

Welcome! The Webinar will begin shortly



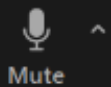
Sustainability and Climate Action Plan Ad Hoc Committee

April 14, 2022

cityofpaloalto.org/ClimateAction

Acting Now for a Resilient Future

Click on Q&A anytime during the presentation to ask questions



Mute



Chat



Raise Hand



Q&A

Leave

- **Recap of February 2021 S/CAP Ad Hoc Meeting**
- **Carbon Neutrality**
 - Introduction to Carbon Neutrality
 - What is California doing?
 - How can natural and working lands help with Carbon Neutrality?
 - Break
 - How can alternative fuels and other technologies help with Carbon Neutrality?
 - What can Palo Alto do?
 - Carbon Neutrality Goals around California
- **Discussion**



- 88 Participants, plus 5 watching on YouTube Live Stream



- 18 Questions, covering the following themes:
 - Community costs for building electrification



- Tariffed on-bill financing



- Alternatives for funding



- Incentives and rebates



- Technical considerations for building electrification

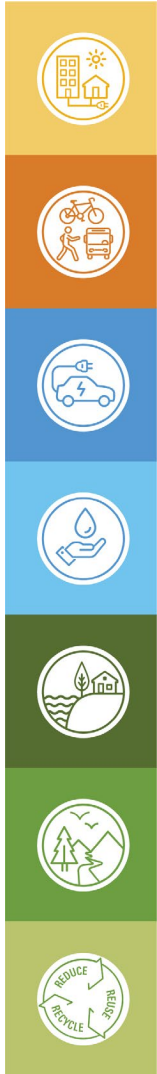


- 2 Comments, covering the following themes:

- Incentives and rebates

- Pricing

Introduction to Carbon Neutrality



California's Goal:

80% ^{BELOW}
1990 LEVEL
BY 2050

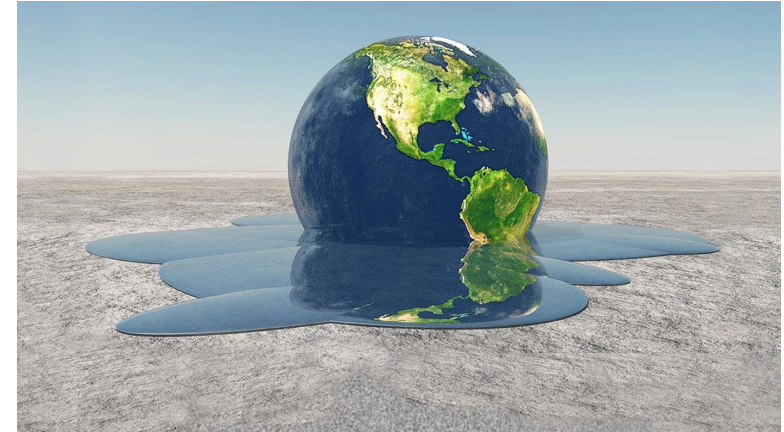
Palo Alto's Goal:

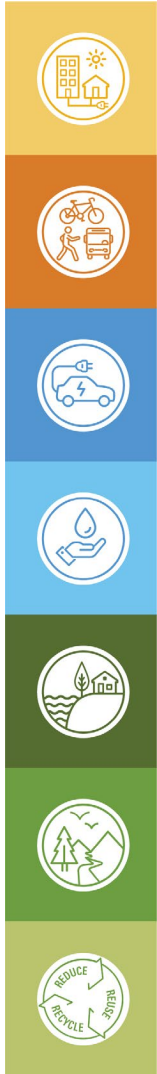
80% ^{BELOW}
1990 LEVEL
BY 2030



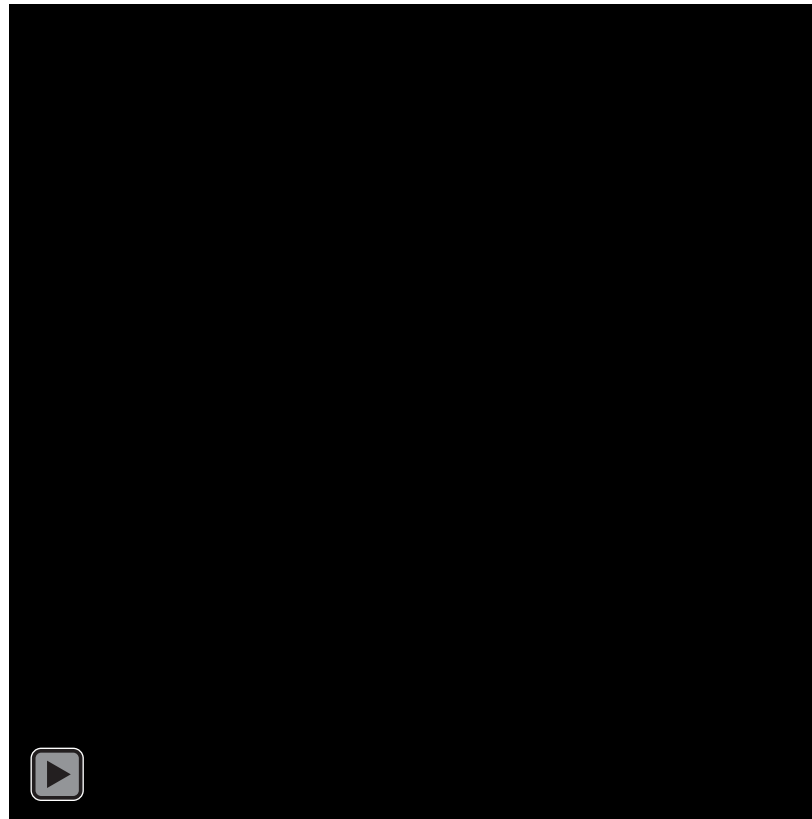
The Importance of 1.5°C (2.7°F)

