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Proposed PATHWAYS Scenario Modeling Assumptions

This table summarizes input assumptions for the PATHWAYS model to explore emission reduction pathways associated with energy use. Separate and distinct models and modeling assumptions will be used to estimate carbon sequestration potential for Natural and Working Lands. A list of acronyms is included in Attachment A.

Sector	Alternative 1 Carbon Neutral by 2035	Alternative 2 Carbon Neutral by 2035	Alternative 3 Carbon Neutral by 2045	Alternative 4 Carbon Neutral by 2045
Smart Growth / Vehicle Miles Travelled (VMT)	VMT per capita reduced 15% below 2019 levels by 2030 and 20% below 2019 levels by 2035	VMT per capita reduced 12% below 2019 levels by 2030 and 22% below 2019 levels by 2045	VMT per capita reduced 12% below 2019 levels by 2030 and 22% below 2019 levels by 2045	VMT per capita reduced 10% below 2019 levels by 2030 and 15% below 2019 levels by 2045
Light Duty Vehicle (LDV) Fuel Economy Standards	Advanced Clean Cars I GHG standards for 2017 - 2025 model years, 2% annual fuel economy improvement for 2026-2035.			
LDV Zero Emission Vehicles (ZEVs)	100% of LDV sales are ZEV by 2025; no Plug-in Hybrid Electric Vehicle (PHEV) sales after 2030 Only ZEVs on road by 2035; no PHEVs on road by 2035	100% of LDV sales are ZEV by 2030; no PHEV sales after 2035	Executive Order N-79-20: 100% of LDV sales are ZEV by 2035	AB 74 ITS Report: 100% of LDV sales are ZEV by 2040
Truck Fuel Economy Standards	California Phase II GHG Standards.			

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Sector	Alternative 1 Carbon Neutral by 2035	Alternative 2 Carbon Neutral by 2035	Alternative 3 Carbon Neutral by 2045	Alternative 4 Carbon Neutral by 2045
Truck ZEVs	100% of MD/HDV sales are ZEV by 2030 Only ZEVs on road by 2035; no PHEVs on road by 2035	100% of MD/HDV sales are ZEV by 2030; Only ZEVs on road by 2045; no PHEVs on road by 2045	100% of MD/HDV sales are ZEV by 2035	AB 74 ITS Report: 100% of MD/HDV sales are ZEV by 2040
Aviation	25% of aviation fuel demand is met by electricity (batteries) or hydrogen (fuel cells) in 2030 and 50% in 2035 50% of aviation fuel demand not met in 2035 because non-combustion alternative not available	25% of aviation fuel demand is met by electricity (batteries) or hydrogen (fuel cells) in 2045	10% of aviation fuel demand is met by electricity (batteries) or hydrogen (fuel cells) in 2045	0% of aviation fuel demand is met by electricity (batteries) or hydrogen (fuel cells) in 2045
Ocean-going Vessels (OGV)	100% of OGVs utilize shore power by 2030 OGVs fuel demand not met in 2035 because non-combustion alternative not available	100% of OGVs utilize shore power by 2030 10% of OGVs utilize hydrogen fuel electric technology by 2035	2020 OGV At-Berth regulation fully implemented with most OGVs utilizing shore power by 2027 25% of OGVs utilize hydrogen fuel cell electric technology by 2045	2020 OGV At-Berth regulation fully implemented, with most OGVs utilizing shore power by 2027 0% of OGVs are zero-emission by 2045

