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Building Decarbonization Efforts

California Energy Commission

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CEC Efforts on Building Decarbonization

This presentation summarizes:

- Updates to Long-standing Regulations
- Implementation of New Legislation
- Key Assumptions for Electricity GHG Intensities
- Ongoing Research & Development

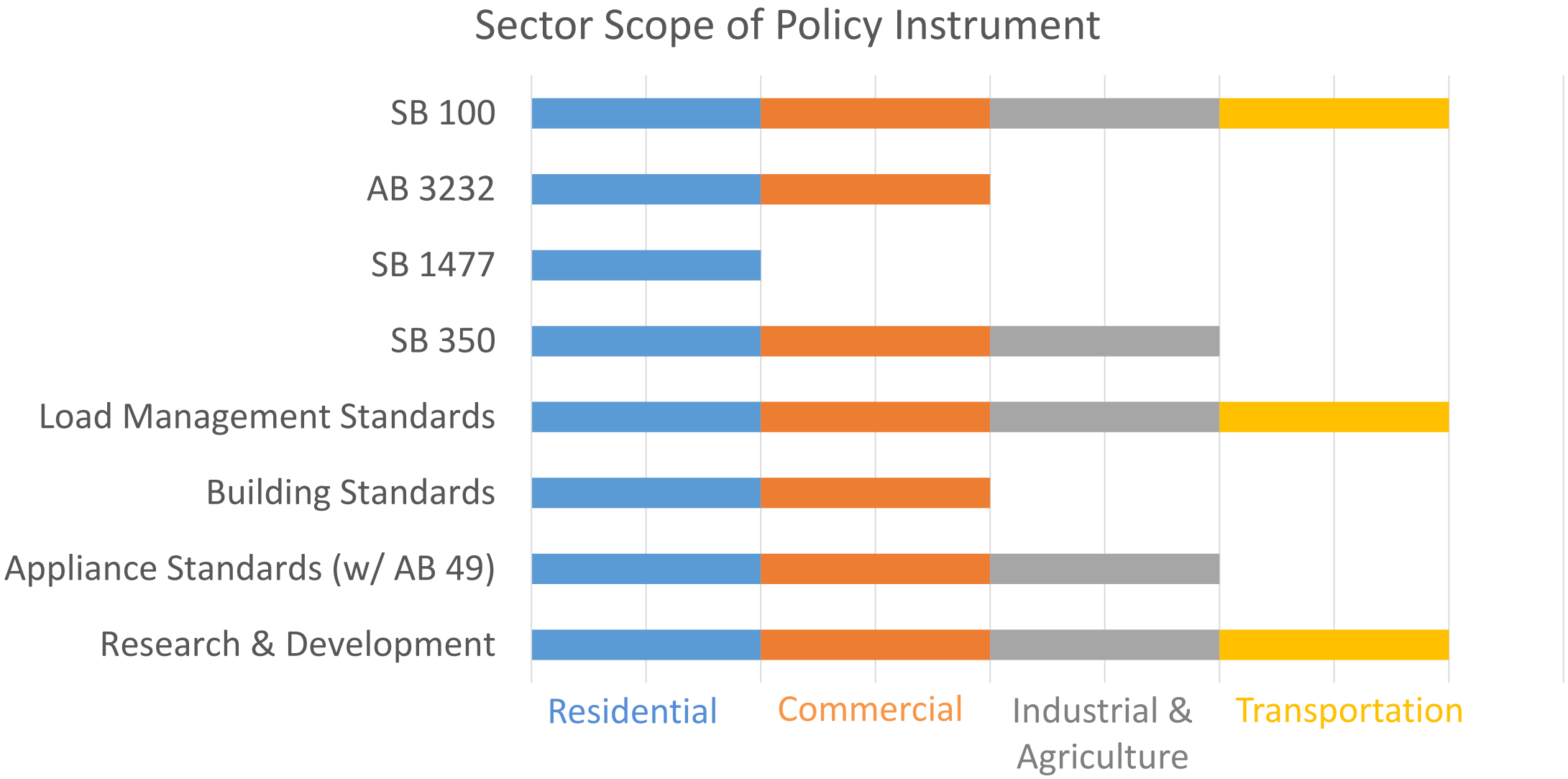
CEC Regulations & Building Decarbonization

- **Building Energy Efficiency Standards** (Title-24)
  - Working towards a performance compliance path for all-electric systems
  - New source energy metric proposed for 2022 title-24 Update
- **Appliance Energy Efficiency Standards** (Title-20)
  - AB 49 (Skinner, 2019) adds demand flexibility to scope of future regulations
- **Load Management Standards** (Title-20)
  - Adopted an Order Instituting Rulemaking in November 2019
  - Focus will be on strategies and technologies to shift electric loads for GHG reductions & cost savings
  - Regulations apply to all Load Serving Entities in California

New Legislation & Building Decarbonization

- **SB 350** (De Leon, 2015)
  - Assess potential to double Energy Efficiency by 2030
  - Increases Renewable Portfolio Standard to 60% by 2030
- **SB 1477** (Stern, 2018)
  - Provides $200M over 4 years for low emission residential new construction & existing residential heating
- **AB 3232** (Friedman, 2018)
  - Assess potential to reduce Building GHGs 40% below 1990 by 2030
- **SB 100** (De Leon, 2018)
  - 100% Zero Carbon Resources for Electricity Retail Sales by 2045

