

Costs, Markets, and Funding Options in Accelerating the Bay Area's Building Electrification

**Presentation to BAAQMD
Stationary Source and Climate Impacts Committee**

by

Jeanne Clinton

former Energy Efficiency and Clean Energy Advisor to
the California Public Utilities Commission and the Governor's Office

April 19, 2021

Incremental costs to replace a gas furnace with an electric heat pump in a Bay Area single family home*

Incremental capital costs per home:

- \$3,580 SAVINGS for 40% of homes with both space heating and central A/C
- \$5,120 incremental cost for 43% of homes with central gas space heating and no A/C
- 5% equipment turnover per year

Operating cost change:

- Homes with A/C can save \$100-400 per year. Best technology & older and larger homes save the most.
- Homes without A/C will spend \$200 more per year on utility bills.

Conclusions:

- Best economics right now are for heat pumps in homes and climate zones using A/C – capital AND operating costs are **reduced** with heat pump HVAC.
- Incentives are critical for now to enjoy favorable economics in cooler regions.
- As technology and market costs decline, and if combined with solar PV, heat pumps can offer favorable economics in cooler regions without incentives.

* Energy and Environmental Economics, Inc. (E3), *Residential Building Electrification in California*, April 2019.

Could be \$3,200 additional cost if an electric panel upgrade is needed (Frontier Energy) but new technologies may avoid this (Redwood Energy). Full references on last slide.

Incremental costs to replace a gas water heater with an electric heat pump in a single family home*

Incremental capital costs per home:

- \$2,020 for 91% of homes with existing gas water heating
- 7% equipment turnover per year

Operating cost change:

- \$25-75 annual bill savings

Conclusions:

- Incentives and lower capital cost from technology innovation are essential to drive transition

* Same references as previous slide

Bay Area cost to upgrade single-family space & water heating

Incremental cost SAVINGS for homes with central air conditioning (A/C).

For 1,960,000 Bay Area single-family homes:

Total Regional Incremental Replacement Cost (over 20 years)

- Heat Pump space heating (with A/C) **\$2.8 billion capital savings**
- Heat Pump space heating (no A/C need) \$4.3 billion incremental cost
- Heat Pump water heating \$3.6 billion incremental cost (14 years)

Annualized Regional Total Incremental Costs

- Heat Pump space heating (with A/C) **\$140 million capital savings**
- Heat Pump space heating (no A/C need) \$216 million cost
- Heat Pump water heating \$252 million cost

Emerging technologies may reduce costs and avoid need to upgrade electric panels*

- New 120 volt equipment models can plug into existing house circuit without panel upgrade.
- New 240 volt high performance heat pump models lower electric operating costs.
- Smart Circuit Splitters and Sharing – enable two loads to share a circuit, alternating; crucial for 120V devices and avoiding panel upgrades.
- Programmable subpanels manage coincident power to stay within 100 amp panel limit.
- See extensive discussion, pictures, and specifications in Redwood Energy and Menlo Spark, *A Pocket Guide to All-Electric Retrofits of Single-Family Homes*, February 2021.*

*Funded in part by Bay Area Air Quality Management District. <https://redwoodenergy.net/wp-content/uploads/2021/02/Pocket-Guide-to-All-Electric-Retrofits-of-Single-Family-Homes.pdf>

Housing characteristics and demographics of Bay Area residents; income and equity considerations

- 7.2 million people (2010 Census)
- 2.8 million households, 56% owned, 44% rented
- 70% of Northern Coast Region residents live in single-family homes, 20% in large multi-family, 10% in small multi-family buildings (Rayef, NRDC)
- 45% of renter households are “cost-burdened”, spending > 30% gross income on housing; 23% spend > 50% (ABAG/MTC 2021)
- 608,000 low income households (i.e. earn < 80% Area Median Income) (Rayef, NRDC)
- 65% of low income households rent, 53% live in single-family homes
- 77% are rent-burdened, 47% are extremely rent-burdened

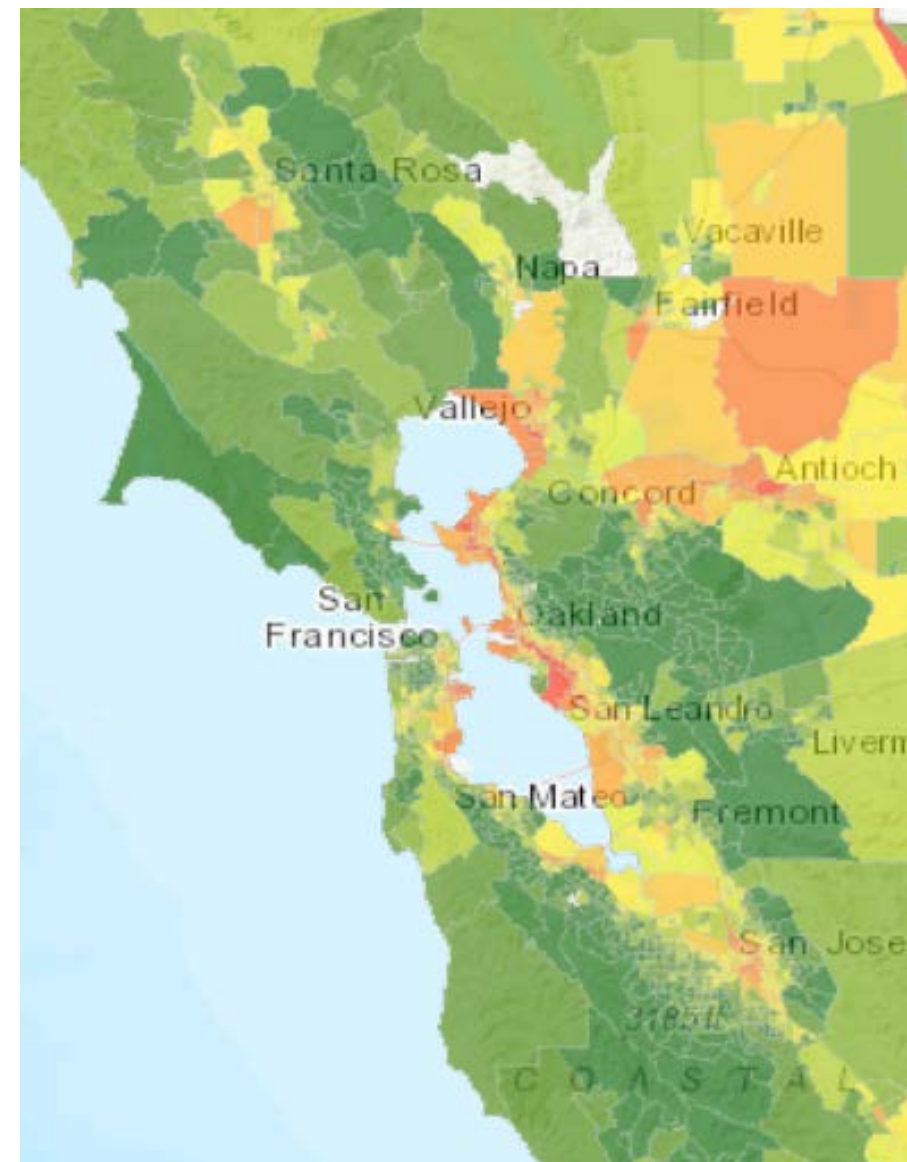
Equity and Health Considerations

Economic and Health Inequalities*:

