

5th
ANNUAL

SILICON VALLEY / SEEDZ

ENERGY STORAGE SYMPOSIUM

The Emerging Market for Customer-Side Energy Storage

May 21, 2014

Microsoft, Mountain View

Event Partners

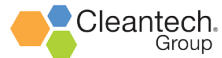


CalCharge

The Center for Sustainable Energy and Power Systems
CENSEPS

Clean Coalition
Making Clean Local Energy Accessible Now

CESA
CALIFORNIA ENERGY STORAGE ALLIANCE



ELECTRIC POWER
RESEARCH INSTITUTE



Energy
Storage
Association



LAWYERS FOR CLEAN ENERGY

McCalmont
Engineering

MegaWatt
Storage Farms, Inc.



**Pacific Gas and
Electric Company**

**PRIMUS
POWER**

SJSU SAN JOSÉ STATE
UNIVERSITY

**SILICON VALLEY
LEADERSHIP GROUP**

SRI International

STRATEGEN
STRATEGIES FOR CLEAN ENERGY



Exhibitors



CESA
CALIFORNIA ENERGY STORAGE ALLIANCE



Santa Clara Valley
Chapter, IEEE

ip | CHECKUPSSM
an eye on invention

Keynote Presentation



JB Straubel

Chief Technology Officer, *Tesla Motors*



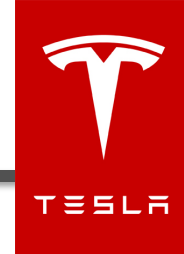
Silicon Valley/SEEDZ Energy Storage Symposium
May 21, 2014
Mountain View, California



TESLA

Energy Storage

EV Battery History



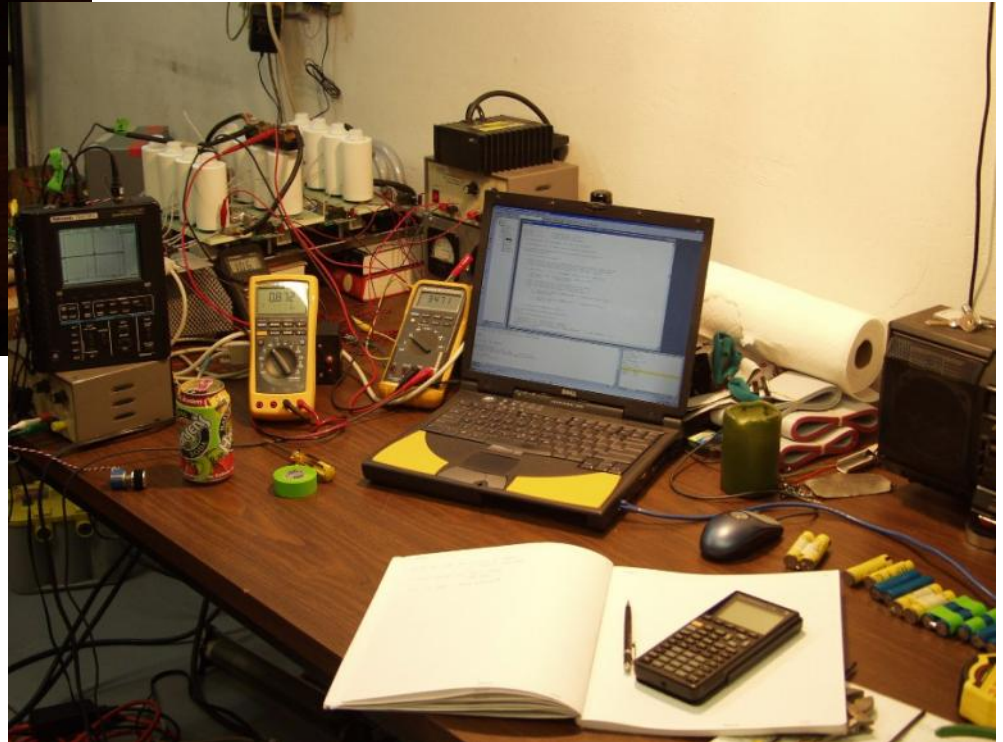
- Lead-acid technology was status quo in 1995
- Performance had stagnated
 - Short lifespan
 - Very heavy
 - Short range

Lithium ion Made Possible:

- 4 X gravimetric energy density
- 6 X volumetric energy density
- 2 X cycle life



Tesla Battery R&D in 2003





A New Idea at the Time (2007):
Desirable Electric Cars

Industry Leading EV Powertrain

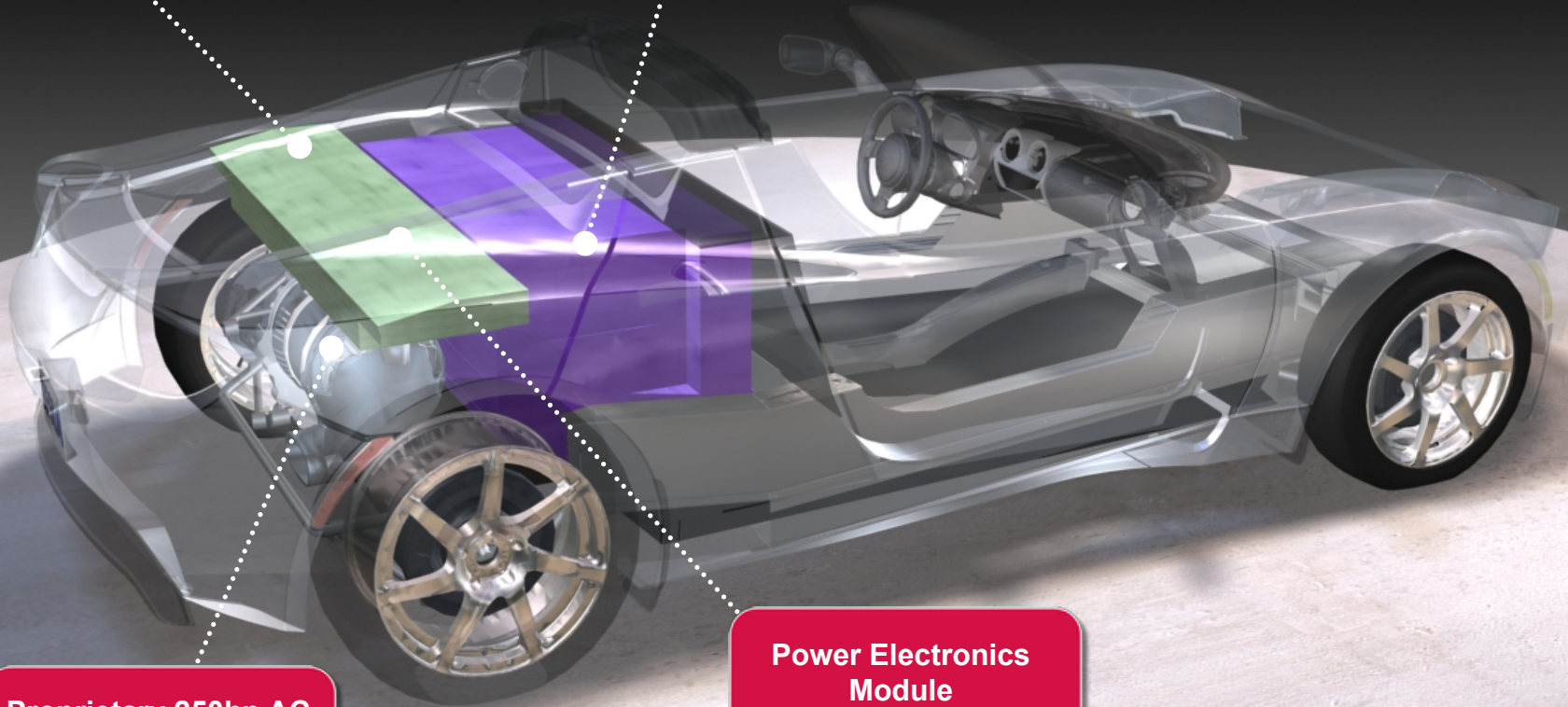


Controls and Software

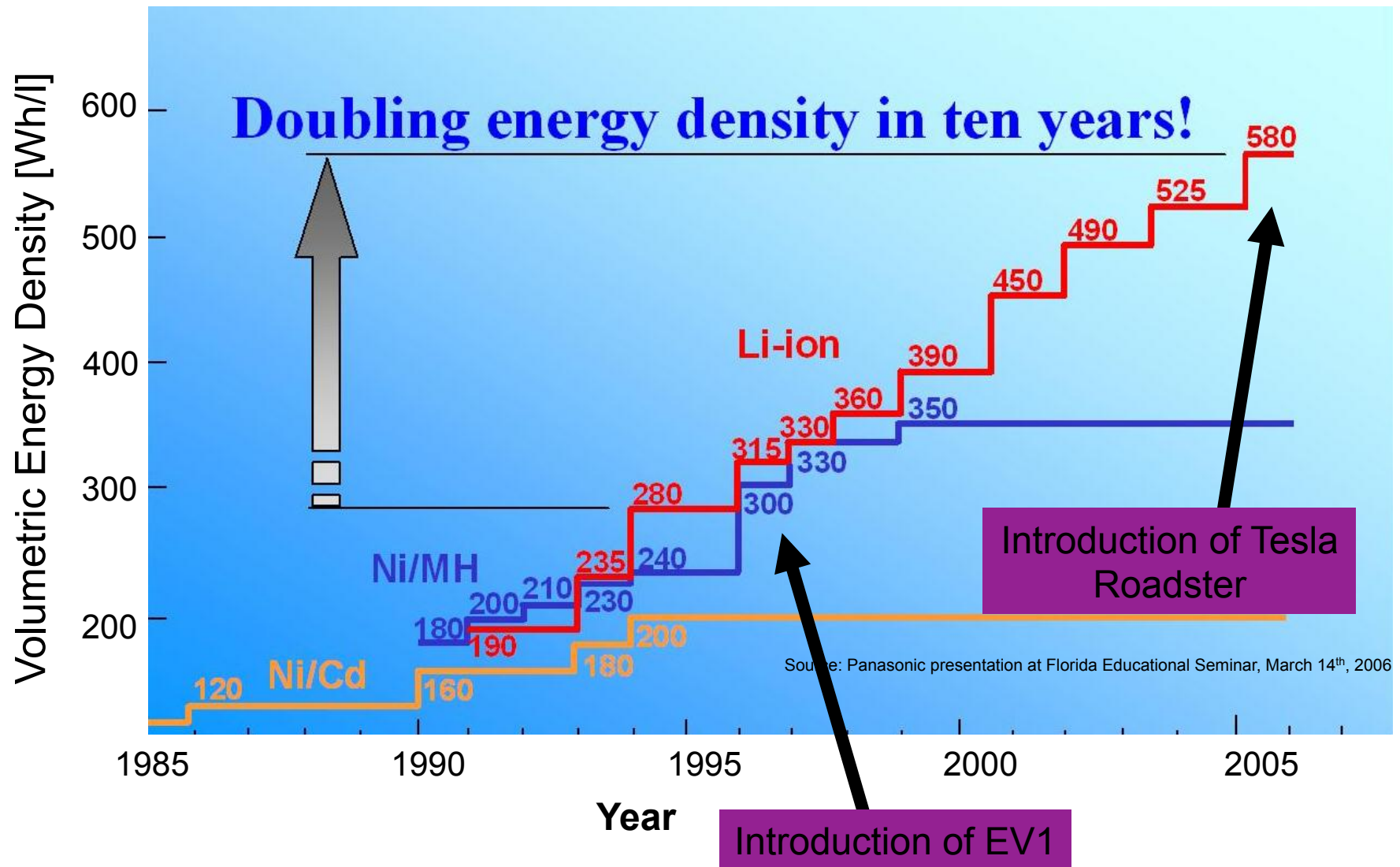
**Proprietary
53 kWh Lithium ion
battery pack**

