Monetizing the Value Proposition for Emerging Advanced Power Generation Markets: A Case Study for California

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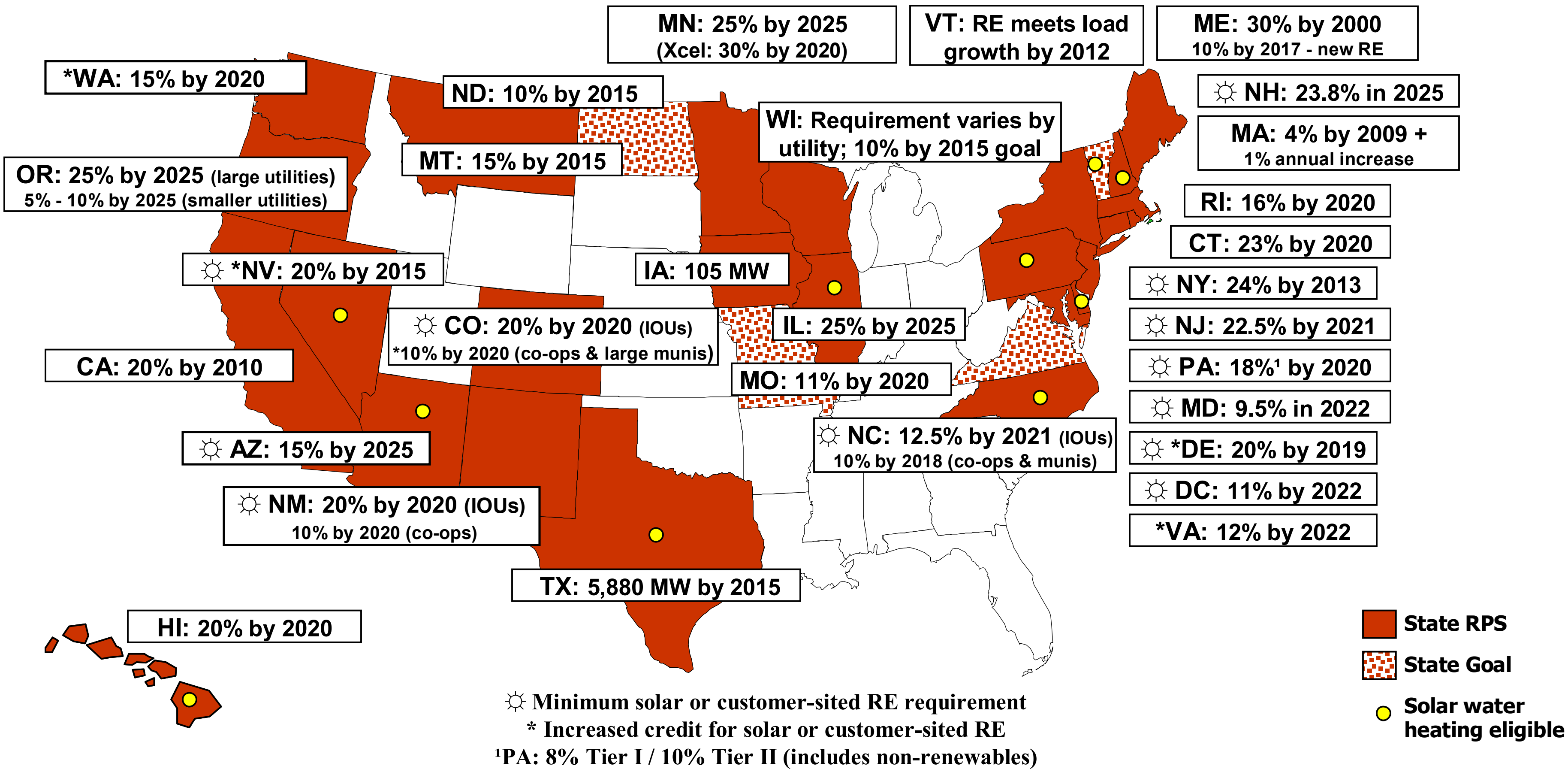
Economic Analysis Can Inform Policy Debate & Implementation

- Energy and environmental policies often target the electricity sector for (i) reduced emissions or (ii) minimum generation/sales from renewable energy.
- Implementation of political and policy mandates should be accomplished as efficiently and cost-effectively as possible.
- Economic analysis can inform the policy debate and provide relative rankings of technology options available to meet mandates.
- And is, more often than not, required.