- Orange areas are considered disadvantaged communities
- In the Bay Area, disadvantaged communities largely are found along the bay shoreline and in eastern Contra Costa.
- Bay Area could reap \$1.1 billion in annual health cost benefits if all gas appliances are replaced with electric models**
- Many low income households lack A/C or underutilize it for economic reasons. Adding efficient A/C with more affordable utility bills could provide significant improvements to indoor comfort and health, and mitigate poor outdoor air quality.
- A/C also is becoming more desirable to escape the effects of wildfire smoke and warmer temperatures in large portions of the Bay Area.

* <https://calenviroscreen-oehha.hub.arcgis.com>

**UCLA Fielding School of Public Health, April 2020.



Electrification Income and Cost Burden Considerations*

- 22% of ALL 2.8 million Bay Area households are low income.
 - 17% of ALL households are low-income *and* rent-burdened.
 - These 17% amount to 470,000 total households.
- It likely will be difficult for these residents on their own to support the added cost of low-NOx appliances, whether out of pocket or in seeking financing. This is especially so when some 60% are renters.

Example: Sharing the cost burden of single family retrofit electrification:

- Some 248,000 Bay Area households live in single family homes AND are both rent-burdened & low income.
- The **annual funding to subsidize 50% of full retrofit costs** for these 248,000 households (using costs from slides 3 and 4):
- \$93 million/year for space heating
 - \$36 million/year for water heating

* Rayef, *Housing Equity & Building Decarbonization*

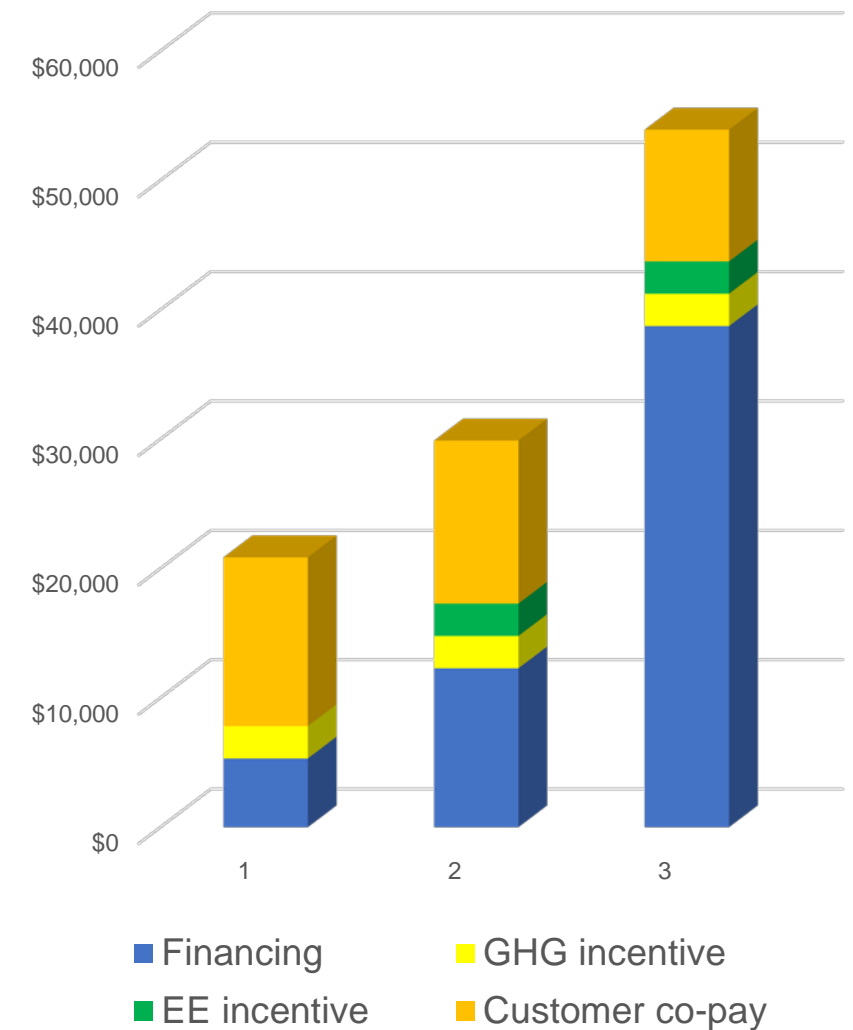
Closing the Cost Gap – A “Value Stack” of Incentives, Co-Funding, and Financing Essential

A borrowed example from Southern California*

Hypothetical transactions for Rancho Cucamonga home

- 1700 sq. ft. home, 1970s vintage
- High energy user: 11,107 kWh, 779 Therms, \$3,610 / yr @ 22 cents/kWh, \$1.50 / Therm

Annual operations	1. HVAC +DHW electrification	2. Electrification + Efficiency	3. Electrification + Efficiency + solar
Installation cost	\$17,112	\$24,804	\$43,929
Annual change in kWh	2,889	249	(9,770)
Annual change in Therms	(719)	(719)	(719)
Annual GHG savings, Mt CO ₂ e	(3.23)	(3.76)	(5.76)
Total annual bill savings	\$443	\$1,023	\$3,228
Annual TOB finance charge	\$354	\$819	\$2,582
Net annual bill savings	\$89	\$205	\$646



*From Bruce Mast et. al., *Towards an Accessible Financing Solution*, 2020.

