Building Appliance Rules: Exposure and Equity Assessment

Advisory Council Meeting
April 11, 2022

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Outcome

- Informational only

- Improved understanding of the distribution of $PM_{2.5}$ impacts from natural gas combustion for residential and commercial space and water heating

Focus of this presentation is:

- NG appliances only (no background / other sources)
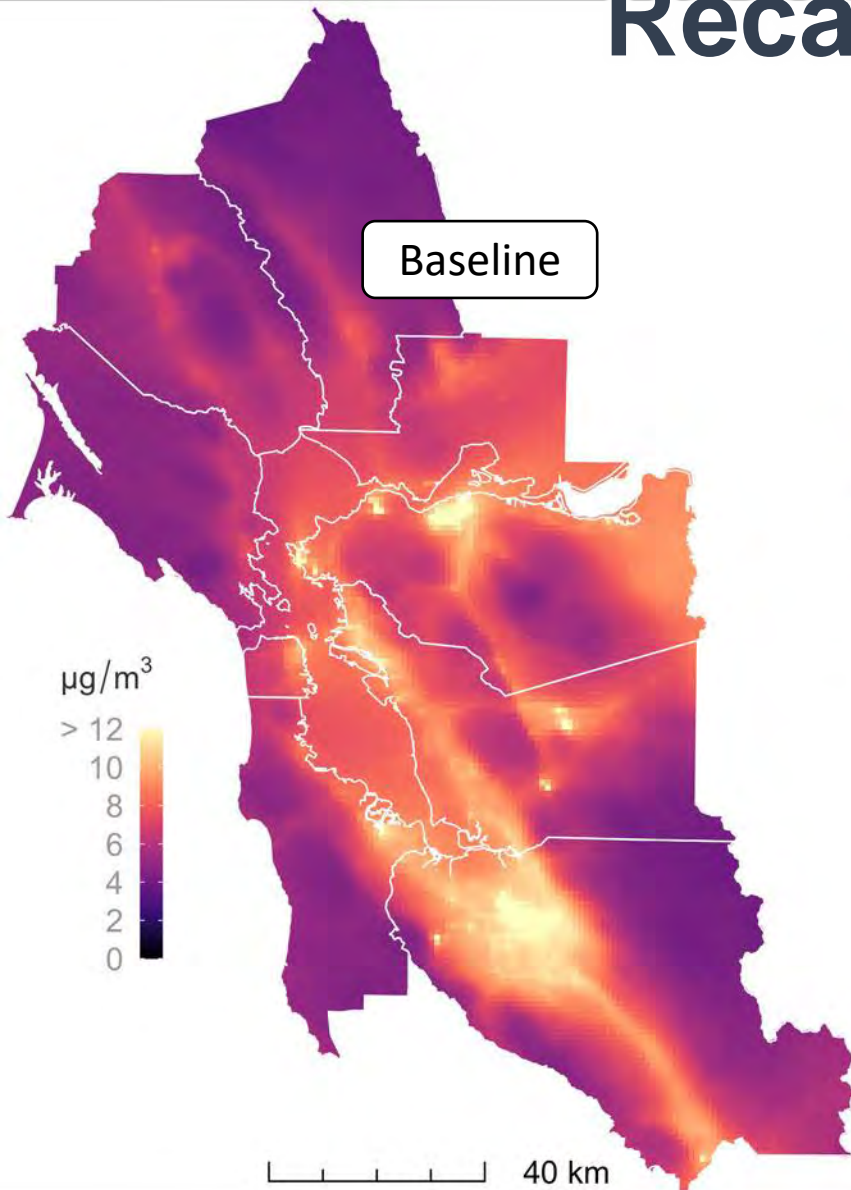- Total (= primary + secondary) $PM_{2.5}$

Key finding: People of color more impacted

- Regionally: Asian / Pacific Islander
- Within counties: African-American / Black or Hispanic / Latino
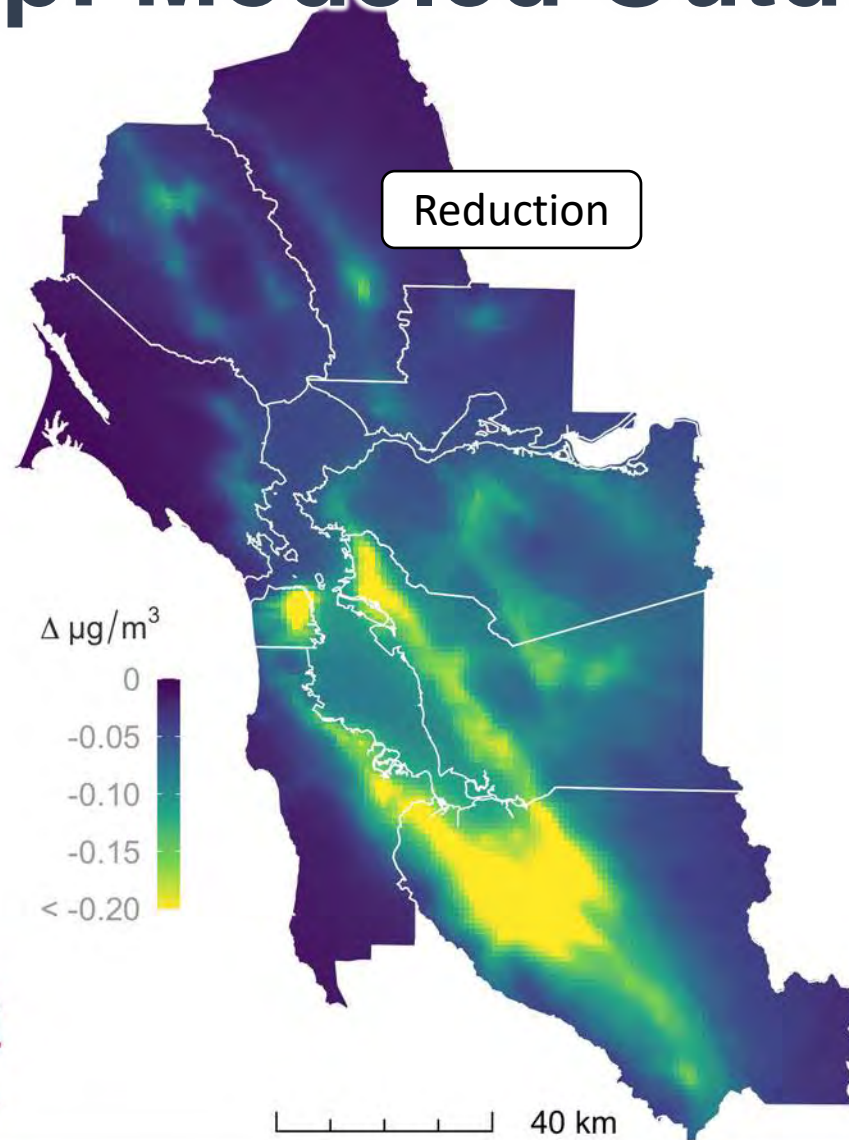
Recap: Modeled Outdoor PM$_{2.5}$

Baseline

Reduction

μg/m³

> 12
10
8
6
4
2
0

Δ μg/m³

0
-0.05
-0.10
-0.15
< -0.20

40 km

40 km

Baseline (Left Map)

- Annual average outdoor *concentrations*, 2018
- Of total (secondary <u>and</u> primary) PM$_{2.5}$
- Attributed to all sources in modeling domain*

Reductions (Right Map)

- From elimination of NO$_x$ <u>and</u> primary PM$_{2.5}$ emissions from Bay Area NG-fueled commercial & residential space/water heating**

* Not just NG appliances. Includes some sources outside SF air basin.
** Excluding permitted sources.

