

# Evaluating and Capturing Benefits of Renewable Energy for California

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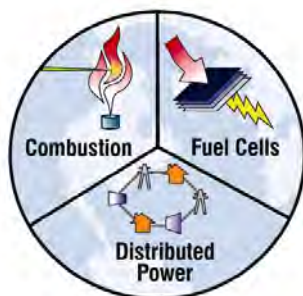
California Energy Commission  
IEPR Lead Commissioner Workshop  
Sacramento, California  
April 12, 2012

**DOCKET**

**12-IEP-1D**

DATE APR 12 2012

RECD. APR 13 2012

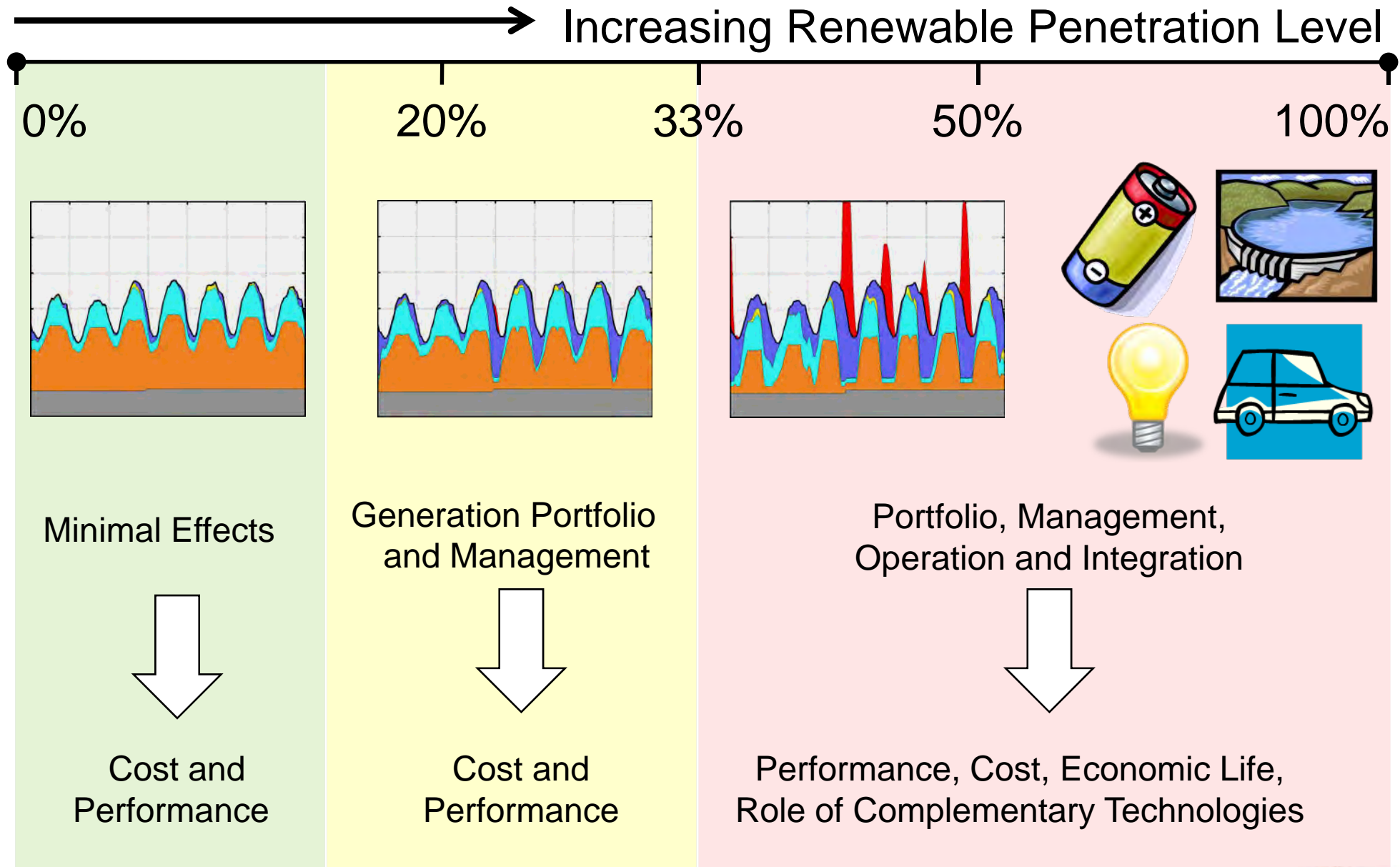


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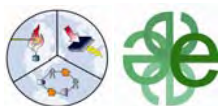


