CALIFORNIA
AIR RESOURCES BOARD

PATHWAYS Scenario Modeling

2022 Scoping Plan Update

December 15, 2021

I. Overview and Process

The Assembly Bill (AB) 32 Climate Change Scoping Plan is an actionable blueprint that lays out a cost-effective and technologically feasible path to ensure California meets its near- and long-term statewide greenhouse gas (GHG) emissions reduction targets. Consistent with AB 32 direction, each Scoping Plan has included a suite of policies and does not rely on a single approach, but rather on a combination of incentives, regulations, and carbon pricing. AB 32 also requires that the Scoping Plan be updated at least once every five years and calls for the California Air Resources Board (CARB or Board) to convene an Environmental Justice Advisory Committee (Committee), to advise the Board in developing the *Scoping Plan*, and any other pertinent matter in implementing AB 32. The Committee provided input that is reflected in the draft scenario assumptions. As has occurred with past Scoping Plans, once the 2022 Scoping Plan is finalized a series of actions are expected to be initiated to develop or refine measures (e.g., regulations, incentive programs) needed to implement the plan.

The CARB kicked off development of the 2022 Scoping Plan Update in June 2021 in coordination with other State agencies. The 2022 Scoping Plan Update will assess progress towards achieving the Senate Bill 32 (SB 32) 2030 target, identify the need for potential adjustments to stay on track, and lay out a path to achieve carbon neutrality no later than 2045. This Scoping Plan update will have the longest planning horizon of any previously-adopted version. This extended 2045 planning trajectory befits a greater focus on the outcomes needed to achieve GHG emissions reductions. CARB will use PATHWAYS[1] to model Scoping Plan scenarios which will identify outcomes in terms of technologies, fuels, energy sources, and infrastructure that will need to be developed to transition away from fossil fuels by mid-century. CARB is also modeling emissions sources and sinks from California's natural and working lands as part of a separate modeling effort.[2] Once completed, the PATHWAYS modeling and the natural and working lands modeling will give CARB a comprehensive picture of the future of California's GHG sources and sinks and will support the adoption of a

[1] *PATHWAYS Model - E3 (ethree.com)*

[2] *Overview of CARB's Natural and Working Lands Modeling*.

pathway to carbon neutrality for the State. The results of the scenario modeling will also be used to evaluate the public health and economic benefits and impacts of the different scenarios. This will include air quality, public health, household costs, and state economic and jobs evaluations.

Achievement of the outcomes of the Scoping Plan will require the development of regulatory measures, funding, technology research and deployment, permitting actions, and other programs and activities. The Scoping Plan provides an economy-wide framework spanning many years, and therefore does not delve into the design details of any program or regulation, nor does it supplant or create new statutes and regulations. These activities will occur as part of post-Scoping Plan adoption implementation involving multiple State and local agencies to ensure a coordinated and just transition away from fossil fuels.

The next steps related to modeling and public engagement are outlined in the table below.

Estimated Timing of Next Steps

Mid December 2021	Transmit scenario input assumptions to E3 to model in PATHWAYS. Outputs from the PATHWAYS modeling will be transmitted to U.C. Irvine and Rhodium Group for the air quality/public health analysis and economic analysis, respectively.
Late January/early February 2022	Public workshop on PATHWAYS preliminary modeling results. Additional public workshop on natural and working lands preliminary modeling results.
Late February	Board Hearing for staff to present on the tools, approach, and elements for the emissions, health, and economic analyses underway
Late March/April 2022	Public workshop on air quality, public health, and economic modeling results
Late March	Board hearing for staff to present and discuss the emissions, health, and economic modeling results of the different scenarios
Early May 2022	Release Draft Scoping Plan for 45-day public comment
June 2022	1st Board Meeting. The Board may provide direction to CARB staff to modify any of the scenarios to inform the Final Scoping Plan, which will be presented at a 2nd Board Meeting by the end of 2022.