Modeled PM$_{2.5}$ Exposure

Bay Area average: +0.14 ug/m^3
- Weighted by 2020 residential population
- All other sources = 8.7 µg/m^3

Generally follows population gradient
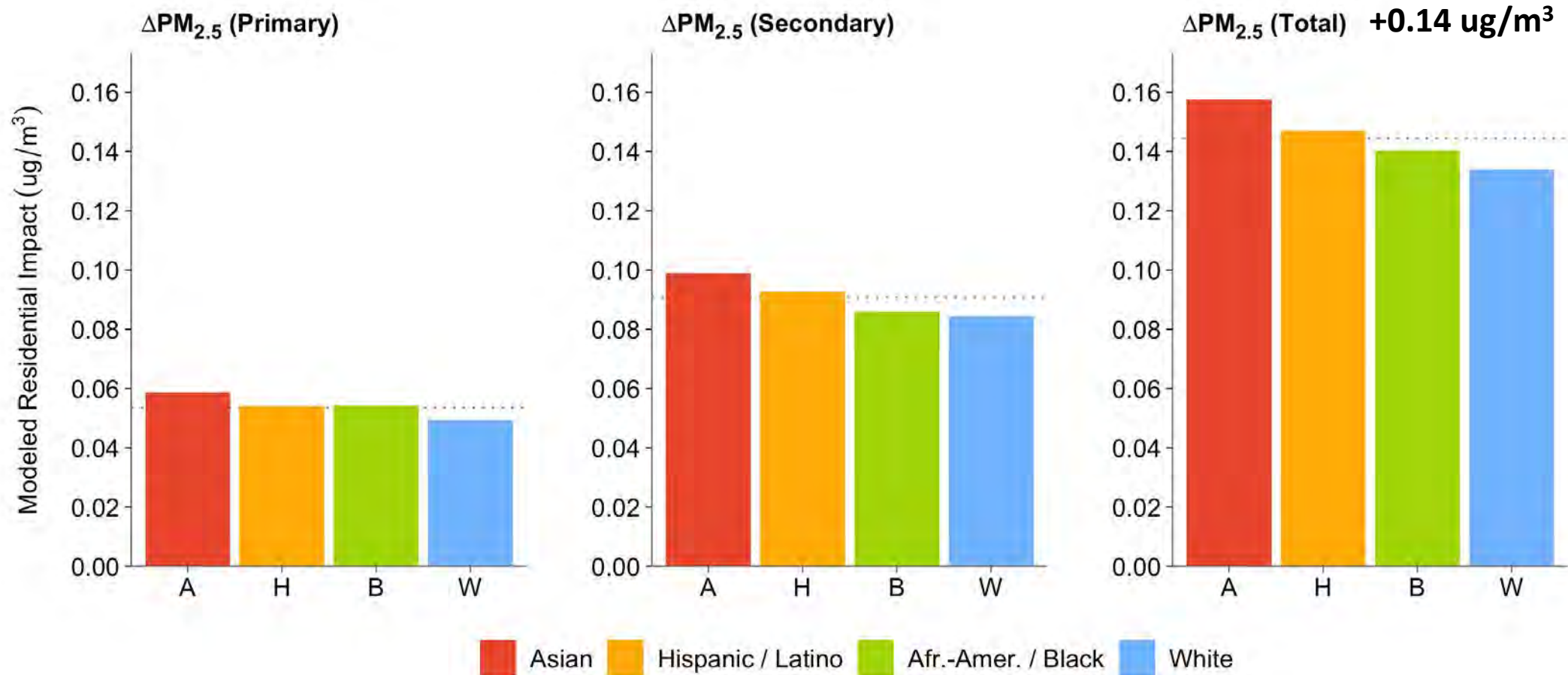- Modified by transport and chemistry
- Residential emissions > commercial

Varies by county and race/ethnicity
- Between-county variation much larger

Population (2020)
- 🔵 White
- 🟠 Hispanic / Latino
- 🔴 Asian / Pacific Islander
- 🟢 African American / Black
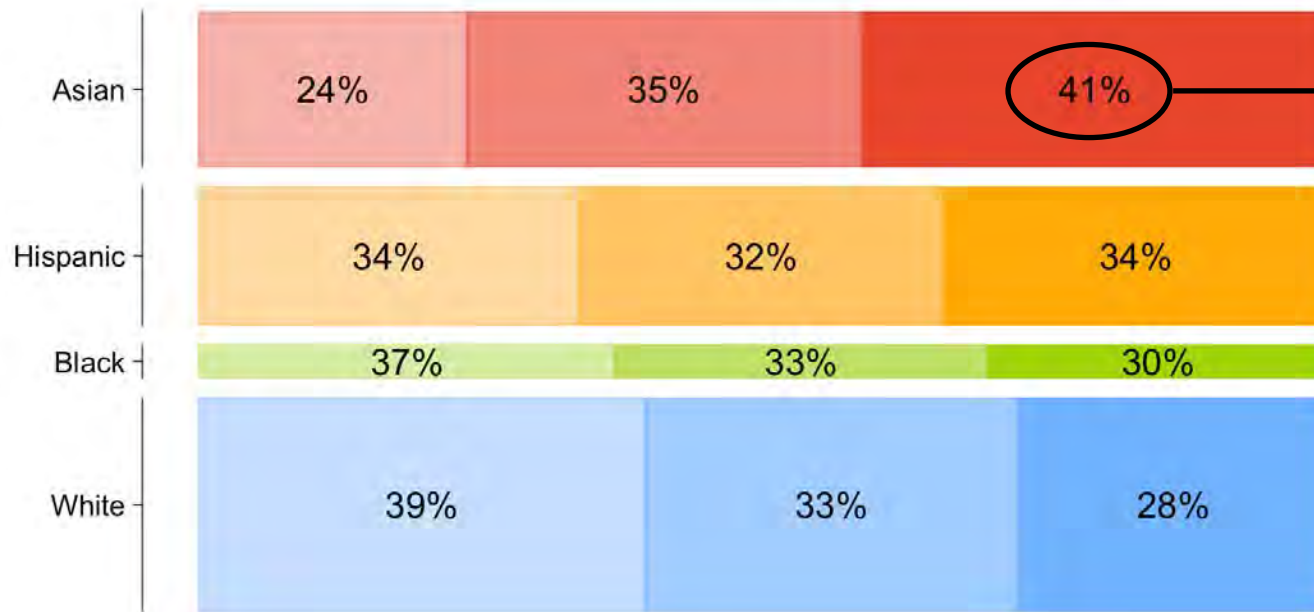
Primary *vs.* Secondary PM$_{2.5}$

Race/Ethnicity *vs.* Total PM$_{2.5}$

Impact attributed to modeled appliances

PM$_{2.5}$ (μg/m^3)   Low: 0.00 to 0.10   Mid: 0.10 to 0.18   High: 0.18 to 0.38

	Low	Mid	High
Asian	24%	35%	41%
Hispanic	34%	32%	34%
Black	37%	33%	30%
White	39%	33%	28%

Equality vs (Modeled) Reality

- If impacts were distributed equally, we would see 33% of each racial/ethnic group in each tertile (Low, Mid, High)

- Instead, we see 41% of Asian residents at "High" level, vs 24% at "Low"

- Pattern reversed for white residents

Within Counties, a Different Pattern

|	White	Hispanic	Asian	Black	(average)
PM2.5 (Total), ug/m3					
Santa Clara	0.21	0.21	0.21	0.21	0.21
San Francisco	0.17	0.18	0.16	0.17	0.17
Alameda	0.15	0.16	0.16	0.17	0.16
San Mateo	0.12	0.13	0.10	0.12	0.12
Contra Costa	0.09	0.09	0.10	0.09	0.09
Napa	0.08	0.09	0.07	0.07	0.08
Sonoma	0.06	0.07	0.07	0.07	0.07
Solano	0.06	0.07	0.06	0.07	0.07
Marin	0.06	0.07	0.06	0.06	0.06
(average)	0.13	0.15	0.16	0.14	0.14

Variation by race/ethnicity
- About ±5% (±0.02 µg/m^3)
- In each row at left, the most-impacted group is highlighted

