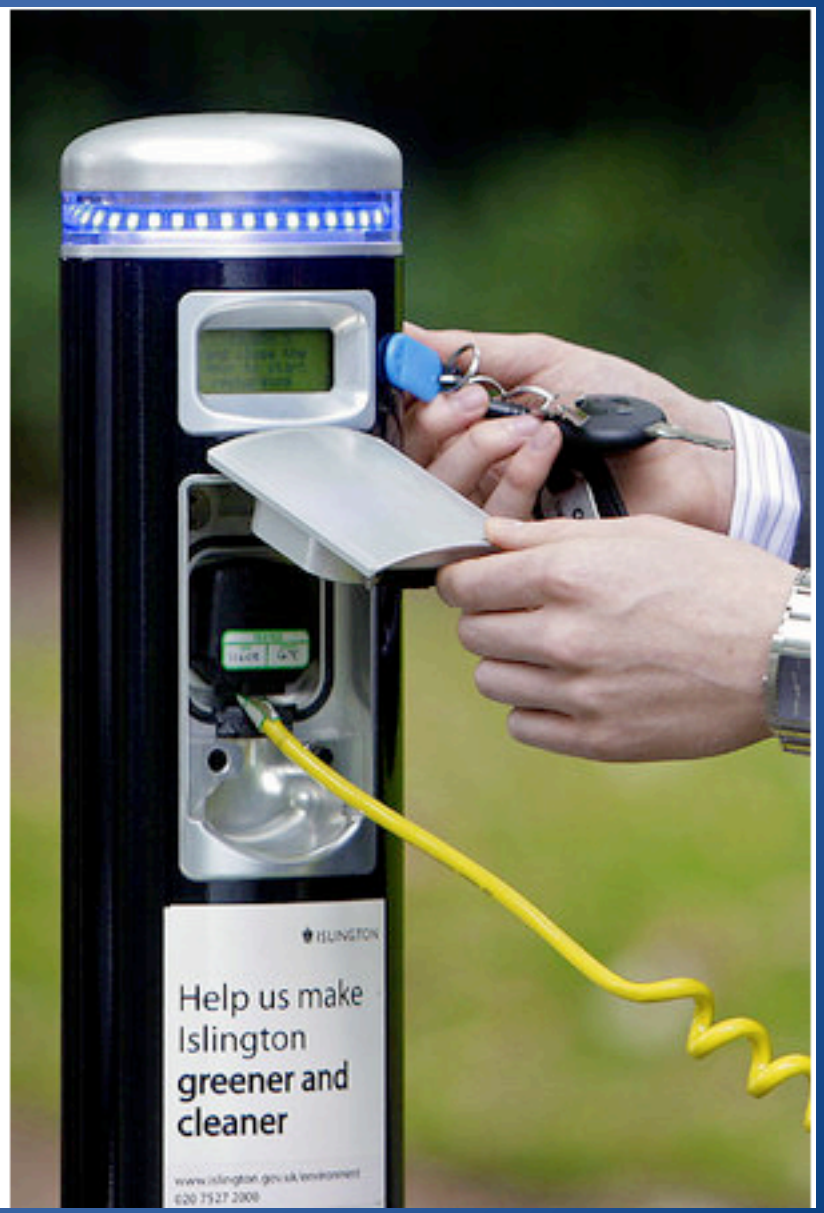
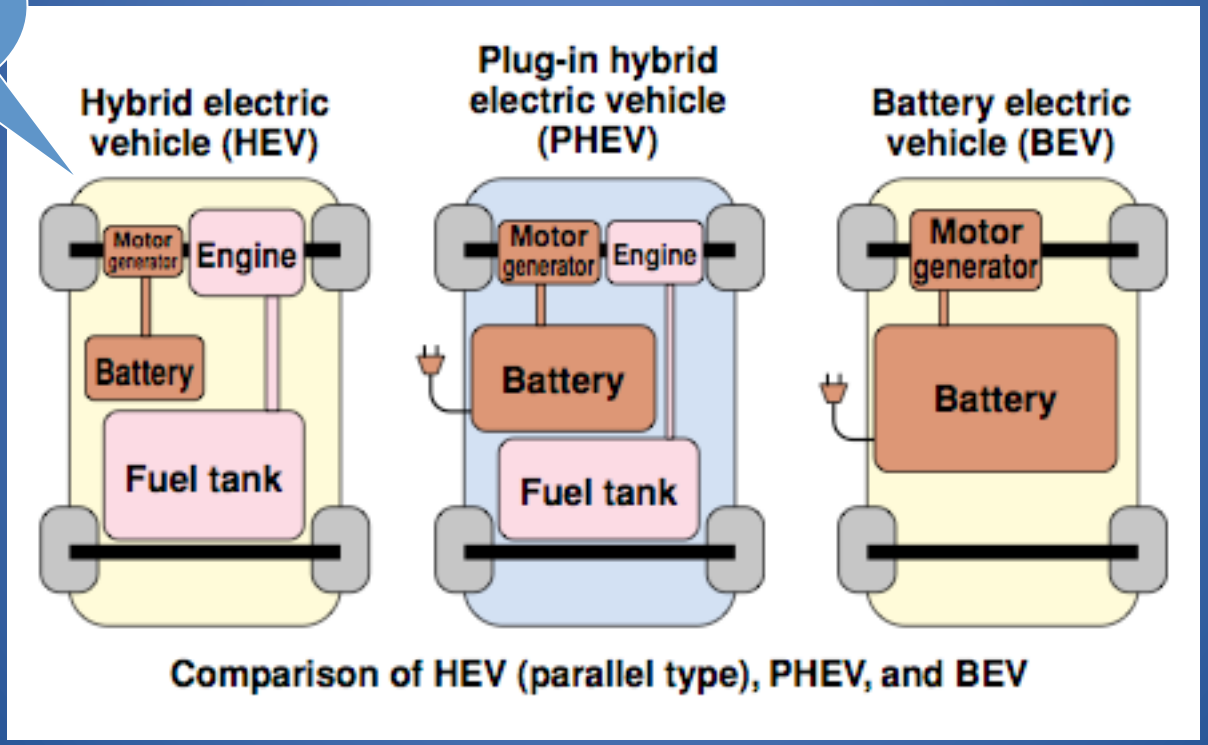
London Charging Station



Comparison of HEV, PHEV and EV

Prius

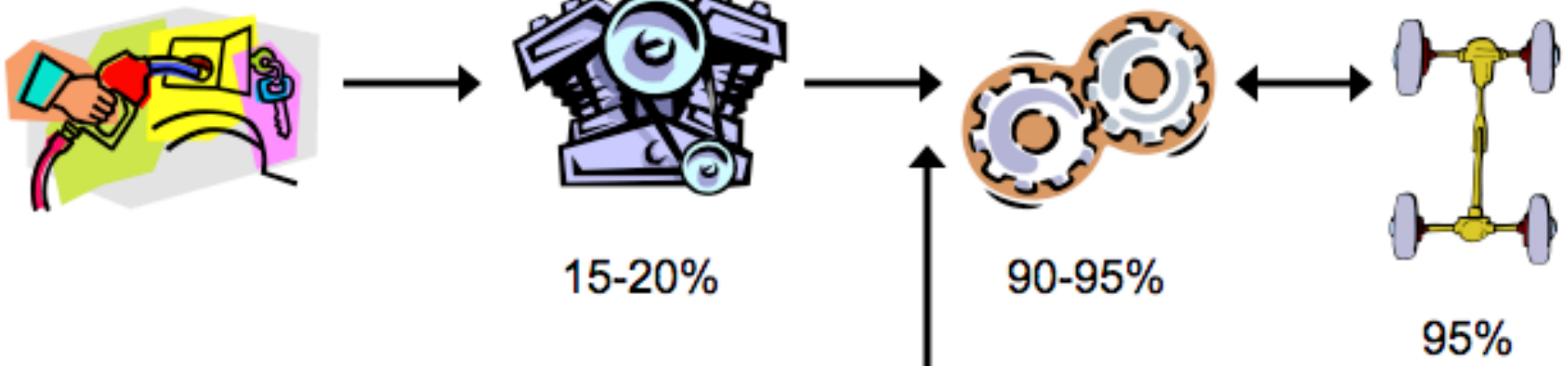


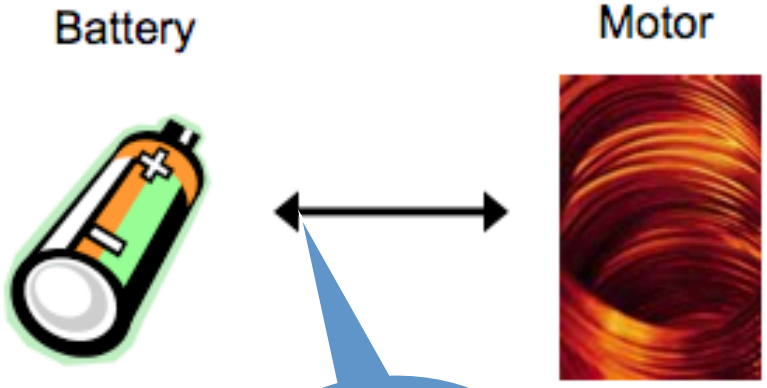
Comparison of HEV (parallel type), PHEV, and BEV

Criepi

Hybrid Vehicle Efficiency

Otto and Diesel cycle limited efficiencies could eventually be replaced by Fuel Cells
Electric path will remain the most efficient.





Regenerative braking

Gasoline: 13-18% Efficient

Electric: 62-77% Efficient

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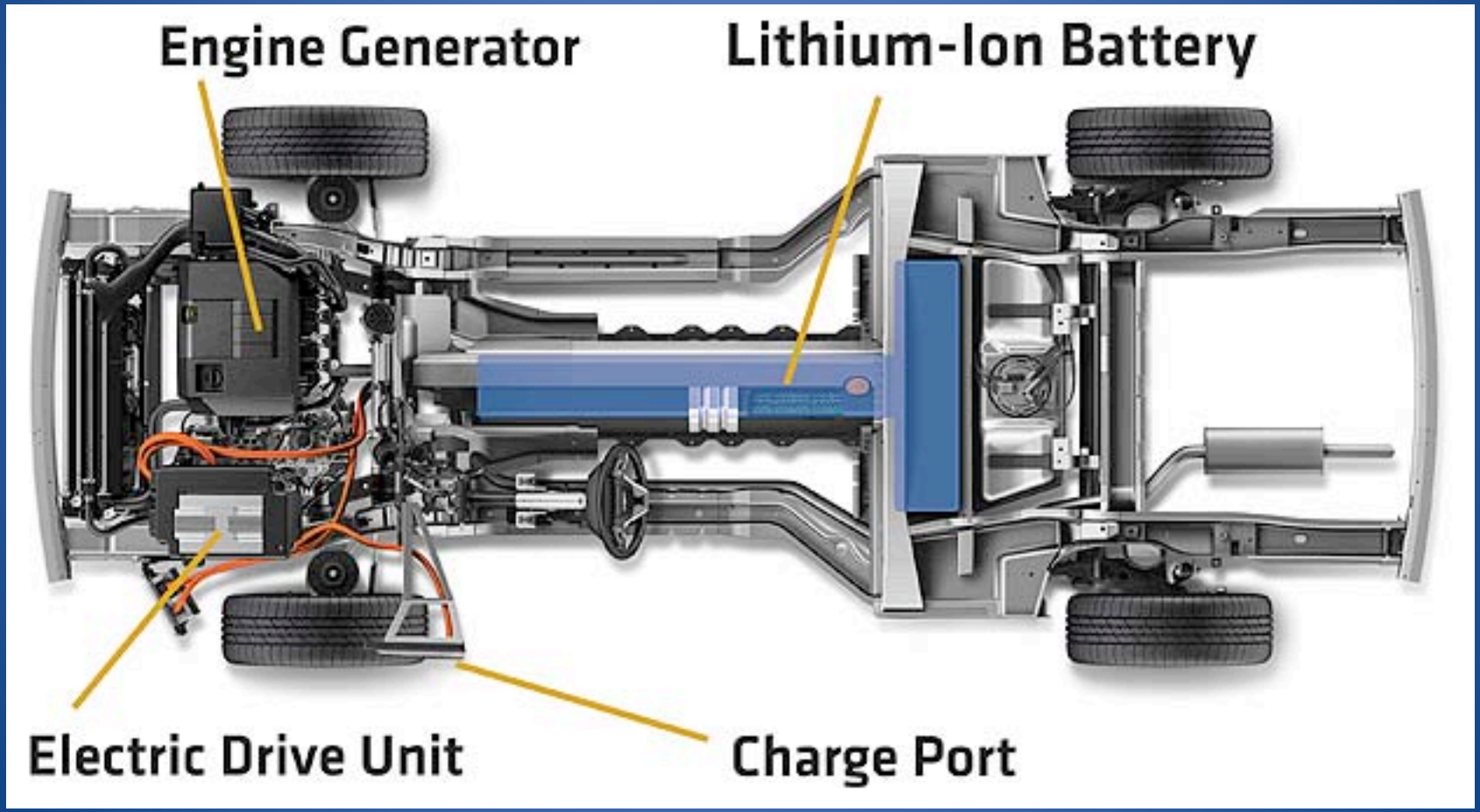
Inside the Volt