**Proprietary 250hp AC
Induction Motor and
Gearbox**

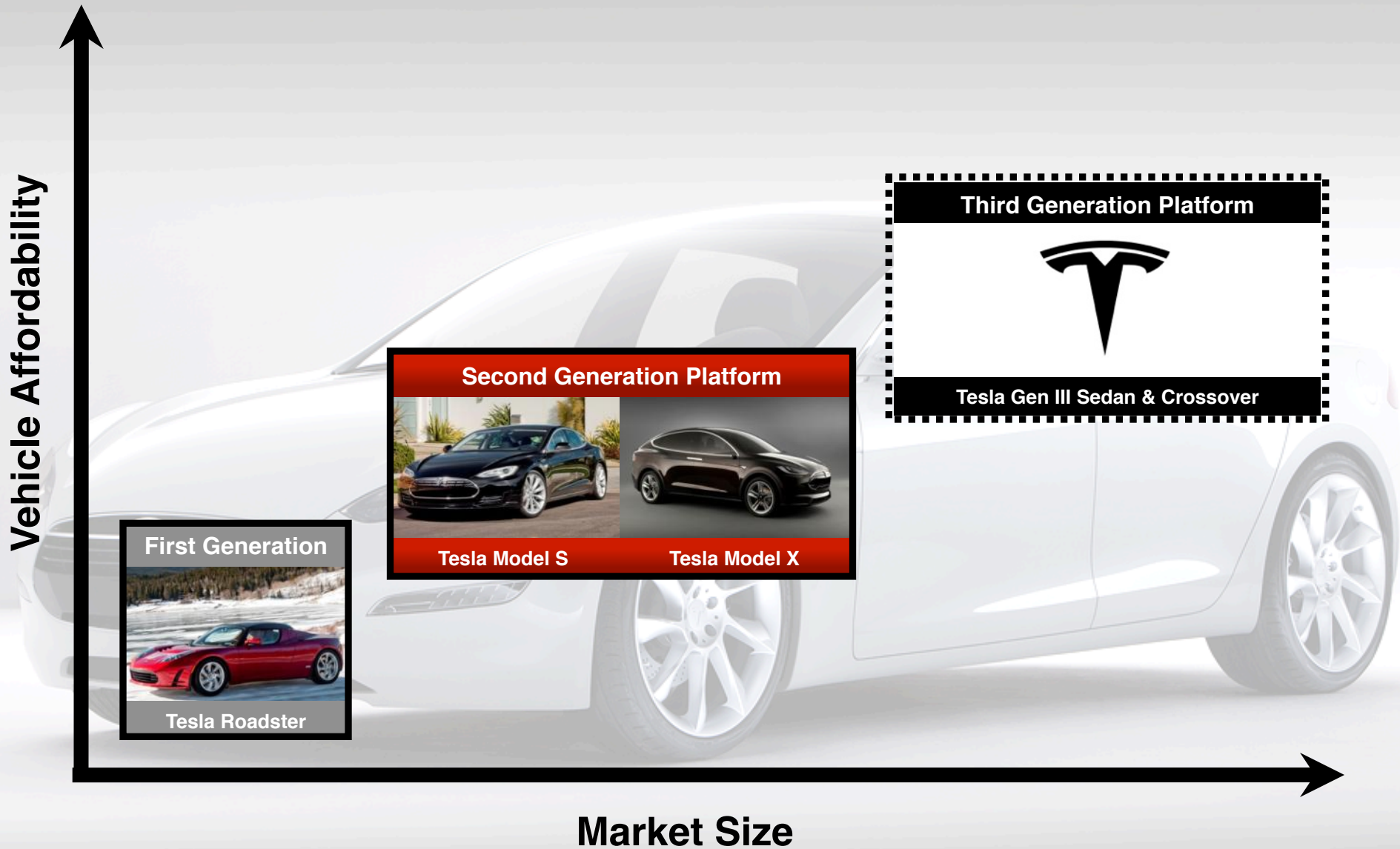
**Power Electronics
Module
(DC-AC Inverter, Charger)**



Battery Energy Density Trend



Roadmap – EVs for the Mass Market



Automotive Products and Partnerships

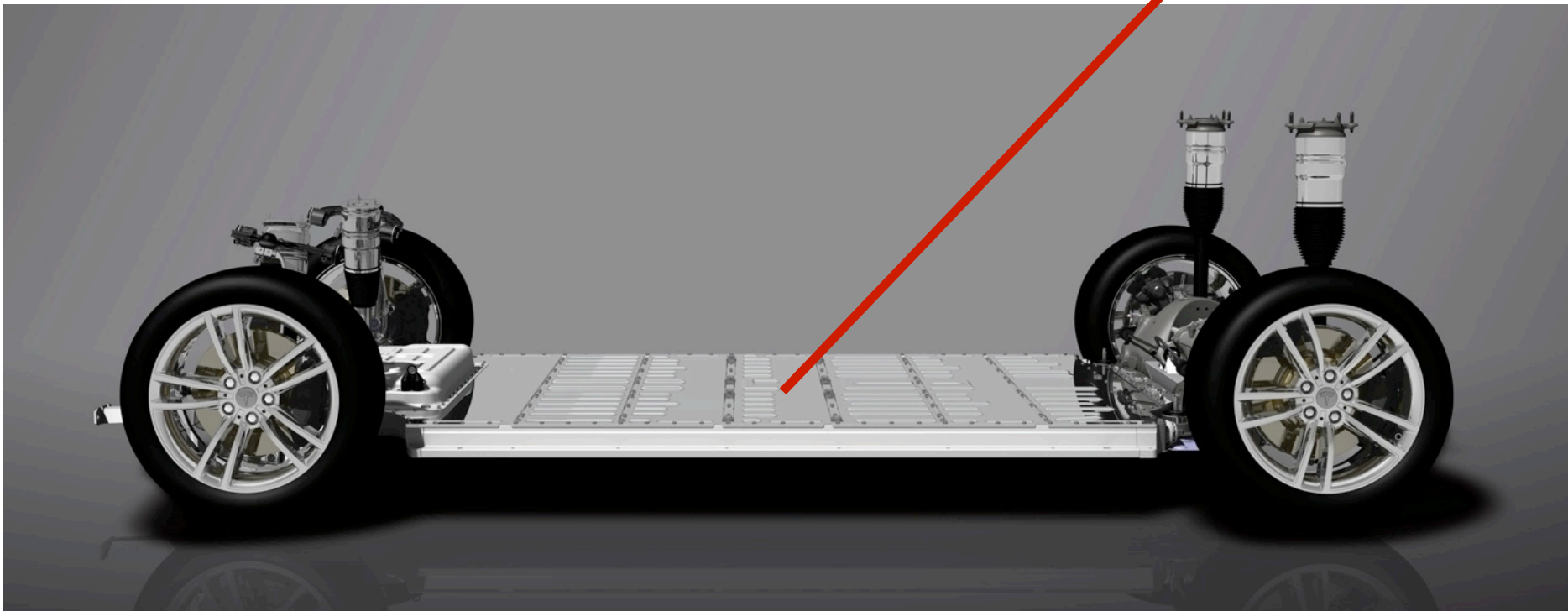


Focus on Energy Storage Cost



- Ground-up design as EV-only (Model S)
- Optimal packaging, safety and performance
- High energy density leads to lower cost