Between-county variation
- About ±30% (±0.08 µg/m^3)
- Larger than racial/ethnic variation *within* counties
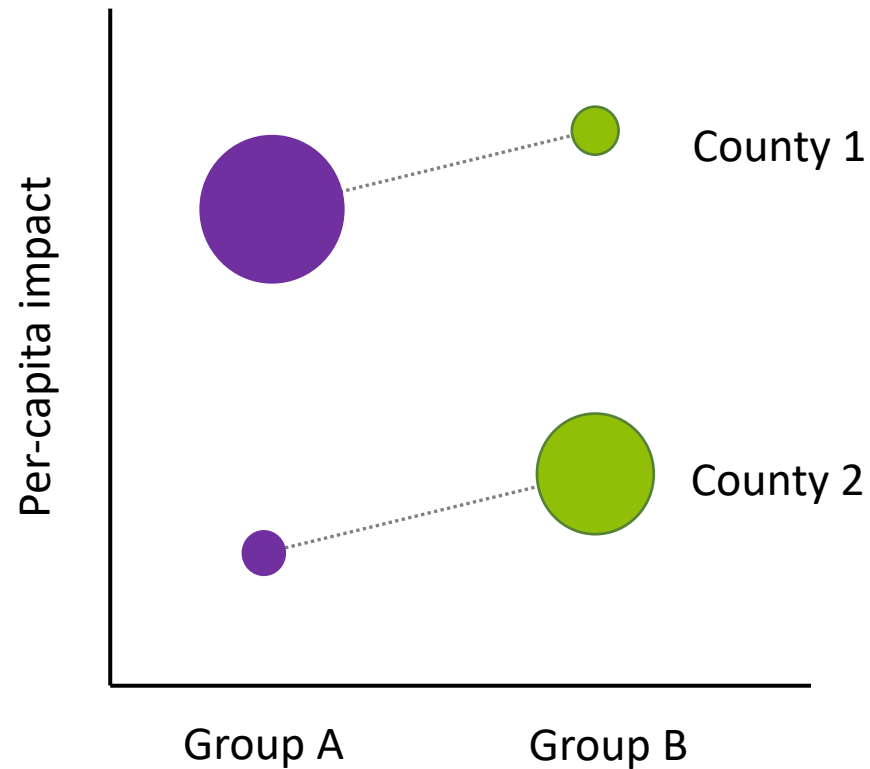
Population Distribution
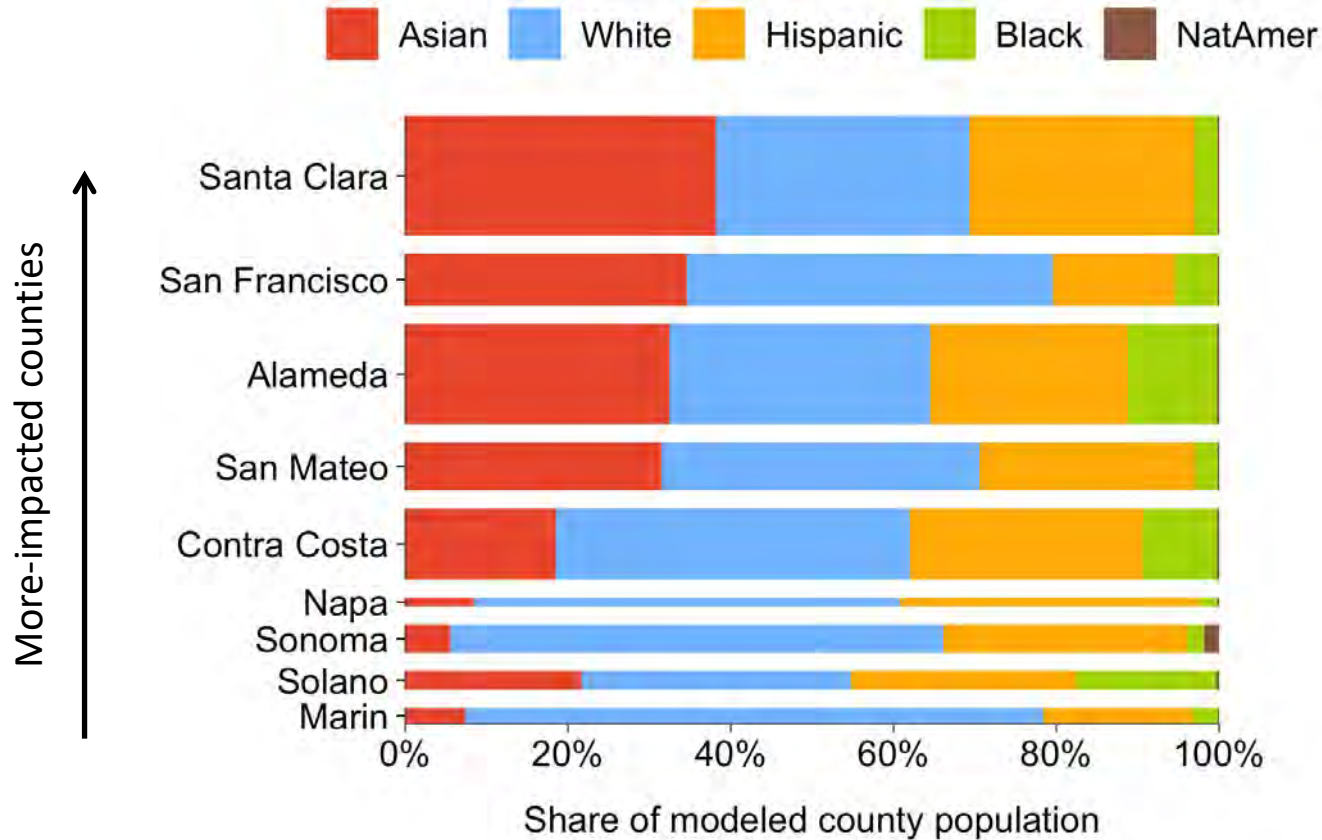
Key Points

- More-impacted Bay Area counties are higher % Asian/Pacific Islander

- The three most impacted comprise:
  - 59% of Bay Area residents
  - 73% of Asian/PI residents
  - 51% of white residents
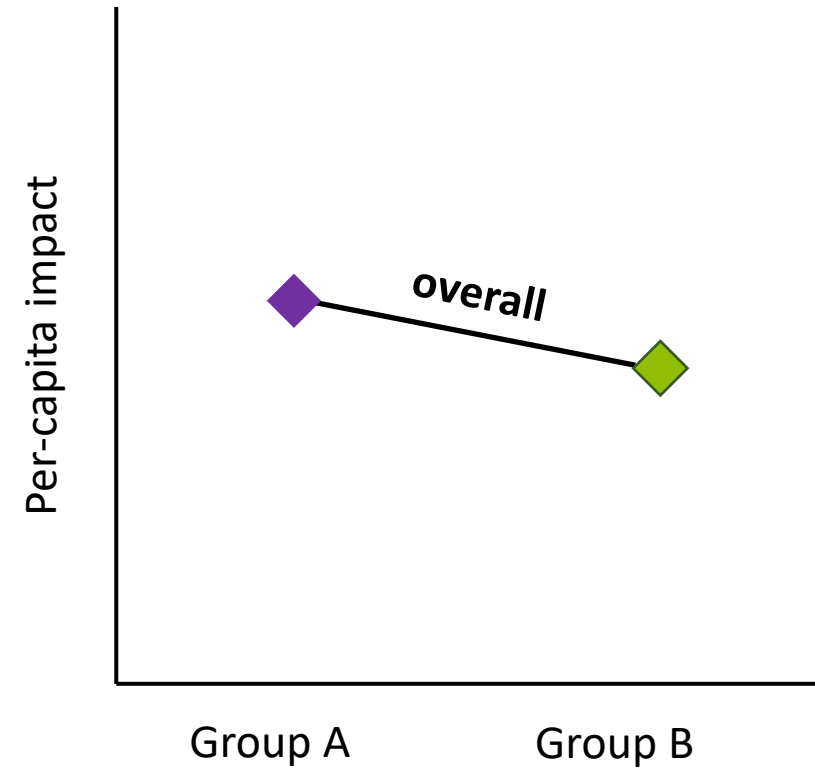
"Per Capita" is Population-Weighted

COUNTY PERSPECTIVE
Circle size = population

Per-capita impact

County 1

County 2

Group A   Group B

REGIONAL PERSPECTIVE
Pattern reversed

Per-capita impact

overall

Group A   Group B

Summary

People of color more impacted

- By $PM_{2.5}$ (secondary and primary) attributed to combustion of natural gas for residential space and water heating

