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CEC Research on GHG impacts of the Natural Gas System

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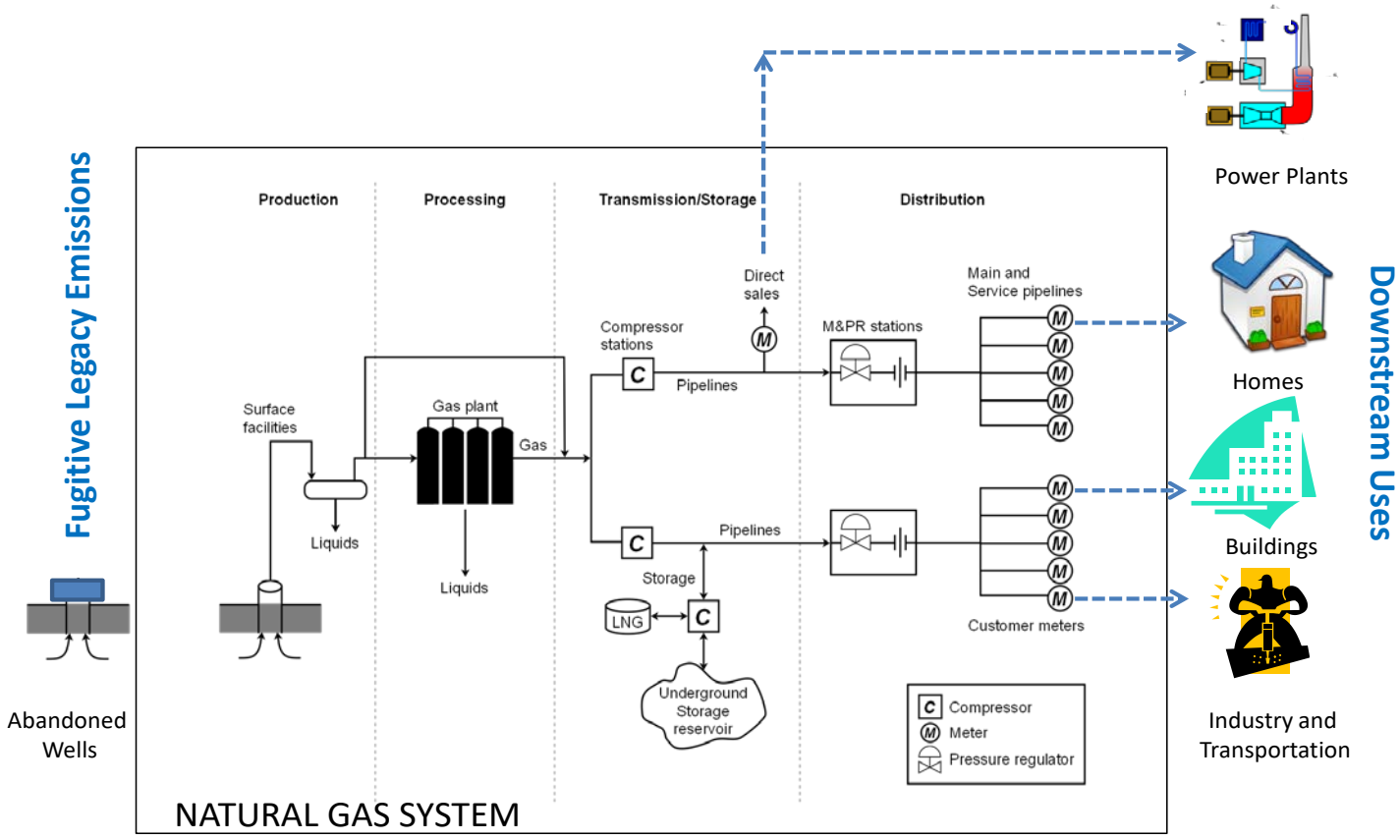
Outline