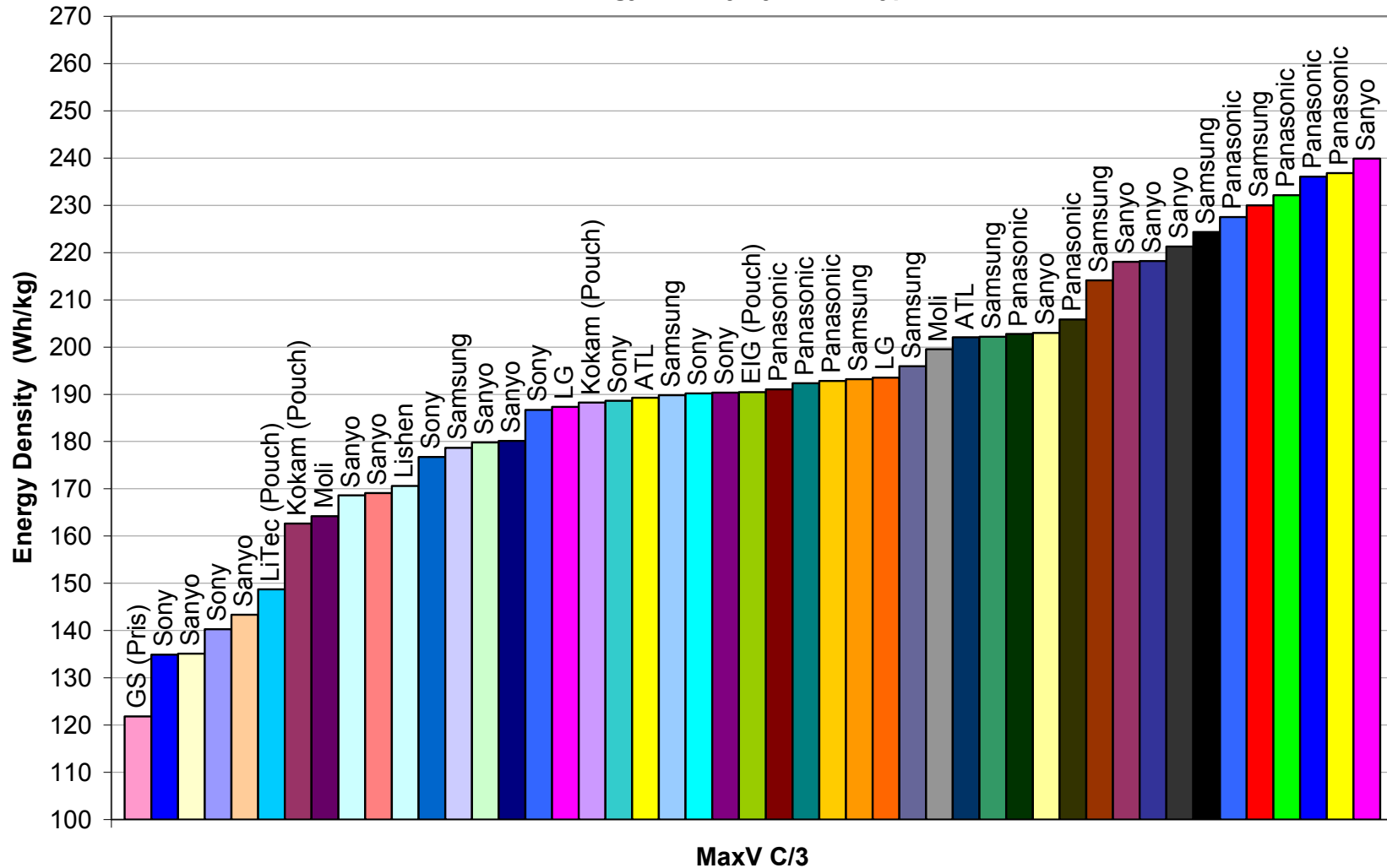
85 kWh Battery Pack



Wide variety of cell performance

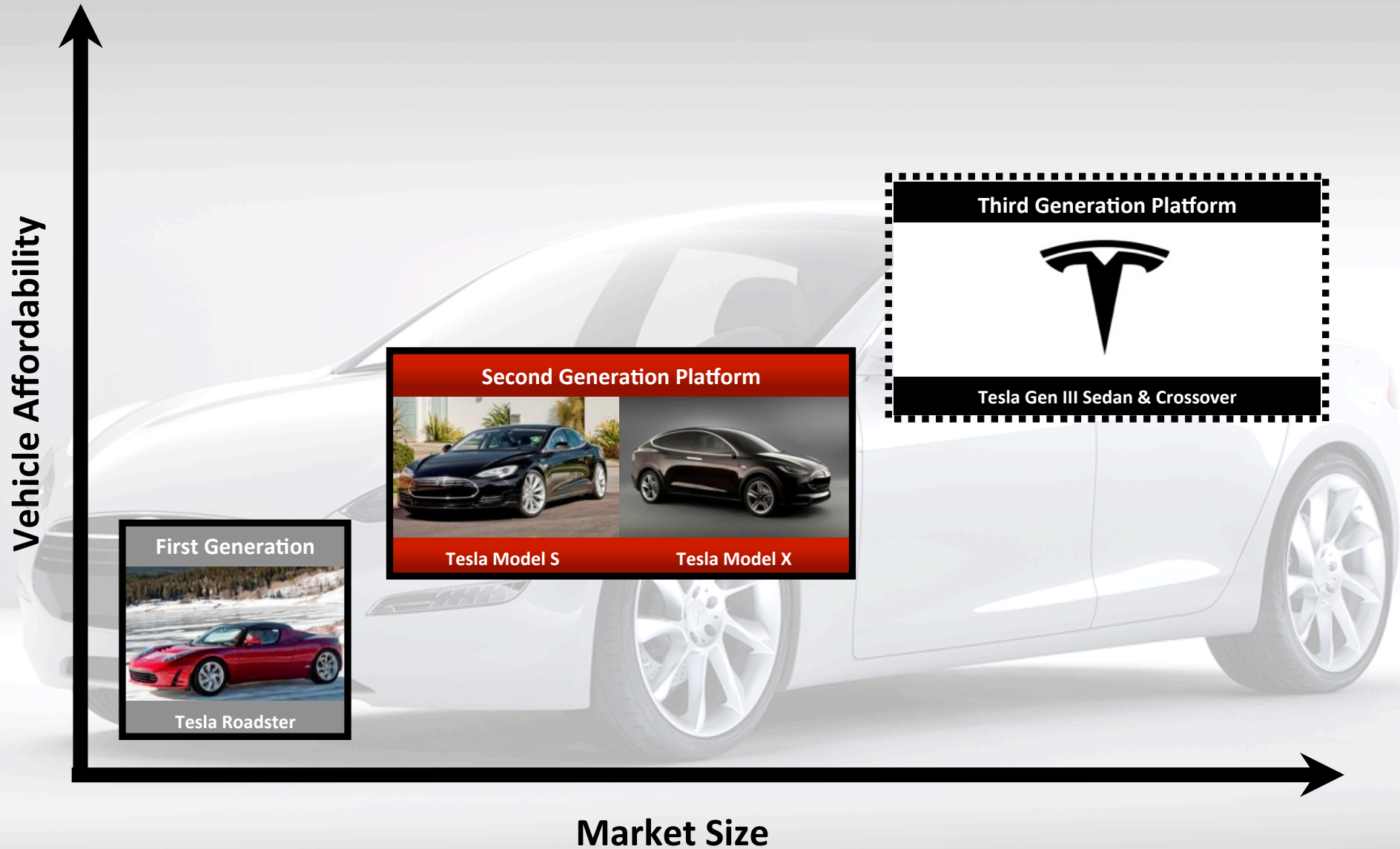


Energy Density by Model Type



Energy Check [Charge at C/3 rate with C/20 cut; Discharge at C/3 rate to 2.7V]

