Welcome! The Webinar will begin shortly

cityofpaloalto.org/ClimateAction

Acting Now for a Resilient Future
Click on Q&A anytime during the presentation to ask questions
Agenda

• 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
2/10/22 S/CAP Ad Hoc Committee Meeting

• 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

2045 Reach Carbon Neutrality
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
Introduction to Carbon Neutrality

• 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:
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
Introduction to Carbon Neutrality

- 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.
Introduction to Carbon Neutrality

- 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.
What is Carbon Neutrality?
California’s Pathway to Carbon Neutrality

Electrification and clean electricity
- Ramping up sales of electric vehicles and building appliances
- 100% sales of heat pumps in buildings
- 100% sales of ZEVs in LDVs and MDVs; 93% in HDVs (incl. HFCV)
- Energy efficiency in buildings is doubled relative to 2015 (SB 350)
- Electricity is ~75% renewable generation

Biofuels and Hydrogen
- Industry is fully decarbonized through a mix of H2, CCS, and electrification
- CA’s total population-weighted share of waste biomass is utilized for diesel and jet fuel, as well as RNG
- Electricity is 100% zero-carbon generation

Carbon Dioxide Removal strategies deployed to reach net zero emissions by 2045
How Could Carbon Neutrality Work in California?
Natural and Working Lands can Remove Carbon
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
Short Break
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
Challenges: Bioenergy w/ Carbon Capture and Storage

- 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

Figure 42. Sedimentary basins with CO₂ storage potential within California

What do these Technologies Cost?

<table>
<thead>
<tr>
<th>CDR Method</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geologic Sequestration</td>
<td>$10-20 per tonne (t) of CO₂</td>
</tr>
<tr>
<td>Land Management</td>
<td>$1-100 / tCO₂</td>
</tr>
<tr>
<td>Accelerated Weathering: Ocean</td>
<td>$50-100 / tCO₂</td>
</tr>
<tr>
<td>Bioenergy with Capture</td>
<td>around $100 / tCO₂</td>
</tr>
<tr>
<td>Direct Air Capture</td>
<td>$400-1000 / tCO₂</td>
</tr>
<tr>
<td>Accelerated Weathering: Land</td>
<td>$20-1000 / tCO₂</td>
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</tbody>
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National Academies of Sciences, Engineering, and Medicine
https://webassets.nationalacademies.org/cdrttechs/
Selected State Actions on Carbon Neutrality

• 2022 Scoping Plan Update - Achieving Carbon Neutrality by 2045
• State Natural and Working Lands Climate Smart Strategy
  – Draft report issued October 2021
• 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
What Could Palo Alto Do?

- 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?

- Current Urban Canopy: 18.50%
- Current Blue Carbon: 0.38%
- Qualitas Algae Farm (10 acres): 0.25%
- Expand Urban Canopy: 2.00%
- Expand Blue Carbon: 0.05%
- Biochar Pilot Project: 5.30%
- Qualitas Algae Farm (250 acres): 6.00%
- Svante: 7.00%
- Climeworks DAC facility: 3.00%
- Combined Strategy: 42.48%

Percentage of CO2 Sequestered Out of Remaining 20%

- Current Unaccounted Sequestration
- Within Palo Alto
- Outside Palo Alto
- Combined Strategy
Carbon Neutrality Goals in California

• 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
Questions and Comments from S/CAP Ad Hoc
Thank You!

Please submit questions or comments to sustainability@cityofpaloalto.org