- Holding to 1.5°C (2.7°F) avoids impacts of 2°C (3.6°F) and higher
- At 2°C (3.6°F) of global warming:
- Major global climate impacts:
 - A “large fraction” of species would face extinction due to an inability to move northward fast enough to stay in the climate to which they are adapted
 - Widespread and diverse impacts globally with major economic impacts
- Major California climate impacts:
 - 5°F to 6°F increase in annual average maximum temperature
 - Increased drought, decreased snowpack (by 2/3), serious impacts to agricultural areas
 - Increase in wildfire frequency and average area burned (as much as 77%)
 - Disproportionate impact to disadvantaged communities





- To limit warming to 1.5 degrees C, we have a “budget” of carbon we could allow to enter the atmosphere. We have almost used that budget:



Animation credits:

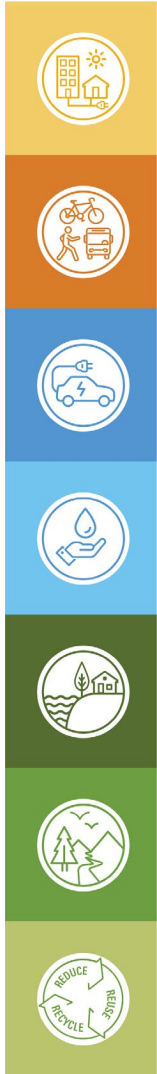


futurearth
Research. Innovation. Sustainability.

GLOBAL CARBON project

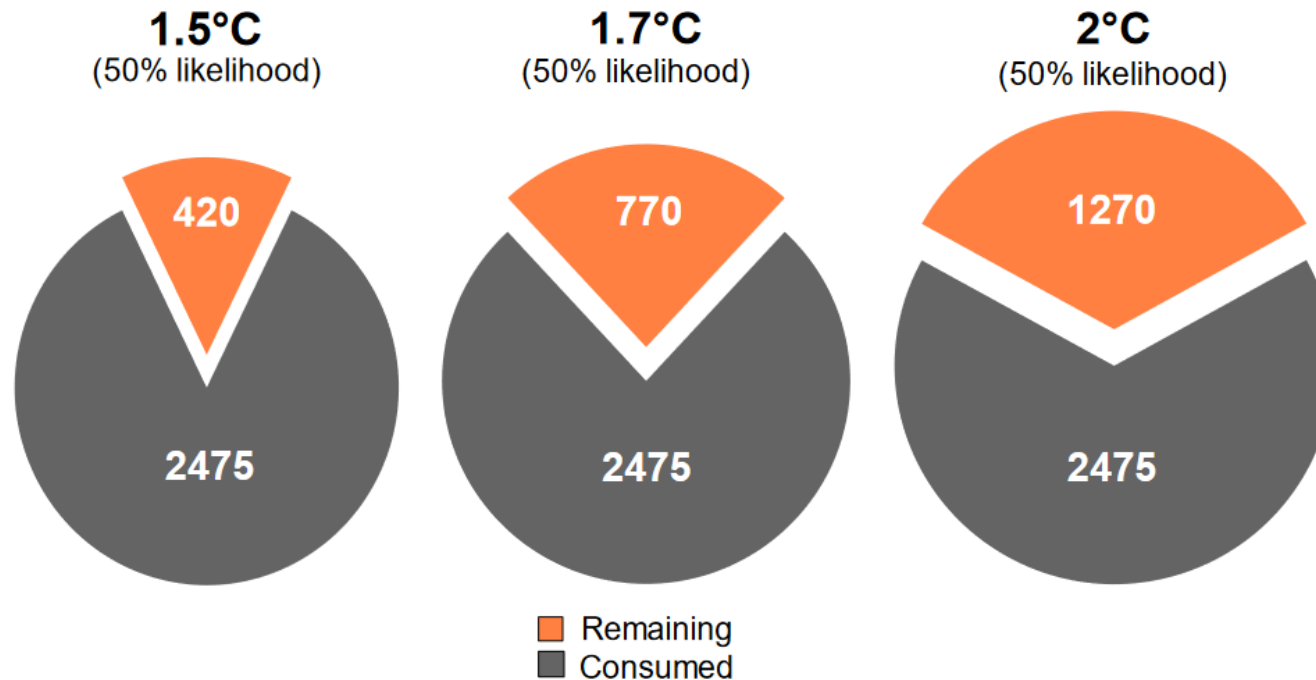
Stanford University

Conceived by **Rob Jackson**, Stanford University,
with input from **Alistair Scrutton**, Future Earth.
Animation by **Jerker Lokrantz/Azote**.