- Methane emissions from the natural gas system: emerging issues
- Some observations about public health impacts
- The natural gas system and decarbonization targets
- Conclusions

Revised schematic of the natural gas system

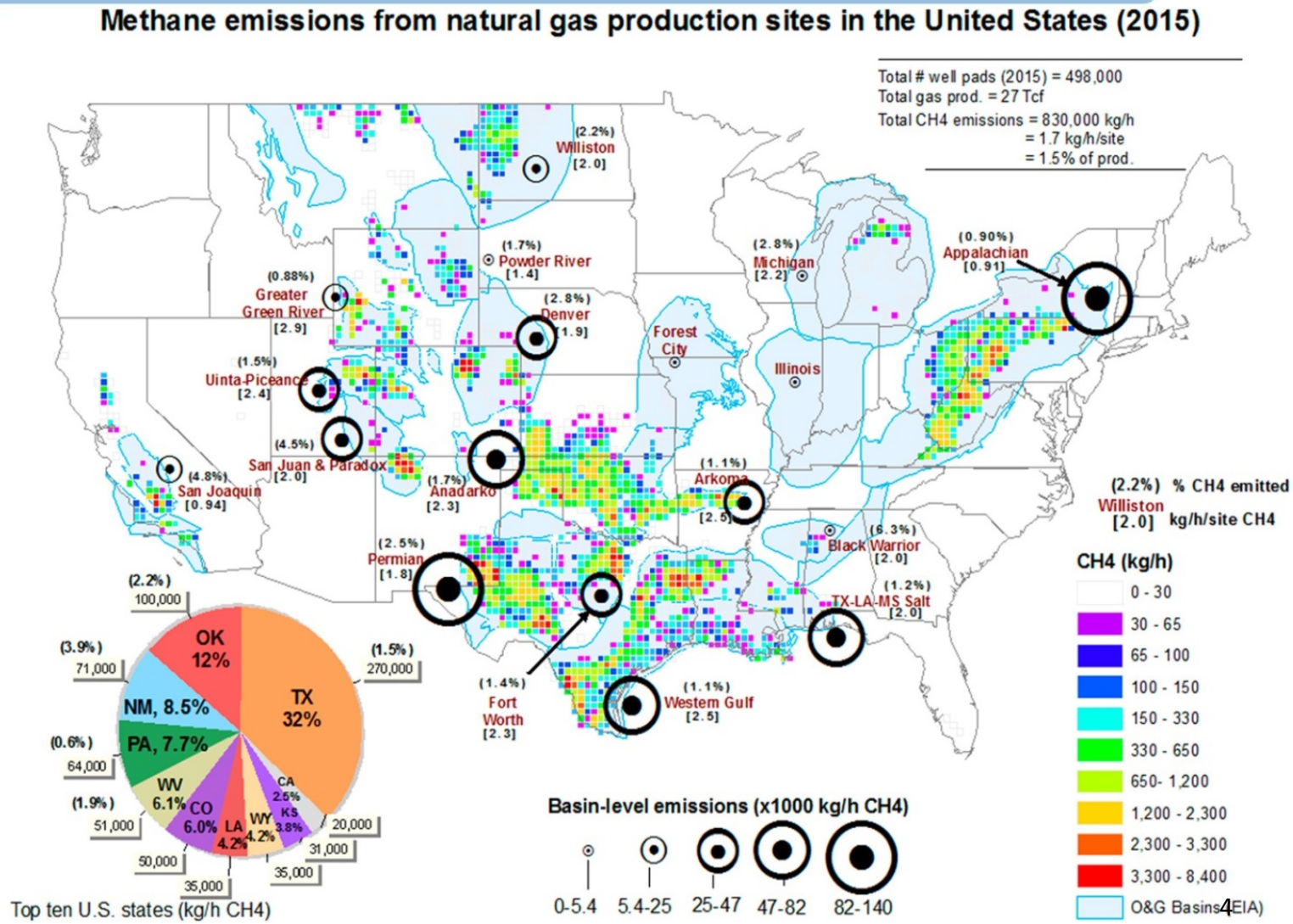
- Historically, methane emissions from the natural gas system focused on the area in the black rectangle (to the right).
- Over the past 6 years, CEC expanded this limited view of the natural gas system to add other potential sources of emissions.
- However, most of the sources of emissions outside the rectangle are still not fully accounted for in official GHG inventories.
- Additionally, there are still significant uncertainties in the level of methane emissions.