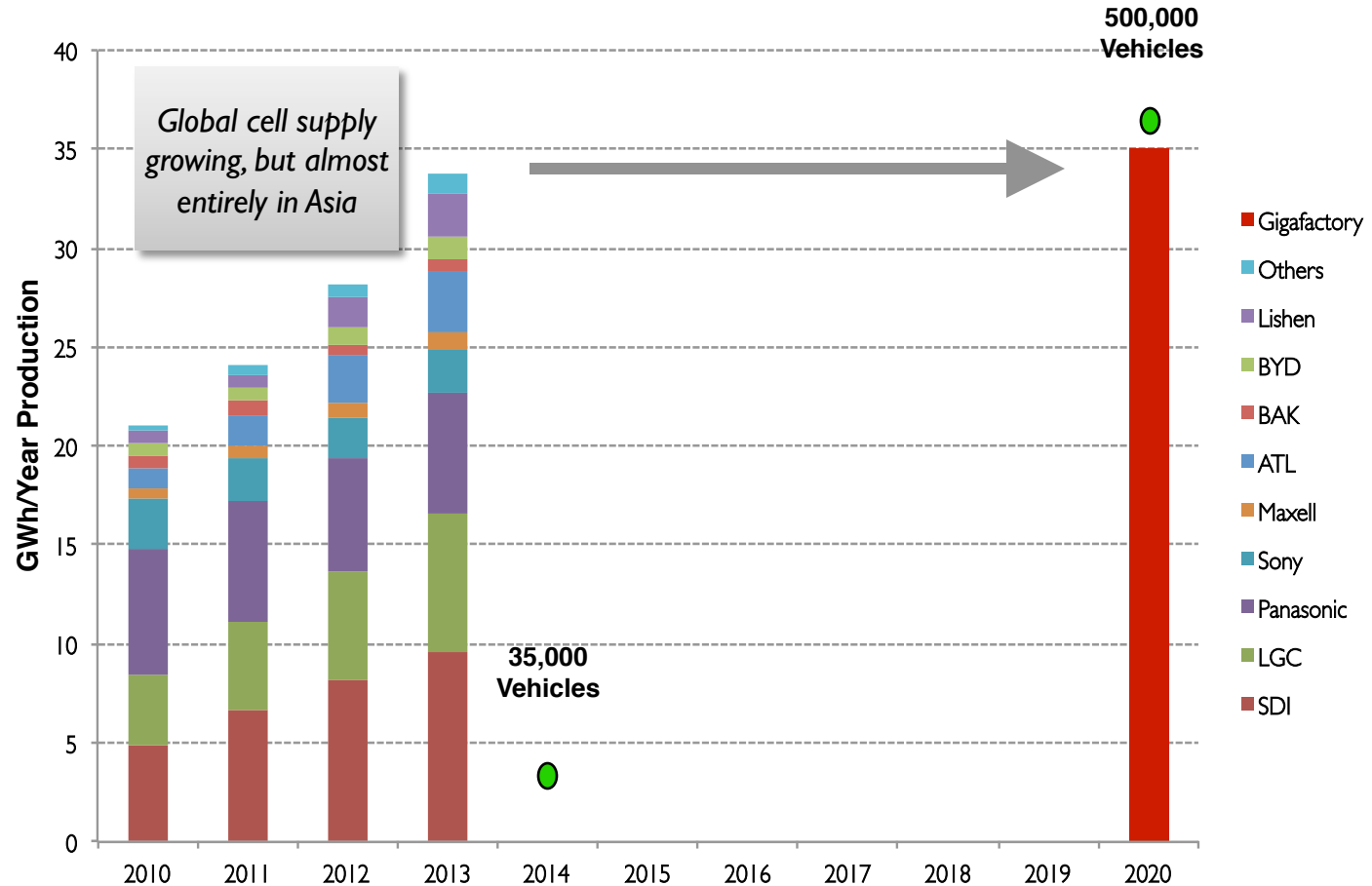
Roadmap – EVs for the Mass Market



Planned 2020 Gigafactory Production Exceeds 2013 Global Production



14

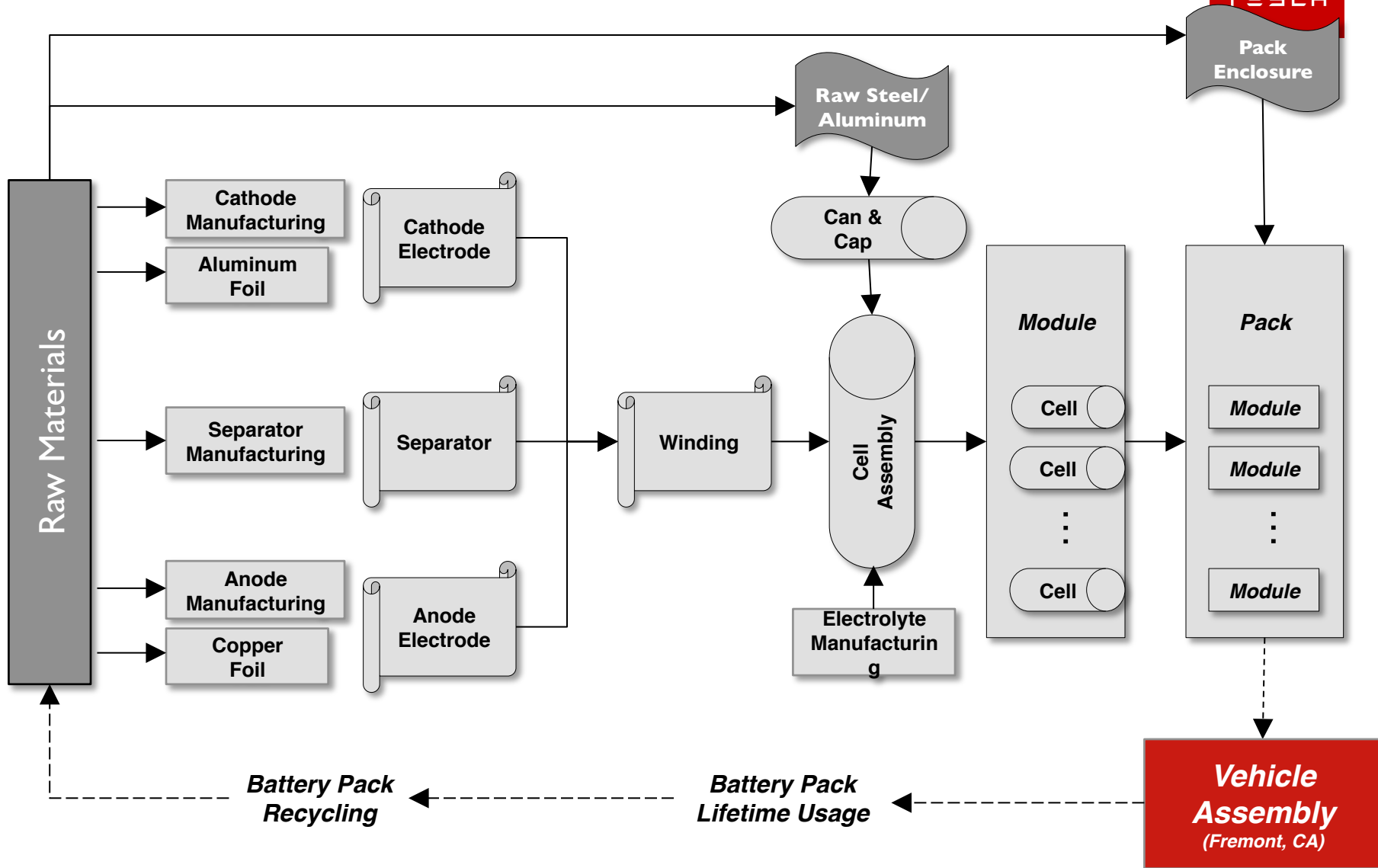


Battery pack cost/kWh reduced >30% by Gen III volume ramp in 2017

Gigafactory Process Flow



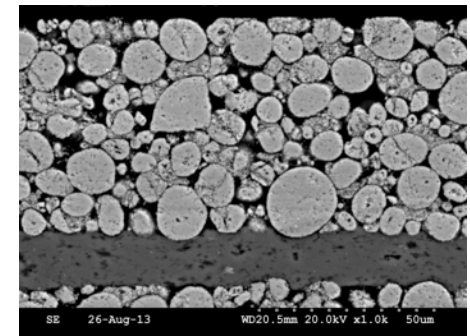
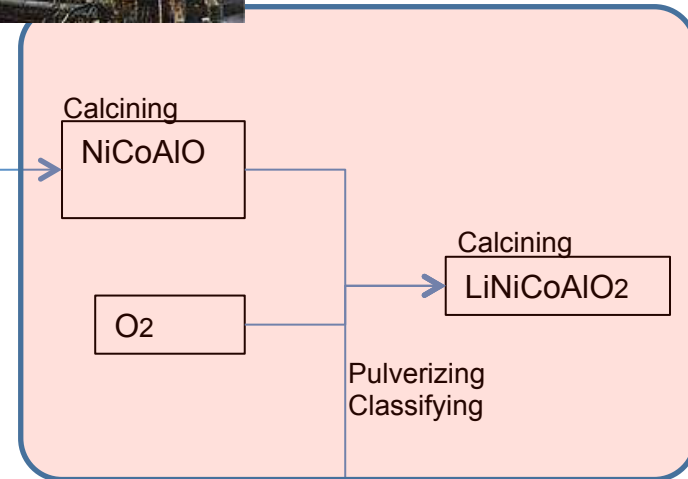
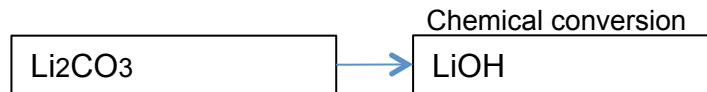
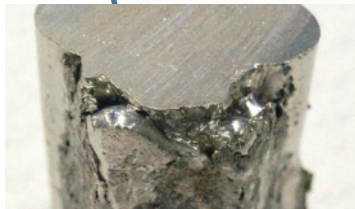
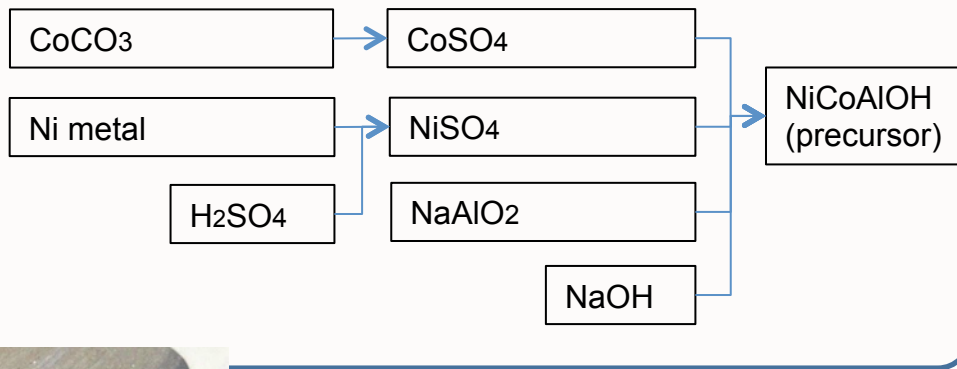
15



Go back to the raw materials cost to begin



smelter



Gigafactory Projected Figures

2020 Tesla Vehicle Volume	≈500,000/yr
2020 Gigafactory Cell Output	35 GWh/yr
2020 Gigafactory Pack Output	50 GWh/yr
Space Requirement	Up to 10M ft ² w/ 1-2 levels
Total Land Area (acres)	500-1000
Employees	≈6,500