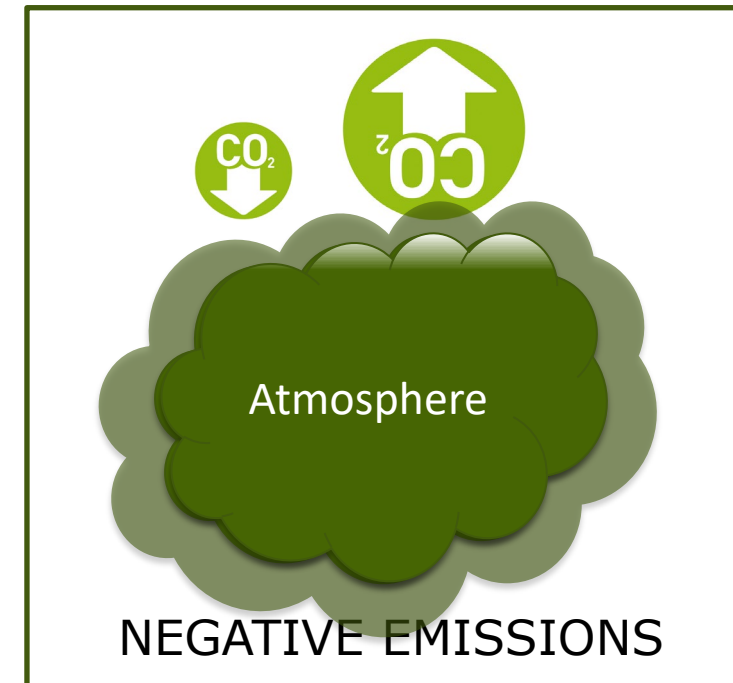
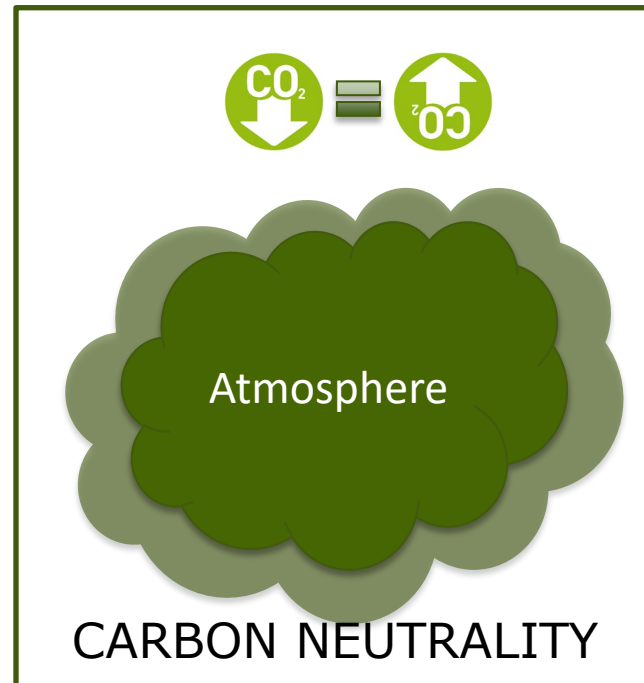
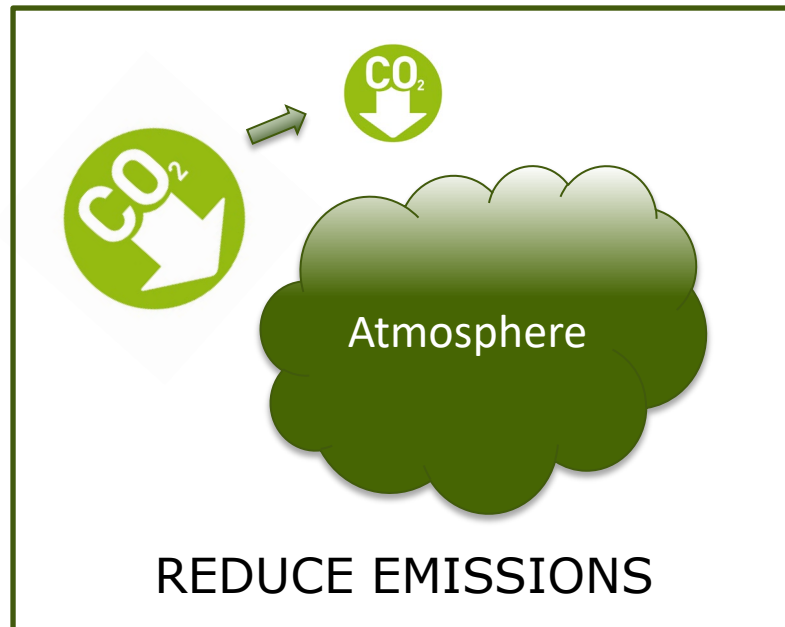
Another view of “carbon budgets:”

