

Strategies to Decarbonize Hawai'i: Webinar on HSEO's Act 238 Study

September 12, 2023

9:00-10:30am HST



**HAWAI'I
STATE
ENERGY
OFFICE**

Virtual Housekeeping

- Please keep yourself muted when not talking.
- 3 ways to comment:
 - Use the "raise hand" feature in WebEx (look for icon in lower right-hand corner of Webex window) and wait to be called on. Unmute yourself when you're ready.
 - Over the telephone: ensure phone is unmuted and then dial *3 to "raise hand" and *6 to mute/unmute your phone line
 - Type your question in the "Chat" window. Please give us time to get to your question.
- Q/A will be at the end of the presentation
- Please keep the "Aloha Spirit" in mind in accordance with [HRS §5-7.5](#) when commenting or addressing others.

Team Introductions

- Monique Schafer, HSEO, Decarbonization Program Manager
- Mark Glick, HSEO, Chief Energy Officer
- Margo Bonner, E3, Managing Consultant
- Ari Gold-Parker, Ph.D., E3, Associate Director
- Jen Cardona, Ph.D., E3, Senior Consultant
- Hannah Platter, E3, Associate Consultant

Agenda

9:00-9:15 Opening Remarks / Introduction
 HSEO

9:15-10:00 Decarbonization Analysis Approach
 E3 Team

10:00-10:30 Q&A

Webinar Objectives

- Introduction to HSEO's Act 238 Decarbonization Study
- Describe the decarbonization analysis approach and study outcomes
- Gather feedback on the analysis approach, including reference and mitigation scenarios (during Q&A and after the webinar)
- Give stakeholders an opportunity to ask any questions of analysis team regarding study approach and outcome (during Q&A and after webinar)

Opening Remarks

Mark Glick – Chief Energy Officer

Outreach Next Steps

- Identify and convene focus groups to review Pathways results
- Public comment and questions via HSEO website through October 31
 - <https://energy.hawaii.gov/what-we-do/clean-energy-vision/decarbonization-strategy/>
- Comments will be published and incorporated in the report.



Hawai'i Decarbonization Study

Study Introduction and Analysis Approach

9/12/2023



Energy+Environmental Economics





- + Study Background and Intro**
 - Decarbonization / Emission Accounting Overview
- + Study Timeline and Tasks**
- + PATHWAYS Modeling Approach**
- + Reference Scenario**
- + Mitigation Scenarios**
- + Discussion Questions**



Hawai'i's GHG Targets

+ Hawai'i Revised Statutes §225P-5, Zero Emissions Clean Economy Target (2018, 2022)

Considering both atmospheric carbon and greenhouse gas emissions as well as offsets from the local sequestration of atmospheric carbon and greenhouse gases through long-term sinks and reservoirs, a statewide target is hereby established to ***sequester more atmospheric carbon and greenhouse gases than emitted within the State as quickly as practicable, but no later than 2045.***

+ Act 238 Session Laws of Hawai'i (2022) – H.B. 1800

- The statewide target includes a ***greenhouse gas emissions limit, to be achieved no later than 2030, of at least fifty per cent below the level of the statewide greenhouse gas emissions in 2005.***
 - ***The Hawaii state energy office shall analyze pathways and develop recommendations for achieving the State's economy-wide decarbonization goals,*** including the statewide greenhouse gas emissions limit and goal to sequester more atmospheric carbon and greenhouse gases than emitted by no later than 2045.
- + This study will address the requirements set forth in Act 238 by developing and evaluating scenarios for Hawai'i to achieve the state's decarbonization goals, using a PATHWAYS model that captures energy use, equipment lifetimes, emissions, and policy measures in all sectors of Hawai'i's economy.



Tracking Progress Towards Decarbonization

+ How is progress measured?

- The State Department of Health (DOH) is responsible for publishing an annual emissions inventory (**HRS §342B-71**).
- The emissions inventory is consistent with IPCC reporting protocols and other state and federal GHG emissions inventory guidelines.^{1,2,3}
 - The inventory is inclusive of direct emissions only, occurring within state boundaries.
 - It is not inclusive of imported lifecycle emissions (e.g. does not include upstream emissions from products produced outside of the state)
 - International bunker fuels and emissions from international aviation are not counted in the inventory. Aviation emissions include emissions from domestic flights departing from Hawai'i

