ENERGY SYSTEMS INTEGRATION

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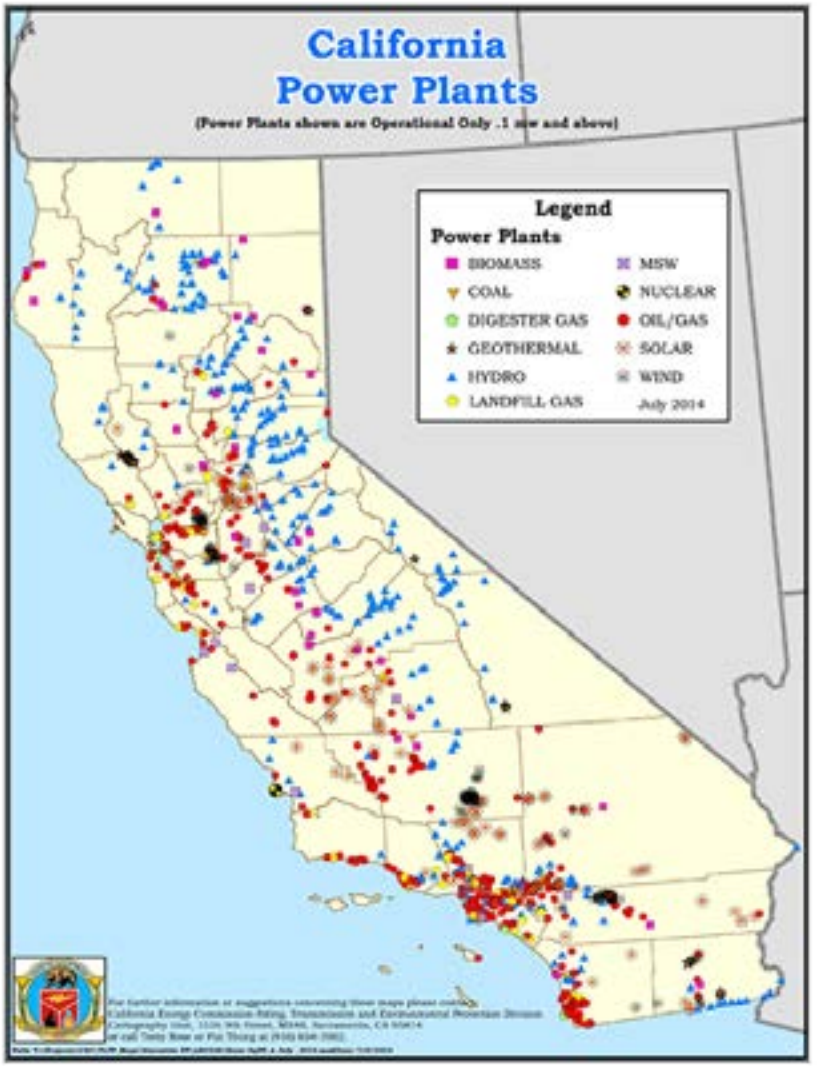
Before I begin……

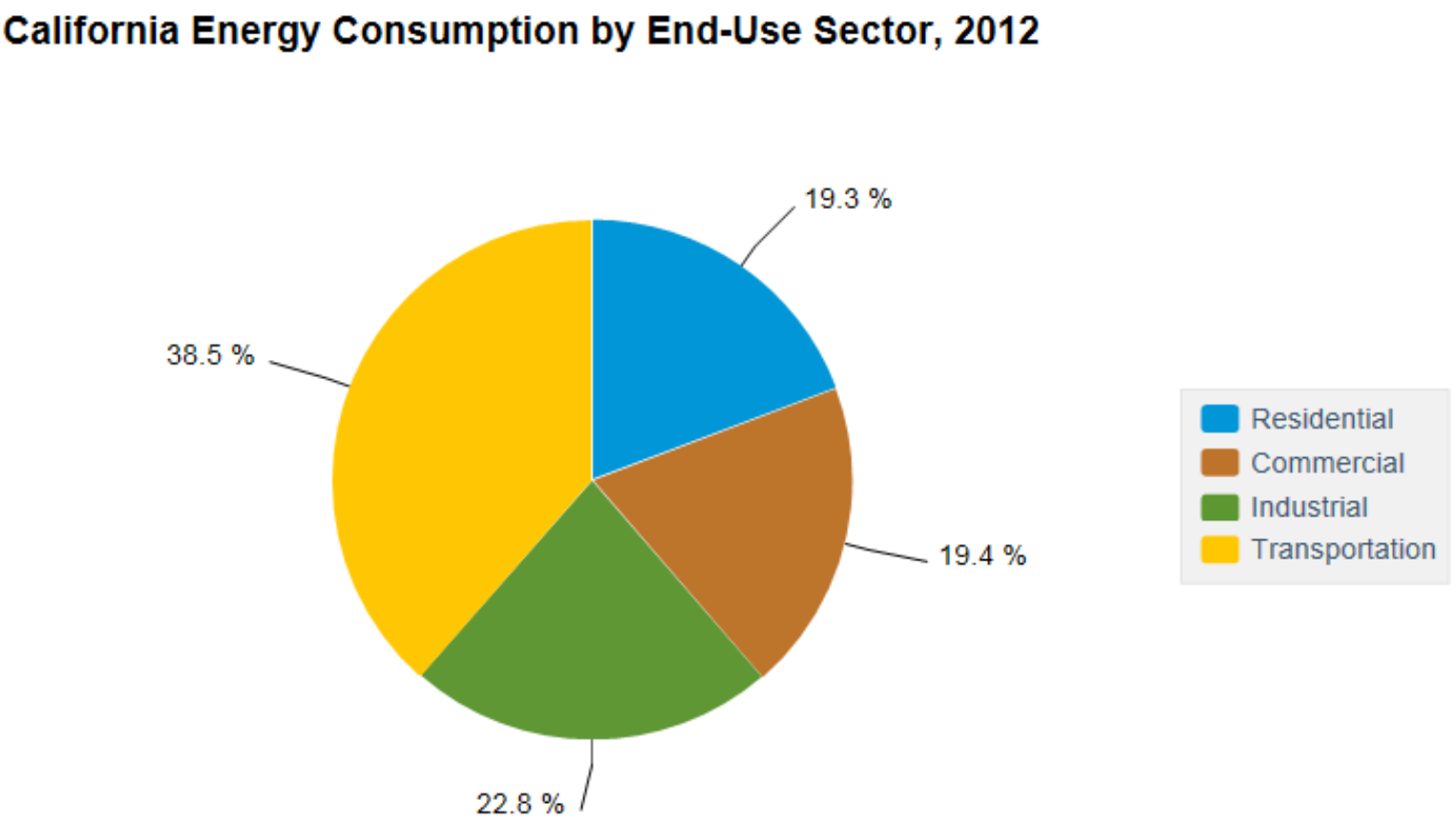
https://www.elitchgardens.com/theme-park/

California

- Population - 38.3 million
- Considerable energy and water demand.
- Imports 25% of its electricity
- Highly interconnected grid
- Large solar energy resource
- Proactive and innovative