Ability of residents to **self-finance** the costs of low-NOx replacement equipment

Existing Mechanisms -- can pay off all/some retrofit costs; work for some, but not all

- State Treasurer's Office CAEATFA* Residential Energy Efficiency Loan (REEL) financing –
 - below-market rates,
 - Longer loan terms,
 - flexible credit due to CPUC** - funded credit supports, but still consumer debt criteria.
- BAYREN Multifamily Building Enhancements (“BAMBE”) program for a wide range of upgrades, including electrification, on multifamily properties.
 - no-cost consulting,
 - cash rebates, and
 - access to financing. Qualifying projects can receive loan capital at 0% interest for up to 50% of the project financing.
 - Targets buildings < 100 units, affordable properties, in disadvantaged communities, and/or resident ownership.
- Local government Tariff on Bill (initiated in Bay Area by Sonoma Water and Hayward)

* California Alternative Energy and Advanced Transportation Financing Authority

** California Public Utilities Commission

Possibilities to **expand** numbers of households **financing** low-NOx appliances

- **CPUC Clean Energy Finance case** will consider proposals later this year after public workshops this summer and fall to review needs, vet possibilities, and consider good models.
 - Could include utility or CCA “Tariff on Bill” mechanisms. These use:
 - Utility or social capital,
 - Cost recovery on utility bill over life of equipment,
 - No consumer credit hurdle,
 - Successor occupants continue to pay-off.
 - May help engage rental properties if landlord co-pays a reasonable share of upgrades.
 - AQMDs’ collaboration and standards could propel market uptake.
- **ABAG \$1 million initial commitment to Tariff On Bill financing** will focus on deployment via water districts. Bill savings determines amount that can be financed. Could help low & moderate income and rental households adopt electrification.
 - Heat pump water heaters possible if economics work; incentives or co-pay likely needed.
 - Sebastopol likely first new community to enroll.
 - Others in North and South Bays in active discussions.

Existing **Co-Funding** helps cover most or all the incremental cost, especially for homes with A/C

California residential decarbonization incentives and market support:

- **Utility incentives** of \$1,000 to \$4,500 for space heating, \$300 to \$1,200 for water heating from
 - Investor-owned utilities (IOUs), e.g. PG&E,
 - Community Choice Aggregators (CCAs), e.g. EBCE, MCE, PCE, San Jose, Silicon Valley, Sonoma),
 - Publicly-owned utilities (POUs), e.g. Cities of Palo Alto, Alameda.
- IOU four-year pilot using \$53 million for the statewide “TECH” decarbonization **market transformation** program. This aims to reduce retrofit technology and installation costs through incentives targeting manufacturers and distributors to stock and promote quality electric heating systems.
 - Additional \$21 million for localized pilots, including low income and multifamily uptake .
 - Successor spending and program(s) depend on pilot outcomes.
- BayREN/AEA **Multifamily** clean heating pilot for whole-building electrification (partially funded by BAAQMD). **Targeted at low income and air-quality impacted areas**. Incentives of \$1,000 / unit for in-unit heat pumps, or up to \$15,000 for central heat pump water heating.

Existing **Co-Funding** can cover even more of the incremental cost for many low income households

Low Income efficiency (and some decarbonization) funding:

- **IOU Energy Savings Assistance** -- \$400 million per year for efficiency direct-installations; heat pumps under consideration. Coordinated with CCAs. (CPUC)
- TECH pilot **will seek localized pilots** to support uptake by low income households. (CPUC)
- Calif. **Department of Community Services & Development** has small & varying levels of federal funding and Greenhouse Gas Reduction Funds (GGRF) for low income weatherization, including efficient electric appliances. Most GGRF funding coming to an end. (CSD and Legislature)
- CCA low income full-cost direct installation programs (**Peninsula Clean Energy** launches 2021)

Prospective Co-Funding and Financing Possibilities

Policy focus must address solutions to reach low income and rental populations.

Future possibilities:

- ? State Greenhouse Gas Reduction Fund (“cap and trade” proceeds) could support low-NOx, GHG-reducing heating technology with support of State Legislature and CARB on GGRF fund allocations. Already supports electric vehicle rebates.
- ? Healthcare industry contributions based on improved indoor AQ and reduced health care service needs for ? (E.g. Contra Costa County pilot to combine health and energy efficiency funds)
- If utilities and public agencies can offset enough of the installation costs, then existing and new finance mechanisms may be able to finance the remaining costs for many, but not all, households.
- Tariff on Bill financing of keen interest to help renters and those with challenges or barriers to utilizing direct consumer credit.

Local Government and Market Support Can Help*

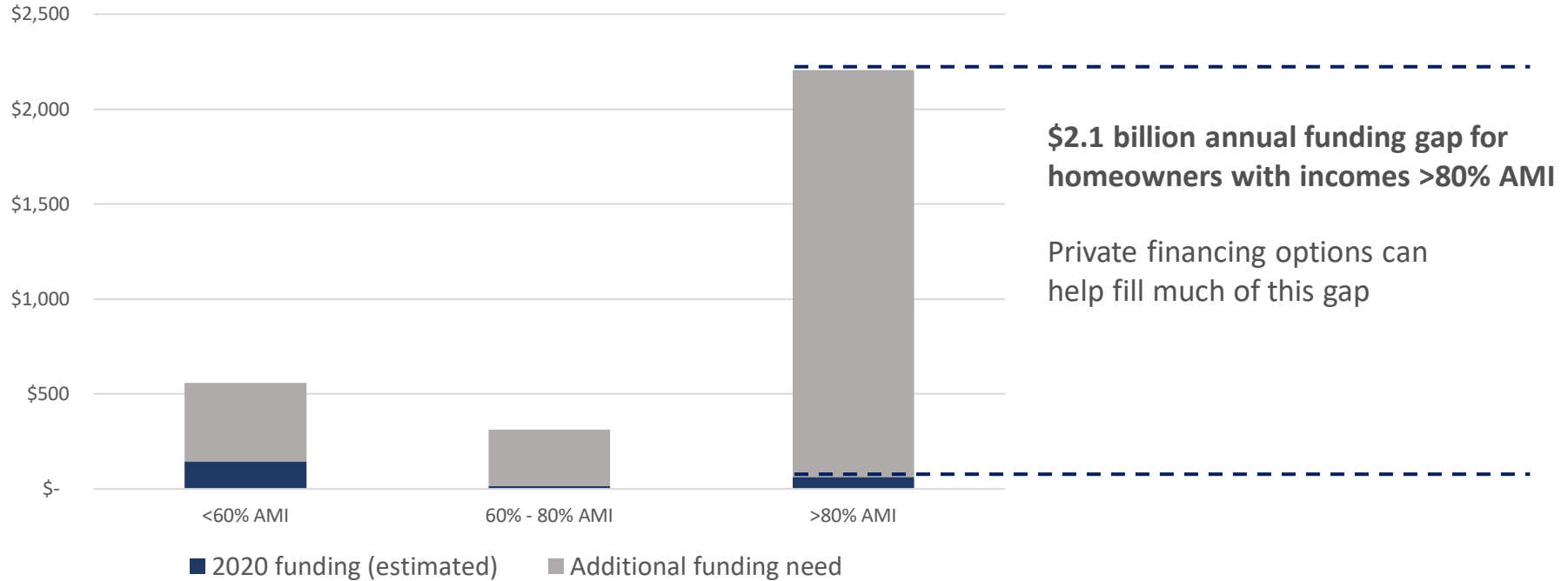
- Bay Area local governments -- Might streamline permit processes and/or waive/reduce fees for permits for the installation work, esp. if a panel upgrade is required. This could be part of local climate action plans.
- Utility decarbonization programs -- Support contractor familiarization with new technology, training, & minimum standards for electric space & water heating replacements. Via TECH pilot or later scale-up.
- HVAC industry – A "certified participating contractor" designation giving qualified contractors an easier sales path with better pricing offers (e.g. SMUD half-price contracts for low income retrofits).
- Consumer awareness and protection initiatives -- Contractor qualifications, project design/specification assurance, possibly supported by State, local governments, utilities.
- Phasing considerations:
 - Warmer Bay Area regions with air conditioning (40%) see the best economic gains because heat pumps provide both heating and cooling. Could start here?
 - Incentive boosts and/or a program to attract lower contractor prices, can make heat pump water heaters (especially plug-in 120 Volt models) the next best gas appliance replacement candidates?
 - The economic case may be harder for smaller multifamily rental properties, where a “split incentive” means the owner pays capital costs while residents pay the utility bills and would capture any savings

* See greater discussion in *Multifamily Clean Heating Pilot*, by Association for Energy Affordability, December 2020.