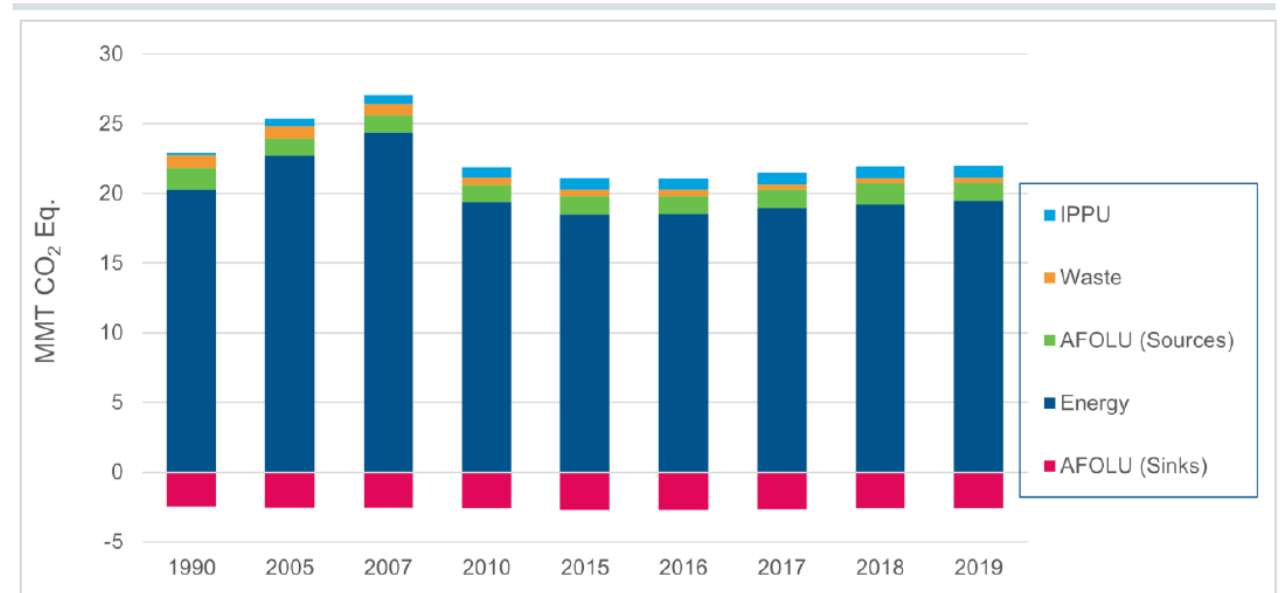
+ The modeling uses the most recent inventory to align emissions in the base year (2019).

¹2006 IPCC Guidelines for National Greenhouse Gas Inventories

²2019 Refinements to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

³U.S. Environmental Protection Agency's (EPA) Greenhouse Gas Reporting Program (GHGRP)

Figure 2-7: Net Hawai'i GHG Emissions by Sector (1990, 2005, 2007, 2010, and 2015 – 2019) (Including Sinks and Aviation)



Source: Hawai'i Greenhouse Gas Emissions Report for 2005, 2018, and 2019. April 2023.
https://health.hawaii.gov/cab/files/2023/05/2005-2018-2019-Inventory_Final-Report_rev2.pdf

*IPPU = Industrial Processes and Product Uses

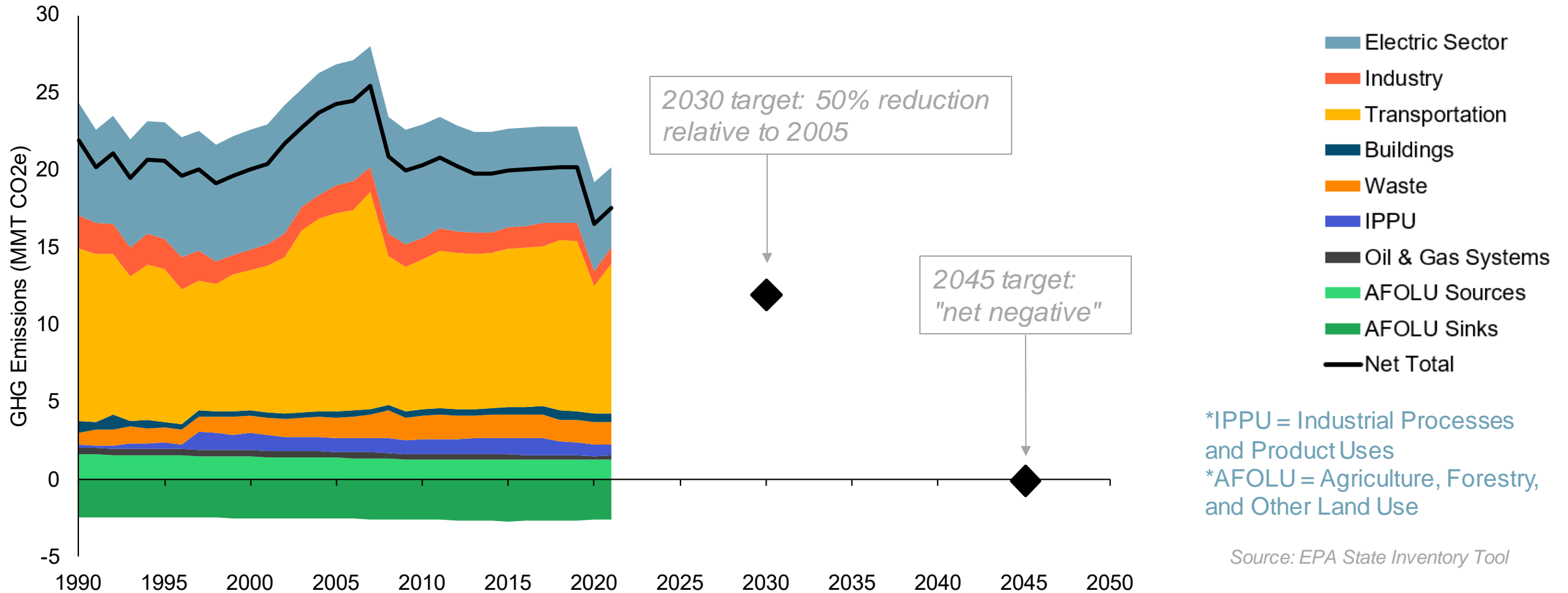
*AFOLU = Agriculture, Forestry, and Other Land Use