New Local
Renewables
Solar and Wind

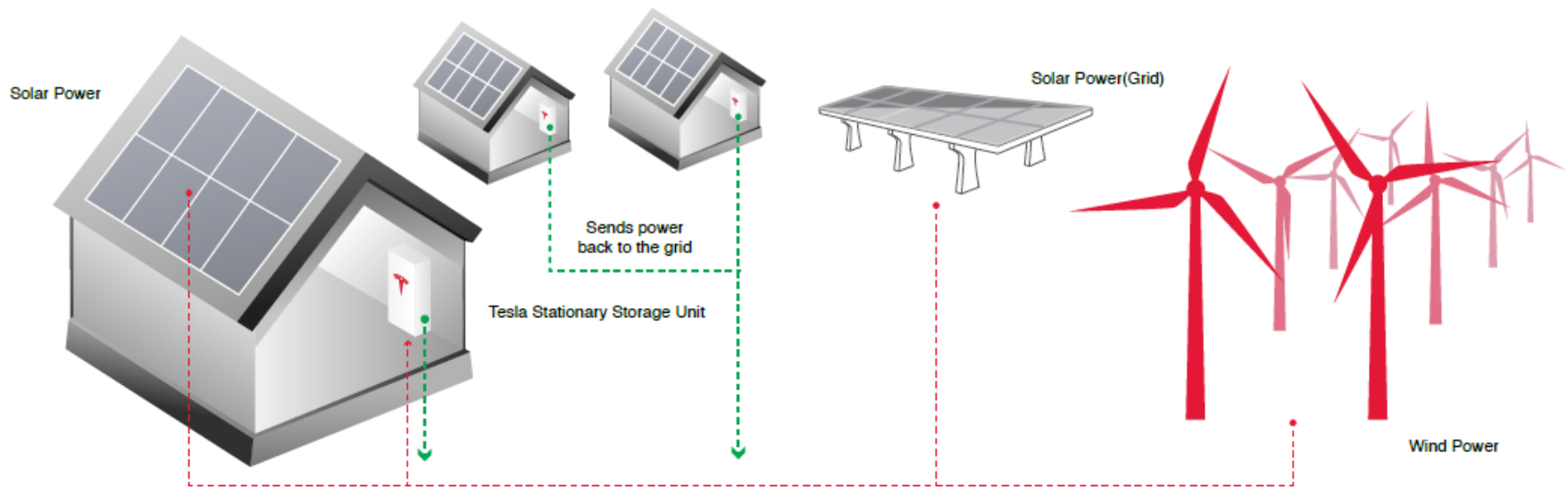


Stationary Storage with Tesla Motors

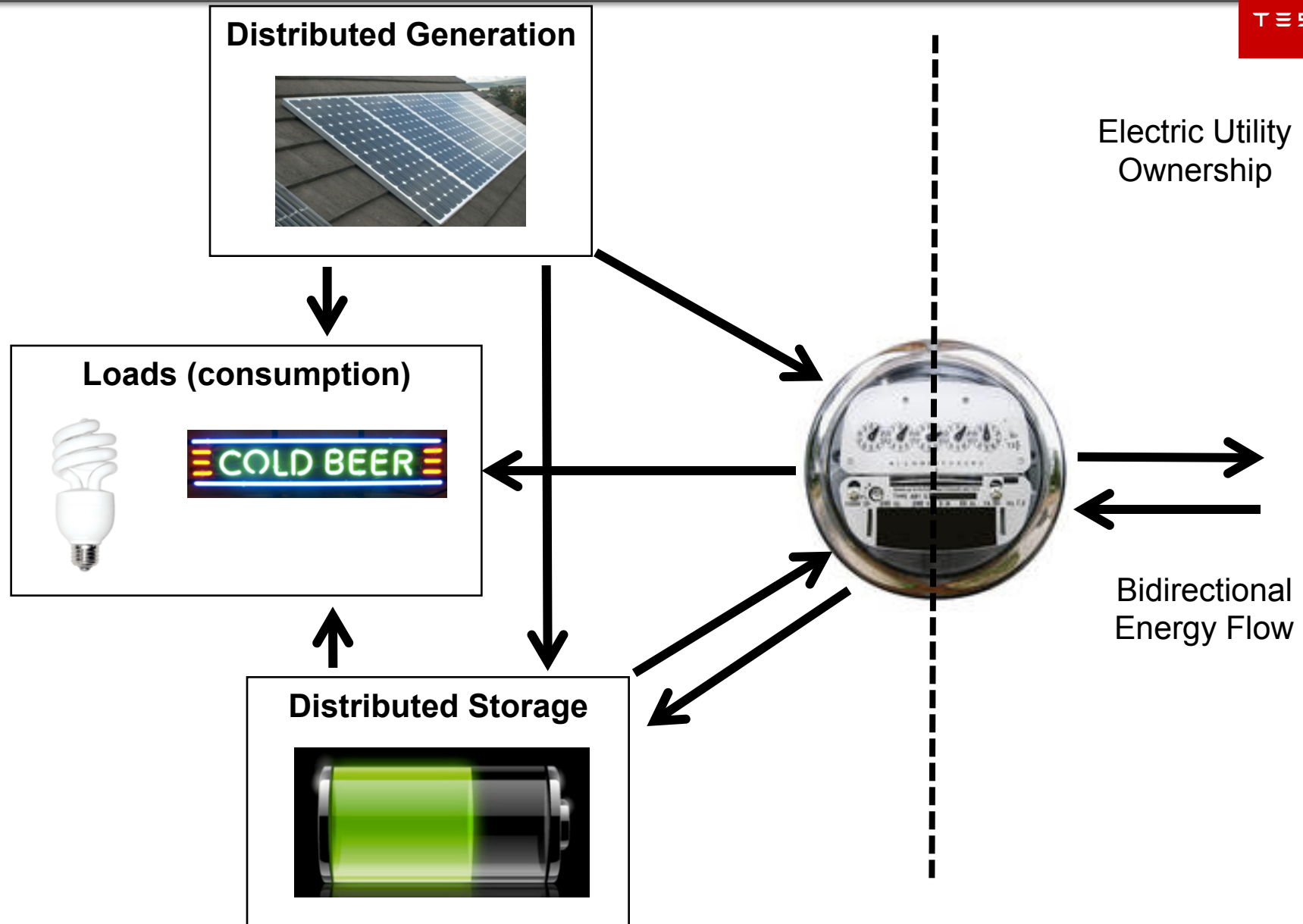
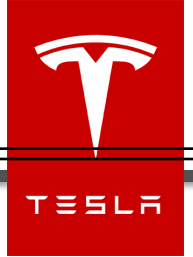


Goal: Enable Clean Transportation

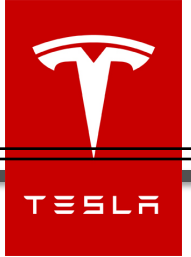
- Electric Vehicles should be paired with a clean, low-carbon grid
- Storage enables less carbon intense grid
- Tesla has the highest performance, lowest cost, storage solution at massive (Gigawatt) scale



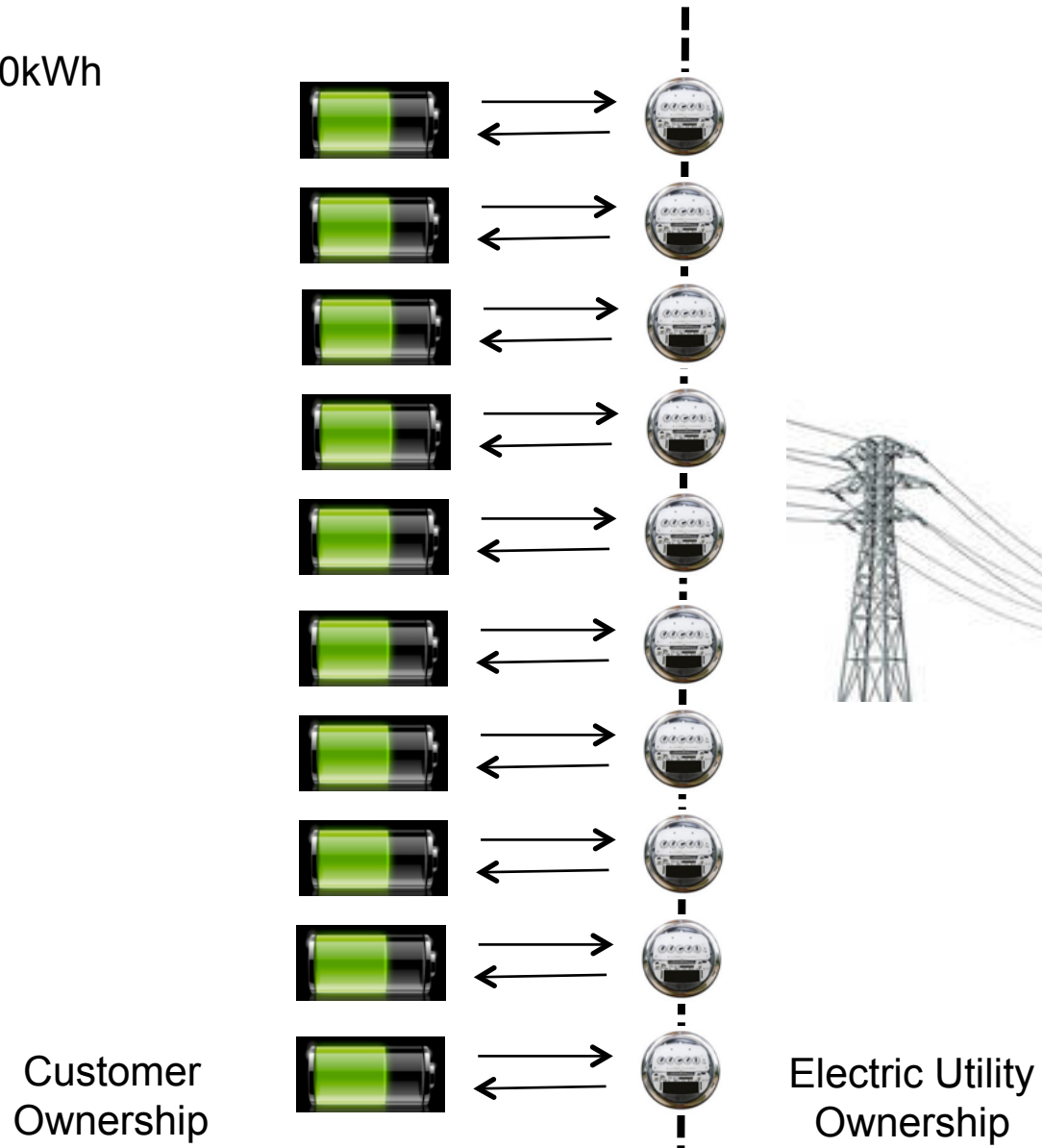
Behind the Meter Concept w/ Solar Net Metering



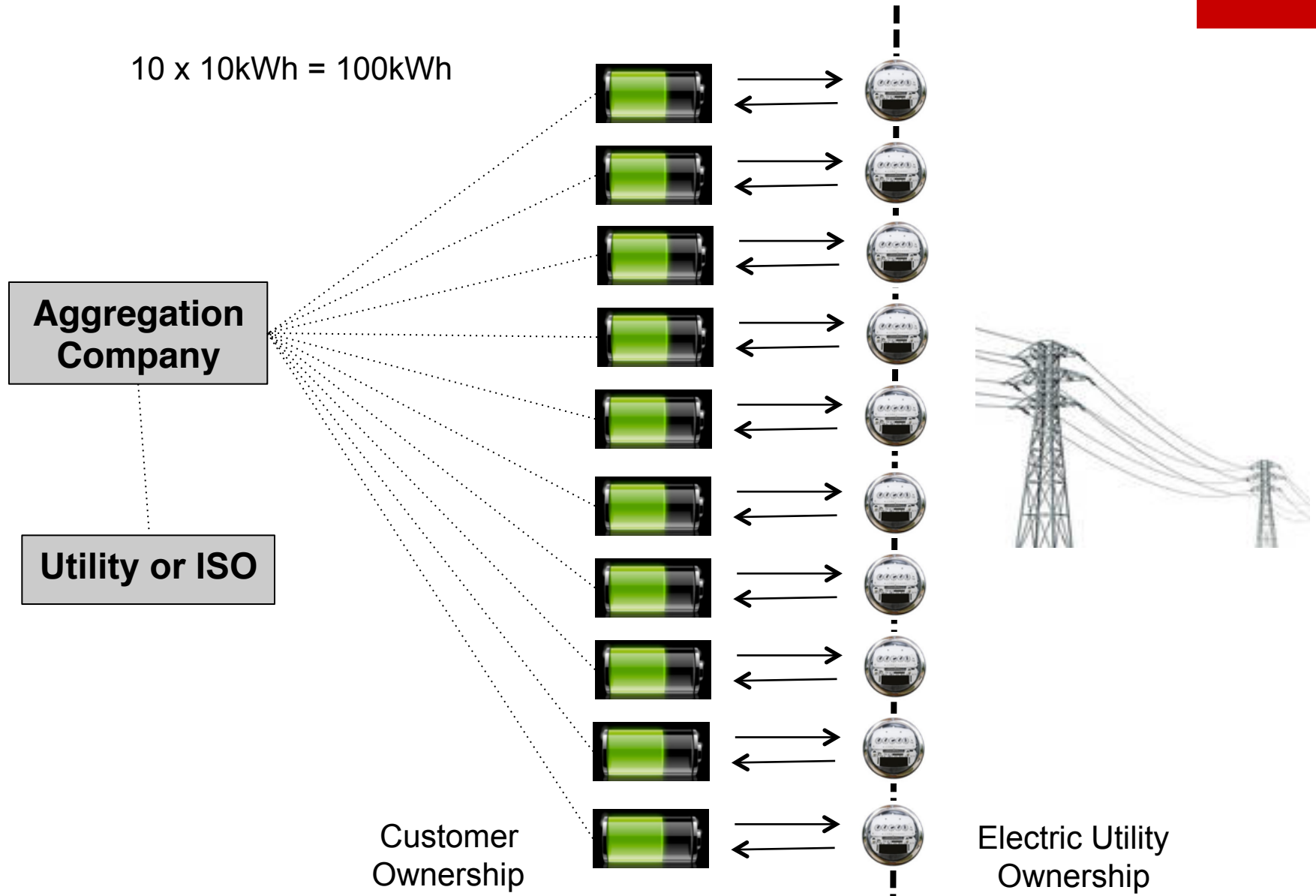
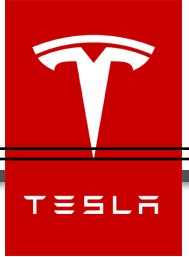
Behind the Meter Storage Aggregation