PHEV GM Volt

Electric Vehicles coming to Market


Chevy Volt


Toyota FT-EV


Mitsubishi iMiEV


Toyota Prius PHEV


Smart ed


Nissan Leaf


Ford Focus EV


Subaru Stella


Mini E


Mercedes Bluezero EV


Tesla Roadster


Think City


Coda Automotive


Detroit Electric


Renault Fluence EV


BYD E6


Chery S18


Vauxhall Trixx

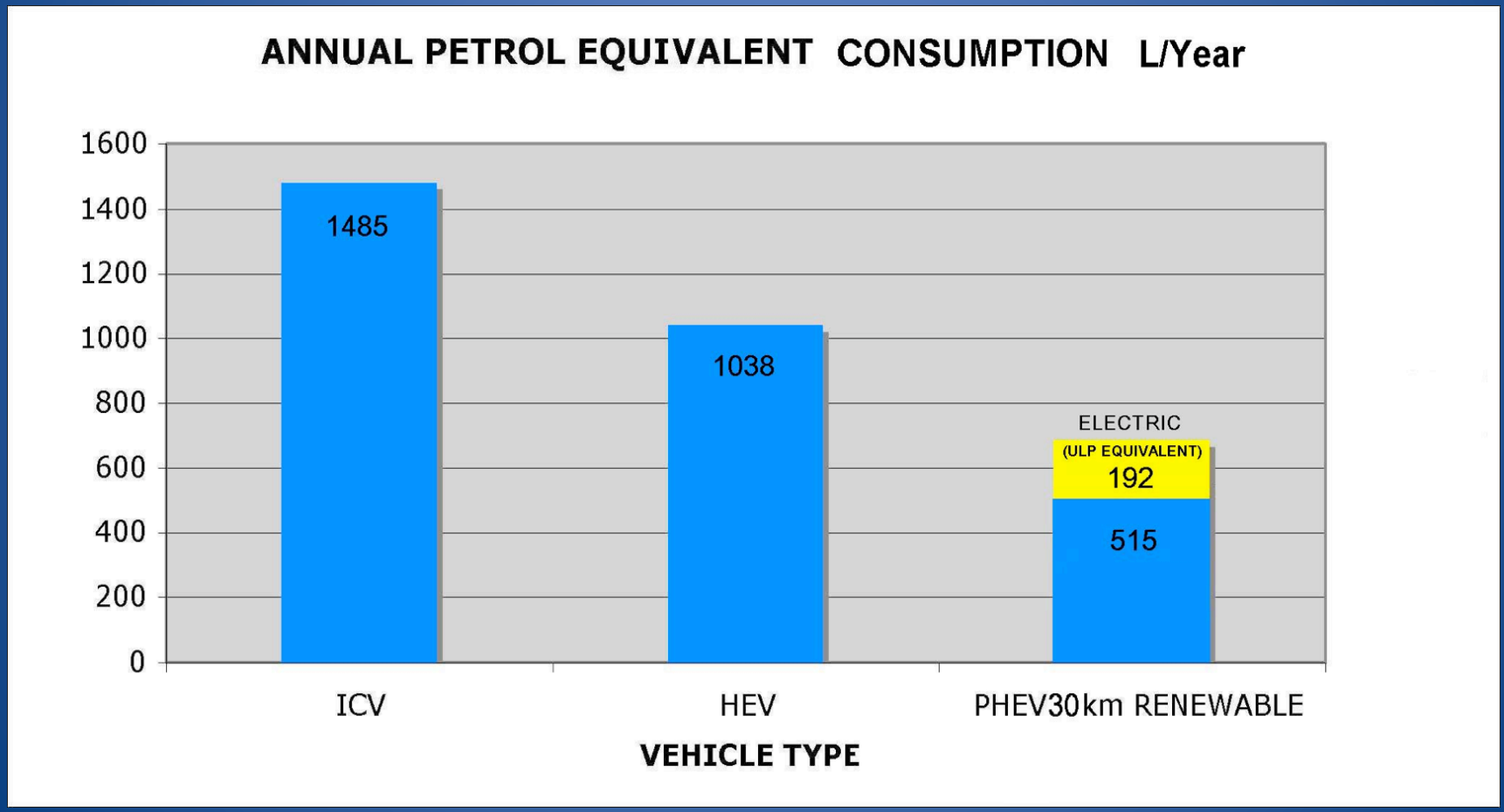

Dodge Circuit


Fisker Karma

Annual Petrol Equivalent Consumption L/year

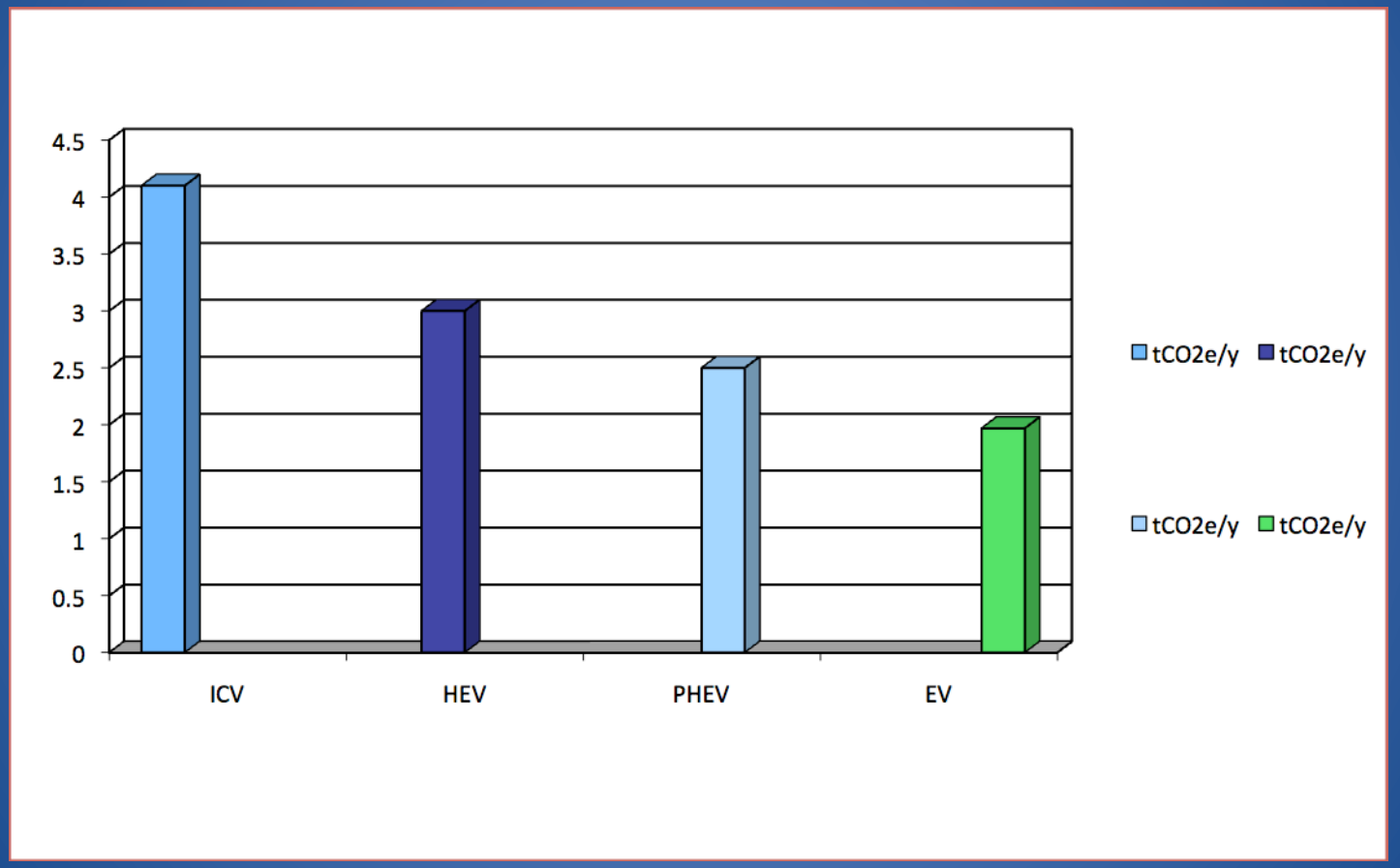
(Commodore or Camry equivalent)
Average distance traveled is 14,400 km/yr (ABS)
70% of population travel less than 30km to and from work (ABS)

PHEV saves 65% of fuel but adds electricity use



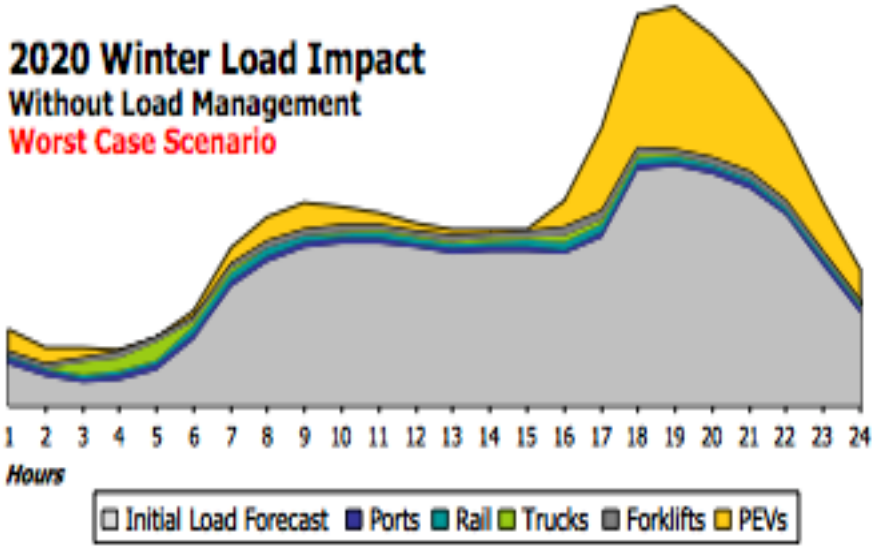
Utility Factor = 0.5 (fraction km the vehicle travels in the electric mode)

2020 Emissions in the Passenger Vehicle Sector (Australia)

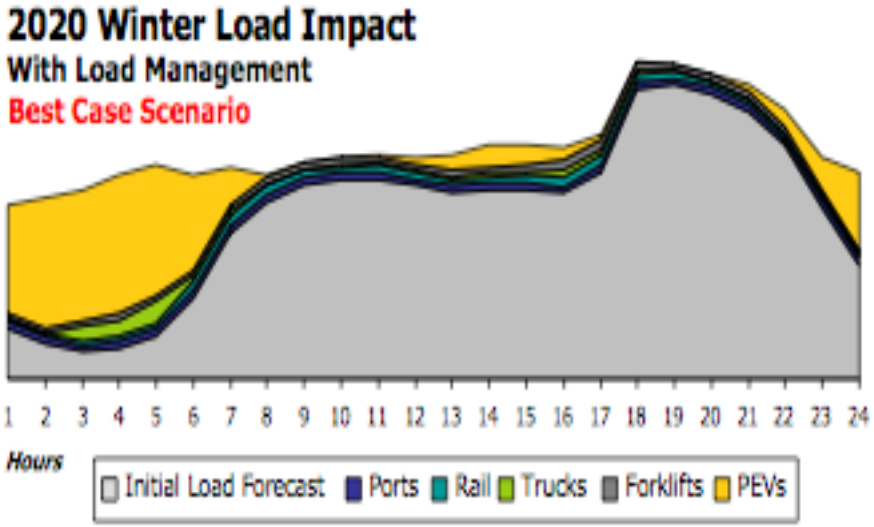


EV Charging Worst and Best Scenarios (California)