Methane emissions from natural gas production in the United States

- Emission levels are not uniform. Emission rates per unit of natural gas produced vary widely from one production region to another.

- Percentages in parentheses above basin names indicate the basin-level emissions normalized by natural gas production (e.g., methane emissions are ~4% of natural gas production in the San Joaquin production basin).



Source: Omara et al., 2018

Overall U.S. methane emissions from the natural gas system

- Methane emissions from the natural gas system in the United States may be equivalent to about 2.3% of production, which is about 60% higher than suggested by the US EPA inventory.

- U.S. methane leakage is important for understanding the full lifecycle emissions of California natural gas use, as the state imports about 90% of the natural gas that it consumes.

Source: Alvarez et al, 2018 (*Science*)

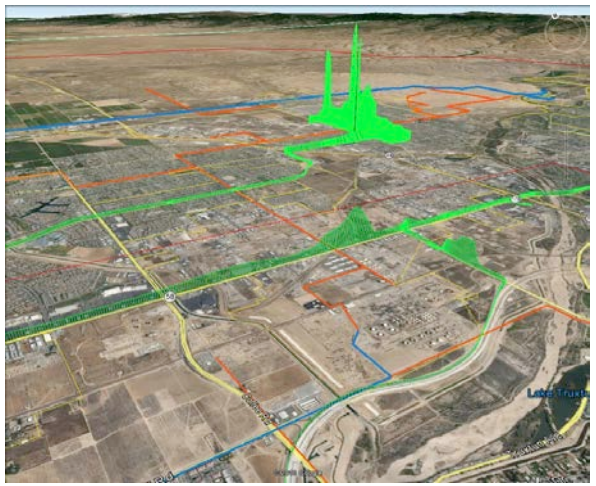
Table 1. Summary of this work's bottom-up estimates of CH_4 emissions from the U.S. oil and natural gas (O/NG) supply chain (95% confidence interval) and comparison to the EPA Greenhouse Gas Inventory (GHGI).

Industry segment	2015 CH_4 Emissions (Tg/y)	
	This work (bottom-up)	EPA GHGI (*17*)
Production	7.6 (+1.9/-1.6)	3.5
Gathering	2.6 (+0.59/-0.18)	2.3
Processing	0.72 (+0.20/-0.071)	0.44
Transmission and Storage	1.8 (+0.35/-0.22)	1.4
Local Distribution*	0.44 (+0.51/-0.22)	0.44
Oil Refining and Transportation*	0.034 (+0.050/-0.008)	0.034
U.S. O/NG total	13 (+2.1/-1.7)	8.1 (+2.1/-1.4)†

Production process (production + gathering + processing) = 10.9 Tg/y
US Total = 13 Tg/y
Production process = 84 % of total

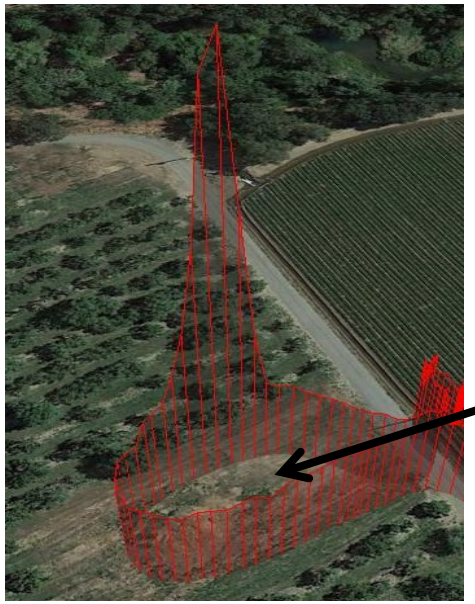
First emissions survey of the natural gas system in California