- Details depend on scale of analysis

Feedback invited

- Future analyses will borrow from / extend this work

Fine Particulate Matter Local Risk Methodology: Key Questions

Advisory Council Meeting
April 11, 2022

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Overview

- Review Gaps in the Regulatory Framework

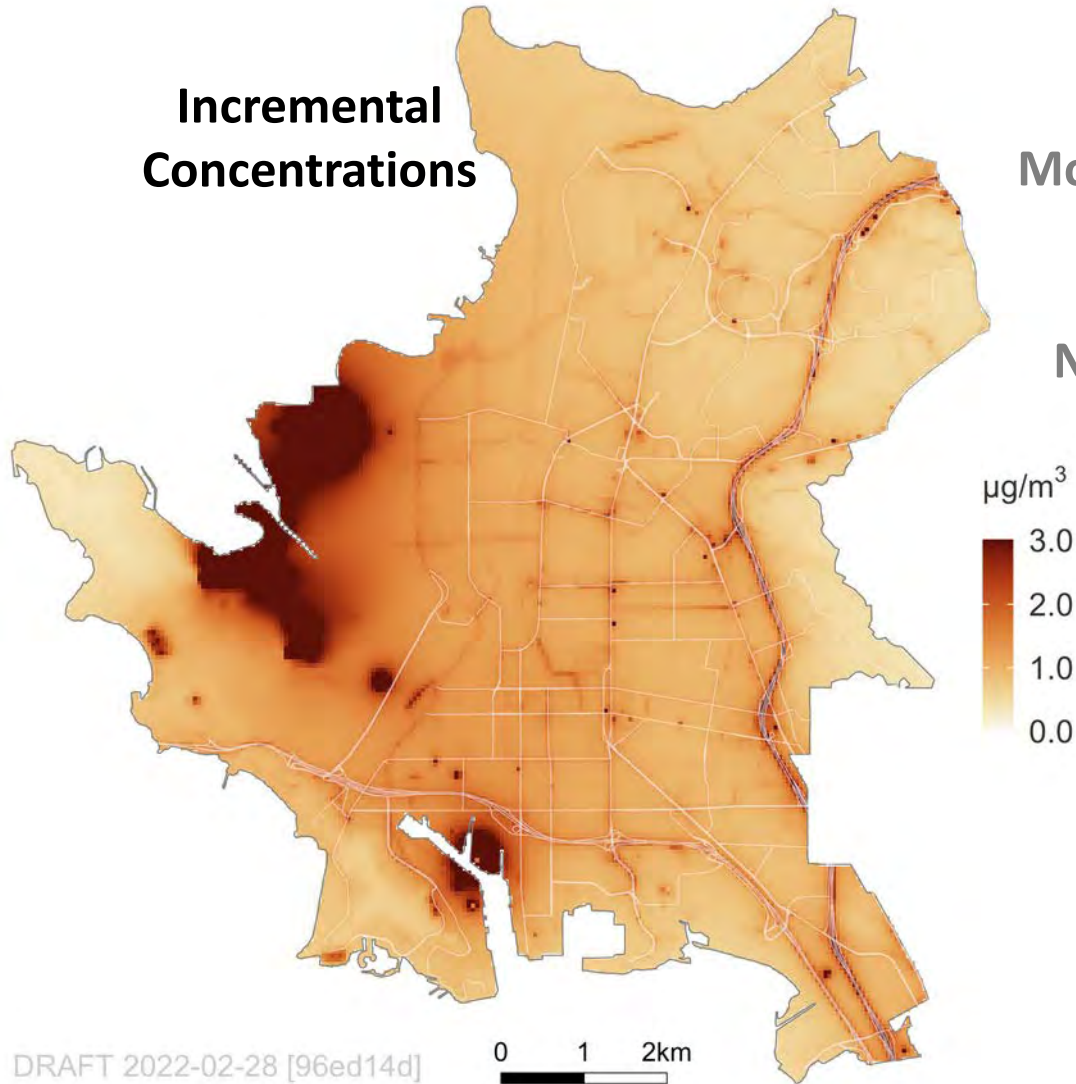- Review Draft $PM_{2.5}$ Local Risk Approach

- Pose Key Questions

Gaps in the Regulatory Framework

Community-Scale Modeling Reveals Localized Impacts of PM$_{2.5}$
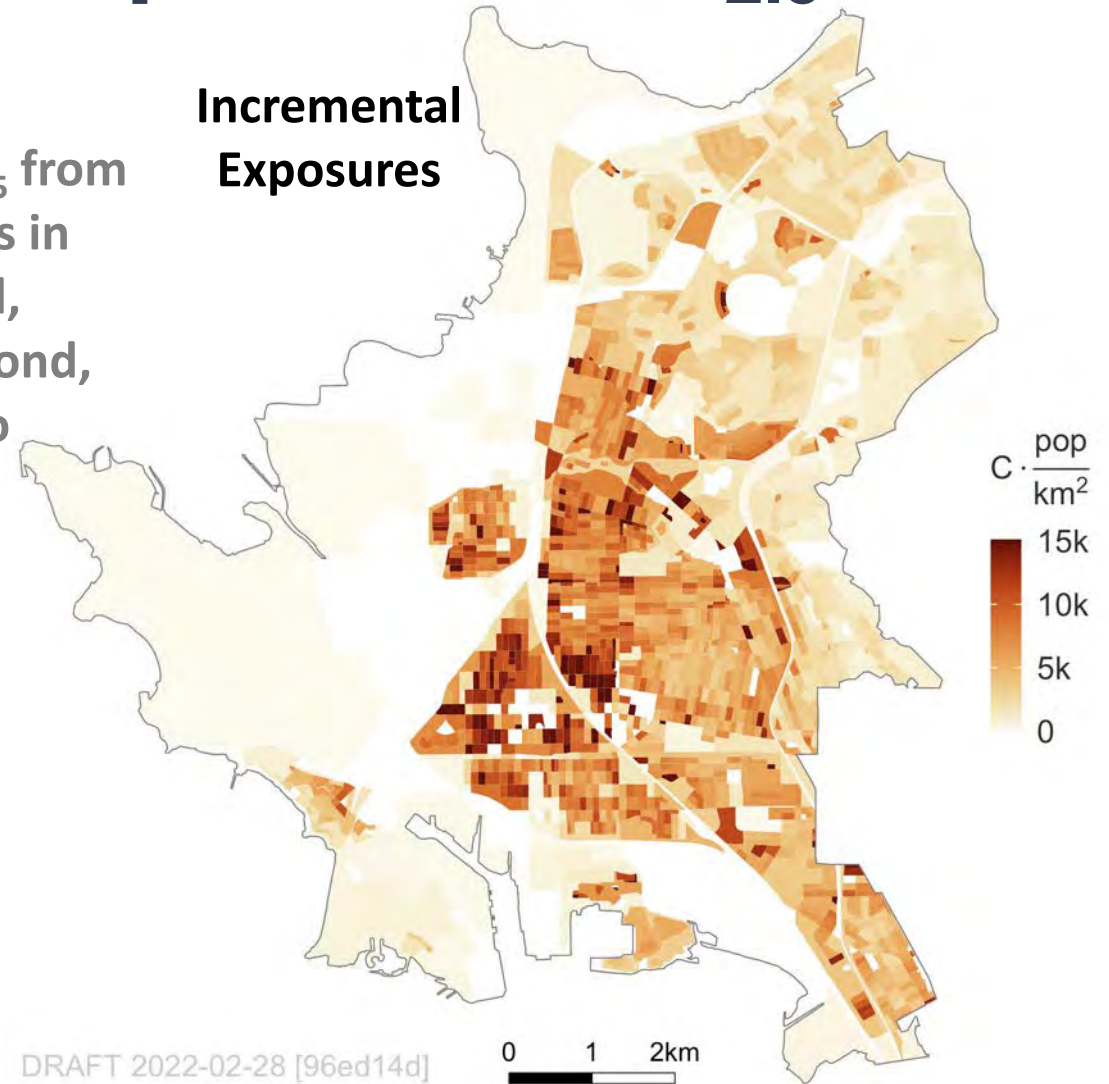

Incremental Concentrations

Modeled PM$_{2.5}$ from local sources in Richmond, North Richmond, San Pablo

Incremental Exposures

µg/m^3

3.0
2.0
1.0
0.0

$C \cdot \dfrac{pop}{km^2}$

15k
10k
5k
0

0 1 2km
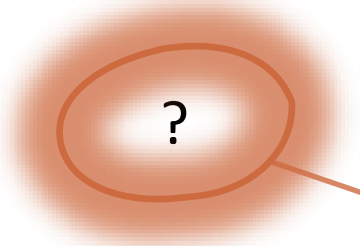
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Gaps in the Regulatory Framework

Air Pollutant

	Risk increment, Source-Specific	Standards-based, Cumulative
Criteria	?	As measured
Toxic	As inventoried	?

Regulatory Framework

What's missing?
- Methods to assess the health impact from a *local* increment in $PM_{2.5}$

- The framework to set a significance level for that impact

How to Reduce the Gap for PM$_{2.5}$?

Air Pollutant

|	Risk increment, Source-Specific	Standards-based, Cumulative
Criteria	?	As measured
Toxic	As inventoried	?