WORST



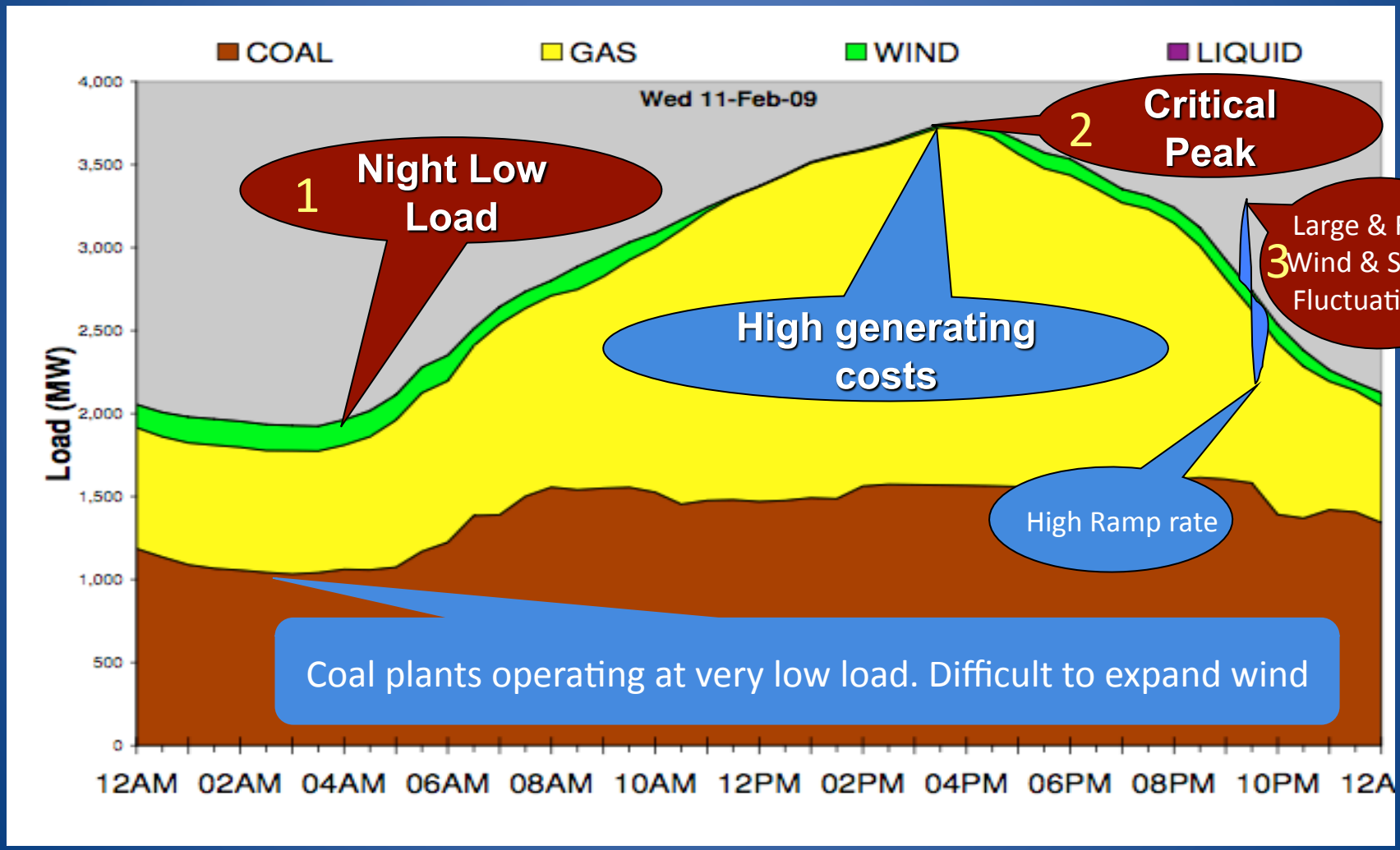
BEST



SCE

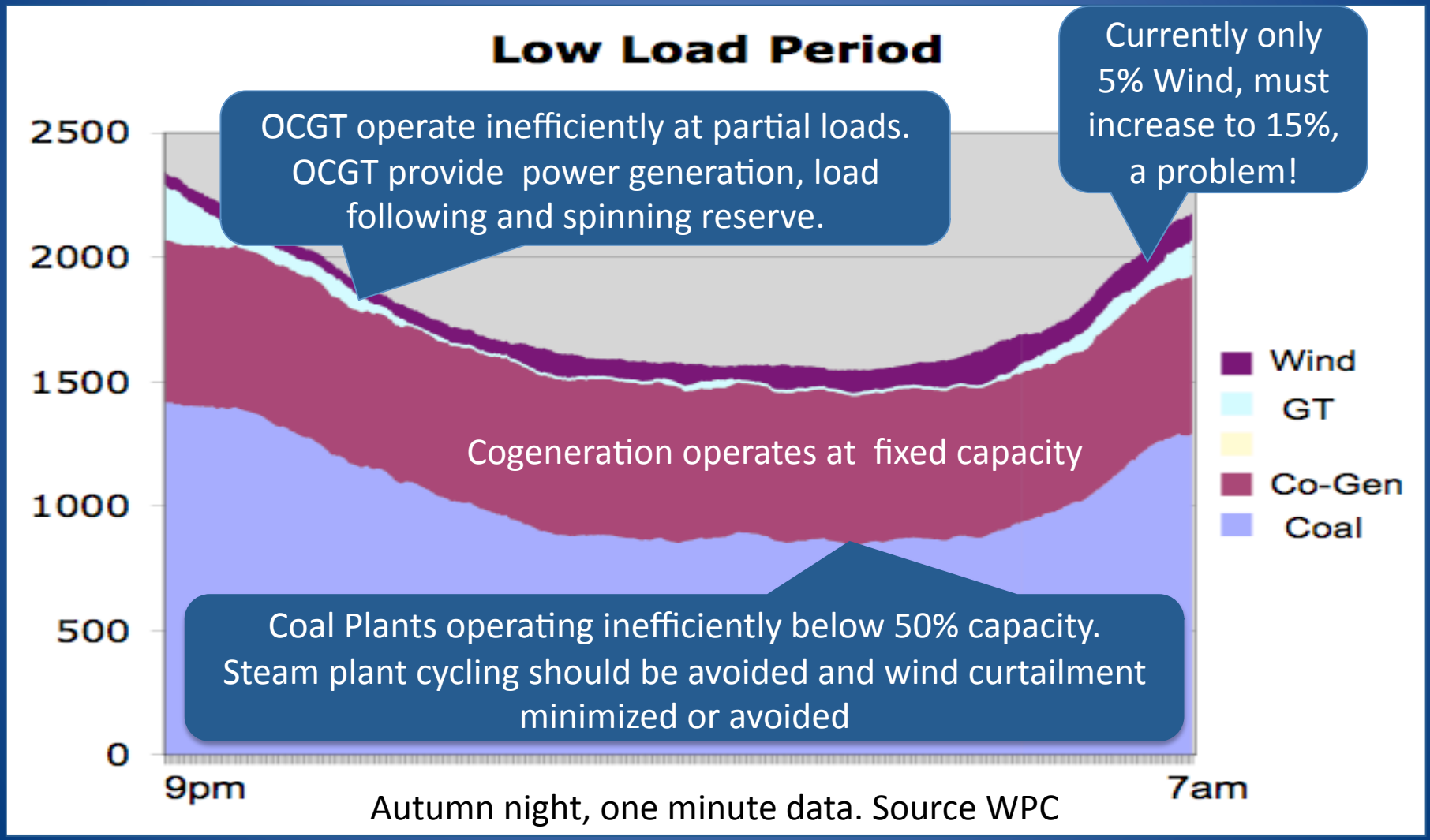
Generation Issues in the SWIS and the RET

Three areas of concern:



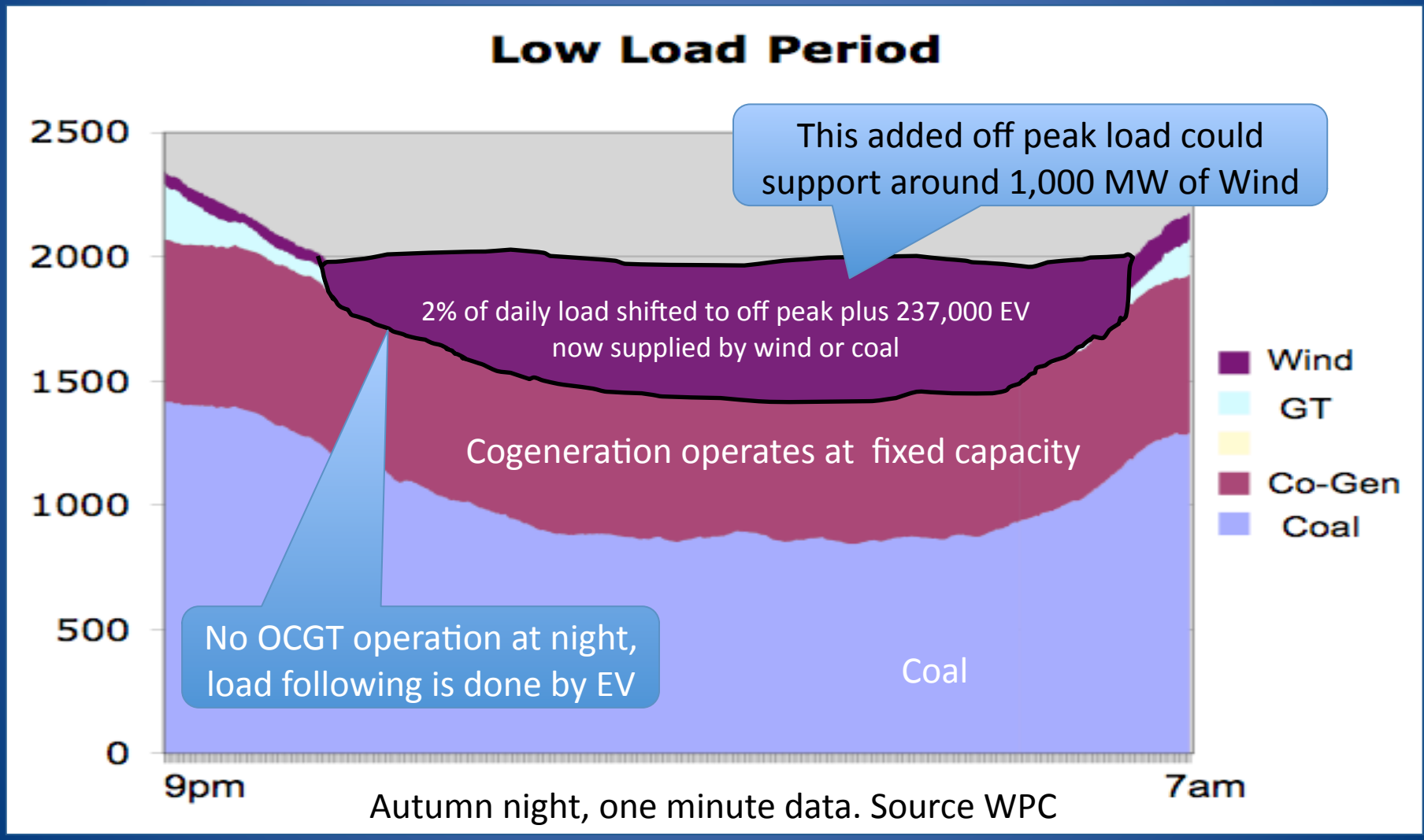
Summer Peak Load. Source: Western Power Corporation (WPC)

Low Load and Limited generation at Night, a problem for increasing Wind capacity



Autumn night, one minute data. Source WPC

Shifting 2% of daily Load by 2020 plus 237,000 EV allows for 1,000 MW of Wind



“Filling the Valleys” to increase Wind

- Electric vehicles charging at night
- Smart tariffs (smart meters) shift 2% load to night
- Responsive loads shift to night
- Ice air conditioning for commercial and large residential use (new) charging at night
- EV supplying Spinning Reserve and Load Following, replaces OCGT at night

The combination of decentralised PV systems with advanced controllers and storage solutions offer advantages for both utilities and users

EPIA
European Photovoltaic Industry Association

Smart grid components

Decentralysed PV systems

Advanced power controllers and smart meters

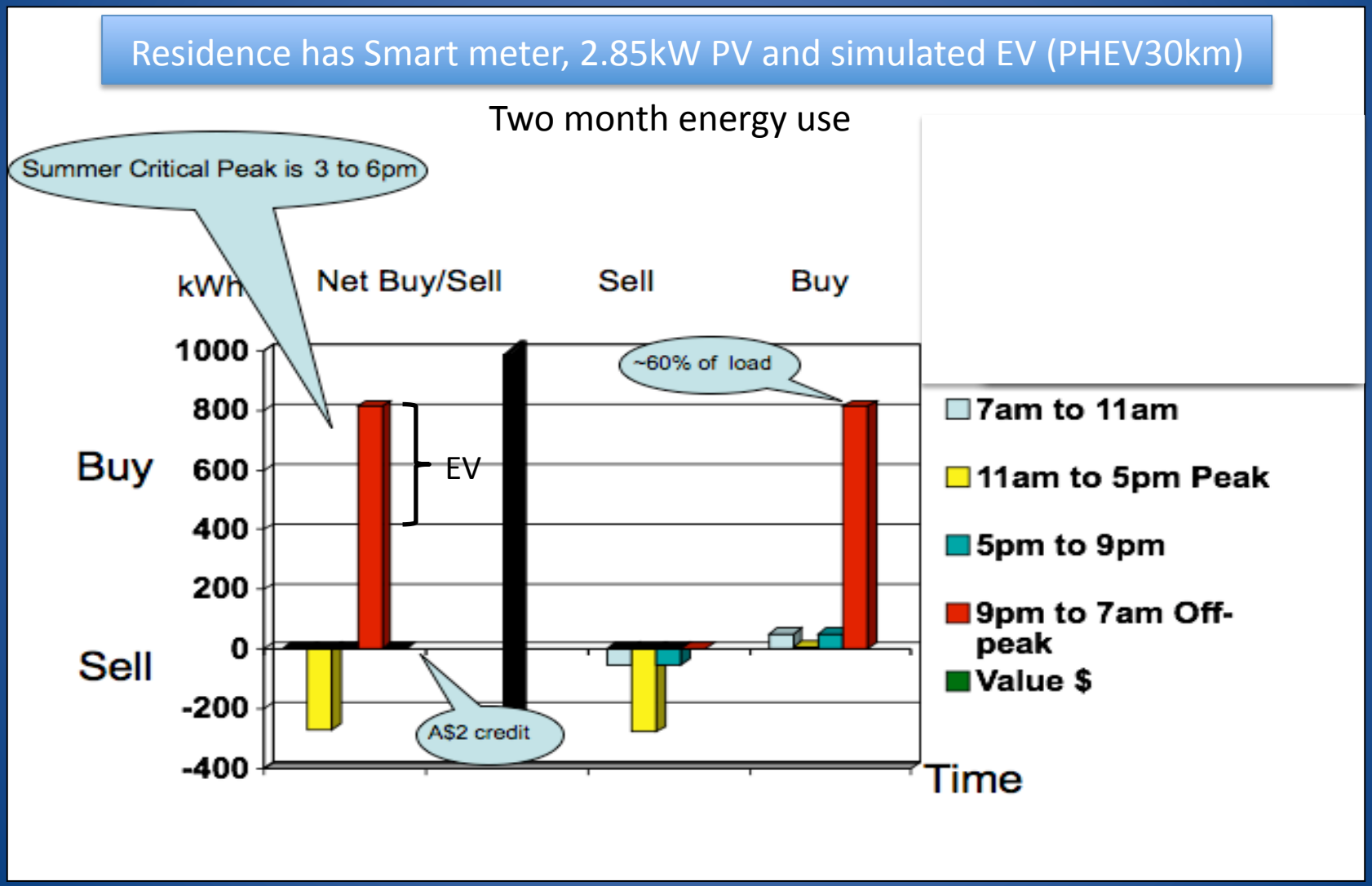
Storage solutions

Advantages

- Load management
  - Spectacular peak shaving capacity
  - Dramatic improvement of utilization factors of centralized production facilities
  - Enablement of effective Demand Side Management by interfacings power-hungry domestic appliances
- Reduction of grid infrastructure investments
  - Local consumption of the PV power produced
  - Reduction of the demand for centralized power
  - Real time decentralized reactive power control
- Outage prevention
  - Perfect fault ride trough capacity
  - Large-scale use of decentralized batteries to mitigate voltage dips at the distribution level
- Outage recovery
  - Seamless supply of back-up power in case of full grid power outages

