Energy and Environmental Economics, Inc.

Energy Efficiency in 2050:
Long-term greenhouse gas reduction targets

Amber Mahone
Energy and Environmental Economics, Inc.

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Why the long-term view matters

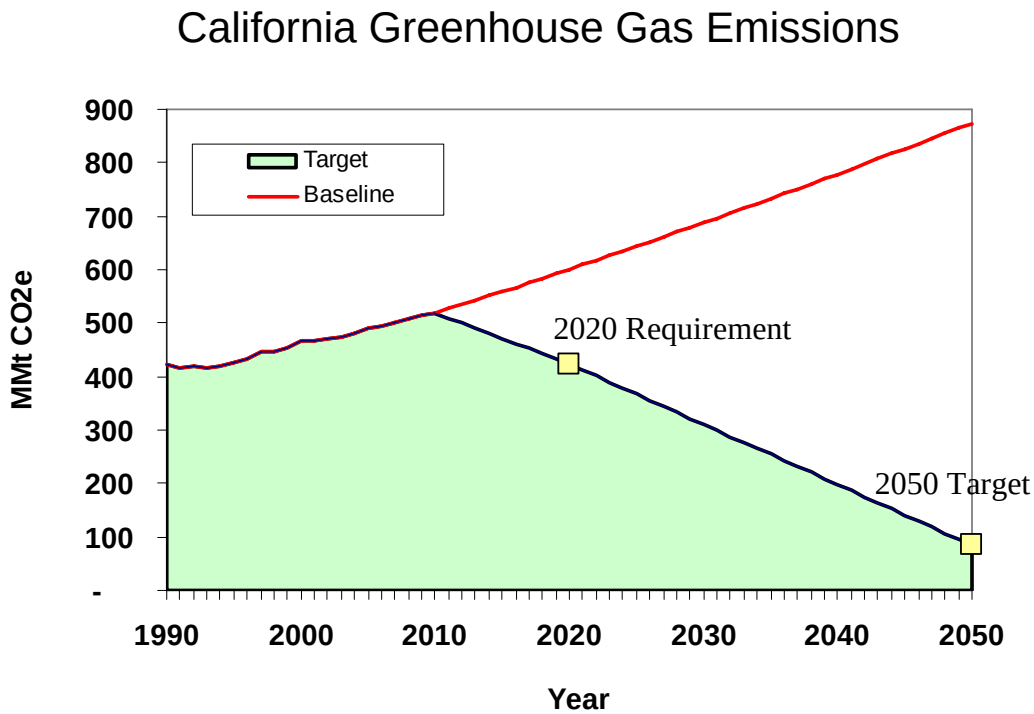
- Scientists tell us that current levels of greenhouse gas (GHG) emissions must be reduced to avert catastrophic climate change
- Federal climate policy is considering 80% reductions in GHG emissions by 2050 (relative to 2005) – Similar targets in many U.S. states
- Reducing GHGs *generally* means reducing fossil fuel consumption
  - Energy efficiency (EE) *generally* reduces fossil fuel consumption
- Long-term, economy-wide analysis of GHG emissions shows the importance of EE
  - EE keeps costs down: cheaper than most low-carbon (and fossil fuel) alternatives
  - EE helps offset expected growth in electricity demand due to electric cars and other sources of new electrification
  - EE reduces need to build expensive power plants and transmission lines

Study Overview

- Key question
  - What does California need to do to meet its 2050 GHG reduction goal?
    - 2050 Target set by Executive Order S-3-05: Reduce statewide GHGs 80% below 1990 levels by 2050
- Infrastructure modeling approach
  - Bottom-up, multi-sector, stock roll-over model
  - Integrated electricity grid dispatch algorithms
  - Calibrated to CA projections of population, gross state product
  - Does not predict pathways based on assumed prices and economic behavior like an equilibrium model
- Independent study sponsored by Hydrogen Energy International (HEI)
  - HEI is seeking to develop a hydrogen-powered electricity generation facility with carbon capture and sequestration (CCS) in California

