Time Scales of Change in a Climate-constrained Fuel Chain Case Study: Petroleum Technology in California

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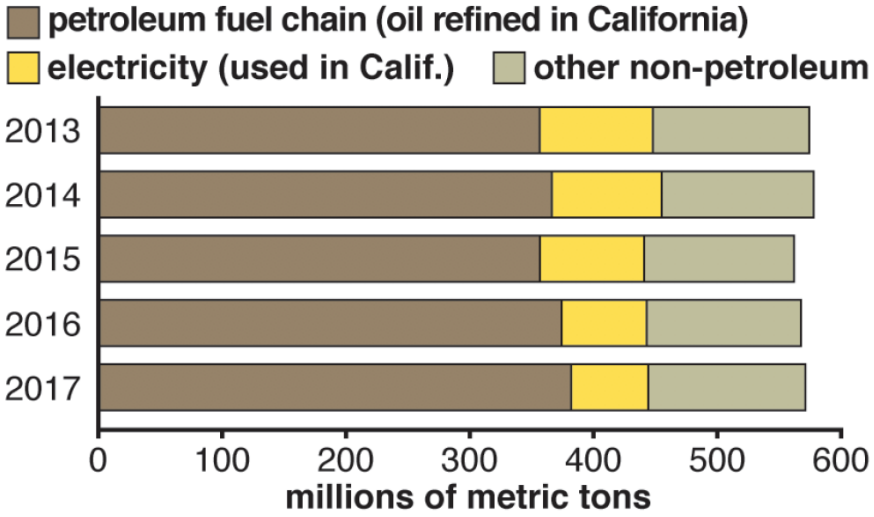
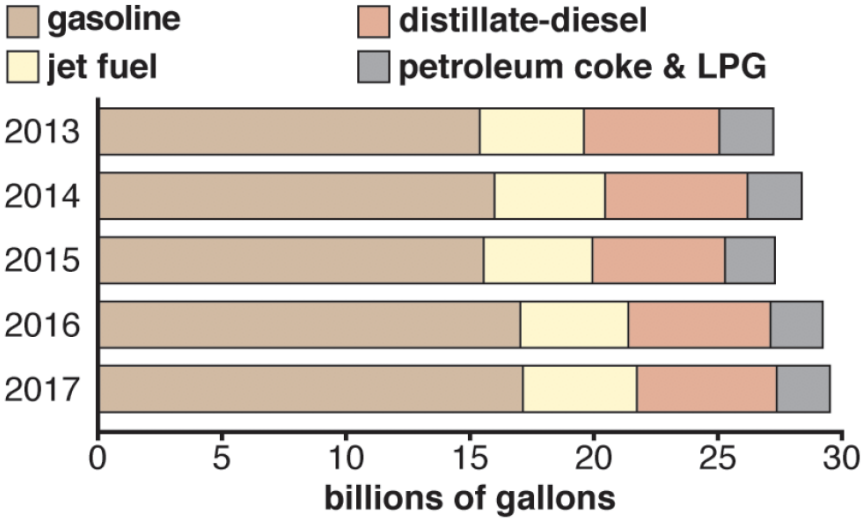
Imagine that every person whose job, family, or community is now dependent on oil is guaranteed job transition support, health care, college tuition, housing, and retirement security.



Greenhouse gas (CO_2e) emissions associated with all activities in California, 2013–2017.



California refinery fuels production, 2013–2017.

Recent trends in statewide CO_2e emissions.

Note: consistent system boundary includes import/export emissions from in-state electricity *and* oil sector activities.

Does the global consensus that oil use must be cut apply to California?