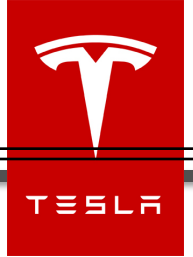
10 x 10kWh = 100kWh



Behind the Meter Storage Aggregation



Behind the Meter Storage Aggregation



$60 \times 10\text{kWh} = 600\text{kWh}$

$100,000 \text{ homes} \times 10\text{kWh} = 1,000\text{MWh} = 1\text{GWh}$

**Aggregation
Company**

Utility or ISO

Customer
Ownership

Electric Utility
Ownership



Downstream (savings)



- **Load Shifting:** Reduce energy costs by charging battery at night and using that energy during the day
- **Peak Shaving:** Lower demand charges by smoothing demand
- **Demand Response** - Retail market participation
- **Grid Services** - Capacity/resource adequacy, frequency regulation, non-spin reserve
- **Capacity Firming** - Support adoption of renewables

Upstream (revenue)

Energy Storage Product Overview



Product Line	Automotive	Residential	Commercial
Power/Energy	310 kW / 85 kWh	5 kW / 10 kWh	200 kW / 400 kWh+

 Listed

Outdoor Rated

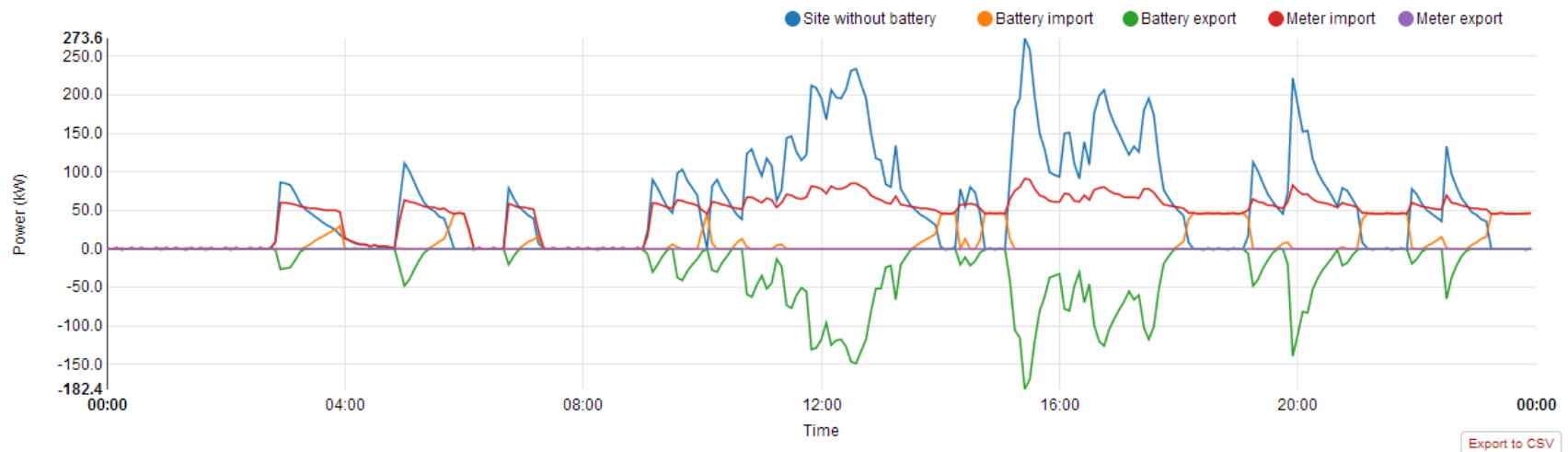
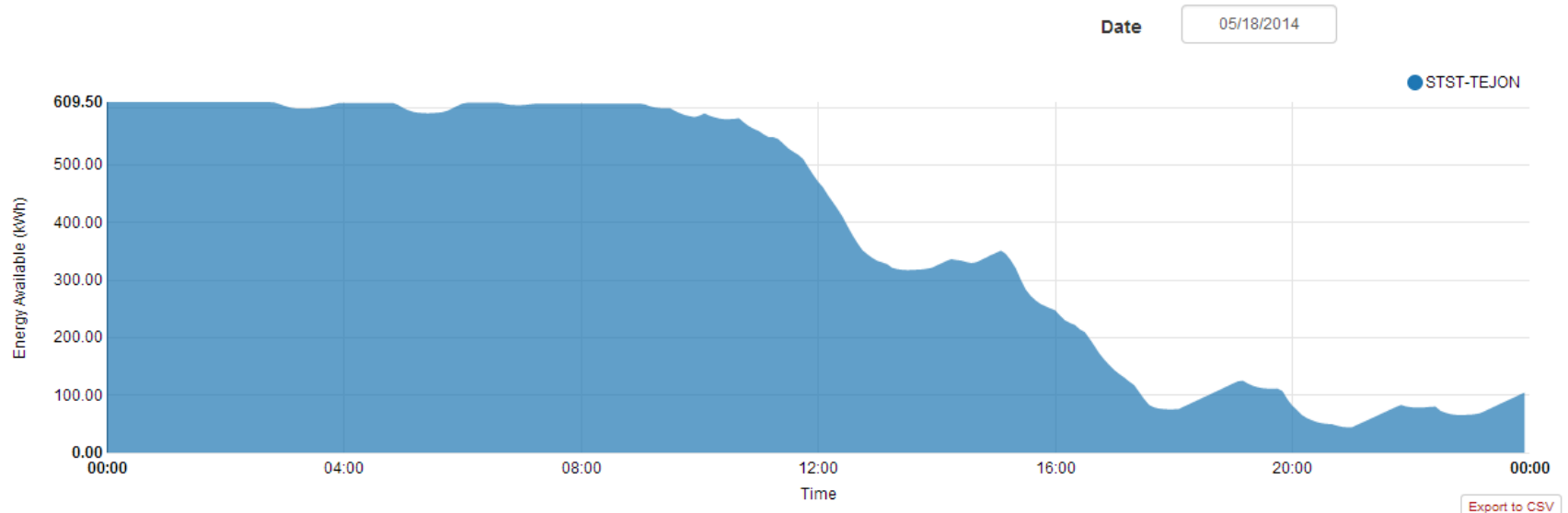



Power Buffering at Supercharger in CA (Tejon Ranch)