Decarbonization Policy Overview



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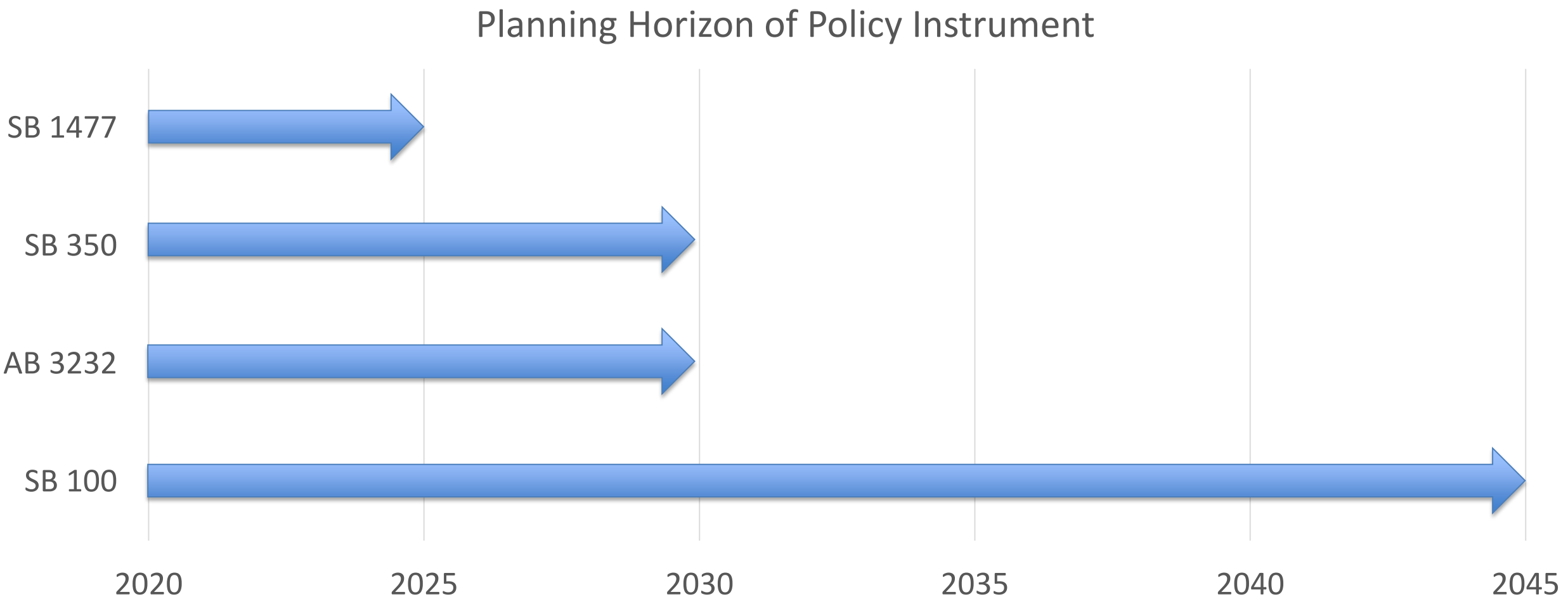


Assumptions for Current Electricity GHG Emission Intensities

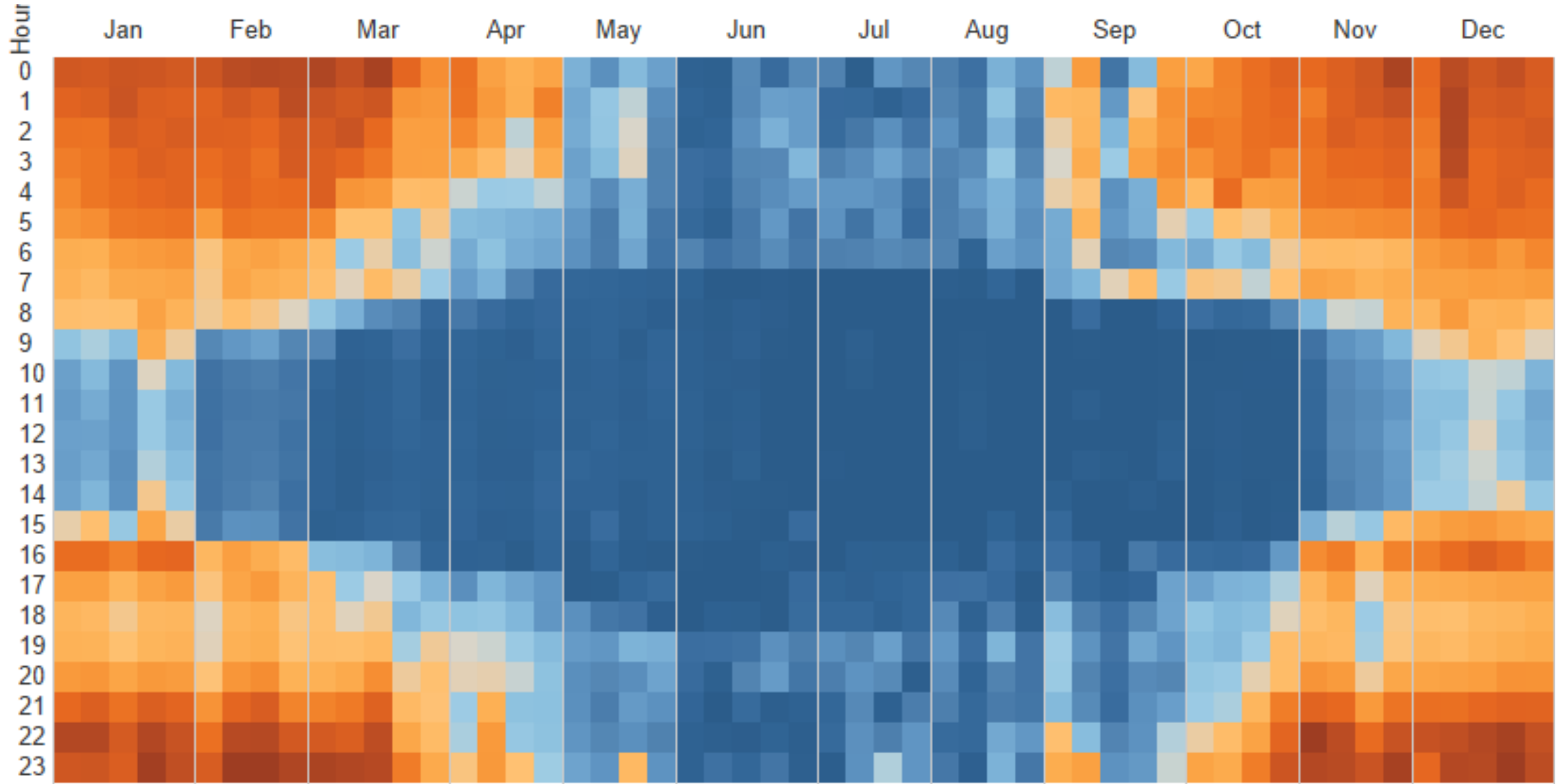
Electricity Demand:

- 2030 natural gas consumption = 40% below 1990
- Electric heat pumps replace gas space and water heating
- No building envelope efficiency improvements
- No load shifting

Electricity Supply:

- 60% RPS by 2030
- 1200 MW battery storage to maintain traditional levels of resource margin
- Out of state renewables: 80% GHG free, 20% default (0.43 tCO2/MWh)
- Long-term marginal emission intensities: reflects the change in generation resources needed to meet demand change

Electricity GHG Emission Intensities Relative to Natural Gas



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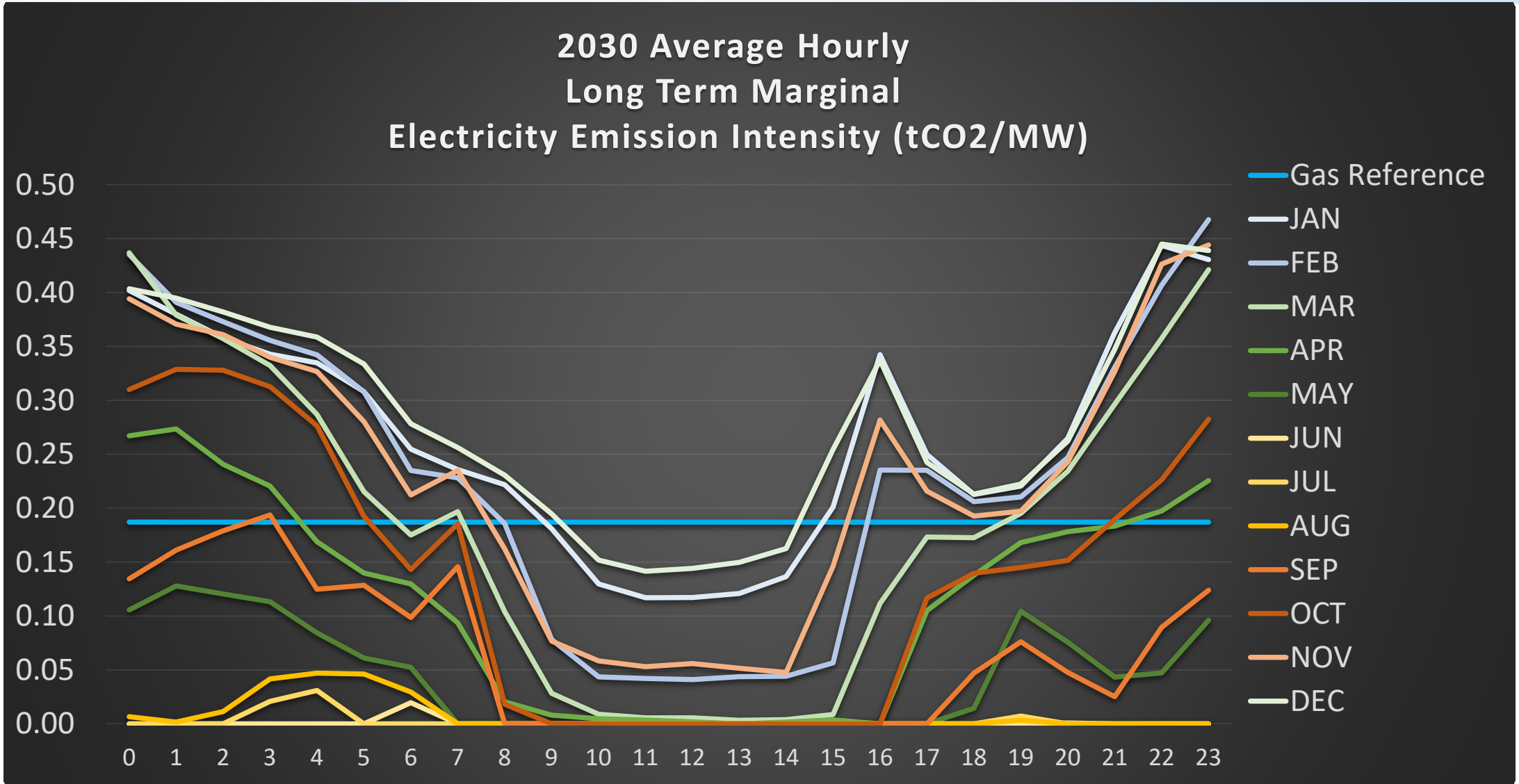
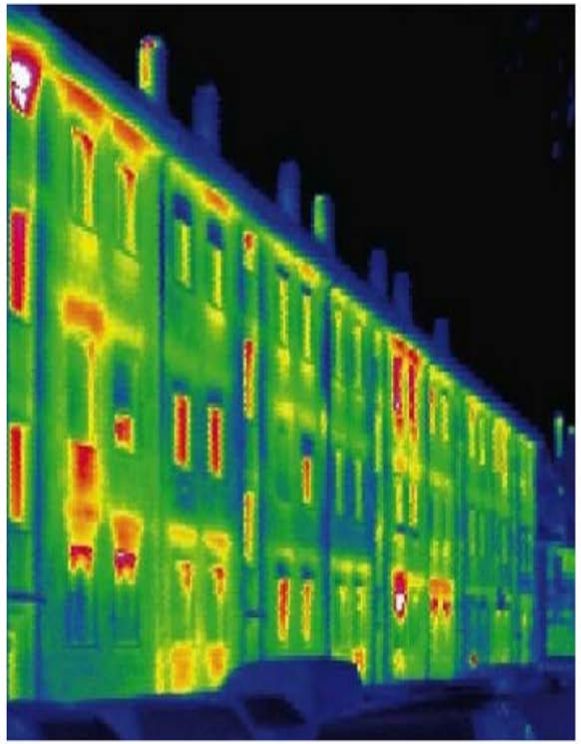
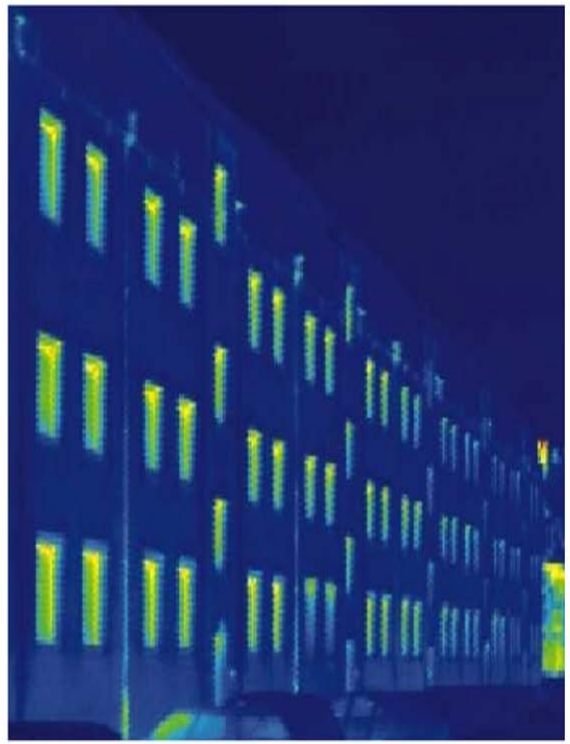