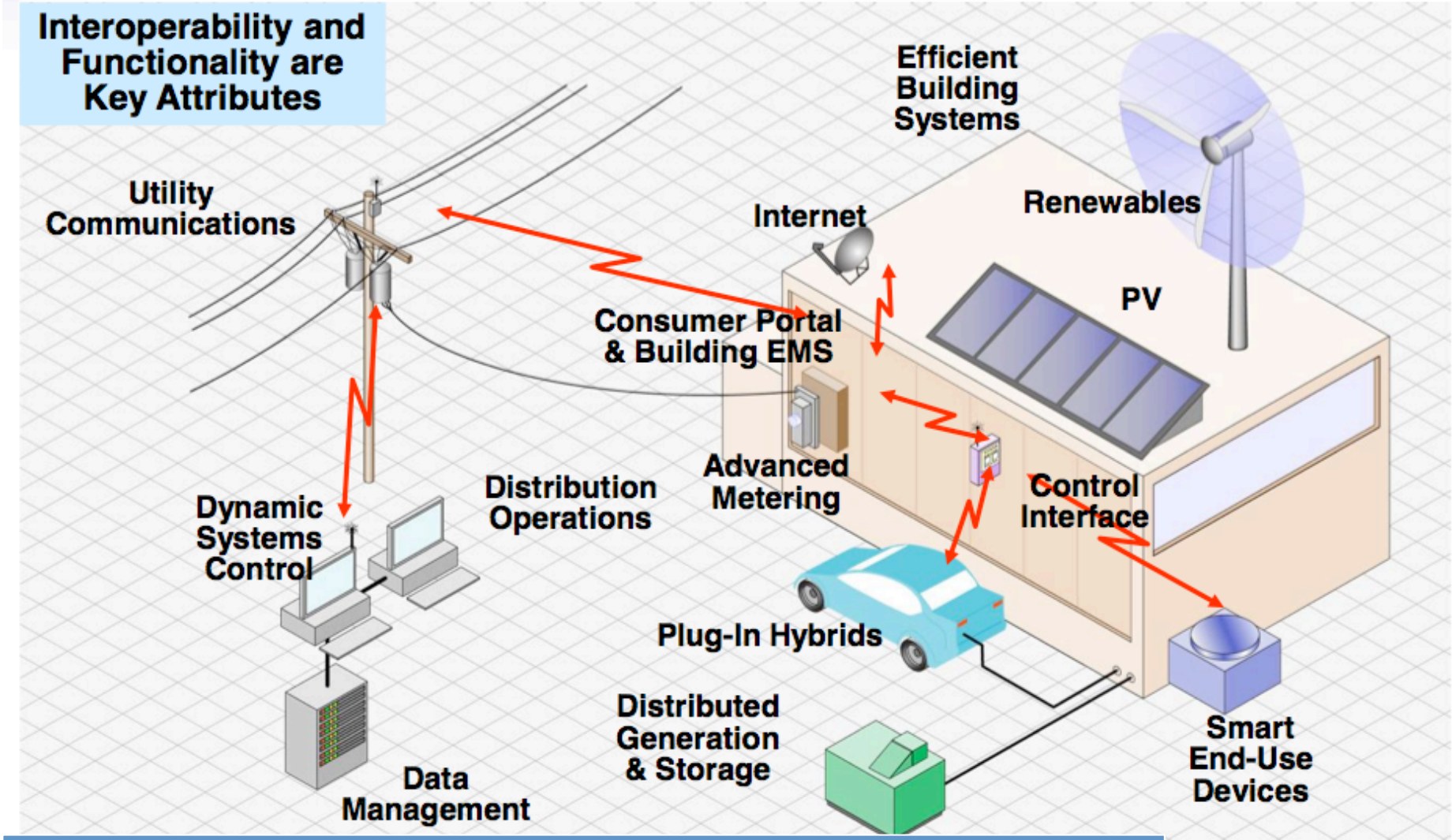
A Perth residential load shift to the night with TOU Tariff, PV and EV
3kWh/d shifted + 7 kWh/d (EV) added = 10kWH added to night load

Residence has Smart meter, 2.85kW PV and simulated EV (PHEV30km)



W. James residence 09

Future Intelligent Infrastructure Enabling PHEVs, Energy Efficiency, Consumer Choice



ENEL Utility, Italy has installed 30 million Smart Meters at a rate of 0.7million/month

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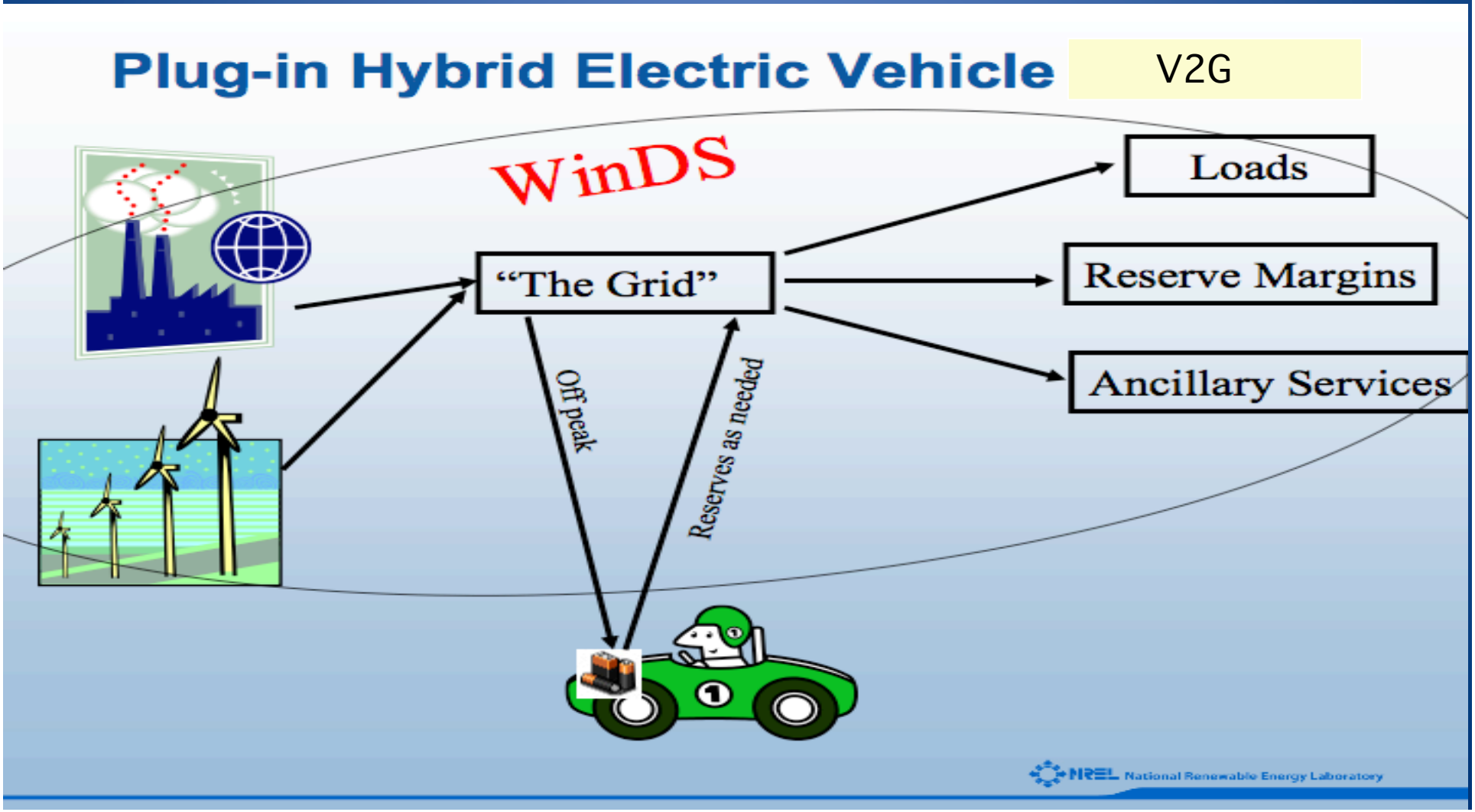
We have now "Hybridized" the Grid

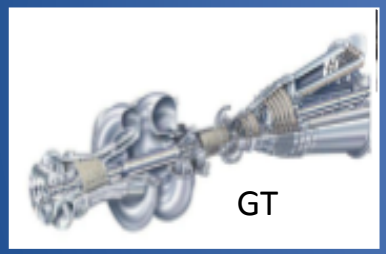
Grid Capacity (SWIS).....4 GW

WA Passenger and Light commercial PHEV potential.....14 GW



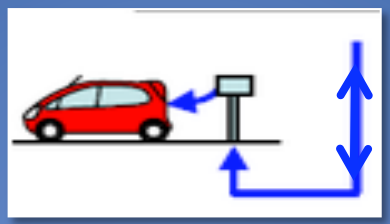
A Partnership Solution

Generation



+

V2G Storage



Other Storage

+

Smart Grid

Fuel Cell Residential

PHEV & EV

Responsive Loads

Quick Start Units
Fast Ramping
Wide Operating Range
Regulation Capability
Wind Prediction
Tracking Solar
V2G

Large Spinning Reserve
Frequency Regulation
Fast Ramp for Wind & Solar
Voltage Support
Excess Wind Used
R.E. Storage (longer term)

Price Sensitive Loads
Responsive to Dispatch
Resp. to Distributed Gen.
Resp. to V2G & PHEV
Smart Appliances
Frequency Responsive
Peak and Off Peak Shifts

Flat ,TOU and RTP Tariffs effect on Peak Load Reduction

Carnegie Mellon study conclusions on PJM, USA:

Tariff Type	% Peak Load reduction *
Flat rate	Nil
Time of use (TOU)	1.1 to 2.4
Real Time Pricing (RTP)	10.4 to17.7

Flat tariffs are inefficient and inequitable:

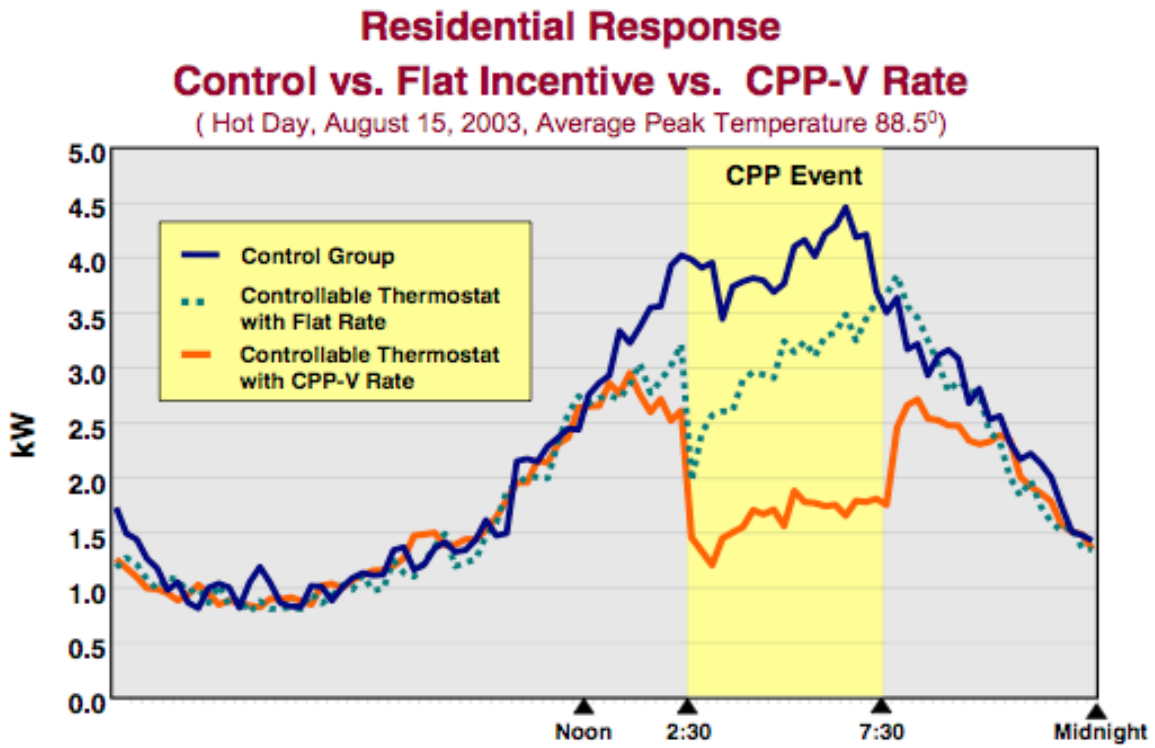
Inefficient because it uses more capital equipment to deliver the same energy.

Inequitable because customers with lower daytime energy and more off peak use subsidize customers with consumption coincident with peak demand

"Half of customer savings from load shifting can be achieved by shifting only 1.7% of all MWh to another time of day". Implies only largest consumers need Smart Meters. *Ref."Impacts of Responsive Loads in PJM" Carnegie Mellon

Tariff and appliance control combination

Price Elasticity's – Load Impacts



Source: Response of Residential Customers to Critical Peak Pricing and Time-of-Use Rates during the Summer of 2003, September 13, 2004, CEC Report.