29 U.S. States Now Have a Renewable Portfolio Standard



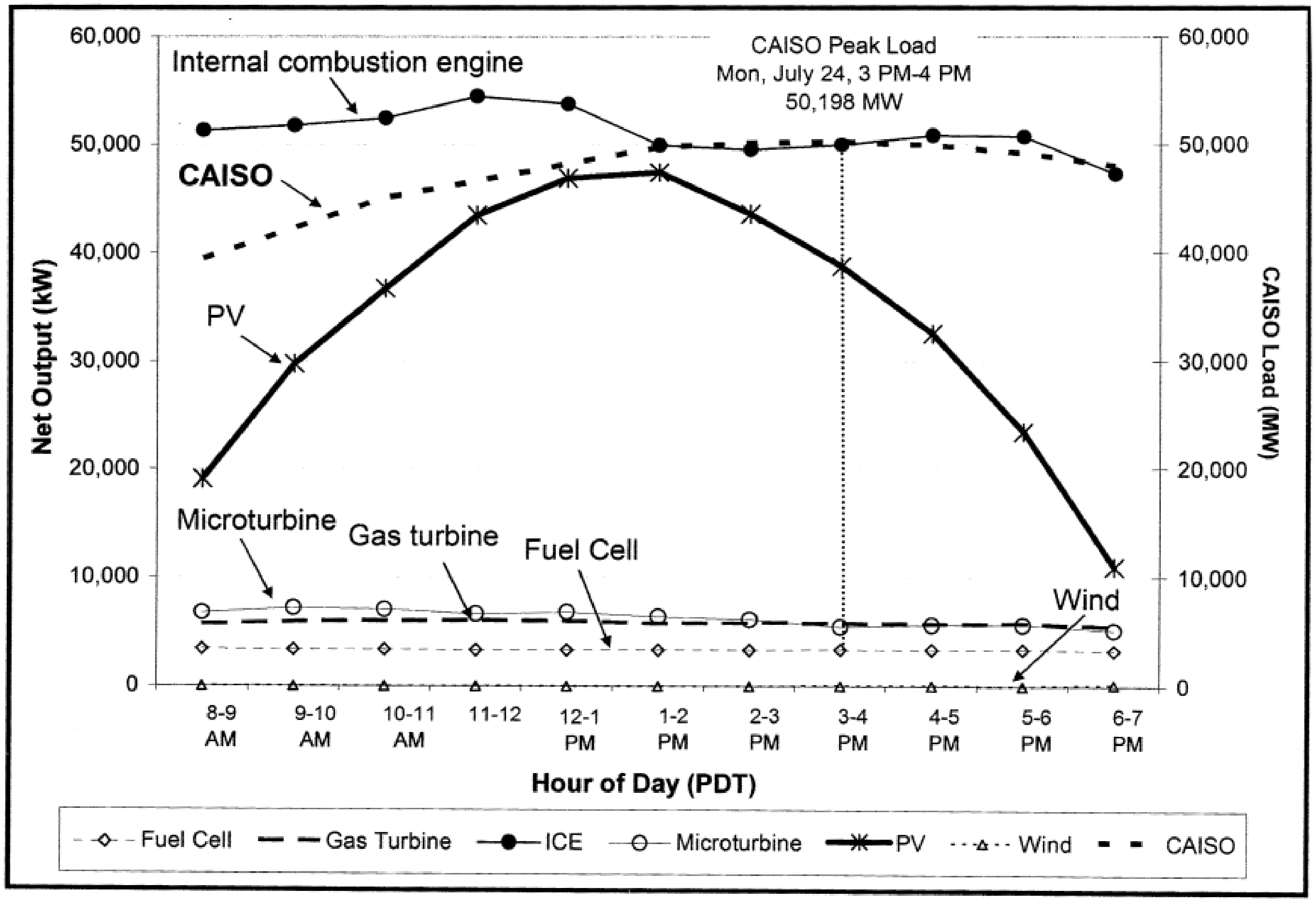
Source: www.dsireusa.org

Unique Attributes = Technology-Specific Value Proposition

- Solar Photovoltaics (“PV”) - Distributed on-peak power, no fossil fuel, no emissions, no noise, modular; weather-dependent, visual impact.
- Fuel Cells - High electrical efficiency, 24/7 distributed power, cogeneration potential, low noise, modular; fossil or renewable fuel.
- Wind Farms - Significant remote intermittent power, no fossil fuel, no emissions; visual and avian impact.
- Hydro - Pumped storage enables price arbitrage, no fossil fuel; precipitation-dependent, fish impact.

