

# **COP26 – Glasgow** **Climate Conference**

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- Head of UNEP: “Cutting methane is the strongest lever we have to slow climate change over the next 25 years . . . need to urgently reduce methane emissions as much as possible this decade.”
- President Biden: “reducing methane is the single most effective strategy to reduce global warming in the near term”
- Over 100 countries committed to methane reduction goals

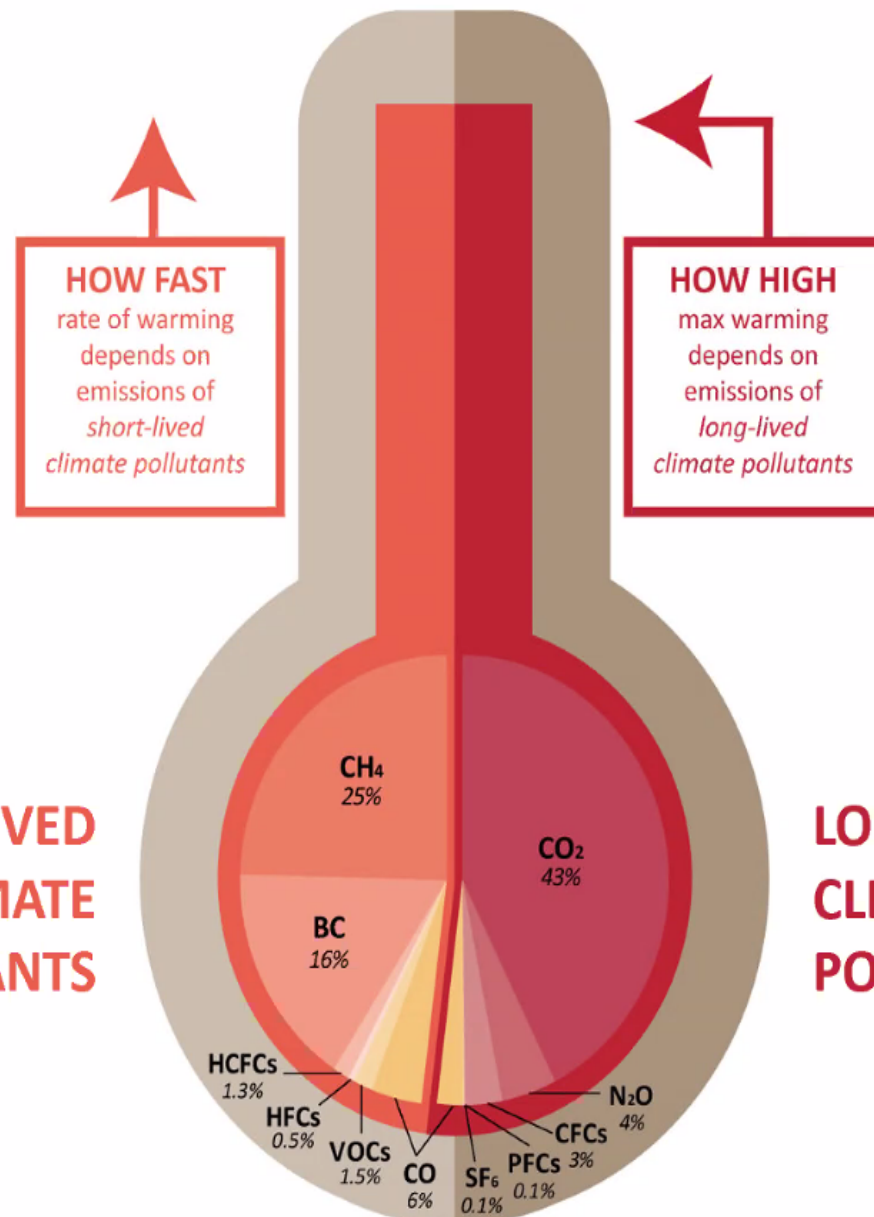
CO<sub>2</sub> accounts for  
~half of today's  
warming

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SLCPs other half!