Achieving Net Zero

+ Achieving Hawaii's interim and 2045 GHG targets will require deep emissions reductions in all sectors of the economy

- The steep decline in emissions required by 2030 indicates that immediate action is necessary



About Energy & Environmental Economics, Inc. (E3)



Technical and Strategic Consulting for **the Clean Energy Transition**

100+ consultants across **4** offices with expertise in economics, mathematics, policy, modeling



San Francisco



New York

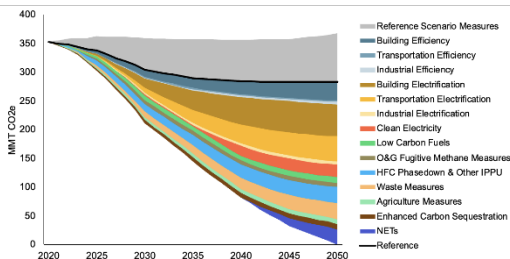


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250+ projects per year focused on energy & environment



Recent Projects

- **Hawai'i Pathways to Net Zero** – E3 developed a Hawai'i PATHWAYS model for Hawaiian Electric to evaluate illustrative scenarios for achieving net zero greenhouse gas emissions in the state, including evaluating impacts on electricity demands for Hawaiian Electric
- **California 2022 Scoping Plan for Achieving Carbon Neutrality** – E3 used its PATHWAYS model to support the California Air Resources Board in developing and evaluating scenarios to achieve carbon neutrality in the state by 2045
- **New York Climate Action Council Scoping Plan** - To meet one of the most ambitious climate goals in the world, E3 developed PATHWAYS scenarios to explore roles for transformations such as building electrification and hydrogen in New York state



Study Timeline

Current Status

Activity	Jul	Aug	Sep	Oct	Nov	Dec
Internal and External Stakeholder Coordination						
Development of Electric Sector Loads (by island)					E3 will present draft results to this group in November. HSEO conducting focus group outreach.	
NREL Electric Sector Modeling						
GHG Emissions and Total Costs by Sector and Scenario						
Other key outcomes including bill impacts, workforce transition recommendations, impacts to low-income and environmental justice communities, and criteria pollutants						
Reporting						

- Data collection and calibration
- Draft and final analysis
- Meeting
- Draft and final report

Act 238 mandates final report delivery no later than 20 days before the start of the 2024 legislative session December 27, 2023



Framework for Scenario Design and Evaluation

Key values driving the trade-offs between different decarbonization scenarios:

1. Minimize land impacts of energy infrastructure

- Maintain and preserve natural lands in undeveloped state
- Preserve arable land for climate smart and regenerative agriculture

2. Reliance on in-state energy (energy independence)

- Limit overseas fuel imports

3. Improve air quality

- Reduce criteria pollutant emissions that impact local air quality
- Reduce combustion-based electricity generation (including biofuels)

4. Limit Reliance on Negative Emissions Technology

- Allows for natural carbon sequestration while limiting reliance on negative emissions technology
- Aims for greatest possible direct emissions reductions

5. Minimize total costs of energy transition

- Focus on most cost-effective emissions reduction measures

6. Ease of implementation

- What large-scale changes are needed for each scenario to be plausible?