Colin Bishopp, Executive Director
Colin@PACENation.org









**Bay Area Counties – Total Funding Needed (from all sources)
Annually for Full Electrification vs. Actual 2020 Funding
(estimated)
(\$, millions)**



Estimates based on CA average numbers of single-family homes in each income group, found in "Assessment of Low Income Homeowner Participation in the Property Assessed Clean Energy (PACE) Program in California," Energy Programs Consortium, 2016

Assumes equal per-home cost of retrofits between income groups.

Funding availability by income level (illustrative)

Funding source	<60% AMI (<\$35,000)	60% - 80% AMI (\$35,000 - \$49,000)	>80% AMI (>\$50,000)
Federal incentives (WAP, LIHEAP)			
Energy Savings Assistance Program			
Low Income Weatherization Program			
Healthy Home Loan Program (e.g. SCEIP, Delaware Septic Rehab Loan Program)			
Residential PACE			
Unsecured lending			
HELOC			
American Jobs Plan (potential)			

Less funding available  More funding available

Income levels and programs (WAP, LIHEAP, ESA, LIWP) sourced from “Assessment of Low Income Homeowner Participation in the Property Assessed Clean Energy (PACE) Program in California,” Energy Programs Consortium, 2016

Filling the Gaps – One Model to Consider



LOGIN

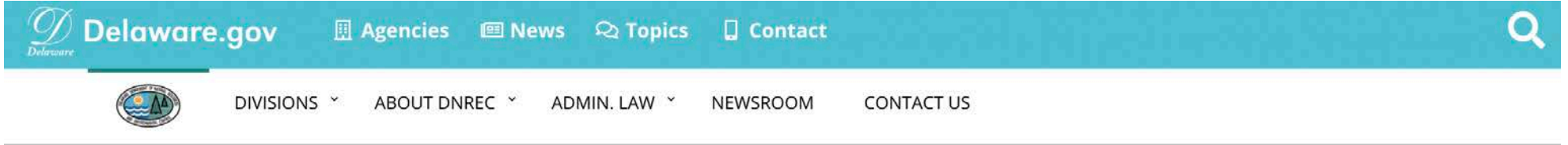
HOME ABOUT SCEIP FAQs PROGRAM EXPANSION ELIGIBLE IMPROVEMENTS FIND A CONTRACTOR ESTIMATE YOUR PROJECT GET STARTED ▾

Sonoma County Energy Independence Program (SCEIP)

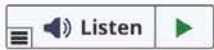
Now Financing Wildfire Safety and Seismic Strengthening Improvements!

- Highly successful model with established “co-funding” practices
- Potential central administrator for BAAQMD

Filling the Gaps – Second Model to Consider



Septic Rehabilitation Loan Program



The Septic Rehabilitation Loan Program provides low-interest financing to replace failing septic systems and cesspools with on-site wastewater disposal systems that will function in an environmentally sound and cost effective manner. The program also provides funding for new septic construction and costs associated with connecting to central sewer systems.

- For low-income homeowners only
- Funded by the Clean Water State Revolving Loan Fund, a potential source for BAAQMD

Costs of Decommissioning Natural Gas Infrastructure

A few points:

- Total society-wide costs resulting from the transition away from natural gas are difficult to quantify, but will be significant
 - 2019 Study by Wood Mackenzie estimated the cost at \$4.5 trillion*
- Significant costs will be borne by ratepayers and taxpayers
- Historically, in analogous situations, low-income homeowners have borne far more than their share of the cost burden

*See: [https://www.woodmac.com/press-releases/decarbonising-us-power-grid-may-cost-us\\$4.5-trillion](https://www.woodmac.com/press-releases/decarbonising-us-power-grid-may-cost-us$4.5-trillion)

And also: <https://www.imf.org/external/pubs/ft/fandd/2019/12/the-true-cost-of-reducing-greenhouse-gas-emissions-gillingham.htm>

Takeaways

- The funding required for full residential electrification is significantly greater than many realize. Infrastructure outside the home must also be upgraded.
 - Annual funding gap in Bay Area counties for homeowners below 80% AMI is at least \$709 million
- For homeowners below 80% AMI there aren't enough grants and rebates and there are very few financing options. PACE is one financing option that has demonstrated an ability to scale, but it's not for everyone.
- In order to electrify all single family homes in the BAAQMD, significant additional *financing* support will be required, alongside available grants, rebates and subsidies.
- BAAQMD has in its backyard at least one model that can be replicated and scaled up: SCEIP.



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AGENDA: 4

Rule Development Concepts for Building Appliance Regulation

Stationary Source and Climate Impacts
Committee Meeting

April 19, 2021

Jennifer Elwell
Senior Air Quality Engineer
jelwell@baaqmd.gov

Presentation Outcome



- Provide information and updates on the development process for amendments to rules impacting building appliances
- Receive feedback from committee members on the presented concepts and direction

