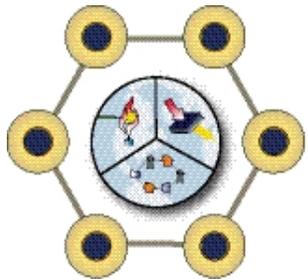


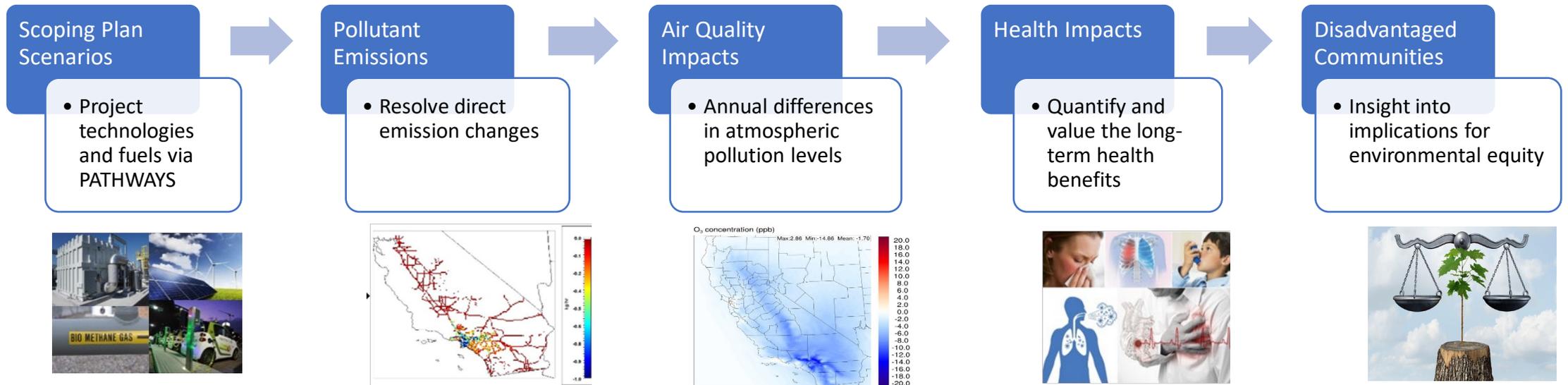
Air Quality and Public Health Benefits of the Scoping Plan



**ADVANCED POWER
& ENERGY PROGRAM**
UNIVERSITY of CALIFORNIA • IRVINE

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Scoping Plan Workshop
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- Provide a detailed assessment of the air quality and public health benefits in California that result from implementing the Scoping Plan
 - Quantify and value health benefits from improvements in outdoor air pollution
 - Provide insight into health savings within socially and economically disadvantaged communities



2.

Atmospheric Chemistry

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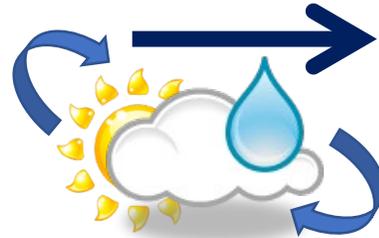
Transport

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Air Pollution

$\text{NO}_x + \text{VOC} + \text{Sunlight} \rightarrow \text{Ozone}$

$\text{NO}_x / \text{SO}_x / \text{VOC} \rightarrow \text{PM}_{2.5}$



1.