— Targets trajectory

Petroleum fuel chain

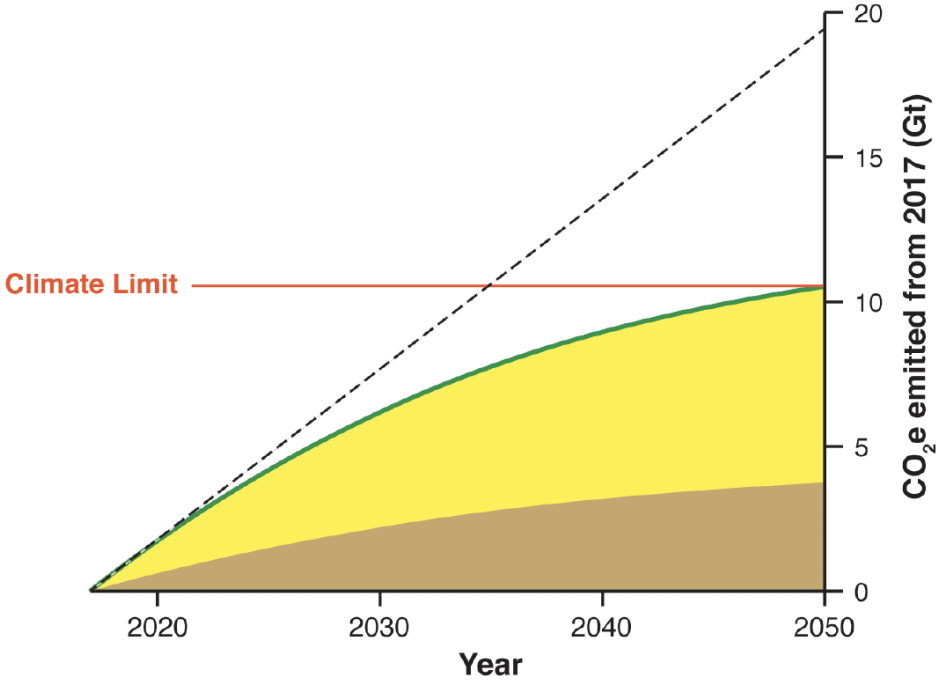
All other non-petroleum activities

--- No emission cuts

Gt: Gigaton; 1 billion metric tons.

CO_2e: carbon dioxide equivalents.

This climate limit (≈10.5 Gt) is consistent with the state's share of global direct emission cuts for a 67% chance of holding the increase in global temperature to between 1.5ºC and 2ºC above pre-industrial levels.



Cumulative emission limit defined by state climate targets through 2050.

- Petroleum fuel chain
- All other non-petroleum activities
- Climate limit defined by state climate targets

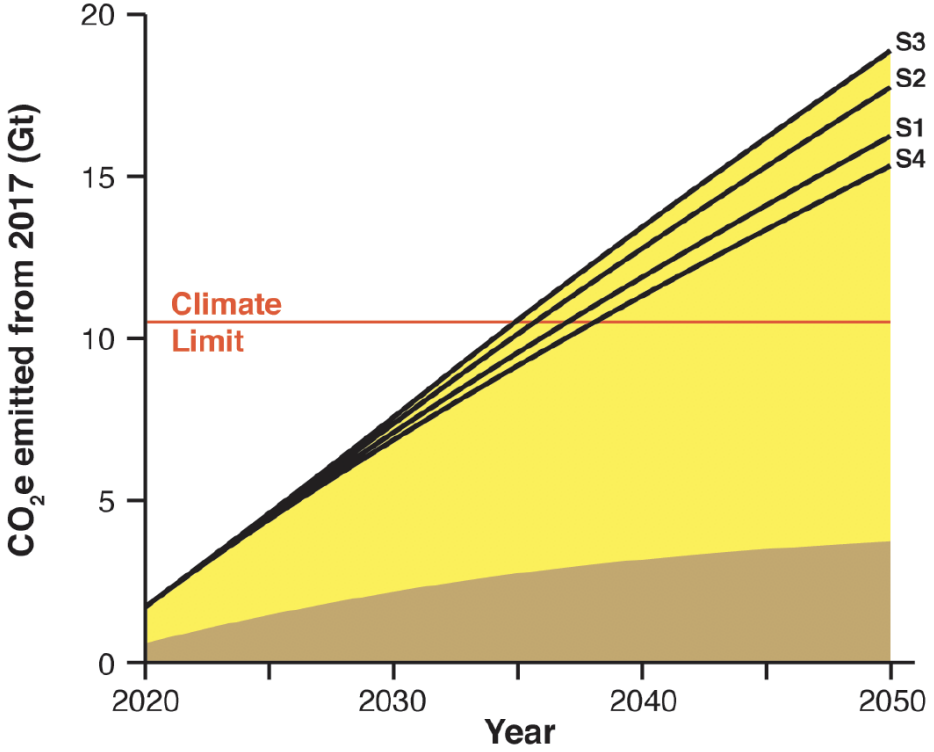
Carbon intensity (CI) scenarios:

S1. No change in current rate of emission/barrel oil.

S2. Switch to low-quality oil during 2020–2031.