CPP=Critical Peak Pricing

California Statewide Pricing Pilot

CPP-F = -15% Reduction with controllable A/C Thermostat & Flat tariff

CPP-V = -34% Reduction with controllable A/C Thermostat & Variable Tariff

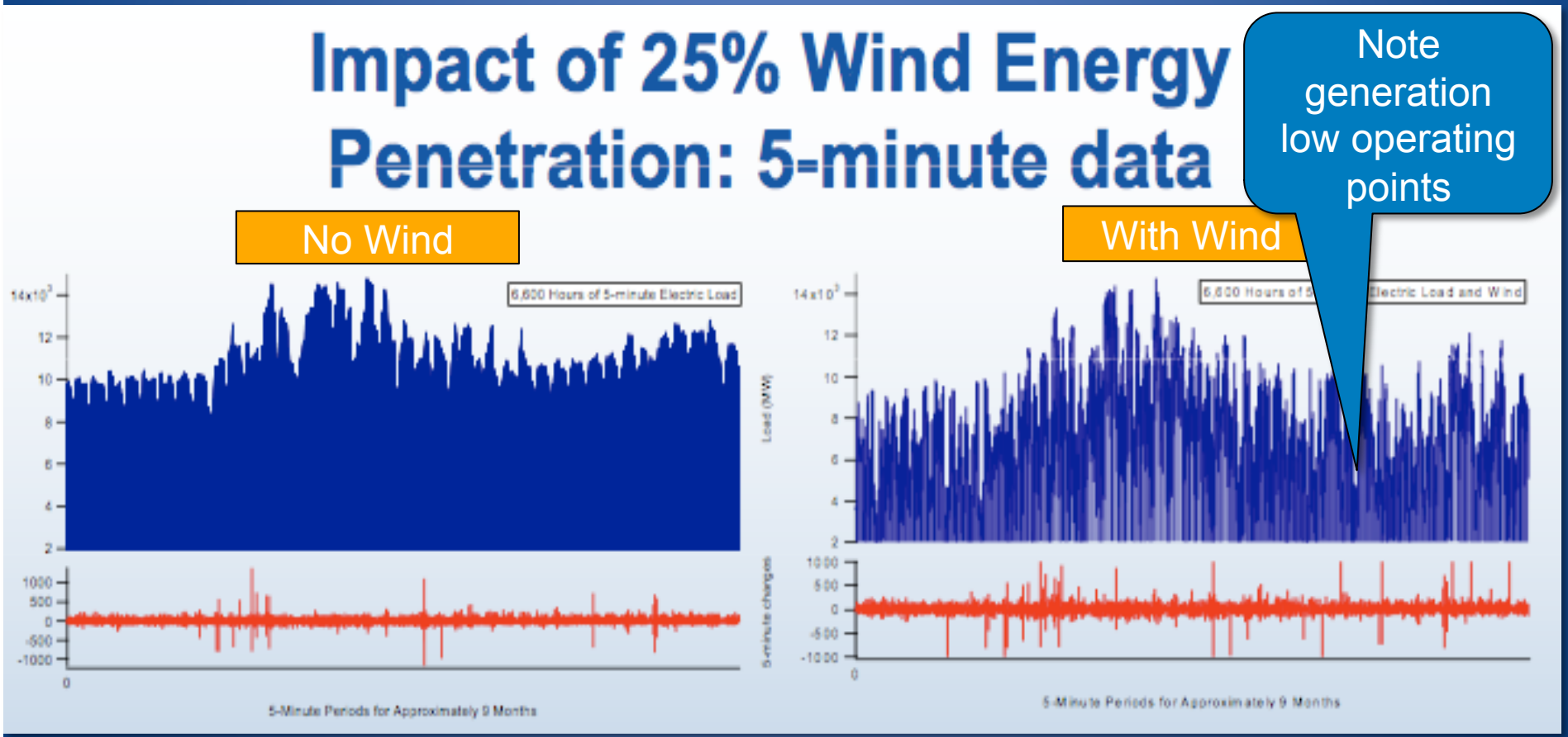
Potential Peak Reduction by 2020

MW

- Residential A/C (Smart Grid & direct control) 500,000 @ 1kW.....500
- Commercial A/C as above + ice storage (5% of 2GW of Com. Load)...100
- Industrial Interruptible Loads (5% of 2GW Industrial Load).....100
- PV Tracking.....200
- EV Spinning reserve and load following.....150
- EV V2G.....100

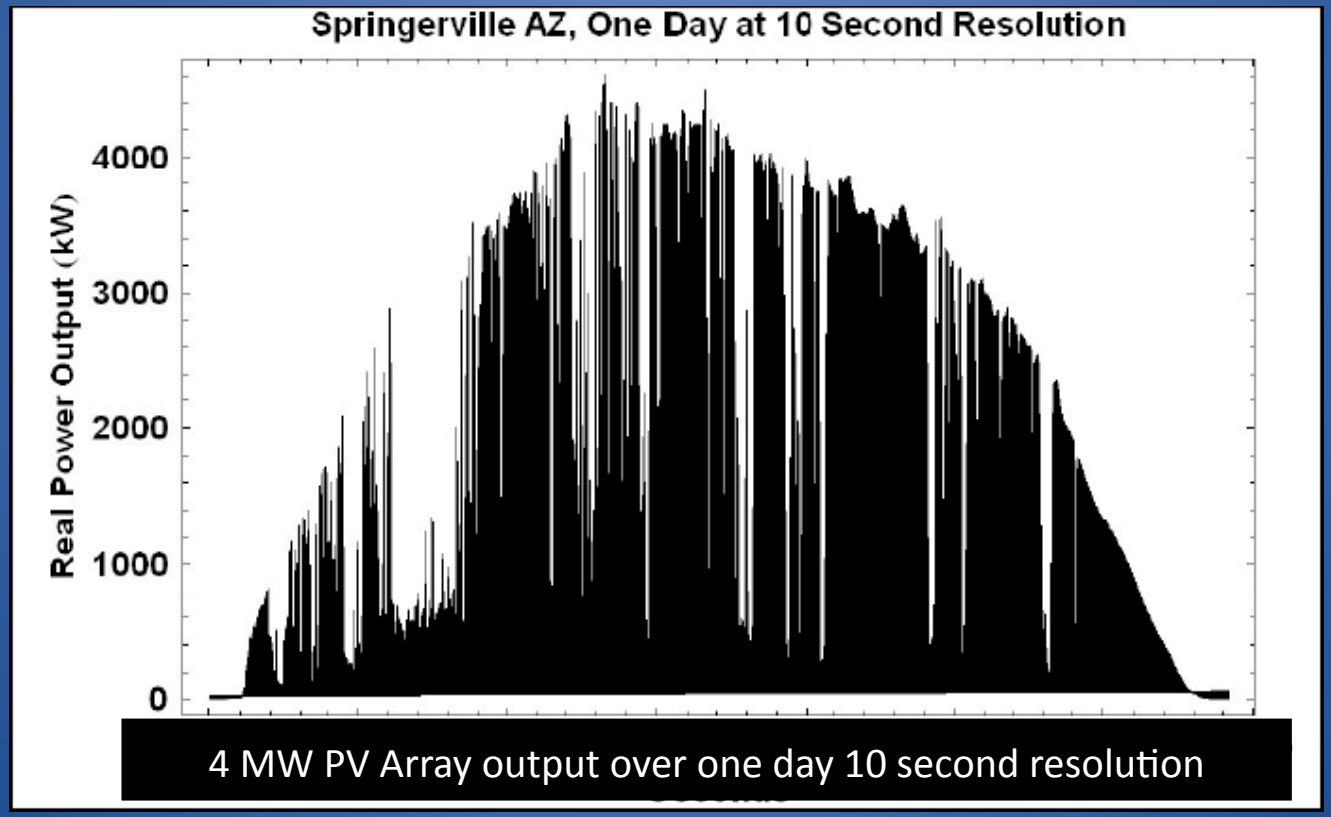
- Total Peak reduction potential.....1,150 MW

Fluctuations are amplified with extra Wind Increasing Ramp and Load Following requirements



NREL Milligan

Solar is also intermittent

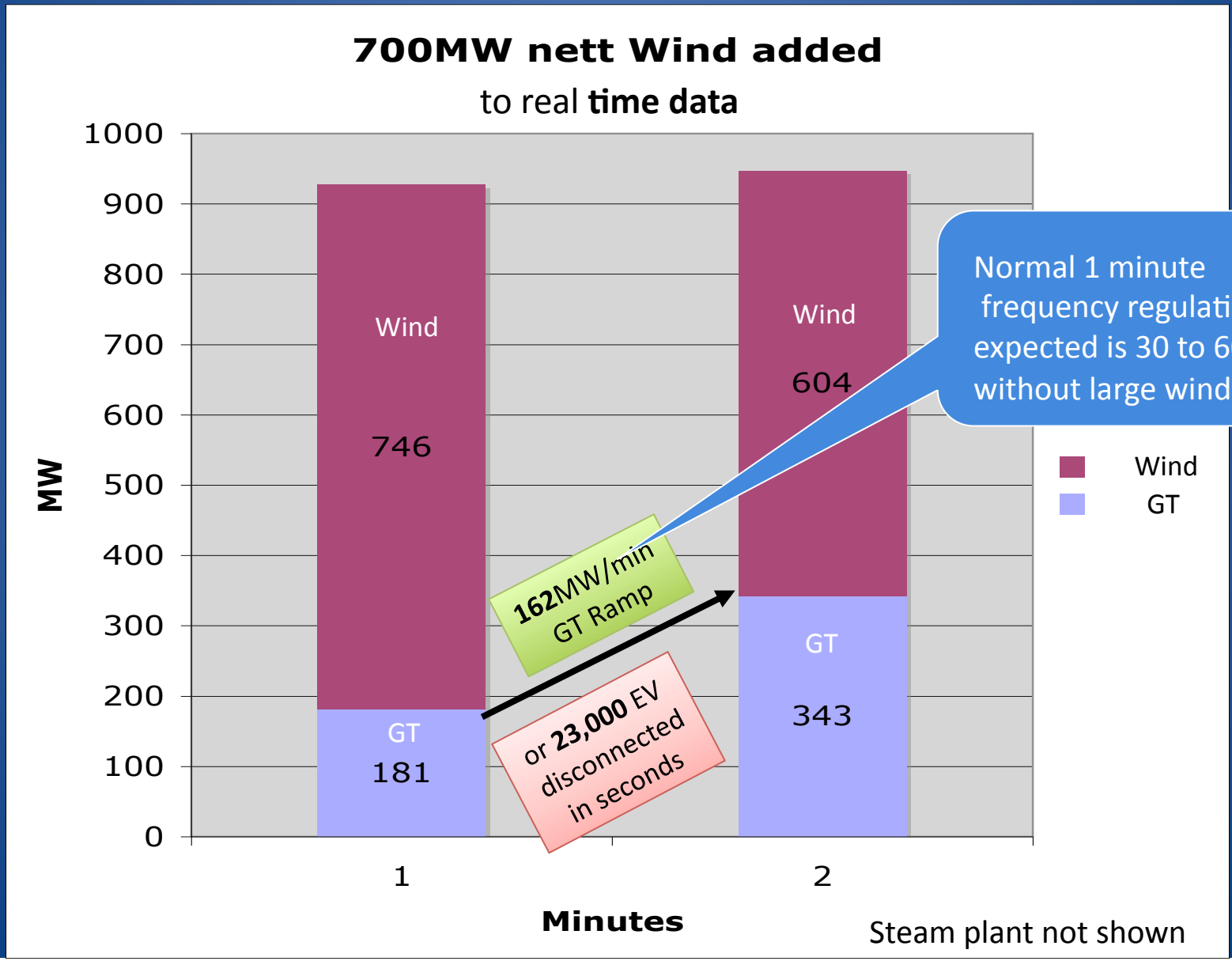


4 MW PV Array output over one day 10 second resolution

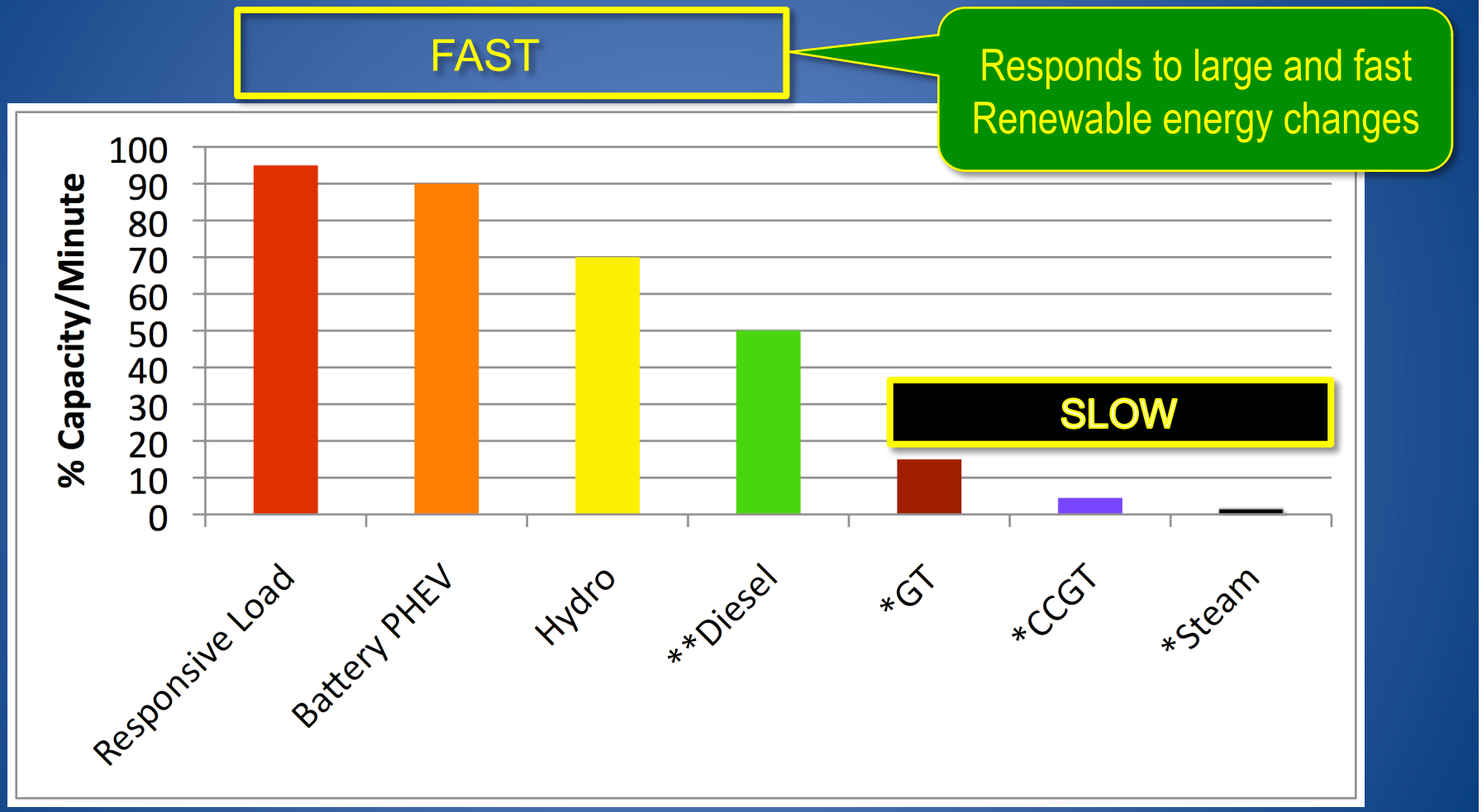
Carnegie-Mellon

Fast Ramp (at high load) due to a 19%/min Wind drop

1,400 MW Wind at 50% capacity = 700MW. (RET 20% in 2020)