SHORT-LIVED  
CLIMATE  
POLLUTANTS

LONG-LIVED  
CLIMATE  
POLLUTANTS



CONTRIBUTION OF EMITTED POLLUTANTS TO TODAY'S WARMING  
data from IPCC AR5 WGI 2013 using positive radiative forcing as a proxy for warming



Today's methane  
emissions will  
warm the climate  
more over next 10  
years than today's  
CO<sub>2</sub> emissions from  
fossil fuels

## RELATIVE MAGNITUDE OF WARMING OVER NEXT 10 YEARS

### CURRENT CH<sub>4</sub> EMISSIONS FROM HUMAN ACTIVITIES

(360 MMt/yr IIASA GAINS 2020)

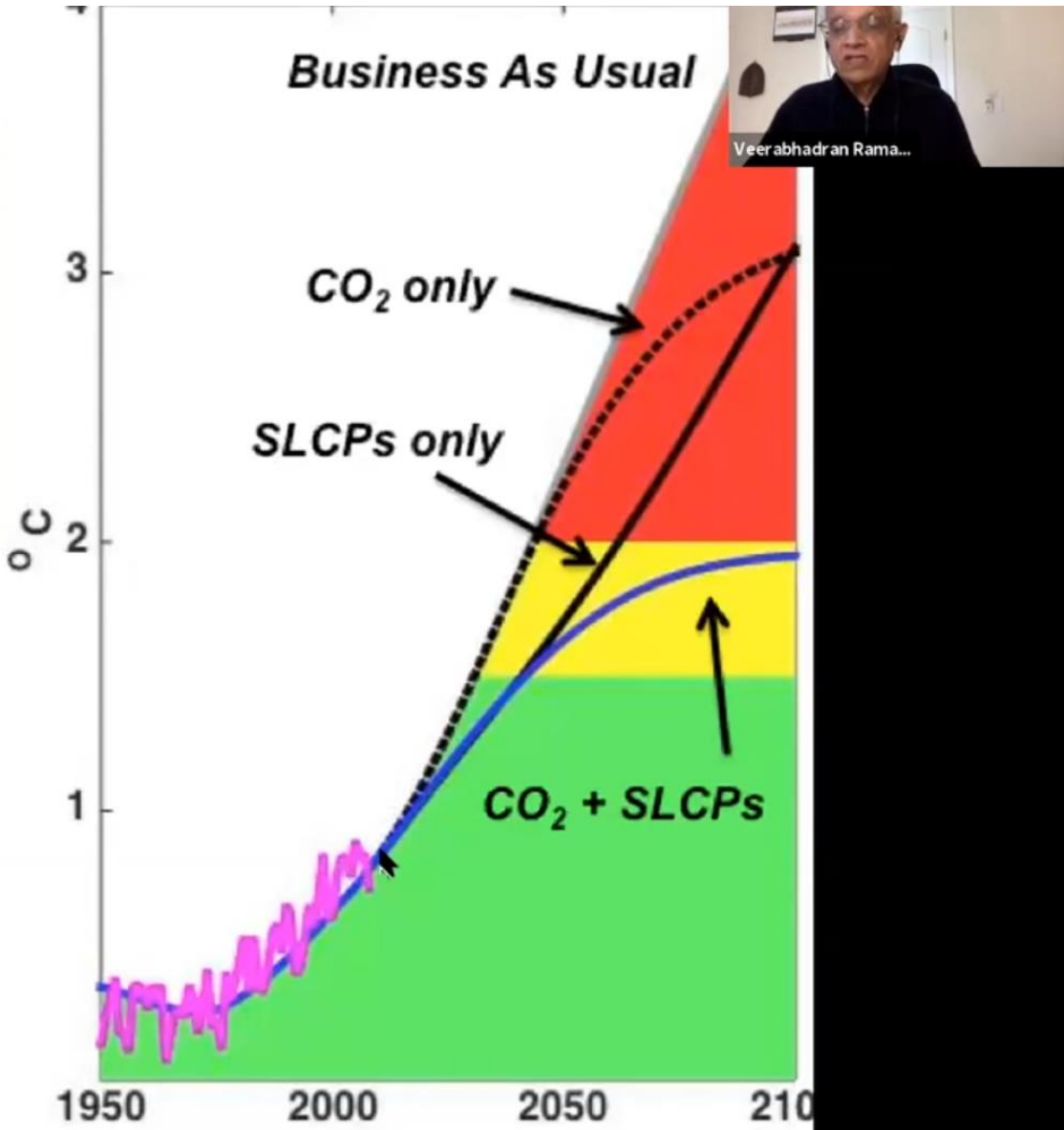


20% more  
than that  
by CO<sub>2</sub>

### CURRENT CO<sub>2</sub> EMISSIONS FROM FOSSIL FUELS

(36,000 MMt/yr CAIT WRI ClimateWatch 2020)





Dr. V. Ramanathan, UCSD  
Scripps Institute:

**“SLCP Reductions are  
The Last Lever We  
Have Left to avoid  
catastrophic climate  
change”**

# SLCP Reductions are Most Cost-Effective of All Climate Investments

- Dairy digesters and diverted organic waste projects cut carbon for \$9/\$10 per ton
- Average cost in CA is ~ \$75 per ton of carbon reduction
- Under LCFS, one ton of carbon reduction costs ~ \$200 per ton
- Many investments cost > \$200 per ton



# Lawrence Livermore National Lab: “Getting to Neutral – Options for Negative Emissions in California”

- Natural and Working Lands



25 MT/year

- Waste Biomass Conversion to energy with CO<sub>2</sub> Storage



83 MT/year

- Direct Air Capture with CO<sub>2</sub> Storage



17 MT/year

Technological readiness: mid-to-high – no new breakthroughs required



# Carbon Intensity of Fuels (grams CO<sub>2</sub>e / MJ)

<b>Diesel</b>	102
<b>Gasoline</b>	100
<b>Corn ethanol</b>	34-75
<b>Natural Gas</b>	68
<b>Fuel Cell (non-renewable hydrogen)</b>	39
