

Decarbonizing the Commercial Buildings Sector

This brief discusses key findings from the following report: Anna Tarplin, Sarah D. Saltzer, Jacques de Chalendar, and Sally M. Benson, “Pathways to Carbon Neutrality in California: Decarbonizing the Commercial Buildings Sector”, Stanford Center for Carbon Storage and Stanford Carbon Removal Initiative, May 2022.

The Commercial Buildings sector in California is large and diverse, with around 600,000 buildings and 2019 emissions 24.2 Mt CO₂e, or 5.8% of California’s total. Commercial buildings have varying natural gas loads depending on subsector, time of day, season, and climate zone. For this study a bottom-up approach was used to develop natural gas consumption load curves (and resultant emissions) for each subsector using building stock data for 10 regions in the state.

KEY FINDINGS

1. Gas heating is the largest contributor to direct emissions from natural gas in the commercial sector (75% of non-CHP consumption). Water heating and cooking are also major contributors (9.5% and 16%, respectively).
2. Natural gas consumption by end-use differs greatly by location and by subsector.
3. Fugitive emissions from refrigerants are of growing concern as we add more heat pumps to the commercial sector. 38% of emissions from the commercial sector in 2018 are from refrigerants.
4. Heating and water heating loads, along with the EIA’s costs and efficiencies for commercial appliances, suggest that heat pumps are more cost efficient than electric heaters and water heaters. Increases in installation costs from changing electric power distribution systems in commercial buildings may change this.
5. It is economical to retrofit building envelope at the same time as electrifying or replacing HVAC equipment, as increasing building thermal efficiency can allow for smaller HVAC equipment to fulfil HVAC demand.
6. In most cases, electrification will result in higher energy bills for a facility despite energy-efficiency improvements. This is a result of the relatively high cost of electricity in California compared to natural gas.
7. It is most likely not economical to abate combined heat and power emissions using carbon capture and storage in facilities emitting less than 25,000 tCO₂e/yr due to high capture costs and lack of incentives.
8. There are a limited number of retailers for large commercial heat pumps. Significant growth in manufacturing and retail supply of heat pumps will be needed if they are to be installed widely.
9. There are a limited number of professionals who are trained in installing heat pumps. Technical vocational training programs need to be developed and expanded.

SUBSECTOR FINDINGS

10. **Schools (K-12)** in California already have decarbonization efforts underway. These facilities can be decarbonized with an added benefit of providing a learning opportunity for students.
11. There are several large **College** CHP facilities (over 25,000 tCO₂e/yr) that can be economically decarbonized using CCS, however most college CHP facilities will likely need to decarbonize through retirement of natural gas heating and electrification.
12. **Restaurants** are one of the largest groups of consumers of natural gas, primarily for cooking. Alternate stove technologies can abate 1.33 MtCO₂e/yr in emissions, but there are major public opinion and cost barriers.
13. In the **Food and Liquor** subsector, leakage from refrigeration equipment and heating demand can be reduced by adopting newer, more thermally efficient refrigerators in supermarkets, grocery stores, and convenience stores with the co-benefit of reducing electricity for refrigeration.
14. **Retail** Sector energy consumption is dominated by interior lighting. Improving lighting efficiency in the Retail subsector while electrifying heating will decarbonize this subsector without too much burden on the grid.
15. The largest energy end-use in the **Hotel** subsector is water heating. Investment in high-efficiency electric water heaters and heat pump water heaters and laundry appliances can help decrease costs and energy consumption in this subsector as it decarbonizes.
16. In the **Office** Sector, “interior equipment” or electricity plug-load is the largest end-use category. However, some natural gas is used for heating and water heating in offices. Electrifying heating and water heating and retrofitting office buildings for energy efficiency will decarbonize this subsector with limited additional burden on the grid.
17. CHP installations in **Healthcare** will be difficult to decarbonize. Many hospitals with CHP fall below the 25,000 tCO₂e/yr threshold, making them uneconomical to retrofit with CCS. Decarbonization options for these facilities will need to provide the same level of reliability as natural gas CHP facilities, or these facilities will need to be offset with negative emissions.