Technology-Specific Contribution to CAISO On-Peak Capacity: 2006

Figure 1-5: SGIP Project Impacts on 2006 System Peak Technology



Source: Itron, ***CPUC Self-Generation Incentive Program Sixth Year Impact Evaluation Draft Report***, **July 31, 2007.**

Traditional Benefit-Cost Analysis Limits Value Proposition

- Only benefits and costs with monetary values based on market exchange are included
- Externalities (+/-), which may be significant, are largely ignored
- Intuitively valuable attributes of distributed generation ("DG") implicitly valued at zero
  - Health benefits associated with reduced emissions
  - Ability to add capacity in small chunks to meet incremental load

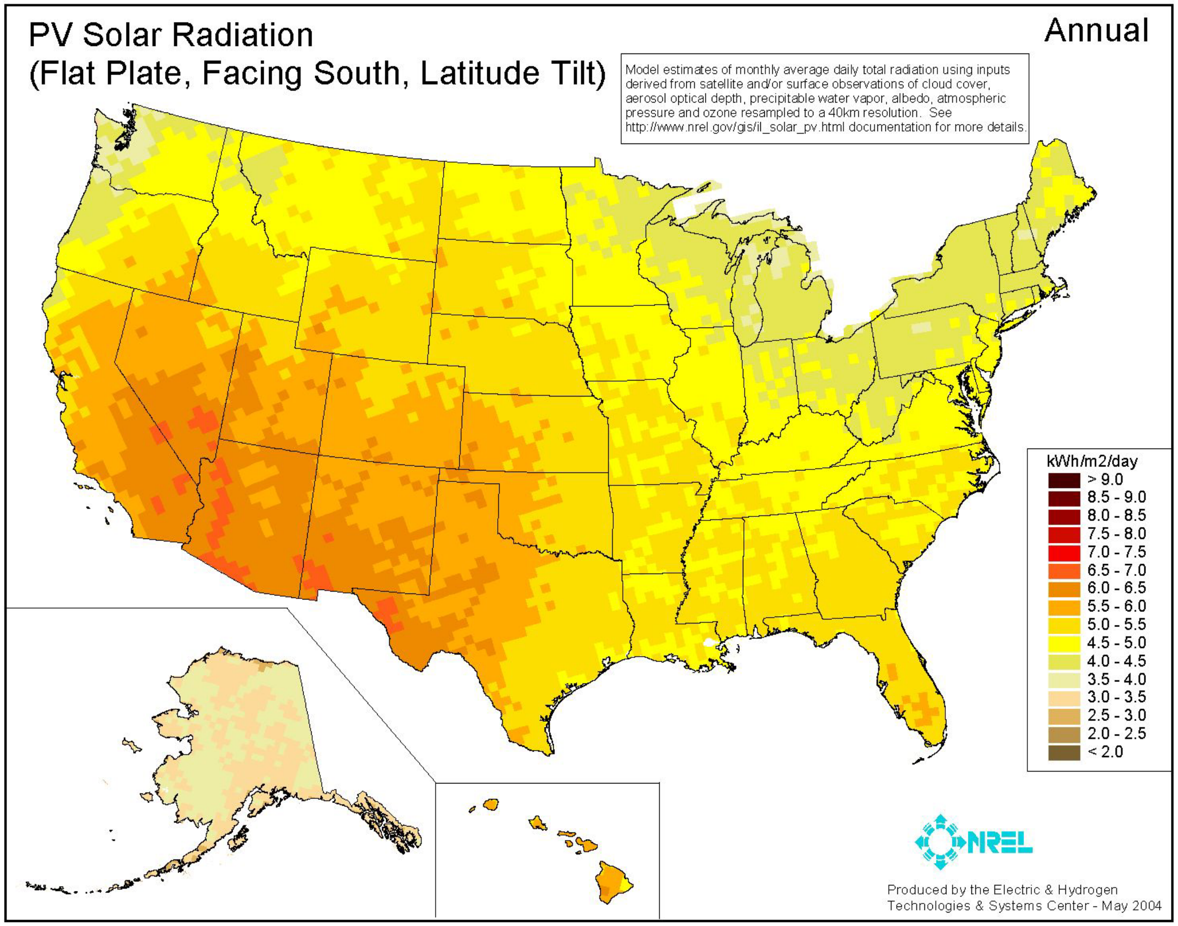
PLEASE Matrix: Valuable DG Attributes Often Not Quantified

