California’s Route to Carbon Neutrality

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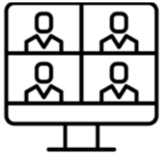
Pathways to Carbon Neutrality in California

Phase 1

Fact Finding and Outreach

Interviews



Workshop

Phase 2

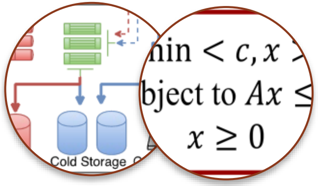
Topical Deep Dives

1. Electricity
2. Transportation
3. Industry
4. Commercial
5. Residential
6. Hydrogen
7. Bioenergy
8. Forest Mgmt

Phase 3

Integrated Economy-Wide Model for Carbon Neutrality By 2045

Energy Systems Modeling



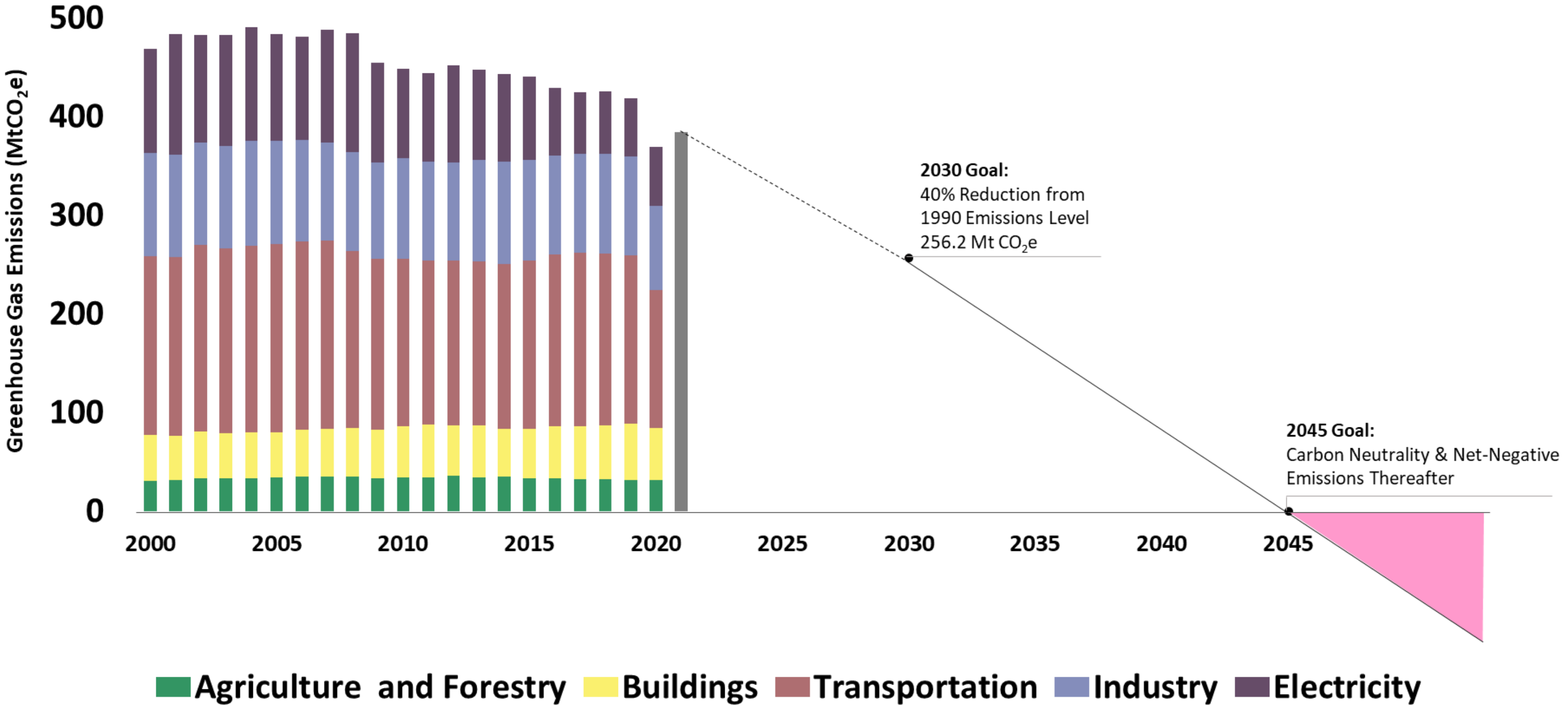
Scenarios and options

https://sccs.stanford.edu/california-projects/pathways-carbon-neutrality-california

Agenda

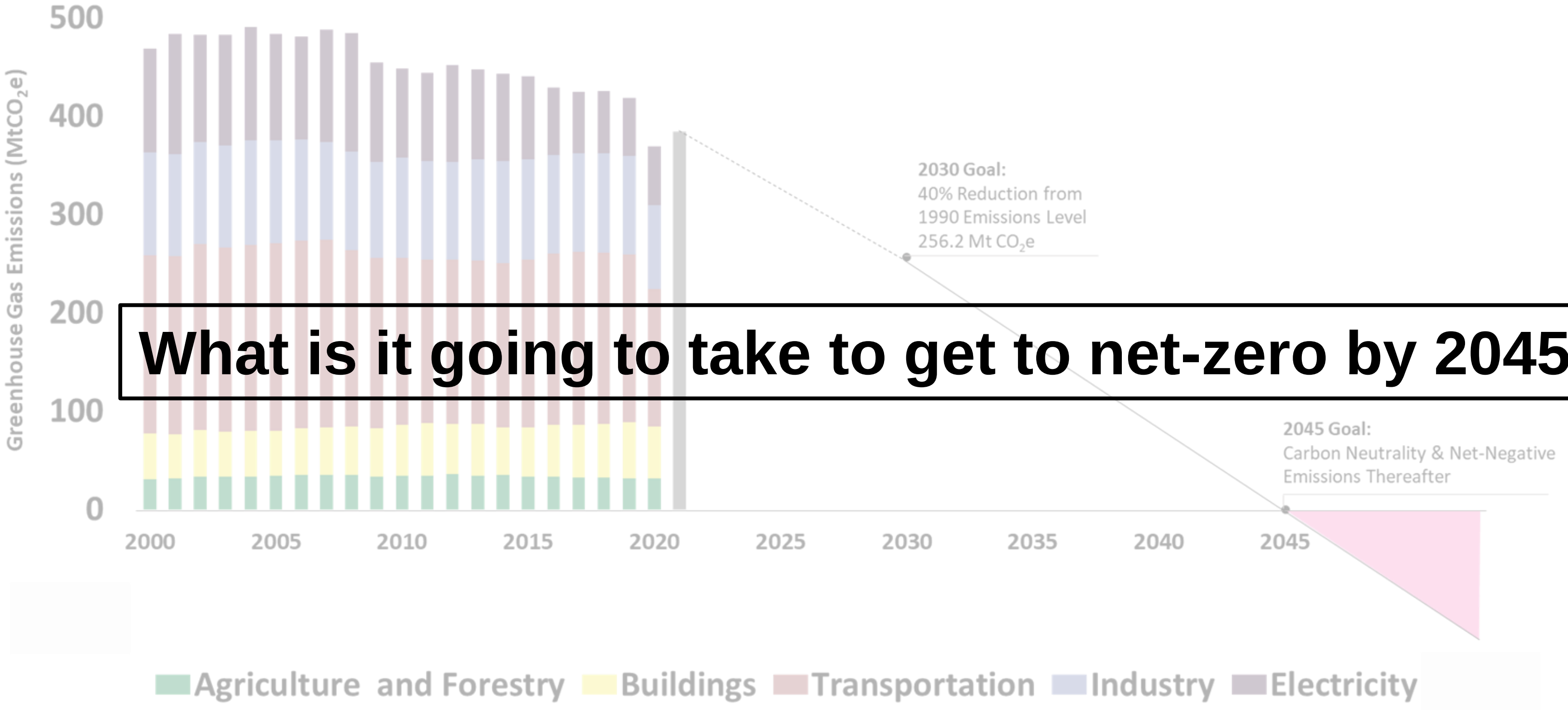
- Motivation
- Model Background
- Comparison between DECAL and the CARB Scoping Plan
- What is it going to take to get to net-zero by 2045?
  - Economy Wide
  - Electricity Sector
  - Transportation Sector
  - Industrial Sector
  - F-Gases
  - Buildings Sector
  - Renewable Diesel
  - Direct Air Capture
- Conclusions and Future Work

California's Historic Emissions and Future Targets



Source: Adapted from CARB (2022)

California's Historic Emissions and Future Targets

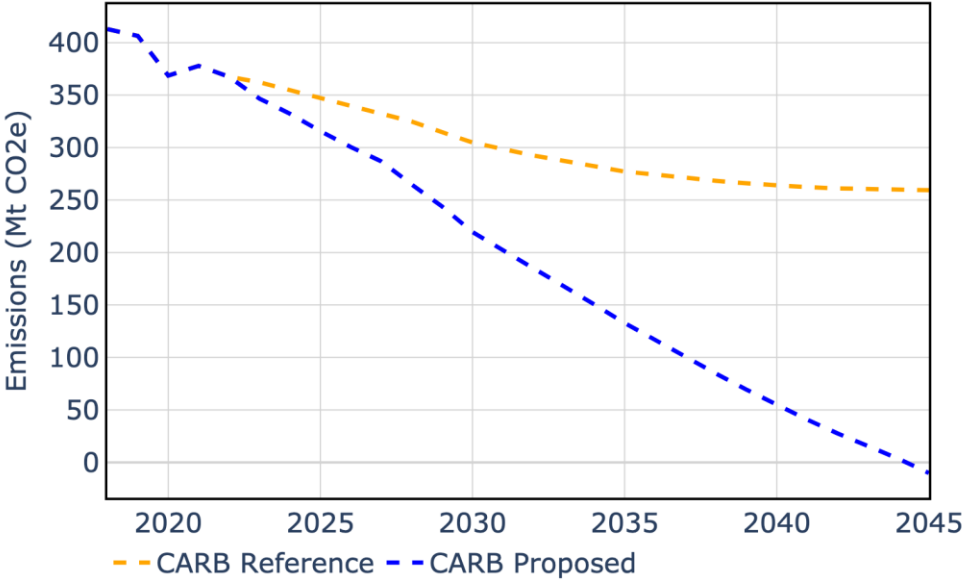


What is it going to take to get to net-zero by 2045?

Source: Adapted from CARB (2022)

CARB 2022 Scoping Plan

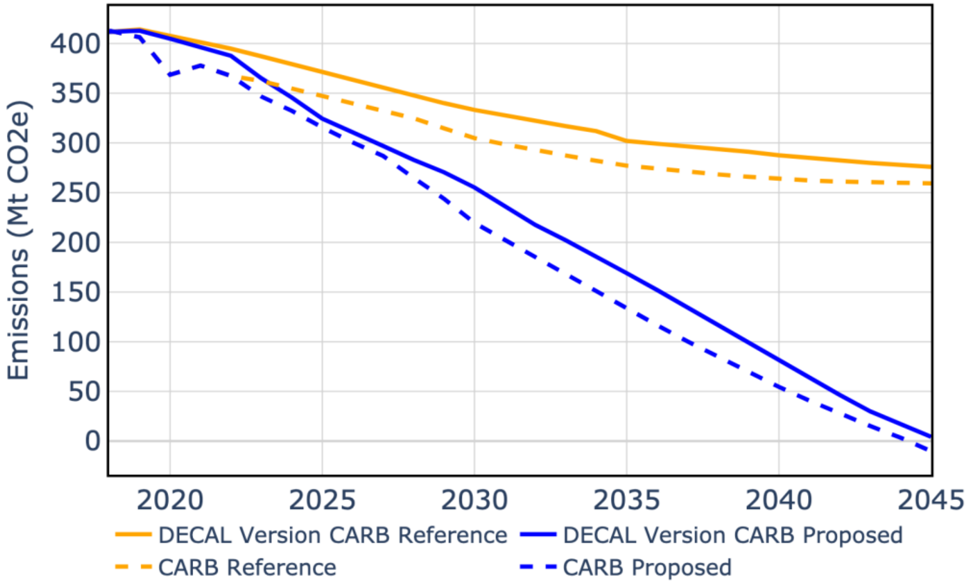
- Every five years, CARB creates a scoping plan to help meet climate goals
- CARB **Reference Case** – CARB's BAU forecast
- CARB **Proposed Scenario** – CARB's proposal for reaching net-zero by 2045



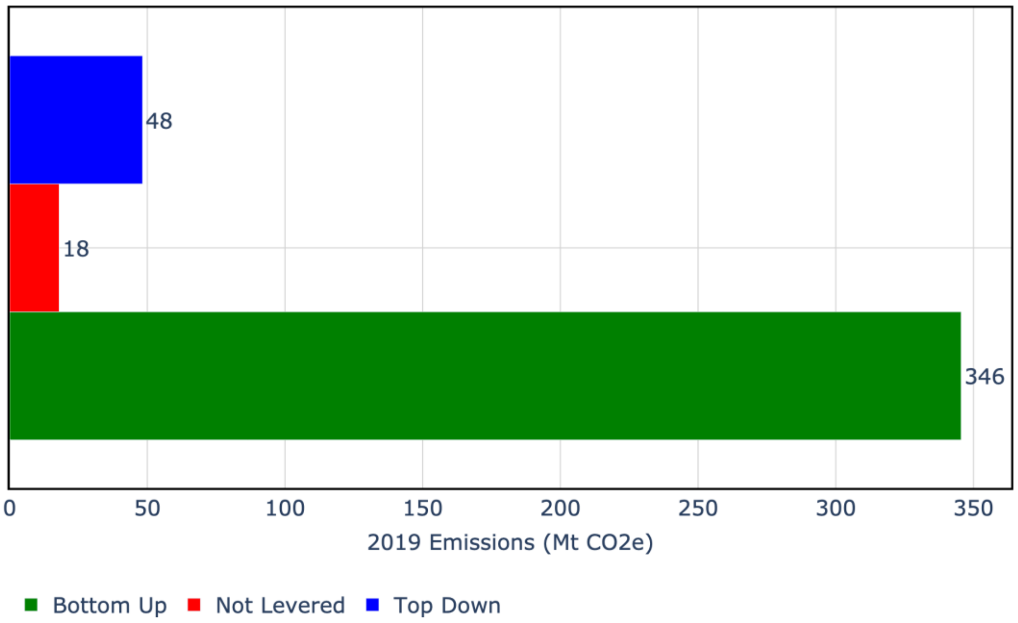
Stanford DECAL Model

Stanford Model: DECAL (**DE**carbonize **CAL**ifornia)

- Built using LEAP (Low Emissions Analysis Platform)
- 3 results we care about most:
    - Emissions
    - Costs
    - Resources
- System boundary: CA, scope 1 & 2 emissions
- Economics from perspective of the state
- Stock & flow in buildings & transport sectors
- Optimization in electricity sector
- Driven by exogenously defined levers
- Not an equilibrium model



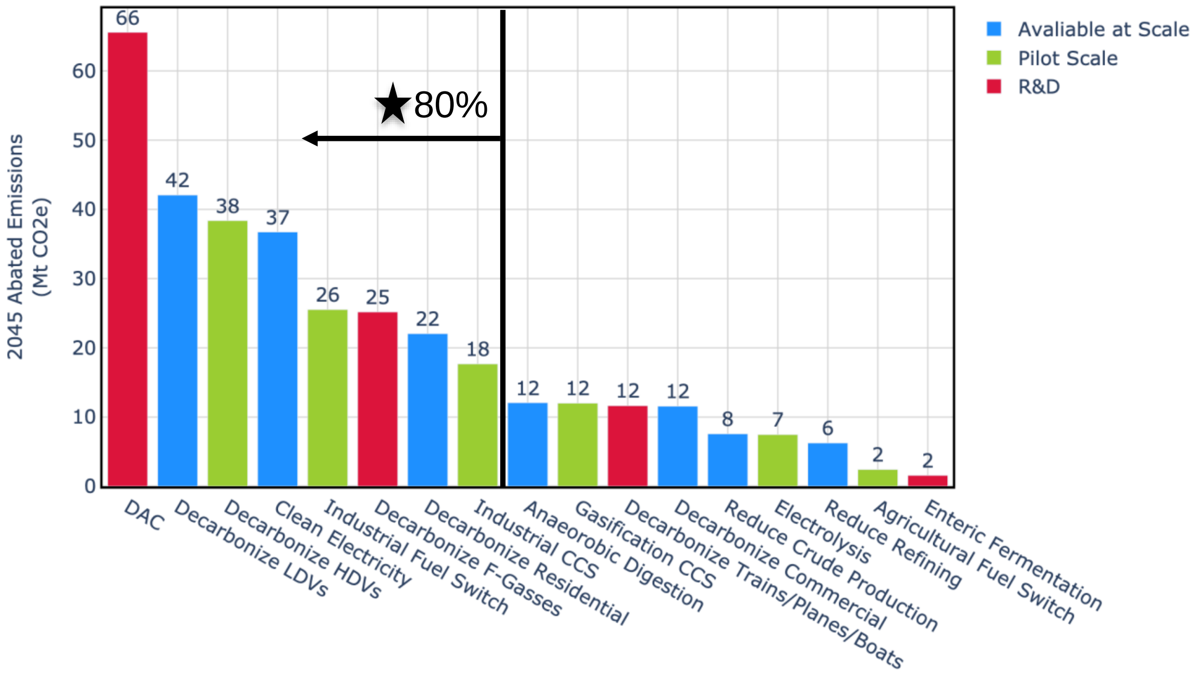
DECAL Levered Emissions



- **Bottom up** – detailed understanding of emissions and costs
  - Automobiles, residential space heating, electricity generation, etc.
- **Top down** – superficial understanding of emissions and costs
  - Residential-other emissions, trains/planes/boats, etc.
- **Not levered** – levers were not used in these scenarios
  - Leftover landfill gas (8.5 Mt), fertilizers (3.6 Mt), waste (2.4 Mt); each less than 1 Mt: aerosols, foams, fire protection, solvents, residue burning, crop residue, liming, manure, rice cultivation