LBNL and Scientific Aviation
2013 - 2016



Methane above ambient (green), distribution (orange) and transmission (blue) pipelines

Methane Plume



Capped well

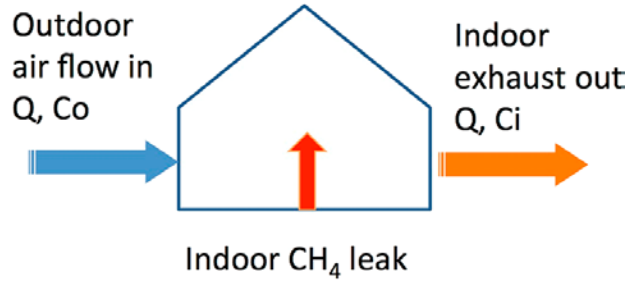
Other sources tested: underground storage units, vehicle natural gas fueling stations, refineries, natural gas and oil fields.

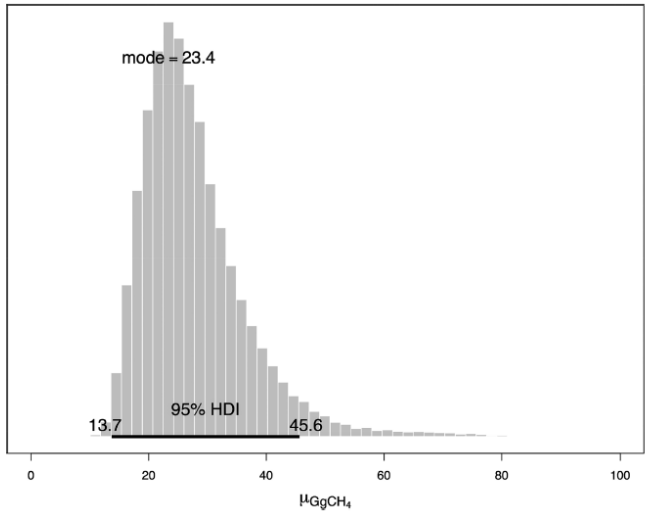
Leaks throughout the system.

Sources: LBNL; Fischer et al., 2017; Steven Conley

Methane emissions from California homes

- CEC-sponsored and LBNL-led project from 2015 to 2018 to measure methane emissions in 75 homes in California.
- Emissions include: (1) whole-house emissions "leaks" and (2) unburned methane from natural gas appliances (e.g., water heaters, furnaces).
- Super-emitter behavior observed, which means that a few sources contribute a disproportionate share of overall emissions.
- Based on the measurements, the researchers estimate that the emissions rate for the residential sector in California is 0.5% of the natural gas consumed in the sector.
- **CARB used the results of the CEC-sponsored study to add, for the first time, methane leaks from homes to the CA GHG inventory. This may be the first time that this source of emissions is included in an official state or national GHG inventory.**



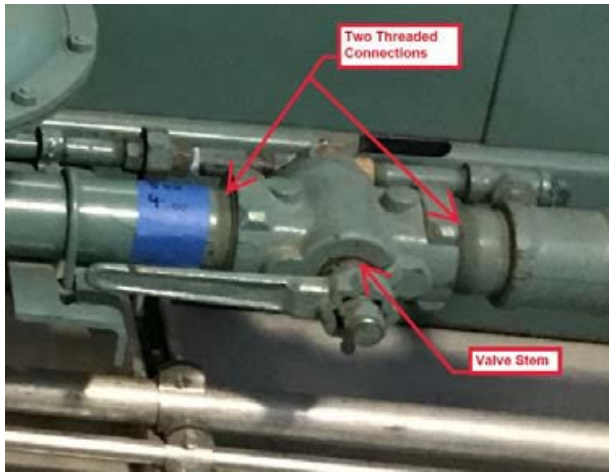


Source: Fischer et al., 2018

Methane emissions from commercial buildings (food services)