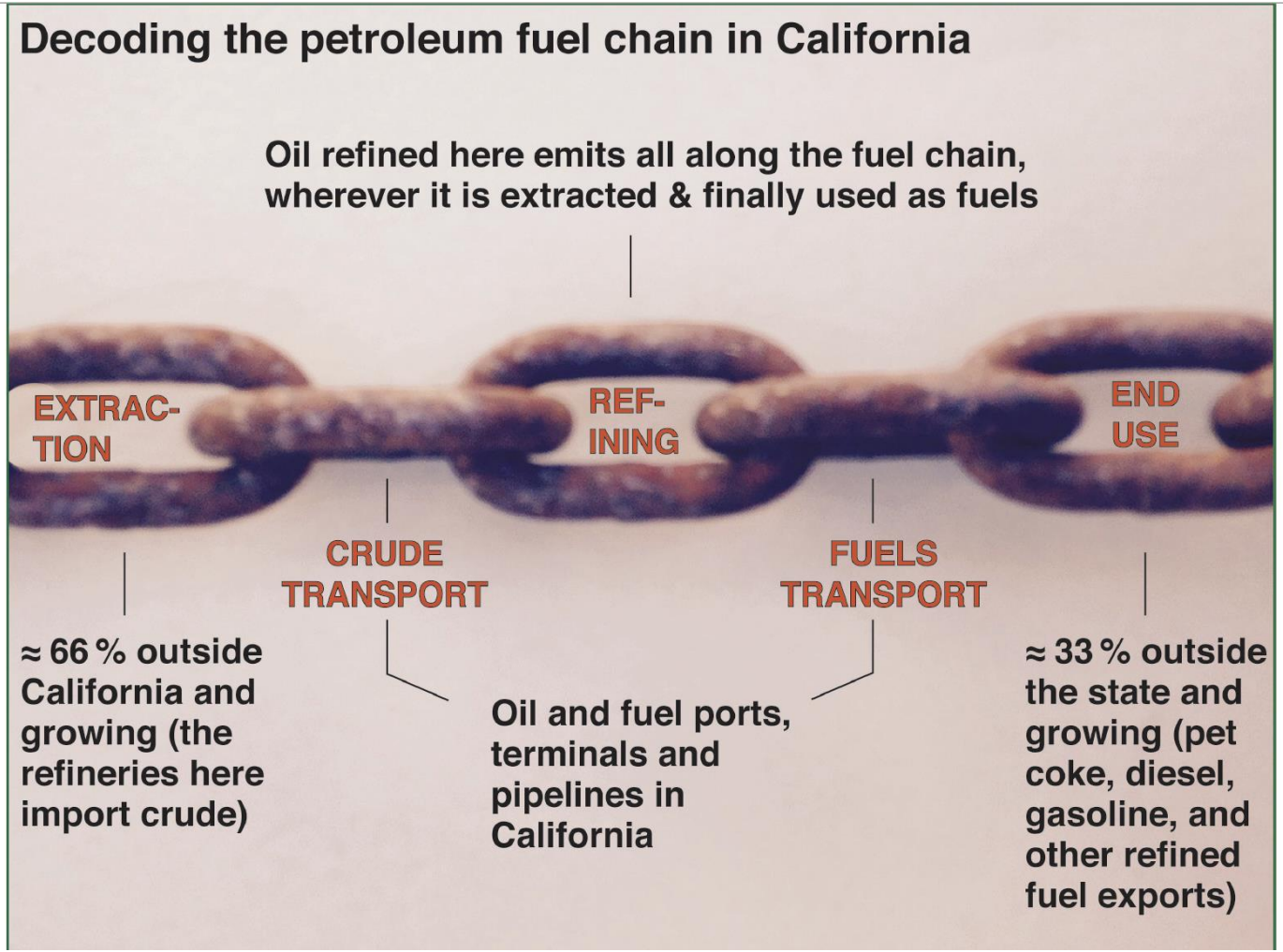
S3. Switch to very low-quality oil during 2020–2031.

S4. Switch to lighter U.S. average oil feed quality and install all CI-cutting upgrades that are proven in practice during 2020–2026.



Cumulative emission along petroleum fuel chain pathways that do not cut oil flow assuming non-petroleum emissions cut to their share of the state's climate limit.

Where in the chain can actions here cut oil flow across the petroleum fuel chain?