The remaining carbon budget to limit global warming to 1.5°C , 1.7°C and 2°C is 420 GtCO₂, 770 GtCO₂, and 1270 GtCO₂ respectively, equivalent to 11, 20 and 32 years from 2022. 2475 GtCO₂ have been emitted since 1750



Quantities are subject to [additional] uncertainties e.g., future mitigation choices of non-CO₂ emissions
Source: IPCC AR6 WG1; [Friedlingstein et al 2021](#); [Global Carbon Budget 2021](#)

- In 2018 the IPCC* said that to limit warming to 1.5 degrees C we need to:
 - Drastically reduce emissions, particularly the use of fossil fuels;
 - Achieve “carbon neutrality” by mid-century, which means taking as much carbon out of the atmosphere as we put in; and
 - Take excess carbon out of the atmosphere (“negative emissions”) and lock it up in the ground or the natural environment





- Top priority is reducing emissions
 - make electricity as green as possible
 - run as many buildings and vehicles as possible on that green electricity.



- Some emissions are hard to reduce (e.g. trucks, industrial processes).
 - Introduce biofuels and green hydrogen to reduce these emissions.

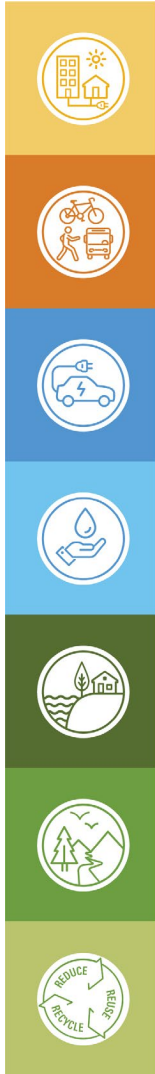


- Offset any emissions that remain with natural/mechanical carbon removal

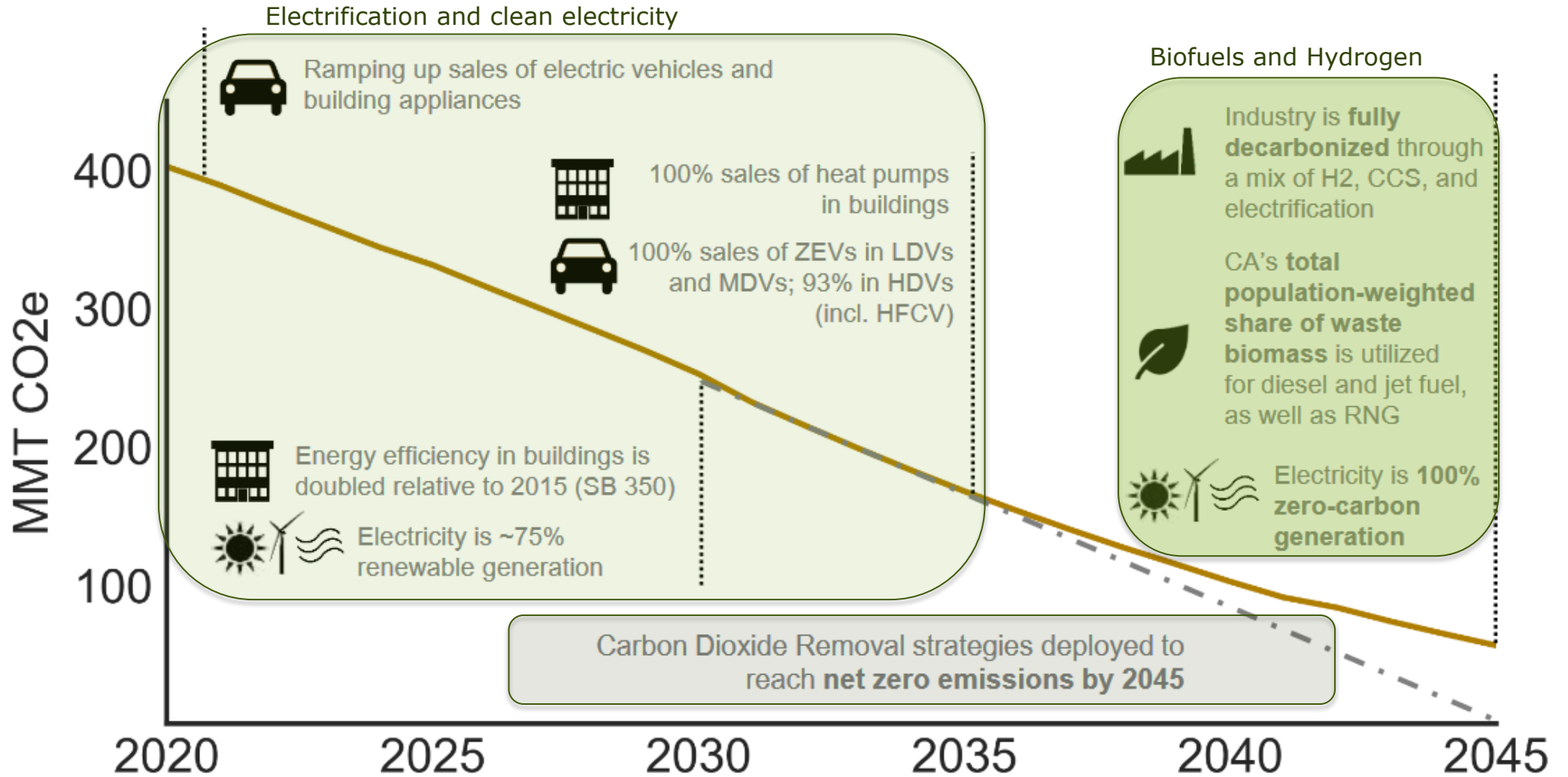
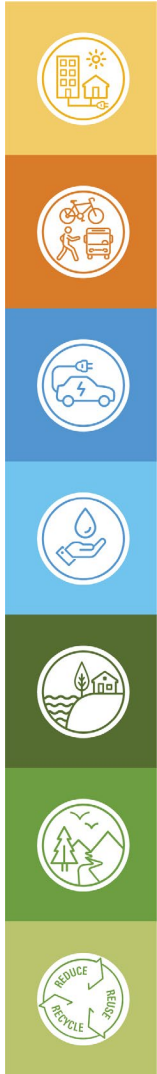