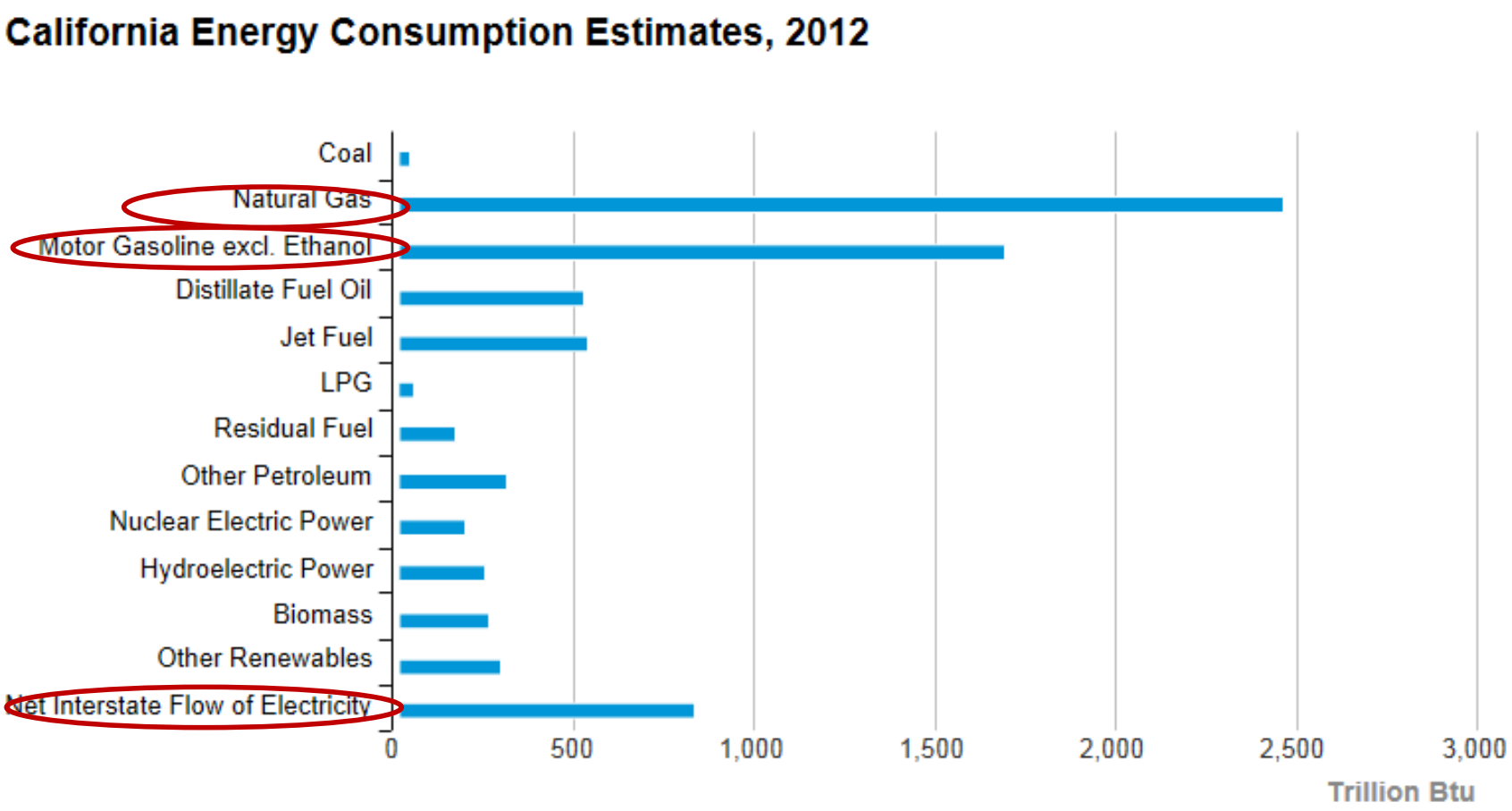


Energy Consumption by End Use



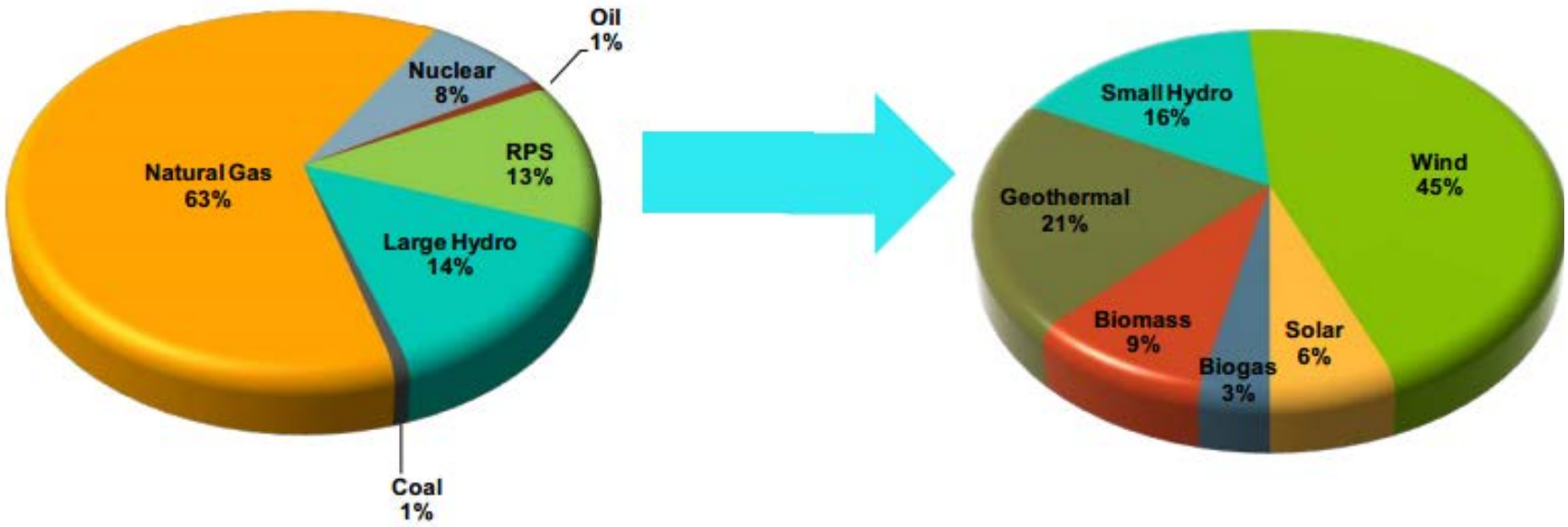
Source: Energy Information Administration, State Energy Data System