- CEC-funded and GTI-led project from 2016 to 2019.
- Bottom-up methodology (sampling of components) that may not capture total emissions.
- According to GTI, a hypothetical large region with multiple urban centers and 24,269 restaurants emits about 0.163 MMTCO2e/yr. CA has about 76,000 restaurants.
- Restaurants may emit the equivalent of more than 1% of the natural gas that they consume.

Natural gas valve



Source: GTI

What about other building types?

- CEC-funded research conducted by ICF and GTI in 2016 – 2020 has examined emissions in about 100 buildings in six building types:
  - Offices
  - Lodging
  - Education
  - Food service
  - Retail
  - Warehouses

- Results will be reported in the next few months.

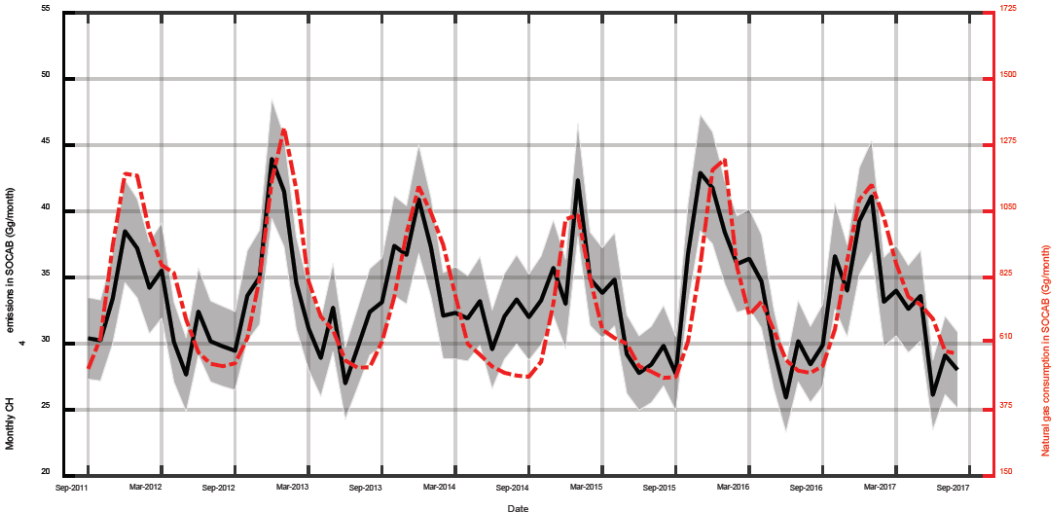
- Official state and national GHG inventories do not yet include methane leaks from commercial buildings.

Methane emissions from homes and buildings in the South Coast Air Basin

- Jet Propulsion Laboratory (JPL)/NASA recently reported methane emissions from homes and buildings in Los Angeles. They estimate that emissions are equivalent to about 1.4% of natural gas consumption in the residential and commercial sectors (He et al., 2019).

- There is a good correlation between estimated emissions calculated using ambient concentrations of methane and seasonal natural gas consumption (see figure).

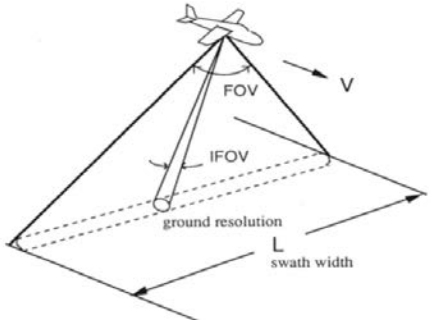
- More studies are needed to corroborate the top-down JPL/NASA estimation of methane emissions.