POLITICAL	LOCATIONAL	ENVIRONMENTAL	ANTIDOTAL Hedge against:	SECURITY	EFFICIENCY (Market, Technical)
Impact on local control of resources	Impact on local tax base	"Renewable energy credits" and "green certificates" impact	Fossil fuel price volatility	Impact on likelihood of system outages	Impact of combined chilling, heating & power ("CCHP")
Impact on "political capital"	Land use impact (*e.g.*, T&D rights of way)	Impact on NOx and SOx emissions levels	Future electricity price volatility	Impact on supply diversity	Impact on competition & market power mitigation
Impact on achieving RPS goals	Impact on local property values	Impact on PM10 emissions level	Utility power outages	Impact on power quality	Impact on project carrying costs
	Noise level impact	Impact on CO_2 emissions level	Utility load forecast uncertainty	Impact on utility grid VAR support	Impact on decision making time required
	Impact on NIMBY and BANANA attitudes	Impact on other emissions levels (*e.g.*, VOCs, mercury)	Uncertain reserve % requirements	Impact on likelihood & severity of terrorist attacks	Impact on project installation time (due to modularity)
	Impact on local economic activity (*e.g.*, job creation)	Impact on material input (*e.g.*, solar panels replace some roofing)	Wheeling costs	Impact on domestic fossil fuel use	Impact on supply options (as DG markets & technologies mature)
	Ability to impact urban load pockets	Healthcare cost impact related to emissions level changes	Future changes in environmental regulations	Impact on fossil fuel import reliance	Impact on load growth responsiveness (due to modularity)
	Ability to impact suburban load pockets	Visibility impact due to emissions impact	Site remediation costs (current and future)		Impact on permitting time and cost
	Ability to impact rural or remote loads	Impact on consumptive water use			Impact on operating life of grid components
	Impact of DG fuel delivery system	Impact on urban "heat islands" (*e.g.*, shading ability)			Impact on resale or salvage value of equipment
	Visual impact	Impact on water & soil pollution levels			

Quantification of DG Value Proposition in California

- Two DG Case Studies Performed
- Solar PV, on behalf of Americans for Solar Power ("ASPv"); completed.
  - CPUC Docket No. R.04-03-017, "Order Instituting Rulemaking Regarding Policies, Procedures and Incentives for Distributed Generation and Distributed Energy Resources."
- Fuel Cells, on behalf of California Fuel Cell Manufacturer Initiative ("CAFCMI"); ongoing.
  - Preliminary quantification of PLEASE matrix beneficial attributes being expanded to full cost-benefit analysis.