Energy Consumption



Source: Energy Information Administration, State Energy Data System

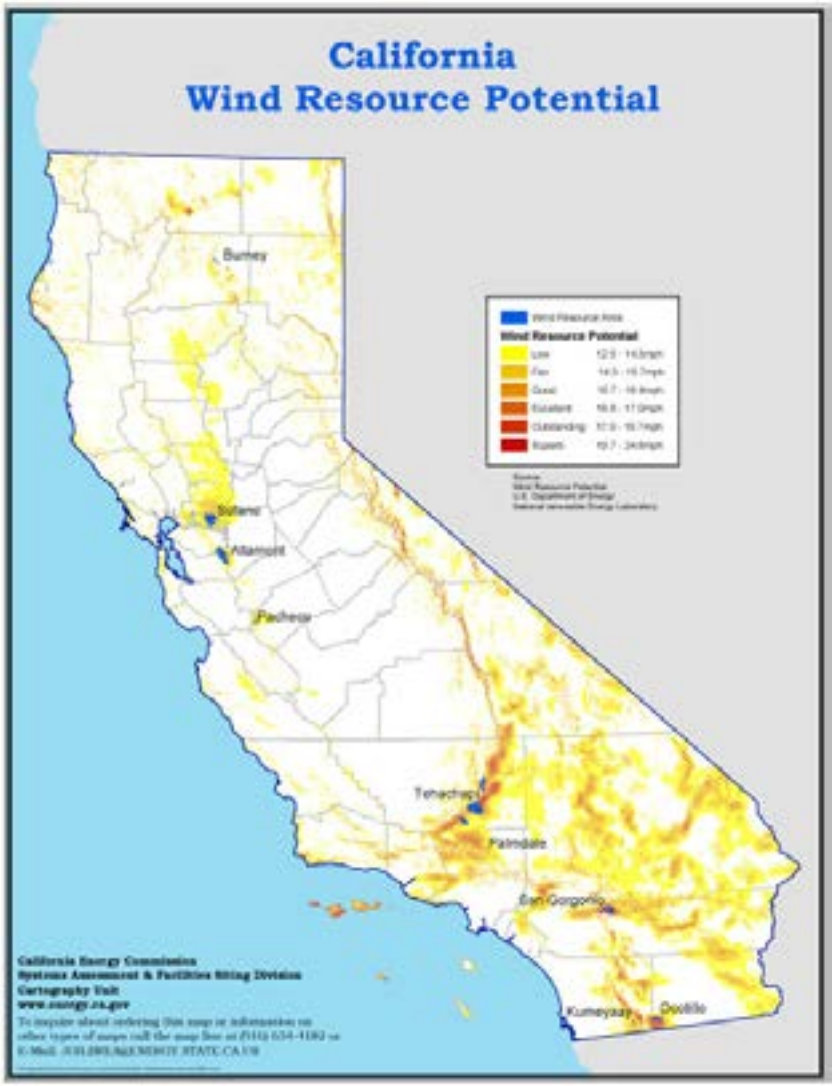
Electricity Generation Mix – 2011

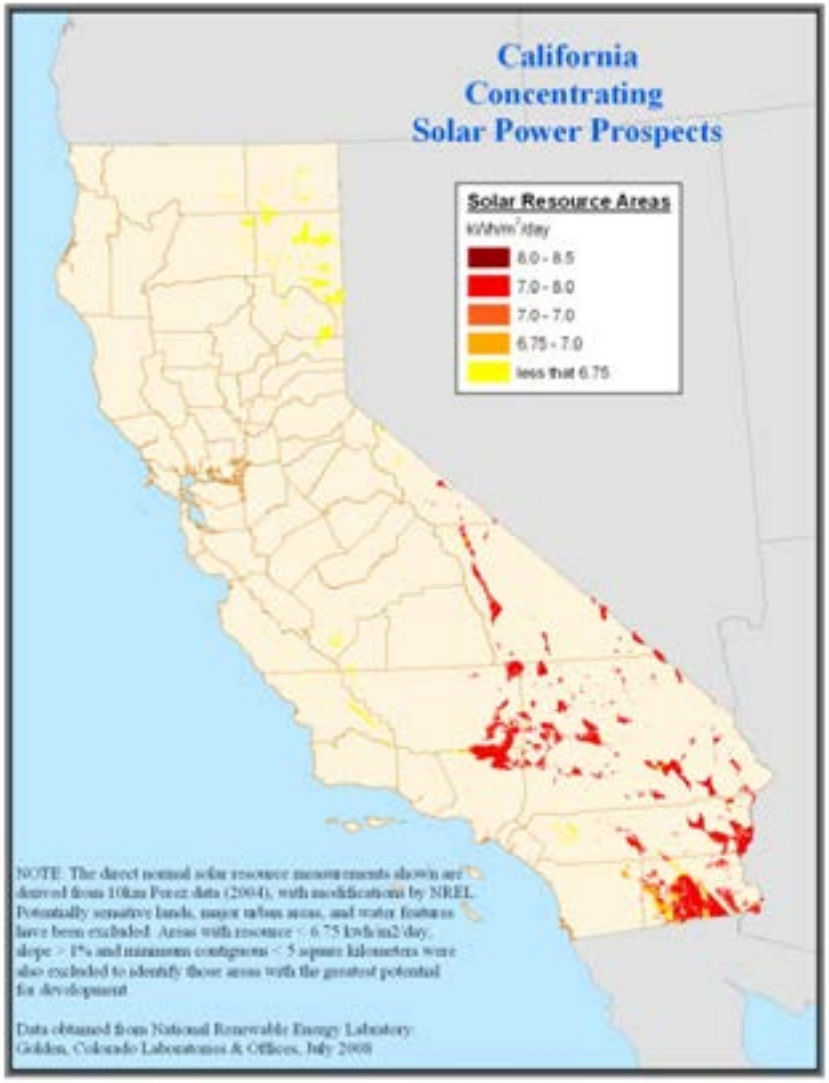


Source: http://www.caiso.com/2b67/2b67e90f7520.pdf

ENERGY RESOURCES

Wind and Solar

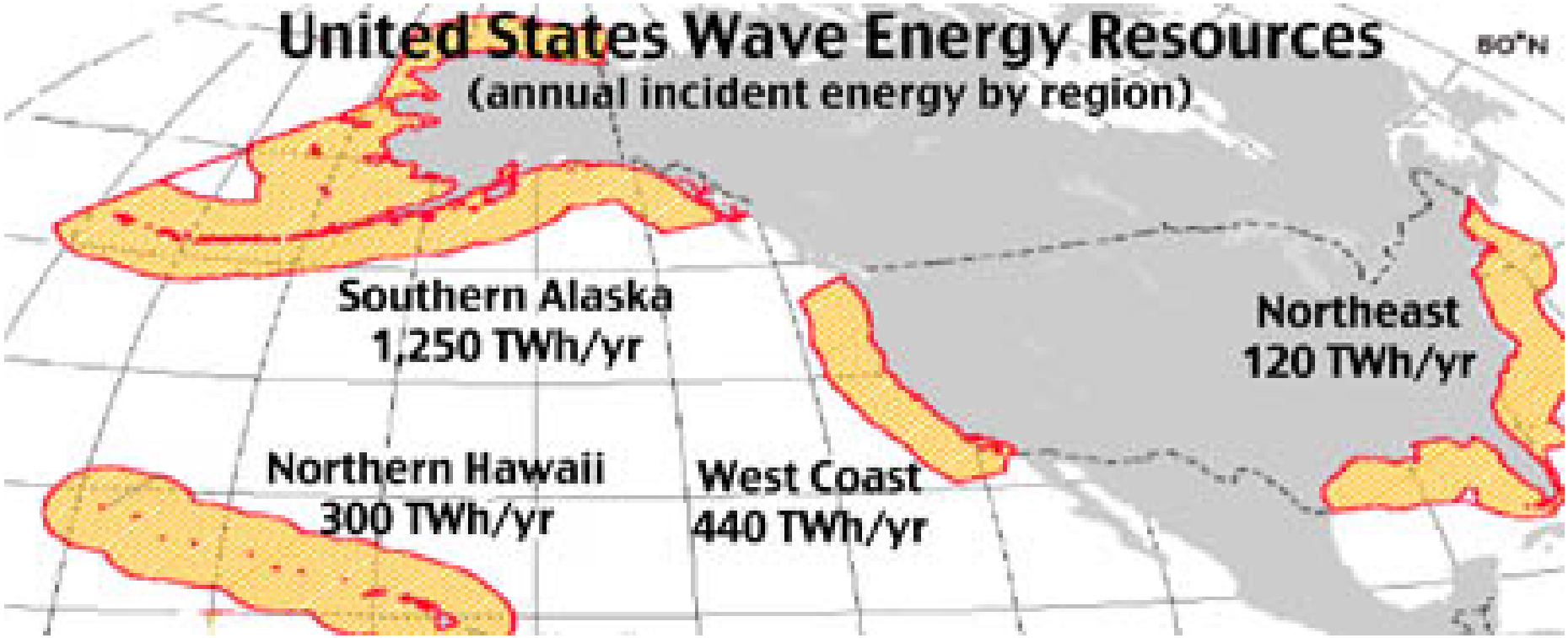




Geothermal

- Considerable geothermal resource

Ocean Energy



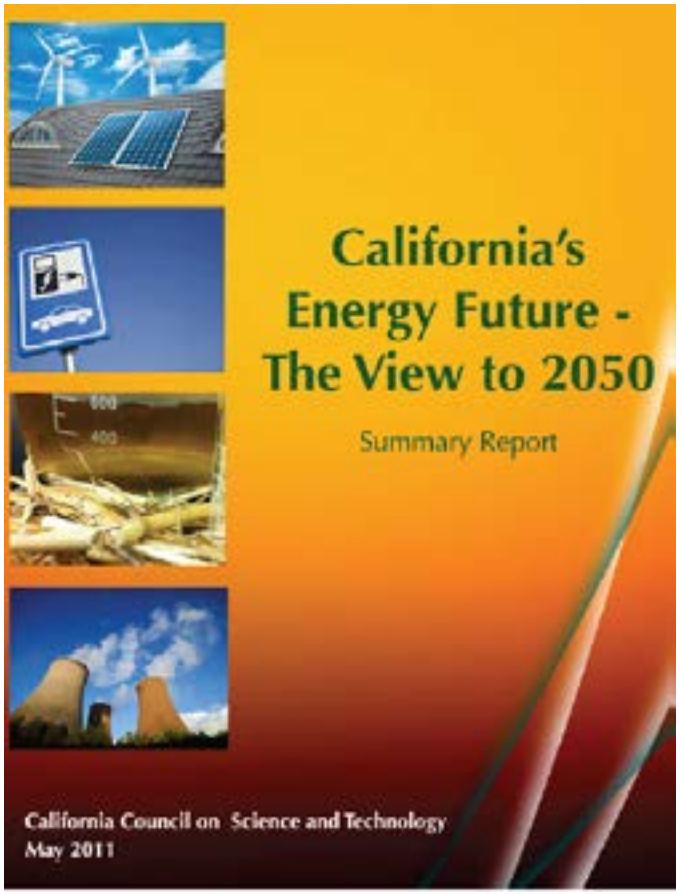
Source: http://www.rnp.org/node/wave-tidal-energy-technology