<b>Electric vehicles (CA power grid)</b>	31
<b>Biodiesel</b>	9 to 50
<b>Landfill Biogas</b>	11 to 40
<b>Biogas from forest waste</b>	14
<b>Wastewater Biogas (large facilities)</b>	8 - 30
<b>Biogas from Diverted Food and Green Waste</b>	-15 to -180
<b>Dairy Biogas</b>	-276 to -550





From the UC President's Office website:

“The University of California has taken a major step toward meeting its 2025 carbon neutrality goals with two innovative clean energy projects in California: the construction of a new biogas plant and a utility-scale solar array . . . The biogas will fuel UC's own utility plants that produce campus electricity, heating and cooling. Currently, these plants burn natural gas, but UC's switch to biogas in 2025 will allow these facilities to provide resilient, clean power.

“UC is leading the state's transition to carbon neutrality with these long-term investments in renewable electricity and biogas,” said David Phillips, associate vice president of UC's department of Energy and Sustainability.

# California Bioenergy Potential from Organic Waste

<b>Feedstock</b>	<b>Amount Technically Available</b>	<b>Billion Cubic Feet Methane</b>	<b>Million Gasoline Gallon Equivalents</b>	<b>Tons of Hydrogen</b> (assuming 85% conversion efficiency)
Landfill Gas	106 BCF	53	457	
Animal Manure	3.4 M BDT	19.5	168	
Wastewater Treatment Gas	11.8 BCF	7.7	66	
Fats, Oils and Greases	207,000 tons	1.9	16	
Municipal Solid Waste (food, leaves, grass)	1.2 M BDT	12.7	109	
Municipal Solid Waste lignocellulosic fraction)	6.7 M BDT	65.9	568	
Agricultural Residue (Lignocellulosic)	5.3 M BDT	51.8	446	
Forest, Sawmill, Shrub & Chaparral Residues	26.2 M BDT	256	2,214	
<b>BIOGAS POTENTIAL</b>		<b>468.5</b>	<b>4,044</b>	<b>4,038,793</b>

