

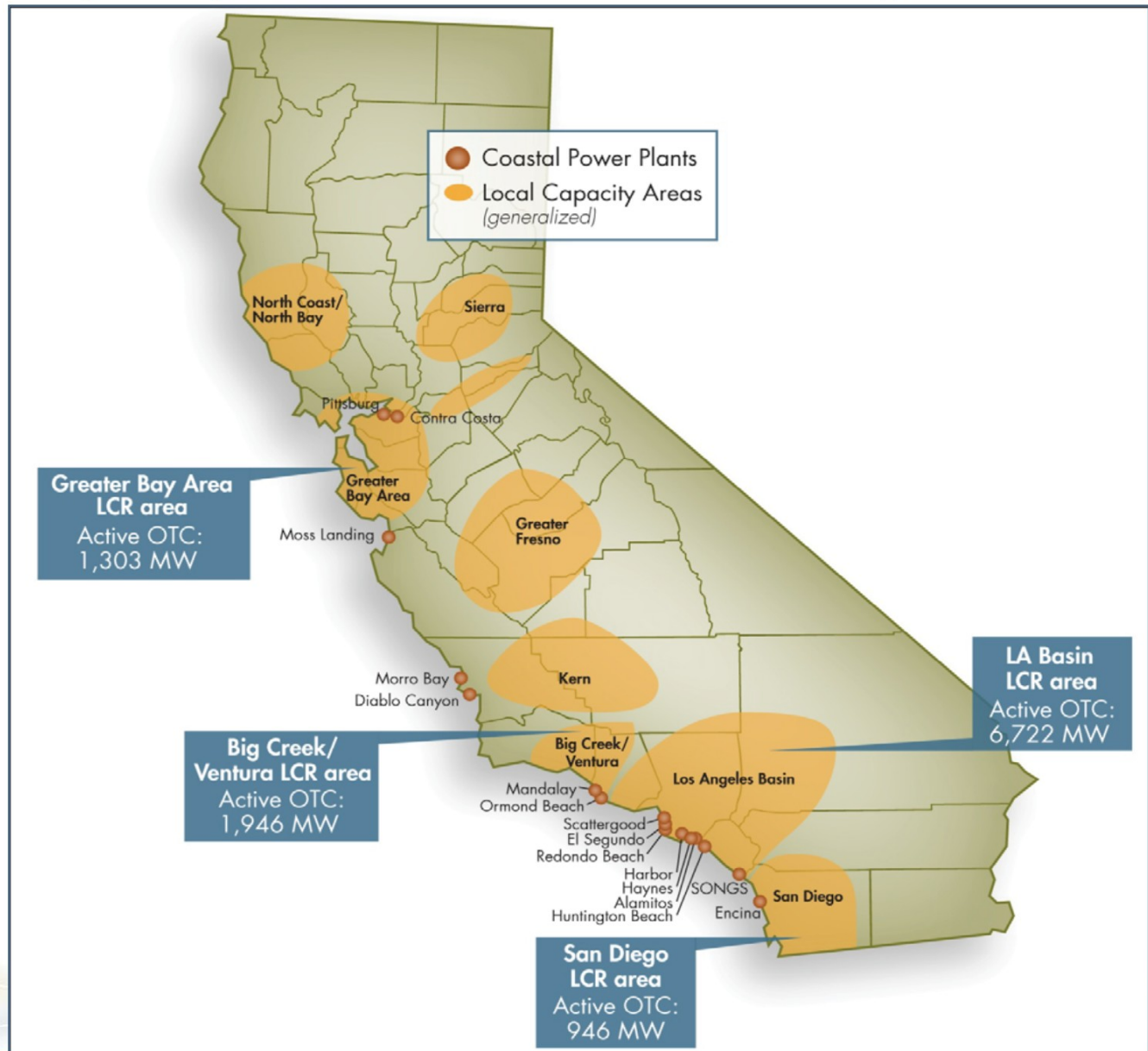
Southern California's Electricity System: One Tough Decade Coming At Us