FUTURE FUEL MIX

2030 and 2050

Fuel Mix 2030 and 2050 – Drivers

- 33% renewables by 2030
  - Thermal plant decommissioning
  - Environmental concerns
- Greater consumer involvement
- GHG emissions reduction
  80% below 1990 levels by 2050
- Population projection of 55 million in 2050

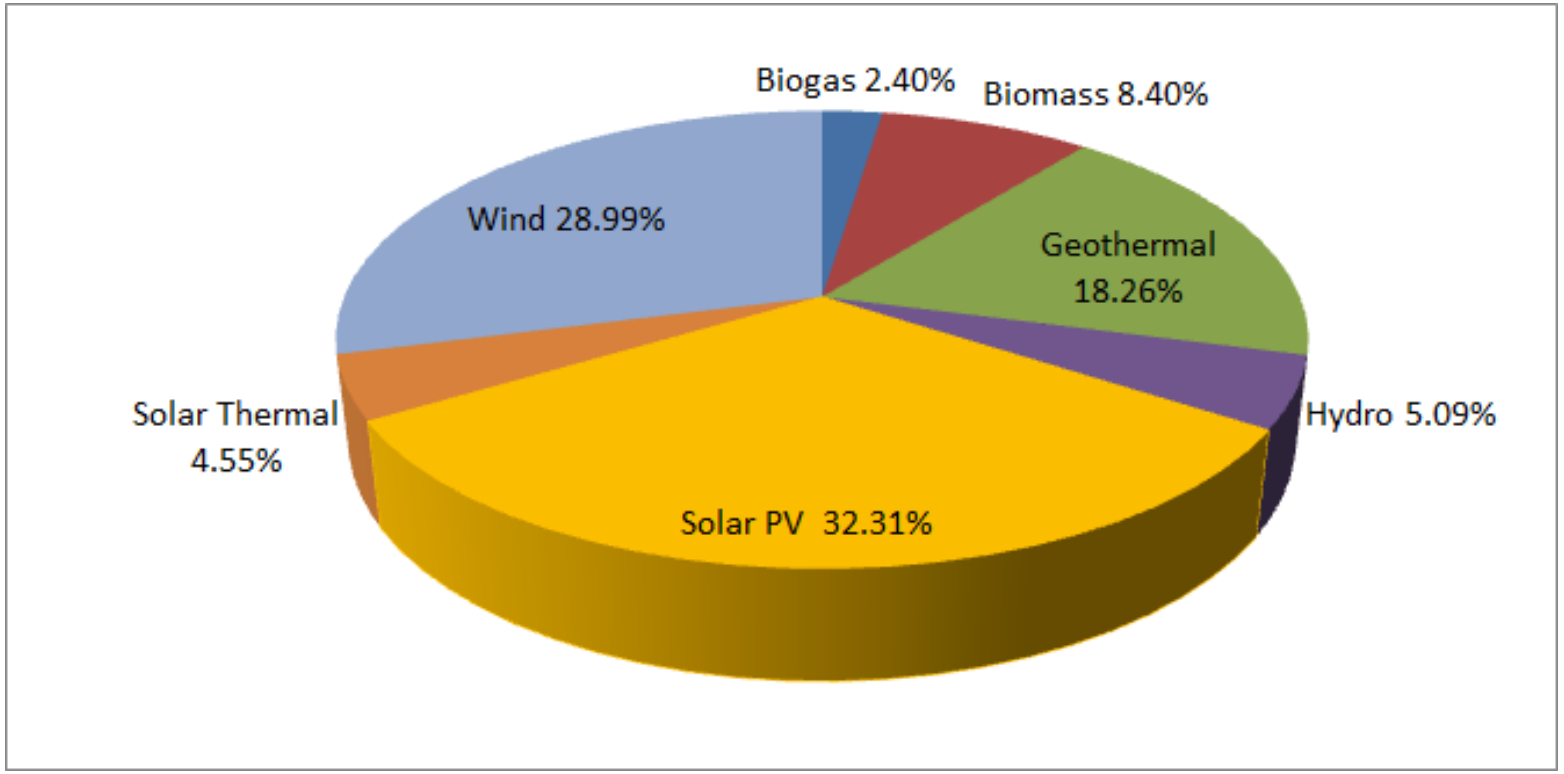


2030 Renewable Generation Mix by Resource Type and Scenario (in GWh)

	33% RPS	40% RPS	50% RPS Large Solar	50% RPS Diverse	50% RPS Small Solar	50% RPS Rooftop Solar
Utility RPS Procurement						
Biogas	2,133	2,133	2,133	4,422	2,133	2,133
Biomass	7,465	7,465	7,465	9,754	7,465	7,465
Geothermal	16,231	16,231	16,231	20,811	16,231	16,231
Hydro	4,525	4,525	4,525	4,525	4,525	4,525
Solar PV - Rooftop	0	943	2,290	2,290	2,290	22,898
Solar PV - Small	6,536	9,365	13,405	13,405	31,724	11,116
Solar PV - Large	22,190	33,504	49,667	29,059	31,349	31,349
Solar Thermal	4,044	4,044	4,044	10,913	4,044	4,044
Wind (In State)	20,789	24,561	29,948	27,659	29,948	29,948
Wind (Out-of-State)	4,985	4,985	4,985	11,854	4,985	4,985
Subtotal, Utility Gen	**88,897**	**107,755**	**134,693**	**134,693**	**134,693**	**134,693**
Customer Renewable Generation						
Solar PV – Rooftop, net energy metered	10,467	10,467	10,467	10,467	10,467	10,467
Subtotal, Customer Gen	**10,467**	**10,467**	**10,467**	**10,467**	**10,467**	**10,467**
Total Renewable Generation						
Total, All Sources	**99,365**	**118,222**	**145,160**	**145,160**	**145,160**	**145,160**