Emissions

NO_x

SO_2

PM

VOC

CO



Two kinds of pollutants in the atmosphere:

- Primary (Emitted)
- Secondary (Formed)

Secondary $\text{PM}_{2.5}$ is particularly important for health impacts

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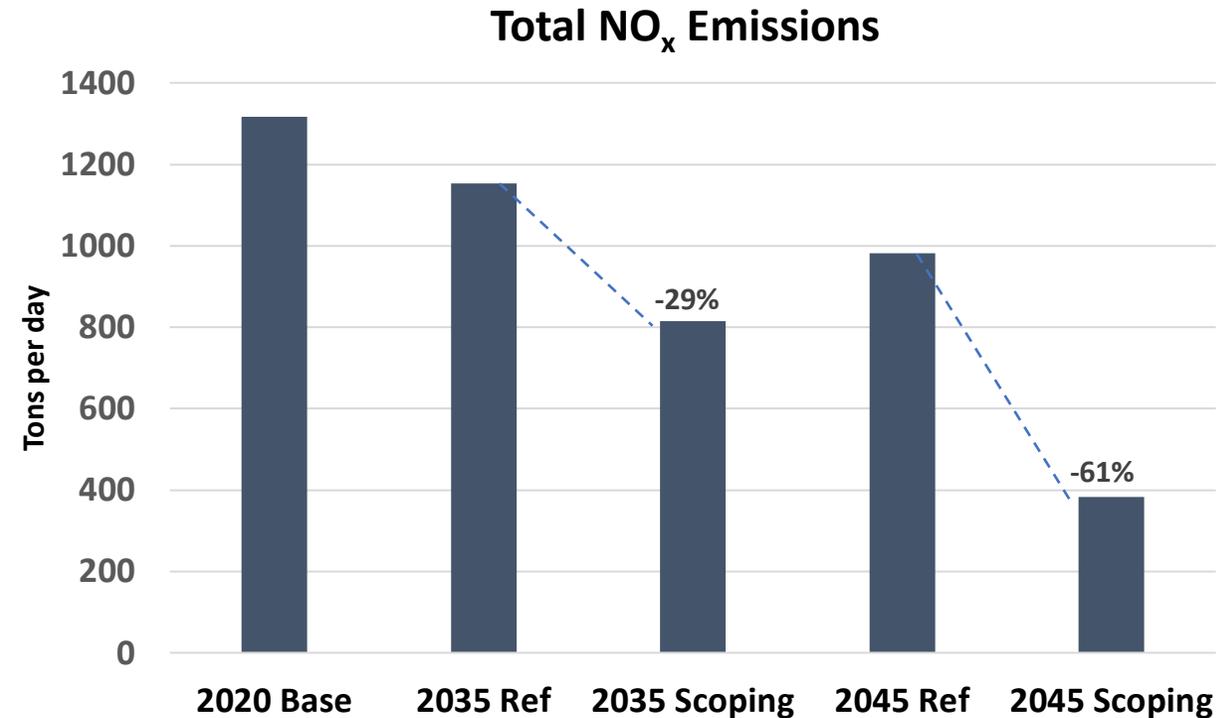
Health Impacts



3.