Economy Wide

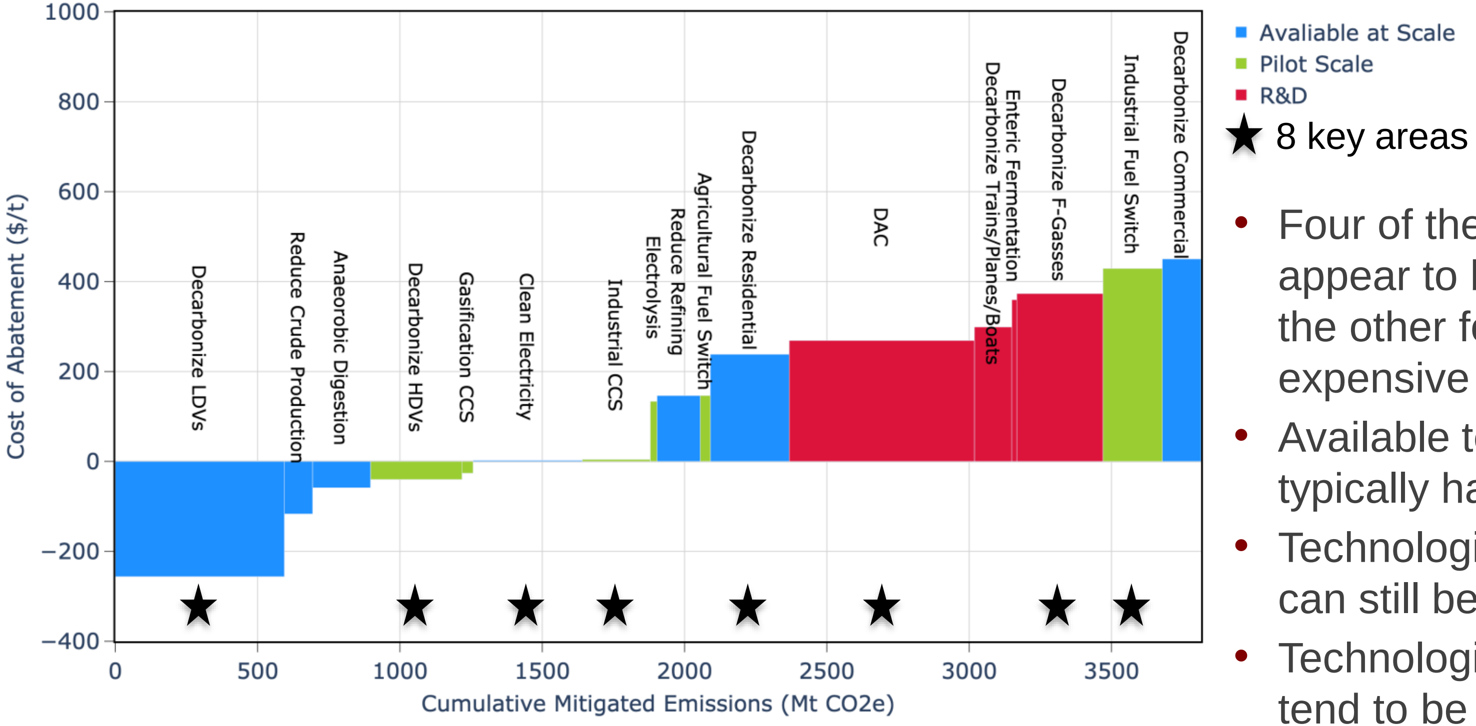
A few policies and programs will be key
Research, development, & scaling is still needed



- Plot shows the impact of each measure in DECAL Version of CARB Proposed scenario
- CARB proposed scenario is highly reliant on DAC
- **80% of the way** to net zero in **8 key areas**
- 40% with technologies available at scale, 30% pilot scale, 30% R&D

Economy Wide Overview

Some policies/programs are affordable, some less so



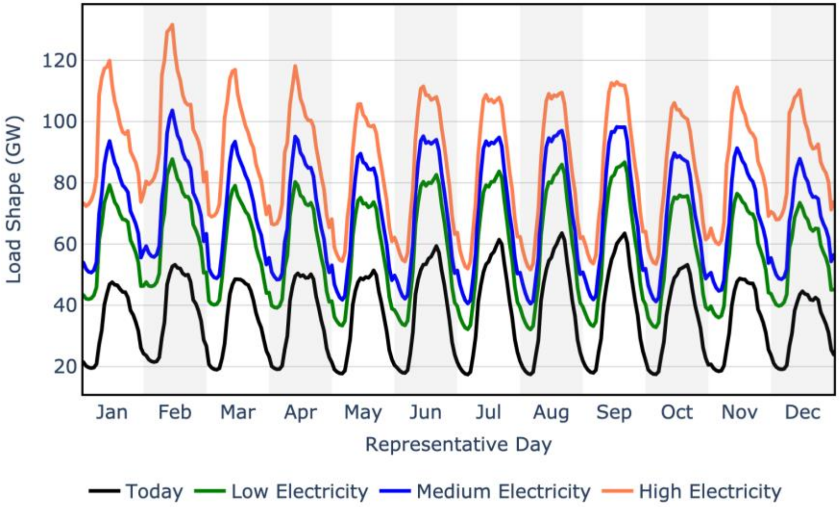
- Four of the eight key areas appear to be cost effective, the other four are more expensive
- Available technologies typically have lower cost
- Technologies at pilot scale can still be cost effective
- Technologies in R&D phase tend to be more expensive

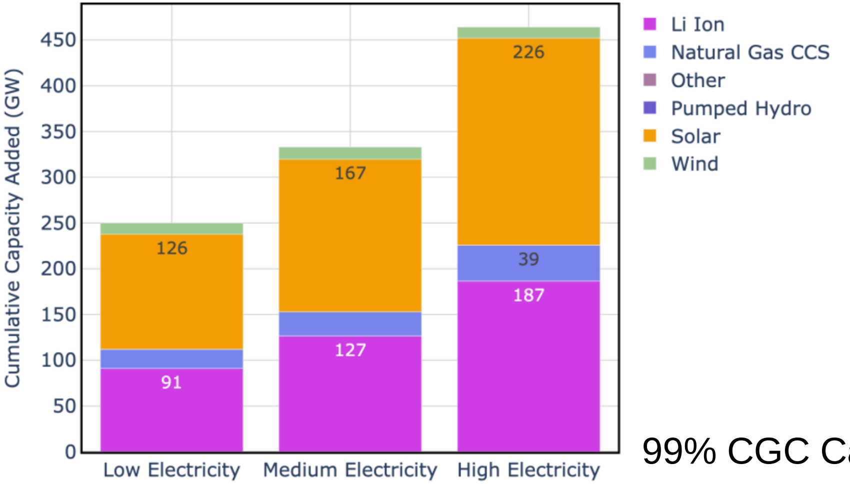
Econon Wide | e- | Transport | Industry | F-Gases | Buildings | RD | DAC

Electricity Sector

We must be proficient at building e- infrastructure

Low: Choose H2, biofuels, & CCS
Med: CARB Proposed
High: Choose electricity





99% CGC Case

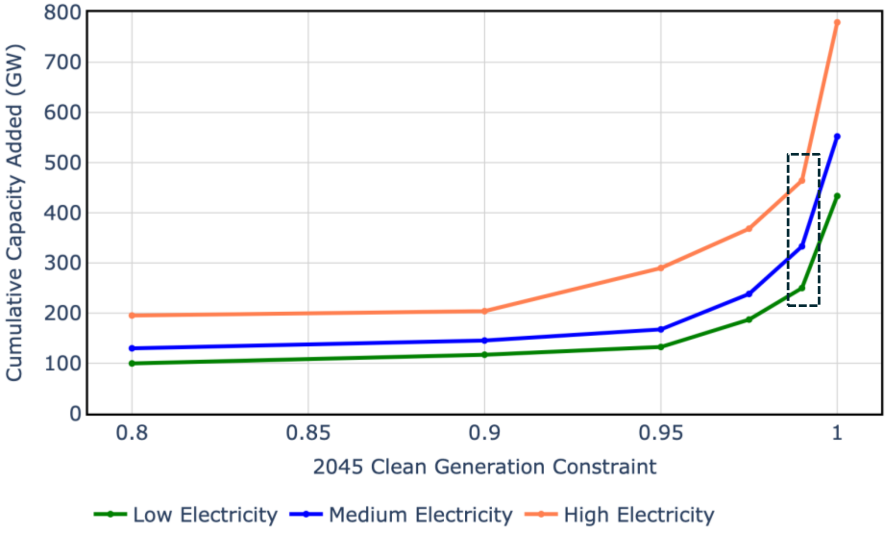
- Between ~20 – 70 GW increase in peak load from the reference case
- Shift to a winter peaking system

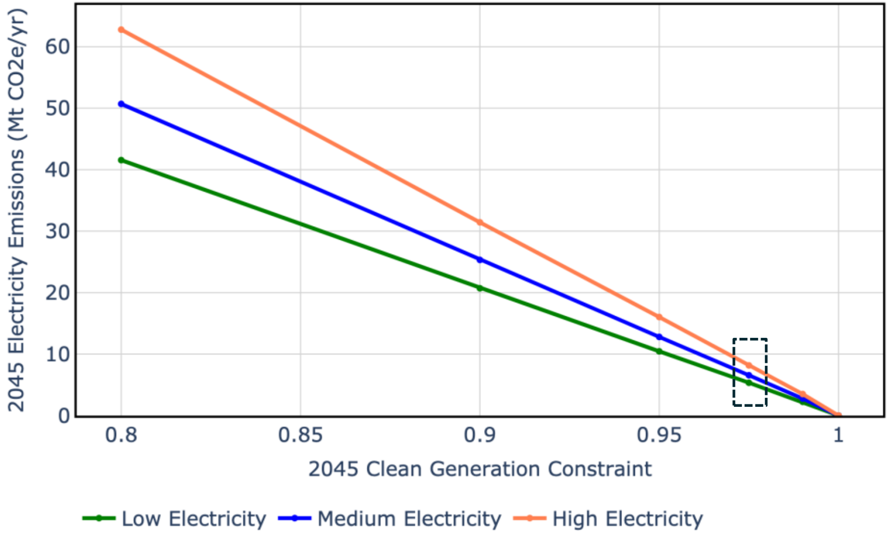
- Bounds of capacity addition for the decarbonized future: 250 – 450 GW
  - Current in-state capacity: 80 GW
  - ~29 GW added since 2000
  - 0.5-2% of CA land taken up by added solar

Electricity Sector

A clean grid will be required…
but 100% clean may not be necessary

Low: Choose H2, biofuels, & CCS
Med: CARB Proposed
High: Choose electricity

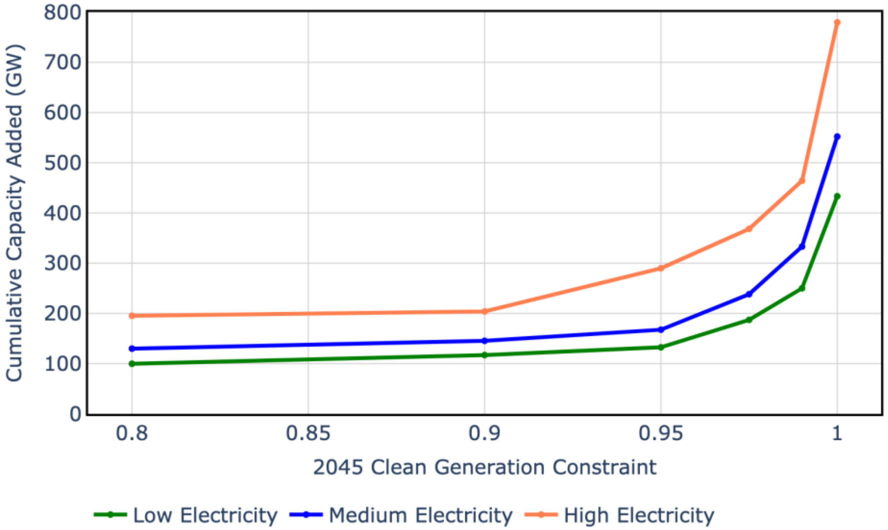


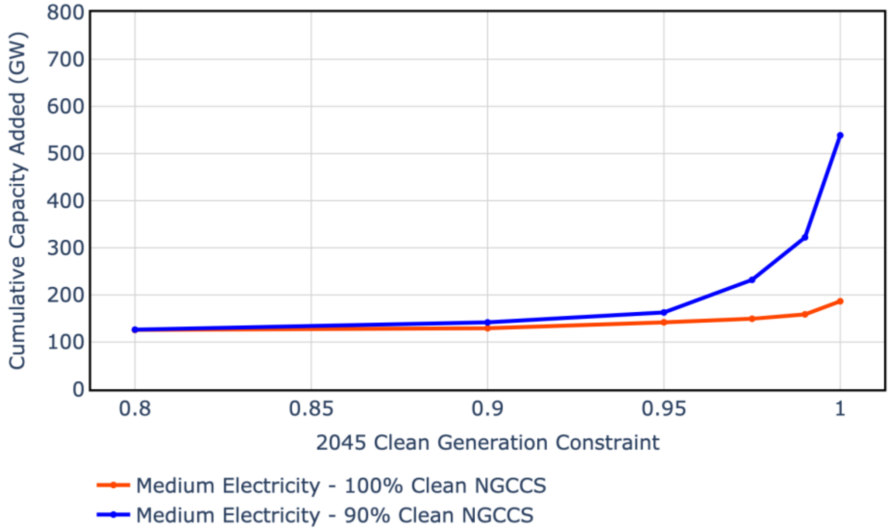


- Going from 99% to 100% CGC requires enormous capacity installations, partially due to lack of NGCCS
- Going from 99% to 100% CGC has small impact on electricity emissions

Electricity Sector

A clean grid will be required…
but 100% clean may not be necessary



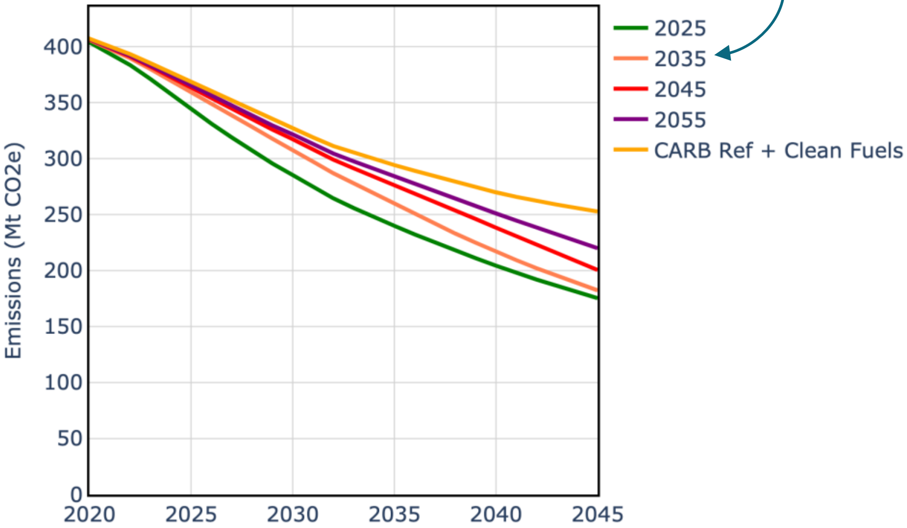


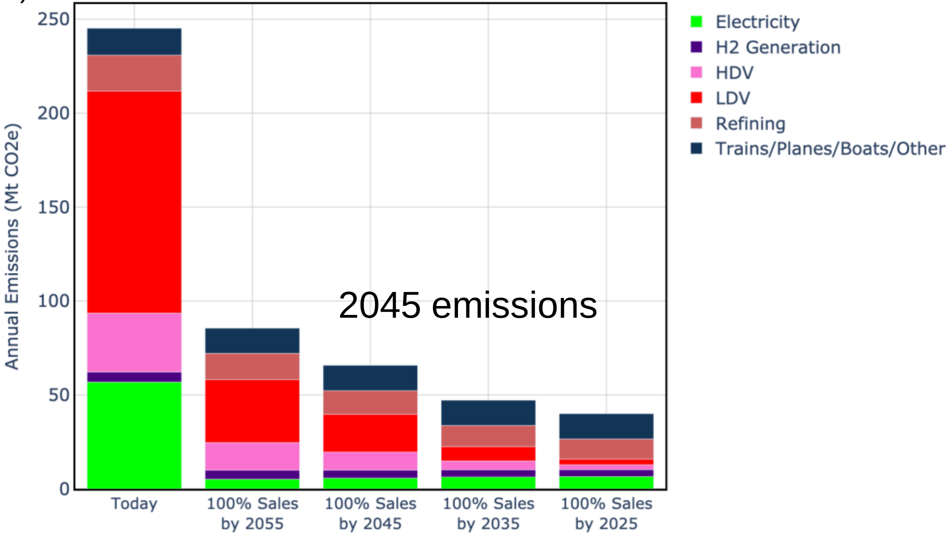
- Going from 99% to 100% CGC requires enormous capacity installations, partially due to lack of NGCCS

- With affordable 100% clean baseload, overbuilding is mitigated
- Effect only becomes important with CGC > 0.95

Transportation Sector
Gradual progress towards an ambitious goal is effective

Start year of 100% ZEV sales: (Similar to CARB Proposed)