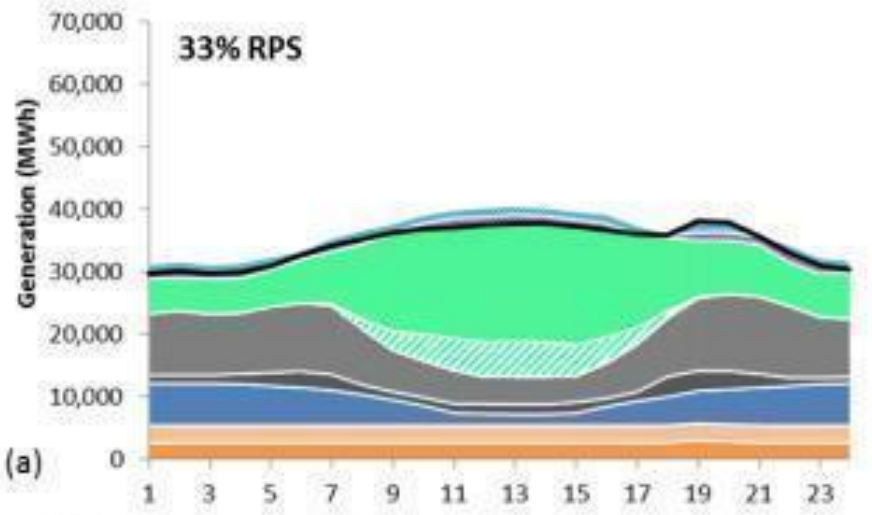
Renewable Electricity Mix in 2030

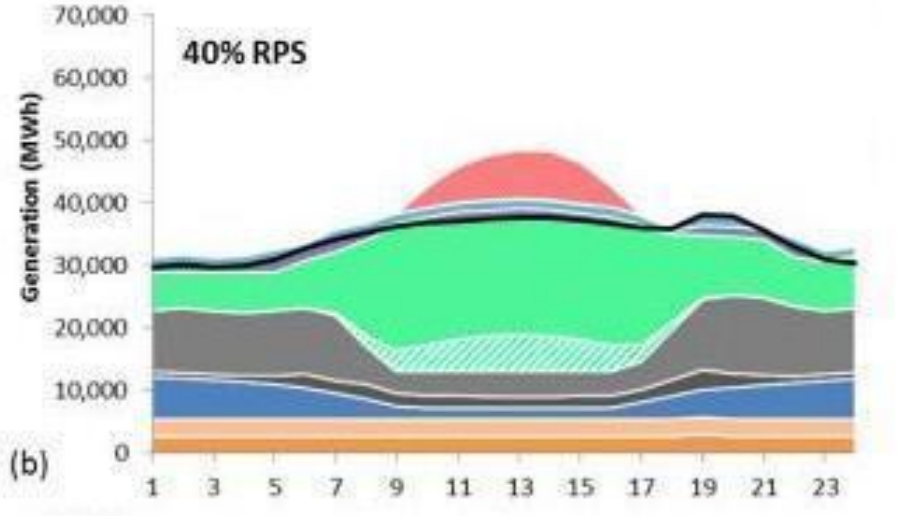
33% RPS target

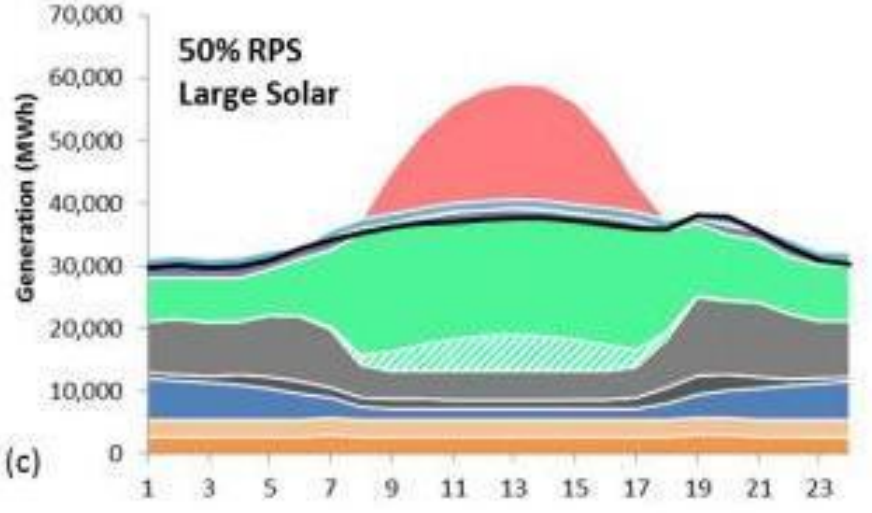


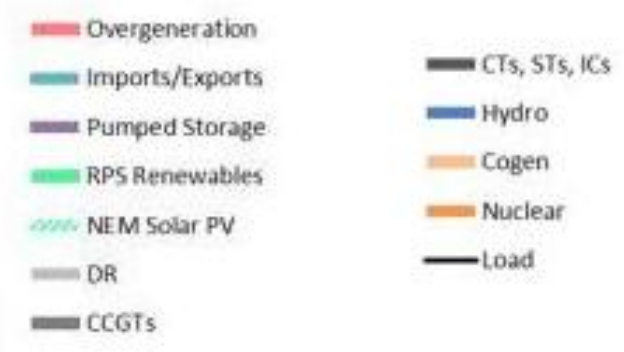
Based on data from :www.ethree.com/documents/E3_Final_RPS_Report_2014_01_06_with_appendices.pdf

Electricity Generation Mix Scenarios 2030









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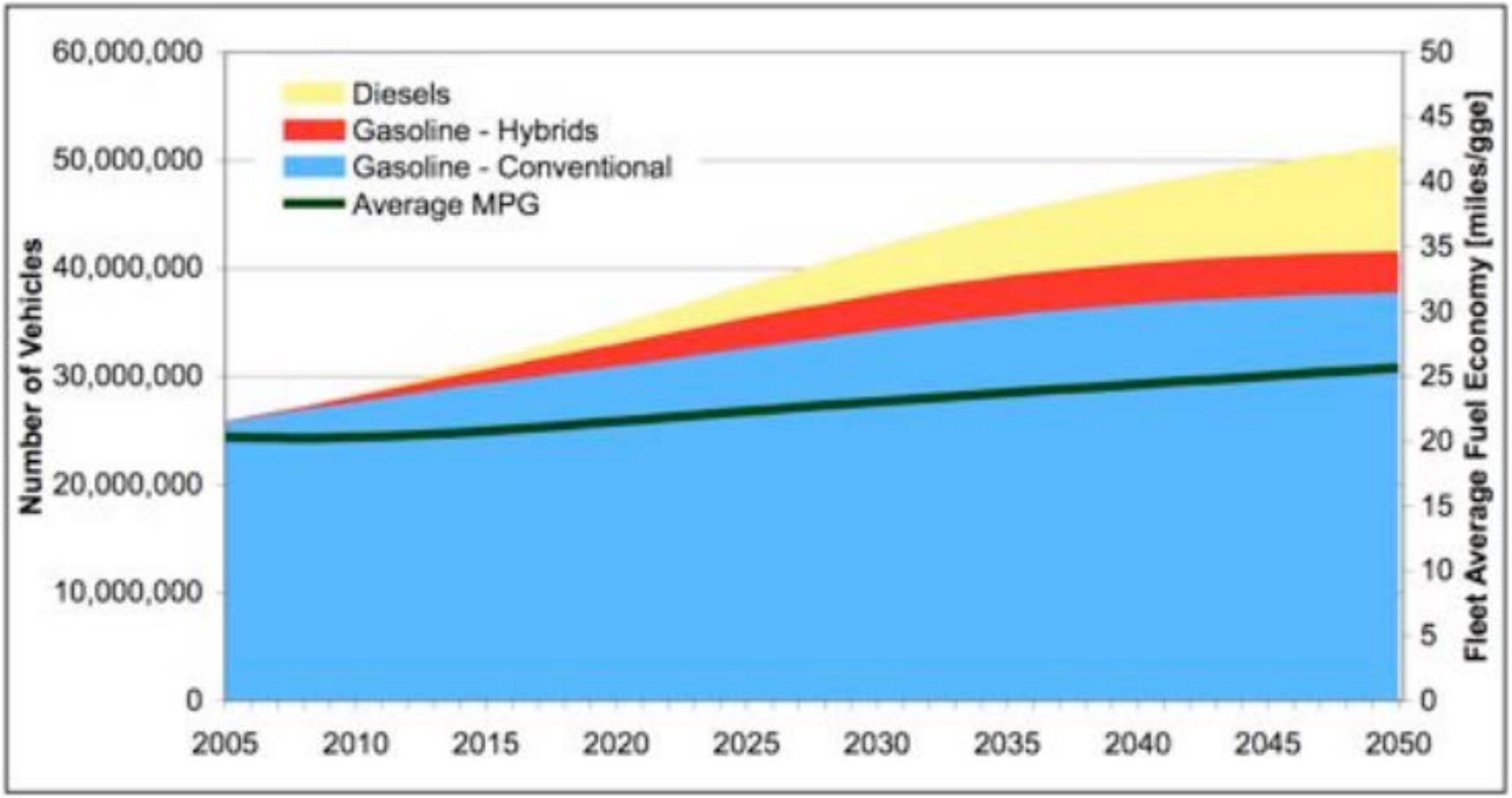
2050 GHG Reduction: Generation Portfolio

Strategy	Assumed plant size	Total plant capacity needed in 2050	Build rate 2011-2050 (Plants/year)
Nuclear	1.5 GW	44 GW	**0.7**
Fossil/CCS	1.5 GW	49 GW	**0.8**
Renewables Mix		**160 GW**	
Wind	500 MW	59 GW	**3**
Central Solar (CSP and PV)	500 MW	57 GW	**3**
Distrib'd. Solar PV	5 kW	19 GW	**100,000**
Biomass/CCS	500 MW	7 GW	**0.3**
CA Biofuels	50 Mgge/yr	5,500 Mgge/yr	**3**
H_2 (onsite NG)	0.5 Mgge/yr	800 Mgge/yr	**40**
H_2 (central plant)	440 Mgge/yr	7,200 Mgge/yr	**0.4**