Presentation Outline



- Background
- Initial Rule Concepts
- Potential Challenges
- Tentative Timeline

Presentation Requested Action



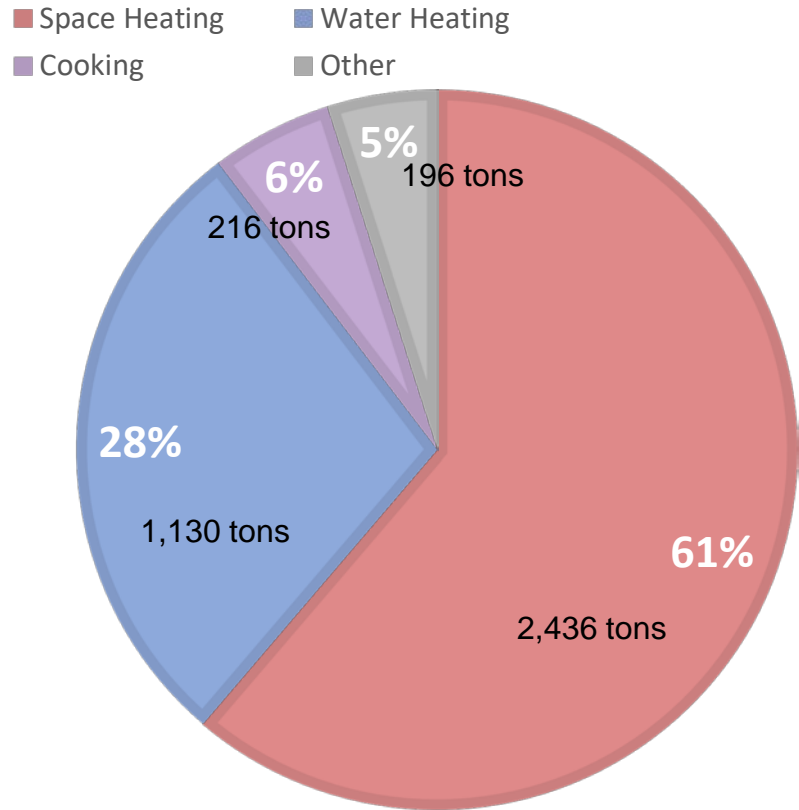
- None; informational item

Background: Rules for Update

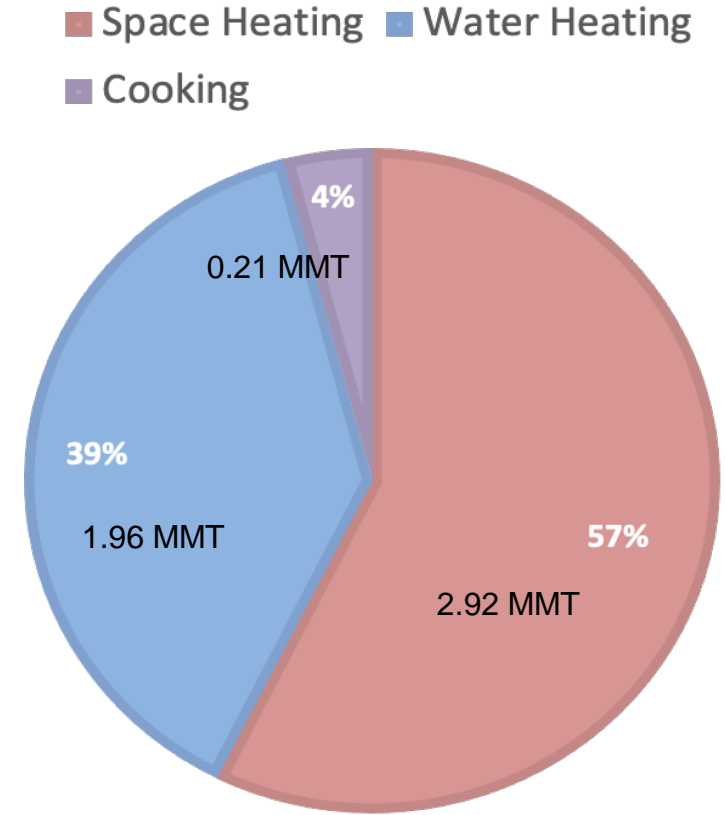


- To address Oxides of Nitrogen (NO_x) emissions associated with buildings, amend:
 - Regulation 9, Rule 4 (Rule 9-4): Nitrogen Oxides from Fan Type Residential Central Furnaces
 - Regulation 9, Rule 6 (Rule 9-6): Nitrogen Oxides from Natural Gas-Fired Boilers and Water Heaters
- Separate effort for Regulation 9, Rule 7 (Rule 9-7): NO_x from Boilers, Steam Generators, and Process Heaters
 - Different emissions sources
 - Different stakeholders

Background: 2019 Emissions

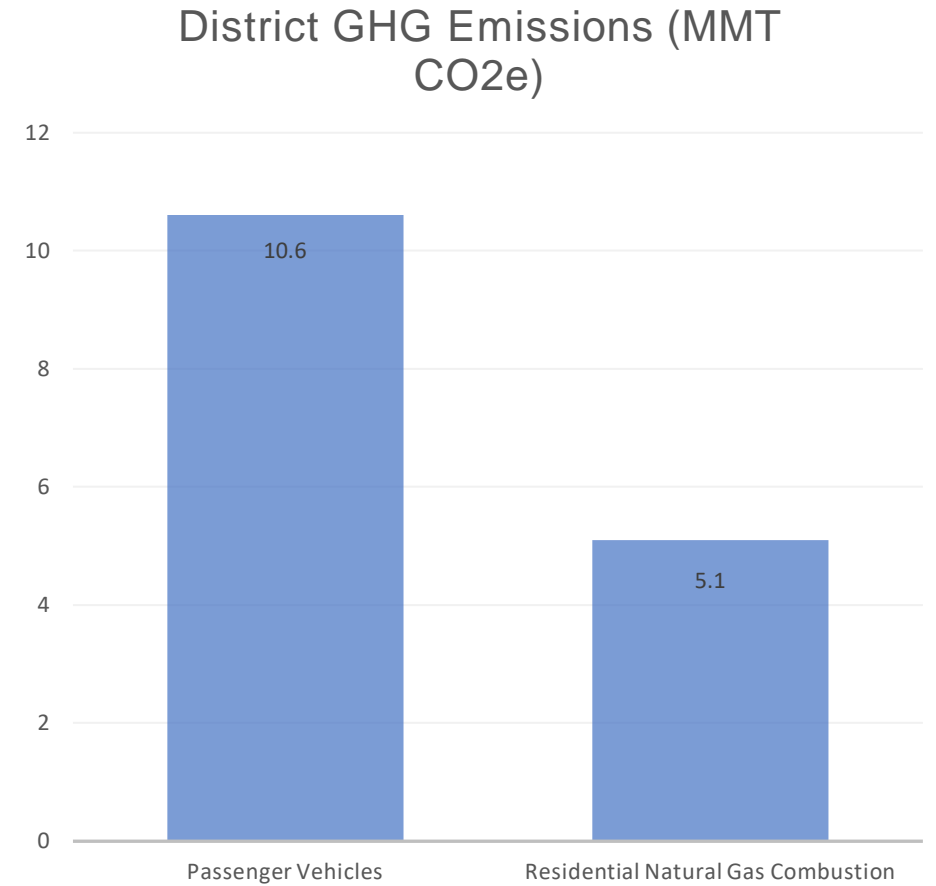
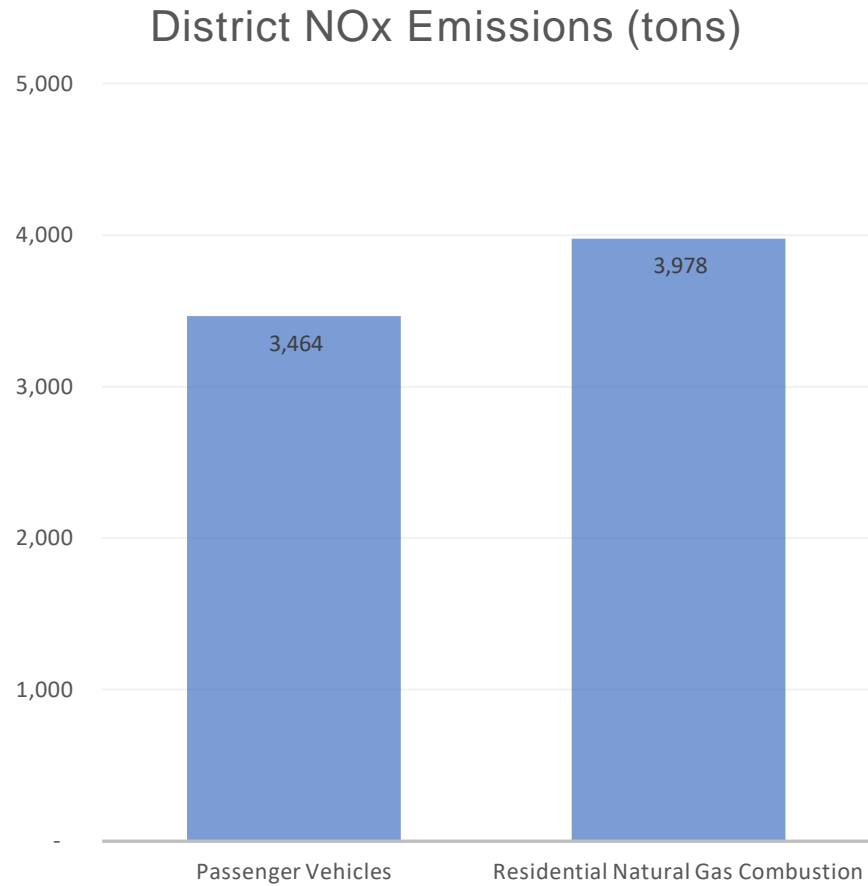