John Geesman

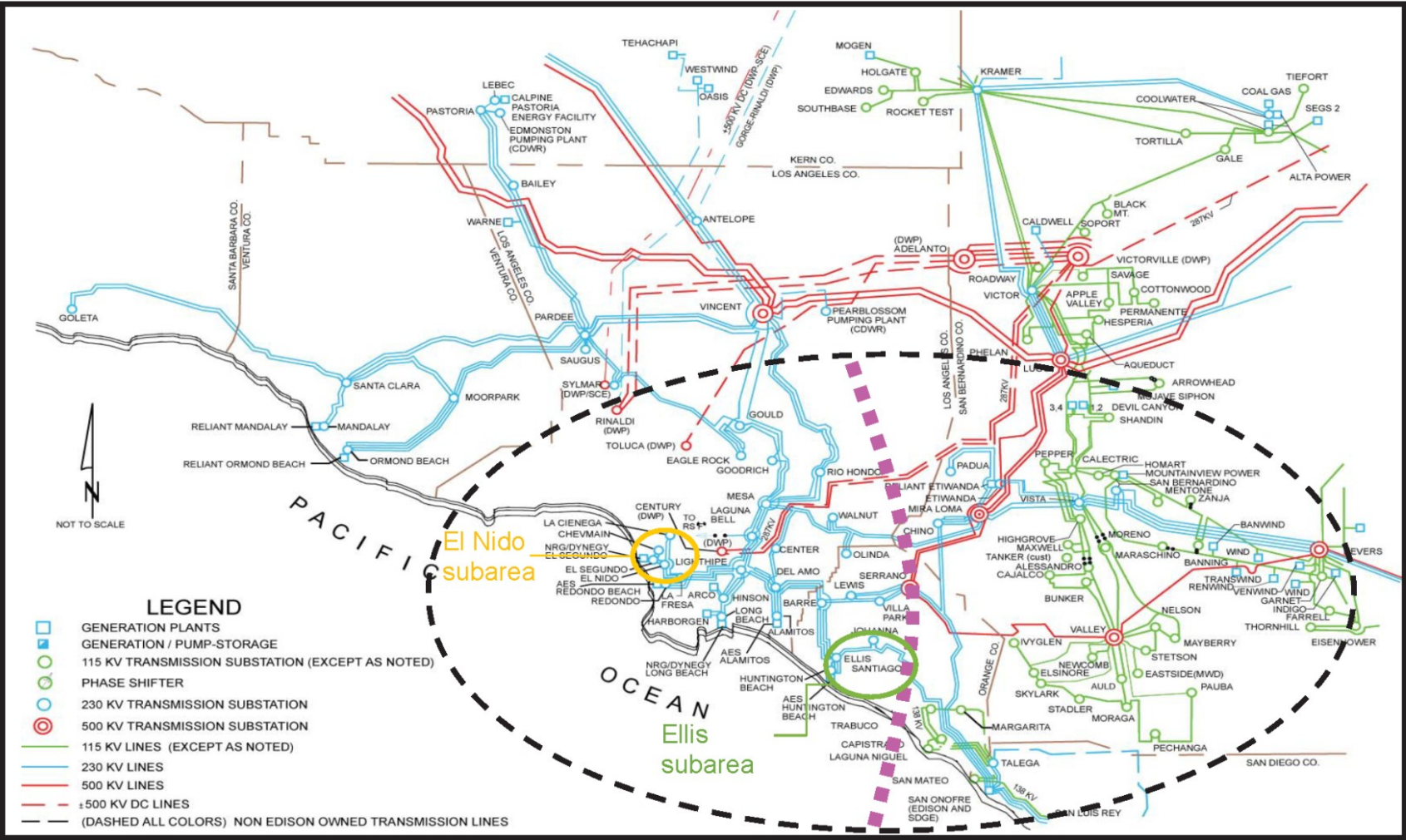
IEEE Green Energy Workshop

November 19, 2012

ISO Local Capacity Areas and Once-Through-Cooling Plants



Overview of LA Basin



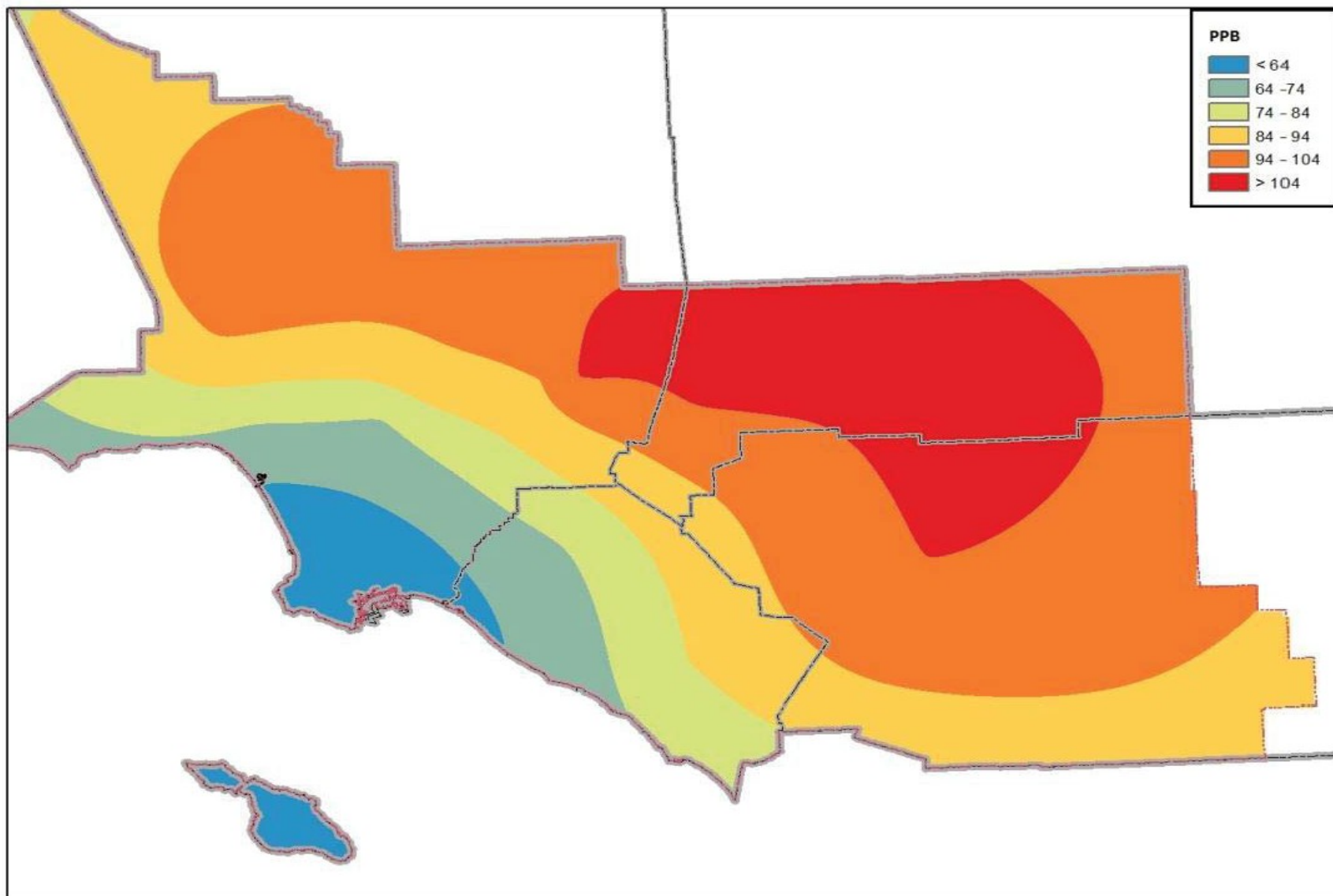


FIGURE 5-12

2008 Baseline 8-Hour Ozone Design Concentrations (ppb)

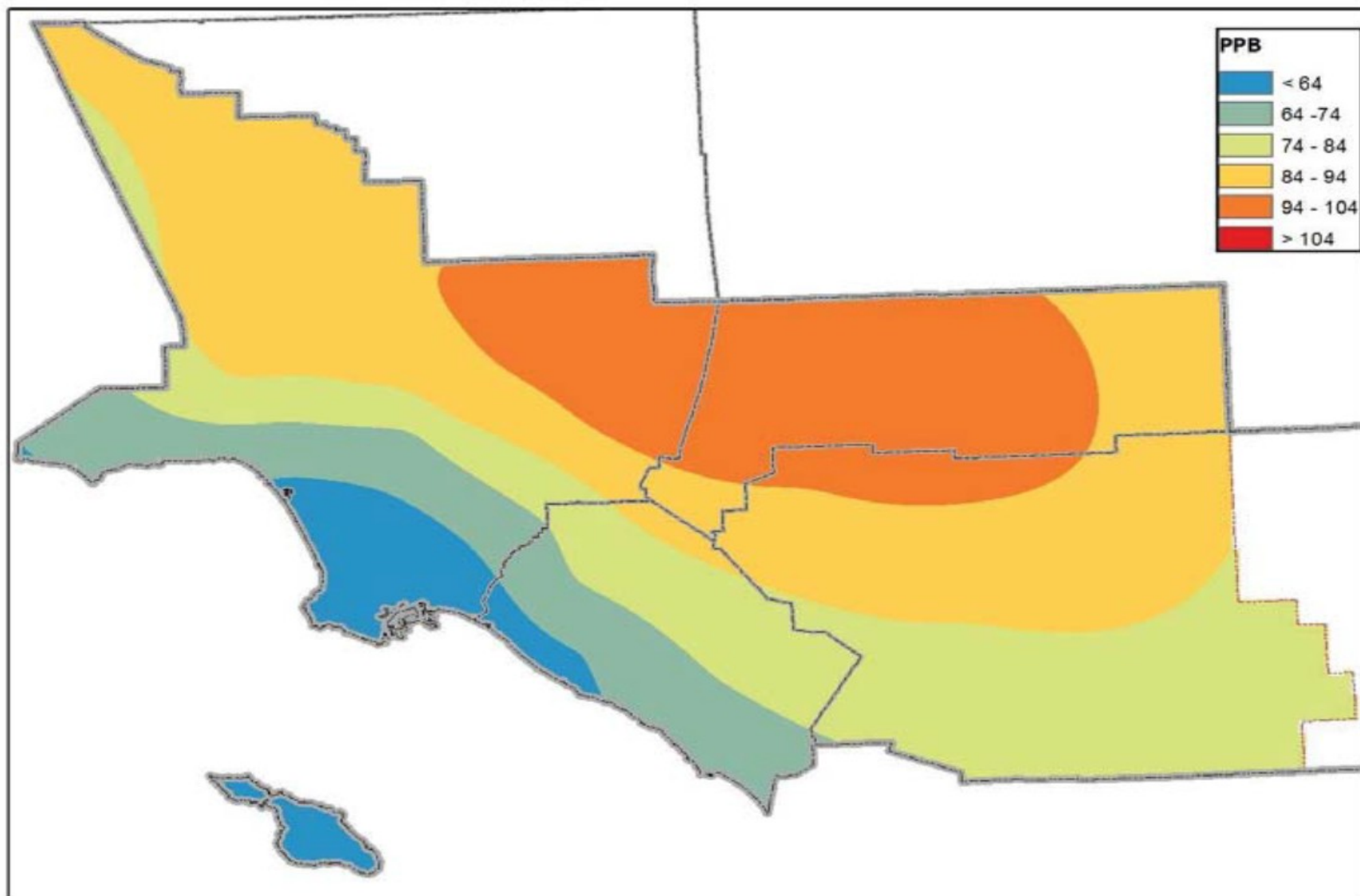


FIGURE 5-13

Model-Predicted 2023 Baseline 8-Hour Ozone Design Concentrations (ppb)

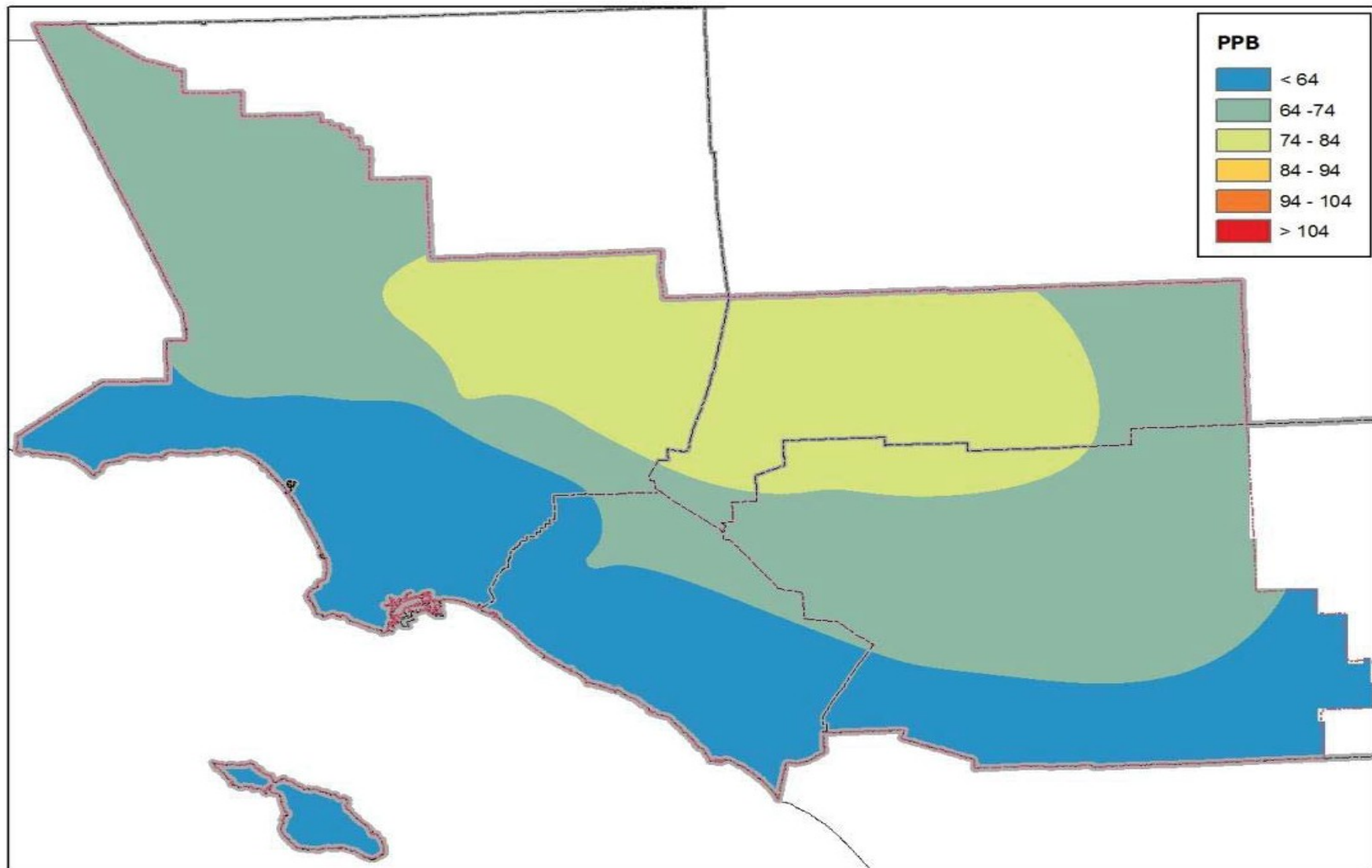
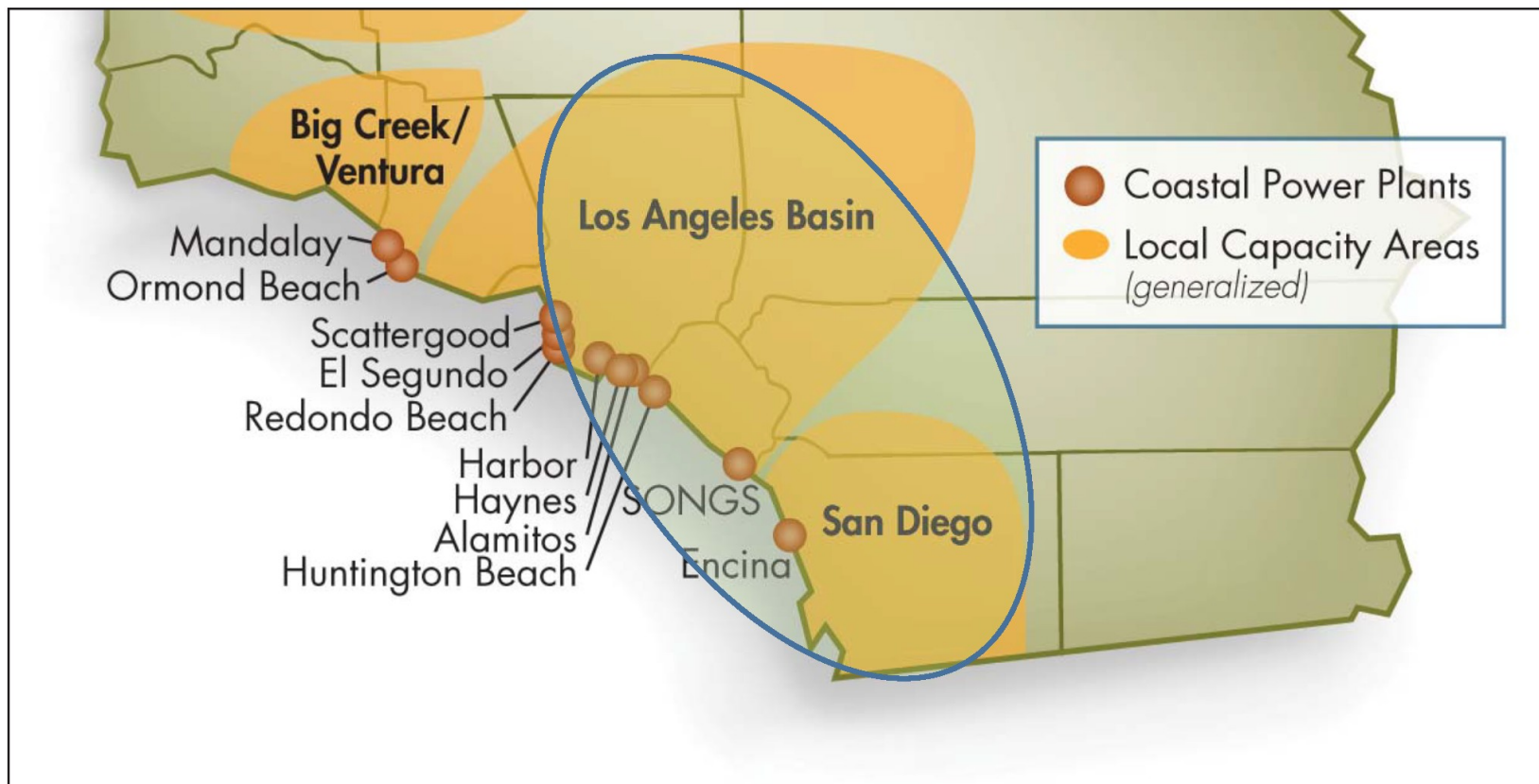