- This concept is being discussed throughout the world – what follows is one discussion by the California Air Resources Board which summarizes the issue well.

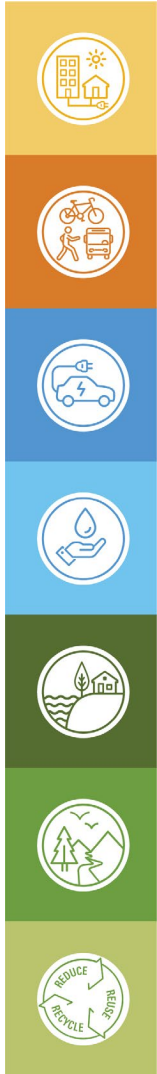




California's Pathway to Carbon Neutrality



How Could Carbon Neutrality Work in California?





Natural and Working Lands can Remove Carbon



Atmospheric Carbon Removal at the Gigaton Scale

Wednesday, September 30, 2020 - 8:30am to 10:00am PDT

Stanford's Precourt Institute for Energy director, [Arun Majumdar](#),

[Ajay Mehta](#), General Manager of New Energies Research & Technology at Shell Oil Company

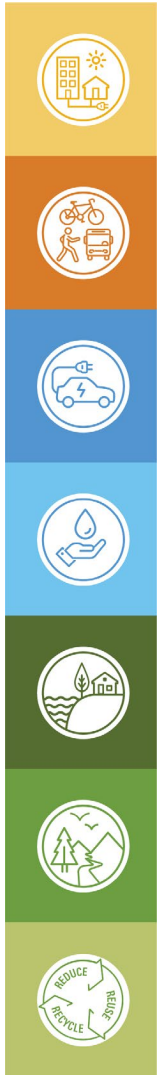
[Chris Field](#), Director of Stanford University's Woods Institute for the Environment;

Stanford University Precourt Family Professor, [Sally Benson](#).