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Sector	Alternative 1 Carbon Neutral by 2035	Alternative 2 Carbon Neutral by 2035	Alternative 3 Carbon Neutral by 2045	Alternative 4 Carbon Neutral by 2045
Port Operations	100% of cargo handling equipment (CHE) is zero-emission by 2030 100% of drayage trucks are zero emission by 2030	100% of cargo handling equipment (CHE) is zero-emission by 2030 100% of drayage trucks are zero emission by 2030	Executive Order N-79-20: 100% of cargo handling equipment (CHE) is zero-emission by 2035 100% of drayage trucks are zero emission by 2035	100% of cargo handling equipment (CHE) is zero-emission by 2037 100% of drayage trucks are zero emission by 2035
Freight and Passenger Rail	100% of passenger and other locomotive sales are ZEV by 2030 50% of line haul locomotive sales are ZEV by 2030 and 100% by 2035 Line haul and passenger rail rely primarily on hydrogen fuel cell technology, and others utilize electricity	100% of passenger and other locomotive sales are ZEV by 2030 50% of line haul locomotive sales are ZEV by 2030 and 100% by 2035 Line haul and passenger rail rely primarily on hydrogen fuel cell technology, and others utilize electricity	100% of passenger and other locomotive sales are ZEV by 2030 25% of line haul locomotive sales are ZEV by 2030 and 100% by 2035 Line haul and passenger rail rely primarily on hydrogen fuel cell technology, and others utilize electricity	100% of passenger and other locomotive sales are ZEV by 2040 100% of line haul locomotive sales are ZEV by 2045 Line haul and passenger rail rely primarily on hydrogen fuel cell technology, and others utilize electricity
Oil & Gas Extraction	Phase out operations by 2035	Phase out operations by 2035	Phase out operations by 2045	Reduce operations in line with petroleum demand

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Sector	Alternative 1 Carbon Neutral by 2035	Alternative 2 Carbon Neutral by 2035	Alternative 3 Carbon Neutral by 2045	Alternative 4 Carbon Neutral by 2045
Petroleum Refining	Phase out production by 2035	CCS on large facilities by 2030 Production reduced in line with petroleum demand	CCS on large facilities by 2030 Production reduced in line with demand	CCS on large facilities by 2030 Production reduced in line with petroleum demand
Electricity Generation	Sector GHG target of 23 $MMTCO_2e$ in 2030 and 0 $MMTCO_2e$ in 2035 Total load coverage Excludes combustion-based generation resources regardless of fuel; hydrogen fuel cells provide firm capacity	Sector GHG target of 30 $MMTCO_2e$ in 2030 and 0 $MMTCO_2e$ in 2035 Total load coverage Includes Renewables Portfolio Standard (RPS)-eligible and zero-carbon generation resources (see Attachment B)	Sector GHG target of 30 $MMTCO_2e$ in 2030 and 0 $MMTCO_2e$ in 2045 Total load coverage Same generation resources as Alternative 2	Sector GHG target of 30 $MMTCO_2e$ in 2030 and 24 $MMTCO_2e$ in 2045 Retail sales load coverage Same generation resources as Alternative 2
Building Energy Efficiency	Align with 2019 IEPR Mid-High (electric) / Mid-Mid (gas)			
New Residential and Commercial Buildings	All electric appliances beginning 2026	All electric appliances beginning 2026	All electric appliances beginning 2026	All electric appliances beginning 2029

Sector	Alternative 1 Carbon Neutral by 2035	Alternative 2 Carbon Neutral by 2035	Alternative 3 Carbon Neutral by 2045	Alternative 4 Carbon Neutral by 2045
Existing Residential Buildings	80% of appliance sales are electric by 2025 and 100% are electric by 2030 All buildings retrofitted to electric appliances by 2035	80% of appliance sales are electric by 2030 and 100% are electric by 2035 Appliances are replaced at end of life	80% of appliance sales are electric by 2030 and 100% are electric by 2035 Appliances are replaced at end of life	75% of appliance sales are electric by 2030 and 100% are electric by 2035 Appliances are replaced at end of life
Existing Commercial Buildings	80% of appliances sales are electric by 2025 and 100% are electric by 2030 All buildings retrofitted to electric appliances by 2035	80% of appliance sales are electric by 2030 and 100% are electric by 2045 Appliances are replaced at end of life	80% of appliance sales are electric by 2030 and 100% are electric by 2045 Appliances are replaced at end of life	75% of appliance sales are electric by 2030 and 100% are electric by 2045 Appliances are replaced at end of life
Industrial Energy Efficiency	Energy demand reduced 6% relative to 2019 IEPR Mid-Mid			
Food Products	50% energy demand electrified by 2030; 100% by 2035	50% energy demand electrified by 2030; 100% by 2035	0% energy demand electrified by 2030; 100% by 2045	0% energy demand electrified by 2030; 10% by 2045
Construction	50% energy demand electrified by 2030 and 100% by 2035	50% energy demand electrified by 2030 and 100% by 2035	25% energy demand electrified by 2030 and 100% by 2035	0% energy demand electrified by 2030 and 10% by 2045