Case Study 1: Solar PV Value Proposition in California



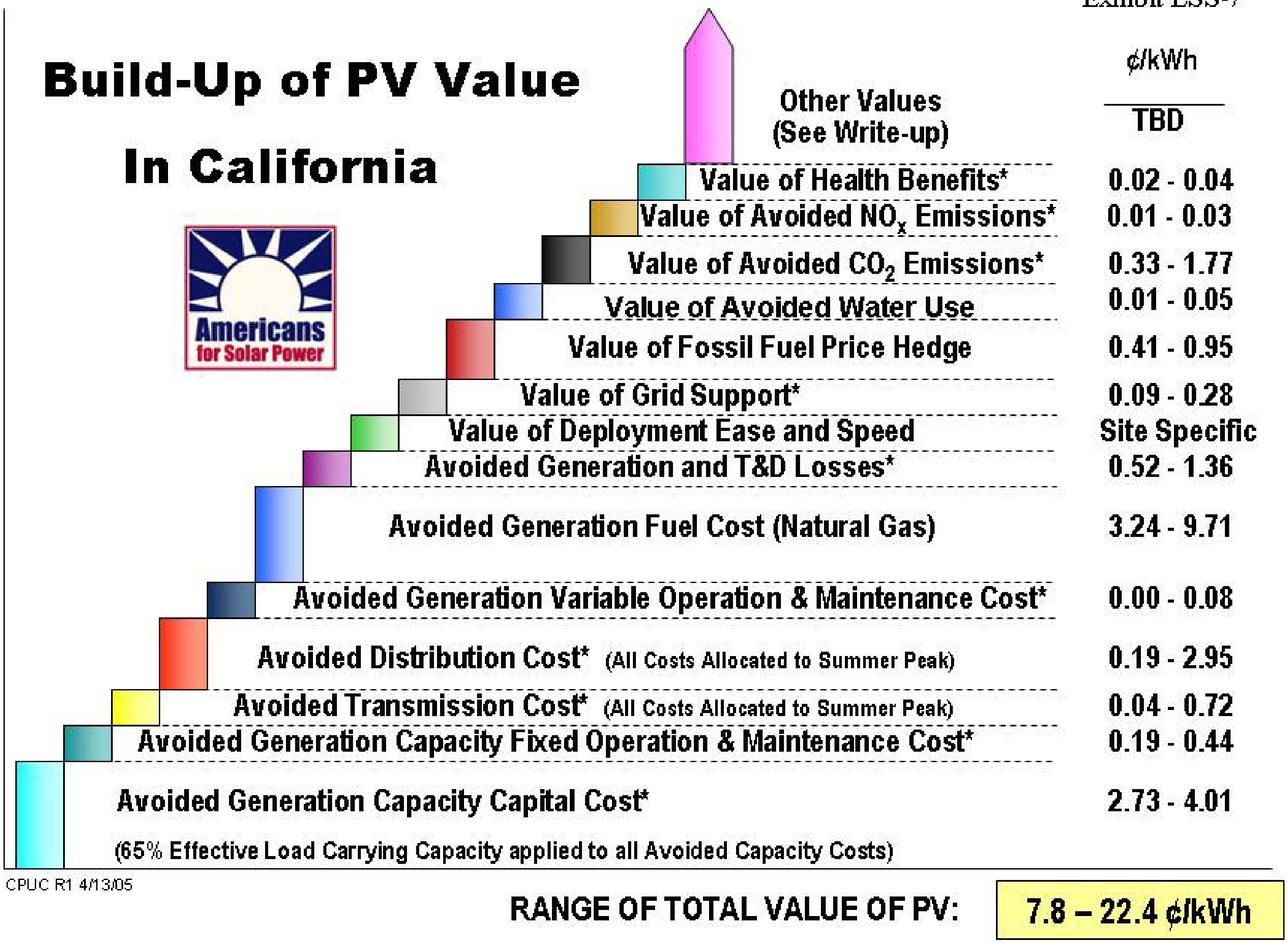
PV in California: Avoided Costs

- Avoided Generator = (i) Natural Gas Combined Cycle Plant ("NGCC") or (ii) Natural Gas-Fired Combustion Turbine
- As a Peaking Technology, Distributed Solar PV Power Generation Avoids:
  - On-Peak Central Plant Generation
    - Capacity Costs
    - Operating & Maintenance Costs
    - Fuel Costs
    - Related Emissions
  - On-Peak Transmission and Distribution
    - Related Losses
- Avoided Emissions – Allowances that are not (widely) traded lack market transparency; valuation less obvious.

Related PV Benefits Both Intuitive and Challenging to Quantify

- Health benefits related to avoided emissions intuitively have value, but how to quantify?
- Avoided exposure to natural gas price volatility provides price hedge value, but how to quantify?
- Installation of PV projects increases local employment, but how to quantify?
- Increased penetration of PV increases potential for increased PV manufacturing in California, but how to quantify?

Exhibit LSS-7



Source: CPUC, Docket No. R.04-03-017, ASPv, *Prepared Testimony on Itron Report on Framework for Assessing the Cost-Effectiveness of the Self-Generation Incentive Program*, April 13, 2005.