UCI 1. Emissions Modeling

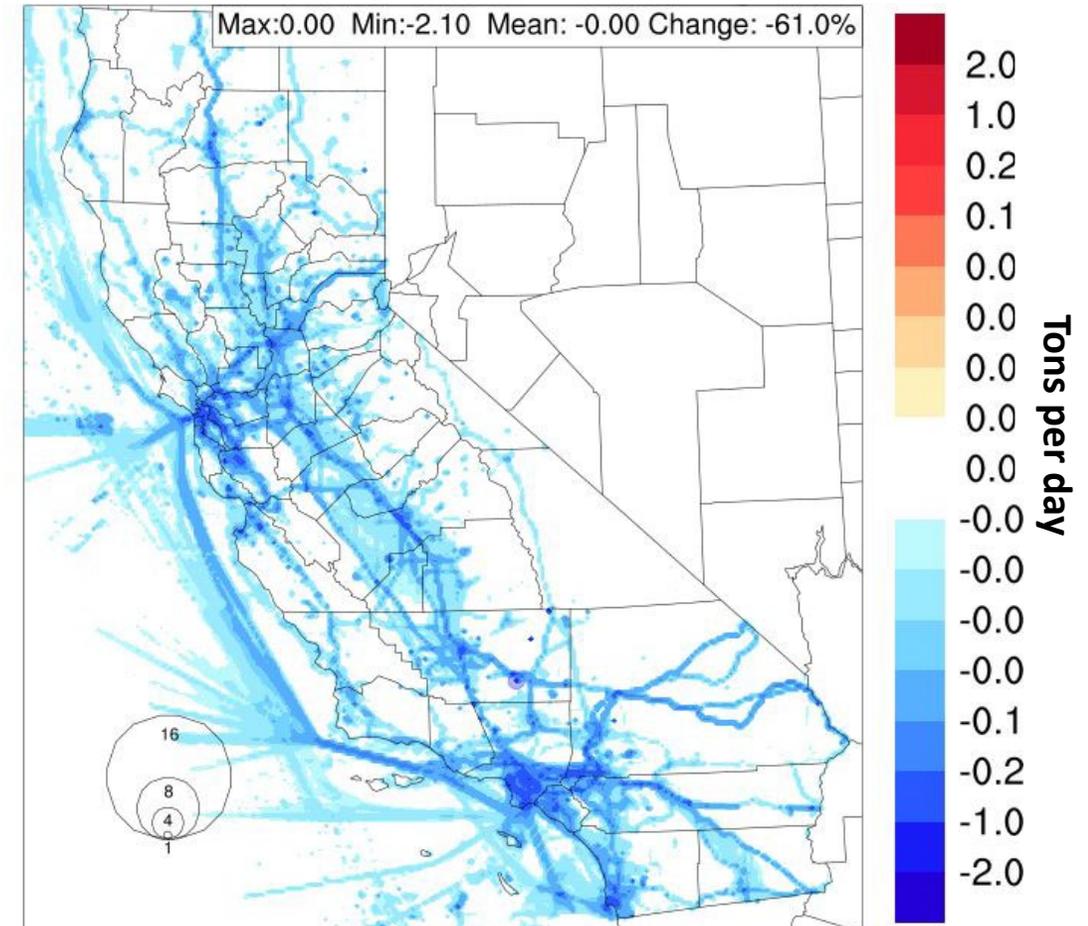
- **Air quality modeling requires the development of a highly detailed criteria pollutant emissions inventory representative of the Scoping Plan scenario in 2045**
 - CARB 2020 serves as a base year inventory* that is projected to 2045
 - Base year inventory contains highly detailed emissions data (total, spatial, temporal) for all sources in California
- **Map energy shifts in end-use sectors to 2045 from PATHWAYS**
 - Utilize energy consumption, fuel, and technology stock data to project total emissions
 - Additional data sources used to account for other factors that impact emissions
 - Reference scenario benchmarked against CEPAM 2019v1.03
- **Scoping Plan achieves large reductions in criteria pollutant emissions relative to the Reference Scenario**
 - Reductions in total NO_x from the are approximately 30% in 2035 and 61% in 2045



*For inventory details: <https://ww2.arb.ca.gov/emission-inventory-documentation>; <https://ww2.arb.ca.gov/california-toxics-inventory>

- **Sparse Matrix Operator Kernel Emissions (SMOKE) model used to map emissions to the locations and activity of sources**
 - E.g., traffic patterns and locations of roadways, locations and activity patterns of refineries
- **Important impacts from emission reduction measures in the transportation sector**
 - Large reductions from on-road and off-road vehicles, ships, and trains
- **Urban regions including Southern California experience largest reductions**
 - Major sources of transportation activity
 - Reductions from residential and commercial buildings, industrial sources including refineries