<https://gef.stanford.edu/events/atmospheric-carbon-removal-gigaton-scale>



Hydrogen Infrastructure can Reduce Emissions



Biofuels can be Carbon Negative

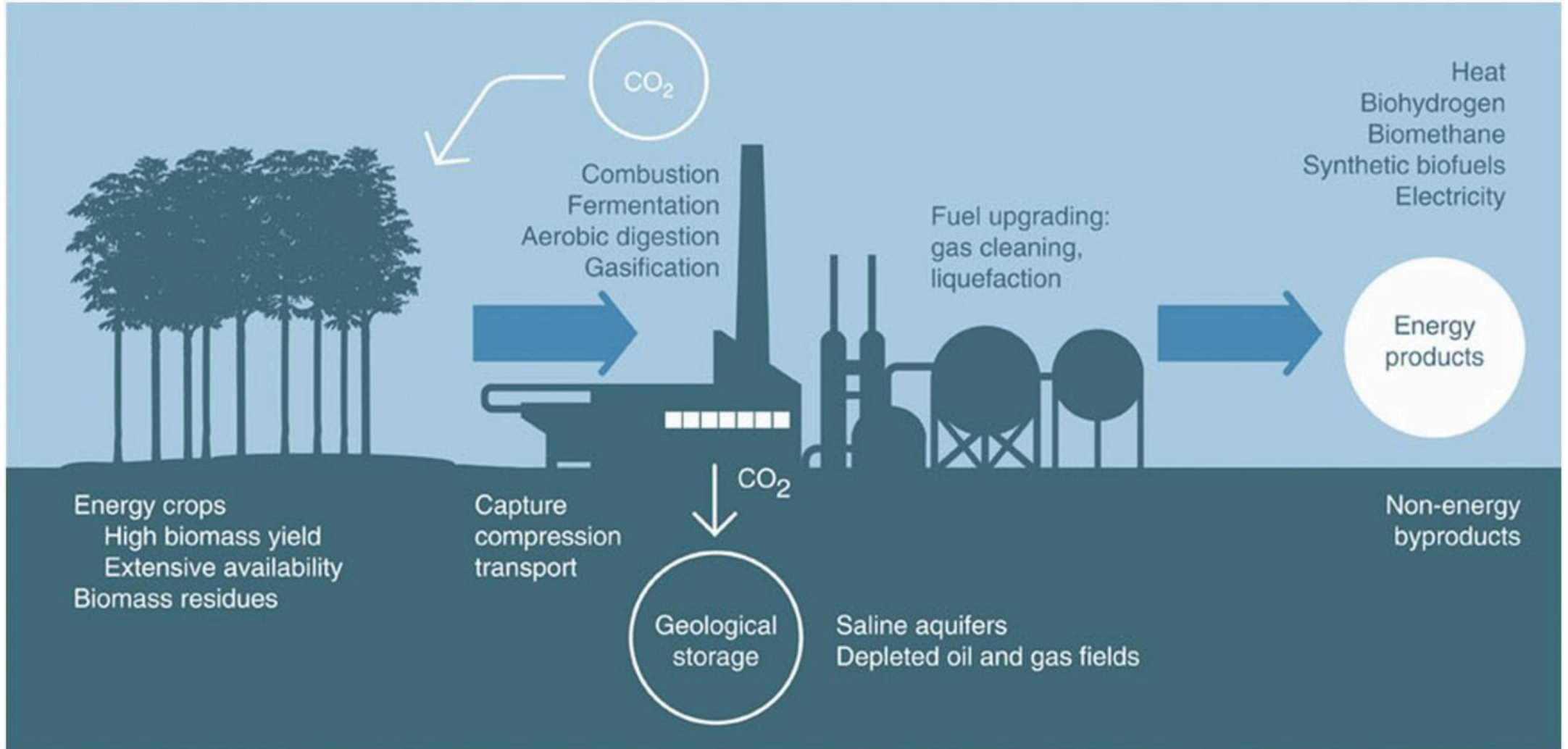
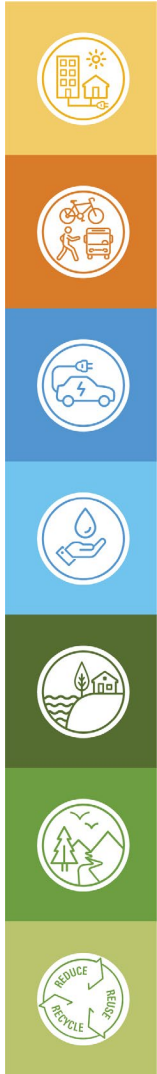


Diagram from the Proceedings of the National Academy of Sciences of the USA, November 22, 2016 113 (47) 13260-13262; <https://doi.org/10.1073/pnas.1617583113>

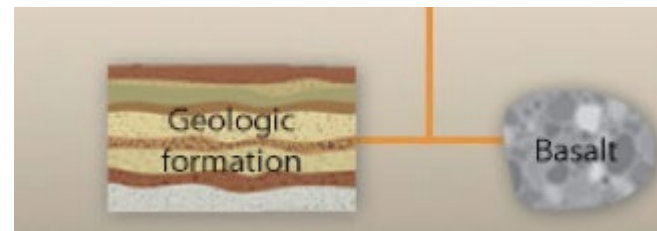
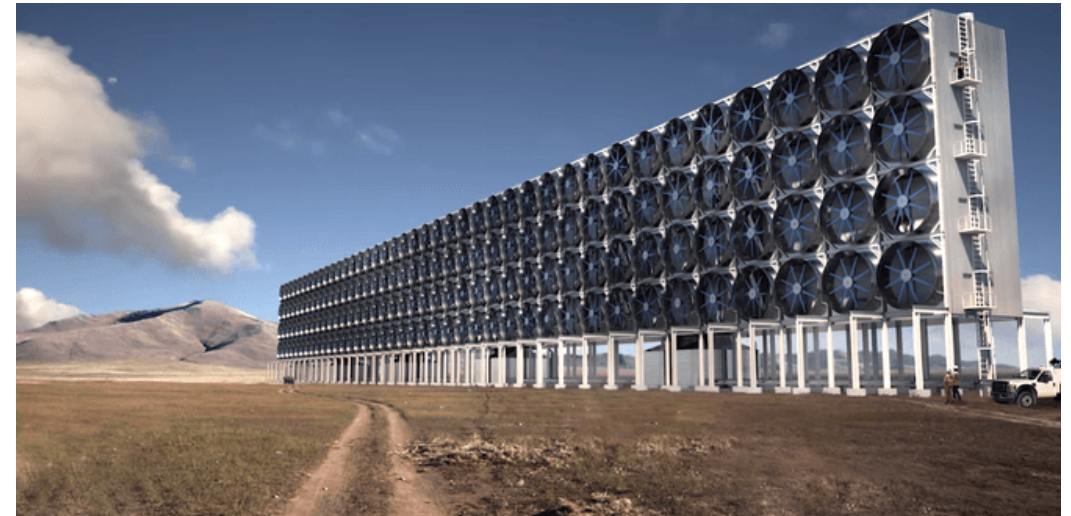
- Capturing CO₂ and storing it underground when making biofuels can result in negative emissions.
- This is bioenergy with carbon capture and storage (BECCS)
- However, BECCS, like new forests, requires enormous amounts of land to capture CO₂ if it is done at large scale
- BECCS processes can involve other types of pollution
- CA has substantial underground carbon storage potential – Lawrence Livermore assessed in 2020 study
- Other types of CDR are in development. Some examples:
 - Direct air capture
 - Mineralization
 - Other natural carbon sinks (algae, biochar, coastal lands)