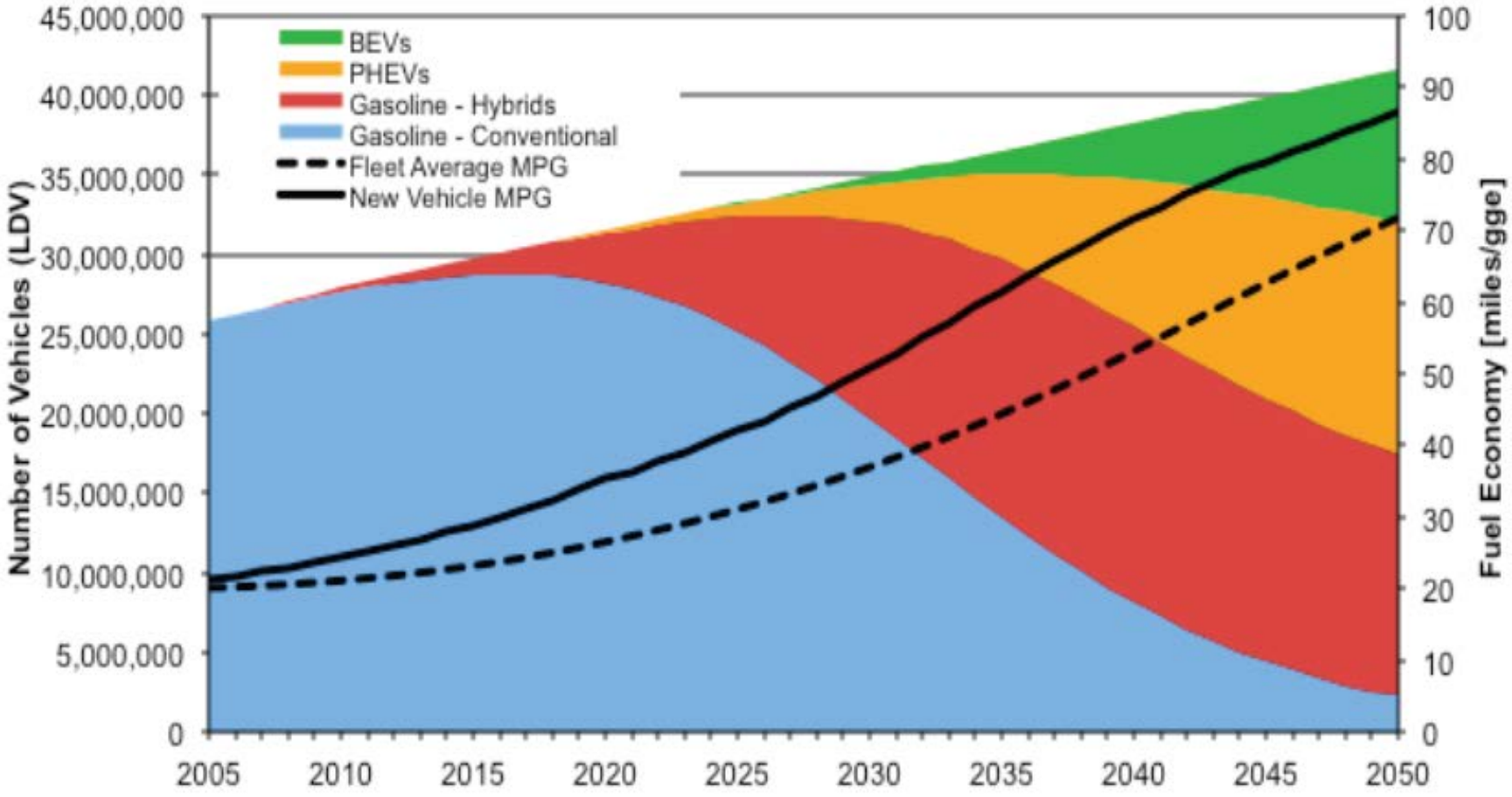
Source: http://www.ccst.us/publications/2011/2011energy.php

Predicted transport energy carriers in 2030 and 2050 - BAU



Source:: California Baseline Energy Demands to 2050 for Advanced Energy Pathways

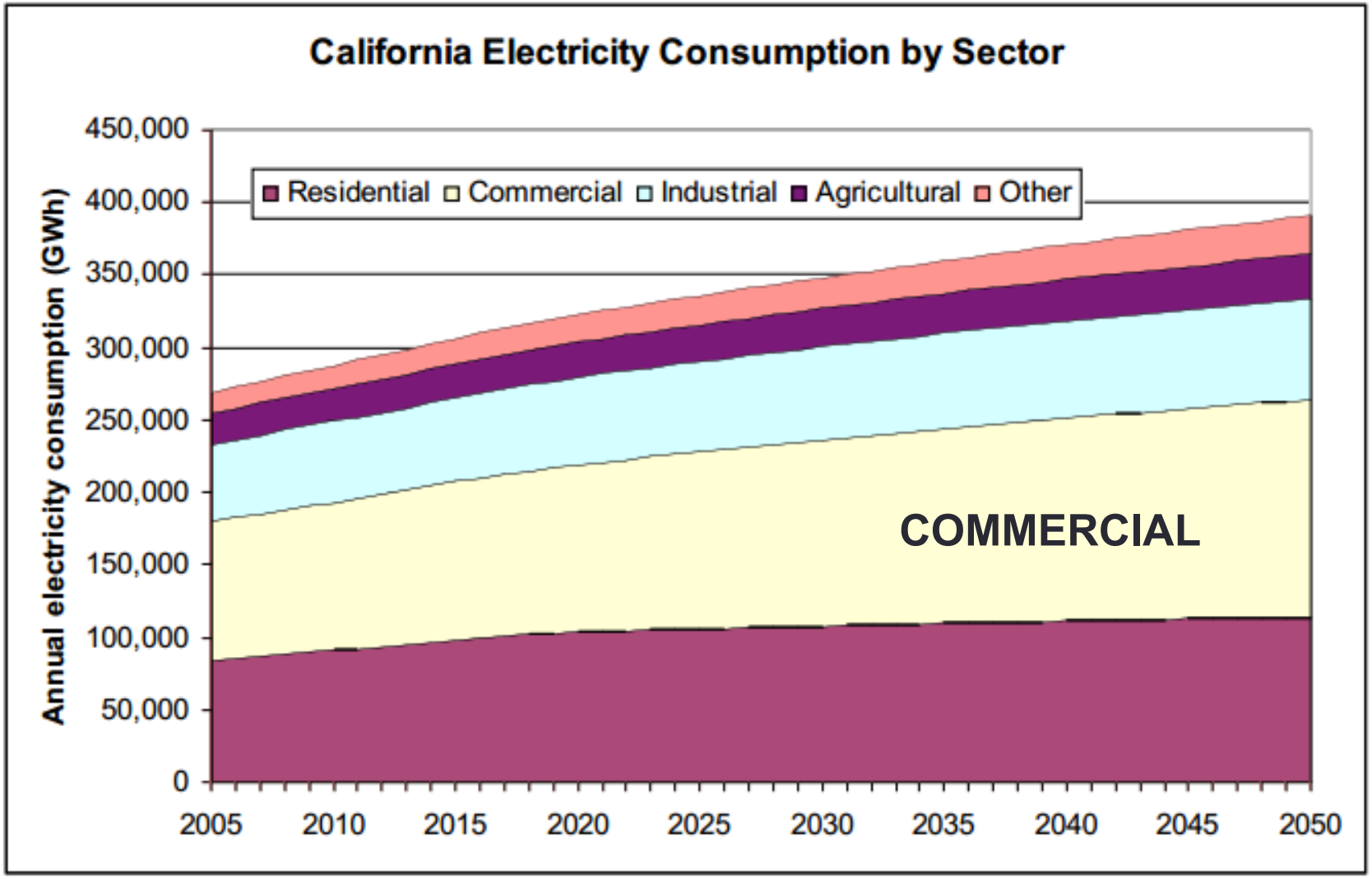
With some innovation – Changes in light duty vehicle mix