Regulatory Framework

Draw from:

- Toxics regulatory framework

- Existing epidemiological studies linking adult mortality to long-term exposures to PM$_{2.5}$

Draft PM$_{2.5}$ Local Risk Approach

Toxics Framework Example: Benzene and Cancer

0.1 µg/m³ benzene

µg/m³
+1.0
+0.8
+0.6
+0.4
+0.2
+0.0
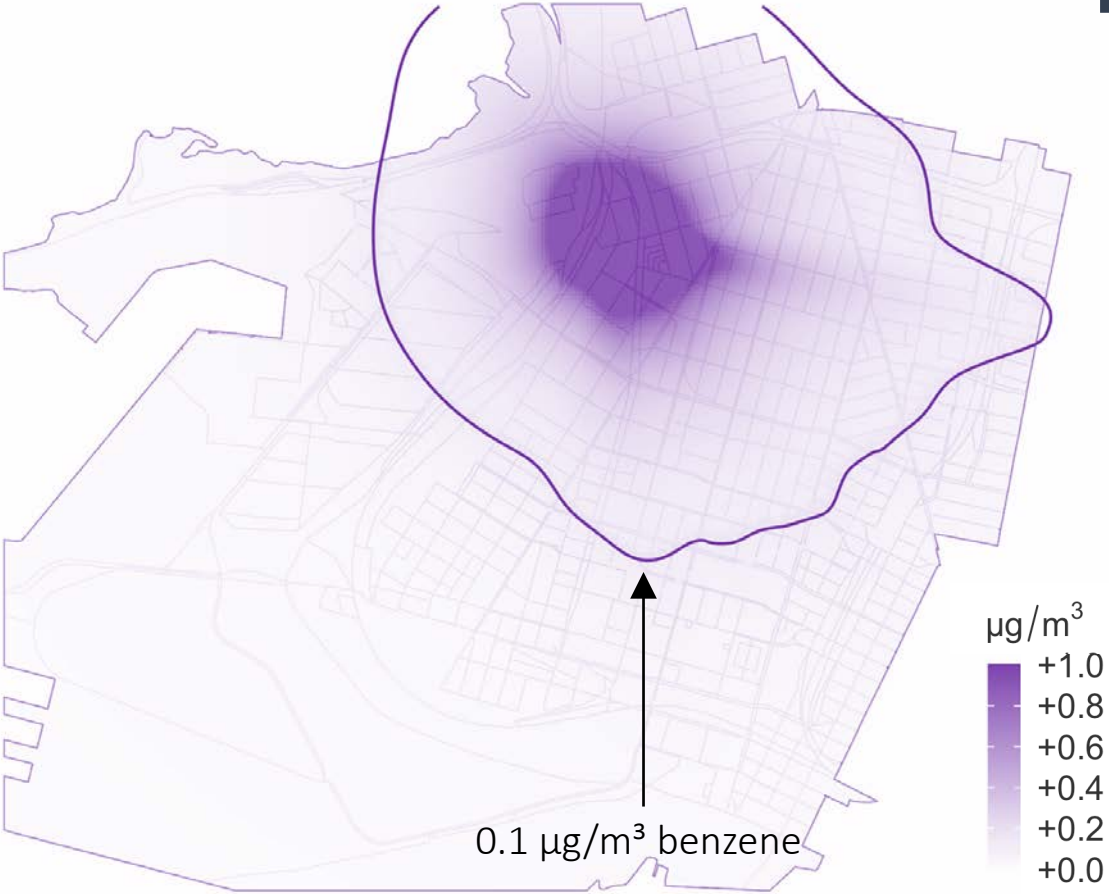
$$\Delta c * k * \text{dose-sensitivity factor}$$

Concentration Increment (Δc)	+0.1 µg/m³ benzene
Slope factor (k)	0.1 (mg/kg-day)$^{-1}$
Unit dosage with age sensitivity factor (30-year)	7×10^{-4} (mg/kg day) $*$ (µg/m³)$^{-1}$
Excess (additive)	7×10^{-6}

PM$_{2.5}$ and Premature Mortality

0.1 µg/m³ PM$_{2.5}$
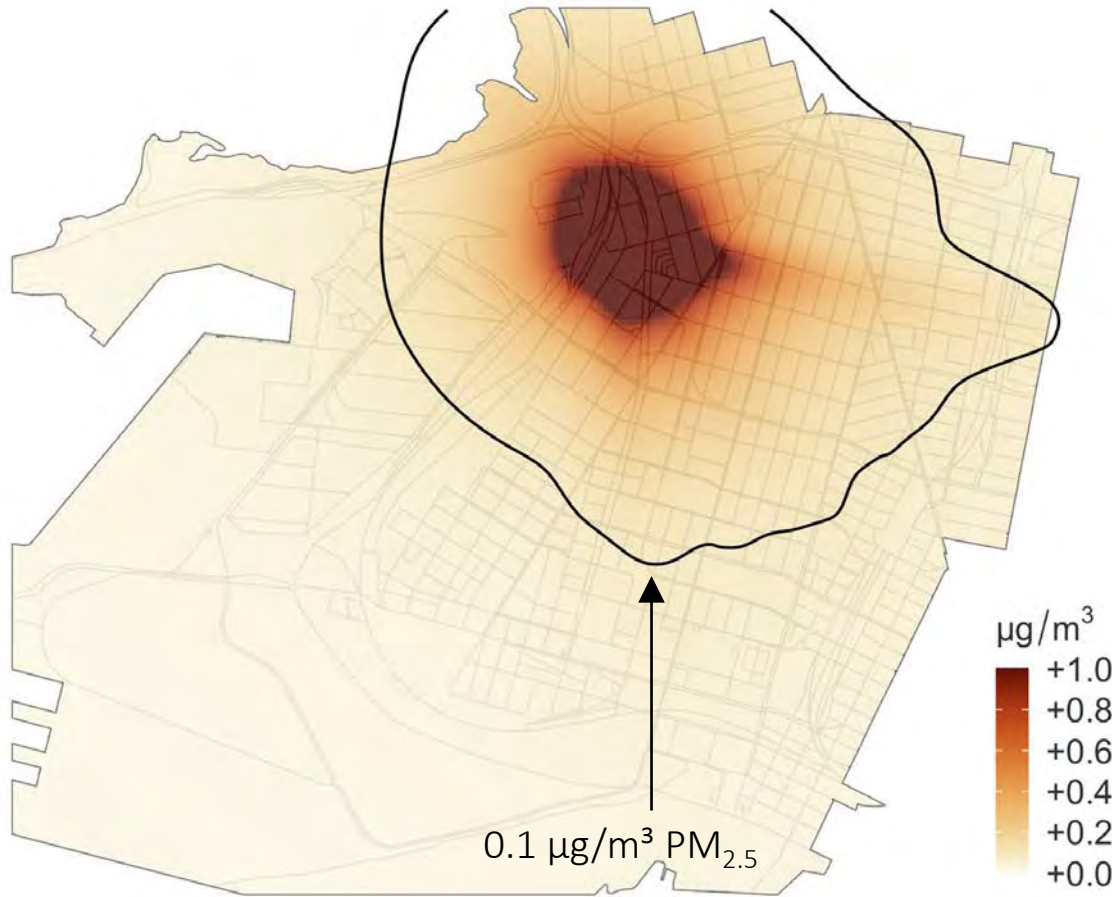
µg/m³
+1.0
+0.8
+0.6
+0.4
+0.2
+0.0

Ⅰ *risk ratio* $\approx \Delta c * \beta$

Exposure increment (Δc)	+0.1 µg/m³ PM$_{2.5}$
Effect estimate (β)	0.007 (0.7%)
Excess (multiplicative)	0.0007 (0.07%)

Ⅱ *difference* $=$ *baseline* $*$ *ratio*

Baseline	9×10^{-3} death/person-yr
Excess incidence (additive)	6×10^{-6} death/person-yr

I. With assumptions, a long-term increment of +0.1 µg/m³ PM$_{2.5}$ ≈ excess (multiplicative) risk of 0.07%

II. For a million adults, this would be an expected excess (additive) incidence of 6 deaths per year on average

Envisioned Applications

- Permitting for new and/or modified sources

- Regulations for existing sources:
  - Prioritizing rulemaking by $PM_{2.5}$ health impact
  - Estimating the health benefits of prospective rules

- Environmental review
  - Under the California Environmental Quality Act

What is a significant level of incremental $PM_{2.5}$ from a health perspective?