# More Renewables, More Challenges

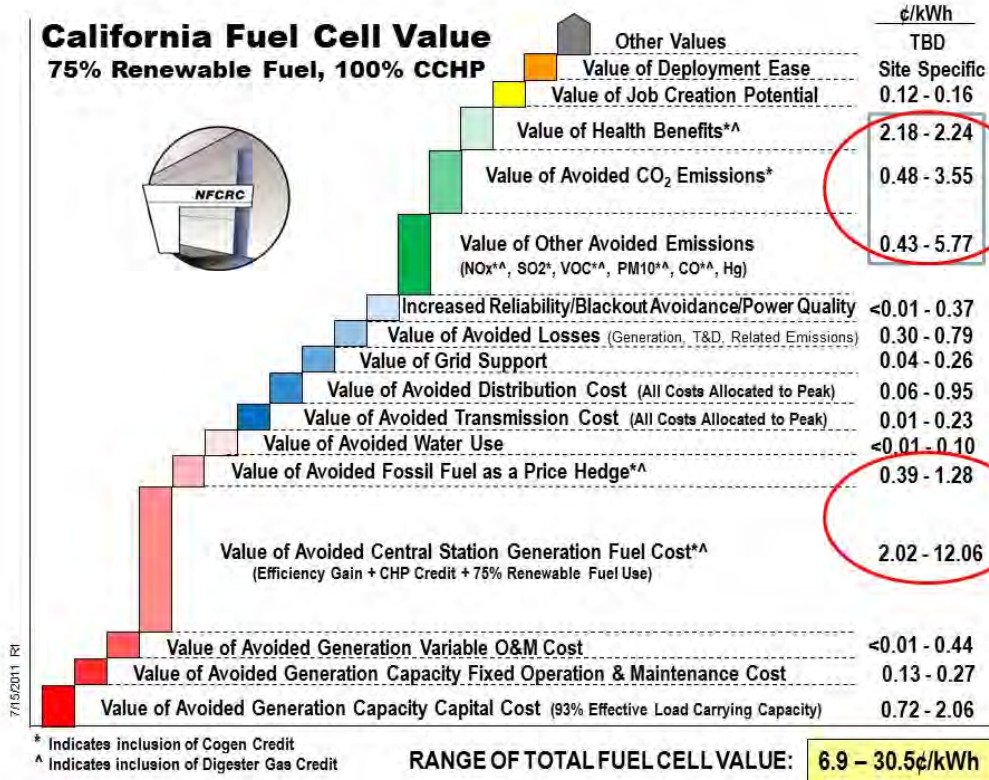


# Economics to Guide Added Grid Flexibility

- **Existing and future technologies needed to buffer intermittency of wind and solar**
- **Baseload Generation**
  - **Fuel cells: Distributed; efficient; low emissions**
  - **Geothermal: Efficient; low emissions**
- **Dispatchable Generation**
  - **Peakers: Natural gas; distributed; inefficient; relatively high emissions**
  - **Solar thermal with storage**
- **Complementary (Non-Generating) Technologies**
  - **Demand Response (DR)**
  - **Energy Storage: Pumped Hydro, CAES, Batteries**



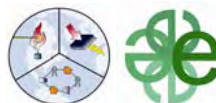
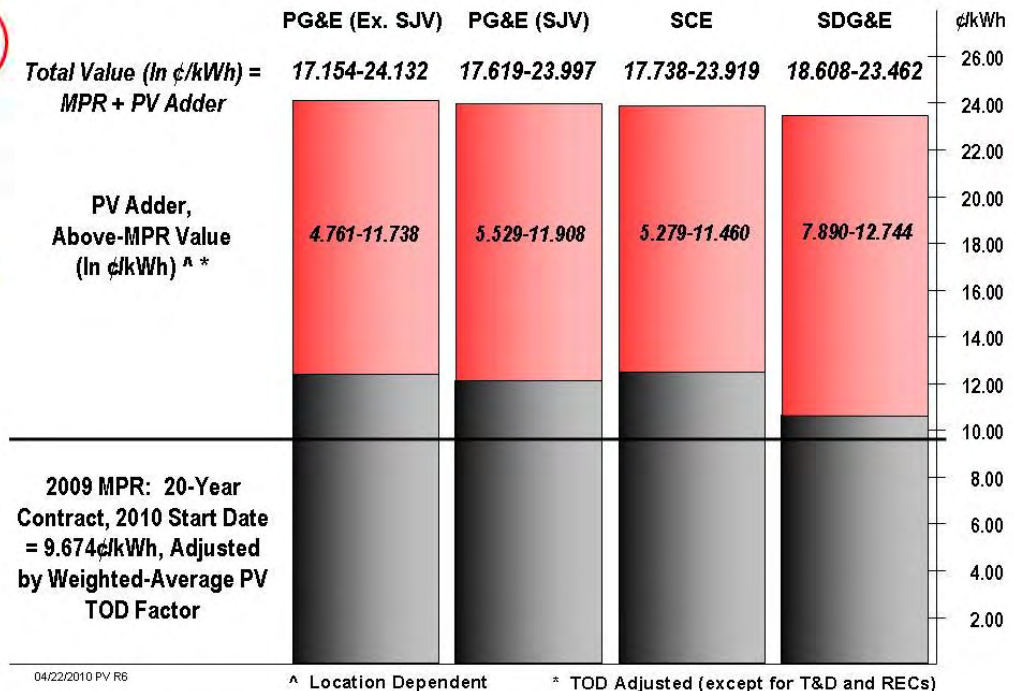
# Initial Technology-Specific Valuation...



- Value depends on what generation is avoided (e.g., peak, baseload)

- Value depends on timing (e.g., avoided fuel costs, emissions allowance costs) and technology

**Small-Scale Solar PV in California: Total Value (2009 MPR + PV Adder)**





# Feeds Simultaneous & Systematic Analysis

- **Each technology impacts every other technology**
- **Each technology creates benefits**
  - Avoided T&D and related grid support
  - Avoided emissions & related health benefits
  - Job creation potential
- **Each technology imposes costs**
  - Need to offset renewable intermittency
  - Electric vehicle charging (depending on timing)
- **Grid-wide valuation captures inter-related and potentially offsetting technology-specific impacts**
  - Peak load reduction/shifting due to DR/solar
  - Emissions impact of required balancing generation