Source:: California Baseline Energy Demands to 2050 for Advanced Energy Pathways

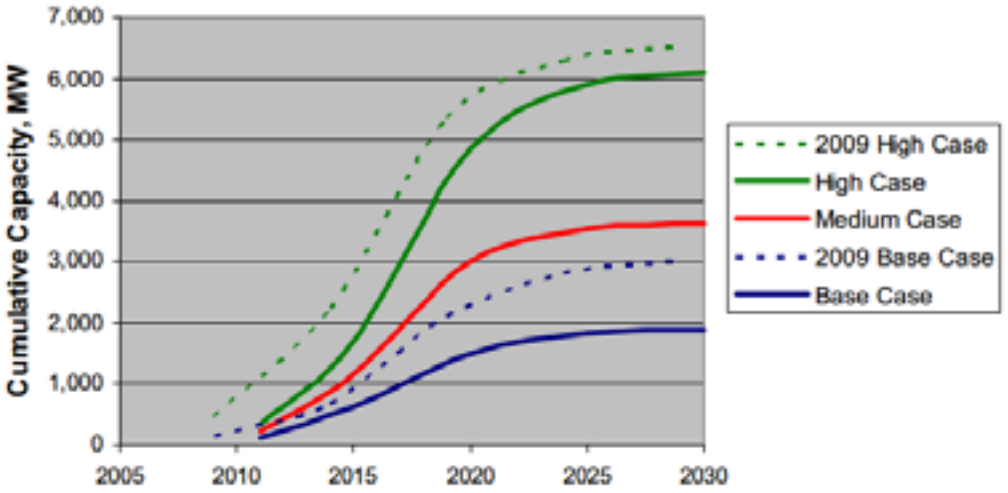
HOW INTEGRATED WILL THE ENERGY SYSTEM BE IN THE FUTURE?

Consumption by Sector



Buildings and Energy Systems

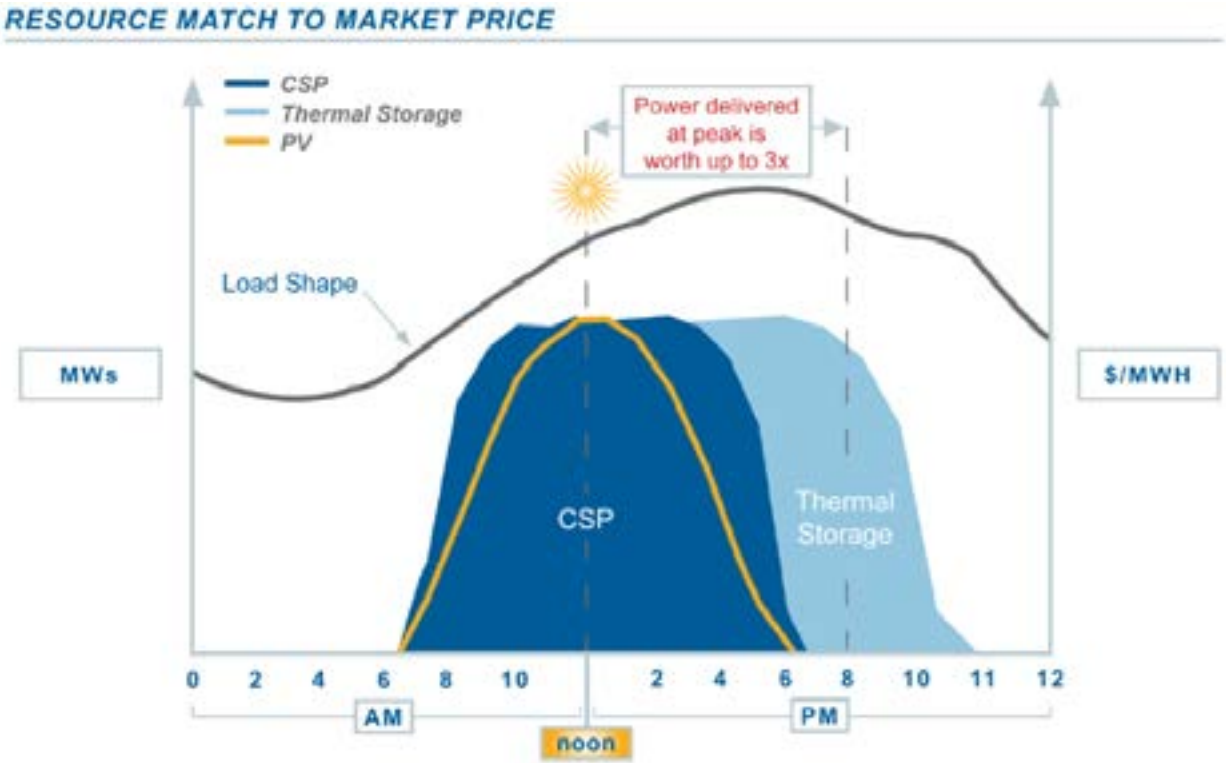
- Energy efficiency
- CHP
- Demand Response
- DER



Source: ICF International, Inc.

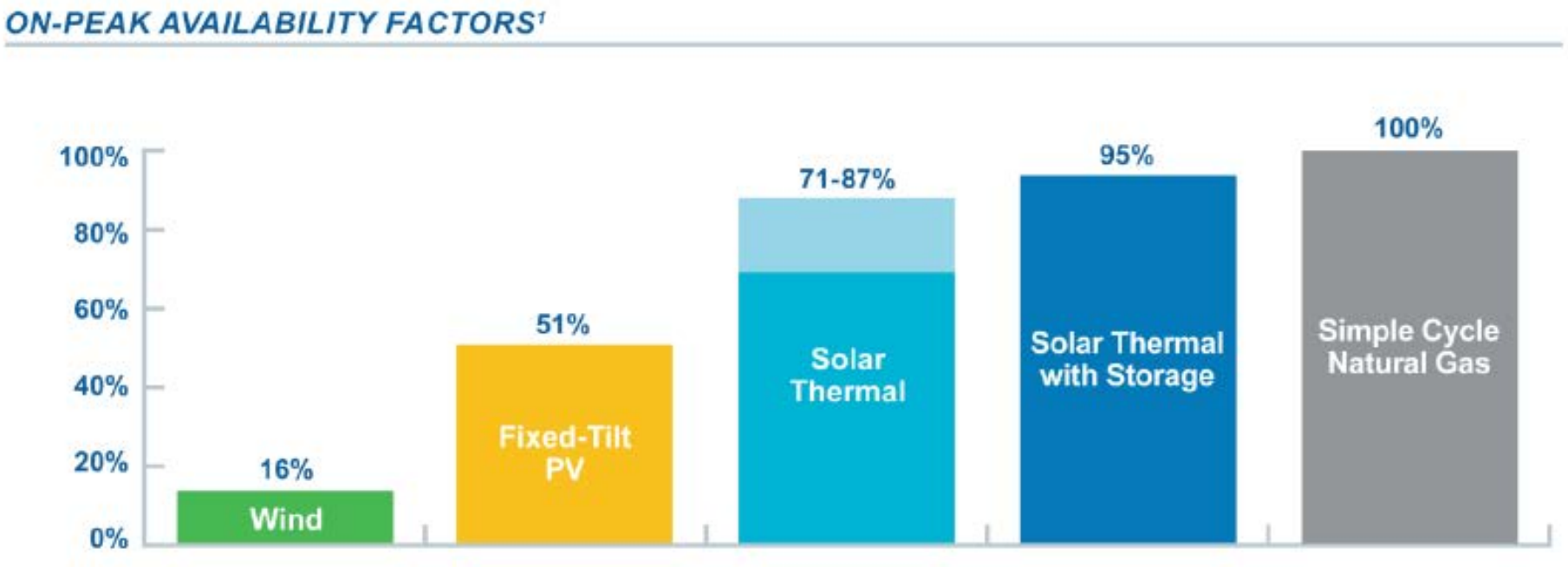
Solar-Thermal

- Solar thermal systems convert sunlight to heat
- Justification: similar arguments that support PV in CA
- Thermal storage vs electrical storage (matching availability and demand)