Baseline and Compliant Scenarios

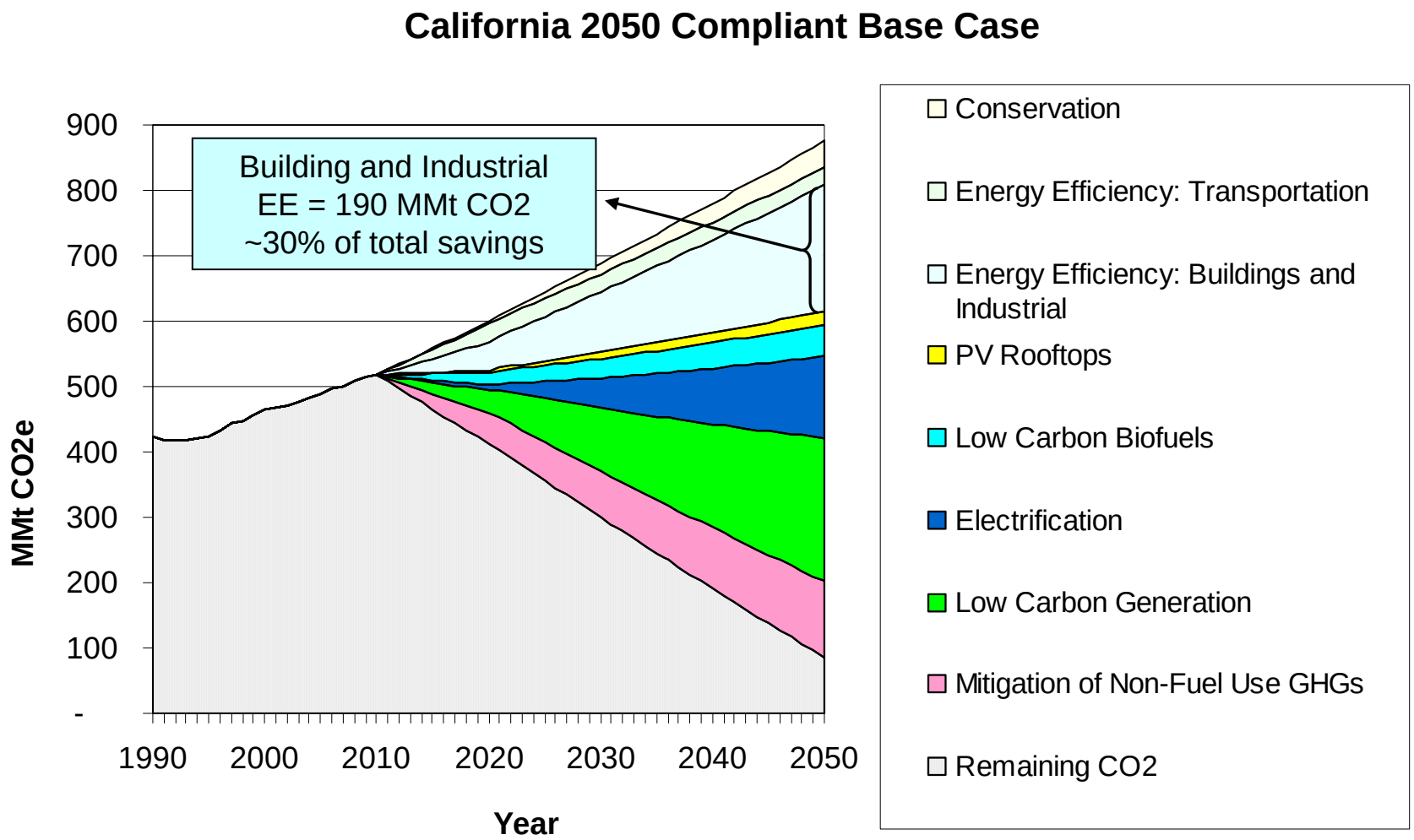
- ‘Baseline’
  - Business-as-usual GHG projection
- ‘2050 Compliant’ Scenarios
  - Reduce emissions 80% below 1990 levels by 2050
    - Test scenarios with varying levels of EE achievements



Five Keys to Achieving 2050 Goal

1. Conservation
   - “Smart growth” - homes are closer to jobs & people drive less
2. Energy efficiency & low-carbon on-site generation
   - Efficiency increases the feasibility of meeting electricity and fuel demands with low-carbon energy
   - Efficiency is essential to keep costs from prohibitive levels
3. Electrification & low-carbon generation
   - All 2050 compliant scenarios require high electrification using low-carbon generation sources
4. Low-carbon bio-fuels
   - Biofuels become a premium fuel for those uses that are not readily electrifiable, particularly Heavy Duty Vehicles
5. Mitigation of non-fuel use GHGs (methane, refrigerant gases, etc.)