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Sector	Alternative 1 Carbon Neutral by 2035	Alternative 2 Carbon Neutral by 2035	Alternative 3 Carbon Neutral by 2045	Alternative 4 Carbon Neutral by 2045
Chemicals and Allied Products; Pulp and Paper	Electrify 50% of boilers by 2030 Electrify 100% of boilers and process heat by 2035 Electrify 100% of other energy demand by 2030	Electrify 50% of boilers by 2030 and 100% of boilers by 2035 Hydrogen for 25% of process heat by 2035 trending to 100% by 2045 Electrify 100% of other energy demand by 2035	Electrify 0% of boilers by 2030 and 100% of boilers by 2045 Hydrogen for 25% of process heat by 2035 trending to 100% by 2045 Electrify 100% of other energy demand by 2045	Electrify 0% of boilers by 2030 and 10% of boilers by 2045 Hydrogen for 0% of process heat by 2035 trending to 10% by 2045 Electrify 0% of other energy demand by 2045
Stone, Clay, Glass & Cement	Facilities close because non-combustion alternative not available	Carbon Capture and Sequestration (CCS) on large facilities by 2030 and on all facilities by 2045	CCS on large facilities by 2030 and on all facilities by 2045	CCS on large facilities by 2030 and on all facilities by 2045
Other Industrial Manufacturing	50% energy demand electrified by 2030 and 100% by 2035	50% energy demand electrified by 2035	0% energy demand electrified by 2030 and 50% by 2045	0% energy demand electrified by 2030 and 10% by 2045
Combined Heat and Power	50% waste heat demand electrified by 2030 and 100% by 2035	Facilities retire by 2040	Facilities retire by 2040	Facilities retire by 2040
Agriculture Energy Use	50% energy demand electrified by 2030 and 100% by 2035	50% energy demand electrified by 2035	0% energy demand electrified by 2030 and 50% by 2045	0% energy demand electrified by 2030 and 10% by 2045

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Sector	Alternative 1 Carbon Neutral by 2035	Alternative 2 Carbon Neutral by 2035	Alternative 3 Carbon Neutral by 2045	Alternative 4 Carbon Neutral by 2045
Low Carbon Fuels for Transportation	No biofuels consumption by 2035	Biomass supply used to produce conventional and advanced biofuels as well as hydrogen	Biomass supply used to produce conventional and advanced biofuels as well as hydrogen	Biomass supply used to produce conventional and advanced biofuels as well as hydrogen
Low Carbon Fuels for Buildings and Industry	RNG used to produce hydrogen for electricity production using fuel cells	In 2030s RNG blended in pipeline Hydrogen blended in natural gas pipeline at 7% energy, ramping up between 2030 and 2040 In 2030s, dedicated hydrogen pipelines constructed to serve certain industrial clusters	In 2030s RNG blended in pipeline Hydrogen blended in natural gas pipeline at 7% energy, ramping up between 2030 and 2040 In 2030s, dedicated hydrogen pipelines constructed to serve certain industrial clusters	In 2030s RNG blended in pipeline Hydrogen blended in natural gas pipeline at 7% energy, ramping up between 2030 and 2040 In 2040s, dedicated hydrogen pipelines constructed to serve certain industrial clusters