Reductions in 2045 NO_x for the Scoping Plan from the Reference Scenario



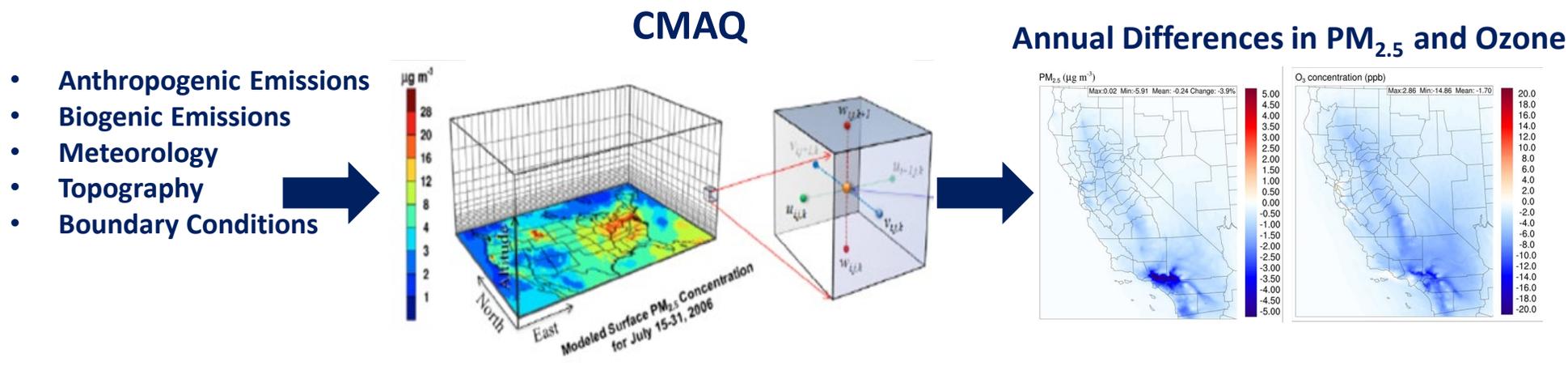
- **Emissions Modeling Caveats**

- PATHWAYS provides statewide averages which do not allow for resolution at the regional or sub-regional level, although the base year inventory does account for those differences
- The locations of existing facilities are accounted for in the assessment due to the uncertainty of siting and locating novel emission sources and any major functional changes to existing sources are not considered
 - However, the increased utilization of novel facilities is accounted for in the total energy to emissions calculations
- Emissions are generated by many processes, including those not related to combustion in energy systems. For example, biogenic emissions, managed burning and disposal, etc. can contribute emissions of NO_x, PM, reactive organic gases (ROG) and others