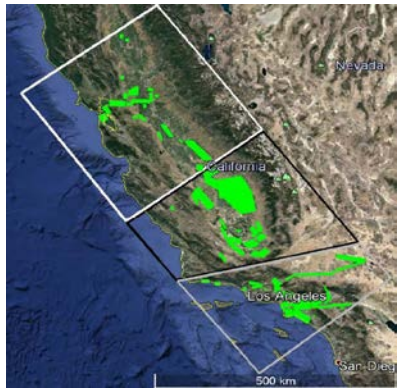


Source: He et al. 2019

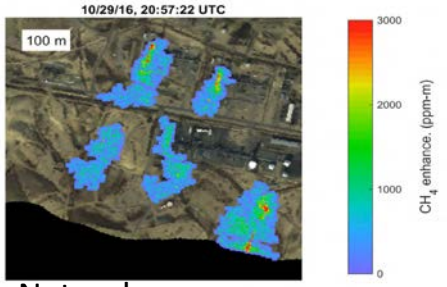
California statewide methane survey beyond buildings

- CEC, ARB, and NASA funded study led by JPL/NASA from 2017 to 2019. CEC funding supported measurements for the natural gas system.
- Utilizes airborne visual and infrared imaging spectrometer.





Source: JPL/NASA



Natural gas processing facility in Kern County

• Point sources (>~ 10 kg/hr of methane) emit an equivalent of 34 - 46% of what ARB reports as statewide methane emissions.

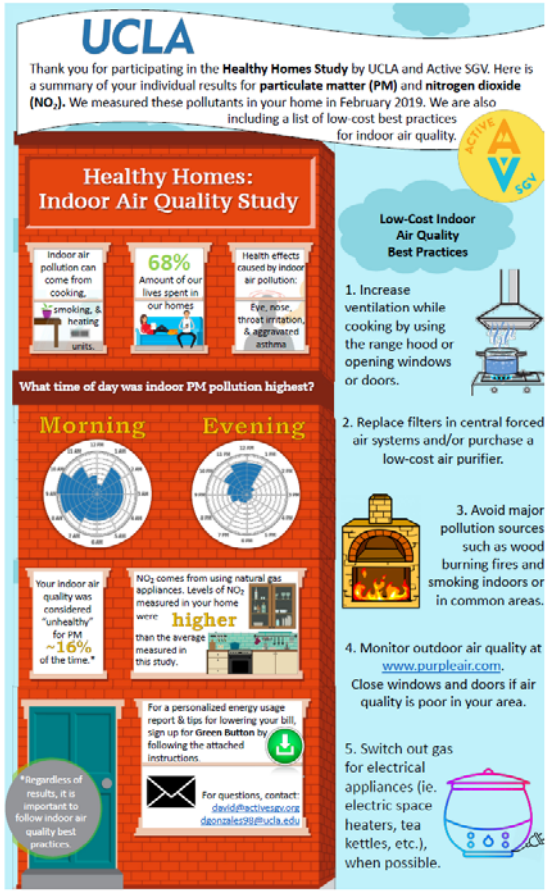
• Methane emissions from associated wells in the southern part of the San Joaquin Valley are equivalent to about 4% of natural gas production.

• Super-emitters in all the sectors investigated – such as landfills and dairy farms – show, in general, discrepancies with standard estimation methods.

Some observations about public health impacts

- Burning of natural gas in our homes can result in poor indoor air quality.
- Based on a study of southern California by Logue et al. (2014), it is estimated that 62% of the population using natural gas for cooking is exposed to NO_2 levels that exceed acute health-based standards and guidelines.
- A 2019 analysis by Garcia et al. examining data from 1993 to 2014 from southern California communities found that NO_2 induces asthma attacks – one of the leading chronic diseases in children – despite the fact that all of the communities examined had ambient concentrations well below the current U.S. EPA NO_2 standard (Garcia et al., 2019).
- As part of a CEC-funded study, UCLA is measuring NO_2 and PM concentrations indoors in homes using natural gas in a disadvantaged community in Los Angeles.