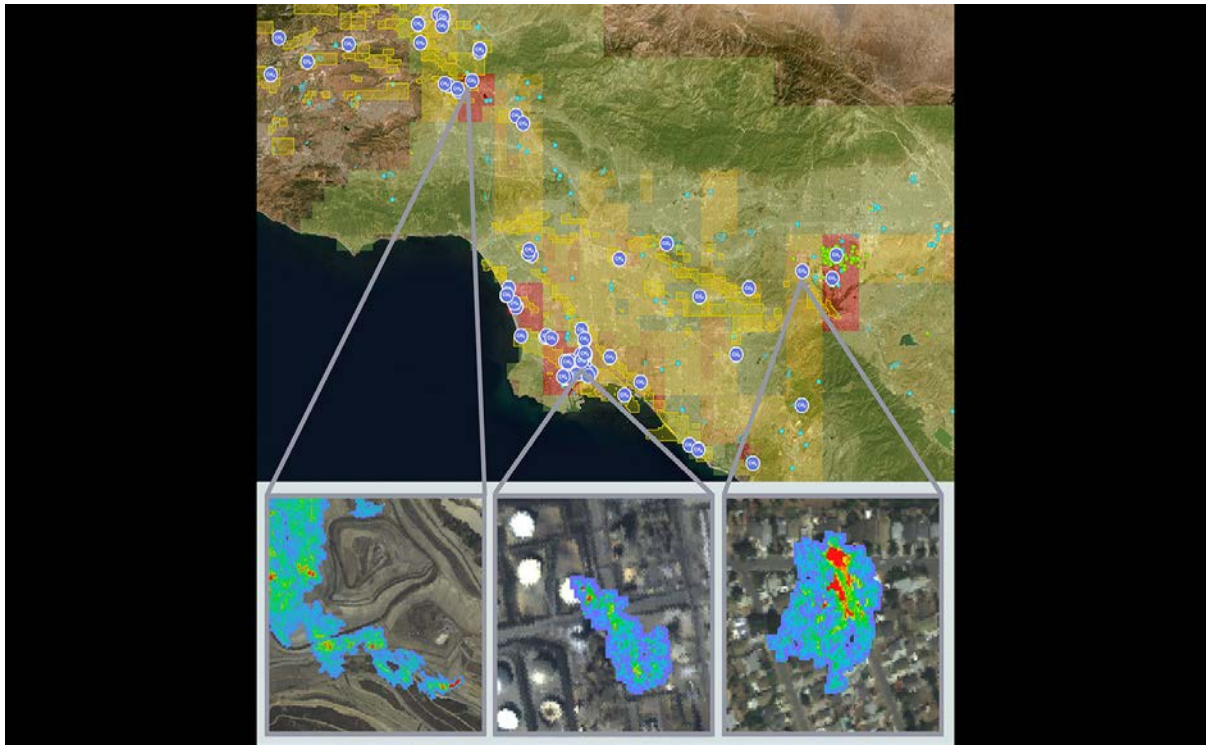
Ongoing Research & Building Decarbonization