California Solar Initiative ("CSI")

- $3.2 Billion Incentive Program
- 10-Year Program (2007-2016) Goals:
  - 3,000 MW installed capacity; maximum on-peak system performance, preceded by energy efficiency measures
  - Self-sufficient solar industry; viable mainstream option
  - Solar energy systems on 50% of new homes in 13 years
- Incentives for 1 kW-5 MW systems; paid only up to 1 MW.
  - Performance-Based Incentives; paid over 5 years (50^+ kW)
  - Expected Performance-Based Incentives; paid up-front (<50 kW)
  - Incentives decline at least 7% per year; ratchet down at threshold installed capacity levels
- New Residential (CEC-Managed)
- Residential Retrofit and Commercial (CPUC-Managed)

Market Identification: Fuel Cell Markets More Diverse than PV

- Baseload DG Market:
  - Cogeneration from Capture of High-Quality Waste Heat
  - Renewable Power – Digester & Landfill Gas (as Available)
  - Flexible Fuel Applications Follow Natural Gas Lead
  - High Efficiency Hybrid Applications
  - Co-Generation of Renewable Hydrogen
- Baseload Central Plant Generation Market:
  - Hybrid Applications
  - Natural Gas- and Coal-Fired Configurations
  - Enhanced Grid Support
  - Large Volume Co-Generation of Hydrogen

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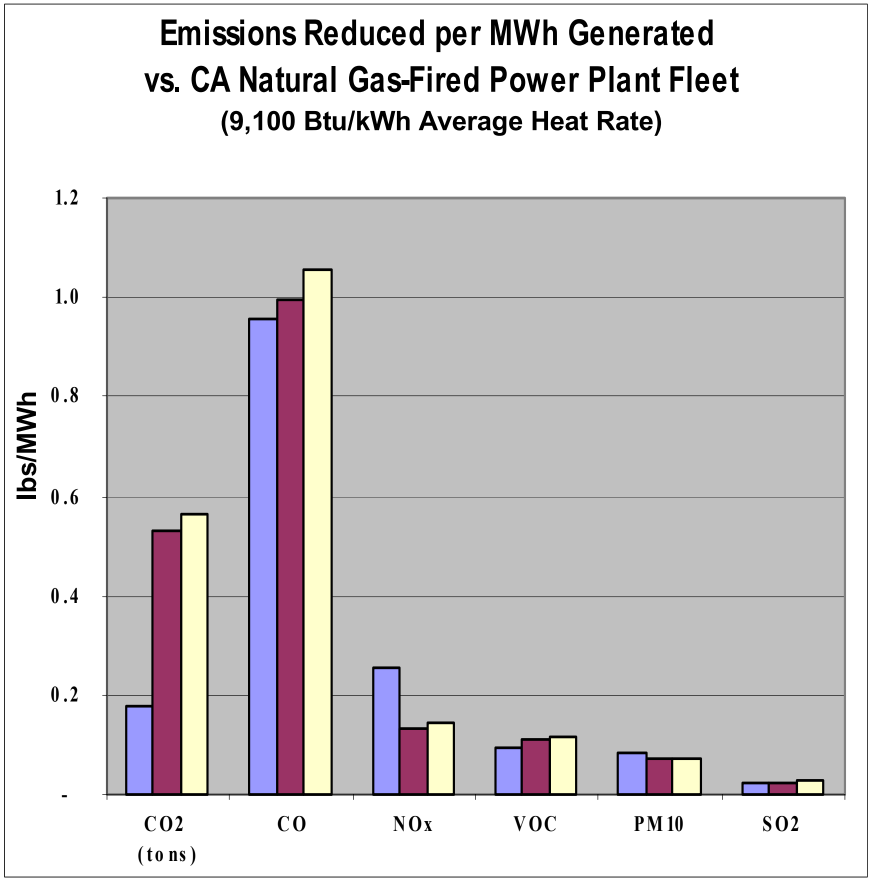
Case Study 2: Fuel Cell Value Proposition in California