UCI 2. Air Quality Modeling

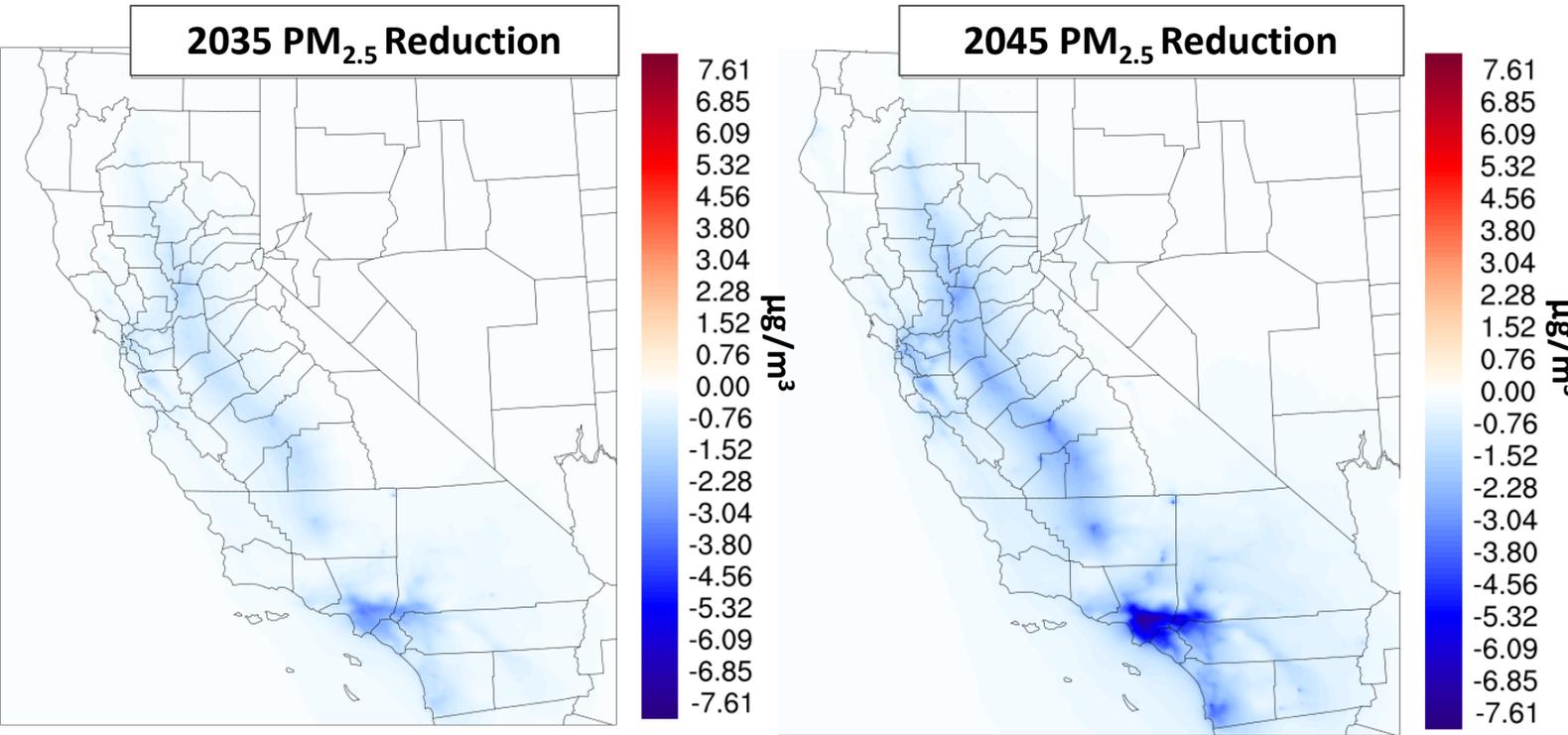
- **Community Multi-scale Air Quality Model (CMAQ) used to develop a comprehensive understanding of how air pollution changes in the Scoping Plan Scenario**
 - 4 km x 4 km horizontal resolution across the entire state
 - Base year model performance has been statistically validated using observational data
 - CMAQ accounts for both primary (**emitted**) and secondary (**formed**) pollutants including ozone and PM_{2.5}
- **Annual simulations are conducted for 2035 and 2045**
 - Provides a **comprehensive** understanding of the impacts experienced throughout the year on air quality from the emission reductions associated with Scoping Plan measures

	Model Version
Base Year Inventory	2020 CARB v0018
Emissions Processing	SMOKE v4.7 and ESTA
Air Quality Model	CMAQ v5.3.2
Chemical Mechanism	SAPRC-07 and AERO6
Biogenic Emissions	MEGAN v2.1
Meteorological Files	WRF-ARW v3.9.1
Boundary Conditions	CESM v2.1/CAM-chem



UCI 2. Air Quality Results – PM_{2.5}

- Results present the improvement in PM_{2.5} in 2035 and 2045 in the Scoping Plan Scenario relative to the Reference Scenario
 - Peak reductions occur in the South Coast Air Basin and Central Valley
 - 42% (2035) and 76% (2045) reduction in National Ambient Air Quality Standards (NAAQS) exceedances