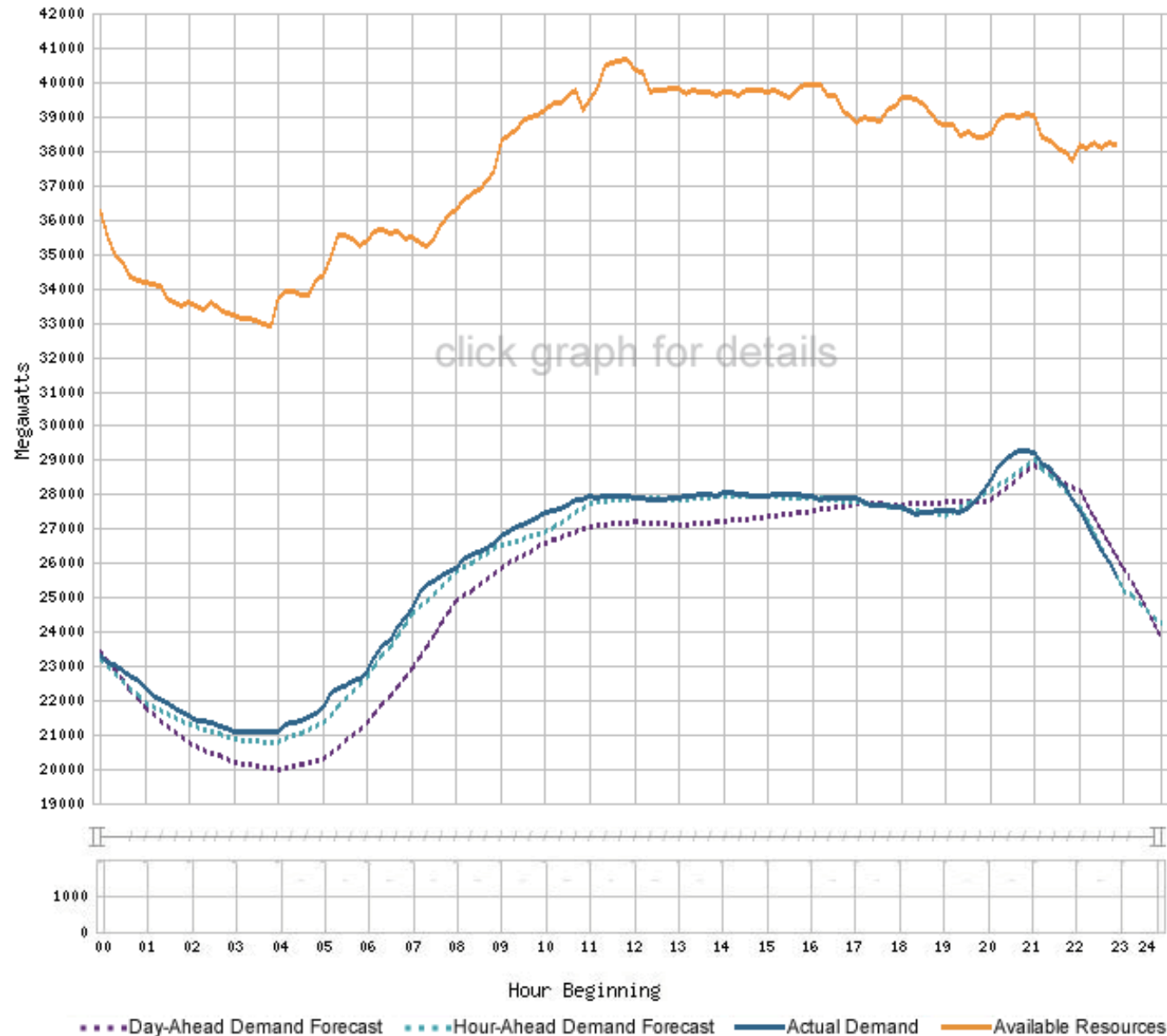


400 kWh battery pack

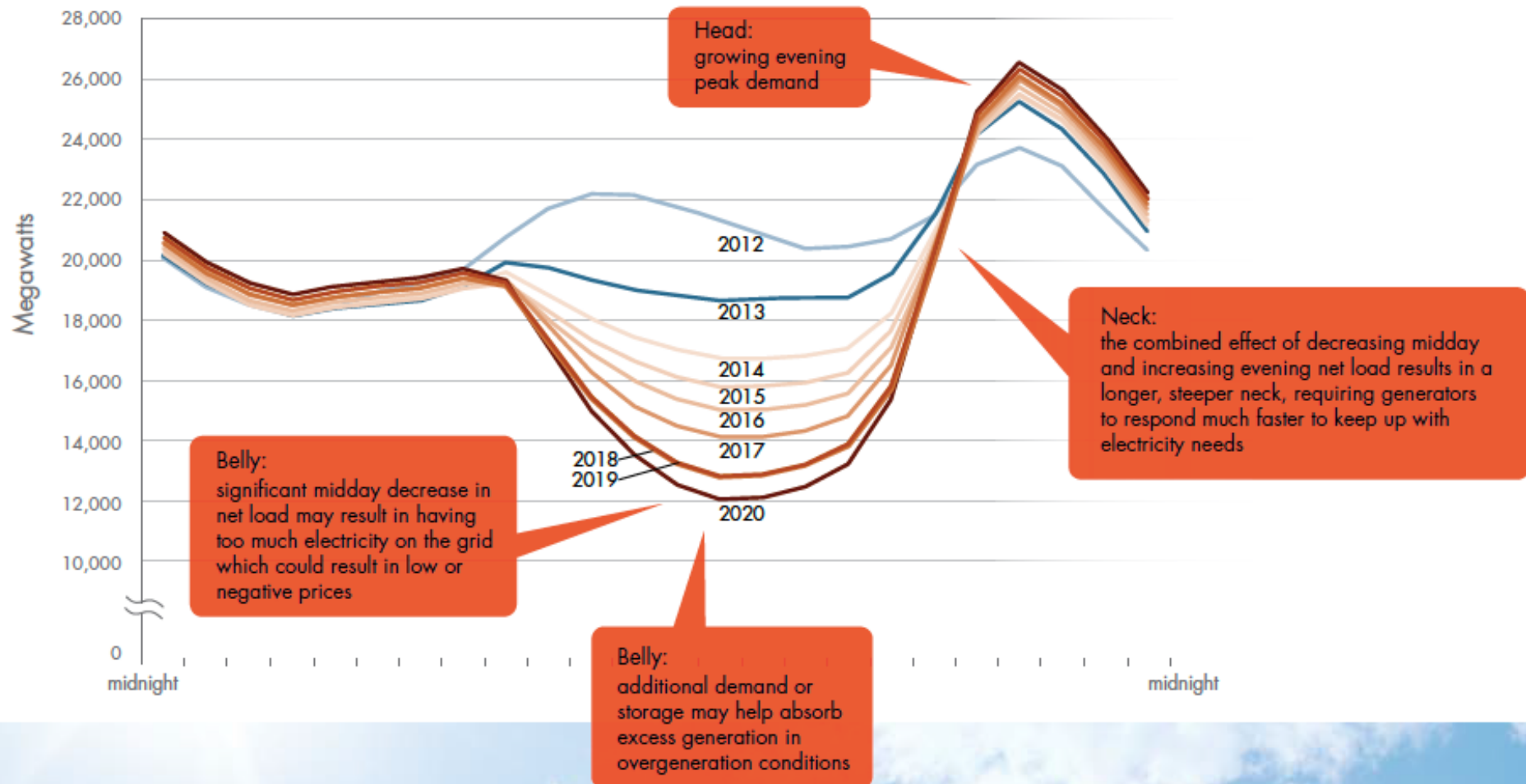
Busiest recent day (Sun 5/18)



CAISO System Load for May 19th, 2014



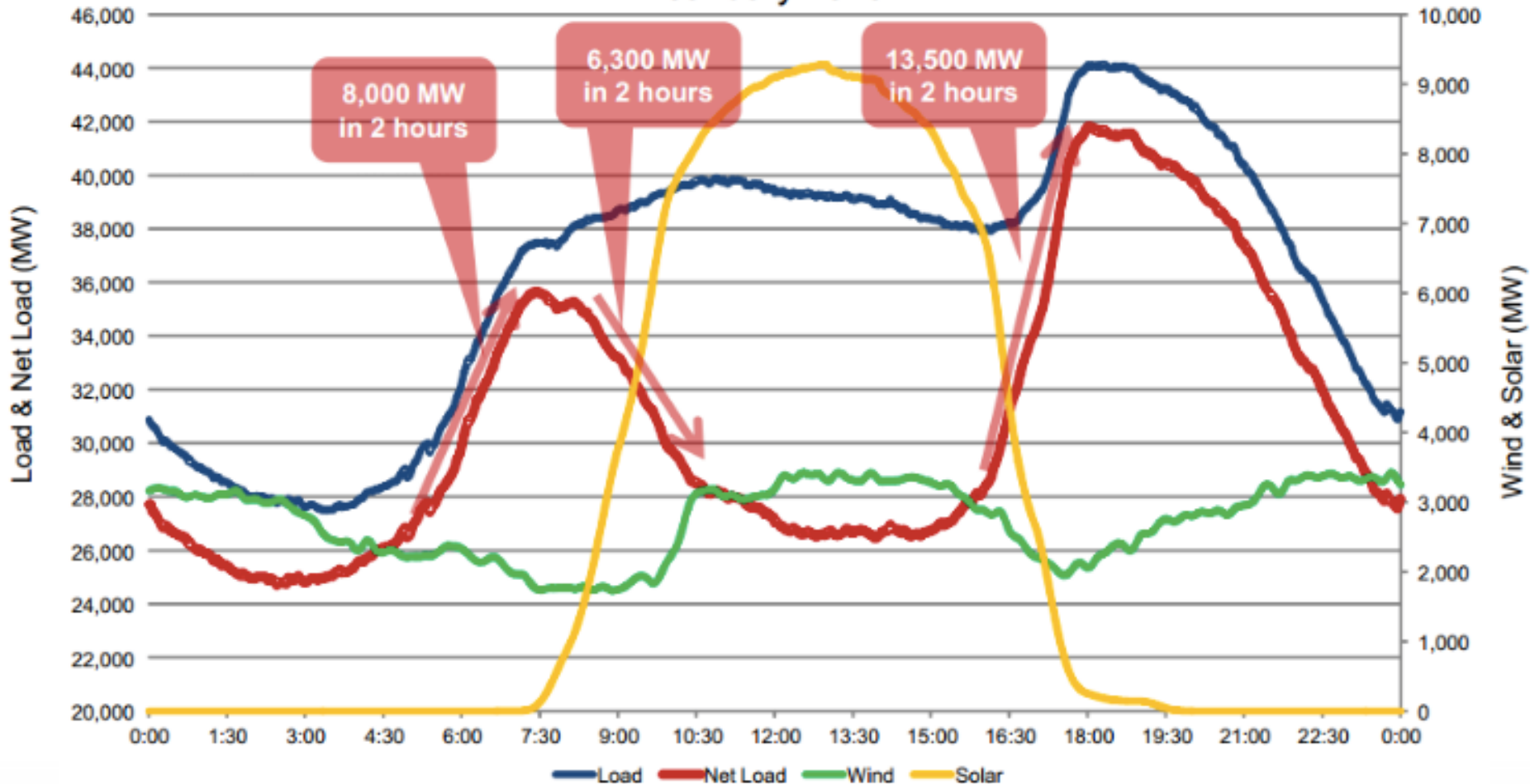
Residential Electric Rates



Residential Electric Rates



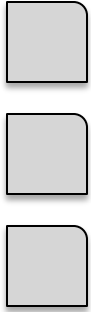
CAISO Load, Wind & Solar Profiles – High Load Case
January 2020



Stationary Storage with Tesla Motors



400 kWh Scalable System



Scalable
Building
Blocks

1MW / 2 MWh



200kW / 400 kWh

200kW / 400 kWh

200kW / 400 kWh

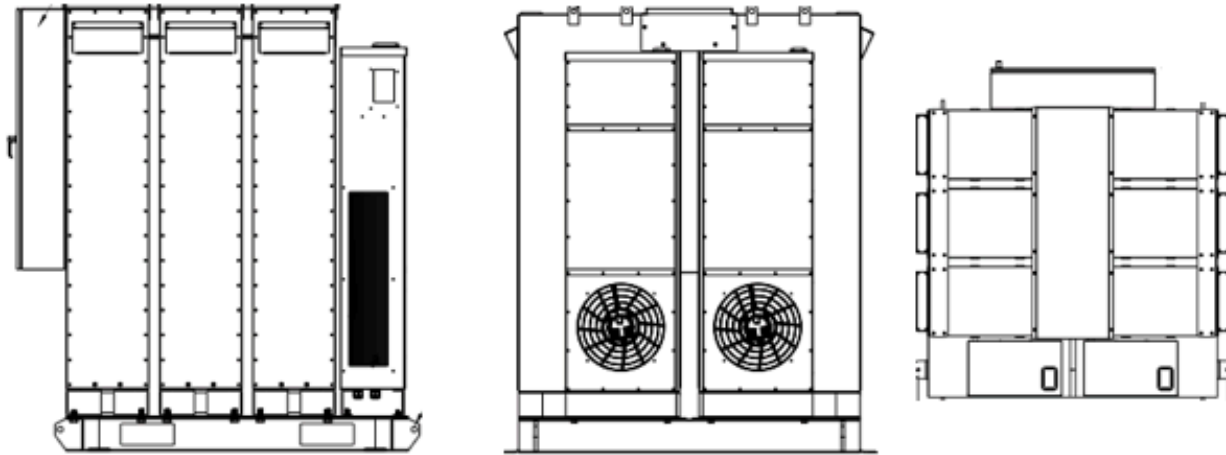
200kW / 400 kWh

200kW / 400 kWh



Tesla Factory
Fremont, CA

400 kWh Building Block



Electrical

Voltage	208 or 480 VAC
Continuous Charge/ Discharge Power (2hr)	200 kW
Rated Storage Capacity*	400 kWh
System Efficiency @ C/2	89% / 80% 1way/RT
System Efficiency @ C/4	93% / 86% 1way/RT