Building End Use Efficiency Research



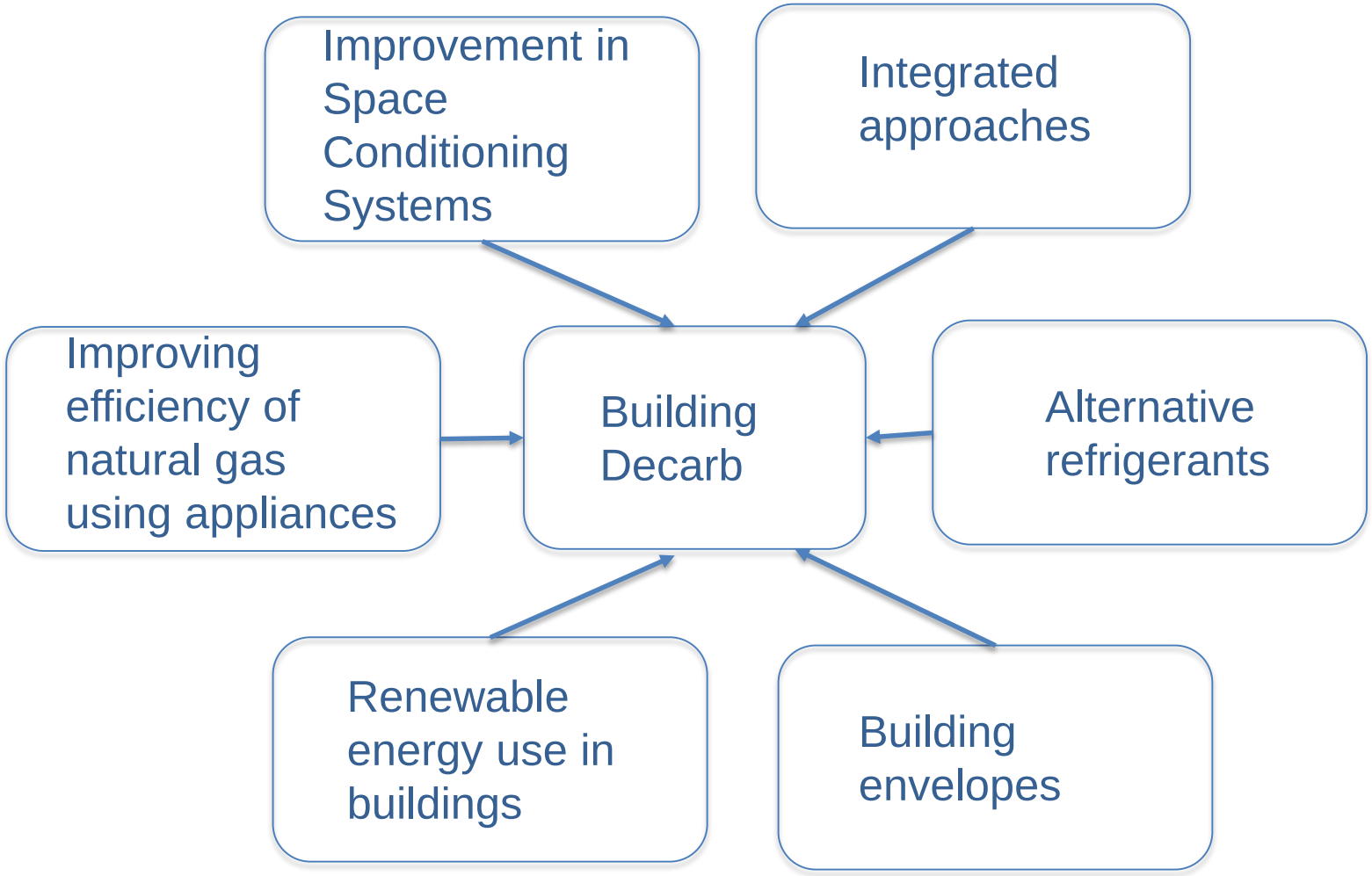


Energy-Related Environmental Research



Advancing Low-Carbon Building Research

- **Challenges:**
  - Cost of equipment and installation
  - Consumer acceptance
  - Concern about future bill increase
- **Goals:**
  - Advance emerging technologies
  - Document technical and economic performance
  - Reduce installation, capital and operating costs
  - Obtain real world feedback from consumers
  - Ensure benefits to low income or disadvantaged communities