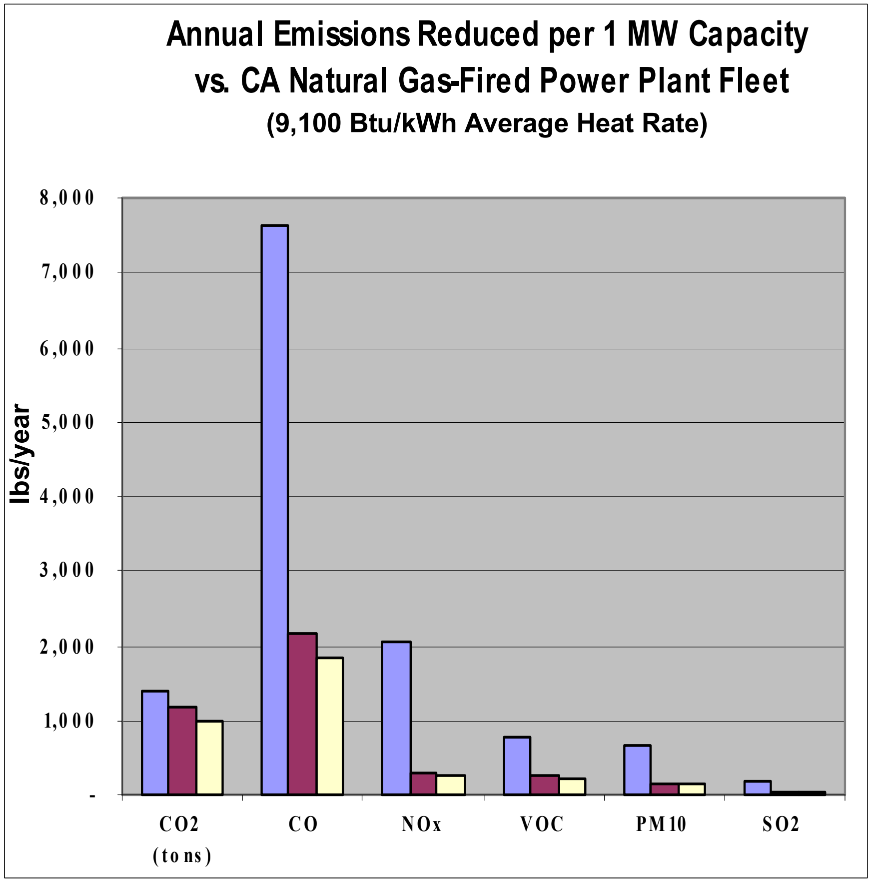
- Large-Scale Distributed Baseload Power Generation
  - Capacity: 100's of kW – 10's of MW
  - Availability: > 90%
  - Technology: Molten Carbonate; Solid Oxide; PAFC
  - Combined Heat & Power: 60% of Total Installed Capacity
- Fuel
  - Natural Gas
  - Renewable – Digester Gas from Waste Water Treatment Plants, Landfill Gas, Other Biogas Sources: 30% of Total Installed Capacity

Fuel Cells in CA: Avoided Costs

- Avoided Generator = (i) In-State NGCC or (ii) Out-of-State Pulverized Coal Central Plant
- Avoided Emissions – Value Depends on Location of Avoided Generator
- Value of Health Benefits – Limited to Avoided In-State Emissions
- Additional Value Proposition Components:
  - Natural Gas Savings (and related Avoided Emissions) due to:
    - Higher Fuel Cell Electrical Efficiency vs. Avoided Generator
    - Avoided Boiler Input due to Cogeneration
    - Avoided Flared Gas Emissions due to Use of Digester Gas
  - Increased Reliability and Blackout Avoidance – Value Increases as Market Penetration of Fuel Cells Increases
  - Increased Power Quality
  - Job Creation Potential – Initially Fuel Cell Installation Only; Potential for In-State Fuel Cell Manufacturing Capacity.

24/7 Fuel Cell Operations = Greater Avoided Emissions than PV & Wind





Fuel Cell @ 91% Capacity Factor; 30% Renewable Fuel; 60% Cogen.

Wind @ 25% Capacity Factor.

Solar PV @ 20% Capacity Factor.

Complementary Technologies: DG/DG & DG/Central Station

- Fuel Cells + PV = Baseload + Peak-Shaving, maximizing most valuable attributes of each DG technology.
- Fuel Cells + Wind = Intermittent wind power could be used to produce "green" hydrogen
  - To fuel the California Hydrogen Highway
  - To fuel hydrogen-based fuel cells
  - To avoid need for transmission lines to bring wind power to load centers.

Conclusion: Steps to Inform Policy Implementation Process

Identify Technology-Specific Attributes

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Calculate Technology-Specific Value Proposition

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Rank Power Generation Technologies by Value Proposition and Suitability for Achieving Policy Mandates

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Contribute to the Efficient Achievement of Policy Mandates at Minimum Cost

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Enable Evolution of Next Generation Products:
(i) Flexible Fuel Hybrid DG;
(ii) Natural Gas- & Coal-Fired Hybrid Central Plant Generation.