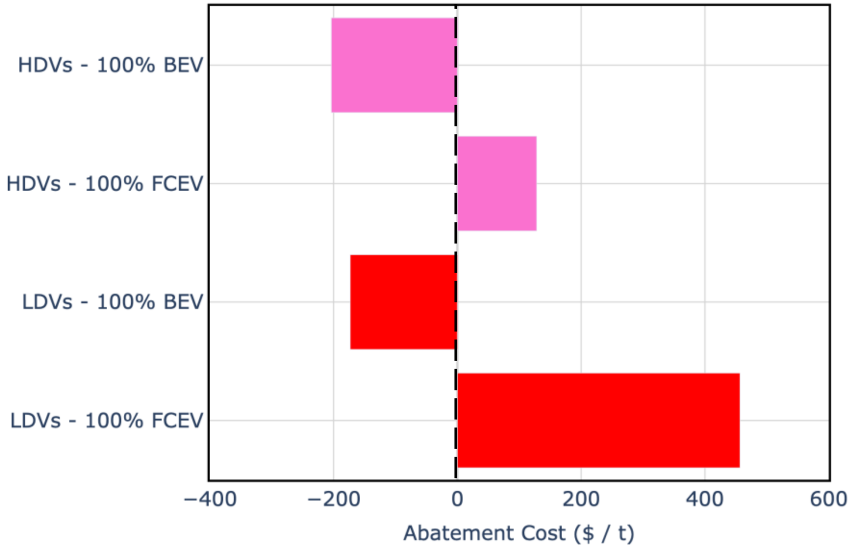


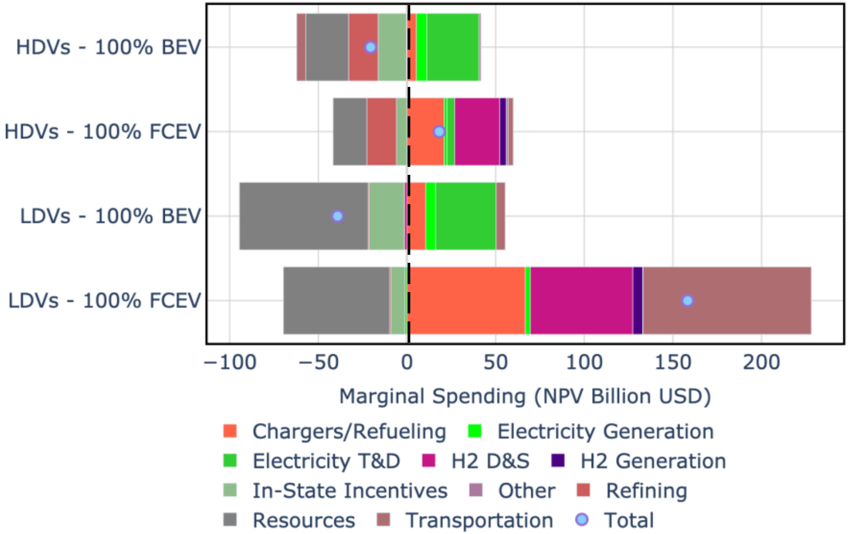


- Important to have gradual progress towards ambitious goal
- Existing 2035 policy will substantially reduce transport emissions; zero near impossible

Transportation Sector

BEVs are an effective option

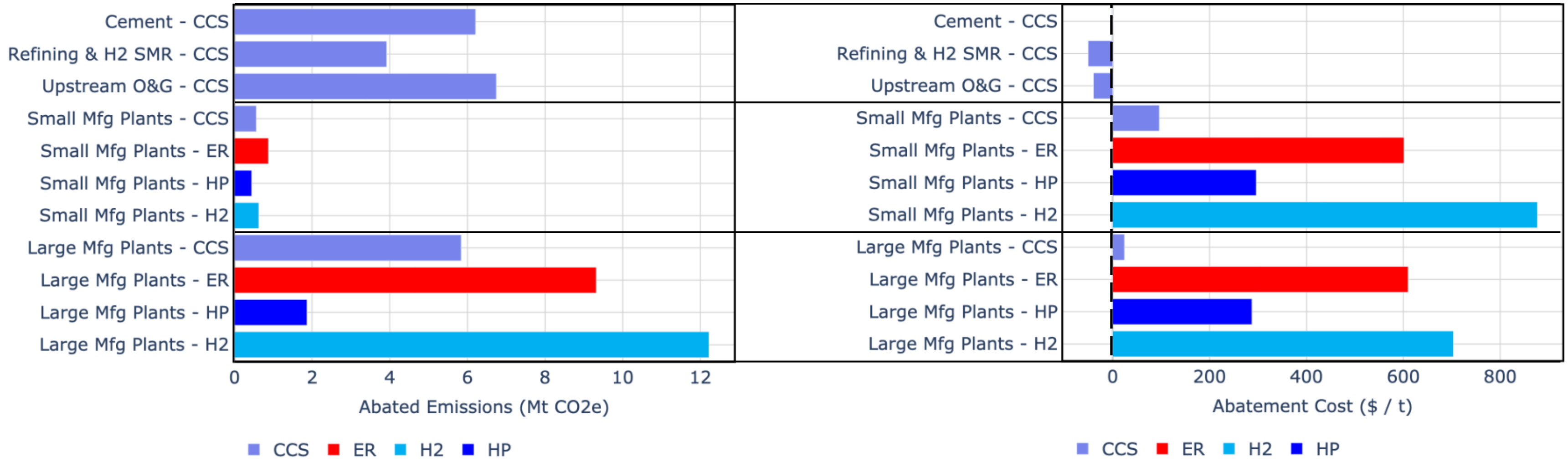




- BEVs are cheaper than FCEVs
- HDVs are a “less costly” problem than LDVs
- Significant cost drivers: vehicle costs, resource savings, H2 D&S, refueling stations, electricity T&D
- Less significant cost drivers: electricity & H2 generation, BEV chargers

Industrial Sector

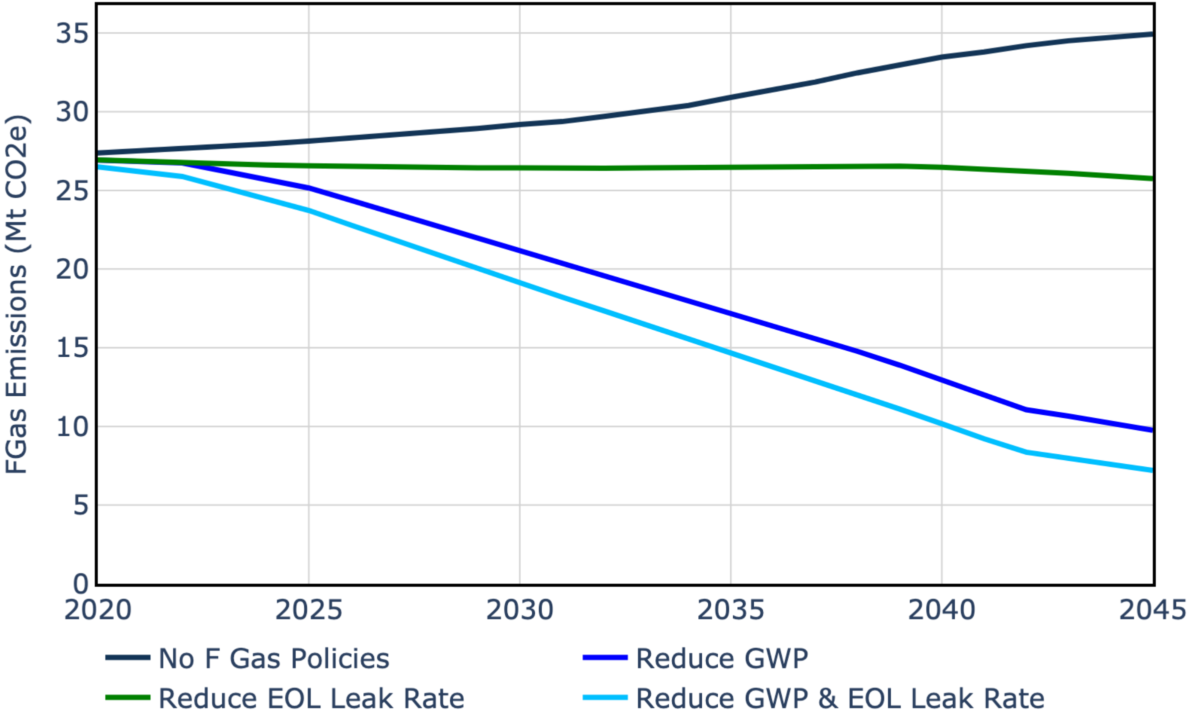
CCS is an effective and affordable option



- CCS is the only modeled option for cement, upstream O&G facilities, and refineries & SMRs
- CCS is an affordable option for all facilities but may be logistically difficult for small manufacturing plants, even if cost effective
- CCS made more affordable by incentives (45Q and LCFS)
- Petrochemical and mineral plants cannot use HPs for process heating due to temp constraints
- Fuel switching to H2 is not a cost-effective solution

F-Gases

Existing solutions are helpful
Innovation is needed for deep reductions



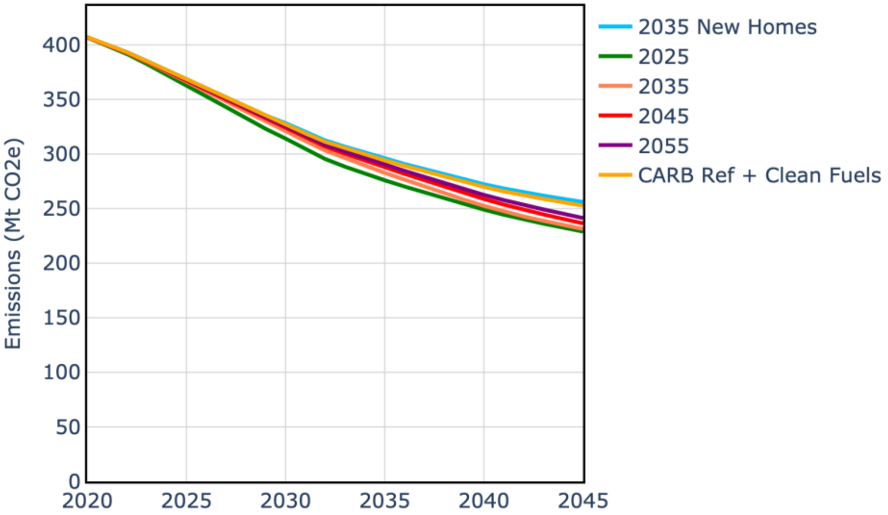
- EOL F-Gas strategies can help keep F-Gas emissions constant, despite installing millions of heat pumps
- Deep reductions will require low GWP refrigerants, like CO_2 or propane

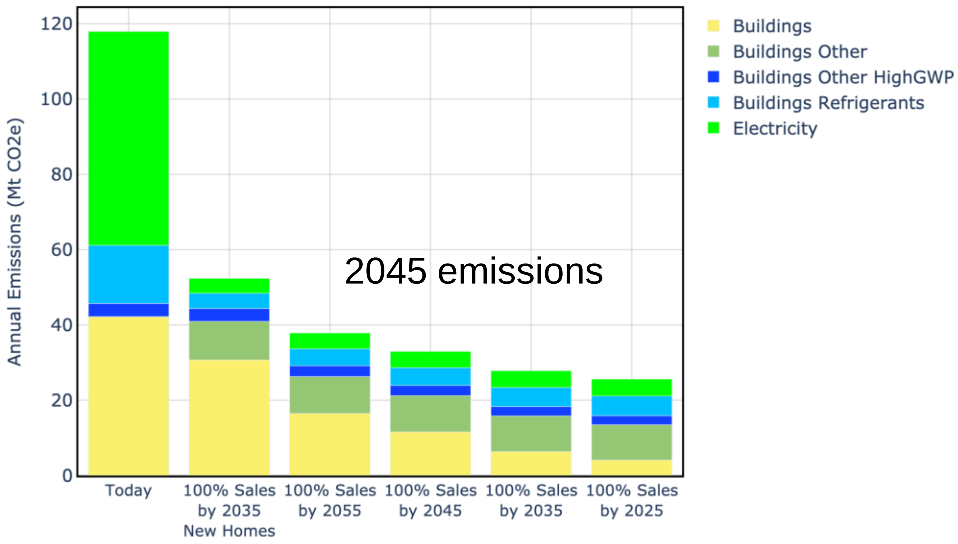
Buildings Sector

Gradual progress towards an ambitious goal is effective

Start year of 100% HP sales:

(Similar to CARB Proposed)

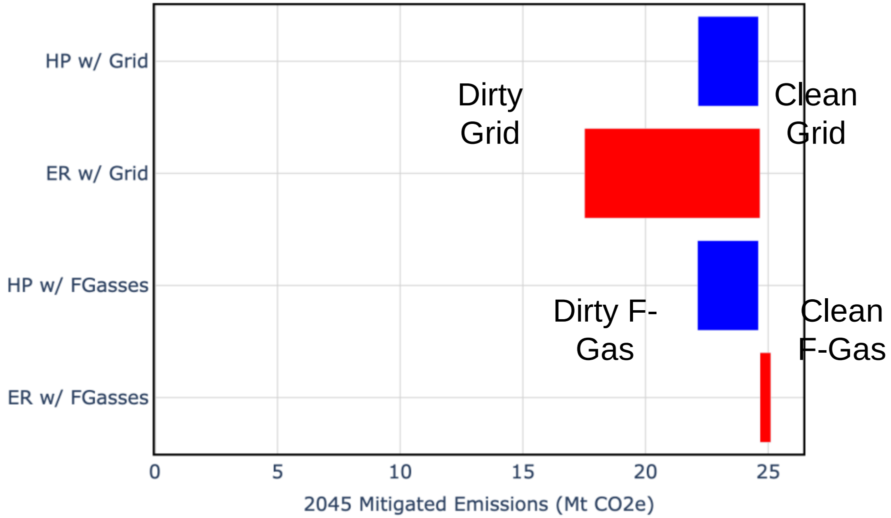


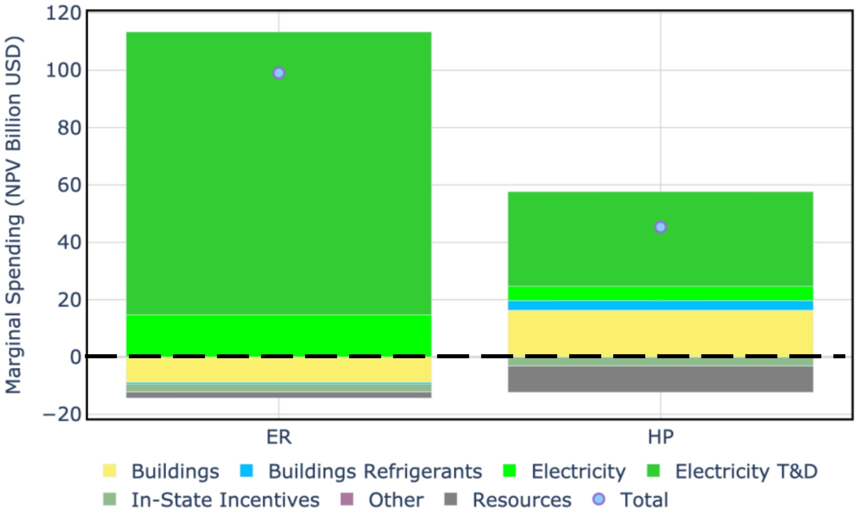


- Existing policy aimed at new homes only has little impact
- Important to have gradual progress towards ambitious goal
- CARB's proposed 2030 policy would substantially reduce building emissions; zero near impossible

Buildings Sector

HPs are overall more effective





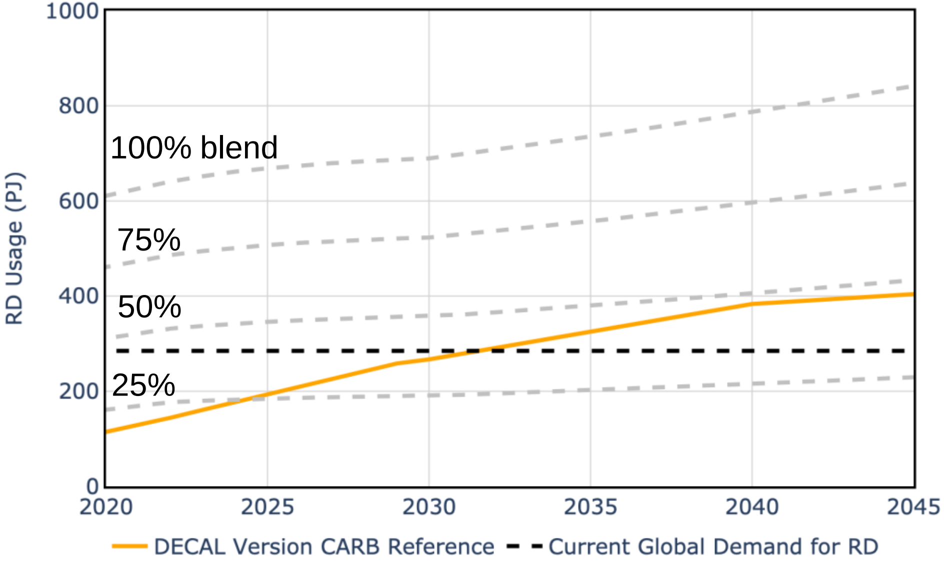
- ER is less effective with a dirty grid
- Whether choosing ER or HPs, the F-Gas stock will remain relatively similar because HPs replace ACs, while ERs still require ACs
    - ACs & HPs both use F-gases; ER do not

- HPs are more efficient than ER (56 GW delta)
- HP - higher upfront costs, lower e- costs
- ER - lower upfront costs, higher e- costs