FIGURE 5-14

Model-Predicted 2023 Controlled 8-Hour Ozone Design Concentrations (ppb)

Short Term - Focus LA Basin and San Diego

“Local Capacity Requirement” Areas



- Due to complementary interaction between these two LCR areas, the studies are coordinated, with San Diego LCR studies performed first. LA Basin LCR studies are performed afterward.

Long-Term (2021) Local Capacity Requirement and Once-Through-Cooling Generation Requirements

LCR Area	Trajectory		Environmental		ISO Base Case		Time-Constrained	
	High	Low	High	Low	High	Low	High	Low
	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)
LA Basin	10,743	10,263	11,246	10,891	11,010	10,516	12,165	11,663
Western LA Basin	9,168	7,797	8,482	7,468	8,831	7,421	8,833	7,397
Ellis	531		597		511		556	
El Nido	619		585		568		620	
OTC	3,741	2,370	2,884	1,870	3,834	2,424	3,896	2,460

Low

High

Note: Mira Loma 500/230kV Bank #2 has a 1-Hr emergency rating that can be utilized by assuming up to 600 MW load shed/transfer after 1-Hr.

Population Growth

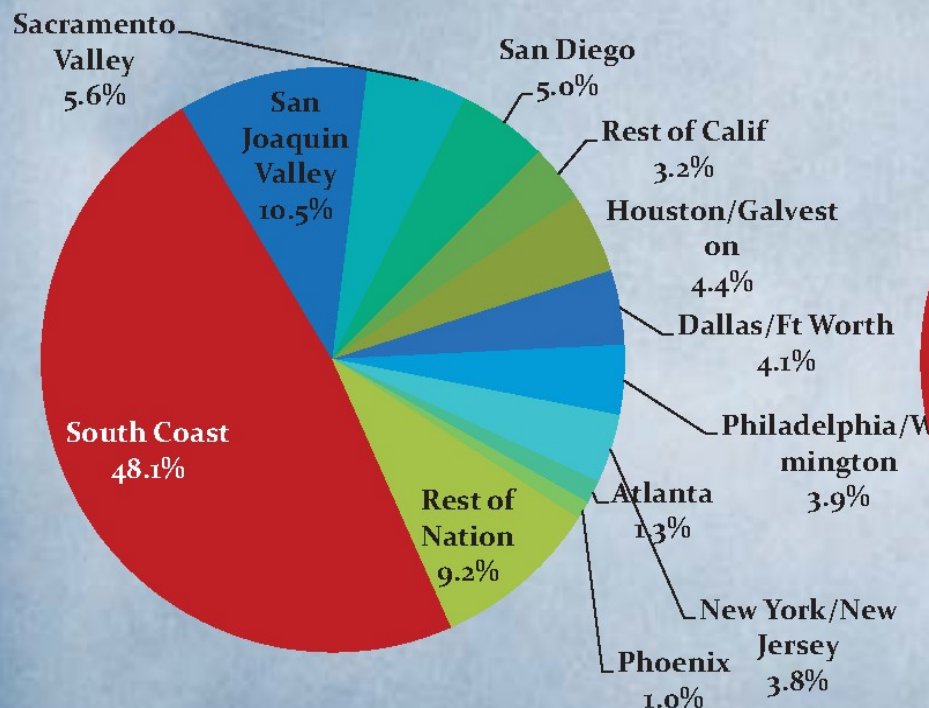
YEAR	POPULATION	AVERAGE PERCENT INCREASE PER YEAR OVER THE PERIOD
1990	13.0 million	--
2000	14.8 million	1.4
2008	15.6 million	0.7
2023 ^a	17.3 million	0.7
2030 ^a	18.1 million	0.7

^aBased on SCAG forecasts in the 2012 Regional Transportation Plan

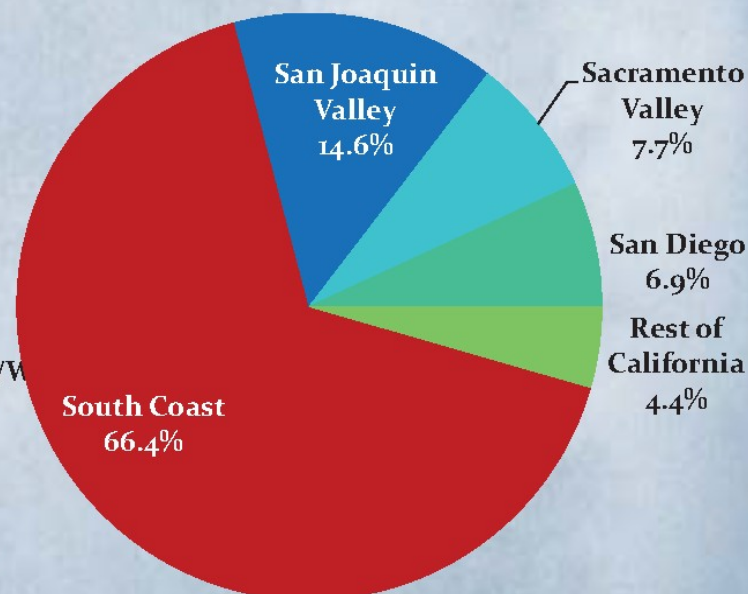
Ozone Exposures*

8-Hour NAAQS = 75 ppb

Nationwide



California



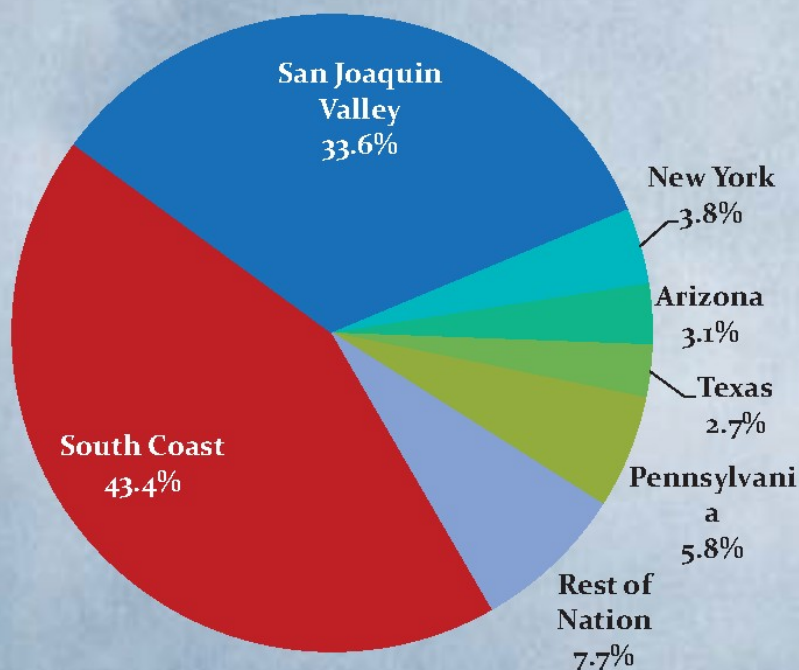
* Population-weighted incremental exposure to ozone above the 8-Hour NAAQS (> 75 ppb), based on 2008-2010 design values

PM2.5 Exposure*

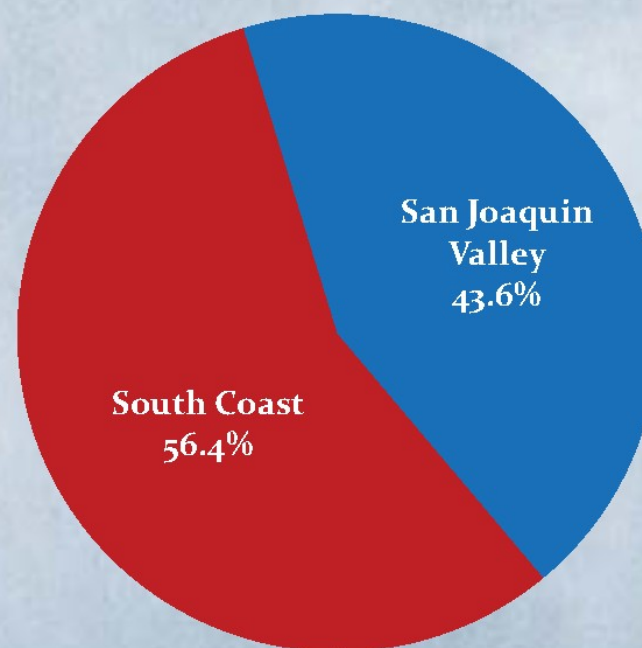
Annual Average NAAQS = 15 $\mu\text{g}/\text{m}^3$