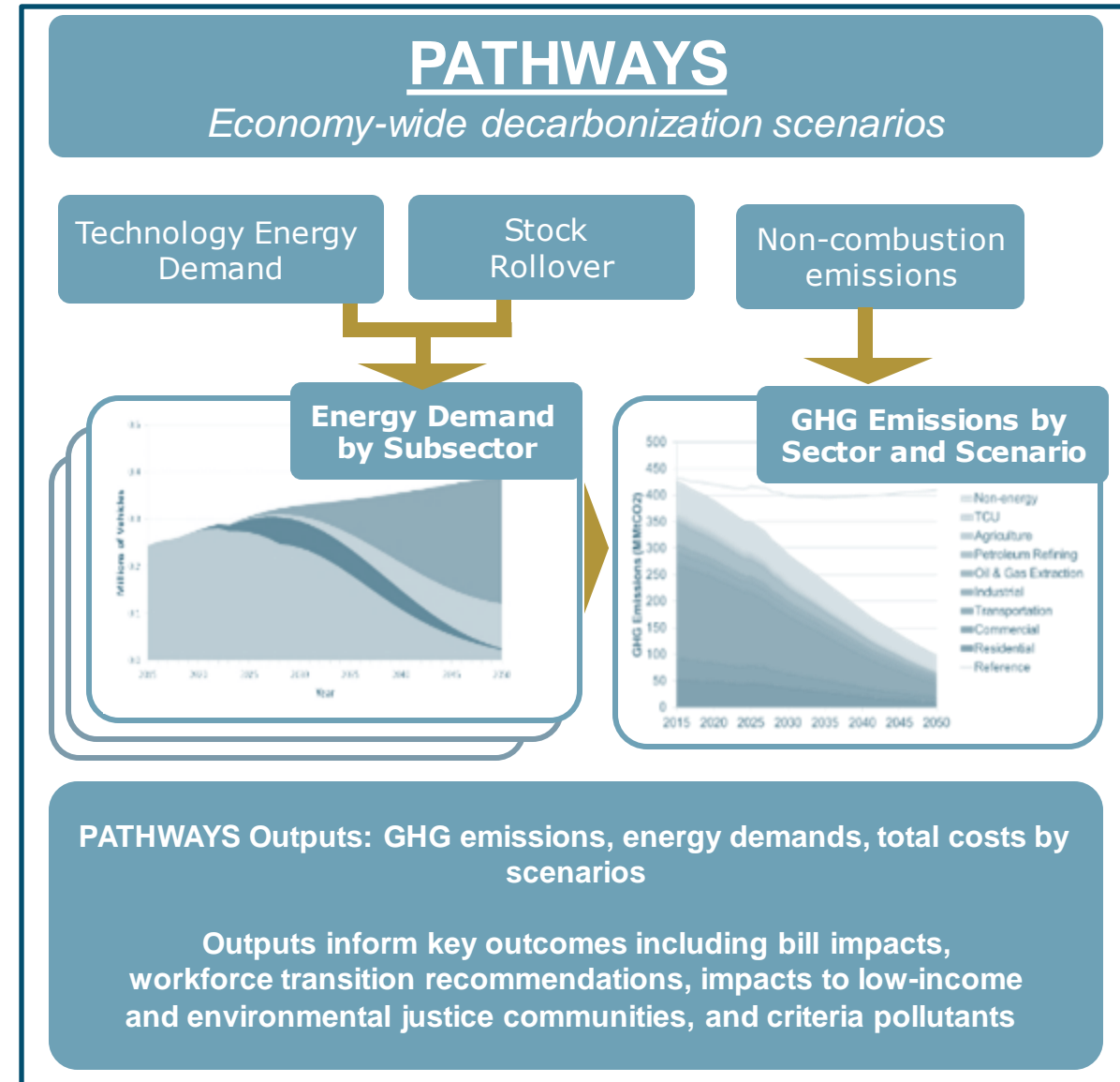
PATHWAYS Modeling Approach

+ PATHWAYS supports economy-wide infrastructure-based GHG and energy analysis

- Captures “infrastructure inertia” reflecting lifetimes and vintages of buildings, vehicles, equipment
- Models physical energy flows within all sectors of the economy
- Allows for comparison between user-defined scenarios

+ Scenarios test “what if” questions

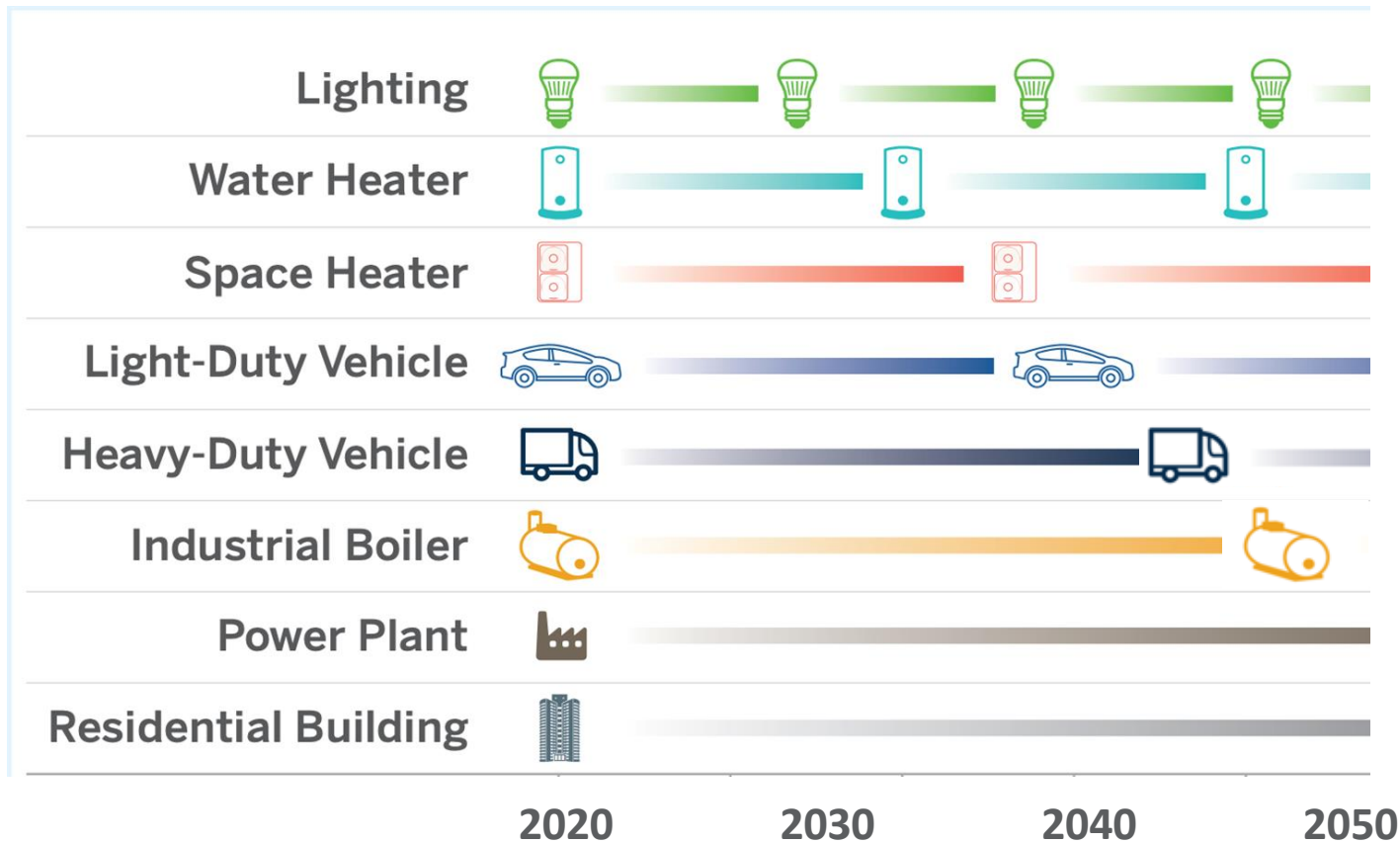
- Reference or counterfactual scenario is developed for consistent comparison in future years
- Multiple mitigation scenarios can be compared that each meet the same GHG emissions goal





