Beyond 33%: California’s Renewable Energy Future, From Near-Term Solutions to Emerging Technologies

Friday, October 17, 2014
California Energy – By the Numbers

GSP $1.96 Trillion (2011)

Electricity Consumption
~260,000 GWh (2010)

Peak Electricity Demand
~61,000 MW (2006)

Energy Expenditures (2010)
~$33.4B Electricity
~$15B Natural Gas
~$72B Petroleum

Total ~ $320 Million/day (2010)
California Greenhouse Gas Emissions

2012 = 460 MMT CO2e/Year
California Greenhouse Gas Emissions

FIGURE 2. GREENHOUSE GAS EMISSIONS AND GROSS DOMESTIC PRODUCT
CALIFORNIA RELATIVE TRENDS SINCE 1990 / GREENHOUSE GAS EMISSIONS (MTCO$_2$E) AND GDP DOLLARS, PER CAPITA

INDEXED TO 1990 (100=1990 VALUES)

GDP PER CAPITA
GROSS GHG EMISSIONS PER CAPITA

1 year
+2%
+1%
1 year

NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Air Resources Board, California Greenhouse Gas Inventory - by Sector and Activity; Bureau of Economic Analysis, U.S. Department of Commerce; California Department of Finance. Analysis: Collaborative Economics

California’s Goals:
Reach 1990 levels by 2020 and 80% reduction by 2050

MMT CO2e/yr

431 MMT CO2e/yr

86 MMT COe/yr

1990 Levels
80% below 1990 Levels

MMT CO2e = Million metric tonnes of carbon dioxide equivalent
Model Questions

• How might California’s energy system evolve to 2030 & 2050:
  • Greenhouse Gas (GHG) trajectories?
  • Energy and technology mix?
  • Infrastructure build rate?
  • Air quality?

• What assumptions drive these results?

• What are common insights across models? Where do they diverge?
## CA Energy Models/Reports Reviewed

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Business As Usual (BAU) Scenarios

- Long et al., 2011
- Williams et al., 2012
- Nelson/Wei et al., 2013
- Yang et al., 2014
- ARB Scoping Plan, 2008
- ARB Scoping Plan, 2014
- Historic
- Roland-Holst, 2012
- AB32 Target

MMT CO2e/yr

2000 2010 2020 2030 2040 2050
Reaching 80 in ‘50 Goals

- Linear Reduction to 80%
- Williams et al., 2012 (Nuke)
- Yang et al., 2014 (Line)
- GHGIS (Case 2)
- Nelson/Wei et al., 2013 (Base)
- Williams et al., 2012 (Hi Renew)
- Yang et al., 2014 (CCS)
- Greenblatt, 2013 (Case 3)
- Nelson/Wei et al., 2013 (-40% BioCCS)
Reaching 80 in ‘50 – Implications for renewables

Box plot = quartiles (box) and max/mins (whiskers) across mitigation scenarios in given year
Red squares = individual scenarios
Percentages above boxes are percent renewable (non-hydro) across mitigation scenarios

Figure 3. 2030 and 2050 electricity generation (TWh/yr) in deep reduction scenarios. Figure includes in-state production and imported generation. Box plot = quartiles (box) and max/mins (whiskers) across mitigation scenarios in the indicated year. Red squares = individual scenarios. Percentages above boxes are percent renewable (non-hydro) across mitigation scenarios.
Reaching 80 in ‘50 – Implications for renewables*

• Total generation (all types) goes from 306 TWh in 2013 to:
  • 290-410 TWh in 2030
  • 245-692 TWh in 2050

• Renewable fraction (non-hydro) ranges from:
  • 30-54% in 2030
  • 38-89% in 2050

• Implied renewable build rate (nameplate capacity):
  • 0.2-4.2 GW/yr through 2030 (average 0.83 GW/yr)
  • 1.5-10.4 GW/yr between 2030-2050 (average 3.9 GW/yr)

*Not including WWS model
TWh = Terawatt hours
GW/yr = Gigawatts per year
How much is one Gigawatt (GW)?

Ivanpah solar facility ~400MW

UC Davis Honda House ~9KW

$\times$ ~2.5

$\times$ ~111,000
Reaching 80 in ‘50 Goals – Key Variables

• Competition for low-carbon generation?
  • Nuclear power
  • Fossil with Carbon Capture and Sequestration (CCS)
Reaching 80 in ‘50 Goals – Key Variables

• Key variables for total electricity consumption
  • Efficiency ↓
  • Electric vehicles ↑
  • Electrification of residential, commercial, industrial heating ↑
THANK YOU!

More information:
• energy.ucdavis.edu
• policyinstitute.ucdavis.edu
• lts.ucdavis.edu
• eec.ucdavis.edu