II. Scenario Development

Since the June kick-off, CARB staff have been soliciting feedback from topical experts, affected stakeholders, and the AB 32 Environmental Justice Advisory Committee (EJ Advisory Committee) at public meetings towards assembling input assumptions for four carbon neutrality scenarios for purposes of modeling using PATHWAYS to inform the Plan update process. A table summarizing proposed PATHWAYS scenario modeling assumptions[3] by sector was presented at a September 30, 2021, workshop. The table in Section III of this document summarizes revisions to the modeling assumptions in bold/strikeout format. These revisions were informed by direction in statute, Governor's Executive Orders, public comments, and the recommendations of the EJ Advisory Committee.[4]

As part of development of the initial modeling scenarios in this Scoping Plan Update, staff engaged with the EJ Advisory Committee early to ensure any modeling included their input. We began engagement on this effort at the *August 3rd EJ Advisory Committee* meeting. The EJ Advisory Committee discussed the modeling scenarios over various meetings in the late summer and fall of 2021.[5] The EJ Advisory Committee submitted *formal comments* on the modeling assumptions to CARB staff at their December 1st meeting. In addition to the comments, the EJ Advisory Committee submitted a *cover sheet* providing additional context to which *CARB responded.*

The four alternative scenarios are designed to explore the potential speed, magnitude, and impacts of transitioning California's energy demand away from fossil fuels. The modeling assumptions listed below identify the primary fossil fuel alternative that is commercially available and technically feasible for widespread use by 2045 for each sector. CARB assumes that any energy demand that remains after the alternative technology or fuel is applied, such as on-road internal combustion engines, industrial processes, and gas use in existing buildings that have not yet decarbonized, will continue to be met by fossil fuels, resulting in residual emissions.

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[3]For natural and working lands modeling, CARB staff published a separate draft set of scenarios for public feedback on December 2, 2021. *NWLScenariosForPublicDistribution.pdf (ca.gov)*. The final table of natural and working lands scenarios will be published in Q1 2021.

[4] *Scoping Plan Meetings & Workshops | California Air Resources Board*; *Environmental Justice Advisory Committee | California Air Resources Board*

[5] EJ Advisory Committee meetings where PATHWAYS modeling inputs were discussed: *August 3rd*, *August 26th*, *September 22nd*, *September 27th*, *October 12th*, *October 15th*, *November 9th*, *November 16th*, and *December 1*.

All four of the proposed alternatives:

- Demonstrate significant, nearly complete transition away from fossil fuels to directly reduce greenhouse gas emissions released into the atmosphere.
- Assume large-scale deployment of existing and emerging zero-carbon emission technologies, as well as continued innovation to further develop solutions that appear promising today.
- Increase reliance on zero-carbon electricity to power vehicles, homes, businesses and industries, which will replace gasoline, diesel, and natural gas use.
- Expand the quantity and availability of renewable hydrogen as a fuel for transportation, buildings, and industries.
- Transition cars, trucks, buses, trains, planes, and boats away from petroleum fuels and implications for phasing out instate production of fuel if any demand for petroleum fuels remains.
- Rely on California residents and businesses to choose zero-emission vehicles and electric appliances for homes and commercial properties.
- Every scenario will have some amount of residual GHG emissions that could be addressed through carbon dioxide removal mechanisms.

At this juncture, staff is evaluating if the natural and working lands will produce residual GHG emissions that must be compensated for in 2035 and 2045 to meet the carbon neutrality goal. The results of the natural and working lands modeling will help determine the extent to which natural and working lands can be relied upon to compensate for residual emissions from fossil fuel combustion and release of non-combustion GHGs, or if they will be a net source of emissions.

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III. PATHWAYS Scenario Modeling Assumptions