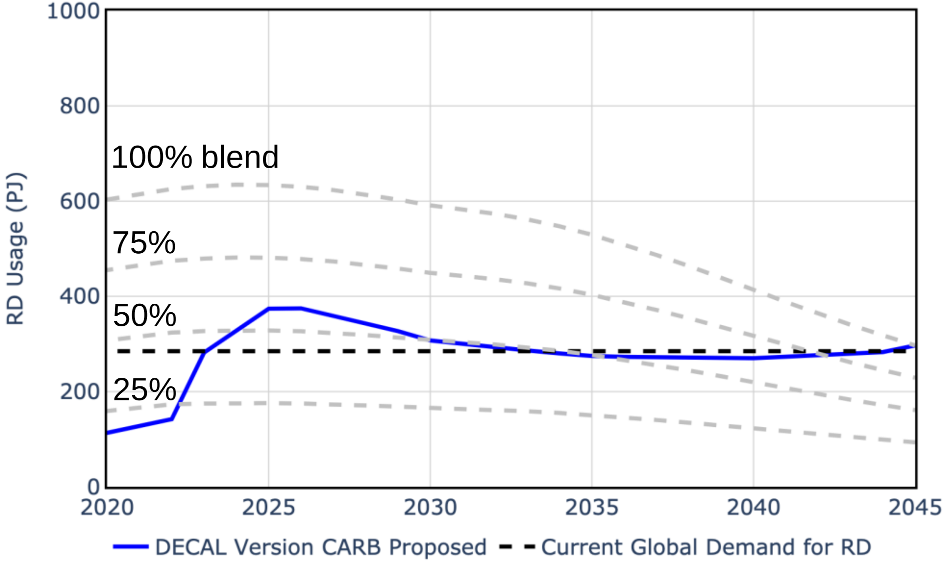
Renewable Diesel
RD will require careful planning

Current Global Demand for RD - www.iea.org/reports/renewables-2021/biofuels

DECAL Version CARB Reference



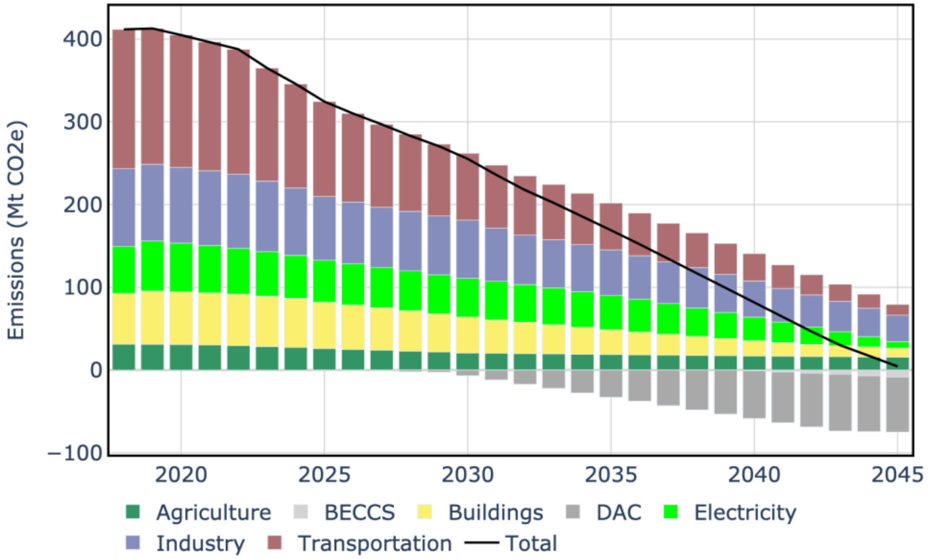
DECAL Version CARB Proposed



- Contour maps and resource proxies can help guide planning
- CARB Proposed strategy may pose risk to resource constraints
- Note: CARB projects 362 | 176 PJ/yr of RD in the Reference | Proposed scenarios

Direct Air Capture (DAC)

Net-zero will be difficult without DAC and/or other innovations



	CARB 2045	DECAL 2045
DAC	64.4 Mt	66.6 Mt
BiCRS	9.1 Mt	8.0 Mt
NWL	1.5 Mt	0 Mt
Total	75 Mt	74.6 Mt

- CARB highly reliant on DAC

Econ Wide | e- | Transport | Industry | F-Gases | Buildings | RD | DAC

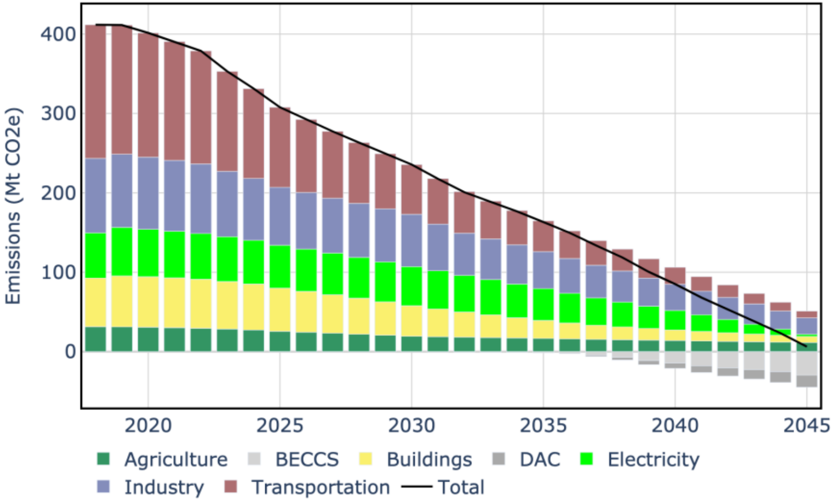
Direct Air Capture (DAC)

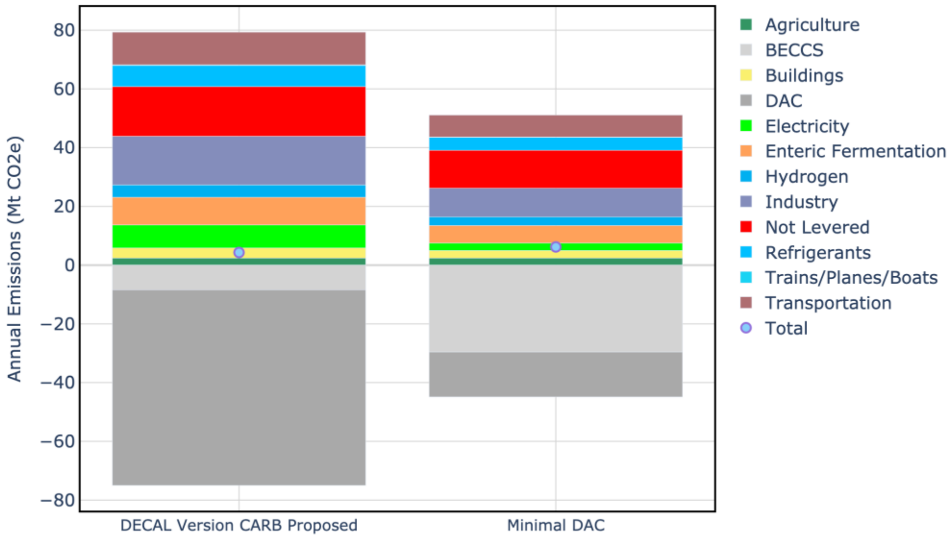
Net-zero will be difficult without DAC and/or other innovations

	DECAL version of CARB Proposed Scenario	Minimum DAC Scenario
Electricity	• 97% clean generation by 2045 • NGCCS is 90% clean • RNG is not used in the electricity sector	• 99% clean generation by 2045 • NGCCS is 98% clean • The electricity sector reaches the same RNG blend as the rest of the economy, 30% by 2045
Transportation	• 100% LDV sales ZEV by 2035 • 100% HDV sales ZEV between 2035-2040 • 100%/50%/25% reduction in emissions from planes/trains/boats	• 100% LDV sales ZEV by 2030 • 100% HDV sales ZEV by 2030-2035 • 100%/80%/55% reduction in emissions from planes/trains/boats
Buildings	• 100% clean sales by 2035/2045 Residential/Commercial	• 100% clean sales by 2030
Industry	• 90% CCS capture rate • 65% deployment of CCS in refining subsector • 50% electrification of “Industry Other” • 0% deployment in remaining landfill capture, fugitive sealants, and waste mitigation strategies	• 98% CCS capture rate • 100% deployment of CCS in refining subsector • 100% electrification of “Industry Other” • 30% deployment in remaining landfill capture, fugitive sealants, and waste mitigation strategies
Hydrogen Production	• RNG is not used to make hydrogen • New hydrogen production consists of 35% Gasification with CCS and 65% Electrolysis.	• Hydrogen SMRs reach the same RNG blend as the rest of the economy, 30% by 2045 • New hydrogen production consists of 65% Gasification with CCS and 35% Electrolysis.
Agriculture	• Seaweed: 50% adoption, 30% reduction in emissions • 0% deployment of low emitting fertilizers	• Seaweed: 80% eligibility, 60% reduction in emissions • 30% deployment of low emitting fertilizers
Refrigerants	• Approximately 85% reduction in refrigerant GWP by 2050	• Approximately 85% reduction in refrigerant GWP by 2045
CDR	• **67 Mt DAC / 8 Mt BECCS in 2045**	• **15 Mt of DAC / 31 Mt BECCS in 2045**

Direct Air Capture (DAC)

Net-zero will be difficult without DAC and/or other innovations





- Even with (beyond) extreme decarbonization assumptions, reaching net-zero emissions still requires 15 Mt/yr of DAC and 31 Mt/yr of BECCS in 2045
- 15 Mt not levered, 10 Mt Industry (Refining, NG leaks, Other), 6 Mt enteric fermentation, 5 Mt LDVs, 4 Mt Refrigerants, 3 Mt HDVs, 3 Mt Buildings, 3 Mt Electricity, 1 Mt Hydrogen

What will it take to reach net-zero emissions by 2045?

- All technologies and resources will be needed to get to net zero by 2045
- Electrification will require major expansion to the existing grid (approximately 250 – 450 GW of capacity depending on degree of electrification)
- Going from 99% to 100% carbon-free electricity generation is very expensive without 100% clean dispatchable power
- Gradual progress towards ambitious ZEV sales goals is effective
- Point source CCS is effective and economically favorable for the industrial sector
- F-Gas mitigation requires innovation
- Gradual progress towards ambitious HP/ER sales goals is effective
- Expanding use of H2 may be very expensive, especially due to distribution & storage
- RNG and RD usage may be limited by feedstock availability
- It is very difficult to reach net-zero by 2045 without significant DAC/CDR

Action Items

R&D Focus Areas

- DAC – cost and parasitic load reduction for DAC technologies
- F-Gases – low GWP F-Gases (e.g.: CO2, propane)
- Li Ion battery costs (vehicles and grid)
- Biofuel feedstocks – identifying additional feedstocks
- H2 Distribution and Storage cost reductions

Policy Implications

- NG water and space heating sales reductions are needed
- Electricity generation – 99% CGC is more cost effective than 100%; clean baseload power can help reduce costs
- Streamline permitting and building of infrastructure – e.g., electricity generation and T&D, BEV charging, DAC, CCS, and biofuel production
- Extend 45Q, especially for some industrial sub-sectors

Future Opportunities

DECAL can address additional important issues:

- What is the cost impact of delaying the net-zero target past 2045 or accelerating it to earlier than 2045?
- What is the impact of peaker and NGCC plant retirements?
- How much cheaper do FCEV's, hydrogen distribution and storage, and/or refueling stations need to be to achieve cost parity with BEVs, especially for HDVs?
- How would a state limit on CCS impact industrial emissions and statewide costs?
- Where should we act first – i.e., which geographic zone (buildings)?
- What are the emissions/cost implications of using excess solar capacity to make H2, store it geologically, and then convert back to e- to meet later demand?
- Where (which subsectors) should alternative fuels be prioritized?
- What are the emissions associated with other pollutants (SOx, NOx, particulate matter) which can have a major impact on local health outcomes?

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Thank you! Questions?

Website link:
https://sccs.stanford.edu/california-projects/pathways-carbon-neutrality-california

Term	Description	Term	Description	Term	Description
AC	Air conditioner	**EOL**	End of life	**PHEV**	Plug in hybrid electric vehicle
AD	Anaerobic digestion	**ER**	Electric resistance	**PTC**	Production Tax Credit
BAU	Business as usual	**FCEV**	H2 fuel cell electric vehicle	**RD**	Renewable diesel (diesel fuel made from a biofeedstock)
BEV	Battery electric vehicle	**LCFS**	Low Carbon Fuel Standard	**Remaining Electricity**	Load satisfied by distributed solar
BiCRS	Biomass carbon removal and storage	**LDV**	Light duty vehicle	**Res**	Residential
CA	California	**LEAP**	Low Emissions Analysis Platform	**RNG**	Renewable natural gas
CARB	California Air Resources Board	**F-Gas**	Fluorinated gas (e.g., refrigerant)	**RPS**	Renewable Portfolio Standard
CCS	Carbon capture & sequestration	**GWP**	Global warming potential	**SH**	Space heater / space heating
CDR	Carbon dioxide removal	**H2**	Hydrogen	**SMR**	Steam methane reforming plant
CGC	Clean generation constraint	**HDV**	Heavy duty vehicle	**T&D**	Transmission and distribution (electricity)
CI	Carbon intensity	**HP**	Heat pump	**D&S**	Distribution and storage (hydrogen)
Comm	Commercial	**Li Ion**	Lithium-Ion batteries	**VMT**	Vehicle miles traveled
CO2e	Carbon dioxide equivalent	**LPG**	Liquid propane gas	**WH**	Water heater / water heating
DAC	Direct air capture	**Mfg**	Manufacturing Small: <25kt co2e/ yr Large: >25kt co2e/ yr	**ZEV**	Zero emission vehicle
DECAL	Our model – **DE**carbonize **CAL**ifornia	**NGCCS**	Natural gas power plant with CCS	**45Q**	Federal program incentivizing CCS & DAC
e-	Electricity	**O&G**	Oil and gas	**% Blend**	Blend percentage of specified fuel (RD, biodiesel, RNG, Ethanol)
E-Gen	Electricity generation	**O&G Upstream**	Upstream oil and gas, including crude extraction		

Backup Slides

Conclusions: What will it take to reach net-zero emissions by 2045?

Economy Wide
- All resources will be needed
- A few policies are key
- Only some are affordable

Electricity Sector
- We must be proficient at building electric infrastructure
- A clean grid is key, but 100% clean may not be needed
- Clean baseload power reduces cost
- Demand response can be helpful but won't replace storage

Transportation Sector
- Gradual progress towards ambitious goal is effective
- BEVs are an effective and affordable option

Industrial Sector
- CCS is an effective and affordable option
- Incentives have a large impact on CCS technoeconomics

F-Gases
- EOL programs are helpful but not enough on their own
- Innovative low GWP refrigerants are needed for deep reductions

Buildings Sector
- Gradual progress towards ambitious goal is effective
- HPs are overall more effective than ER, though there are different tradeoffs

Fuel Switching
- **Hydrogen**: H2 is expensive, but is most cost-effective in HDVs. Generation costs are small compared to the cost of end-technologies and distribution & storage.
- **RNG & RD**: Careful resource planning will be required due to feedstock constraints

DAC
- Net-zero will be difficult without DAC/CDR
- DAC add lots of load

Question List

DECAL has been used to address these questions:

CARB and DECAL comparison

- Can the DECAL model match the yearly emissions forecast by the CARB Reference case and Proposed scenario when run under the same set of assumptions?
- Do DECAL decarbonization costs align with CARB cost estimates?

System Wide

- Can one resource or technology get us to net-zero by 2045?
- Is there a 'silver bullet'?
- What policies and technologies have the most impact on emissions reductions?
- Is there any "low hanging fruit"?
- Which policies and technologies will have the most impact on the electric load?

Electricity Sector

- How much capacity needs to be added to the grid and from what resources?
- What is the cost and resource impact of a 100% clean generation constraint in 2045?
- How does a 100% renewable grid compare to a grid that maintains firm power resources (e.g., NGCCS)
- What is the impact of shifting loads (e.g., day vs night EV charging)

Transportation Sector

- What is the effect of changing the start date of the Clean Cars II regulation and the Advanced Clean Truck program?
- How do costs and emissions of different vehicle fuel types (BEV, FCEV) compare?

Industrial Sector

- Which decarbonization technology is preferable for the industrial sector?
- What is the impact of incentives on CCS technoeconomics?

F-Gases

- What is the impact of F-gases?
- What is the effect of EOL versus annual F-gas policies?

Buildings Sector

- What is the effect of changing the rate of electrification in the buildings sector?
- How do costs and emissions of different electrification options compare?
- Can the F-gas 'problem' be mitigated by focusing on electric resistive heating instead of heat pumps?

Fuel Switching

- What role can hydrogen play to decarbonize California and what is the impact of different generation methods on costs?
- What role can renewable diesel play to decarbonize California?
- What role can renewable natural gas play to decarbonize California?

CDR

- What is the minimal amount of CDR/DAC required while still meeting a net-zero goal?