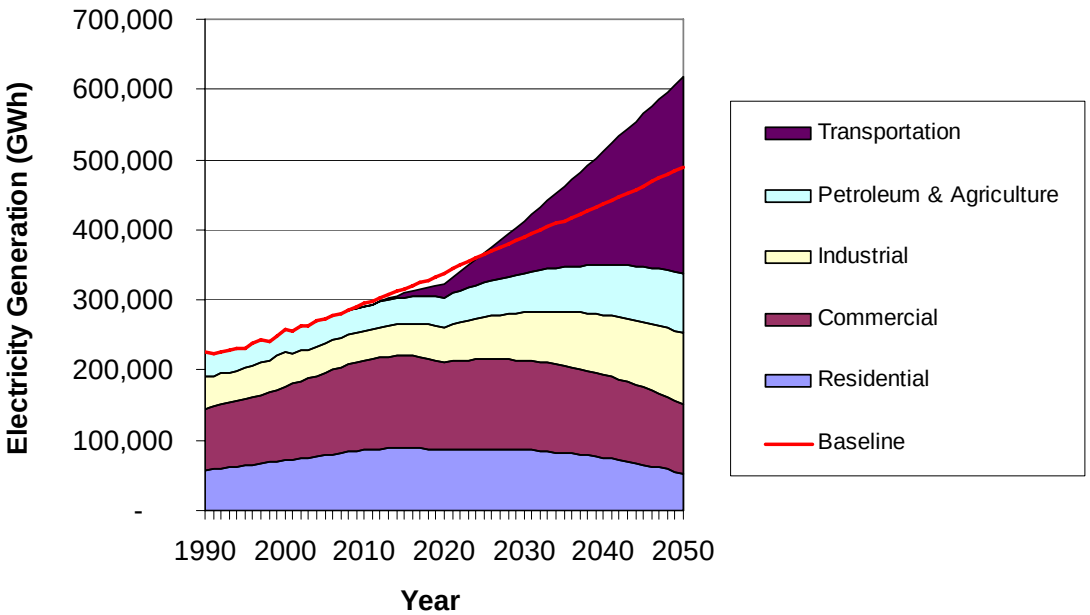
How do we get there?



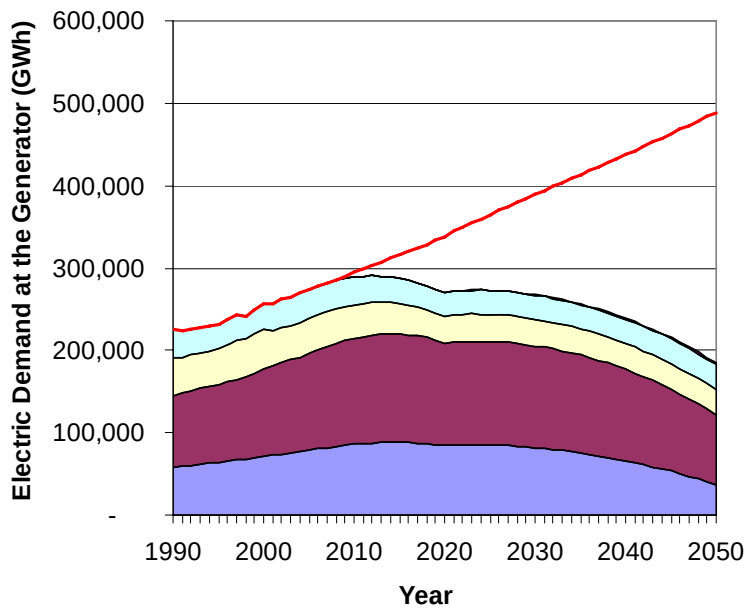
Competing Effects of Energy Efficiency and Electrification

- High levels of energy efficiency could nearly flatten load growth
- Efficiency gains are offset by electrification – to reduce emissions from fossil fuel use in transportation and other sectors