Nationwide



California



* Population-weighted incremental exposure to PM2.5 above the NAAQS annual standard, based on 2007-2009 data

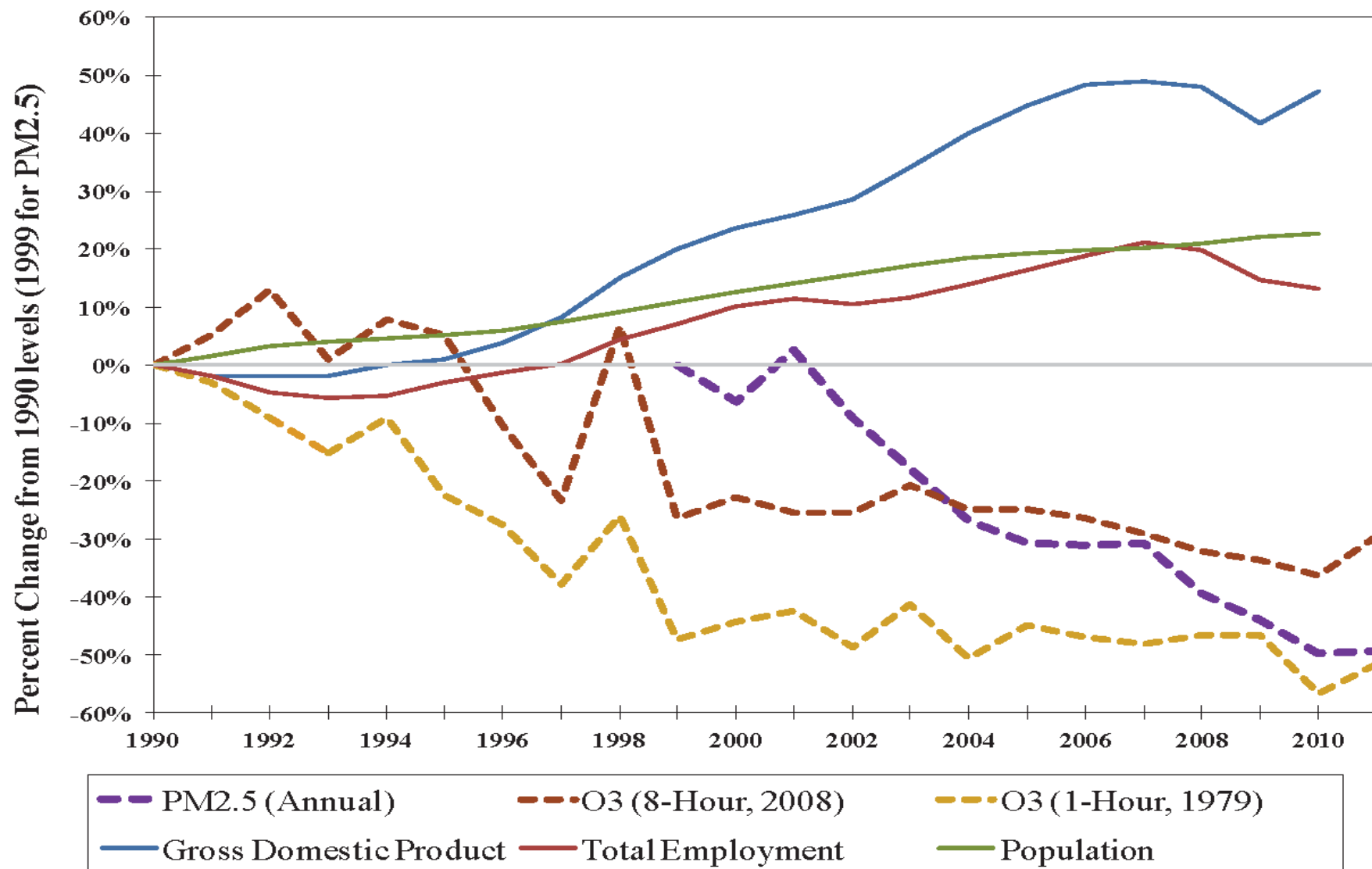
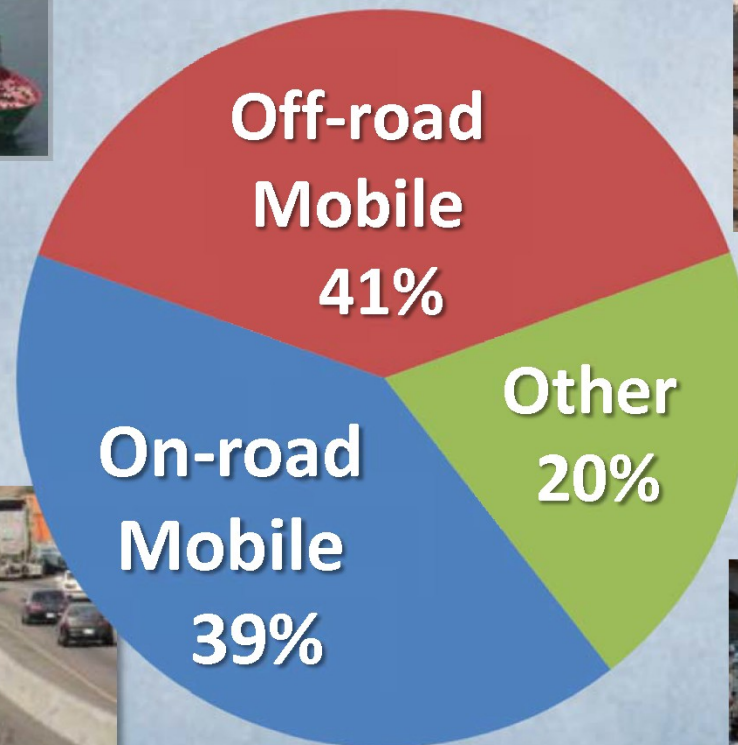


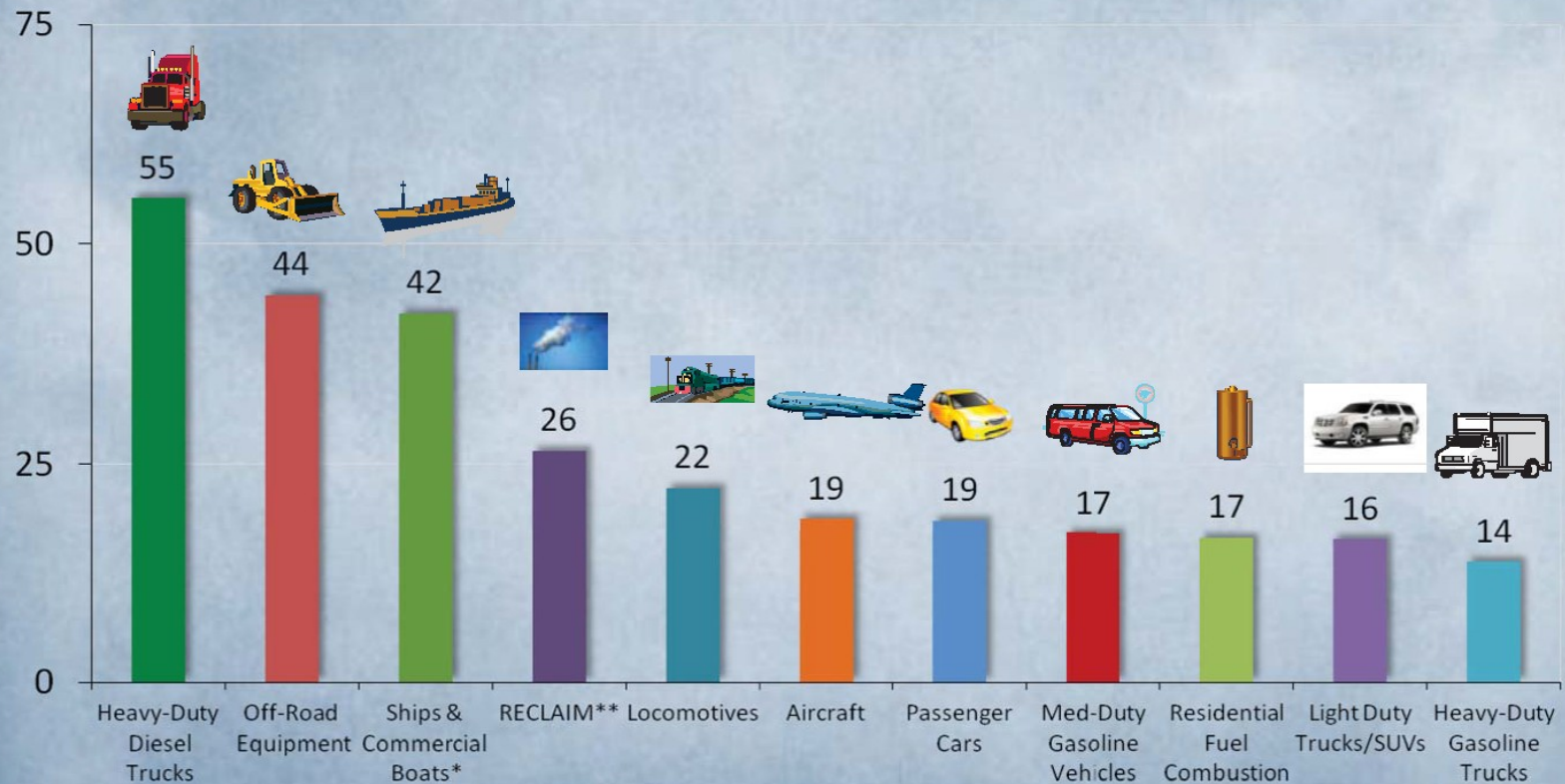
FIGURE 1-5

Percent Change in Air Quality Along with Demographic Data of the 4-County Region (1990-2011)

Mobile Sources Cause 80% of Remaining Air Pollution in South Coast



Top NOx Source Categories (2023) (2012 AQMP Draft Inventory)



+ Draft 2012 AQMP as of May 4, 2012 (preliminary estimates)