Other

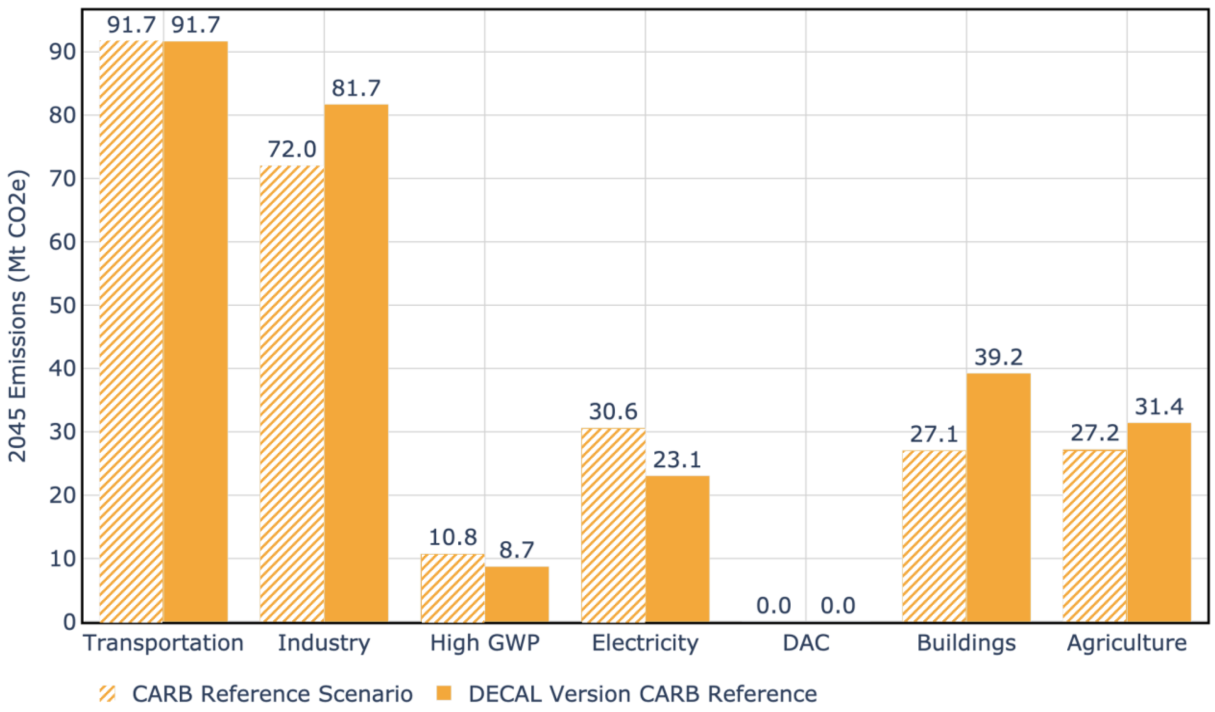
- Where a choice is available, which technology is most effective?
- What are the 'next best' options in case the first fails?
- How will cost reductions over time affect overall costs?
- How sensitive are overall system costs to fuel prices?
- How important are incentives?

Future Opportunities

Stanford team thinks there are additional important issues to be addressed

- **Equilibrium & optimization modeling**
- **Multi agent modeling**
  - State
  - Resident
  - Business owner
- **Risk-based modeling**
- **Model scope (other states and countries)**
- **Impacts (example - criteria air pollutants)**
- **Energy distribution infrastructure**
  - Poles & wires (electricity)
  - Pipelines (NG, H2, CO2)
- **More technologies**
  - Energy efficiency (buildings, industry)
  - New industrial heating and electric storage options
  - Hydrogen economy

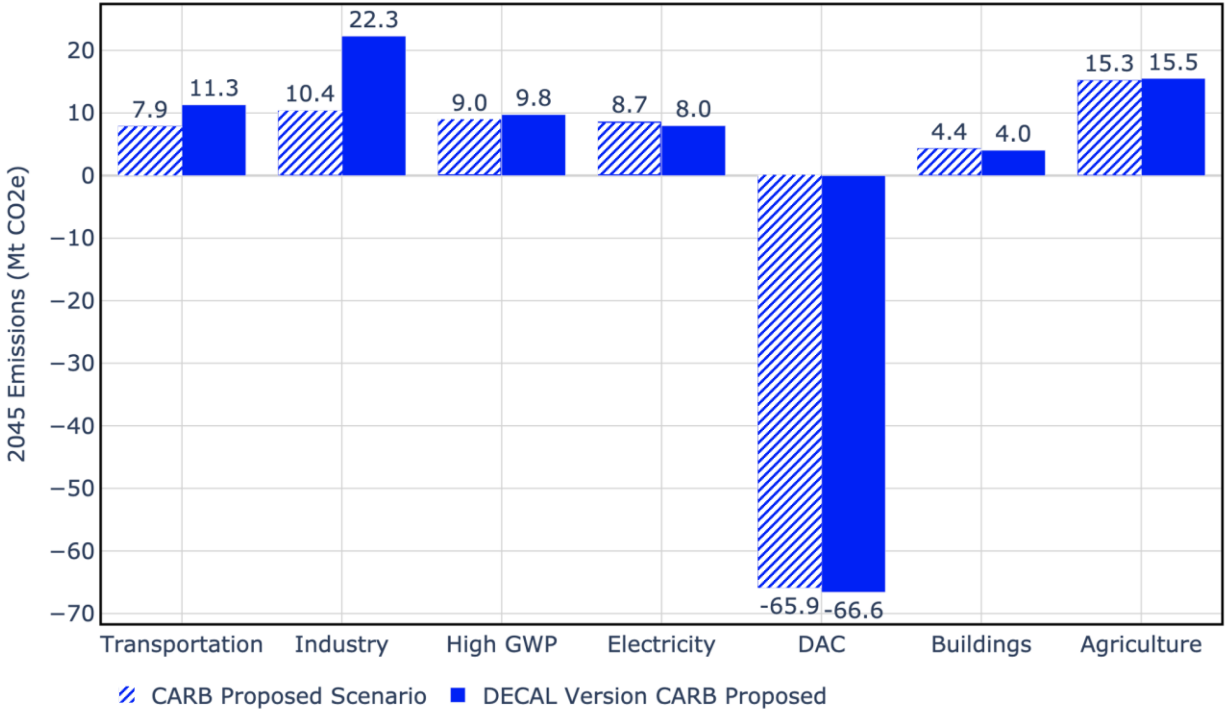
Comparison between DECAL and CARB Scoping Plan



Key Differences:

- **Industry**: DECAL starts 6 Mt higher than scoping plan to align with GHG inventory; refineries unable to reduce output due to high diesel demand
- **Electricity**: Iteration on DECAL's CGC was done in an attempt to match CARB's results as closely as possible
- **Buildings**: DECAL starts 7 Mt higher than scoping plan to align with GHG inventory; residential & commercial 'other' untouched in Reference
- **Agriculture:** DECAL does not assume any changes to livestock populations or manure management practices

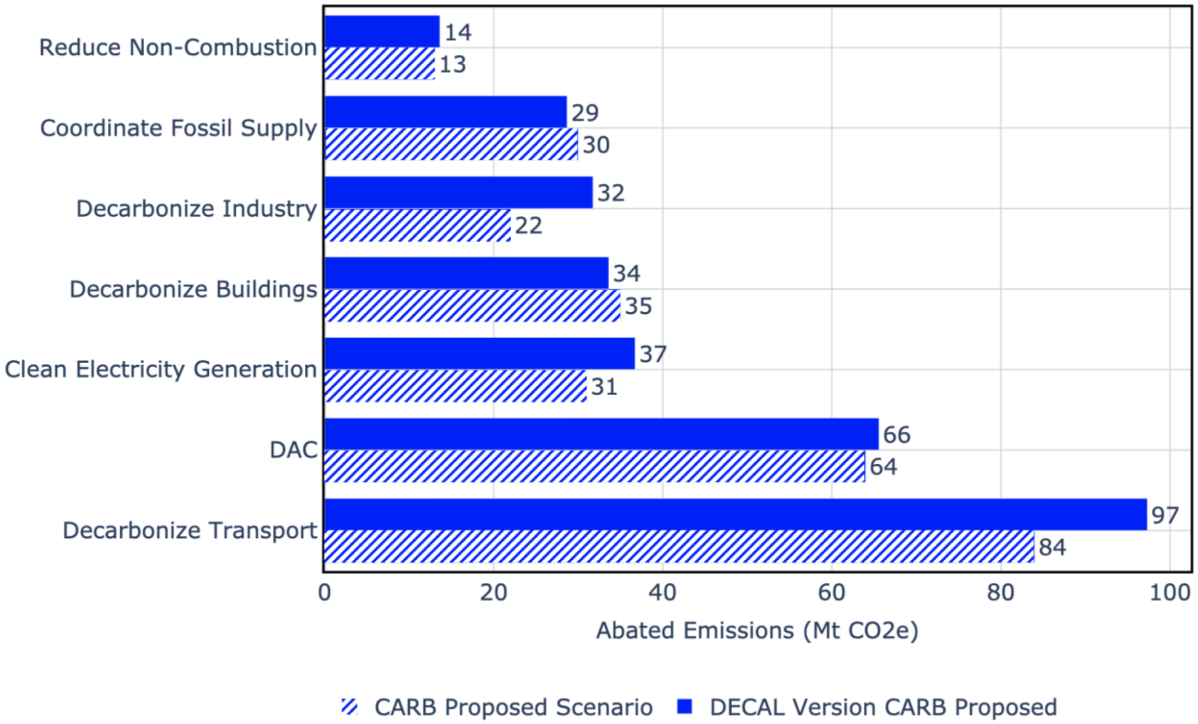
Comparison between DECAL and CARB Scoping Plan



Key Differences:

- **Transportation:** slower transition dynamics in DECAL Version of CARB Proposed
- **Industry**: DECAL starts 6 Mt higher than scoping plan to align with GHG inventory; DECAL assumes only certain refinery units are eligible for CCS; general inefficiencies in CCS capture (90% capture rate assumed)

Comparison between DECAL and CARB Scoping Plan



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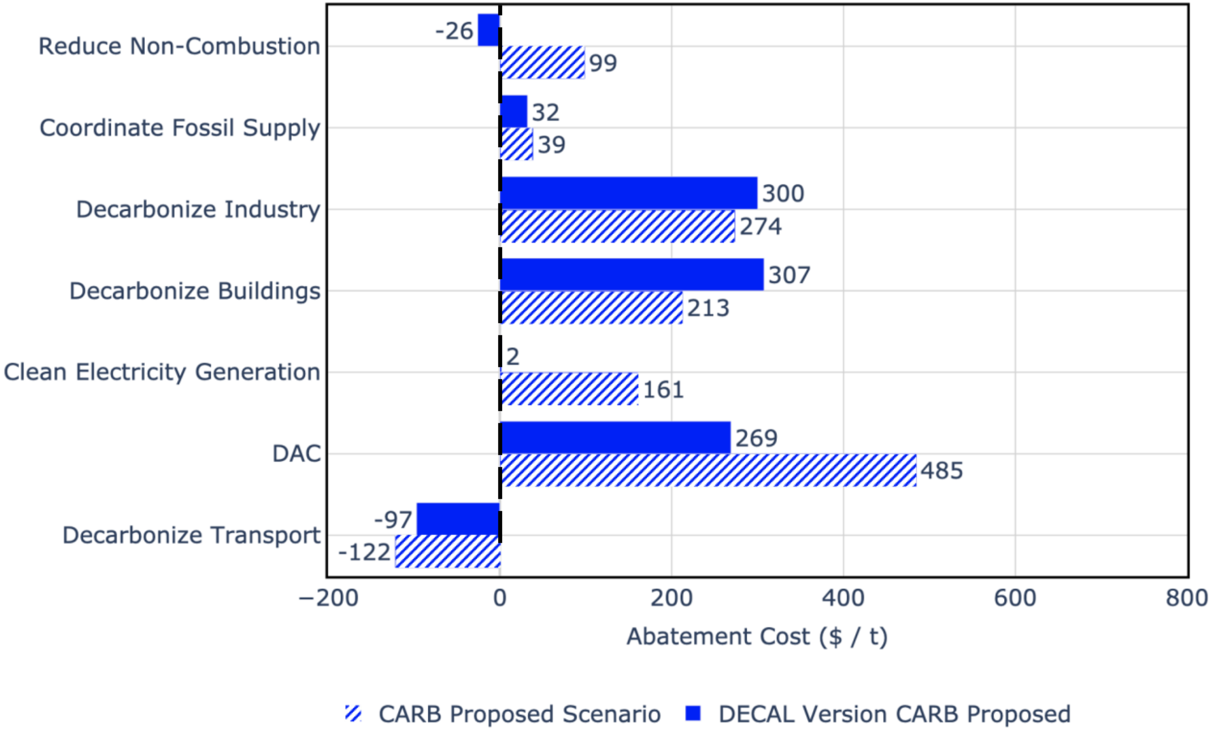
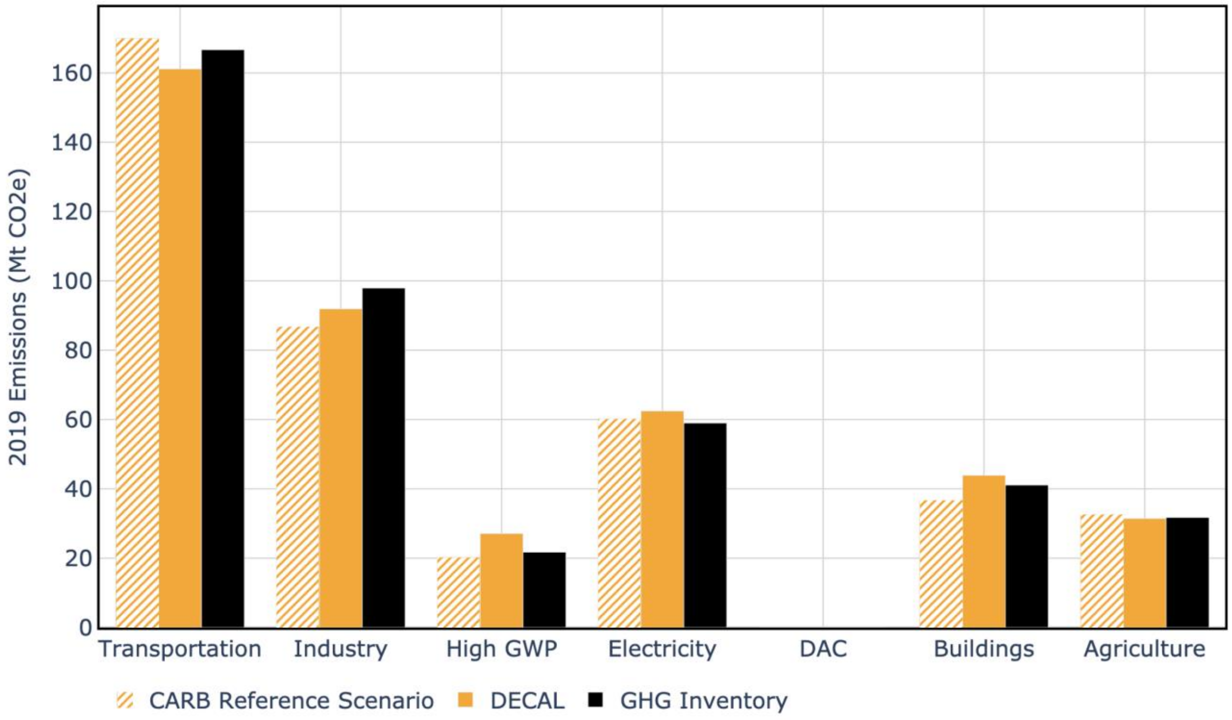
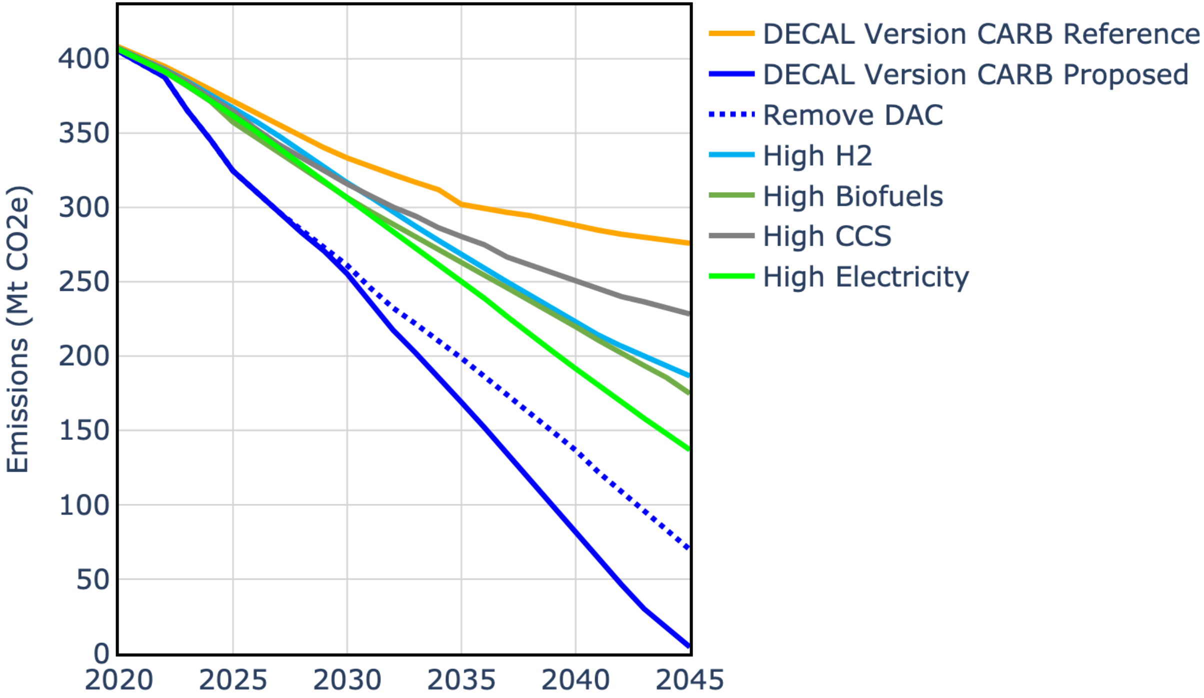