Ramp Rates

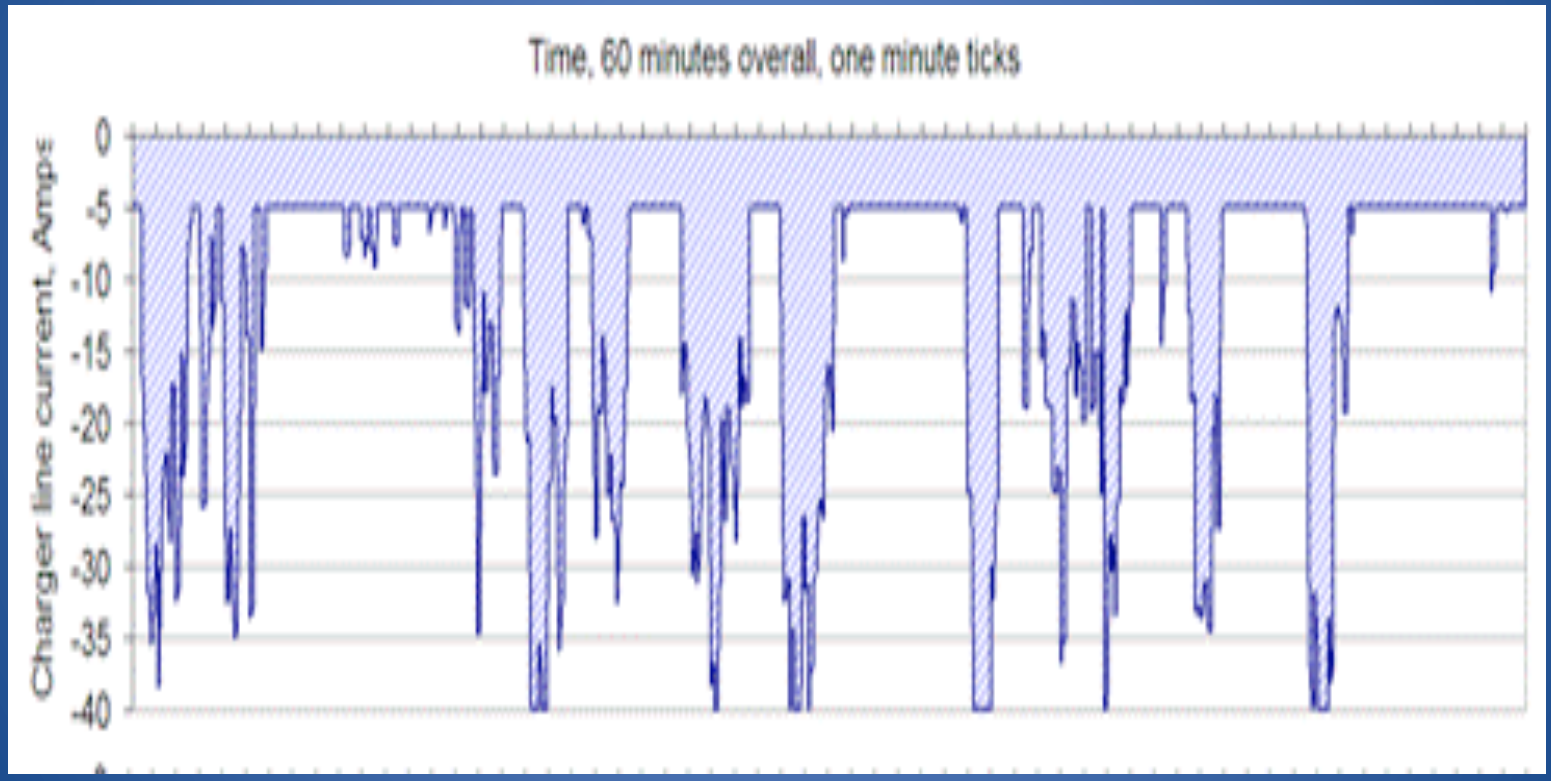


*The commission for energy Regulation & Northern Ireland Authority for Energy Regulation

**Wartsila

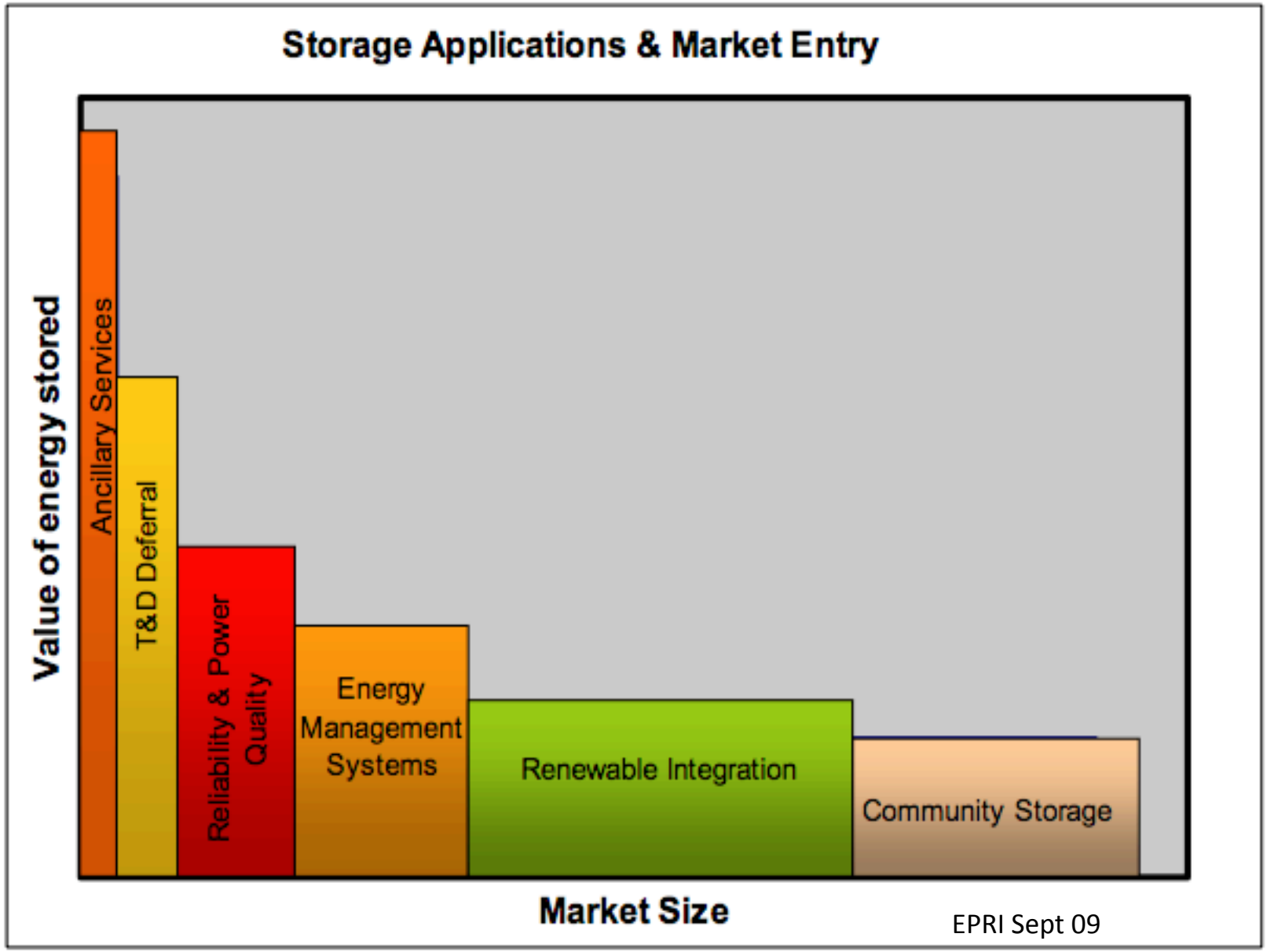
Power Dispatch Commands (AGC) to EV

two way communication with Smart Meter
(Cal CASIO, PG&E and Tesla Motors)

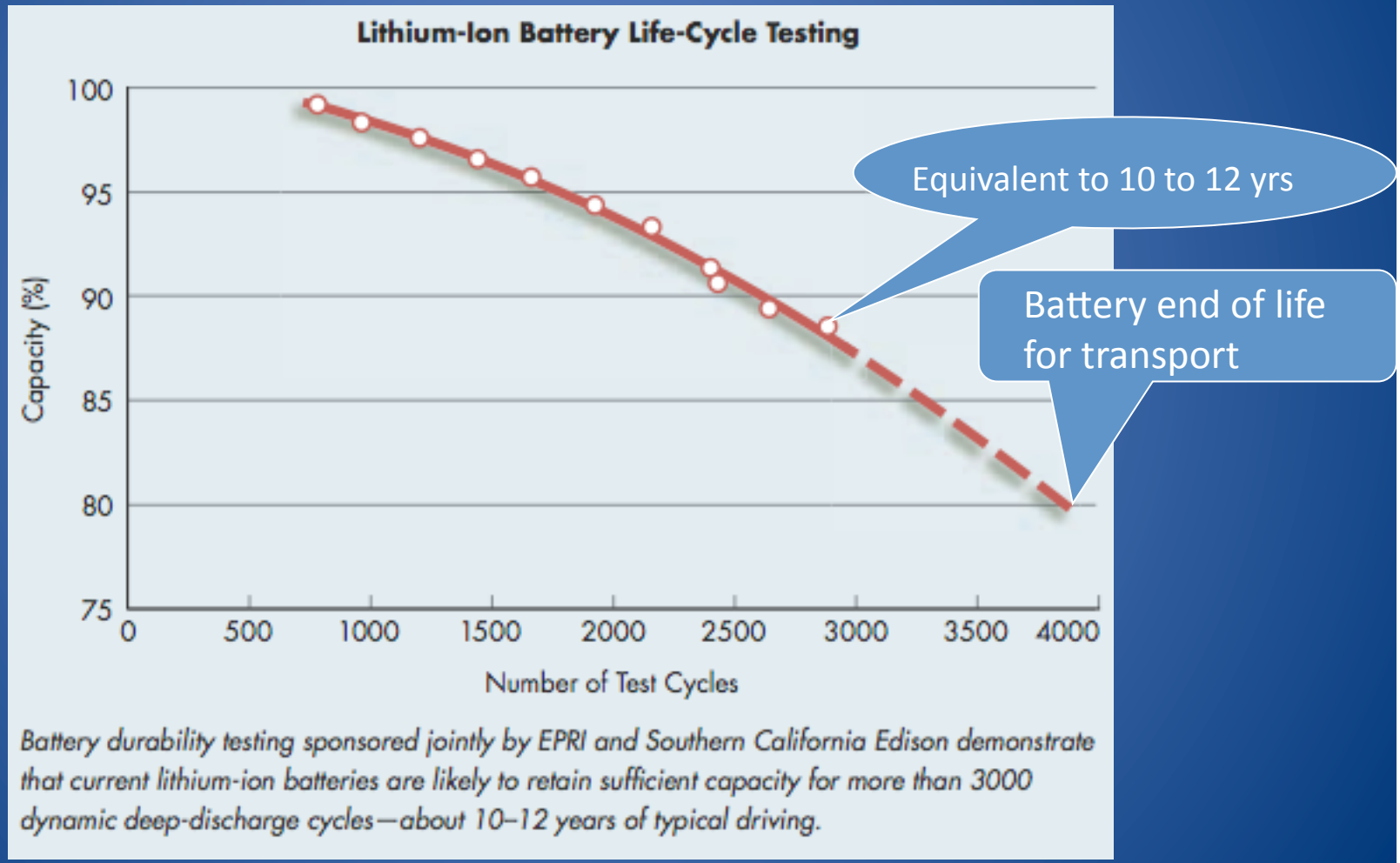


Blue hatch lines shows charging or frequency regulation DOWN
Regulation UP is done by disconnecting Evs not discharging batteries

TESLA


Storage Applications & Market Entry
Value of energy stored
Ancillary Services
T&D Deferral
Reliability & Power Quality
Energy Management Systems
Renewable Integration
Community Storage
Market Size
EPRI Sept 09