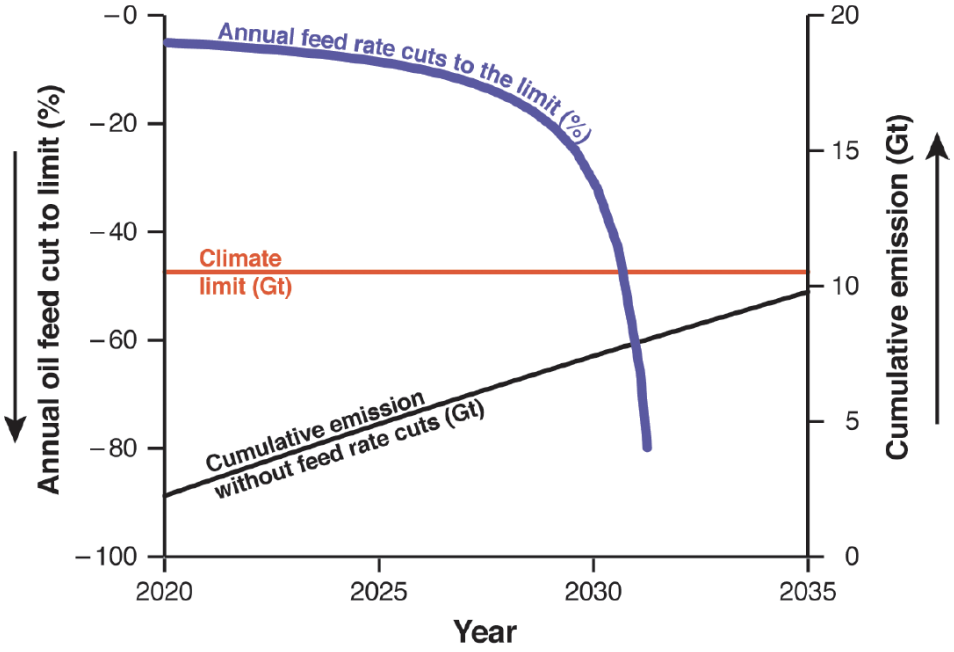

Decoding the petroleum fuel chain in California
Oil refined here emits all along the fuel chain, wherever it is extracted & finally used as fuels
EXTRAC-TION
REF-INING
END USE
CRUDE TRANSPORT
FUELS TRANSPORT
≈ 66 % outside California and growing (the refineries here import crude)
Oil and fuel ports, terminals and pipelines in California
≈ 33 % outside the state and growing (pet coke, diesel, gasoline, and other refined fuel exports)

What is the most feasible pathway to the state's climate limit?

- **Transition impacts**
- Climate-stranded assets
- California fuel supplies

Pathways shown start refining rate cuts in different years and assume non-petroleum emission cuts to their share of the state's 2050 climate limit.

As delaying refining rate cuts allows more emission buildup (rising on the right axis) and the time left to meet the climate limit shortens (bottom axis), the annual oil feed rate cuts needed to meet the limit deepen (falling on the left axis). These *annual* cuts to the limit (blue curve) deepen faster and faster with delay from 2020 to 2031.



Effect of delay on annual refinery feed rate cuts to the state's 2050 climate limit: Scenario S1, 20% capacity reserve.

Minimum sustained annual cuts to meet the limit by year the cuts begin, accounting for:

- At least 20% of current refining capacity staying in service through 2050 for potentially irreplaceable products (e.g., jet fuel).
- At least 10% of current refining capacity staying in service through 2050 for irreplaceable products.