Comparison between DECAL and GHG Inventory



Economy-Wide

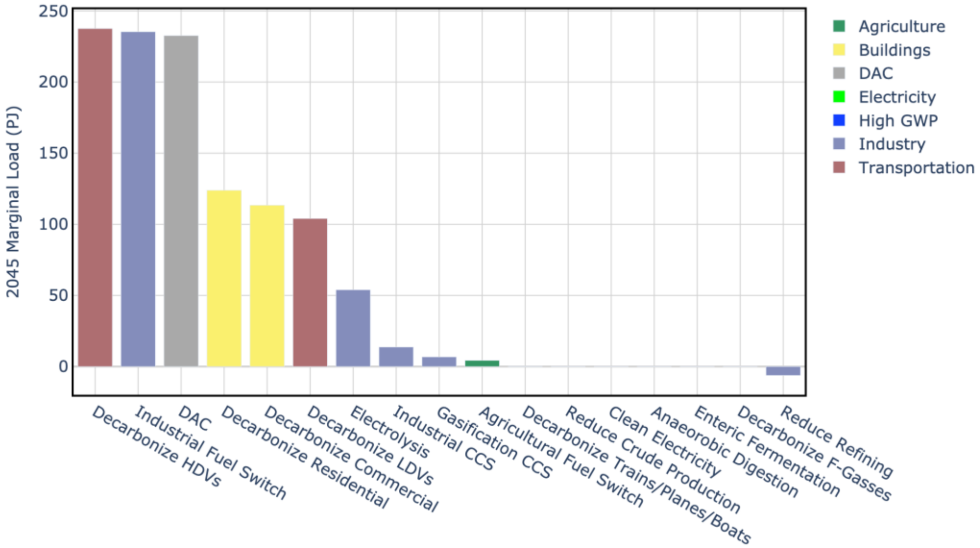
All resources and technologies will be needed

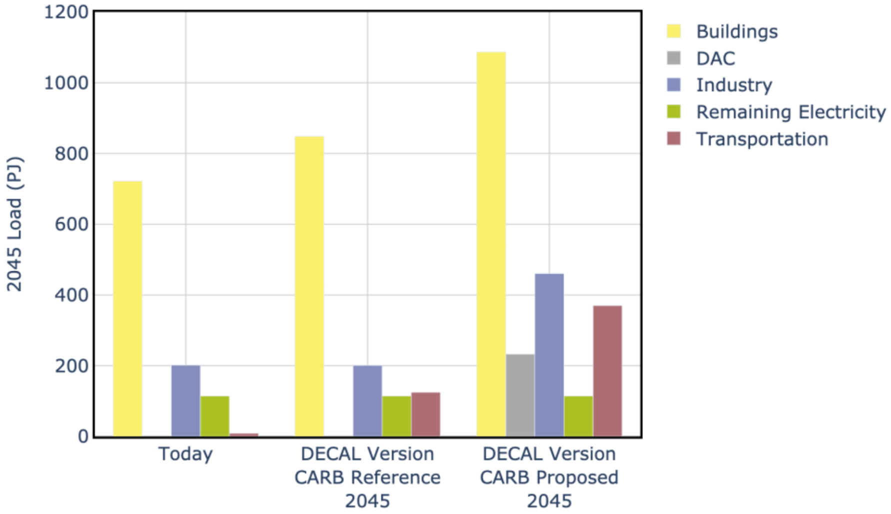


There is no silver bullet – resources and technologies must be combined to reach our goals

Economy Wide Overview

Electric load will grow in every sector



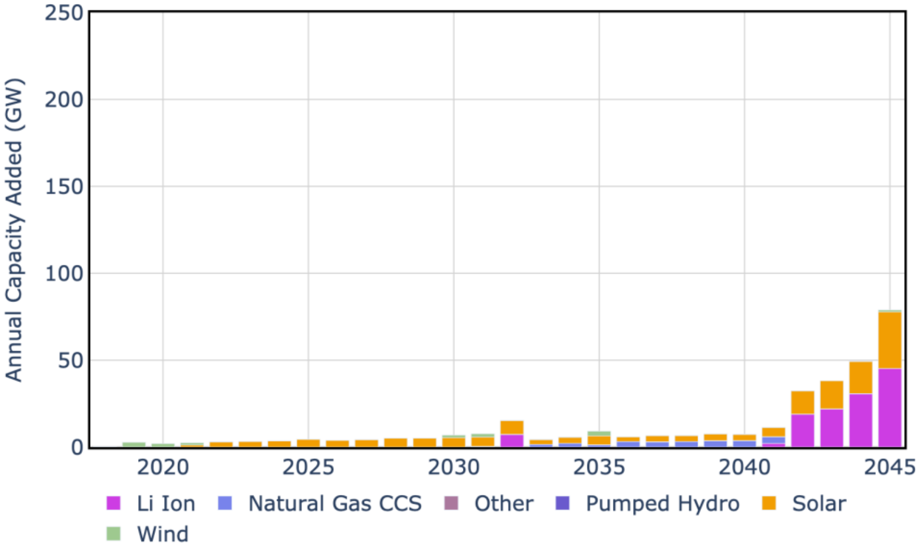


- DAC has large impact on electric load
- Buildings are and will remain the largest sectoral electric load
- Growth in electric load in transportation, industry, and buildings are all significant

Electricity Sector

A clean grid will be required…
but 100% clean may not be necessary

Medium Electricity, CGC = 99% by 2045



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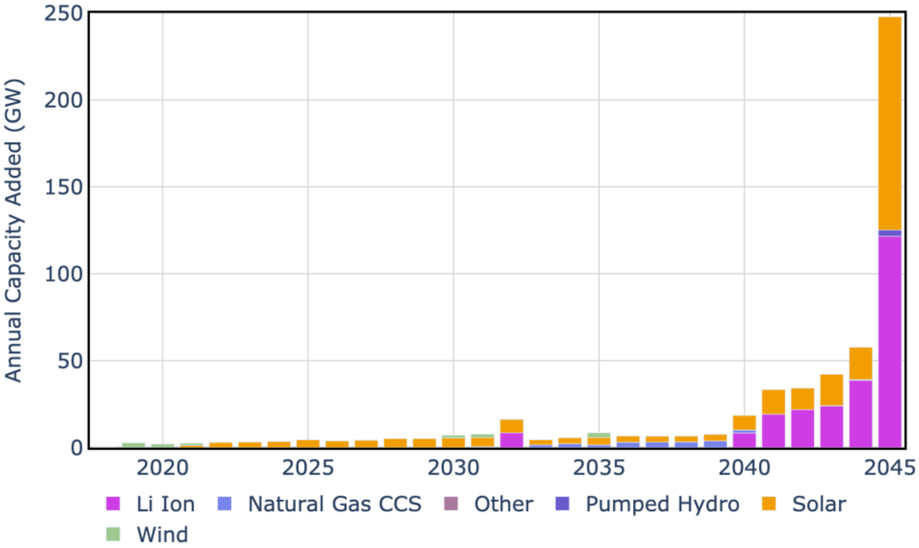

- Going from 99% to 100% ”clean” requires enormous capacity installations, in large part due to lack of NGCCS

Electricity Sector

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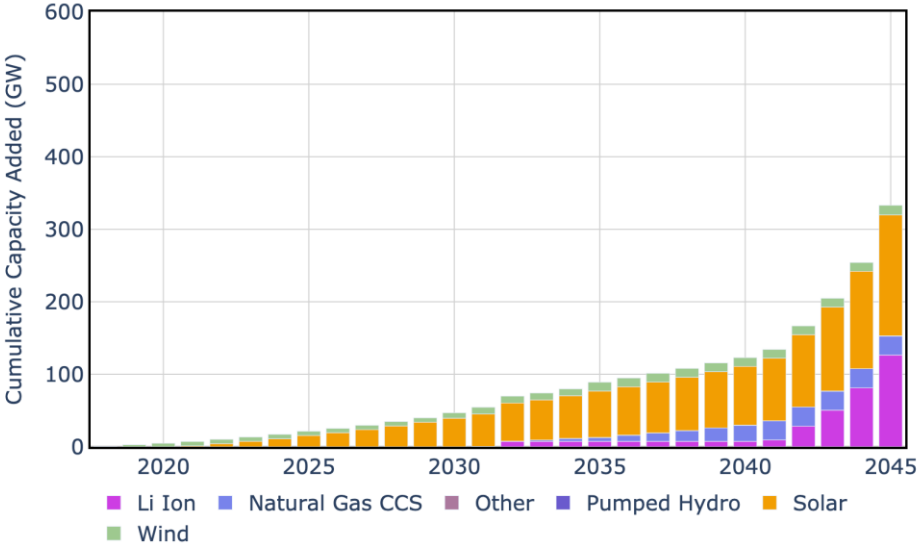

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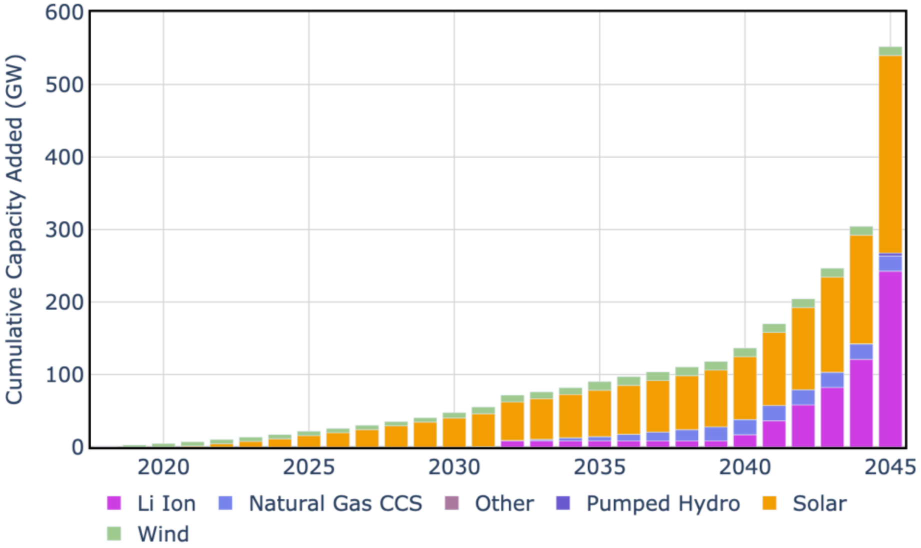
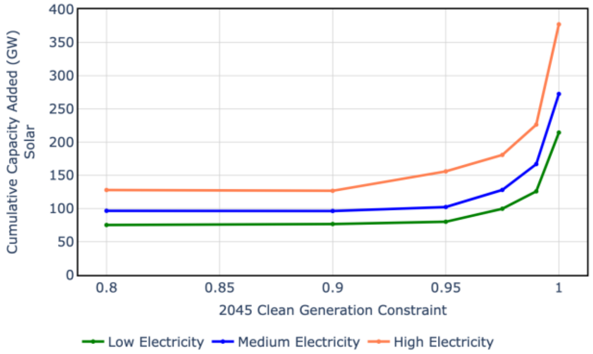


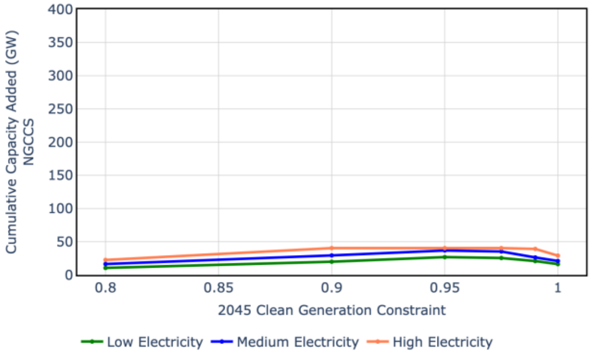
- Going from 99% to 100% ”clean” requires enormous capacity installations, partially due to lack of NGCCS

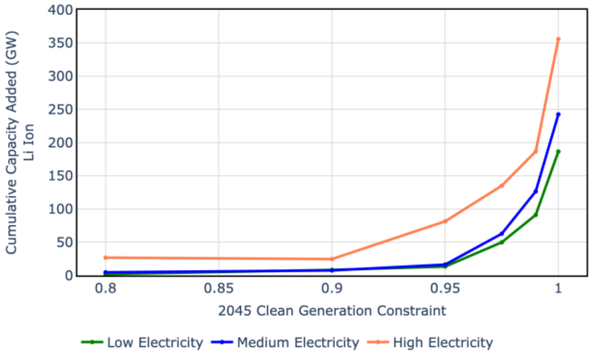
Electricity Sector

A clean grid will be required…
but 100% clean may not be necessary

Low: Choose H2, biofuels, & CCS
Med: CARB Proposed
High: Choose electricity



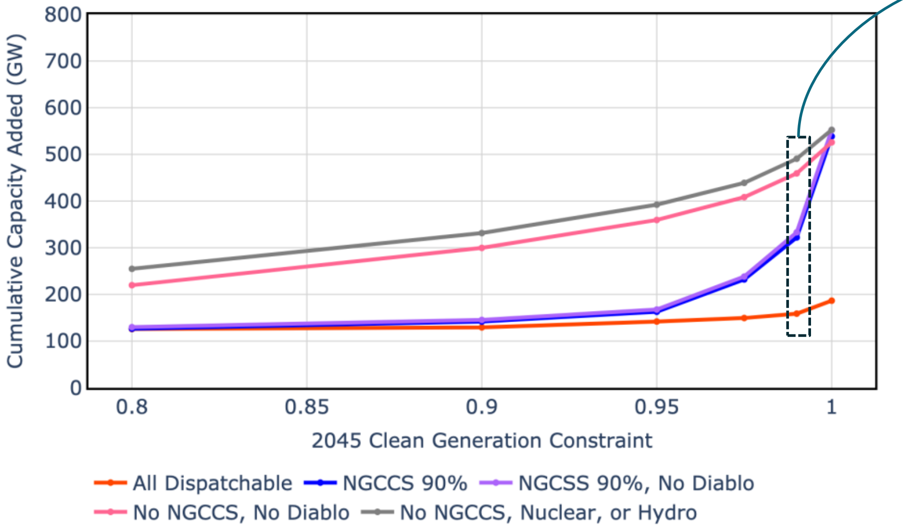




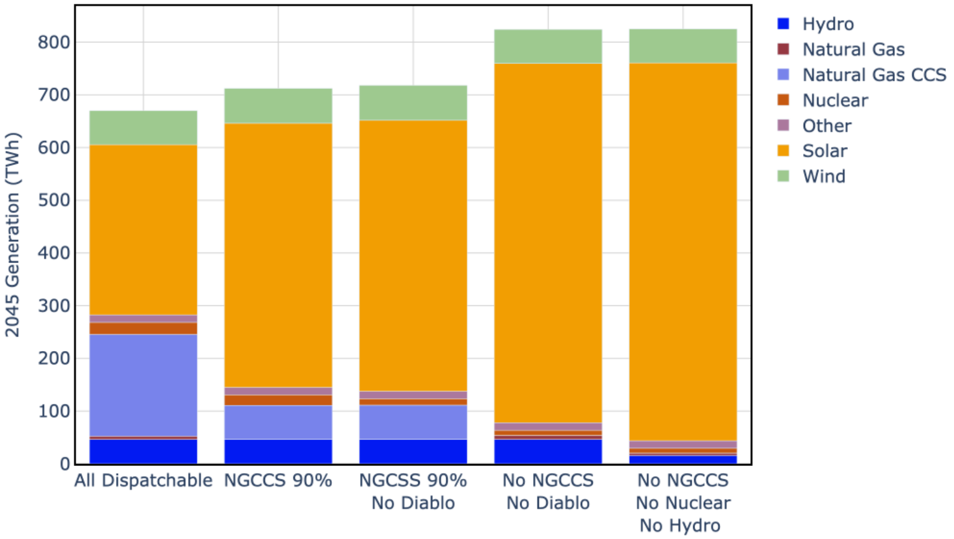
- 99% → 100% clean generation requires much more solar & batteries, largely because NGCCS must be used less
- A small amount of NGCCS can help prevent significant overbuild

Electricity Sector

Clean dispatchable power limits overbuilding



99% CGC Case

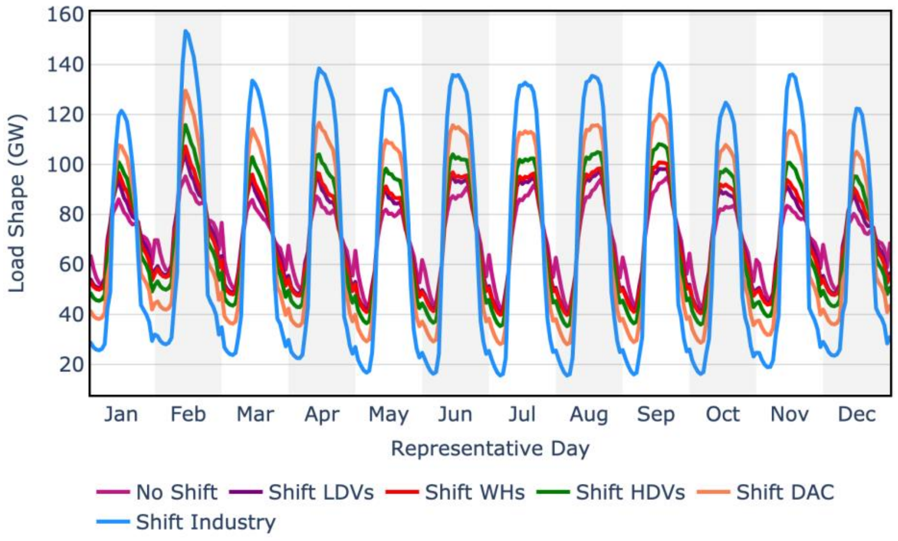


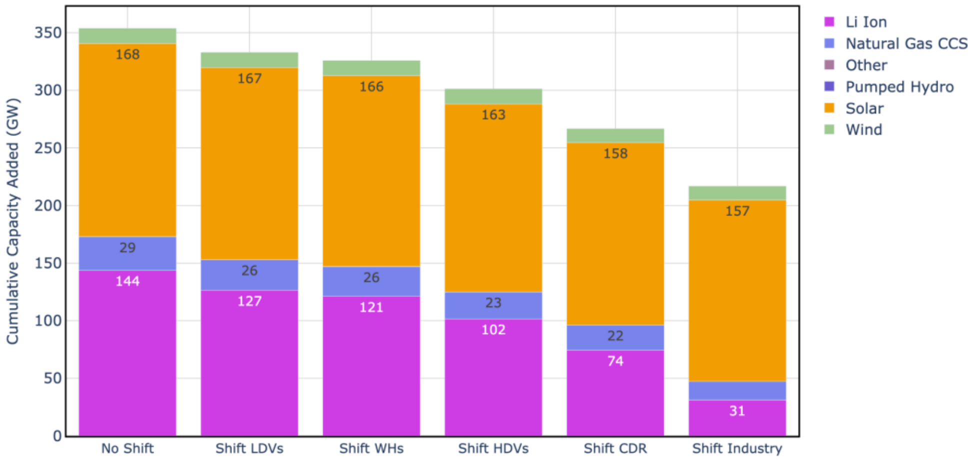
- NGCCS & Hydro make a big difference
- Diablo Canyon makes a small difference
- Small amount of clean dispatchable power reduces capacity expansion significantly