PATHWAYS model captures the timing of the transition to net zero GHGs with equipment lifetimes

- + Long lifetimes of equipment affect realistic timing of emissions reductions
 - 2045 / 2050 GHG goals are more feasible if implementation begins soon

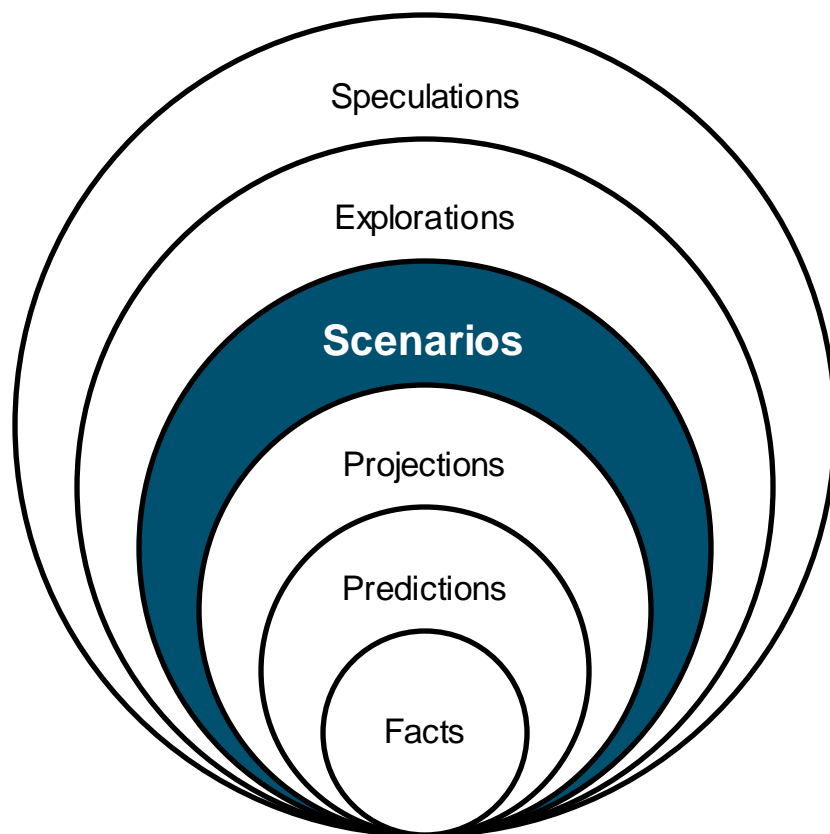


Note: This figure was originally published by E3 (Williams et al 2014); this version was modified with graphic design improvements by the Building Decarbonization Coalition. Replacement cycles are illustrative and do not precisely reflect values used in modeling.



PATHWAYS is a user-defined scenario tool

PATHWAYS scenarios evaluate uncertain and complex futures



+ PATHWAYS does not make *forecasts*.