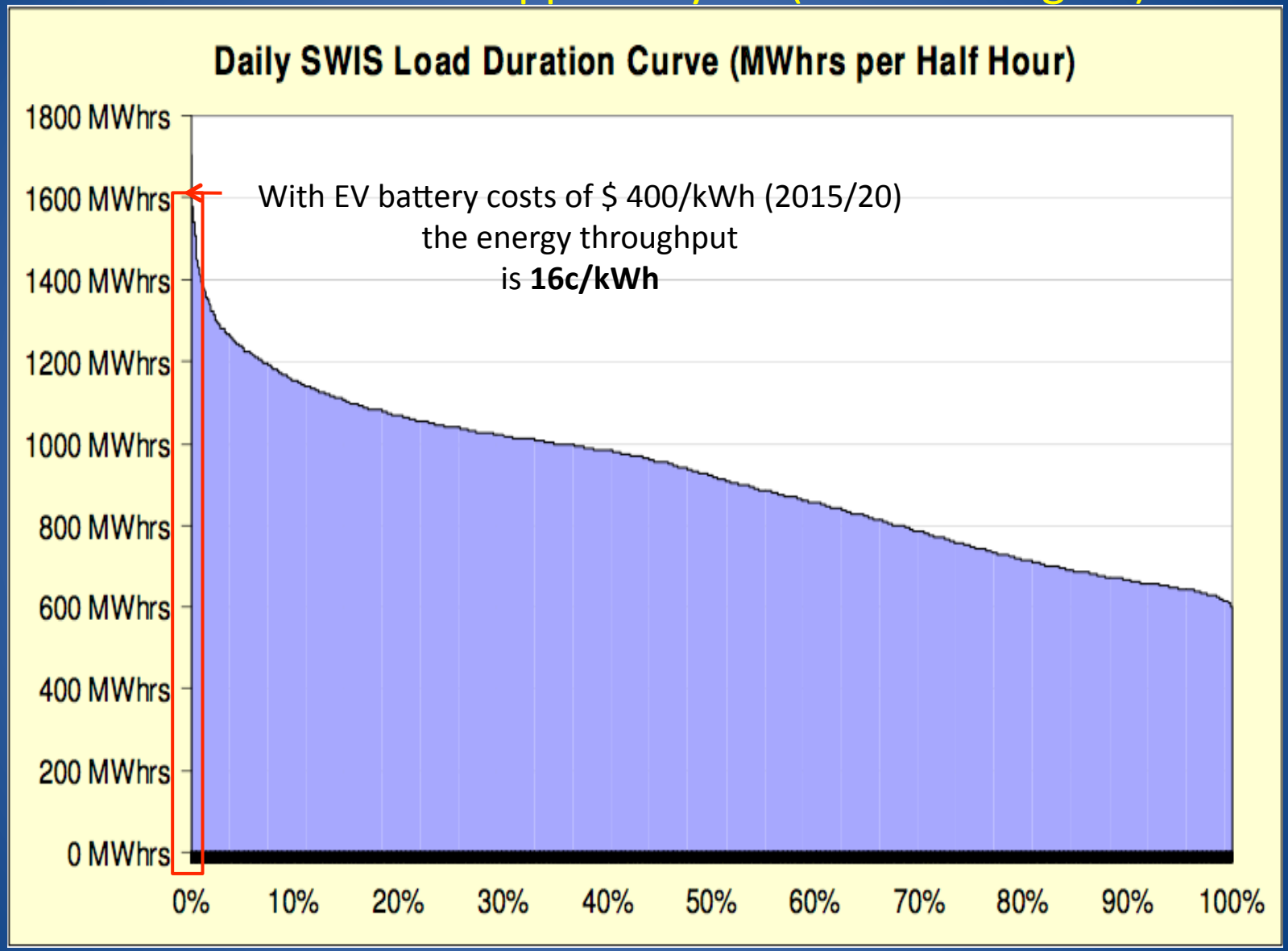
LI-Ion Battery Life-Cycle Testing



Battery durability testing sponsored jointly by EPRI and Southern California Edison demonstrate that current lithium-ion batteries are likely to retain sufficient capacity for more than 3000 dynamic deep-discharge cycles—about 10–12 years of typical driving.

EPRI

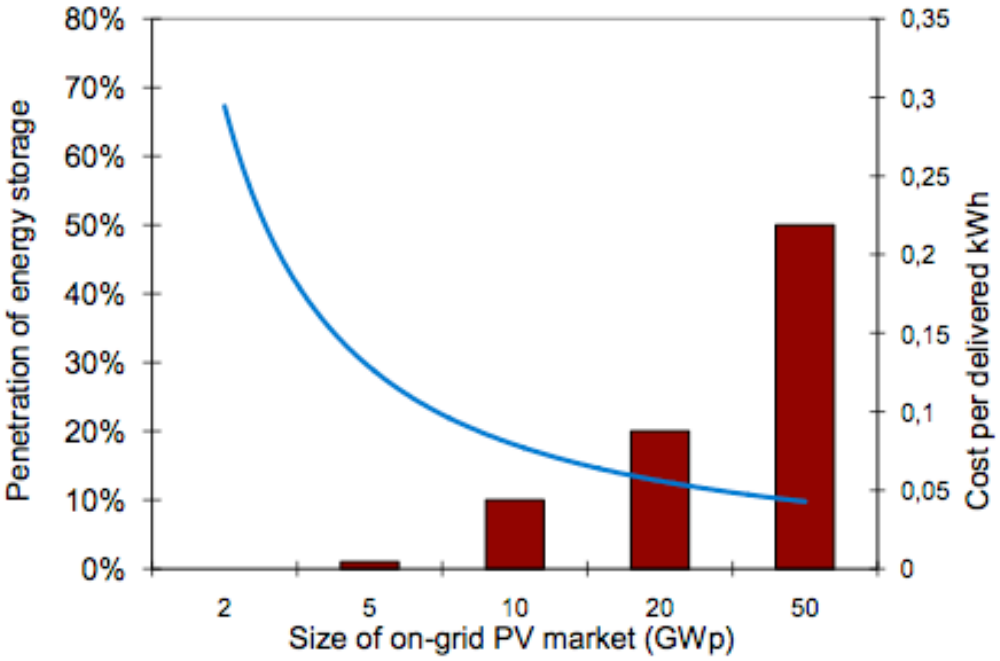
Partial Critical Peak supplied by EV (and Tracking PV)



Storage cost are expected to reach ~6 €ct/kWh of energy throughput by 2020 in a conservative case

External data

Storage cost evolution



Assumptions

- Only existing technologies considered
- 25 GWp of PV systems equipped with storage systems
- 10 GWh of storage systems in place by 2020

Results

- Storage system costs expected to decrease to be 300 €/kWh of capacity by 2020
- Cost of use estimated at 0.06€/kWh of energy throughput for 20GWp capacity

Considering the development of e-mobility, cost of storage use could go down to 6€ct/kWh by 2020

Sources: EU Commission, EnerSys, A.T. Kearney analysis

The Savings

$M/y

- Valley filling (increased Coal plant efficiency at night)……50
- Ancillary services supplied by EV (night time)*……..19
- Critical Peak lopping 24% (Responsive loads + V2G)…….19

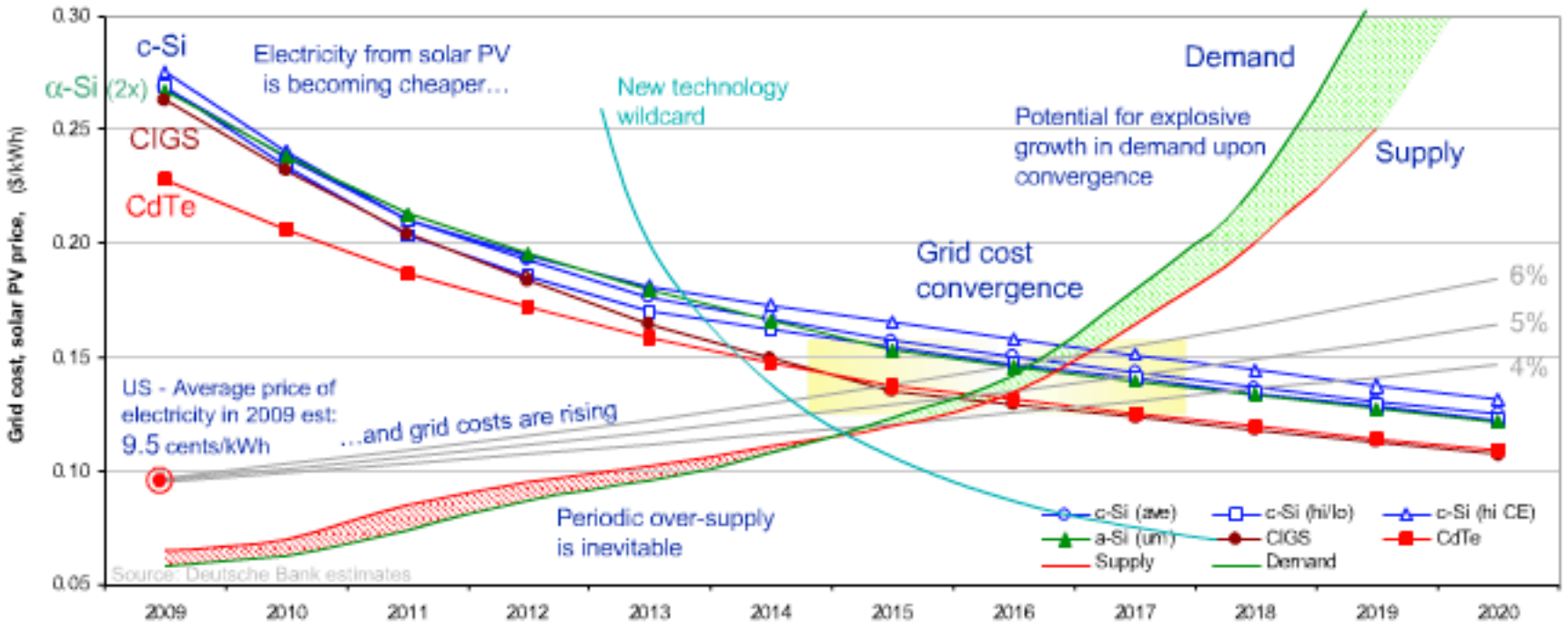
- Total savings per year……$88M/y
- Cost of 500,000 Smart meters @($250 + $150 Installation) = $200M
- Payback time $200M÷$88M = 2.3 yrs

- * Ancillary services report 2009 WPC. Total cost of A/S = $ 38 M/y

PV Breakthrough Events (Dec. 09)

- Factory gate price for crystalline modules drops to US$ 2/W and US$ 1 to $1.50 for thin film
- Chinese product arrives in the market
- Finance returned to the PV market after the financial crisis
- Silicon supply has increased due to more players processing it
- Crystalline product reaches 20% efficiency and thin film exceeds 10% efficiency
- Huge increase in number of manufacturers
- FirstSolar signs a 3,000 MW deal with China

PV US$ Cost Projection (April 2009)



- No technical breakthroughs are required to achieve solar PV cost reduction curve(s)
- "Grid parity" is a conditional number; no single number is adequate
- Oversupply is inevitable and will be acute over the near term (credit driven)
- New technology could accelerate solar PV cost reduction

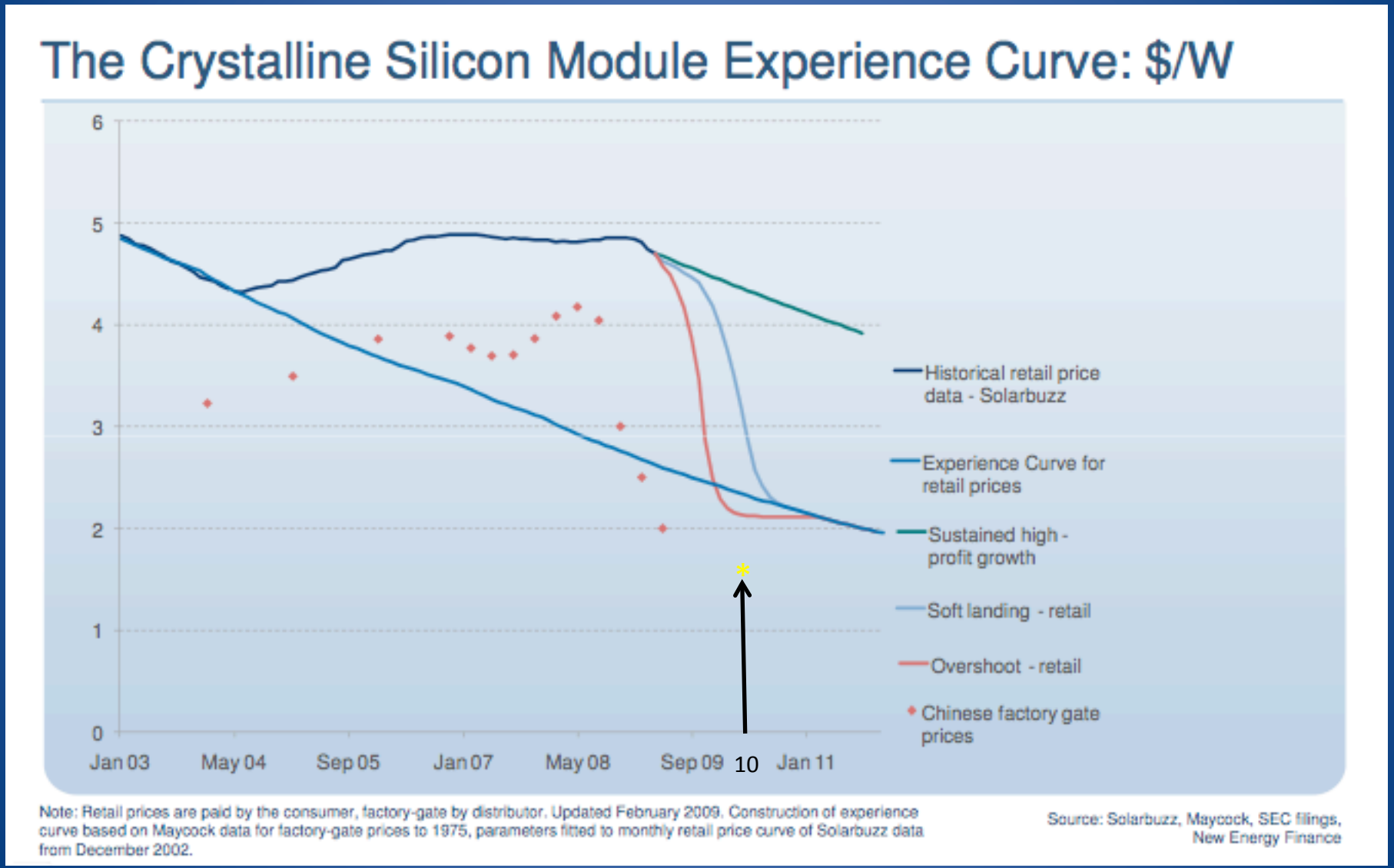
Broad cost convergence over the next 6 plus years