*Net energy delivered at AC voltage, based on 2hr discharge at rated power

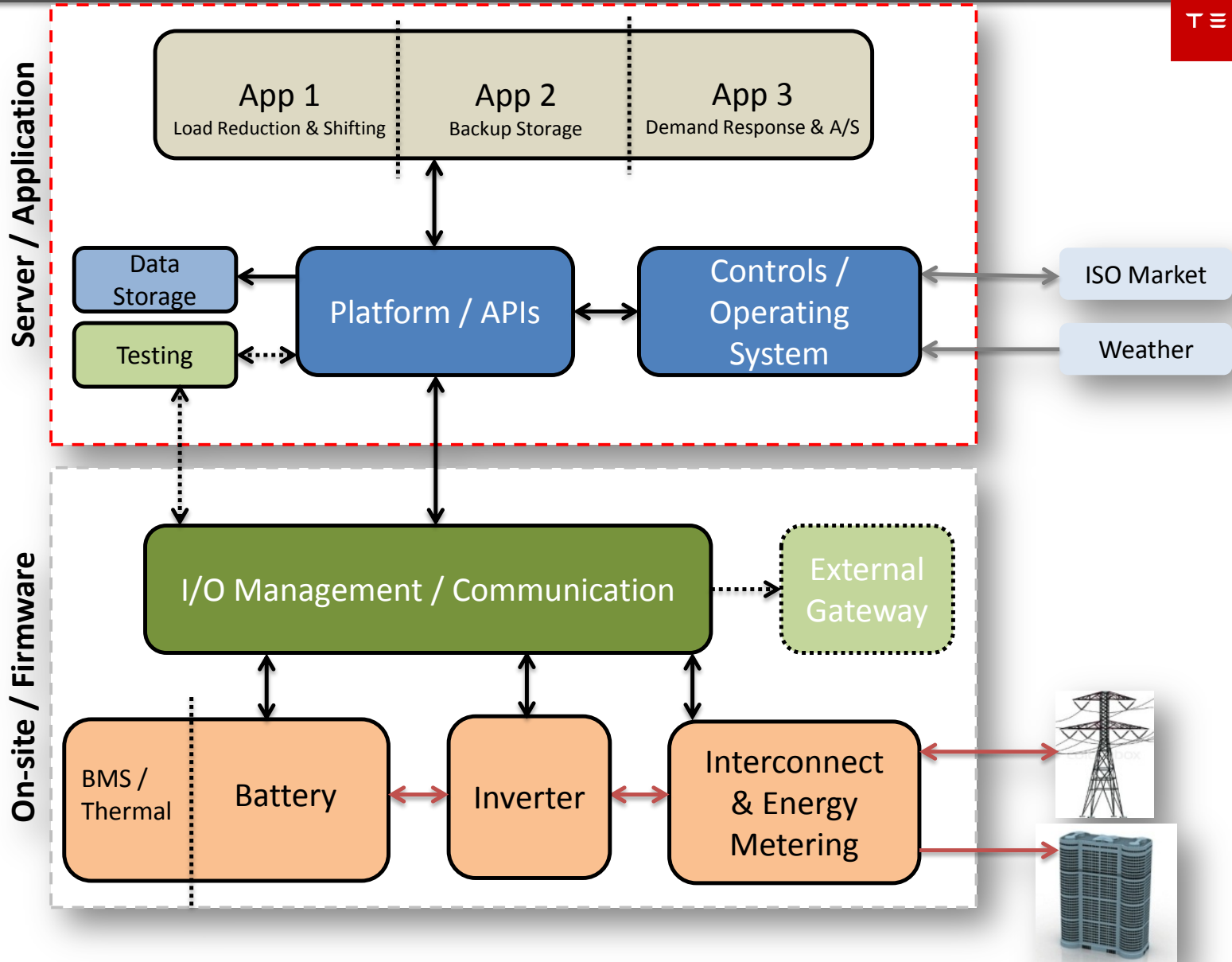
Mechanical & Mounting

Packaging	10 ft. Steel Pallet
Weight	8,000 kg / 17,637 lb.
Dimensions	1750 x 2500 x 1500mm / 69 x 99 x 59 in

Regulatory

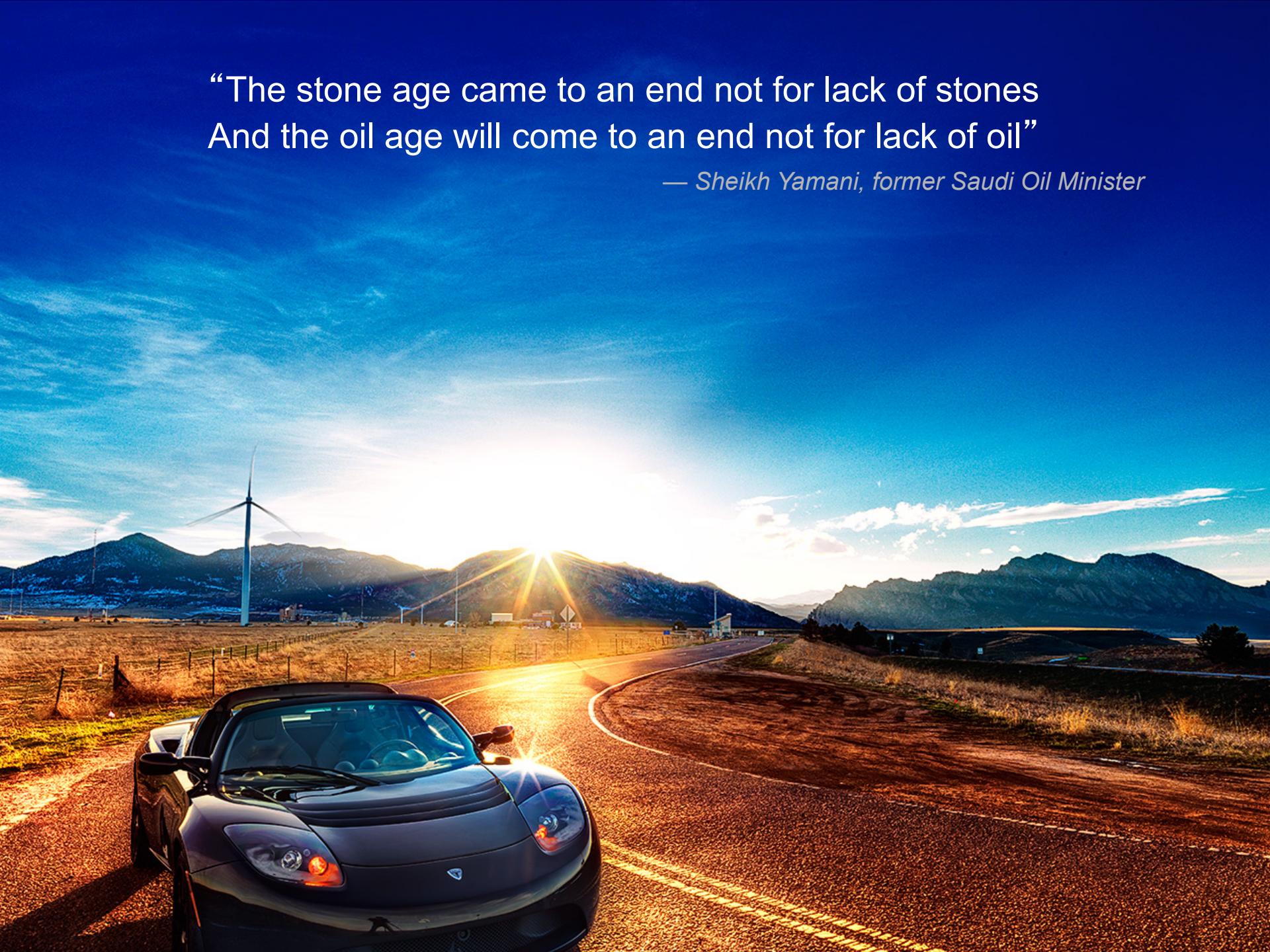
Lithium-Ion Cells	UL 1642
Power Electronics	UL 1741
System (planned)	UL 1973

Architecture



“The stone age came to an end not for lack of stones
And the oil age will come to an end not for lack of oil”

— Sheikh Yamani, former Saudi Oil Minister



Keynote Presentation



JB Straubel

Chief Technology Officer, *Tesla Motors*



Silicon Valley/SEEDZ Energy Storage Symposium
May 21, 2014
Mountain View, California

5th
ANNUAL

SILICON VALLEY / SEEDZ

ENERGY STORAGE SYMPOSIUM

The Emerging Market for Customer-Side Energy Storage

May 21, 2014

Microsoft, Mountain View

Event Partners

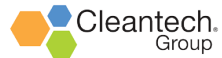


CalCharge

The Center for Sustainable Energy and Power Systems
CENSEPS

Clean Coalition
Making Clean Local Energy Accessible Now

CESA
CALIFORNIA ENERGY STORAGE ALLIANCE



ELECTRIC POWER
RESEARCH INSTITUTE



Energy
Storage
Association



LAWYERS FOR CLEAN ENERGY

McCalmont
Engineering

MegaWatt
Storage Farms, Inc.



**Pacific Gas and
Electric Company**

**PRIMUS
POWER**

SJSU SAN JOSÉ STATE
UNIVERSITY

**SILICON VALLEY
LEADERSHIP GROUP**

SRI International

STRATEGEN
STRATEGIES FOR CLEAN ENERGY



Exhibitors



CESA
CALIFORNIA ENERGY STORAGE ALLIANCE



Santa Clara Valley
Chapter, IEEE

ip | CHECKUPSSM
an eye on invention