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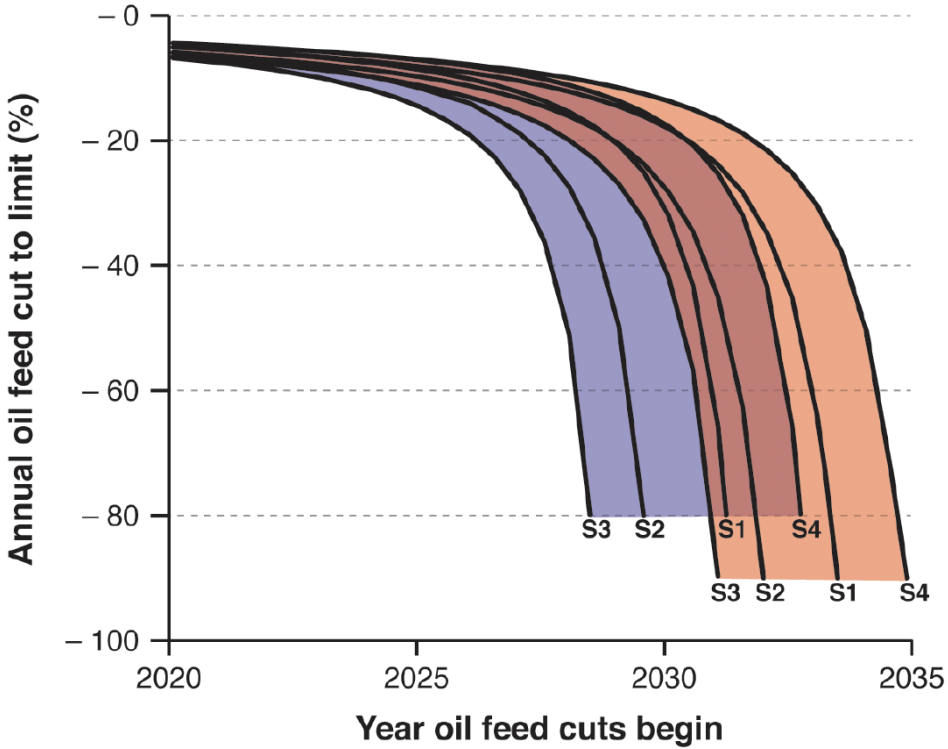

Effect of delay on annual refinery feed rate cuts to the state's 2050 climate limit: Scenarios S1–S4, 10–20% capacity reserve.

What is the most feasible pathway to the state's climate limit?

- Transition impacts
- Climate-stranded assets
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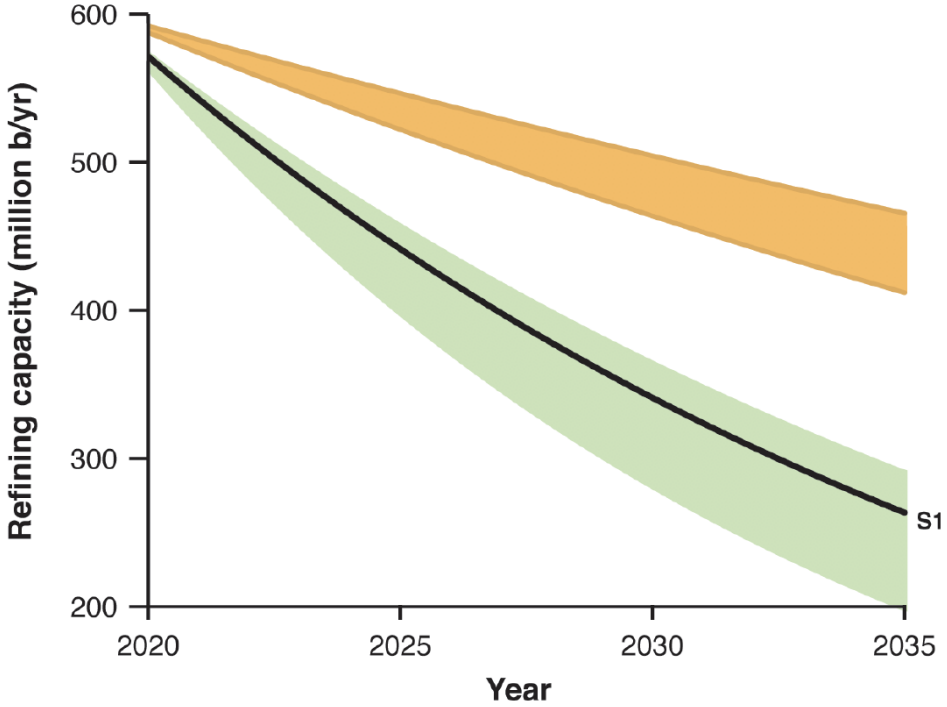
- Capacity in service assuming use of existing, already-built refining equipment for its operable duration. Orange shading shows the range of 1.59–2.34% annual capacity loss based on California refining equipment data. This estimate only applies if no new refinery projects are built.
- Capacity in service assuming the best-case pathways to the climate limit: starting in 2020 to decommission 4.4–6.7% of capacity each year. The **black line** shows Scenario S1, which assumes no new projects expand or prolong the operable duration of refineries.



Refining capacity left in service on best-case paths to the climate limit *versus* that if the refinery equipment already built is used for its operable duration.