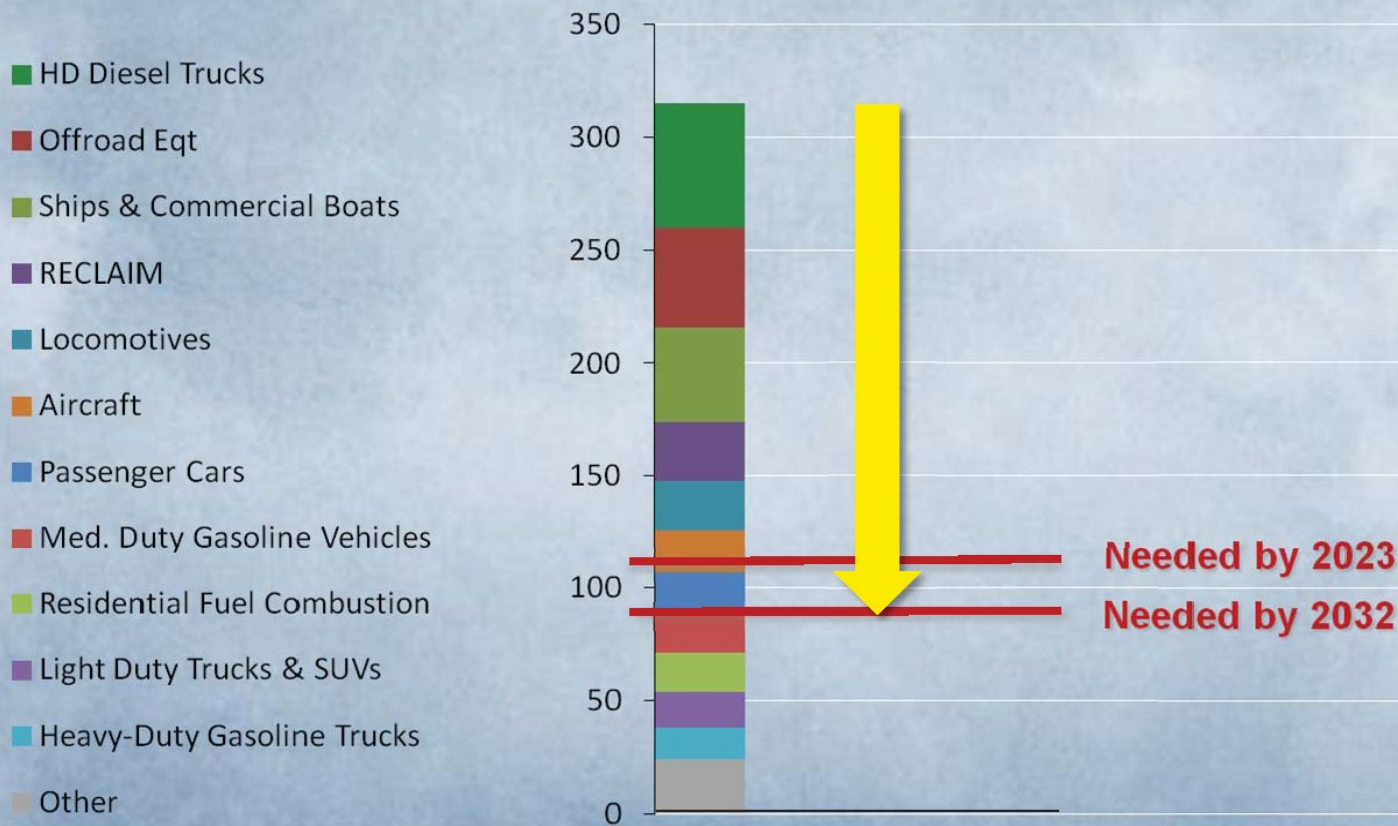
* Oceangoing vessels = 33.8 tons/day

** RECLAIM: 320 largest stationary sources, including all refineries and power plants

Nitrogen Oxides Emissions in 2023

with Adopted Standards

and Additional Needed Emission Reductions (tons per day)



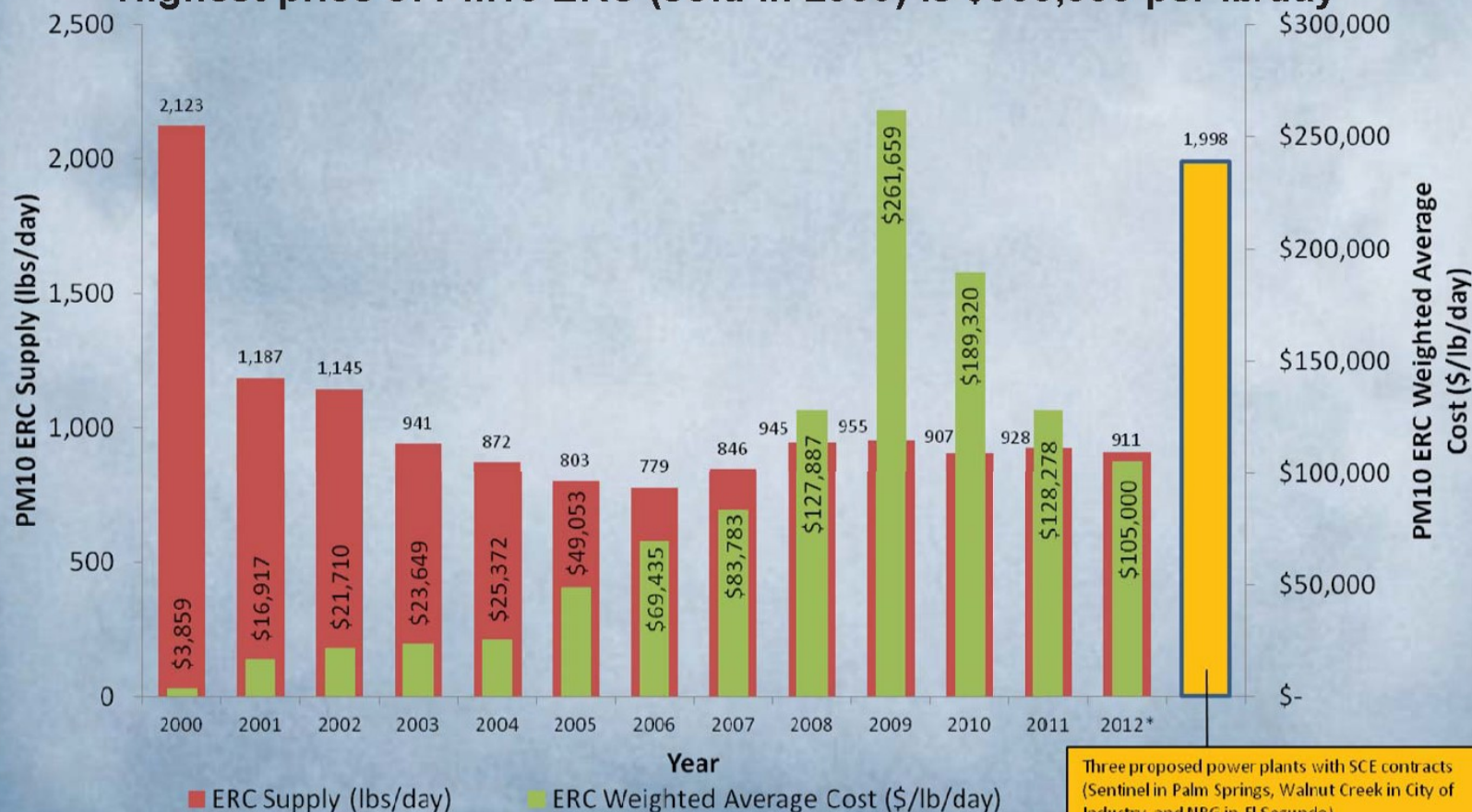
* Source: Ambient ozone modeling conducted by SCAQMD, 2012; data preliminary

Emission Offset Shortage / PM10 ERC Supply & Cost 2000 – 2012*



Supply decreased by 57% since 2000;
Cost increased by 2,621% since 2000

Highest price of PM10 ERC (sold in 2009) is \$350,000 per lb/day



Three proposed power plants with SCE contracts (Sentinel in Palm Springs, Walnut Creek in City of Industry, and NRG in El Segundo)

*Through April 2012

Short Term - Focus LA Basin and San Diego

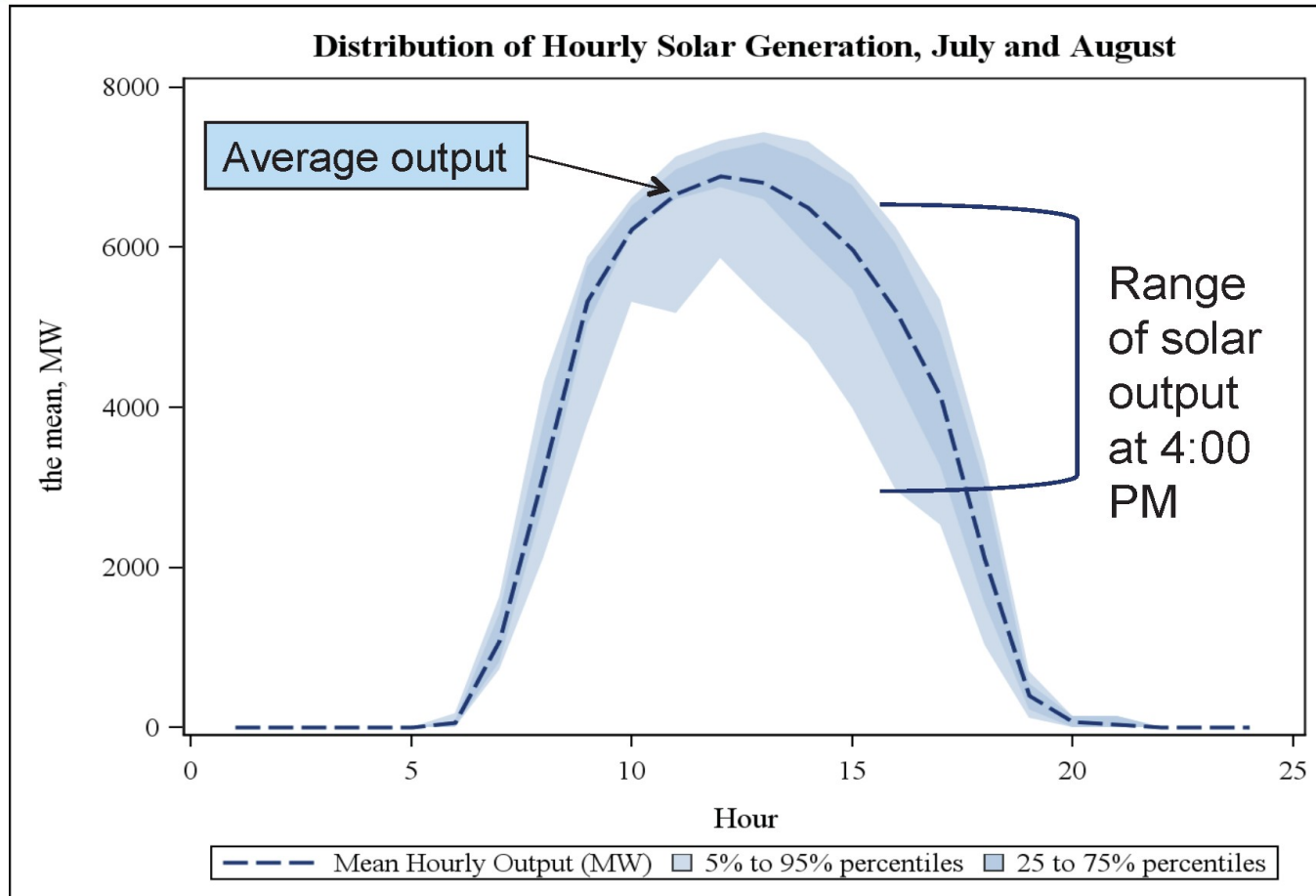
“Local Capacity Requirement” Areas



- Due to complementary interaction between these two LCR areas, the studies are coordinated, with San Diego LCR studies performed first. LA Basin LCR studies are performed afterward.