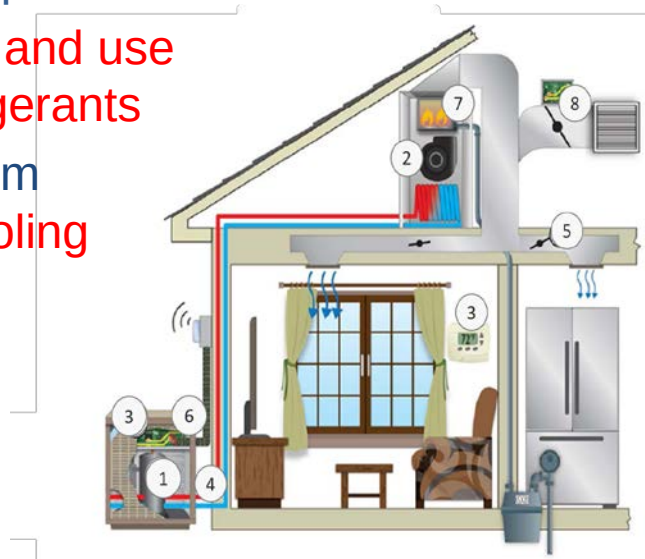
Advancements in Space Conditioning and Alternative Refrigerants

Commercial Building Space Conditioning (EPC-15-004)

- Develop and demonstrate climate appropriate air conditioning system that optimizes occupant comfort and reduce energy use and peak demand
- Includes a combination of variable refrigerant flow technology with indirect evaporative cooling
- Evaluate applicability of low GWP refrigerants
- Initial test results show electric savings of about 33%.

Residential Space Conditioning (EPC-14-021)

- Design and test an advanced residential heat pump space-conditioning system
- Includes variable-capacity compressor and variable speed fans, zonal ventilation control, and other efficient components
- Evaluated applicability and use of low GWP R-32 refrigerants
- Integrated HVAC system showed 22 to 32% cooling energy savings



Integrated Approaches and Reducing Natural Gas Use

Integrated approaches: Customer-Centric Approach to Scaling Integrated demand side management (IDSM) Retrofits (EPC-15-053)

- Develop and demonstrate an approach to scale multifamily retrofits in disadvantaged communities that focus on customer needs with minimal disruption to occupants
- Demonstration sites: Ontario and Fresno

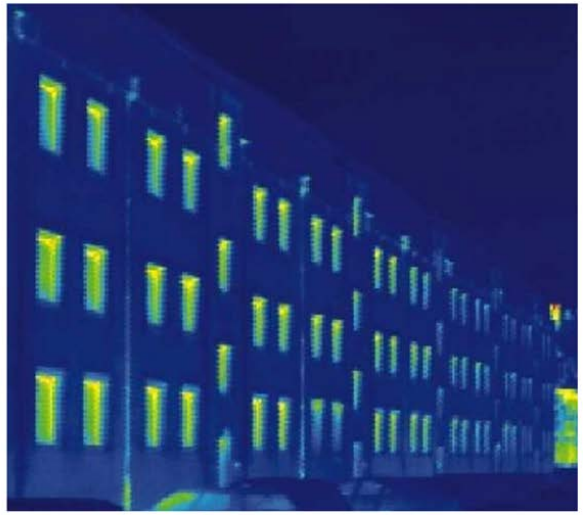
Improvements in Natural Gas Use: Demonstrating Natural Gas Heat Pumps for Integrated Hot Water and Air-Conditioning in Restaurants (PIR-16-001)

- Goal is to demonstrate a 40% reduction in natural gas usage and offset 20% of the air conditioning cost.
- Pilot sites: two full-service restaurants in Southern California
- Preliminary data shows gas heat pumps able to meet 80% of the hot water demand for the restaurants. M&V to continue for 12 months

Advancements in Building Envelopes and Solar Thermal

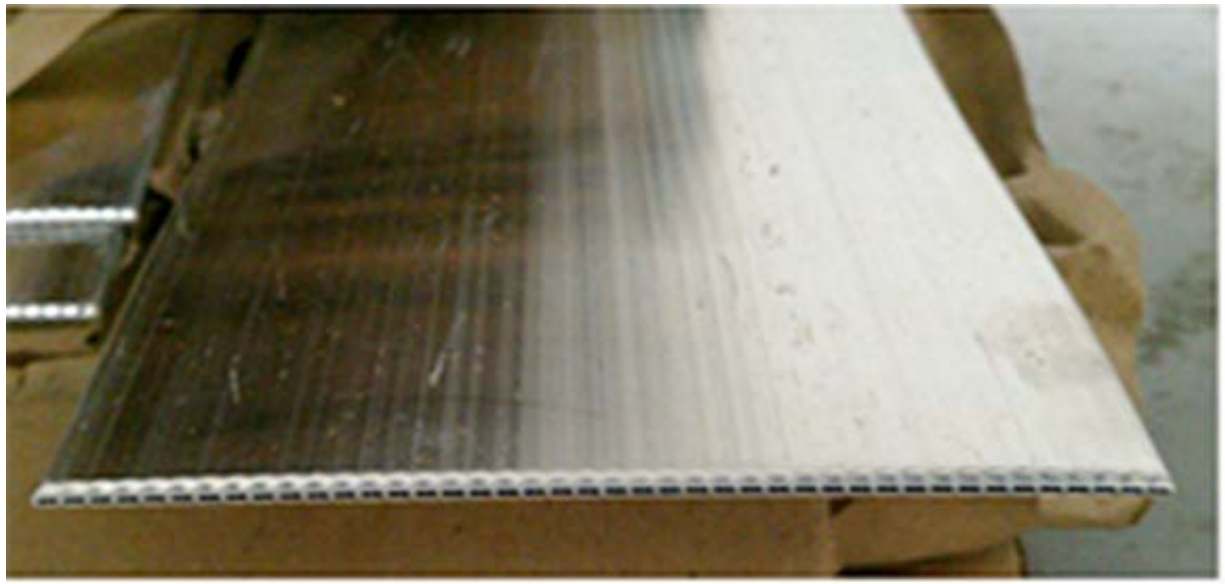
Improve Building Envelopes (EPC-16-067)