Stephen O'Rourke (212) 250-8670

April 2009

Deutsche Bank

Crystal PV Costs & Projection (Feb.09)



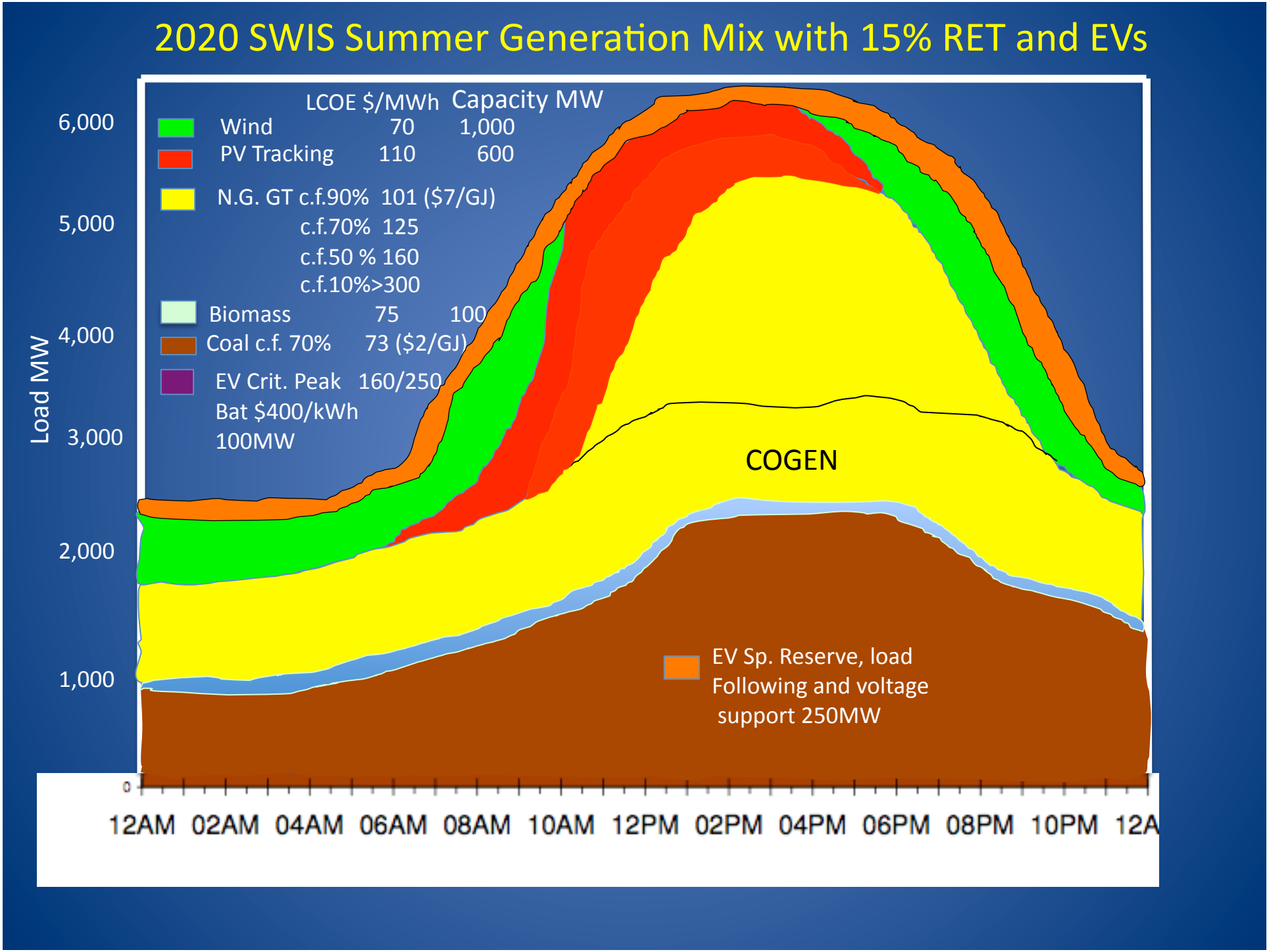
New Energy Finance

2020 Renewable Energy Target (RET) for the SWIS

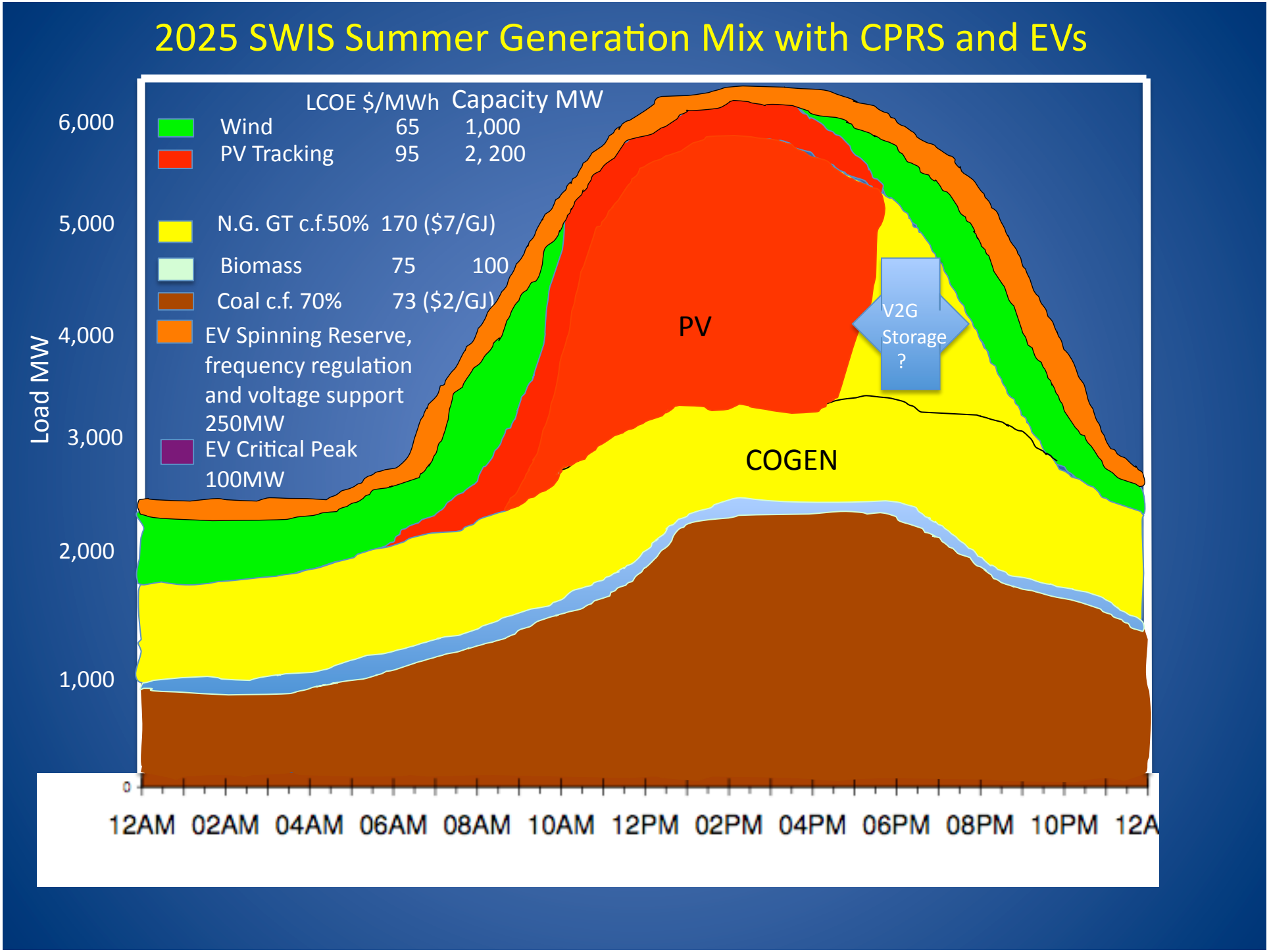
- 2020 RET for Australia is 45,000 GWh over a generation prediction of 290,000 GWh

- 2020 RET for SWIS is 3,900 GWh over a generation prediction of 25,000 GWh

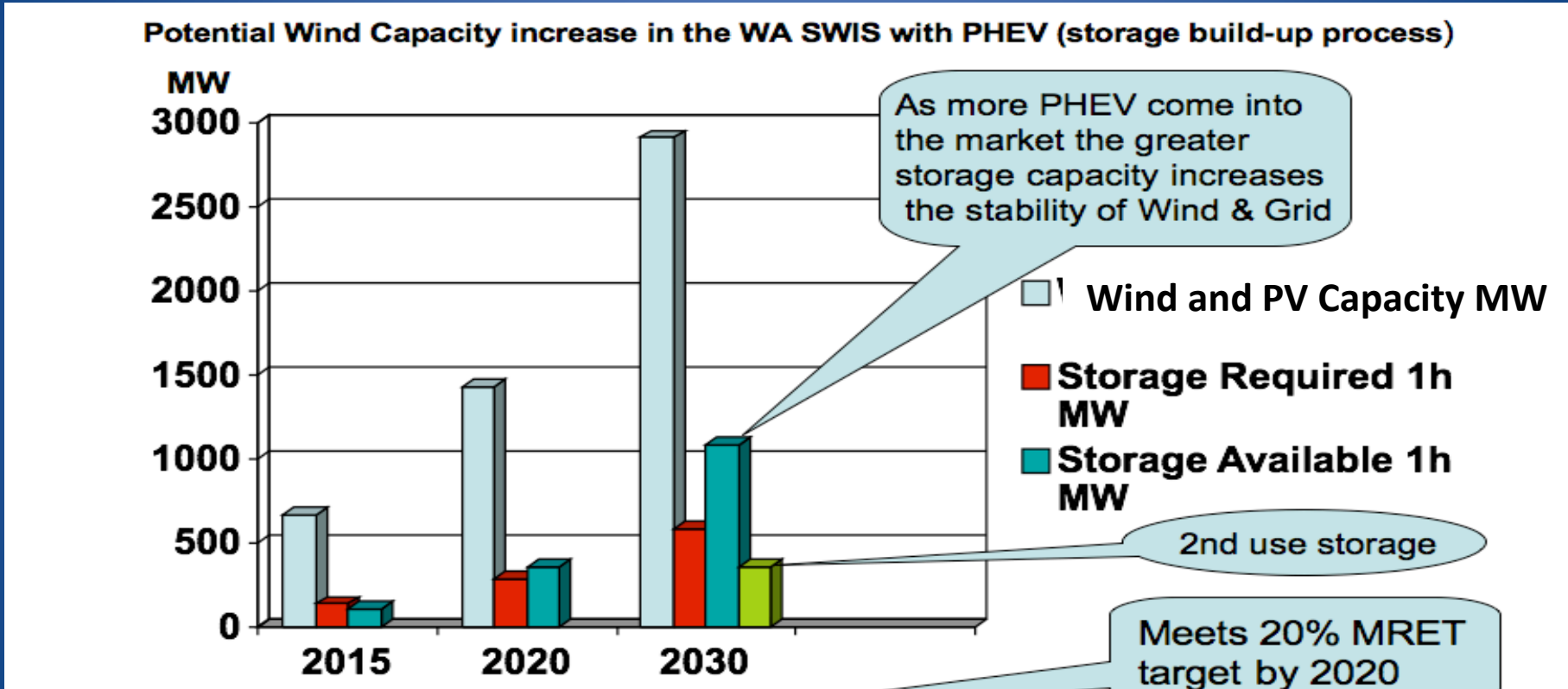
2020 SWIS Summer Generation Mix with 15% RET and EVs



2025 SWIS Summer Generation Mix with CPRS and EVs



WA's Potential Wind and PV capacity increase in the SWIS with PHEV (storage build-up process)



Wind & PV %	10	20	30	Energy Wind/Energy Total Plant
PHEV Req.x1000	35 (3%)	74(6%)	237(15%)	(%) of Fleet
EPRI x 1000	30	165	550	Cumulative Market Projection
Mc KINSEY x 1000	25	87	(240 ?)	ditto and selected for graph
CSIRO/BITRE	--	67(4.2%)	185 (10%)	ditto
RETROFITS	?	?	?	?

Emission Abatement in 2020

	$KtCO_{2e}/y$
• Wind	2,625
• Ancillary Services	79
• Valley Filling	910
• Peak Shaving (includes Solar Tr.)	300
• Total	3,914 $KtCO_{2e}/y$

- Or 21% GHG savings from BAU in 2020

RECs

- Emissions saved by wind and Solar ….2.63MtCO_{2e}/y
- @ $12/tCO2e……..$ 31.44 M/y
- @$25/tCO2e……..$ 65.50 M/y
- @$50/tCO2e……..$131.00 M/y

Conclusions for 2020

- EVs are an important enabler for wind solar and ancillary services
- Smart grids are essential to EVs and to shape the daily load curve
- PV is becoming the “low hanging fruit” power generation source
- Modelling of the new generation mix and EVs is required, CUSP is interested in doing this work together with stakeholders