Effect of delaying decommissioning on climate-stranded assets assuming no change in refinery operable duration.

Climate path start	Decommission (%/yr)		Operable loss (%/yr)	
	Case C1	Case C2	Case C1	Case C2
Jan 2020	5.0 %	5.0 %	2.7–3.4 %	2.7–3.4 %
Jan 2025	8.7 %	8.2 %	6.3–7.1 %	5.8–6.6 %
Jan 2031	64 %	24 %	61–62 %	21–22 %
Jan 2033	100 %*	64 %	100 %*	62 %
Jun 2033	100 %*	90 %	100 %*	88 %

Assumes the current 1.59–2.34 %/year wear-out rate with delay: this underestimates impacts of delay if refining capacity continues to expand.
Scenario S1 for both capacity reserve cases, C1 and C2, are shown.
* Values of 100% indicate paths foreclosed before the given start date.

What is the most feasible pathway to the state's climate limit?

- Transition impacts
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Pathways to 2050 climate limit starting in 2020, assuming at least 20% of current refining capacity stays in service through 2050.

Period when decommissioning export capacity (dashed line: gasoline & diesel export capacity) can achieve pathway to the 2050 climate limit. **Red lines:** period for Scenario S1.

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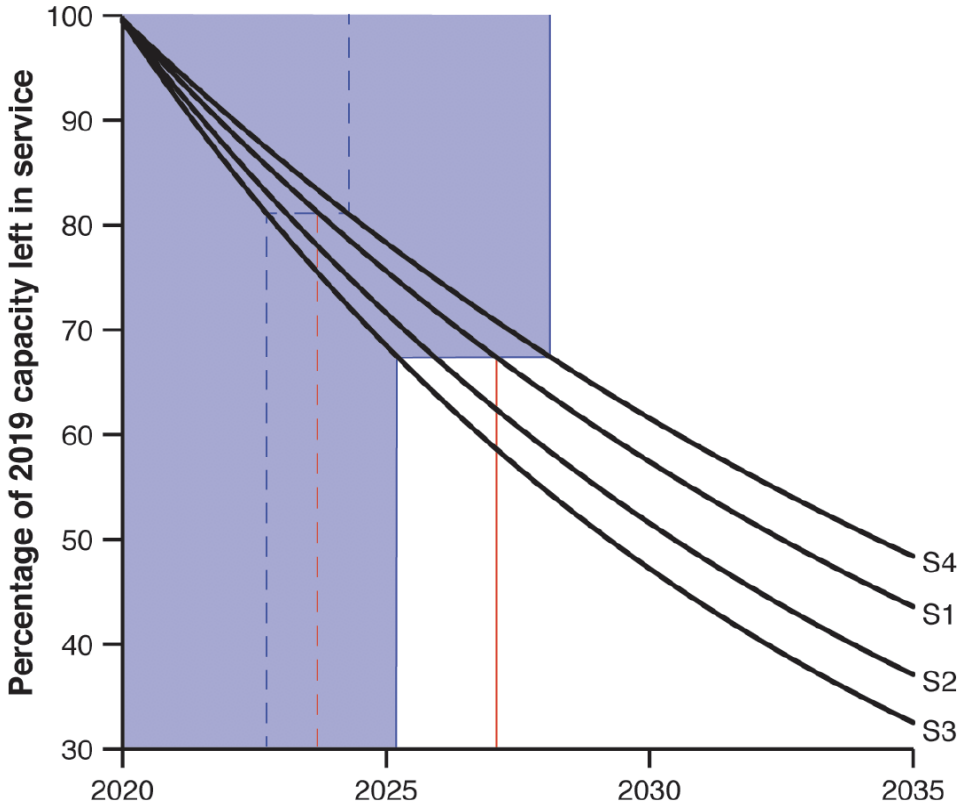

Effect of decommissioning export capacity first along early action pathways to the state's climate limit, 20% capacity reserve.

Some implications for immediate action

Challenge the environmental injustice of permitting harmful refinery emissions solely to export fuels that Californians do not use or need.

City, county, regional, **and** ***state*** **officials could take this action.**

Acknowledge that quickly starting a gradual decommission of refining capacity is an essential part of the most feasible paths to achieving state climate goals with proven technology.

The state's *Air Resources Board* could take this action.

Quantify local taxes and fees paid by oil companies and develop sustainable alternatives to replace these revenues locally as refineries decommission.

City **and** ***county*** **officials could take this action.**