Direct Air Capture can Remove CO₂ from the Air



- CO₂ is removed from the air using industrial processes and injected into stable geologic formations
- Requires substantial amounts of carbon-free energy
- Costs more, but uses less land area
- Requires stable geologic formations to store CO₂



Where can Carbon be Stored in California?

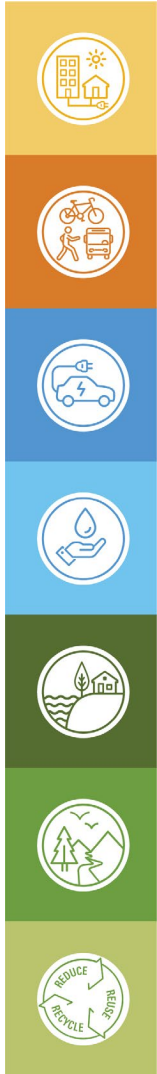


Figure 60. Map of potential CO₂ trunk pipeline. California

Sarah E. Baker, Joshua K. Stolaroff, George Peridas, Simon H. Pang, Hannah, M. Goldstein, Felicia R. Lucci, Wenqin Li, Eric W. Slessarev, Jennifer Pett-Ridge, Frederick J. Ryerson, Jeff L. Wagoner, Whitney Kirkendall, Roger D. Aines, Daniel L. Sanchez, Bodie Cabiyo, Joffre Baker, Sean McCoy, Sam Uden, Ron Runnebaum, Jennifer Wilcox, Peter C. Psarras, Hélène Pilorgé, Noah McQueen, Daniel Maynard, Colin McCormick, *Getting to Neutral: Options for Negative Carbon Emissions in California*, January, 2020, Lawrence Livermore National Laboratory, LLNL-TR-796100



Figure 42. Sedimentary basins with CO₂ storage potential within California

What do these Technologies Cost?



CDR Method	Cost
Geologic Sequestration	\$10-20 per tonne (t) of CO ₂
Land Management	\$1-100 / tCO ₂
Accelerated Weathering: Ocean	\$50-100 / tCO ₂
Bioenergy with Capture	around \$100 / tCO ₂
Direct Air Capture	\$400-1000 / tCO ₂
Accelerated Weathering: Land	\$20-1000 / tCO ₂

National Academies of Sciences, Engineering, and Medicine
<https://webassets.nationalacademies.org/cdrtechs/>



- 2022 Scoping Plan Update - Achieving Carbon Neutrality by 2045
- State Natural and Working Lands Climate Smart Strategy
 - Draft report issued October 2021
 - https://resources.ca.gov/-/media/CNRA-Website/Files/Initiatives/Expanding-Nature-Based-Solutions/FINAL_DesignDraft_NWL_100821_508-opt.pdf
- Low Carbon Fuel Standard program – provides credits for carbon capture and storage from direct air capture or biofuel processes
- SB 1440 Implementation – Annual biomethane procurement targets established for investor-owned gas corporations as of February 2022
- AB 74 - Transportation Carbon Neutrality
- SB 100 - Zero Carbon Electricity Retail Sales by 2045



- Evaluating Strategies and Scenarios for Carbon Neutrality for the City of Palo Alto



- Stanford Public Policy Practicum Team

- Leila Doty, Matt Jacquez, Nidhi Mahale, Theresa Nelson, Taiwo Odunowo, Ben Paladino