Feedstock Data: Rob Williams and Stephen Kaffka, UC Davis, presentation to the California Energy Commission on January 30, 2017;  
Lawrence Livermore National Lab assessment of forest, sawmill, shrub & chaparral residues, January 2020

# Landfills

- High methane leakage = 46% of California's methane emissions \*
- Half of captured landfill gas is flared
- Truck emissions to transport waste
- Water and air pollution

# Compost

- Can emit as much methane as landfills \*
- Emits 3.5 times more GHG emissions than bioenergy + compost\*\*
- May contain PFAS chemicals
- Does not provide carbon negative emissions or sequestration

\* NASA Jet Propulsion Lab - <https://methane.jpl.nasa.gov/>

\*\* Morris, et al, *Evaluation of Climate, Energy, and Soils Impacts of Selected Food Discards Management Systems*, Prepared for the State of Oregon Dep't of Environmental Quality

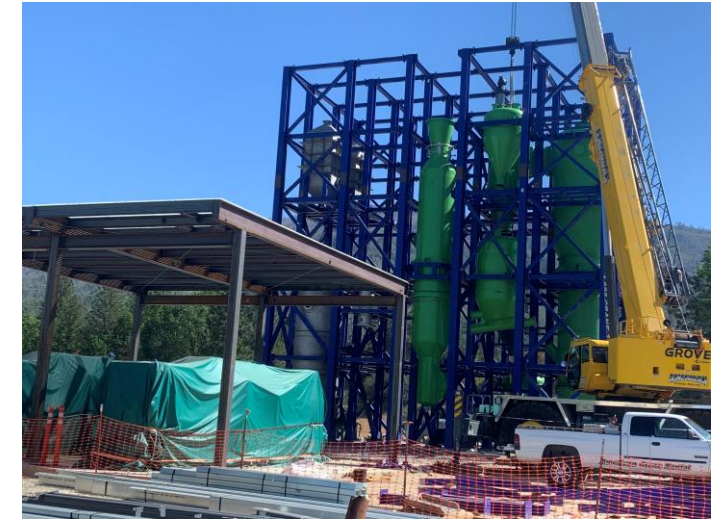
# Procurement Opportunities

- **BioMAT** – requires 110 MW of new, small-scale bioenergy from 3 MW or smaller projects that use diverted organic waste, food processing waste, wastewater biogas – price offered is \$127/MWh, but price will go up with 5 projects in queue
- **CPUC Decision 21-06-035** requires 1,000 MW of new “firm” renewables, including bioenergy and geothermal, to come online by 2026, no size limit
- **Low Carbon Fuel Standard** – credits going for \$190-\$200 / ton of carbon reduction
- CPUC has proposed adoption of a **biomethane procurement program** that would require gas utilities to procure enough biogas to meet landfill diversion requirement of SB 1383 (73 BCF annually by 2030)





# Biogas can Provide Locally Sourced, Carbon Negative Generation and Storage



# **Pathways for Improving Bioresources Management**

- Need to prioritize SLCP reductions in state budget
- Need to focus all regulations and incentives on lifecycle carbon intensity, with priority on SLCP reductions and carbon negative projects
- Need to put gasification and pyrolysis on equal footing with AD and compost
- Need to move away from direct combustion / move toward hydrogen where possible
- Need more procurement programs like CPUC adoption of biomethane procurement requirement and requirement for firm renewable power
- Need to rate-base interconnection for all bioenergy sectors
- Need to demonstrate benefits/applications for biochar

# THANK YOU

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**Bioenergy**  
Association of  
**California**