District Residential Natural Gas Combustion
NOx Emissions (tons)



District Residential Natural Gas Combustion
GHG Emissions (MMT CO2e)

Background: 2019 Emissions



Initial Rule Development Concepts



1. Updated ultra-low NO_x standards that align with South Coast and San Joaquin Valley with a short-term compliance schedule and;
2. Introduction of a technology-forcing zero emissions NO_x standard with a longer-term compliance schedule

Potential Emission Reductions



	Stage 1: Ultra-low NOx Standard		Stage 2: Zero NOx Standard*	
	NOx Reduction	Greenhouse Gas (GHG) Reduction	NOx Reduction	GHG Reduction
Rule 9-4 (Furnaces)	65%	N/A	98%	85%
Rule 9-6 (Water Heaters)	N/A	N/A	96%	85%

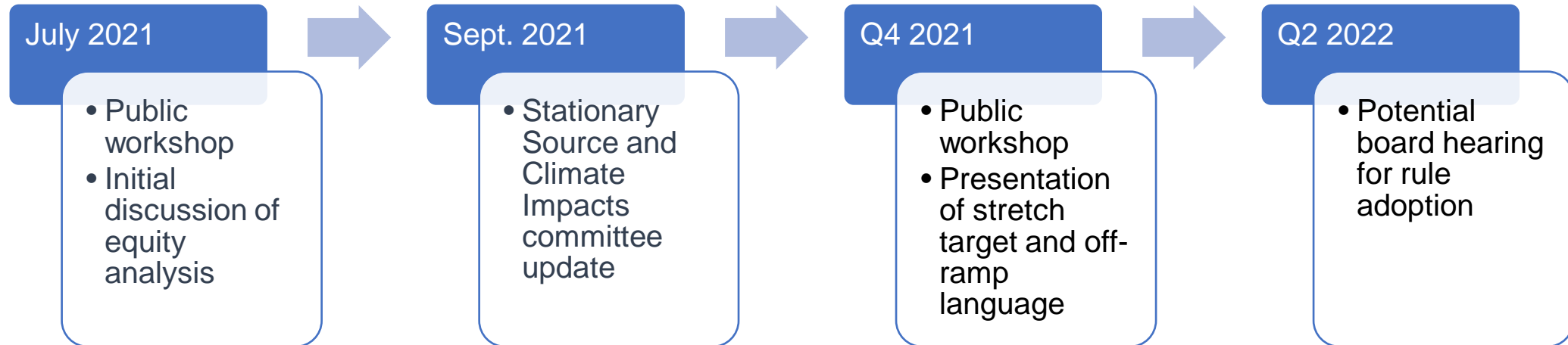
**Assuming electric replacements, 2018 PGE Base Plan (15% NG Power Plants, operating at 5 ppm NOx)
All potential reductions on a per-unit-replaced basis*

Potential Challenges



- Market Readiness
 - Air District effort complemented by city and county “reach codes”, increased proliferation of zero-emission solutions
- Cost of Compliance
 - Point of sale regulation – costs borne by individual consumers
 - Staff will seek to further understand and mitigate these concerns
- Regulatory “Off-Ramp”
 - In the case of unforeseen challenges (technology, financial hardship)
 - Structure to be determined based on public engagement process

Tentative Timeline



Feedback Requested/Prompt



- Questions and comments?



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AGENDA: 5

Source Test 101

**Stationary Source and Climate Impacts
Committee Meeting
April 19, 2021**

**Elaine Ko
Supervising Air Quality Engineer
eko@baaqmd.gov**

Presentation Outcome



- Learn about the Air District's Source Test team
- Understand the pros and cons of increasing the number of source tests currently being performed by Air District staff