Electricity Sector

(Scenarios are additive, not independent)

Shiftable loads make some difference
Deep shifting will be more challenging





- Industry makes the biggest difference, but is also the least shiftable

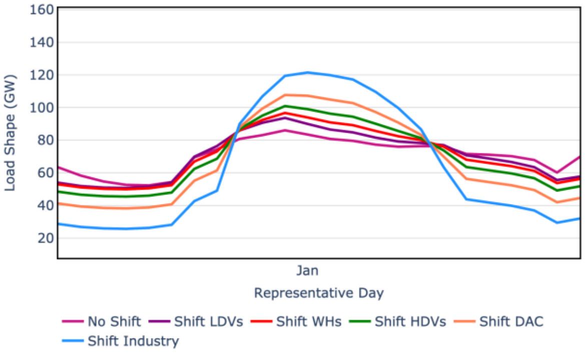
- By shifting load to day-time, less solar and battery storage are required
- Decarbonized future will require significant Li-Ion regardless of shifting

Electricity Sector

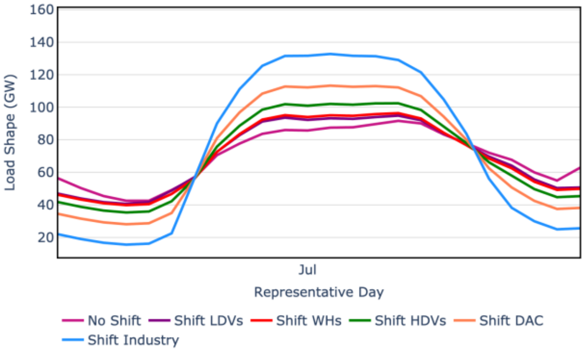
(Scenarios are additive, not independent)

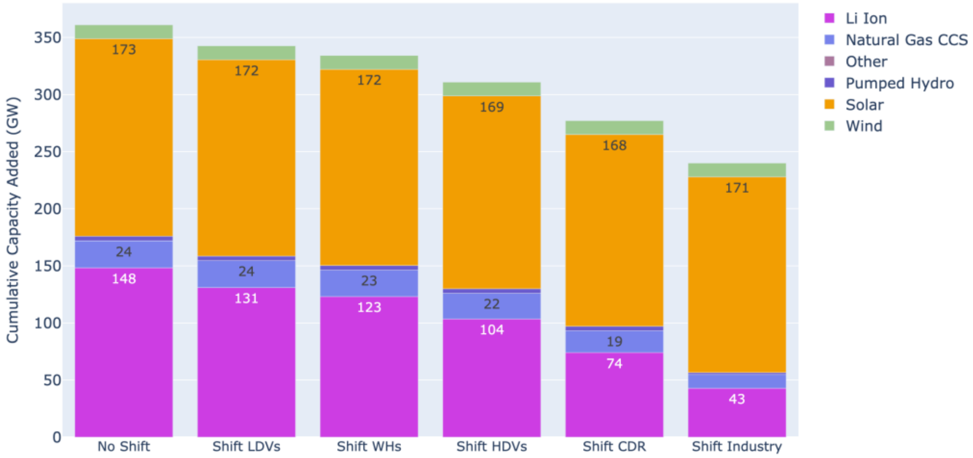
Shiftable loads make some difference
Deep shifting will be more challenging

January



July





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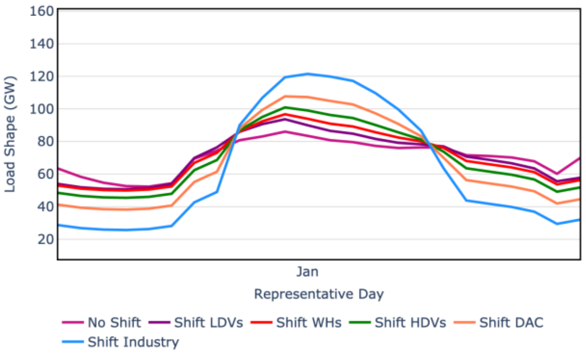
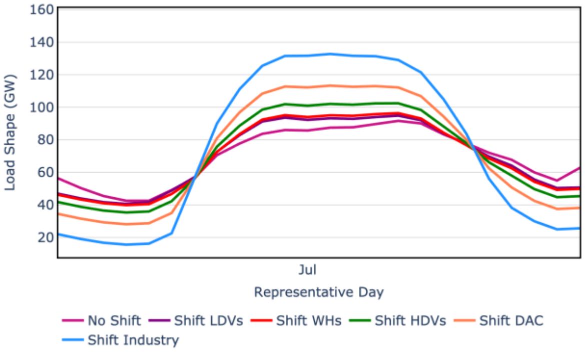
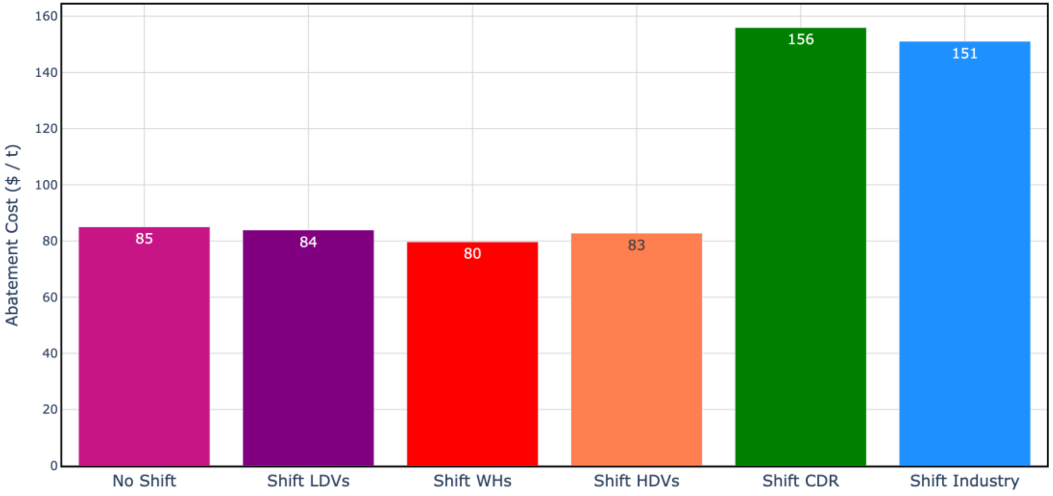


July



Overbuilding DAC is expensive



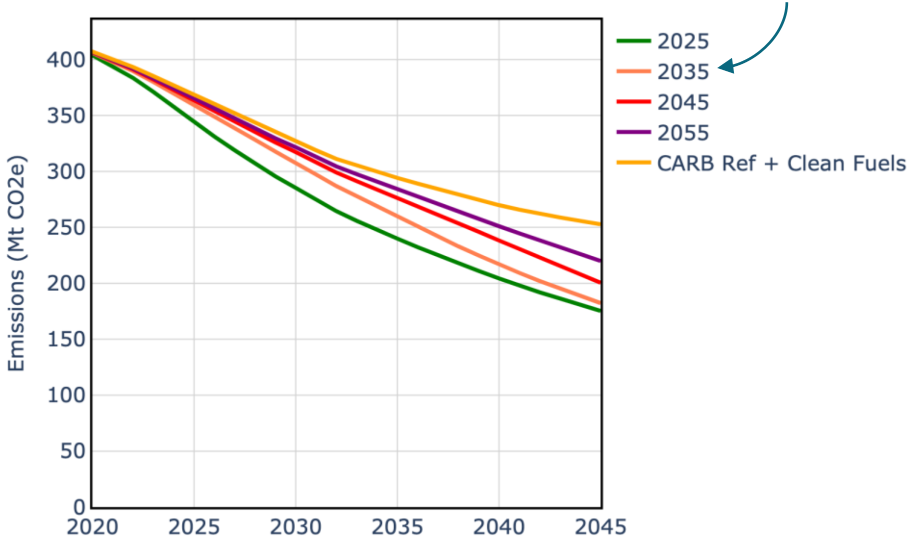
Shifting these loads doesn't affect cost much

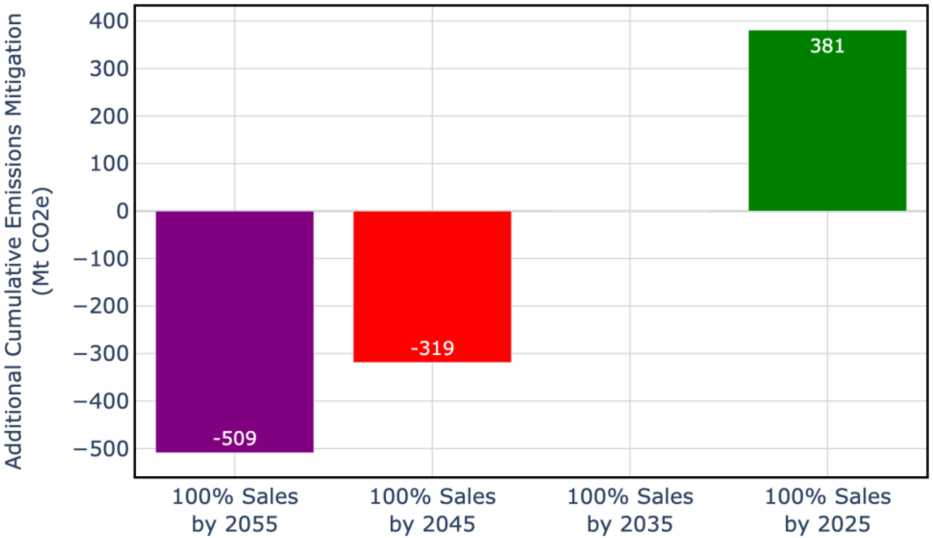
Transportation Sector

Gradual progress towards an ambitious goal is effective

LEAP Version CARB Proposed mitigates ~3135 Mt cumulatively

Start year of 100% ZEV sales: (Similar to CARB Proposed)

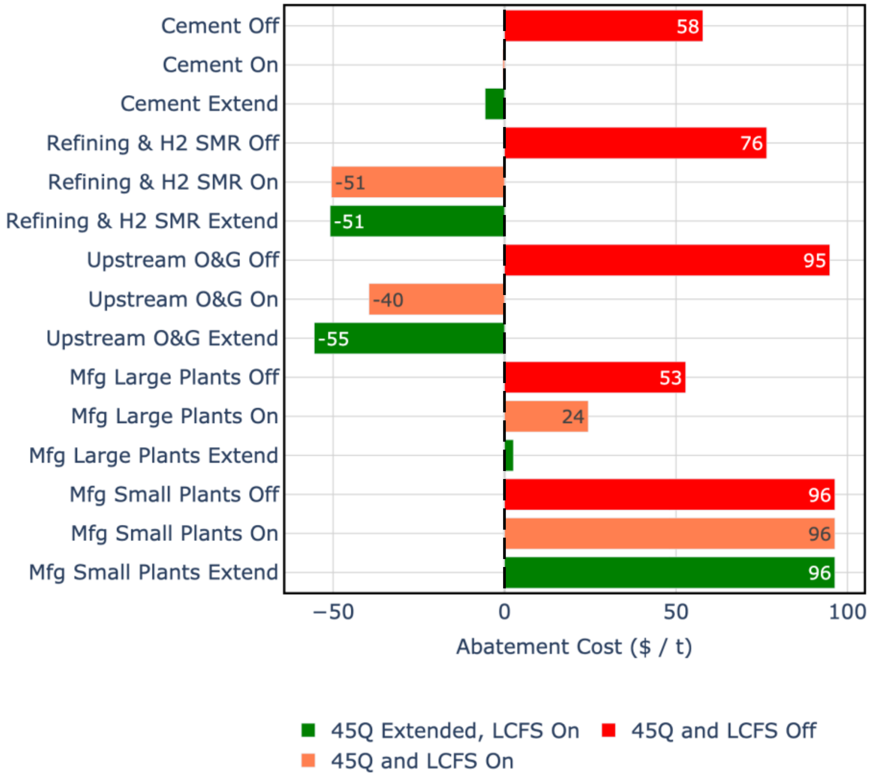




- Important to have gradual progress towards ambitious goal
- Existing 2035 policy will substantially reduce transport emissions; zero near impossible
- Reaching goal by 2055 / 2025 can change cumulative emissions mitigation by about -16% / +12%

Industrial Sector

Incentives have a large impact on CCS technoeconomics

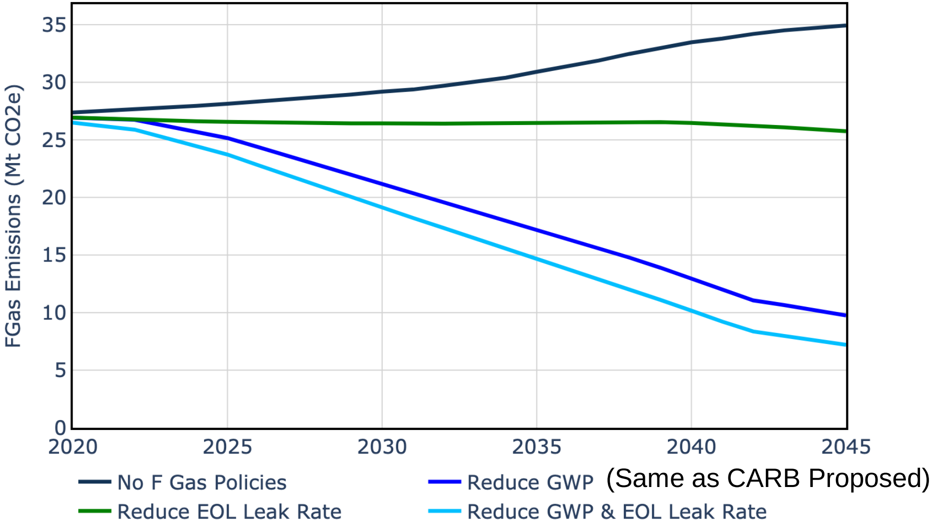


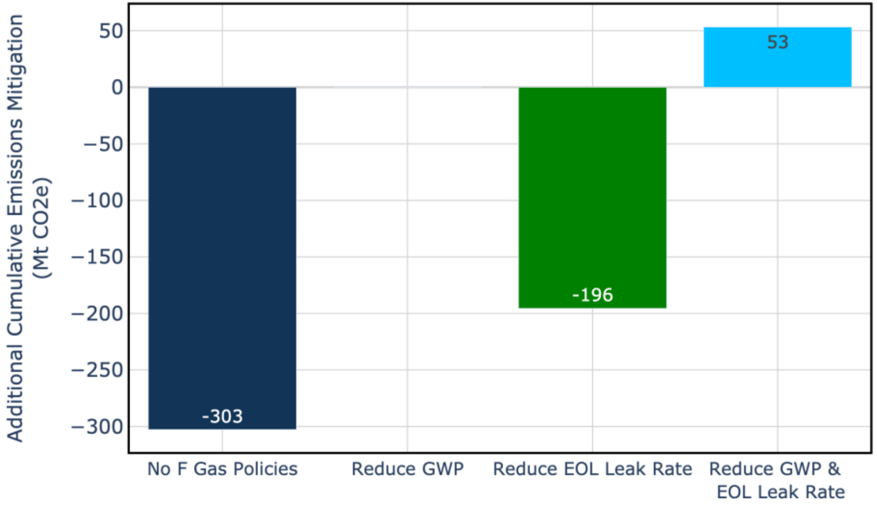
- CCS is financially attractive with incentives, less so without them
- Extending 45Q can help in cases where CCS is less viable in near term

F-Gases

Existing solutions are helpful
Innovation is needed for deep reductions

LEAP Version CARB Proposed mitigates ~3135 Mt cumulatively





- EOL F-Gas strategies can help keep F-Gas emissions constant, despite installing millions of heat pumps
- Deep reductions will require low GWP refrigerants, like CO_2 or propane
- Handling of F-Gases can change cumulative emissions mitigation by about -10% to +2%