- Develop thermal building insulation material with high R-value at a cost commensurate with conventional insulation materials
- Includes packed nanoparticle bed to reduce the cost of manufacturing and lead to high mechanical strength.
- The goal is to develop insulation with a R/inch value of at least 9



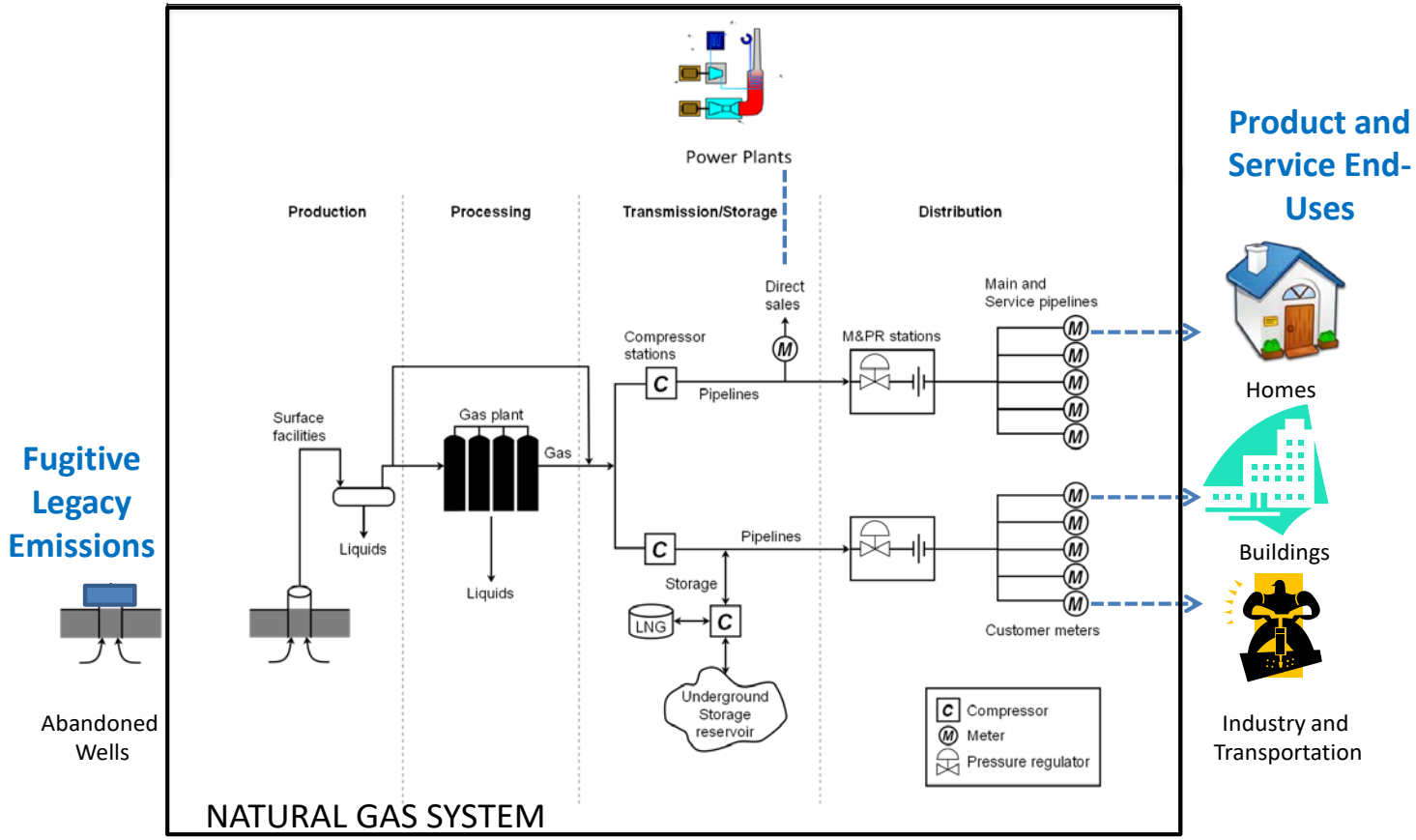
Increase Renewable Energy Use (500-15-006)

- Demonstrate aluminum mini-channel solar water heating collectors on residential buildings in the Los Angeles Basin
- Potential to reduce the upfront cost of solar water heating by 30%



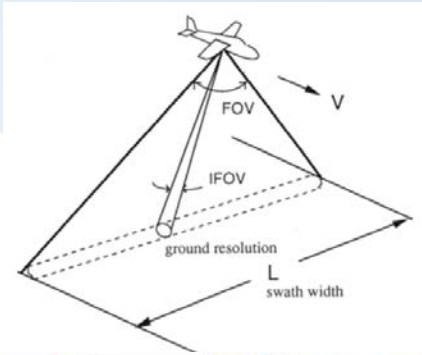
Research on Methane Leaks from California's Natural Gas System

- Traditionally, analyses of natural gas sector emissions only considered sources inside the black rectangle.
- CEC's research program has expanded this limited view to include other potential sources of emissions.
- Official GHG inventories do not include most of these "downstream of the meter" emissions.



Adapted from:
Franco, Ziaja, Hou, Bining. Methane Emissions Associated with Natural Gas Consumption in California. Unpublished draft CEC staff paper. 2015.