Envisioned Source Types

- Aggregate processing facilities, concrete batch plants

- Short-term projects, such as construction sites

- Combustion sources, such as power co-generation facilities

Staged Approach for Permitting

- Source is below an established emissions limit

  - Based on pre-modeled case studies

- Source passes a screening evaluation that considers emissions and receptor distance

  - Based on pre-modeled case studies

- A source-specific evaluation is required
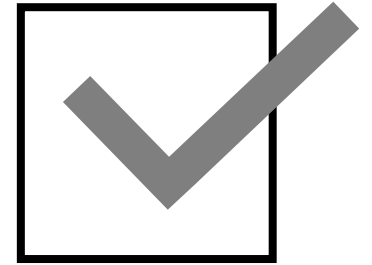
Key Questions

Key Questions (cont.)

- Is the proposed methodology/framework clear?

- Does it seem adequate, fit for purpose?

- Simplicity *versus* complexity?

Reasons To Be Simple

- Adoption
  - Quicker and broader, especially if familiar

- Implementation
  - Faster results with fewer resources

- Transparency
  - Easier to understand and communicate

- Longevity
  - Fewer components = less brittle over time

Ways To Be Less Simple

- In converting concentration (µg/m^3) to risk ratio
    - Consider multiple health endpoints
    - Use group-specific effect sizes

- In converting ratio(s) to difference(s)
    - Allow baseline(s) to vary by group or place

- Take co-stressors into account somehow
    - Other pollution, environmental, social, …

- Evaluate pop.-weighted local burden (in addition to max. impact)

- Evaluate short-term impacts from short-term projects

Ways To Be More Simple

- None, or few, of the examples above

- Adopt a margin of safety to cover vulnerability, susceptibility, uncertainties, and unknowns

Rollout and Communication

People will compare "per million", but:

- PM$_{2.5}$ mortality estimates are unbiased by design
  - … unless a margin of safety is adopted
    - Cancer "risk" in a toxics framework is near an upper bound by design
- Cancer and mortality are not naturally commensurable
- Neither is a complete set of hazards
- Lifetime vs annual

Next Steps

- Proposal: increase number of case studies
  - Broader sample of source types, emission magnitudes, and siting relative to population
  - To motivate and ground further discussion
  - To improve estimates of scope (i.e., which sources matter most)
  - To improve sense of which methodological complexities might add the most value

- Feedback and additional suggestions invited

Combustion Analysis Proposal

Advisory Council Meeting
April 11, 2022

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Concept

Purpose

Methodology

PM Reduction Strategy Nexus

Next Steps

Concept

Prepare report on health and climate impacts of combustion.

Assess health, climate and equity impacts from sources of and exposure to particulate matter, specifically combustion sources.

Track PM$_{2.5}$ concentrations to combustion sources.

Purpose

✓ To better understand equity and health impacts of combustion at regional and local scale.

✓ To inform legislative advocacy.
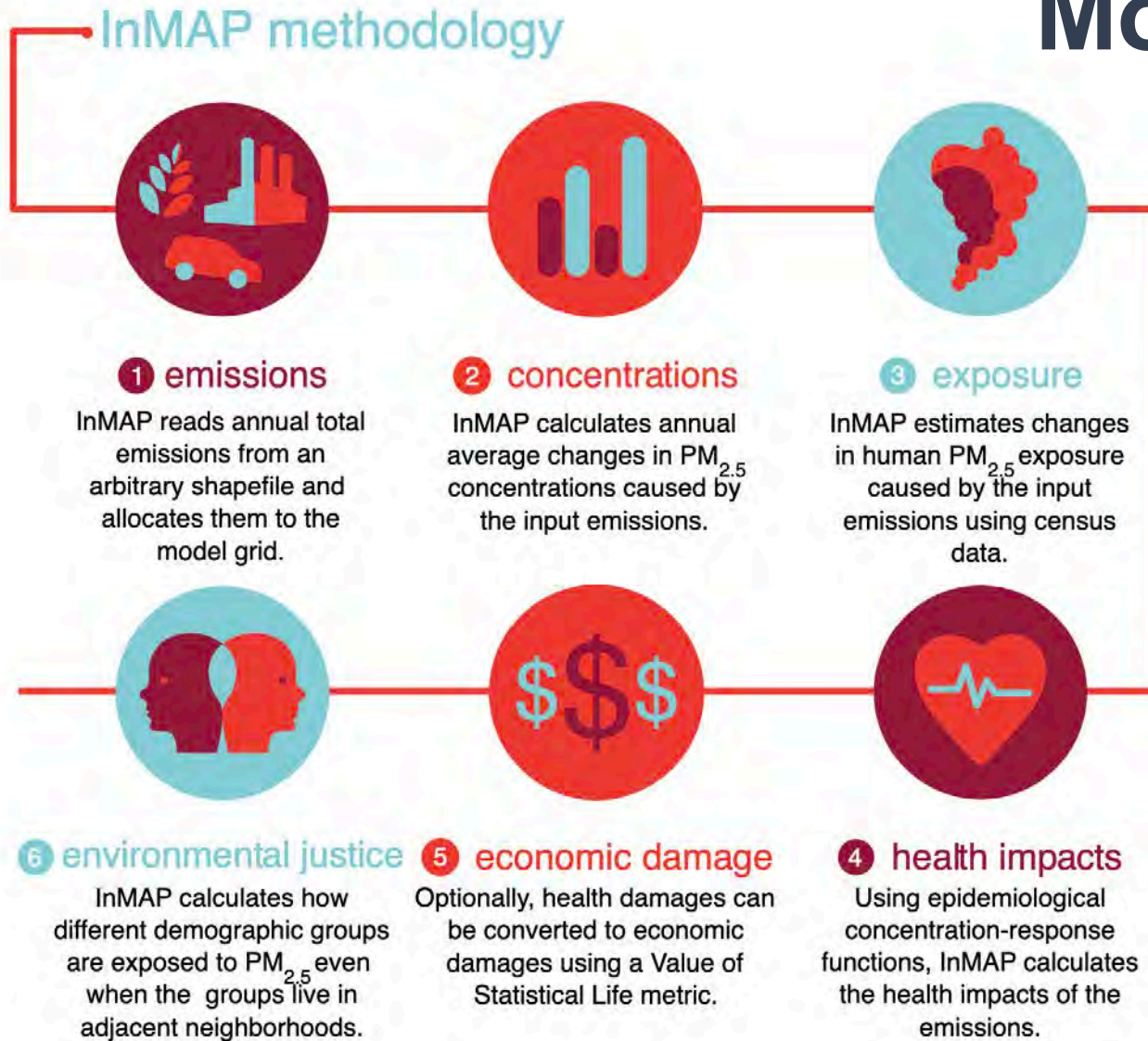
✓ To inform prioritization of PM reduction efforts.

Methodology

- Use Intervention Model for Air Pollution (InMap) for major source categories.

    o A reduced complexity air quality model, well suited for:
    - Regional- and community-scale $PM_{2.5}$ source apportionment
    - Investigating equity issues
    - Providing faster turnaround

- Use traditional chemistry-transport model for select source categories, e.g., appliances, wood-burning.

More About InMap

InMAP methodology

① emissions
InMAP reads annual total emissions from an arbitrary shapefile and allocates them to the model grid.

② concentrations
InMAP calculates annual average changes in $PM_{2.5}$ concentrations caused by the input emissions.

③ exposure
InMAP estimates changes in human $PM_{2.5}$ exposure caused by the input emissions using census data.

⑥ environmental justice
InMAP calculates how different demographic groups are exposed to $PM_{2.5}$ even when the groups live in adjacent neighborhoods.

⑤ economic damage
Optionally, health damages can be converted to economic damages using a Value of Statistical Life metric.

④ health impacts
Using epidemiological concentration-response functions, InMAP calculates the health impacts of the emissions.