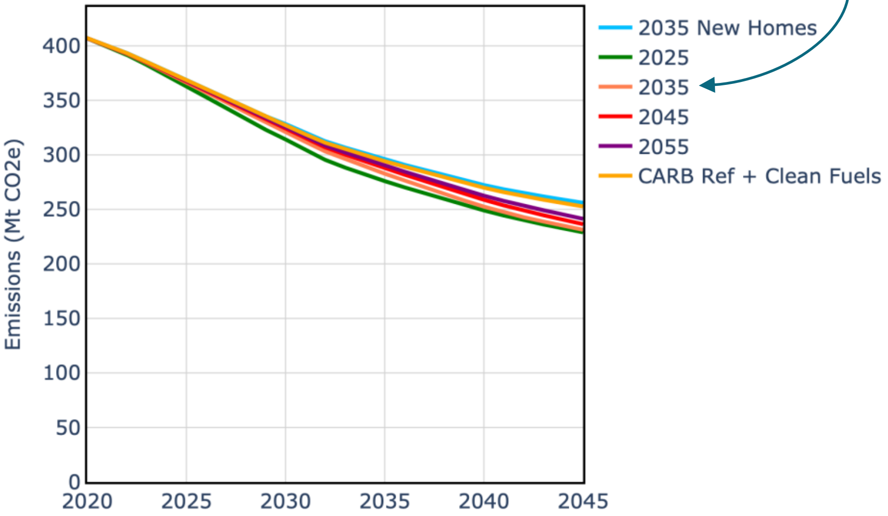
Buildings Sector

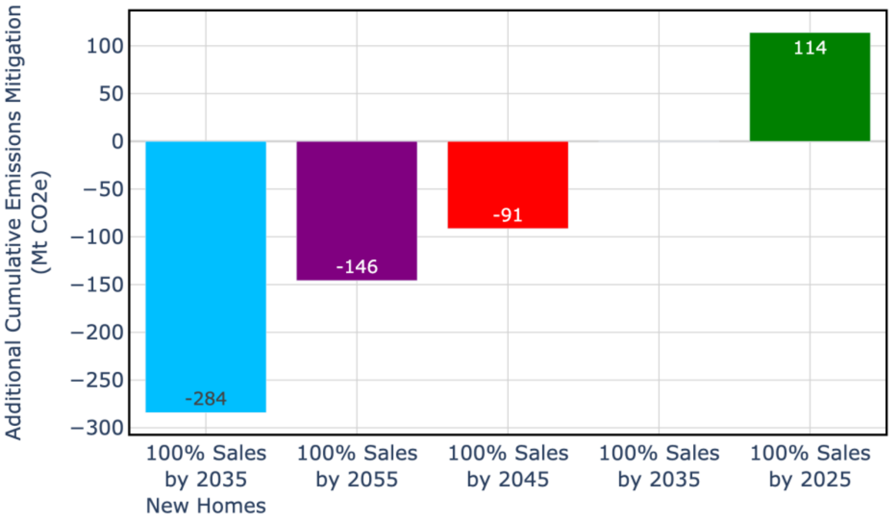
Gradual progress towards an ambitious goal is effective

LEAP Version CARB Proposed Mitigates ~3135 Mt Cumulatively

Start year of 100% ZEV sales:

(Similar to CARB Proposed)

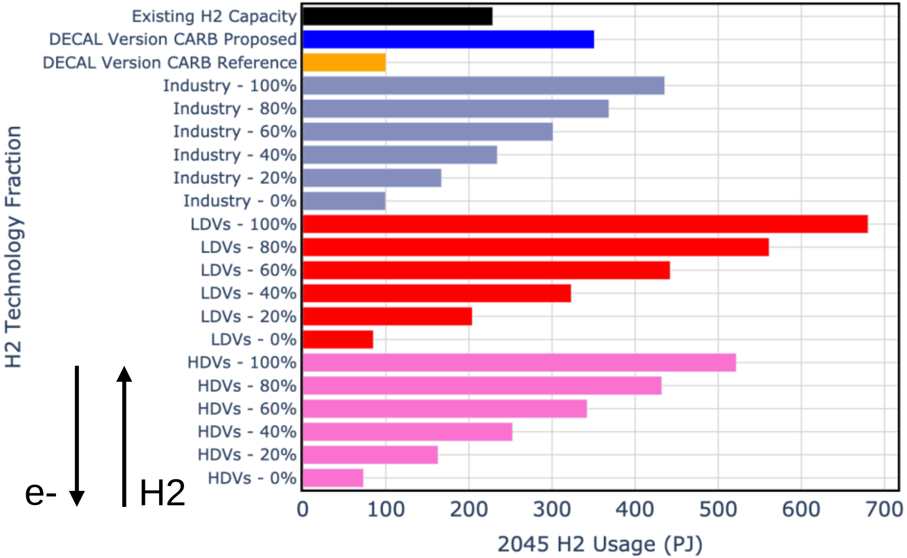


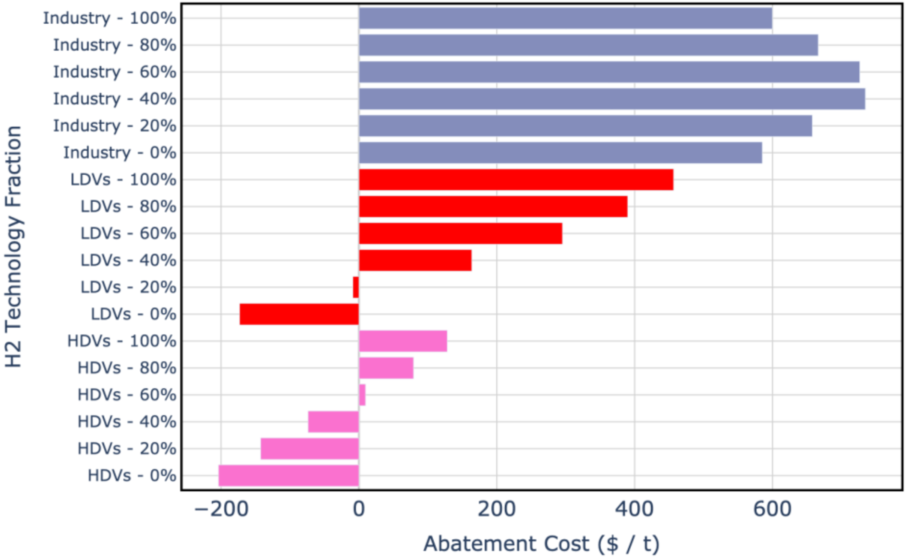


- Existing policy aimed at new homes only has little impact
- Important to have gradual progress towards ambitious goal
- CARB's proposed 2030 policy would substantially reduce building emissions; zero near impossible
- Reaching goal by 2055 / 2022 can change cumulative emissions mitigation by about -9% / + 4%

Hydrogen Usage

H2 is expensive and will require careful planning





- Left plot provides helpful guideposts as to “how much” H2 can be used in each sector
- H2 is expensive; cost should play into planning as well
- H2 may be best prioritized in HDVs
- H2 distribution & storage is significant driver in overall costs; H2 generation is not

Hydrogen Usage

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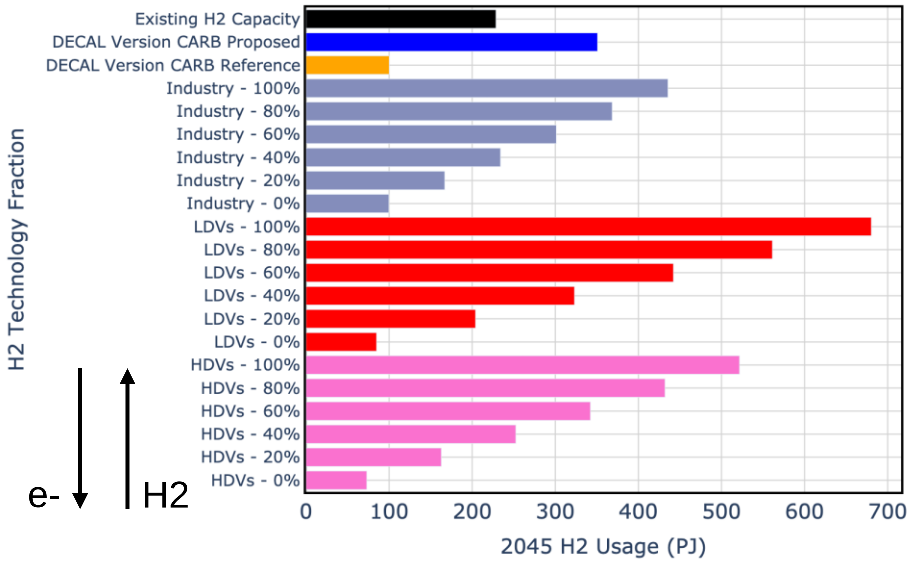

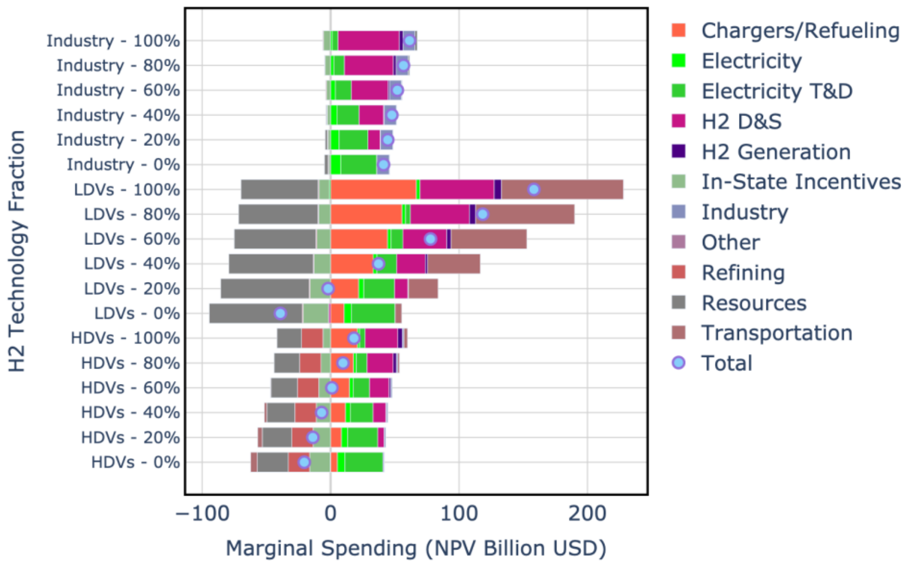

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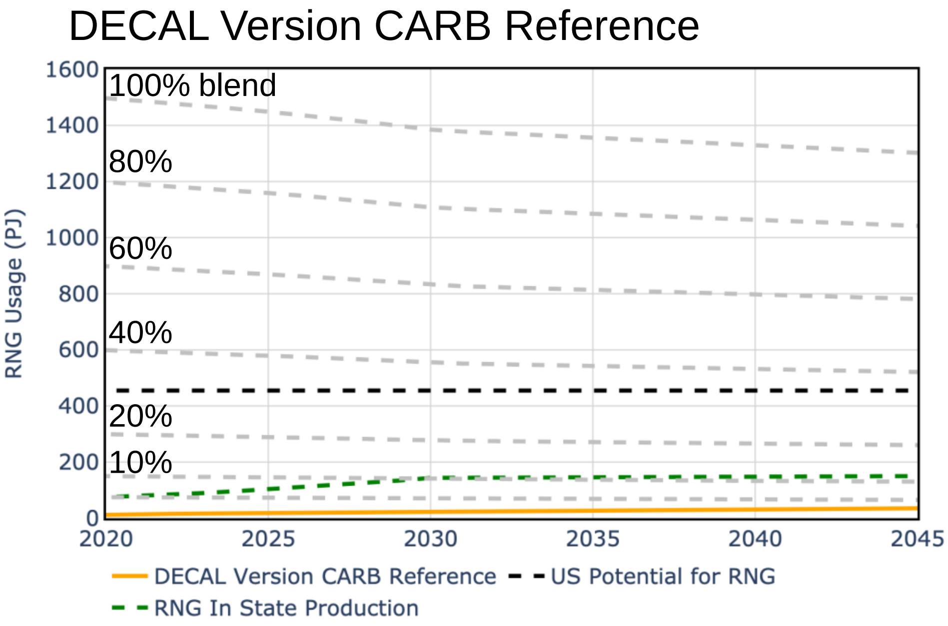
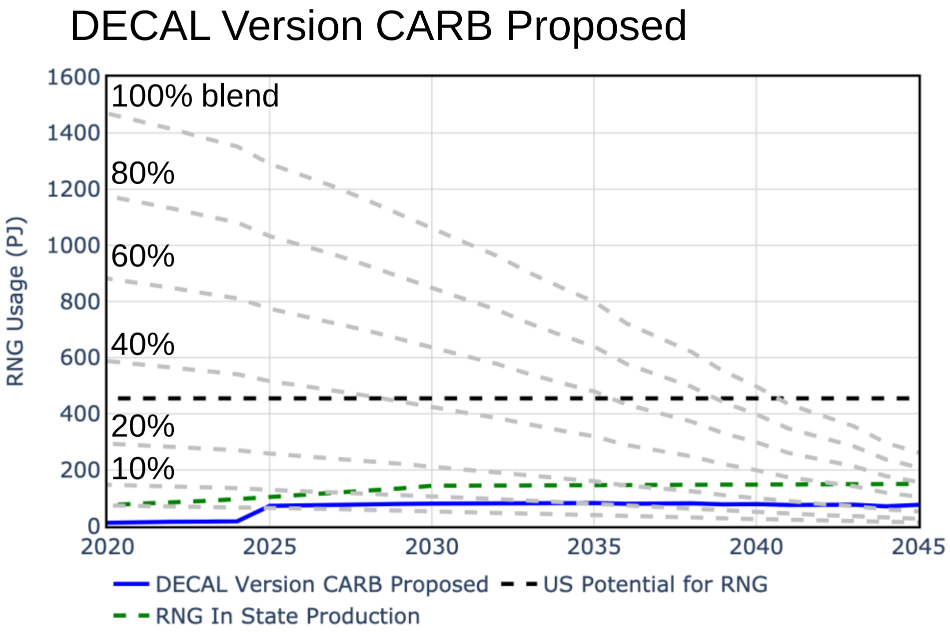
Renewable Natural Gas

RNG can only play a limited role

**US Potential for RNG -www.nrel.gov/docs/fy14osti/60178.pdf*
***RNG In State Production – Arifi et. al, 2022 (assumes food waste used for AD instead of compost)*





- Contour maps and resource proxies can help guide planning
- Note: CARB projects 12 | 59 PJ/yr of RD in the Reference | Proposed scenarios

Renewable Natural Gas

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**US Potential for RNG -www.nrel.gov/docs/fy14osti/60178.pdf*
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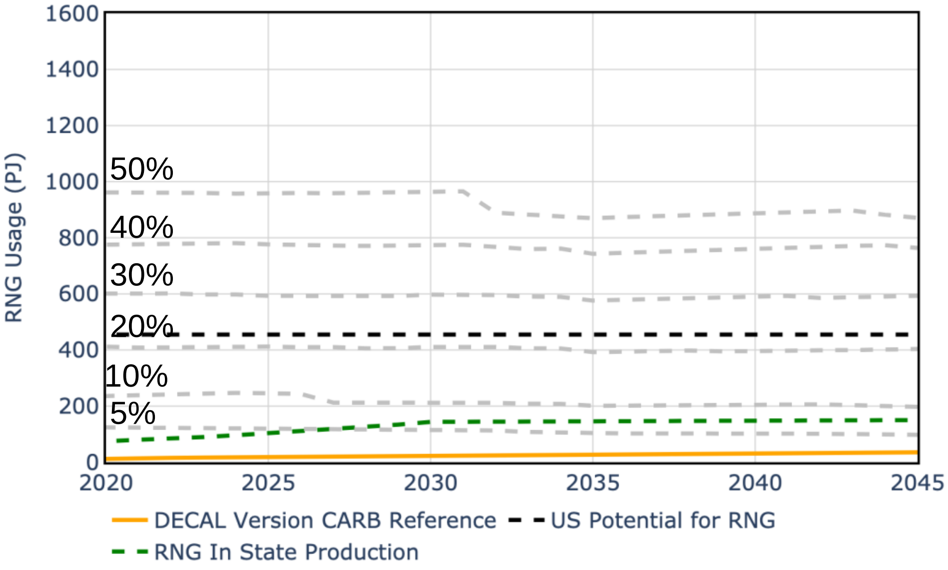
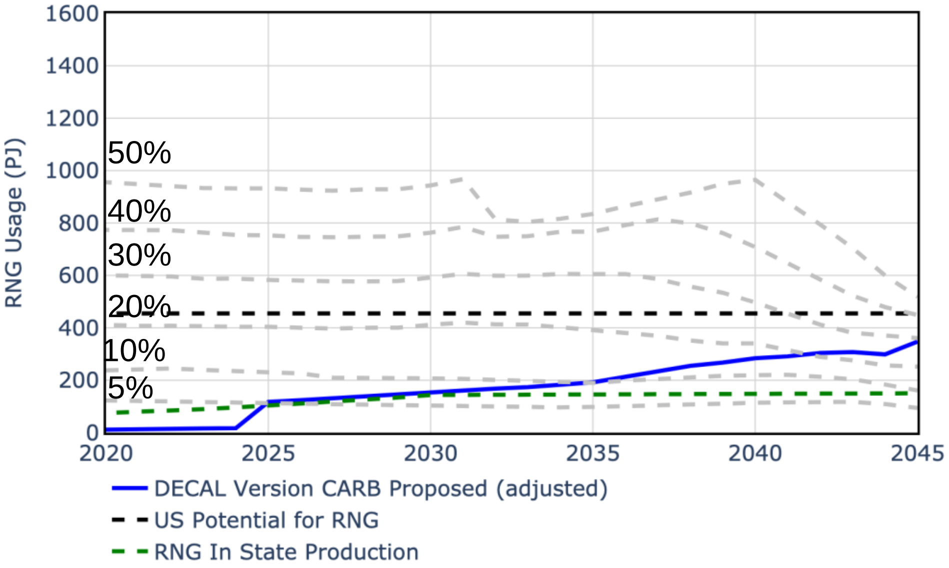
DECAL Version CARB Reference



DECAL Version CARB Proposed



- Using RNG in electric and hydrogen sectors changes planning