Electric Demand Including Electrification Meets 2050 GHG Target

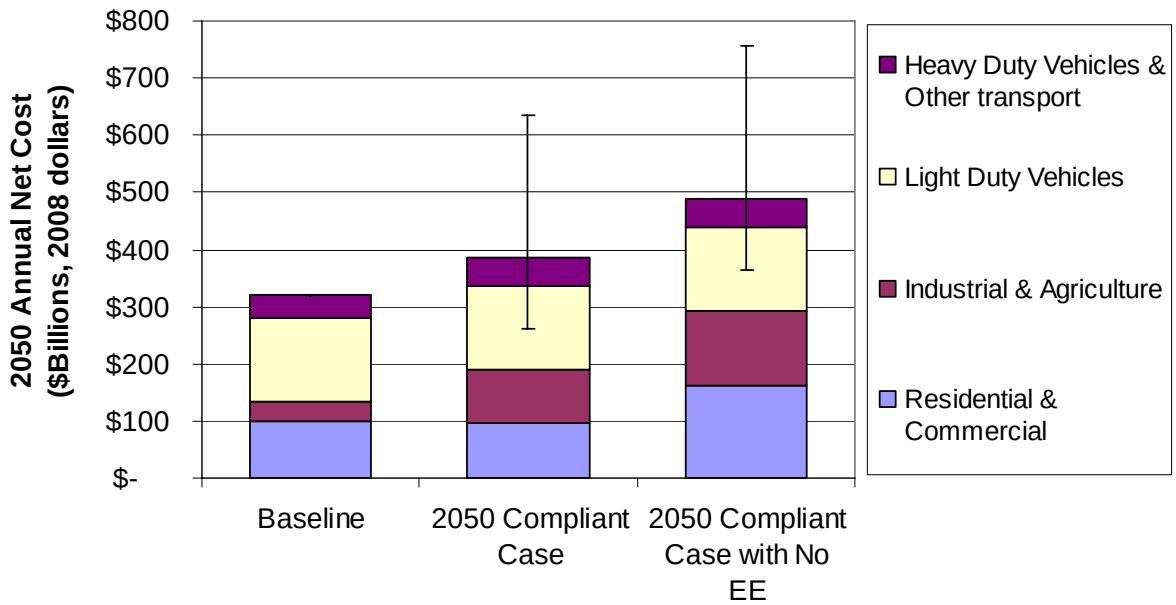


Electric Demand Excluding Electrification Does Not Meet 2050 GHG Target



Costs are Uncertain…

- 2050 Compliant Case is about $66 billion higher cost than Baseline
  - 1.3% of California GSP in 2050, $1,200/person/yr in 2050
- "2050 Compliant Case with No EE" results in ~$100 billion higher cost than 2050 Compliant Case
  - Assuming $0.12/kWh for electric EE, $15/MMBtu for gas EE and $20-$30/MMBtu for electrification in residential, commercial and industrial sectors in 2050
- Error bars represent uncertainty surrounding emission reduction measure costs (testing twice and half the emission reduction measure cost assumptions).



Avoided Infrastructure

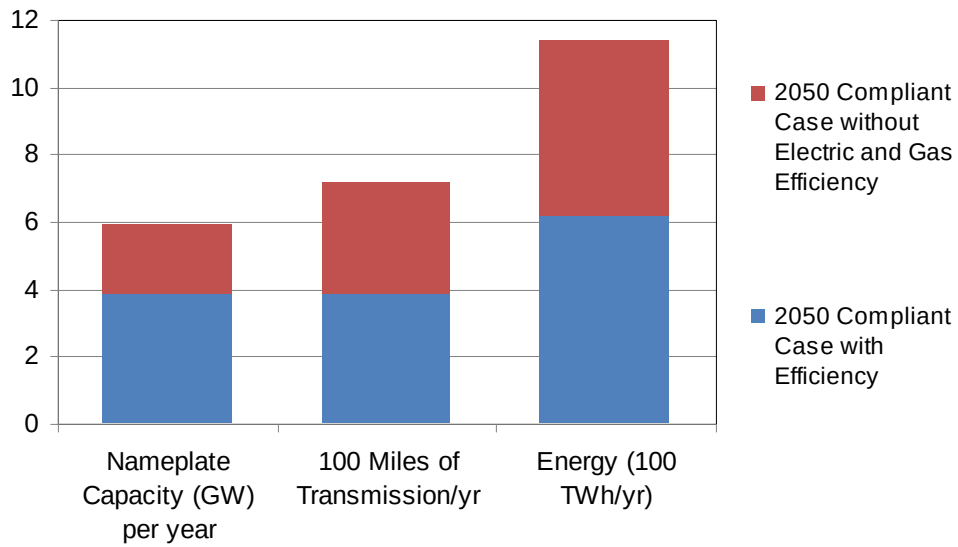
- High levels of EE nearly cuts in half the need to build additional low-carbon electricity power plants to meet GHG target over 40 years

2 Cases:

"With Efficiency" reduces GHGs to 80% below 1990 levels by 2050

"Without Efficiency" meets same GHG target, but requires higher levels of electrification and more low-carbon electricity generation

Approximate Infrastructure Requirements by 2050



Implications

- Achieving 80% cuts in GHG emissions by 2050 will require massive increases in energy efficiency
  - To achieve EE approaching technical potential will require starting soon
- Technology & behavioral breakthroughs in EE are needed
  - Will require new programs, approaches and higher investment – Not just cap and trade carbon price signals
- Without high EE achievements:
  - Higher cost of compliance with GHG reduction goals
  - GHG reductions must be achieved other ways - more electrification & low-carbon electricity generation
  - The infrastructure challenge of building enough new, low-carbon power plants could become too big

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Thank you

Amber Mahone
Energy and Environmental Economics, Inc.
101 Montgomery Street, Suite 1600
San Francisco, CA 94104
(415) 391-5100
Amber@ethree.com