- PATHWAYS GHG mitigation scenarios are *back-casts*
- Allows hypothesis testing predicated on meeting emissions targets
- Reference scenario aligned with existing data and forecasts (e.g. Hawai'i GHG inventory) and expert judgment of current trends
- Mitigation scenarios developed to answer key questions surrounding decarbonization in Hawai'i



1. Reference Scenario Overview

Slide Updates Highlighted

+ The Reference Scenario represents a business-as-usual (BAU) future of energy and emissions

- Includes existing state and federal policies that impact emissions in Hawai'i
- Does not include aspirational targets without clear mechanisms for achievement in place (e.g. the 2030 and 2045 statewide emissions targets will not be achieved in the reference case)

Sector	Key Reference Assumptions
Key Economic Drivers	<ul style="list-style-type: none"> • Population growth forecast from the Hawai'i Department of Business, Economic Development & Tourism • Commercial square footage growth forecast from the U.S. Energy Information Administration Annual Energy Outlook 2023 • Reference aviation travel demand forecast from the DBEDT long range-forecast
Electric sector	<ul style="list-style-type: none"> • Renewable portfolio standard targets (40% RPS-eligible generation by 2030, 100% RPS-eligible generation by 2045)
Transportation	<ul style="list-style-type: none"> • Reference zero-emissions vehicle sales projections for light, medium, and heavy duty vehicles using the "Moderate with CA-only ACC II" scenario from 2023 International Council on Clean Transportation report • Reductions in light-duty vehicle miles traveled on O'ahu based on O'ahu regional transportation plan (BAU elsewhere) • Fuel efficiency improvements in aviation: 50% of the reference efficiency forecast from the Annual Energy Outlook (less efficiency than forecasted for the mainland given the relatively newer fleet of airplanes in Hawai'i)
Buildings	<ul style="list-style-type: none"> • Solar water heating for all new residential buildings • Energy efficiency in line with the BAU reference case from the 2020 State of Hawai'i Market Potential study by Applied Energy Group
Refinery	<ul style="list-style-type: none"> • Planned conversion to biorefining for a small unit slated for operation in 2025 (~5% of production)
Natural and Working Lands	<ul style="list-style-type: none"> • Reference projection from 2017 US Geological survey report that examined future changes in climate, land use, land cover and disturbance in Hawai'i



2 – 4. Mitigation Scenarios Overview

Scenarios 2-3 focused 2045 emissions target

2: High Electrification

A scenario that models widespread electrification of the transportation and buildings sectors, dramatically reducing fuel combustion.

3: High Electrification + Additional Demand Reductions

A high electrification scenario coupled with substantial demand reductions. A key goal is to explore policy options that focus on behavioral changes and have potential to limit land use impacts.