Presentation Requested Action



- None; informational item

Meteorology and Measurement



Facilities

Communities

Source Testing

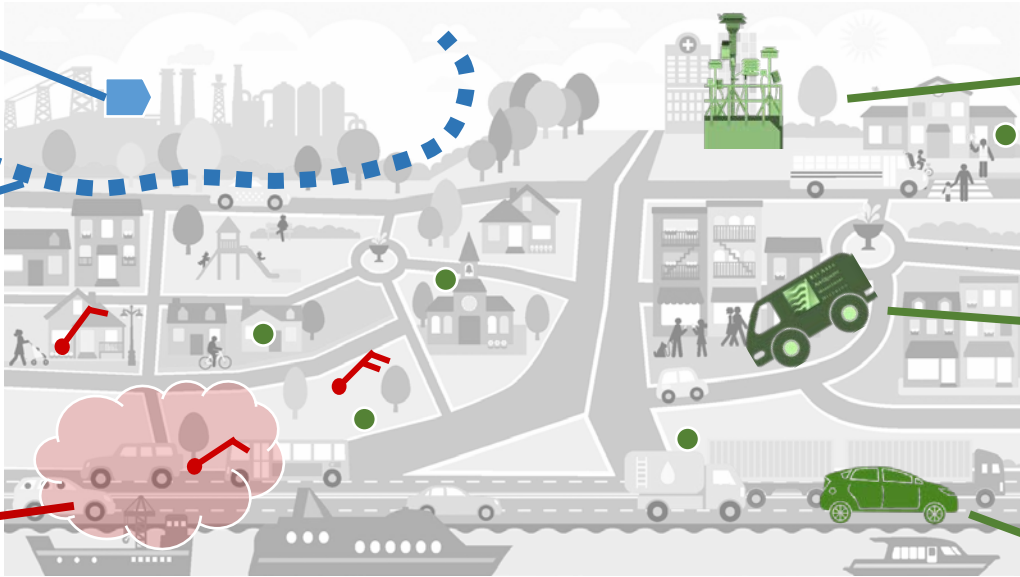
Emissions from facilities

Fence line Monitoring

Facility emissions that may impact communities

Meteorology

Air quality forecasting for Spare the Air, Wildfire smoke updates and advisories



Regional Network

High accuracy equipment at 30+ stations in the Bay Area

Portable/Mobile Monitoring

High accuracy equipment on a moving vehicle or temporarily sited

Hyperlocal Monitoring

Medium accuracy equipment to measure block-by-block air pollution

Sensor Networks

Technical support for low cost, real-time sensors for higher density data, community-led science

Source Test 101: Presentation Outline



Who conducts tests

Testing methods and data review

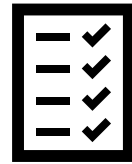
How is data used

Key projects

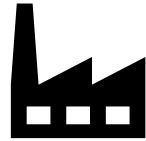
Research new technologies



Roles for Source Testing



Method Review



Sampling



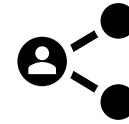
Sample Processing



Draft Report



2 Levels of Review



Report Available

Conducted by Staff



Reviewed by Staff



Done by Air District Staff



Done by Contractor

Source Categories and Number of Tests* (2019)



	Conducted by Staff	Reviewed by Staff**
Refineries	32	190
Power plants	3	16
Cement/asphalt/concrete production	2	19
Landfills/compost facilities	8	33
Wastewater treatment plants	20	24
Bulk terminals	34	10
Cargo tanks	233	0
Gasoline dispensing facilities	69	2,730
Other	11	127

* Each test in the table includes multiple compounds

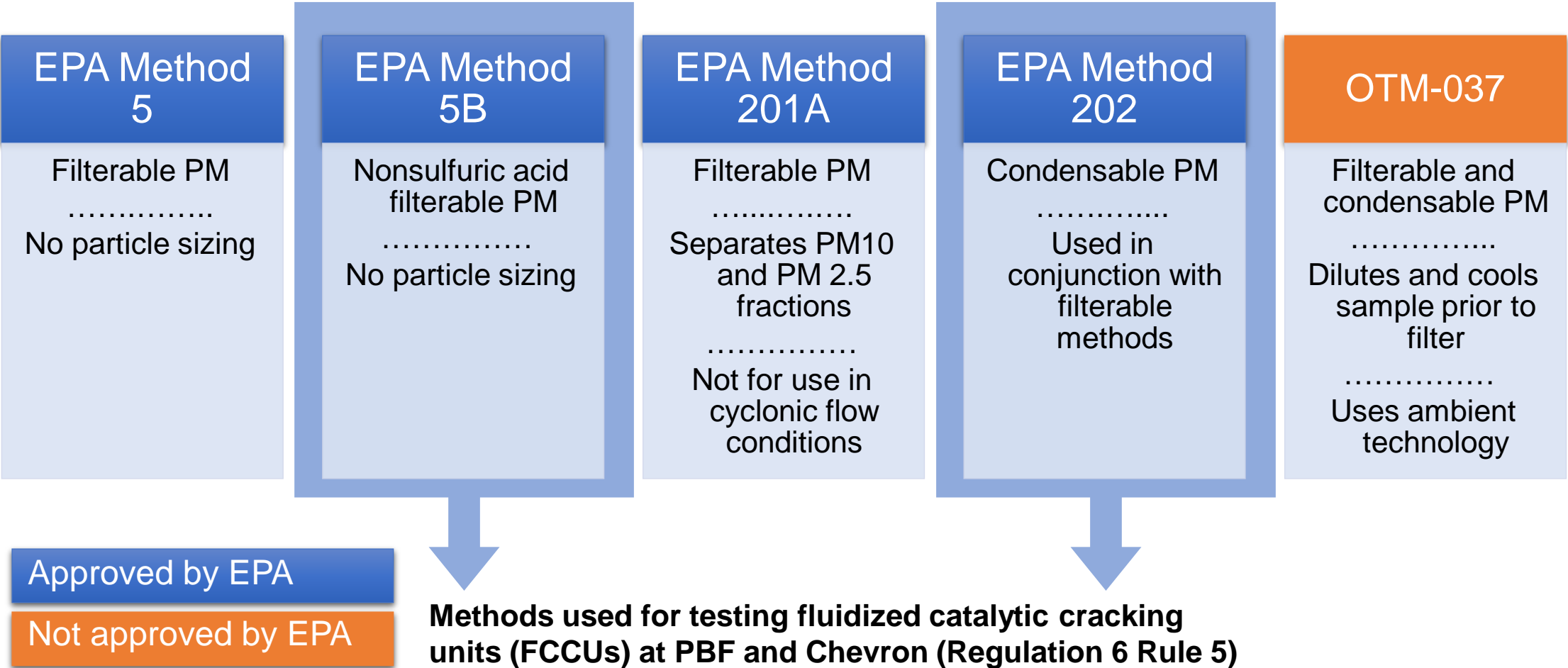
** Ensure third party protocol, testing, quality control, and quality assurance meets standards

Options for Who Conducts Source Testing



- Currently: Some source testing conducted by staff, majority conducted by contractors and reviewed by staff
 - Combines high volume/scaling of contractor testing with District derived data
- All Title V source testing conducted and reviewed by staff
 - Could delay testing for rules, permitting, and enforcement AND/OR
 - Requires more dedicated resources (Estimated to be at least 12 additional Full Time Employees (FTEs), \$2 Million in initial capital expenses, \$125K and \$600K per year in additional capital and operating expenses)
- All tests conducted by contractors and reviewed by staff
 - Review is more rigorous, more staff time allocated to witnessing tests