Source: Tessum, et al., *PLoS ONE*, 2017

InMap method:

1) Emissions

2) Concentrations

3) Exposure

4) Environmental justice

5) Economic damage

6) Health impacts
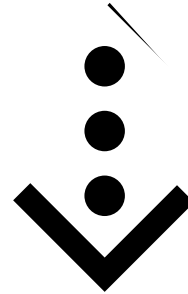
InMap Sample Results
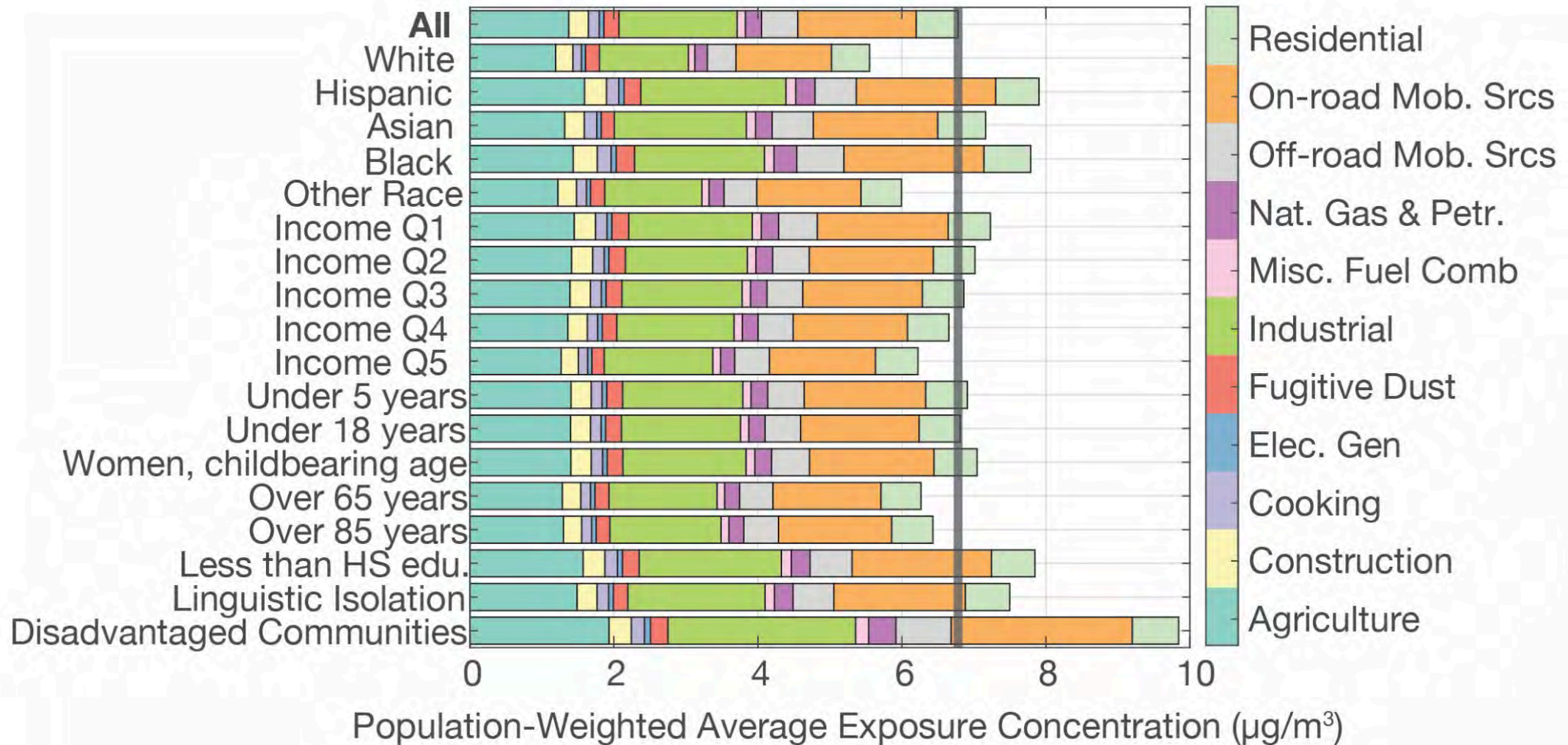
Apte et al. 2019, Prepared for CARB and Cal EPA, Contract: 17RD006

PM Reduction Strategy Nexus

Analysis will be performed to evaluate all PM sources, with an emphasis on combustion sources.

Analysis will inform prioritization of policy and other efforts to reduce particulate matter.

Next Steps

Source Evaluation

Evaluate combustion sources identified in inventory and as key community concerns, e.g., cement plants, bulk materials handling, construction.
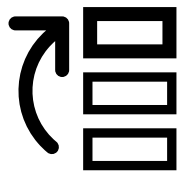
Source Prioritization

Identify sources for policy intervention. Determine if additional statutory authority is needed.

PM STRATEGY PROGRESS REPORT

Advisory Council
April 11, 2022

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OUTLINE

01 Background

02 Air District Approach

03 Highlights

04 Next Steps

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BACKGROUND

- Advisory Council's *PM Reduction Strategy Report* adopted in December 2020.

- Includes 28 recommended strategies.

- Nearly 100 Air District efforts are advancing recommendations.

APPROACH

Community Priorities – Sources identified in community actions plans, such as in West Oakland's *Owning Our Air* community emission reduction plan, and through direct community input.
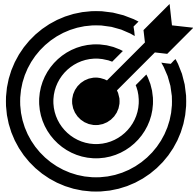
Health impacts – Sources that have the greatest health impacts, i.e., evaluate health impacts from major PM source categories, such as refineries, woodsmoke and residential natural gas use.

Drivers of PM – Sources that are the major drivers of PM emissions and exposure.

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CHALLENGES

- Limited staffing and other resources.
- Law treats PM as regional pollutant.
- Fugitive dust emissions not well quantified.
- Short duration and localized exposure not completely addressed in research or air quality standards.

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HIGHLIGHTS

SUCCESSES

- **PM from Refineries -** Reduced PM emissions from largest PM sources at refineries by the maximum extent feasible.

- **Source Priority Criteria -** Developed "prioritization framework" for rules on stationary sources.

- **PM Modeling -** Updated regulatory-grade, regional PM modeling platform.

- **Community Action Plans -** Implementing West Oakland community action plan, *Owning Our Air*. Richmond-North Richmond-San Pablo pending; East Oakland designated.

Refinery Rule 6-5

- The Air District's Rule 6-5 minimizes particulate matter emissions from Fluidized Catalytic Cracking Units, or FCCUs.

- Largest single source of PM emissions at refineries and some of the largest sources of PM in Bay Area.

- Amendments anticipated to reduce PM by 493 tons per year.

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HIGHLIGHTS (cont.)

CURRENT WORK

- **Residential Sources -** Quantifying health and equity impacts and considering rule of major residential sources.

- **PM Health Impacts –** Working on a methodology to quantify PM health impacts from facilities.

- **PM Monitoring -** Developing insights from PM measurement data, including data from low-cost sensors and regulatory monitoring.

- **Community Data -** Developing detailed source apportionment for PM in Richmond-North Richmond-San Pablo.

- **Incentives –** Ongoing distribution of mobile source incentives to reduce emission from cars, trucks and off-road sources.

Mobile Source Incentives

- In 2021, distributed over $76 million in incentives to reduce emissions from cars, trucks, and off-road sources.

- Eighty-six percent went to high pollution, disadvantaged or low- income communities. Reduced over 68 tons per year of PM_{10} and nearly 217 tons per year of nitrogen oxide.

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PRIORITY ACTIONS

Health Protective Targets

Recommendations to establish more stringent, health protective PM targets. Recommendations address establishing $PM_{2.5}$ concentration targets and standards based on scientific evidence.

Impacted Communities

Recommendations regarding community actions plans, assessments of health impacts and community-level exposure to PM. Better enforcement, new and improved rules and electrification of sources in impacted communities and improved permitting of facilities.
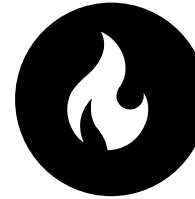
Wildfires

Recommendation to further develop and implement strategies and health protective measures to protect people's health during wildfire episodes, especially those living in impacted communities.
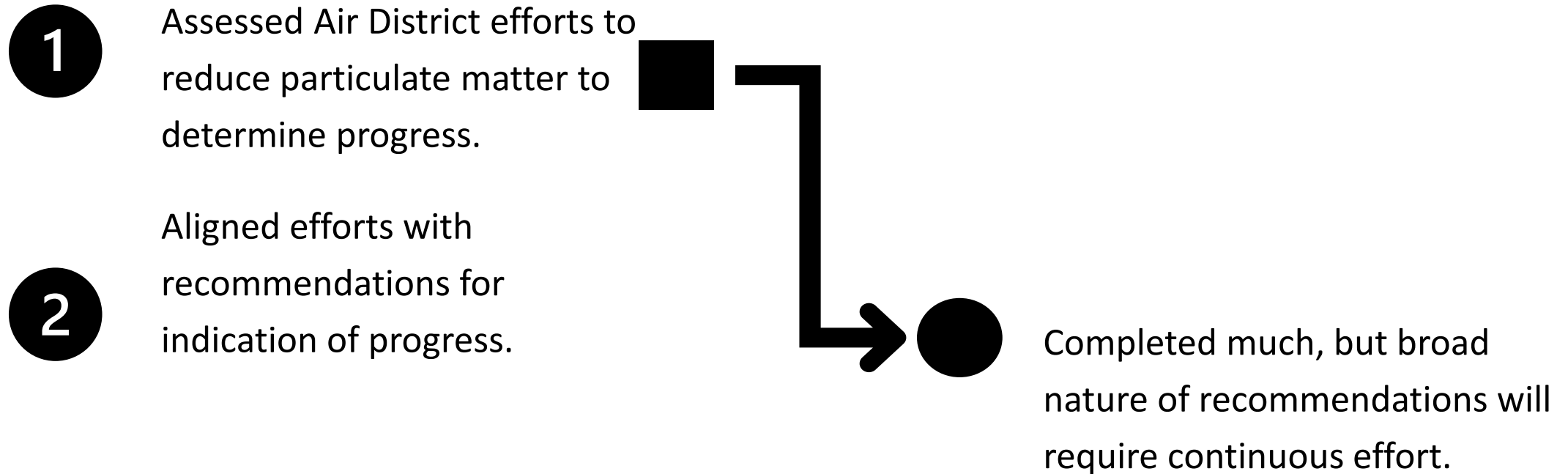
Regional PM

Recommendations to improve PM air quality data and access to PM emissions data. Reduce PM from vehicles, road dust, buildings, commercial cooking and residential wood burning.