Scenario 4 focused on 2030 target

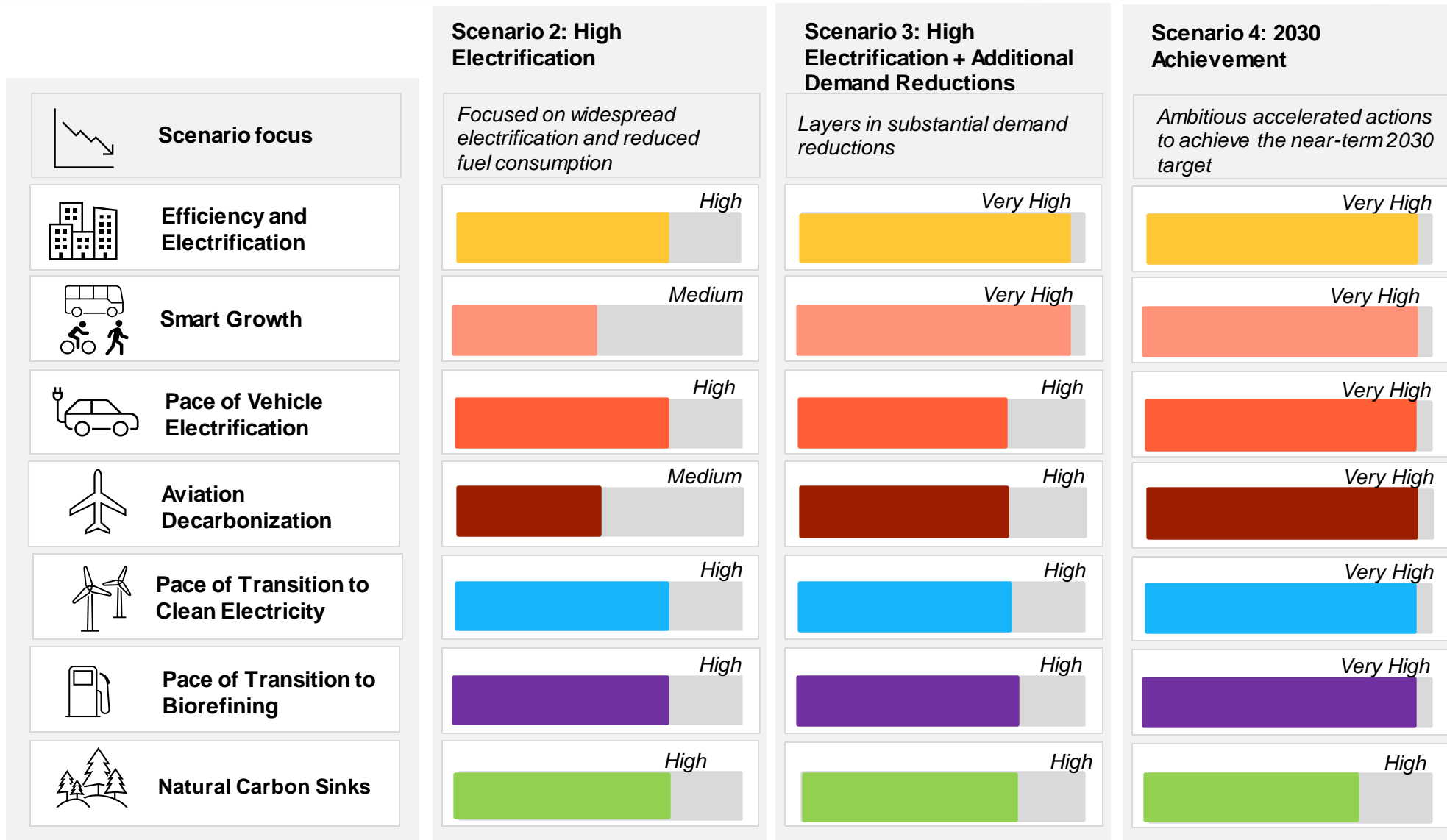
4: 50% by 2030 Achievement

This scenario would include transformative demand reductions and examine the feasibility of policy options that achieve the 50% emissions reduction by 2030 target.

All scenarios achieve net-negative economy-wide emissions by 2045



Level of Transformation by Mitigation Scenario





Focus Questions: Scenario Evaluation Criteria

- + **Do the proposed scenario evaluation criteria reflect the right set of metrics for Hawai'i to evaluate different policy and technology options to reduce greenhouse gas emissions?**
- + **Are there other scenario evaluation criteria that the HSEO should consider evaluating?**
 1. **Minimize land impacts of energy infrastructure**
 - Maintain and preserve natural lands in undeveloped state
 - Preserve arable land for climate smart and regenerative agriculture
 2. **Reliance on in-state energy (energy independence)**
 - Limit overseas fuel imports
 3. **Improve air quality**
 - Reduce criteria pollutant emissions that impact local air quality
 - Reduce combustion-based electricity generation (including biofuels)
 4. **Limit Reliance on Negative Emissions Technology**
 - Allows for natural carbon sequestration while limiting reliance on negative emissions technology
 - Aims for greatest possible direct emissions reductions
 5. **Minimize total costs of energy transition**
 - Focus on most cost-effective emissions reduction measures
 6. **Ease of implementation**
 - What large-scale changes are needed for each scenario to be plausible?



Focus Questions: Reference Scenario

- + Does the Reference scenario, as presented, adequately capture current policies and expected trends in Hawai'i?
- + Are there any additional policies or trends that you think would be useful to include?



Focus Questions: Mitigation Scenarios

- + Any additional greenhouse gas mitigation technologies that you think would be useful to include?
- + Do the proposed GHG mitigation scenarios capture a plausible range of greenhouse reduction strategies and outcomes?



Questions, Comments and Feedback

+ Any additional questions or feedback that you have?

Outreach Next Steps

- Slide deck will be posted on HSEO's Website.
- Public comment and questions via HSEO website through October 31
<https://energy.hawaii.gov/what-we-do/clean-energy-vision/decarbonization-strategy/>
- Comments will be published and incorporated in the report.
- Stay tuned for future meetings.



Mahalo



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Appendix: Detailed Scenario Assumptions and Data Sources



Scenario Assumptions by Sector (1 of 4)

	1. Reference	2. High Electrification	3. High Electrification + Demand Reductions	4. 2030 Achievement
Electric sector generation (2030)	RPS (40% zero-carbon) ¹	HECO voluntary targets ⁴ (70% GHG reduction from 2005 levels)		80-90% GHG reduction from 2005 levels (TBD based on scenario outputs)
Electric sector generation (2045)	RPS (100% zero-carbon) ²	Same as reference		
Transportation On-road	Reference light, medium, and heavy duty zero-emissions vehicle sales projections using the "Moderate with CA-only ACC II" scenario from 2023 International Council on Clean Transportation report ³ .	Light duty vehicles: 100% ZEV sales by 2035		Light duty vehicles: 100% zero-emissions vehicle sales by 2035, plus stock buy-backs with 100% electrification
		Medium and heavy duty vehicles: 100% ZEV sales by 2045		Medium and heavy duty vehicles: 100% zero-emissions vehicle sales by 2040
		100% decarbonized diesel and gasoline by 2045 (S-curves starting in 2030 for diesel and 2035 for gasoline)		
Transportation Other Off-road	Business-as-usual	100% decarbonized diesel and residual fuel oil by 2045 (S-curves starting in 2030)		

¹ https://www.capitol.hawaii.gov/hrscurrent/vol05_ch0261-0319/hrs0269/hrs_0269-0092.htm

² https://www.capitol.hawaii.gov/hrscurrent/vol05_ch0261-0319/hrs0269/hrs_0269-0092.htm