This table summarizes input assumptions for the PATHWAYS model to explore emission reduction pathways associated with energy use. Text in bold/strikeout reflect revisions incorporated to the version presented at the 2022 Scoping Plan Update – Scenario Inputs Technical Workshop, September 30, 2021. 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
GHG emissions reduction relative to SB 32 target	**55% below 1990 levels by 2030**	**55% below 1990 levels by 2030**	**40% below 1990 levels by 2030**	**40% below 1990 levels by 2030**
Smart Growth / Vehicle Miles Travelled (VMT)	VMT per capita reduced ~~15~~**25**% below 2019 levels by 2030 and ~~20~~**30**% below 2019 levels by 2035	VMT per capita reduced ~~12~~**15**% below 2019 levels by 2030 and ~~22~~**20**% below 2019 levels by ~~2045~~**2035**	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~~**2030**; 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~~**2035**; Only ZEVs on road by 2045; no PHEVs on road by 2045	**AB 74 ITS Report: 100% of MD/HDV sales are ZEV by 2040**~~100% of MD/HDV sales are ZEV by 2035~~	~~AB 74 ITS Report:~~ 100% of MD/HDV sales are ZEV by ~~2040~~**2045**
Aviation	25% of aviation fuel demand is met by electricity (batteries) or hydrogen (fuel cells) in 2030 and 50% in 2035 **Sustainable aviation fuel meets rest of aviation fuel demand that has not already transitioned to hydrogen or batteries**	25% of aviation fuel demand is met by electricity (batteries) or hydrogen (fuel cells) in 2045 **Sustainable aviation fuel meets most or rest of aviation fuel demand that has not already transitioned to hydrogen or batteries**	10% of aviation fuel demand is met by electricity (batteries) or hydrogen (fuel cells) in 2045 **Sustainable aviation fuel meets most or rest of aviation fuel demand that has not already transitioned to hydrogen or batteries**	0% of aviation fuel demand is met by electricity (batteries) or hydrogen (fuel cells) in 2045 **Sustainable aviation fuel meets most or rest of aviation fuel demand in 2045**
Ocean-going Vessels (OGV)	100% of OGVs utilize shore power by 2030 **10% of OGVs utilize hydrogen fuel cell electric technology by 2035** **Rest of** 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 **cell** 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

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~~**2037** 100% of drayage trucks are zero emission by 2035	100% of cargo handling equipment (CHE) is zero-emission by ~~2037~~**2045** 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 **primarily** 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 **primarily** 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% **of line haul locomotive sales are ZEV** by 2035 Line haul and passenger rail rely primarily on hydrogen fuel cell technology, and others **primarily** 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 **primarily** utilize electricity
Oil & Gas Extraction	Phase out operations by 2035	~~Phase out~~**Reduce** operations **in line with petroleum demand** 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 **in line with petroleum demand**	CCS on ~~large facilities~~ **majority of operations** by 2030 Production reduced in line with petroleum demand	CCS on ~~large facilities~~ **majority of operations** by 2030 Production reduced in line with **petroleum** demand	CCS on ~~large facilities~~ **majority of operations** 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~~ **10** $MMTCO_2e$ in 2035[6] ~~Total~~ **Retail sales** load coverage Includes Renewables Portfolio Standard (RPS)-eligible and zero-carbon generation resources (see Attachment B)	Sector GHG target of ~~30~~**38** $MMTCO_2e$ in 2030 and ~~0~~**24** $MMTCO_2e$[7] in 2045 ~~Total~~**Retail sales** load coverage Same generation resources as Alternative 2	Sector GHG target of ~~30~~**38** $MMTCO_2e$ in 2030 and 24 $MMTCO_2e$[8] 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)			

[6] 10 and 24 $MMTCO_2e$ are placeholder GHG targets based on the 2021 SB 100 Joint Agency Report Accelerated Timelines and Core Scenario modeling results, respectively. The corresponding GHG target based on updated loads will be determined from the Scoping Plan modeling results and will correspond to meeting 100% of retail sales with eligible renewable and zero-carbon resources.

[7] Ibid.

[8] Ibid.