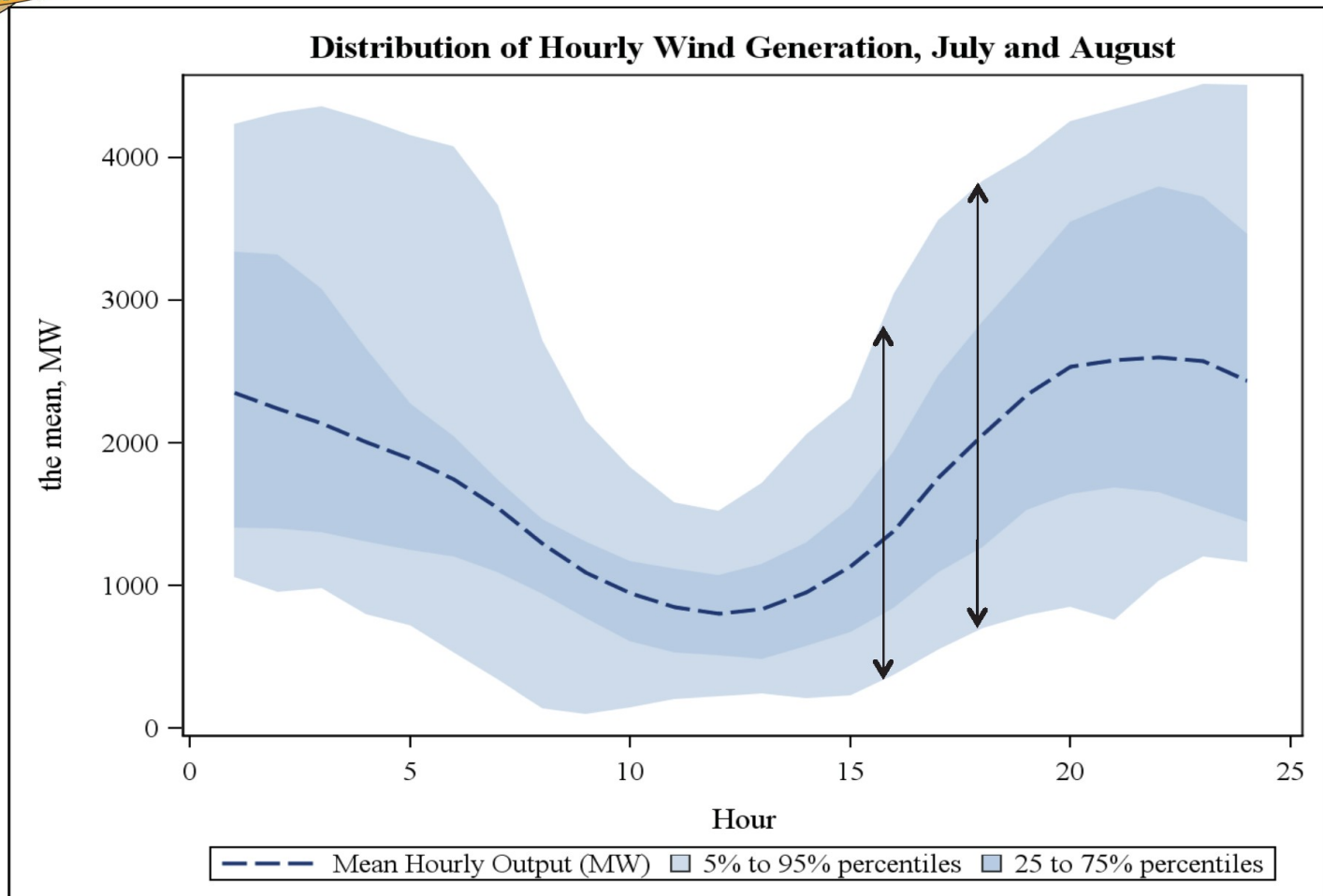


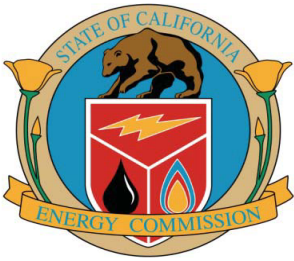
Solar Output Varies



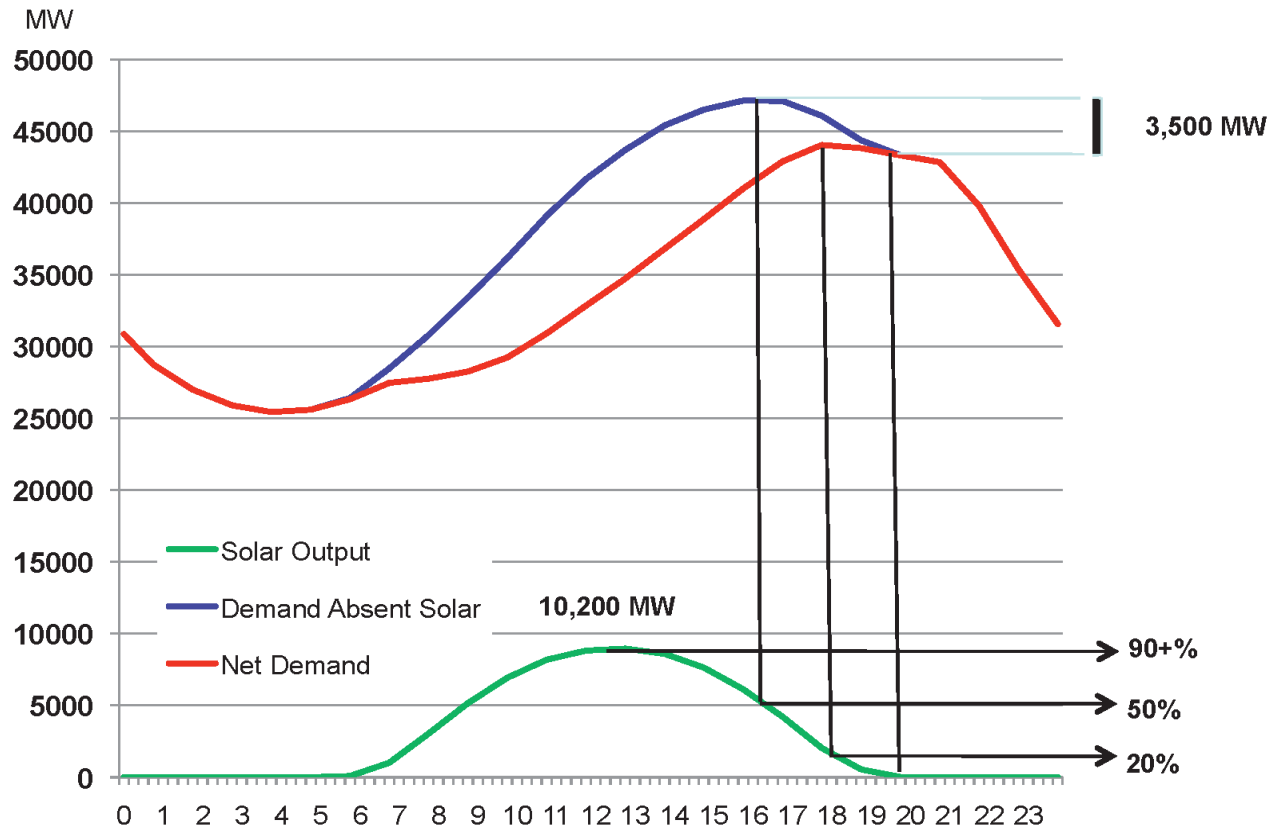


Wind Output Varies



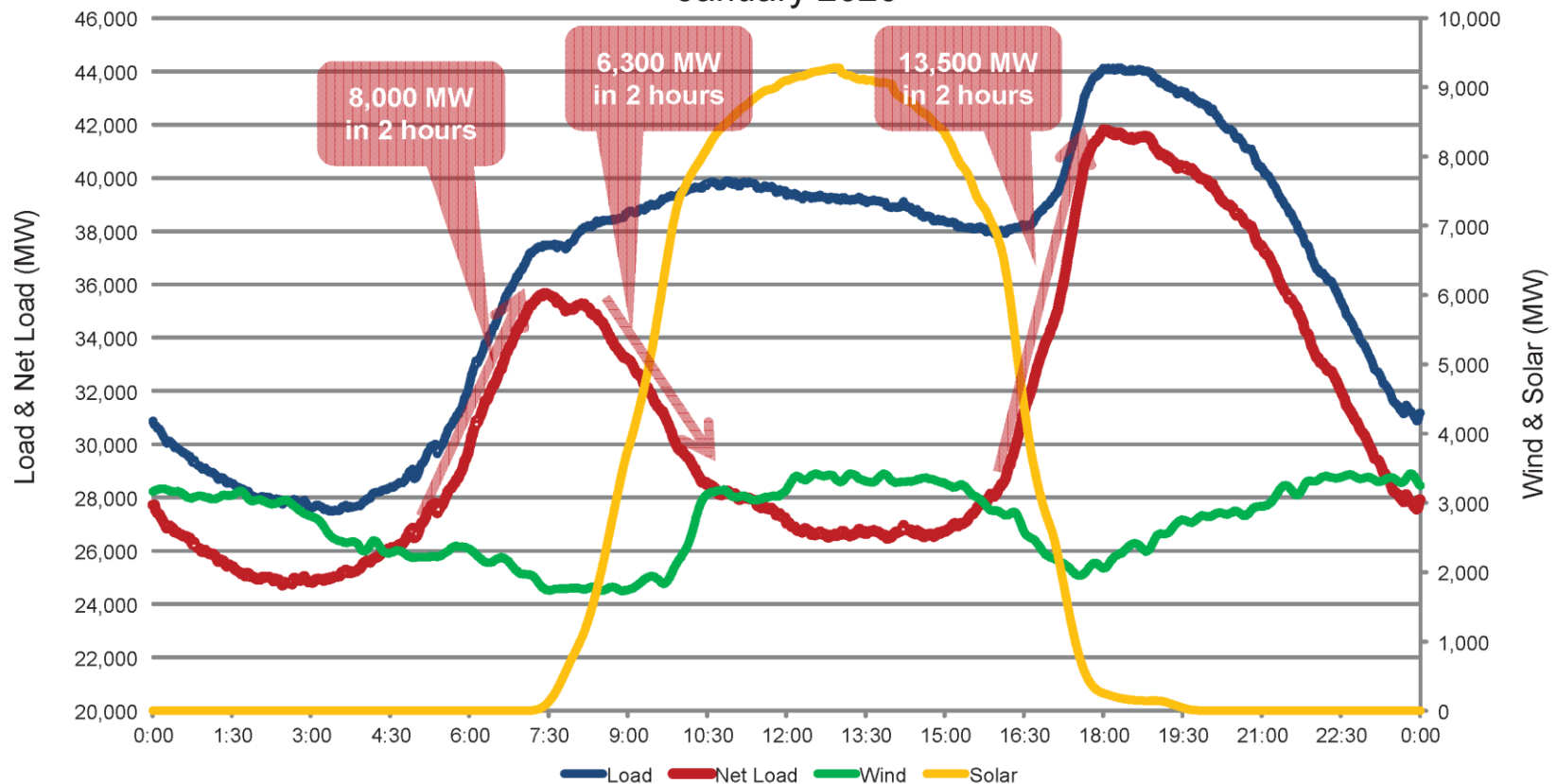


Limits on Solar Capacity Value (illustrative values)



Conventional resources will be dispatched to the net load demand curve – High Load Case

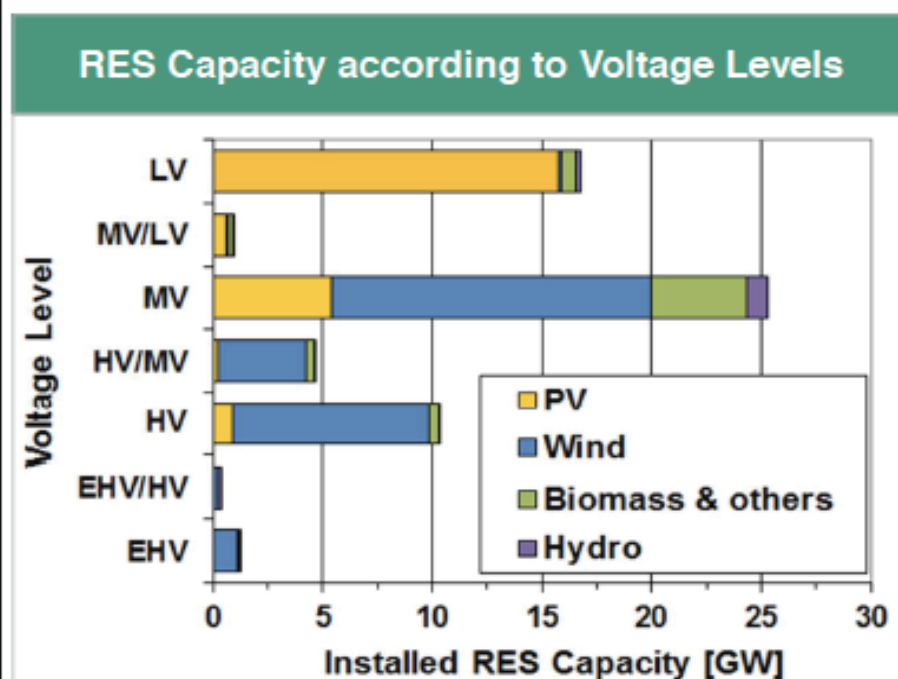
Load, Wind & Solar Profiles – High Load Case
January 2020



PV in Germany is mostly DG

PV Status Quo in Germany – Distribution of RES in the Grid

Over 1,000,000 PV systems are already installed. The majority of these systems is installed in the low voltage grid.



