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Plug-in Hybrid Electric Vehicles

- Emissions reduction
 - 6.68 MMT CO₂e in 2020
 - \$88.61 / Mt CO₂e
- Reductions potential is non-overlapping with fuel efficiency standards
- Incorporated learning by doing to account for changing technology costs
- Cost to state based on incentive structure similar to CA Million Solar Roofs model
- Compared with NREL numbers, costs are similar
- PHEV cost curve is being integrated with other transportation elements into common transportation model
- Drew data from PNNL, NREL, NESCCAF, other sources

Renewable Power

- All renewable resources were taken from E3's most recent GHG calculator that models the power sector. We used the case with 20% RPS in the baseline and up to \$160/tonne CO₂e to build the RE supply curve.
- One of the major takeaways is that after 20% RPS, the renewable options are not cheap
- Wind – 3.3 MMT, \$84/tonne
- Biogas – 1MMT, \$34/tonne
- Biomass – .7MMT, \$190/tonne
- Small Hydro – 6MMT, \$96/tonne
- Geothermal – 1MMT, \$70/tonne

IGCC with Carbon Capture and Sequestration

- E3's output resource mix does not include CCS because of high costs.
- If reduction measures costing less than \$250/tonneCO₂ are insufficient for AB-32's target, CCS could be considered.
 - Costs come from E3's inputs, and corroborating literature
- Potential of 6.5MMtonnes if all electricity growth after 2015 is IGCC w/CCS;
- But satisfying electricity demand with more cost-effective renewable resources and efficiency measures reduces CCS potential.

Non-CO2 Gases

Measures	Emission Reductions	Costs (\$/MMTCO2eq)	Uncertainty/ Caveats
Landfill Gases: Capture and Destruction	2.3	42	Baseline emissions from landfills are uncertain. Methodology in development.
Recycling and Composting	3	23	Estimates are mostly a placeholder.
Landfill Gases to Energy Systems	1	34	Costs for electricity generation from biogas has been estimated as an aggregate. Estimates are for electricity generation in addition to the RPS requirement (20%).
Manure Management (Electricity Generation)			
High-GWP gases: refrigeration systems	8.5	28	Costs are highly uncertain. Further emission reductions from stationary refrigeration systems are possible.
Total	14.8		

Non-CO2 Gases: Discussions and Future Research

- Potential for emission reductions for Non-CO2 gases are significant.
- The present estimates are based on the CAT analysis (2006).
- Estimates for electricity generation from biogas is based on E3 calculator. The quantity appears to be in the low range of possible estimates.
- Costs estimates for High-GWP would need further analysis to reflect the true social cost of the measures.
- Recycling is an important unknown.

Cement

- Fuel Switching: 100% natural gas for heat (2.2 MMT or 14% reduction)
 - Cost \$119/MT – Expensive
- Pozzolans: substitute 25% of all cement with fly ash (2.4 MMT reduction)
 - Cost \$0/MT – But usable fly ash expected to decline
- Efficiency: increase the efficiency of plants (0.8 MMT reduction)
 - Cost (\$33)/MT – But how efficient are CA plants today?
- Biggest question: Leakage
 - Increased imports from: China, Taiwan, Thailand

Combined Heat and Power

- Divided into industrial sector and residential and commercial sector
 - Each sector divided into two growth scenarios
 - Relying on increased incentives only
 - Extension of Self Generation Incentive Program (SGIP)
 - Production tax credit extension
 - Aggressive expansion through full set of policy options
 - Further expands incentives and production tax credits
 - Provides avoided cost of transmission and distribution to distributed generators
 - Includes changing regulatory processes
 - Increased funding for R&D
 - Two scenarios are non-overlapping
 - Based on data from EPRI / CEC

Combined Heat and Power

- Industrial
 - Incentives only
 - 1.26 MMT CO₂e
 - \$30 / MT CO₂e
 - Aggressive expansion
 - 7.13 MMT CO₂e
 - \$6 / MT CO₂e
- Residential and Commercial
 - Incentives only
 - 2.3 MMT CO₂e
 - \$30 / MT CO₂e
 - Aggressive expansion
 - 12.8 MMT CO₂e
 - \$6 / MT CO₂e

Smart Growth Planning

- Offers significant potential for reducing emissions in addition to other benefits
- Emission reductions and costs hard to estimate
 - Most current models not suited for land use change
 - Inherent complexities in predicting development patterns
 - Possible costs and their magnitudes difficult to enumerate and estimate
- Reduction amount of 7.06 MMT estimated using the smart growth scenarios of four major regions
- Cost likely to be negative – high uncertainty
- An additional 2.82 MMT (total 9.88MMT) is from other transportation related measures listed in CAT 2007 analysis

GHG Mitigation in Agricultural Soils

- Data used: CEC study (and census) that estimates potential in 10 counties and supply curve for Yolo county
- Strategies considered: reduced tillage, manure application, and winter cover cropping
- 1.05 MMT of emission reduction @ \$6 per MT
- Concerns:
 - Extrapolation of costs and emissions from only a subset of CA counties and for only six chosen crops
 - High uncertainty and non-permanence of emissions' reduction
 - Further research needed on N₂O emissions

Forestry

- Estimates based on CAT analysis (2007)

Measure	Emissions Reduction	Cost (\$/ MT)
Afforestation/ Reforestation	1.98	10.6
Conservation forest management	2.35 MMT	2
Forest Conservation	0.4 MMT	37.5

- Concerns:
 - Significant double counting in excluded measures
 - Uncertainty and permanence issues
 - Other measures being added and estimates being revised by number of groups

Petroleum Refining & Production

- Emissions in 2004:
 - 35 MMT from refining
 - 12 MMT from production
- Estimates for potential reductions (4.4 MMT and 3 MMT) based on CARB's workshop presentations
- Cost numbers (\$30/ MT of CO₂eq) are placeholders
- No publicly available data: data for analysis being sought