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TARGETS

- Will request Community Advisory Council to take up the issue of **community-specific PM targets**.

- Working with US EPA on **more stringent air quality standards for PM.**

- Working with the Office of Environmental Health Hazard Assessment to **develop method to assess exposure to local sources of particulate matter**.

Not Started

Started

75% Started

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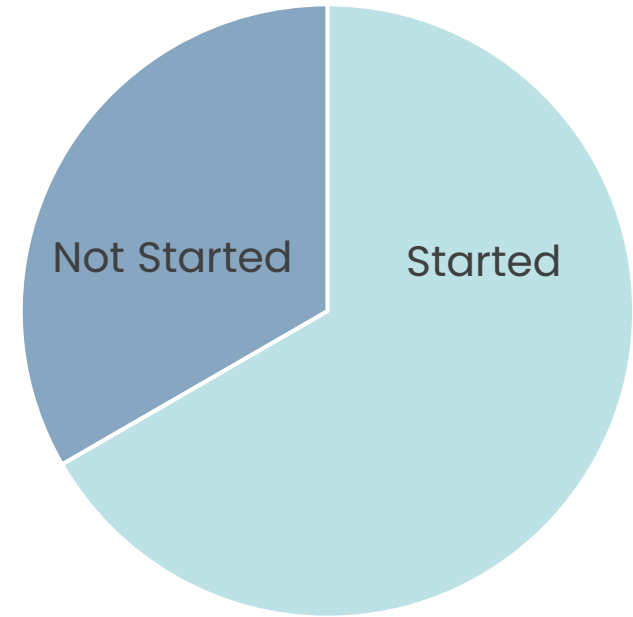
IMPACTED COMMUNITIES

- **West Oakland community action plan completed**. Richmond-North Richmond-San Pablo underway, East Oakland up next.

- Reviewing sources of PM emissions in communities and **best methods for reducing PM**.

- **Rule 6-5 minimizes PM from FCCUs**, some of the largest individual sources of PM.

- **Enforcement and notice of violation fact sheets and targeted inspections** are set to begin in designated AB 617 communities.

Ongoing

Started

80% Started

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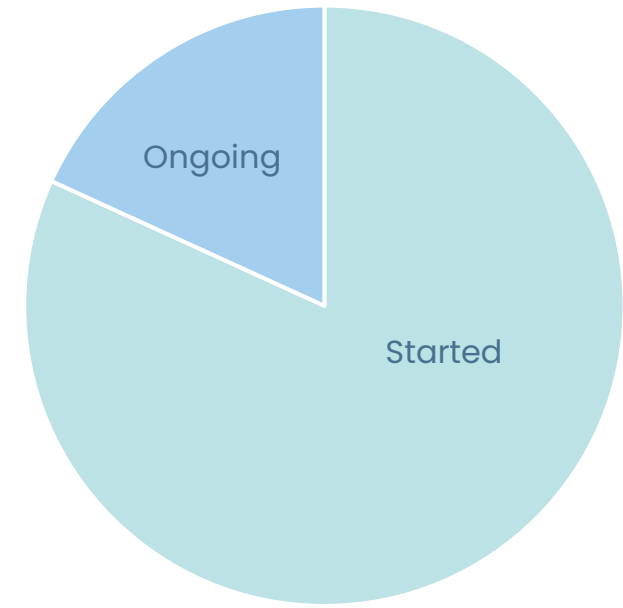
WILDFIRES

- **Ongoing public outreach** efforts: wildfire safety videos, 300 media interviews, social media coverage, press conferences, web pages, public booths, etc.

- **Implementing $3 million state grant** for counties to improve air filtration in public buildings, i.e., clean air shelters.

- **Clean Air Filtration Program** improves access to high efficiency air filtration for those most vulnerable to wildfire smoke and air pollution.

70% Started or Ongoing

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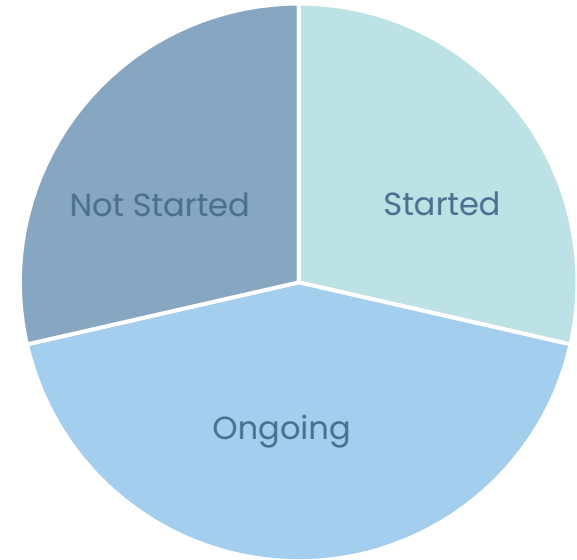
REGIONAL PM

- Considering amendments to Rule 9-4 and 9-6, to set **zero-emission limits on nitrogen oxides from residential furnaces, water heaters and boilers**.

- Ongoing **PM reports on monitoring data** and how to access.

- Ongoing **incentives** for mobile sources, especially in impacted communities.

- **Improved monitoring reports for region**. Data monitoring reports summarizing air quality data, patterns and trends, comparisons to standards.
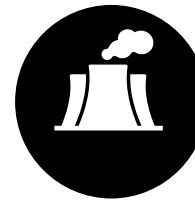

80% Started or Ongoing

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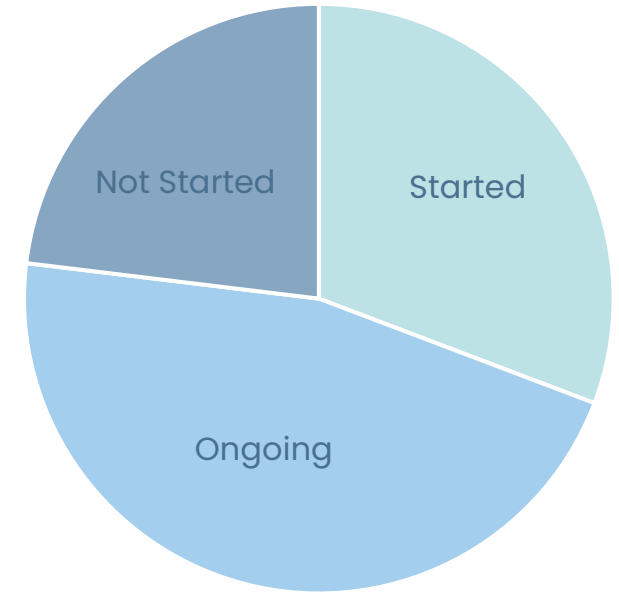
NEXT STEPS
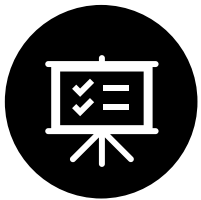
Objectives and Key Results
Develop objectives and key results to guide Air District's work to reduce PM emissions and exposure.

Changes to Permitting Rules
Consider further changes to permitting rules to address local PM impacts.

Source Evaluation
Evaluate PM sources identified in inventory and as key community concerns, e.g., cement plants, bulk materials handling, construction.

Source Prioritization
Identify sources for policy intervention.

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