Source: DGS (2012)

Amount of overall PV capacity in LV grid:

- ~ 69%
- PV plants with less than 100 kWp

Amount of overall PV capacity in MV grid:

- ~ 26 %
- PV plants greater than 100 kWp

Germany

80M people
80MW peak
1M PV systems
25GW PV

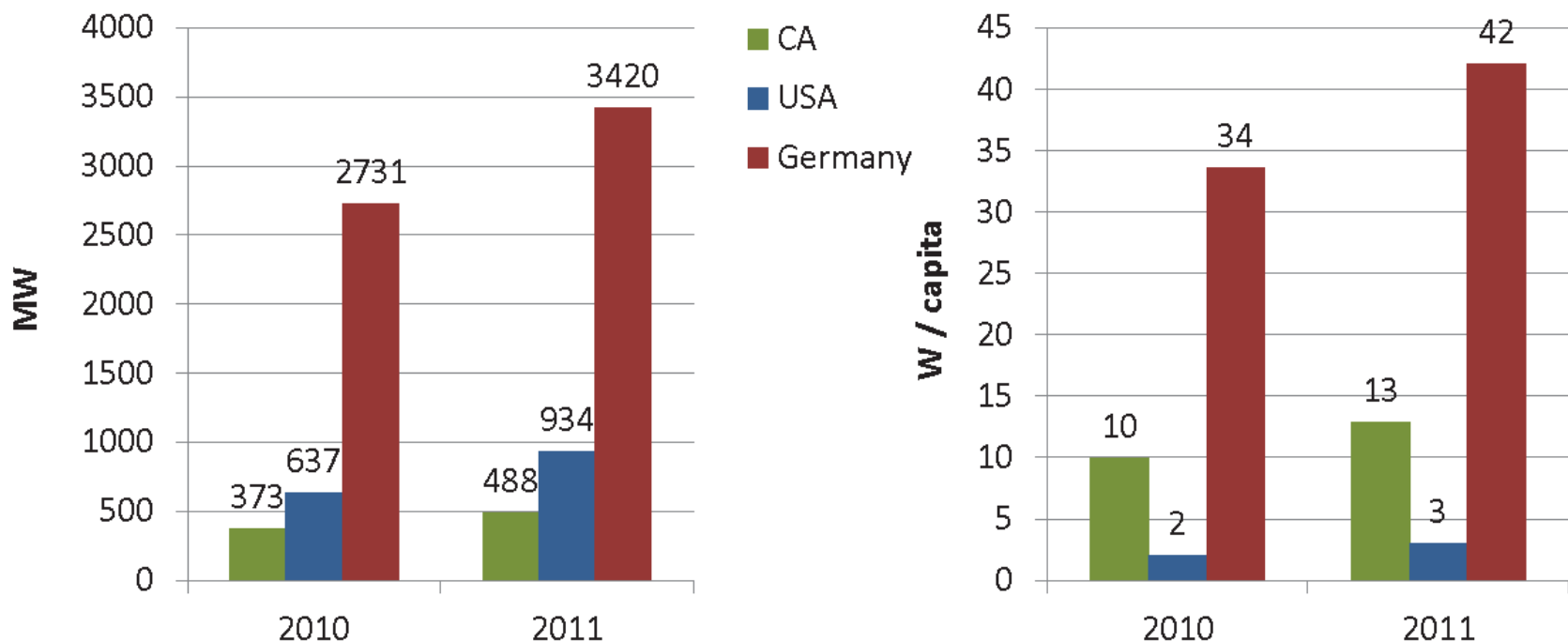
California

37M people
60MW peak
150K systems
3GW PV

Cumulative Residential Installations in Germany 3.6x Greater (14x on per Capita Basis) than in United States



Cumulative residential PV installations



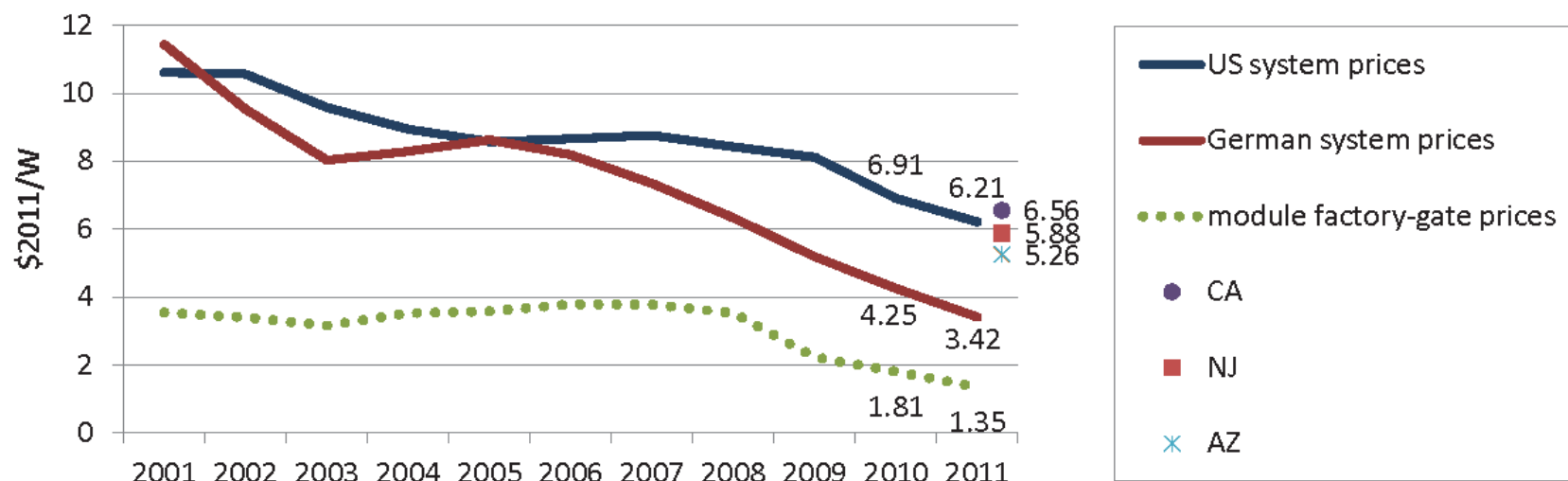
Data Sources:

US: GTM/SEIA; Germany: BNetzA (Federal Grid Agency)

Residential PV System Prices Have Often Been Higher in the U.S. Than in Germany



Median Installed Price of Customer-Owned PV Systems ≤ 10 kW*



* **Note:** Focusing on systems ≤ 10 kW serves as a proxy for the residential market, as the project-level installed price data for German systems used for this figure do not include host customer type

Data Sources:

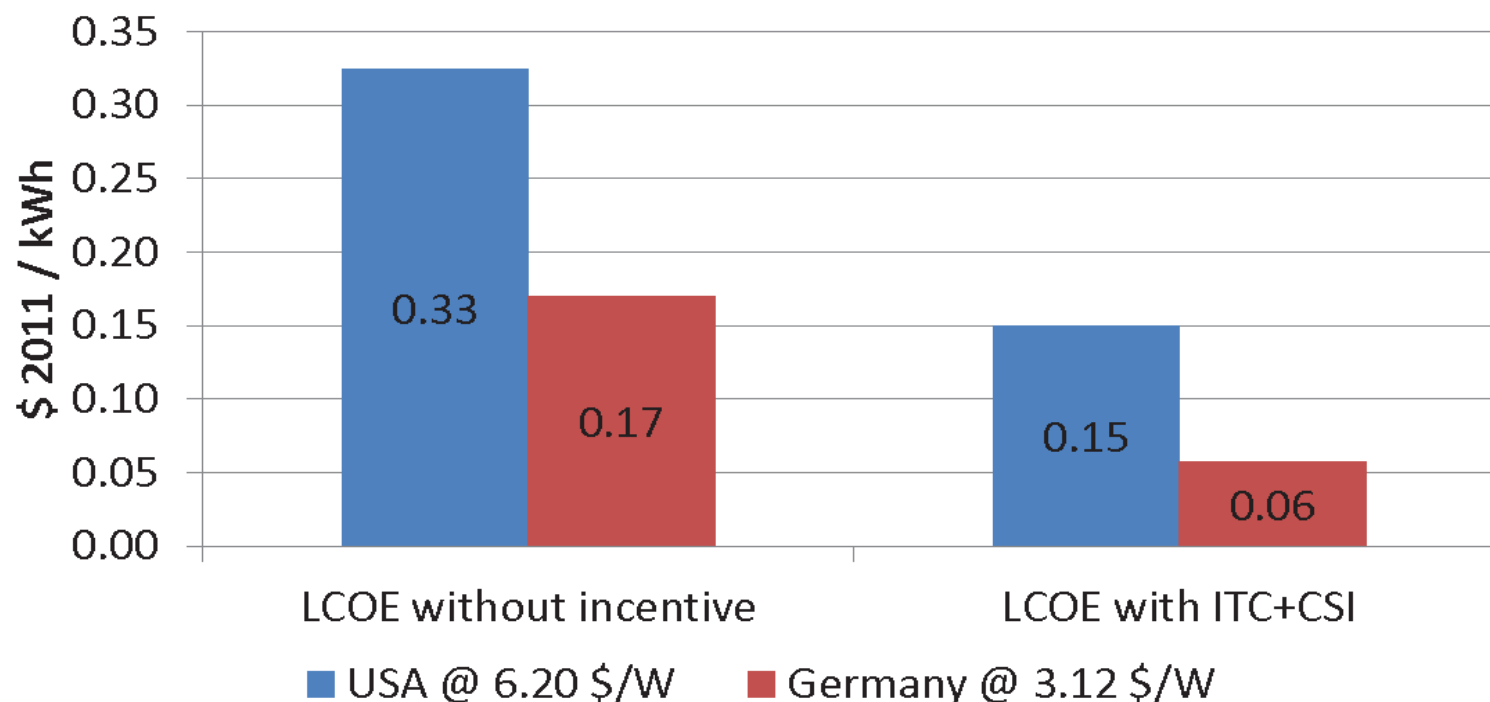
U.S. System Prices are derived from LBNL's TTS dataset and are equal to the median of customer-owned systems ≤ 10 kW installed in each year. **German System Prices** are the averages of individual price quotes in EuPD's dataset (2008-2011) or the average of prices reported by IEA, Photon, KfW, and Schaeffer (2001-2007).

Module Factory-Gate Prices are the average of prices reported by IEA, GTM, IRENA, Navigant, and Photon (annual currency exchange rates were used for module prices estimates)

PV would be competitive in the US at German cost



LCOE for a residential PV system in Los Angeles

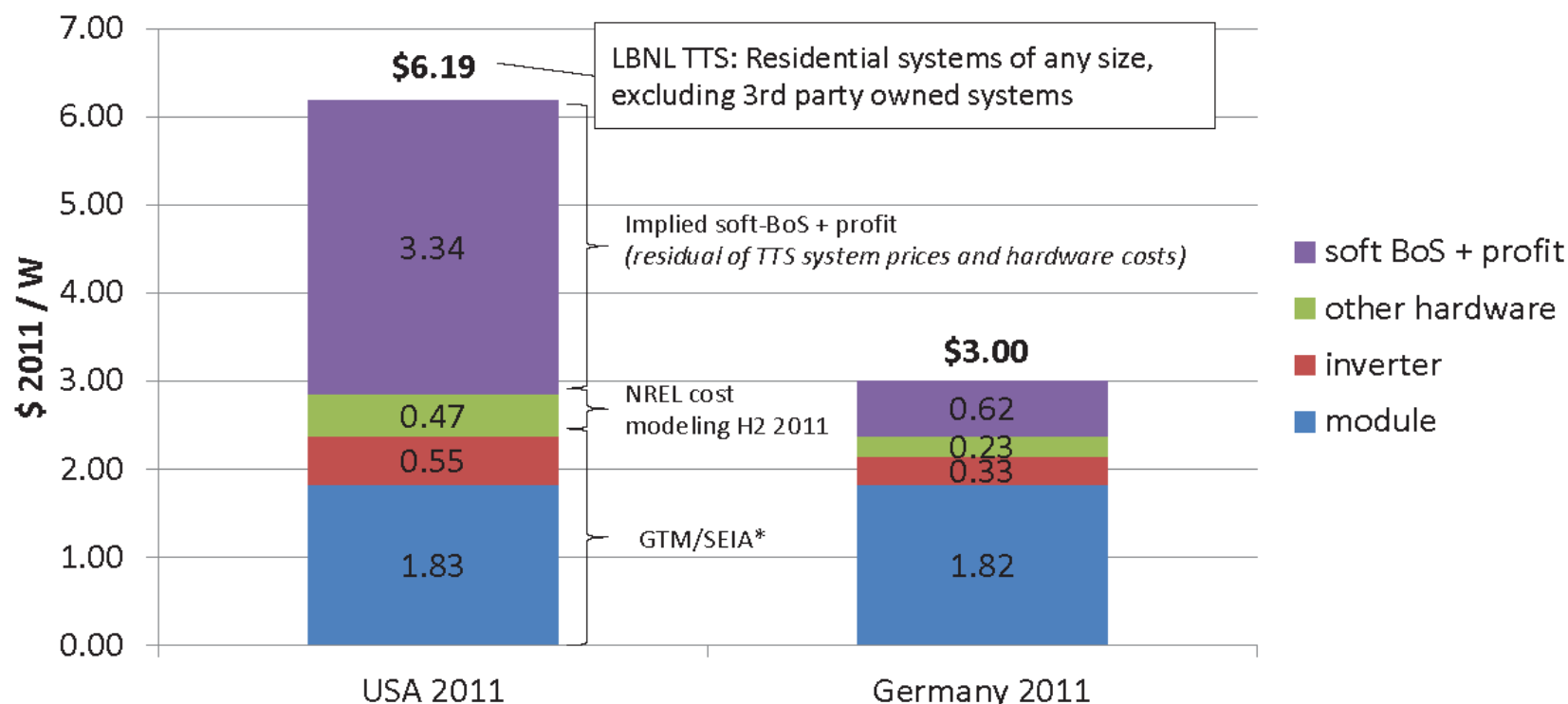


Based on TTS and EuPD data using NREL's System Advisory Model

Soft Costs for Residential PV in Germany Are ~\$2.7/W Lower Than in the U.S.



Total soft costs for residential PV in Germany, including margin, are just 19% of the implied soft costs for U.S. residential PV (\$0.62/W vs. \$3.34/W)



* Notes: US module and inverter prices are based on average factory gate prices for Q4 2010-Q3 2011 as reported by GTM/SEIA with an adder of 10% to account for supply chain costs. Inverter efficiency assumed to be 85%.

Germany - Summary

- High incentives and goals promoted distributed solar deployment in Germany
- Low PV system prices continue to drive market
- Extremely simple and standardized interconnection process helps deployment
- German utilities are able to rate-base the cost of distribution system upgrades
- High penetrations have demanded changes in PV system design and operations
- Germany has updated interconnection guidelines and inverters to require volt/VAR capability, trip setting variations, fault ride through capability and ability to remotely curtail system output
- Germany has a goal of 80% RE by 2050 – will need to make significant system upgrades to achieve this level

Distribution Integration Issues

- The current electrical grid is designed to move electricity in one direction, from central-station generators to substations to customers.
- However, as more distributed generation is added to the system, power generated by these resources may exceed demand and flow backward into circuits or substations, requiring new protection and control strategies to avoid damaging the electric system.
- There is a high variability in distribution system design, construction and sometime operating practice. This does not make a standard solution easy.
- There are an increasing number of requests for interconnection and the need to reduce the complexity, expense, and length of time associated with that process.

Integration Solutions

- **Technology Solutions**

- Distribution system upgrades – need clear definition on who pays for what. May not be the least expensive solution – need optimal cost from a systems perspective
- Inverter technologies with advanced functionality (volt/VAR control, fault ride through, remote communications, power curtailment) - All have been proven in the lab but need testing in a larger system-wide context
- Standardized control and communications interfaces are needed to provide remote control for contingencies – needs to be secure
- Standard methods to identify best locations for integration are underway
- Integration of local load control and energy storage will help reach higher penetration levels

- **Standards and Regulatory Solutions**

- Update Interconnection requirements to include advanced inverter functionality
- IEEE 1547, UL 1741, SGIP, WDAT, Rule 21 – need to be updated
- Streamline interconnection process based on rigorous screens – let low impact system connect quicker
- Streamline and digitize permitting process