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Sector	Alternative 1 Carbon Neutral by 2035	Alternative 2 Carbon Neutral by 2035	Alternative 3 Carbon Neutral by 2045	Alternative 4 Carbon Neutral by 2045
Non-combustion Methane Emissions	No additional landfill or dairy digester methane capture Maximize deployment of alternative manure management strategies Enteric strategy deployed before 2030 Divert 75% of organic waste from landfills by 2025 Oil and gas methane emissions are nearly eliminated when combustion phased out	Rapidly increase landfill and dairy digester methane capture Some alternative manure management deployed for smaller dairies Enteric strategy deployed before 2030 Divert 75% of organic waste from landfills by 2025 Oil and gas fugitive methane emissions reduced 50% by 2030 and further reductions as infrastructure components retire in line with reduced natural gas demand	Increase landfill and dairy digester methane capture Some alternative manure management deployed for smaller dairies Enteric strategy deployed in 2030 Divert 55% of organic waste from landfills by 2025 and 75% by 2030 Oil and gas fugitive methane emissions reduced 50% by 2030 and further reductions as infrastructure components retire in line with reduced natural gas demand	Increase landfill and dairy digester methane capture Limited alternative manure management deployed Enteric strategy deployed in 2030 Divert 55% of organic waste from landfills by 2025 and 75% by 2030 Oil and gas fugitive methane emissions reduced 45% by 2030 and further reductions as infrastructure components retire in line with reduced natural gas demand
High Global Warming Potential Emissions	Rapid building electrification results in increased hydroflourocarbon (HFC) emissions	Low GWP refrigerants introduced as building electrification increases mitigating HFC emissions	Low GWP refrigerants introduced as building electrification increases mitigating HFC emissions	Low GWP refrigerants introduced as building electrification increases mitigating HFC emissions

Sector	Alternative 1 Carbon Neutral by 2035	Alternative 2 Carbon Neutral by 2035	Alternative 3 Carbon Neutral by 2045	Alternative 4 Carbon Neutral by 2045
Carbon Dioxide Removal (CDR) from the atmosphere	No CDR	CDR deployed by 2030 to achieve GHG emissions 55% below 1990 levels by 2030 target CDR scaled to compensate for remaining GHG emissions in 2035	CDR demonstration projects deployed by 2030 CDR scaled to compensate for remaining GHG emissions in 2045	CDR demonstration projects deployed by 2030 CDR scaled to compensate for remaining GHG emissions in 2045

ATTACHMENT A: List of Acronyms

AB	Assembly Bill
CCS	Carbon Capture and Sequestration
CDR	Carbon Dioxide Removal
CHE	Cargo Handling Equipment
GHG	Greenhouse Gas
HDV	Heavy-Duty Vehicle
HFC	Hydrofluorocarbon
IEPR	Integrated Energy Policy Report
ITS	U.C. Davis Institute of Transportation Studies
LDV	Light-Duty Vehicle
MD	Medium Duty
$MMTCO_2e$	Million metric tonnes of carbon dioxide equivalent
PHEV	Plug-in Hybrid Electric Vehicle
OGV	Ocean-Going Vessel
RNG	Renewable Natural Gas
RPS	Renewables Portfolio Standard
VMT	Vehicle Miles Traveled
ZEV	Zero-Emission Vehicle

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ATTACHMENT B: Generation Technologies to be included in Modeling

Technology	Eligibility Basis
Solar PV	RPS
Solar thermal (existing only)	RPS
Onshore wind	RPS
Offshore wind	RPS
Geothermal	RPS
Bioenergy	RPS
Fuel cells (green hydrogen)	RPS
Small hydro (existing only)	RPS
Large hydro (existing only)	Zero-carbon
Nuclear (existing only)	Zero-carbon
Drop-in renewable fuels (green hydrogen, biomethane)	Zero-carbon
Natural gas generation with CCS	Zero-carbon