From: http://brightsourceenergy.com

Solar-Thermal: Matching Demand

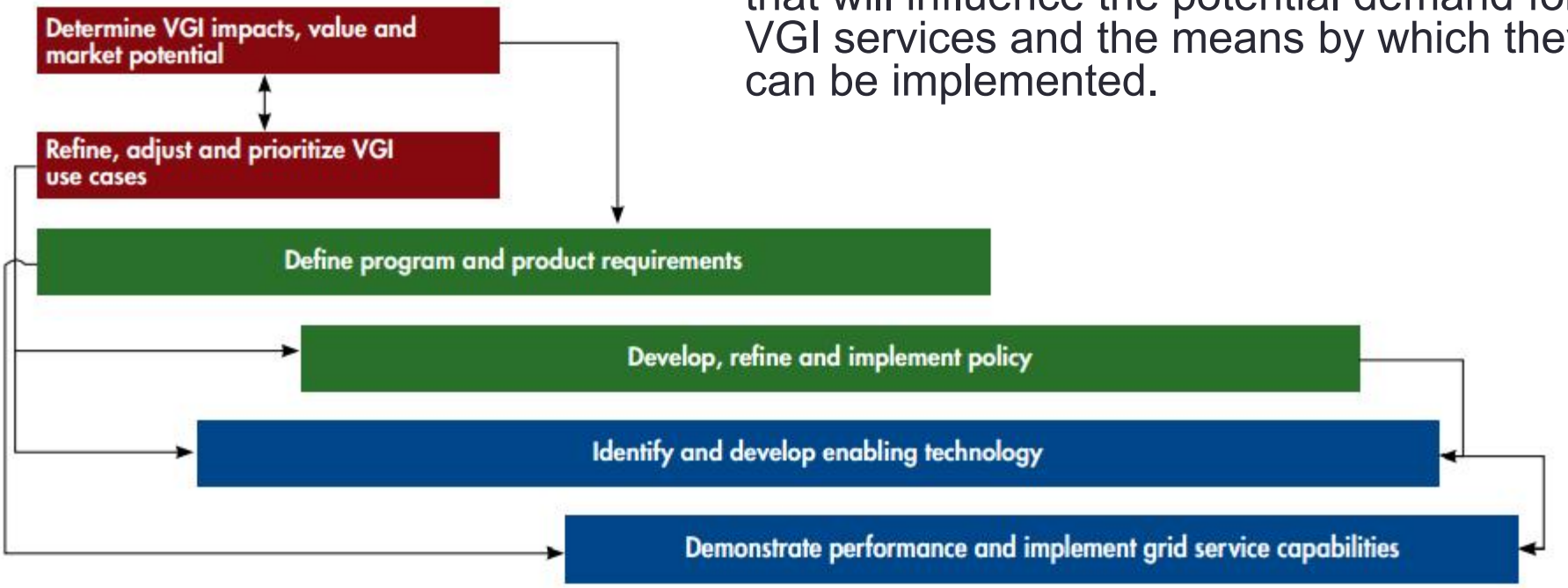


From: http://brightsourceenergy.com

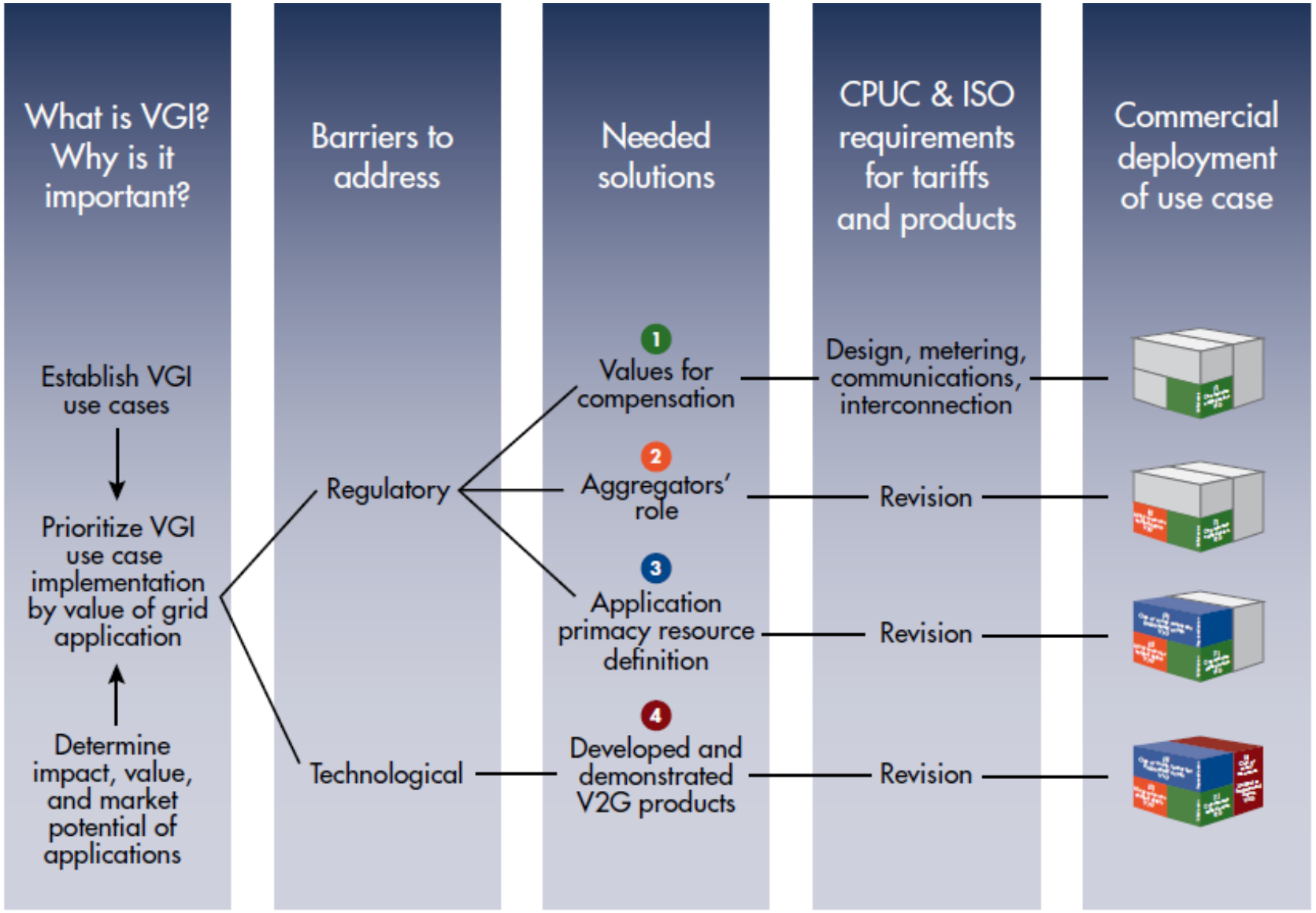
California Vehicle-Grid Integration

- Governor Jerry Brown set a target of 1.5 million zero-emission vehicles (ZEVs) on California roads by 2025

- A number policy initiatives are underway that will influence the potential demand for VGI services and the means by which they can be implemented.



Roadmap


What is VGI? Why is it important?
Barriers to address
Needed solutions
CPUC & ISO requirements for tariffs and products
Commercial deployment of use case
Establish VGI use cases
Prioritize VGI use case implementation by value of grid application
Determine impact, value, and market potential of applications
Regulatory
Technological
1
Values for compensation
2
Aggregators' role
3
Application primacy resource definition
4
Developed and demonstrated V2G products
Design, metering, communications, interconnection
Revision
Revision
Revision

ISSUES AND CHALLENGES

ISSUES

- Renewable curtailment
- Consumer involvement
- Transport reliance on petroleum
- Technology limitations

GETTING THERE!

Getting There: Technology

- Technology translations → Valley of death
  - Moving technology from prototype to deployment
- Innovation ecosystem
  - Fuels (non-carbon, CCS)
  - Zero Emissions load balancing
  - Nuclear (base load)
  - Hydrogen
  - BioXXX
- Funding

Summary: To Achieve Targets

- Enhance regional coordination
- Greater infrastructural ties
- Diversify the renewable energy portfolio
- Invest in energy storage
- Use electricity demand as a tool
- Target commercial sector
- Technology translation and innovation

Discussions?