³ <https://theicct.org/wp-content/uploads/2023/01/ira-impact-evs-us-jan23-2.pdf>

⁴ <https://www.hawaiianelectric.com/about-us/our-vision-and-commitment/climate-change-action>



Scenario Assumptions by Sector (2 of 4)

	1. Reference	2. High Electrification	3. High Electrification + Demand Reductions	4. 2030 Achievement
VMT Reductions	BAU w/ 5% reduction on O'ahu by 2030 based on O'ahu regional transportation plan ¹	Same as reference	Additional mitigations from SSTI ³ Policy Scenario (~20% statewide reduction in total VMT by 2045)	
Residential Buildings	EE Market Potential Study: "BAU – Reference" ² Solar water heating for all new residential buildings	EE Market Potential Study: "BAU – High" 100% sales of electric devices for all end uses by 2035	EE Market Potential Study: "Economic Potential" 100% sales of electrified devices for all end uses by 2035	
Commercial Buildings	EE Market Potential Study: "BAU – Reference"	EE Market Potential Study: "BAU – High" 100% sales of electric devices for all end uses by 2040	EE Market Potential Study: "Economic Potential" 100% sales of electrified devices for all end uses by 2040	
				Aggressive commercial water heating electrification

¹ <https://oahumpo.org/ortp/>

² <https://puc.hawaii.gov/wp-content/uploads/2021/02/Hawaii-2020-Market-Potential-Study-Final-Report.pdf>

³ https://ssti.us/wp-content/uploads/sites/1303/2020/04/SSTI_Hawaii_VMT_forecasts.pdf



Scenario Assumptions by Sector (3 of 4)

	1. Reference	2. High Electrification	3. High Electrification + Demand Reductions	4. 2030 Achievement
Gas Pipeline/ Propane Blend	N/A	100% decarbonized gas by 2045		100% decarbonized gas by 2035
Refinery	BAU refinery operations. Includes planned conversion of one unit for biorefining by 2025 (~5% of operations) ¹	Transformation to 100% biofuel production by 2045 starting in 2025		
		Planned biorefining unit coming online in 2025, and larger unit capable of refining higher volumes coming online in 2030. Transition to 100% biorefining by 2045.	Planned biorefining unit + additional larger unit capable of refining higher volumes both coming online in 2025. Transition to 100% biorefining by 2035.	
Aviation	Fuel efficiency improvements (using 50% of forecasted reduction from AEO reference versus 100% that AEO forecasted) ² Visitor arrival forecast from DBEDT long-range forecast ⁴	Fuel efficiency improvements (50% of forecast from AEO reference)	Fuel efficiency improvements (100% of forecast from AEO reference)	
		10% SAF blend by 2030 (HA target ³) and 40% SAF blend by 2045		15% SAF blend by 2030 (greater than HA target) and 40% SAF blend by 2045
			Increase average length of stay to reduce flight miles while maintaining tourist activity	
		Increase in electric inter-island aviation, for applicable flights only, by 2045 (start ramping up in 2040)		
			Interisland ferry to replace portion of interisland flights	

¹ <https://www.parpacific.com/press-releases/par-pacific-announces-significant-investment-hawaii-renewable-fuels-production>

² EIA Annual Energy Outlook 2023 Table 47 https://www.eia.gov/outlooks/aeo/tables_ref.php

³ <https://newsroom.hawaiianairlines.com/releases/hawaiian-airlines-commits-to-new-milestones-on-path-to-net-zero-carbon-emissions>

⁴ <https://dbedt.hawaii.gov/economic/economic-forecast/2045-long-range-forecast/>



Scenario Assumptions by Sector (4 of 4)

	1. Reference	2. High Electrification	3. High Electrification + Demand Reductions	4. 2030 Achievement
Hydrogen	N/A	Explore upper bound on potential of H2 to reduce load impact via HDV fleet conversion and commercial buildings	Same as reference	Same as reference
Waste (non-combustion)	EPA Non-CO ₂ Emissions Report: Baseline ¹	EPA Non-CO ₂ Emissions Report: Max abatement available below \$100/tCO ₂ e ¹		
Natural and Working Lands	Future Carbon Storage and Carbon Fluxes in Ecosystems of Hawai'i Report: Baseline ^{2,3}	Mitigation scenarios from Reversing Climate Change: A study of pathways through Hawai'i's natural & working lands Report 5		
Refrigerants	Refrigerant management in line with Kigali Amendment ⁴	Refrigerant management incremental to Kigali Amendment		

¹ <https://www.epa.gov/global-mitigation-non-co2-greenhouse-gases/us-state-level-non-co2-ghg-mitigation-report>

² <https://pubs.usgs.gov/pp/1834/a/pp1834.pdf>

³ https://health.hawaii.gov/cab/files/2023/05/2005-2018-2019-Inventory_Final-Report_rev2.pdf

⁴ <https://ww2.arb.ca.gov/sites/default/files/2018-12/CARB-Potential-Impact-of-the-Kigali-Amendment-on-HFC-Emissions-Final-Dec-15-2017.pdf>

⁵ https://planning.hawaii.gov/wp-content/uploads/Conservation-International-FINAL-Report_GHG-4.30.2020.pdf