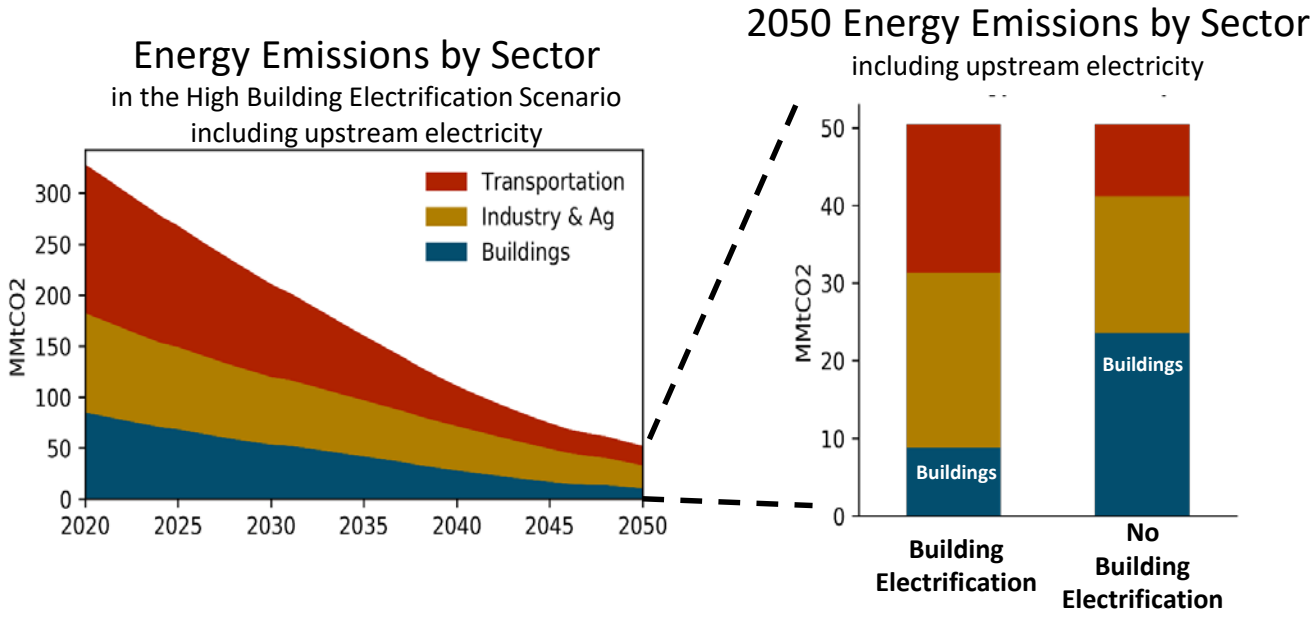
Source: UCLA



Switch out gas for electrical appliances .....when possible

The natural gas system and decarbonization targets

- The decarbonization of the energy system in California will require substantial reductions of <u>fossil</u> natural gas consumption.
- Energy and Environmental Economics, Inc. (E3) is conducting a study for the CEC PIER Natural Gas Program to estimate the role of natural gas in a carbon constrained world in California. A draft final report will be available in September-October and final report in November-December.
- Renewable Natural Gas (RNG) can play an important role in the future. However, the study suggests that RNG should be used in applications that are difficult to electrify (e.g., industry applications and heavy-duty trucks).



E3 - CEC Staff Workshop – June 6, 2019

Conclusions

- Methane emissions from homes and buildings are important. These emissions are an emerging issue that should be considered in future studies about decarbonization of the California economy.

- The public health implications of the use of natural gas for cooking should be considered in policy discussions.

- CEC and ARB are already planning additional studies to better understand methane emissions levels and public health impacts.

Thank you !

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