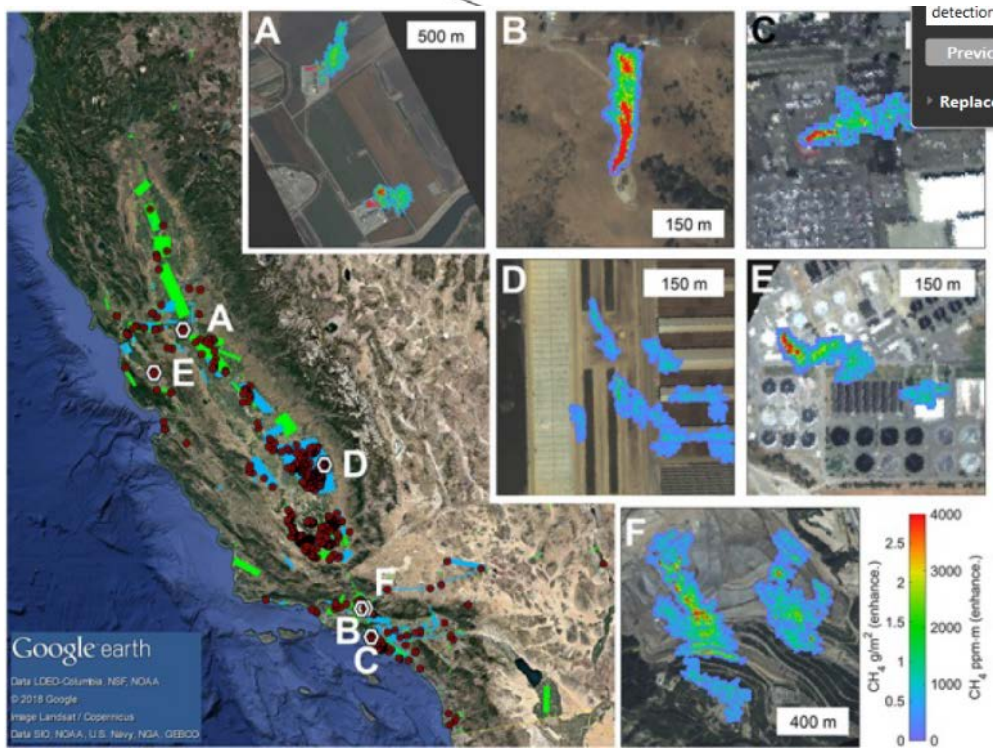
California Statewide Methane Survey for Point Sources



Led by JPL and recently published in *Nature*, a large field study funded by ARB, NASA/JPL, and CEC characterized point sources from multiple sectors based on airborne survey.[1]

Highlights:

- Point sources (>~ 10 kg/hr of methane) emit an equivalent to 34-46% of the state's 2016 methane inventory.
- Methane emissions from associated wells in the southern part of the SJ Valley are equivalent to about 4% of natural gas production.
- Results in all sectors investigated, including landfills and dairy farms, generally show discrepancies from results based on standard estimation methods.

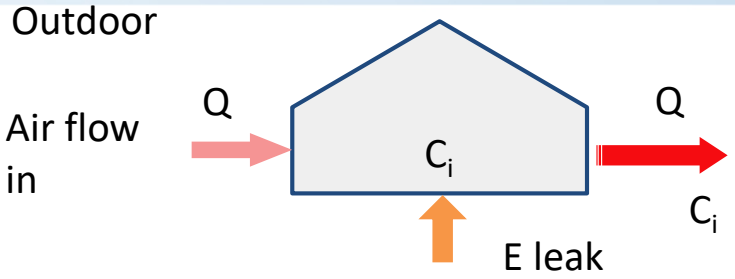


Source: JPL. Provided in support of CEC grant 500-15-004

1. Duren, R.M., Thorpe, A.K., Foster, K.T. et al. California's methane super-emitters. Nature 575, 180–184 (2019) doi:10.1038/s41586-019-1720-3.
Available online at: https://www.nature.com/articles/s41586-019-1720-3

Residential Behind-the-Meter Emissions

- A CEC-sponsored field study conducted measurements of residential behind-the-meter emissions in ~75 homes using blower door test.[1]
- Results suggest that leaked natural gas is ~0.5% of total residential consumption, valued at approximately $30,000,000 per year.
- CARB used results as basis for inclusion of residential post-meter natural gas leaks in the most recent GHG inventory (published 2019).[2]
- The PIER natural gas R&D funding request for FY 2019-2020[3] includes support for further characterization of methane emissions from the residential sector.



Source: LBNL. Provided in support of CEC grant 500-13-006.

1. Fischer, M. L., W. Chan, S. Jeong, and Z. Zhu (LBNL). 2018. *Natural Gas Methane Emissions From California Homes*. California Energy Commission. Publication Number: CEC-500-2018-021. https://ww2.energy.ca.gov/publications/displayOneReport_cms.php?pubNum=CEC-500-2018-021
2. See https://ww3.arb.ca.gov/cc/inventory/pubs/reports/2000_2017/ghg_inventory_00-17_method_update_document.pdf
3. See https://ww2.energy.ca.gov/2019publications/CEC-500-2019-035/CEC-500-2019-035.pdf

Additional, Ongoing Research on Methane Emissions Beyond the Residential Sector

- Field measurements in non-residential buildings, including hospitals and restaurants. (PIR-15-003, PIR-15-017)
- Field measurements in industrial sector, including: natural gas power plants, CNG fueling stations, etc. (PIR-16-014)
- Development of blueprint design for cost-effective continuous measurement of methane leaks across the entire NG system, including residential, commercial, and industrial sectors, as well as production fields. (PIR-17-015)