- Carbon sequestration practices and Negative Emissions Technology

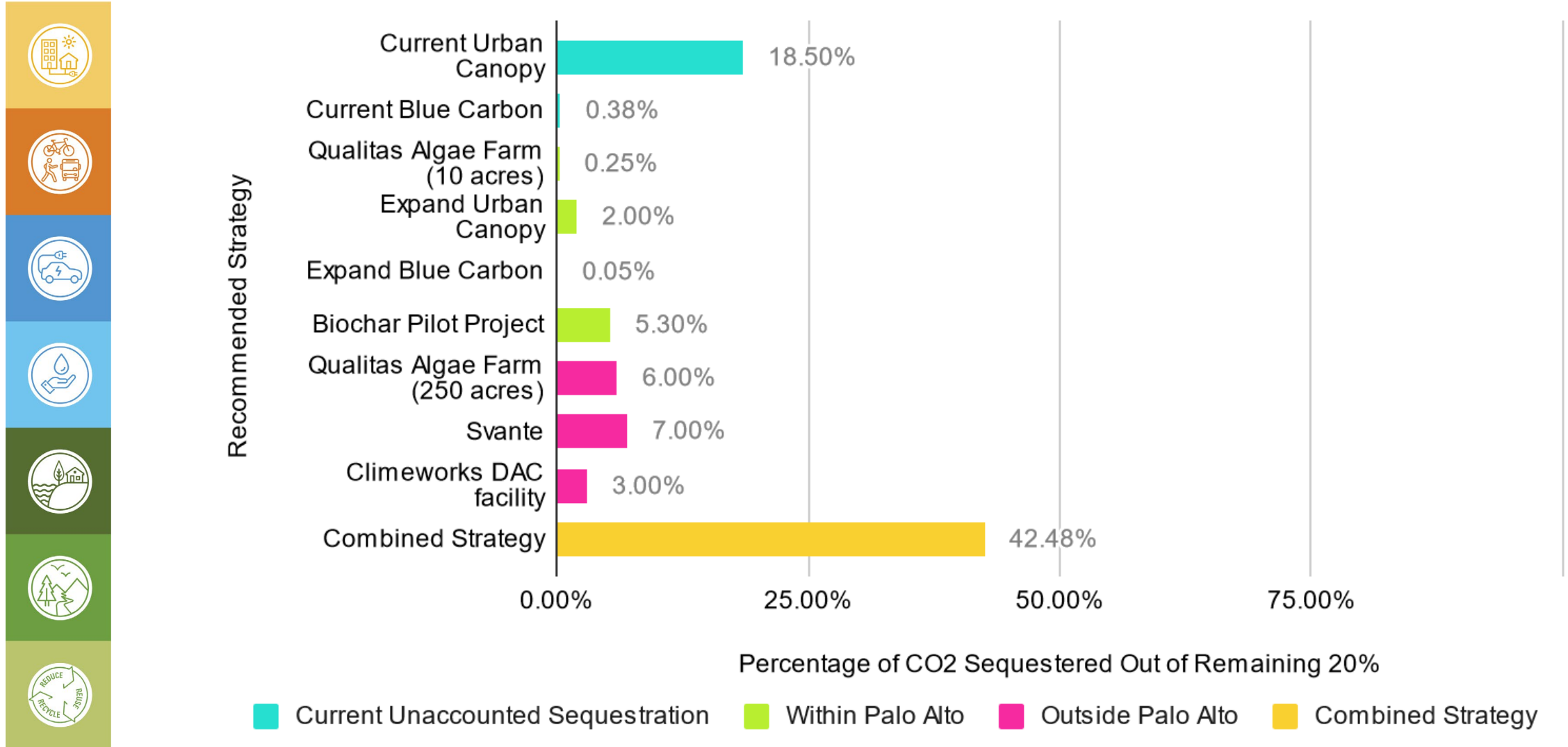
- Natural Carbon Sequestration: Urban Forest, Blue Carbon, Biochar, Algae



- Negative Emissions Technology: Solvent Carbon Capture, Mineralization Carbon Capture

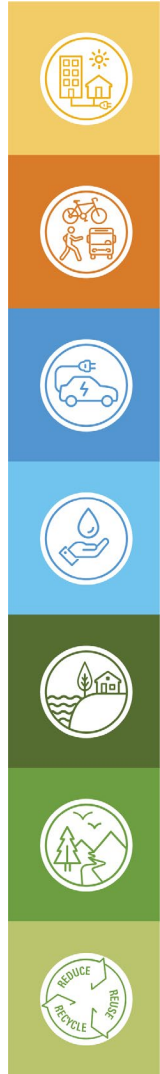


What Could Palo Alto Do?





- Target Carbon Neutrality by:
 - 2030: Irvine, Los Angeles, Menlo Park, San Jose
 - 2035: San Luis Obispo, San Mateo County, Santa Barbara
 - 2040: Davis
 - 2045: Albany, Berkeley, Dublin, Fremont, Los Angeles County, Oakland, Redwood City, Santa Clara County, Santa Monica
 - 2050: Long Beach, San Francisco, Santa Monica





SUSTAINABILITY & CLIMATE ACTION PLAN

Thank You!

Please submit questions or comments to
sustainability@cityofpaloalto.org

Acting Now for a Resilient Future



CITY OF
**PALO
ALTO**