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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
New Residential and Commercial Buildings	All electric appliances beginning 2026	All electric appliances beginning 2026	All electric appliances beginning 2026 **(residential) and 2029 (commercial)**	All electric appliances beginning 2029
Existing Residential Buildings	80% of appliance sales are electric by 2025 and 100% **of appliance sales** are electric by 2030 All buildings retrofitted to electric appliances by 2035	80% of appliance sales are electric by 2030 and 100% **of appliance sales** are electric by 2035 Appliances are replaced at end of life	80% of appliance sales are electric by 2030 and 100% **of appliance sales** are electric by 2035 Appliances are replaced at end of life	75% of appliance sales are electric by 2030 and 100% **of appliance sales** are electric by 2035 Appliances are replaced at end of life
Existing Commercial Buildings	80% of appliances sales are electric by 2025 and 100% **of appliance sales a**re electric by 2030 All buildings retrofitted to electric appliances by 2035	80% of appliance sales are electric by 2030 and 100% **of appliance sales** are electric by 2045 Appliances are replaced at end of life	80% of appliance sales are electric by 2030 and 100% **of appliance sales** are electric by 2045 Appliances are replaced at end of life	75% of appliance sales are electric by 2030 and 100% **of appliance sales** 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 **directly and/or indirectly** electrified by 2030; 100% by 2035	50% energy demand electrified **directly and/or indirectly** by 2030; 100% by 2035	~~0~~**7.5**% energy demand electrified **directly and/or indirectly** by 2030; ~~100~~**75**% by 2045	~~0~~**7.5**% energy demand electrified **directly and/or indirectly** by 2030; ~~10~~**30**% 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
Construction Equipment	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~~**75**% by ~~2035~~**2045**	0% energy demand electrified by 2030 and ~~10~~**50**% 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~~**50**% of process heat by 2035 ~~trending to~~**and** 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~~**and** 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~~**and** 10% by 2045 Electrify 0% of other energy demand by 2045
Stone, Clay, Glass & Cement	~~Facilities close because non-combustion alternative not available~~**CCS on all facilities by 2035** **Some process emissions reduced through alternative materials**	Carbon Capture and Sequestration (CCS) on ~~large~~**40% of operations** ~~facilities~~ by ~~2030~~**2035** and on all facilities by 2045 **Some process emissions reduced through alternative materials**	CCS on ~~large~~**40% of operations** ~~facilities~~ by ~~2030~~**2035** and on all facilities by 2045 **Some process emissions reduced through alternative materials**	CCS on ~~large~~**40% of operations** ~~facilities~~ by ~~2030~~**2035** and on all facilities by 2045 **Some process emissions reduced through alternative materials**
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

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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
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~~**25**% energy demand electrified by 2030 and ~~50~~**75**% by 2045	0% energy demand electrified by 2030 and ~~10~~**50**% by 2045
Low Carbon Fuels for Transportation	No biofuels consumption by 2035**, except for aviation demand**	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 **directed to Cement facilities by 2035**~~used to produce hydrogen for electricity production using fuel cells~~	In 2030s RNG blended in pipeline **Renewable** Hydrogen blended in natural gas pipeline at 7% energy **(~30% by volume)**, ramping up between 2030 and 2040[9] In 2030s, dedicated hydrogen pipelines constructed to serve certain industrial clusters	In 2030s RNG blended in pipeline **Renewable** Hydrogen blended in natural gas pipeline at 7% energy **(~30% by volume)**, ramping up between 2030 and 2040 In 2030s, dedicated hydrogen pipelines constructed to serve certain industrial clusters	In 2030s RNG blended in pipeline **Renewable** Hydrogen blended in natural gas pipeline at 7% energy **(~30% by volume)**, ramping up between 2030 and 2040 In 2040s, dedicated hydrogen pipelines constructed to serve certain industrial clusters

[9] The University of California Riverside, under a CPUC-sponsored study, will be releasing preliminary results in 2022 on the safety of blended hydrogen/natural gas fuel stock in a variety of applications. Further

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~~ **Aggressive adoption of enteric strategies by 2030** **Rate of dairy herd size reduction increases compared to historic levels** 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~~ **Aggressive adoption of enteric strategies by 2030** **Rate of dairy herd size reduction increases compared to historic levels** 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~~ **Moderate adoption of enteric strategies by 2030** Divert ~~55~~**75**% 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~~ **Moderate adoption of enteric strategies by 2030** Divert ~~55~~**75**% 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

assessment of hydrogen blends is needed to determine the precise impacts to the existing pipeline network, which is anticipated to be addressed in a future CPUC proceeding.

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
High Global Warming Potential Emissions	**Low GWP refrigerants introduced as building electrification increases mitigating** ~~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
Residual Emissions - Carbon Dioxide Removal (CDR) from the atmosphere	**CDR scaled to compensate for remaining, limited GHG emissions in 2035**~~No CDR~~	CDR deployed by 2030 to achieve GHG emissions 55% below 1990 levels by 2030 target**, as necessary** CDR scaled to compensate for remaining GHG emissions in 2035	CDR demonstration projects deployed by 2030 **to achieve GHG emissions 40% below 1990 levels by 2030 target, as necessary** CDR scaled to compensate for remaining GHG emissions in 2045	CDR demonstration projects deployed by 2030 **to achieve GHG emissions 40% below 1990 levels by 2030 target, as necessary** 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