Example Method Review: Particulate Matter Methods



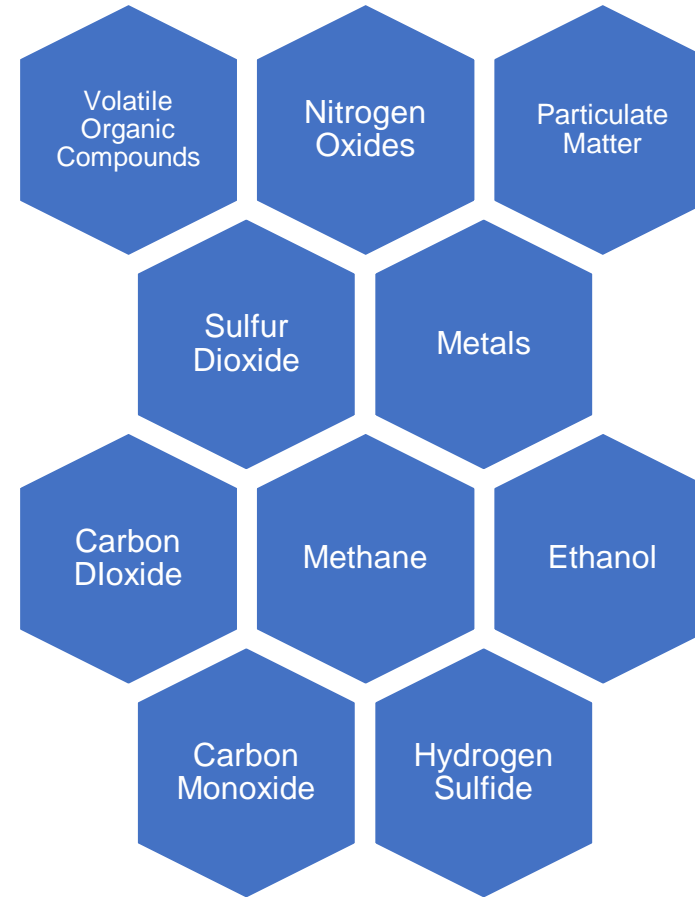
Sampling



Sample Processing and Analysis



Samples are broken down into their components and quantified



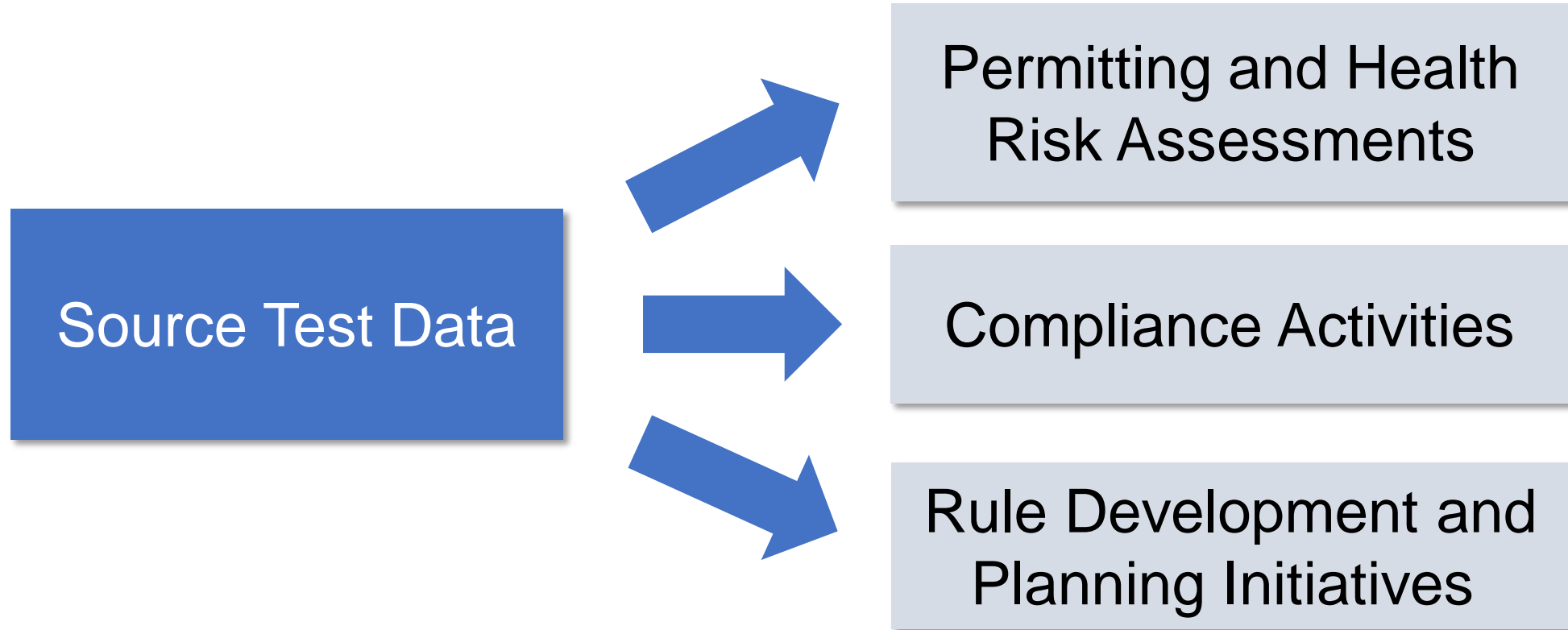
Public Records Requests for Source Test Reports



A screenshot of the Bay Area Air Quality Management District website. The top navigation bar is blue and contains the following links: Languages: English, About the Air District, News & Events, Online Services, Publications, Forms, Public Records (highlighted with an orange box and an orange arrow pointing down), Contact Us, and Login. Below the navigation bar is the BAAQMD logo and tagline: "BAY AREA AIR QUALITY MANAGEMENT DISTRICT A HEALTHY BREATHING ENVIRONMENT FOR EVERY BAY AREA RESIDENT". To the right of the logo is a search bar with a magnifying glass icon and the text "popular searches: Refinery Rules, Climate, Asbestos". Further right is a "Public Data Cen" icon. Below the search bar is a teal navigation bar with the following categories: ABOUT AIR QUALITY, RULES & COMPLIANCE, PERMITS, COMMUNITY HEALTH, PLANS & CLIMATE, and FUNDING. The main content area features a large banner with a background image of a man working at a computer. The banner text reads: "Support for Businesses Aiding COVID-19 Response" and "Air District to expedite permits for businesses aiding in public health response". A white button with the text "APPLICATION INSTRUCTIONS" is positioned at the bottom center of the banner.

www.baaqmd.gov

How is Source Test Data Used



Key Projects



Oversight of Fenceline Monitoring at refineries



.....
Investigate odors that can be attributed to 3 South Bay waste facilities



Research New Technologies



Goals	Technologies Evaluated
Monitor ammonia continuously, in a way that is comparable to existing point-in-time methods	Ammonia Continuous Emissions Monitors (CEMS)
Sampling equipment that can be used in area sources like landfills and compost piles	Flux chamber



Questions?



- Questions/Feedback