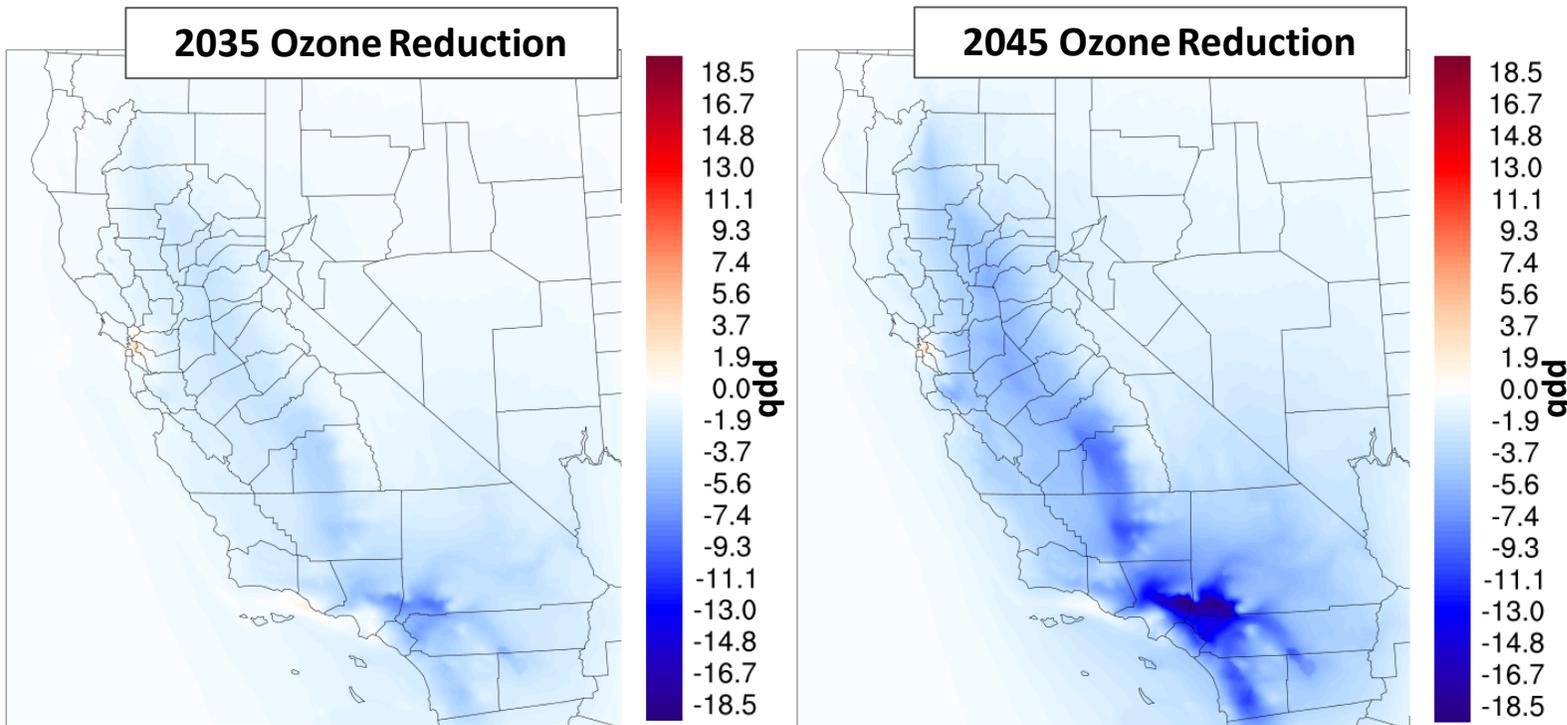


	Δ Annual Average PM _{2.5}	
	Total Reductions	Pop-Weighted Reductions
2035	-3.5 µg/m ³	-1.4 µg/m ³
2045	-7.8 µg/m ³	-3.1 µg/m ³

	Annual PM _{2.5} NAAQS Exceedances (12 µg/m ³)	
	Reference	Scoping Plan
2035	508	293
2045	500	119

UCI 2. Air Quality Results – Ozone

- Results present the difference in ground-level ozone in 2035 and 2045 in the Scoping Plan Scenario relative to the Reference Scenario
 - Improvements are significant with peak reductions in the South Coast Air Basin
 - 41% (2035) and 62% (2045) reduction in NAAQS exceedances from the Reference

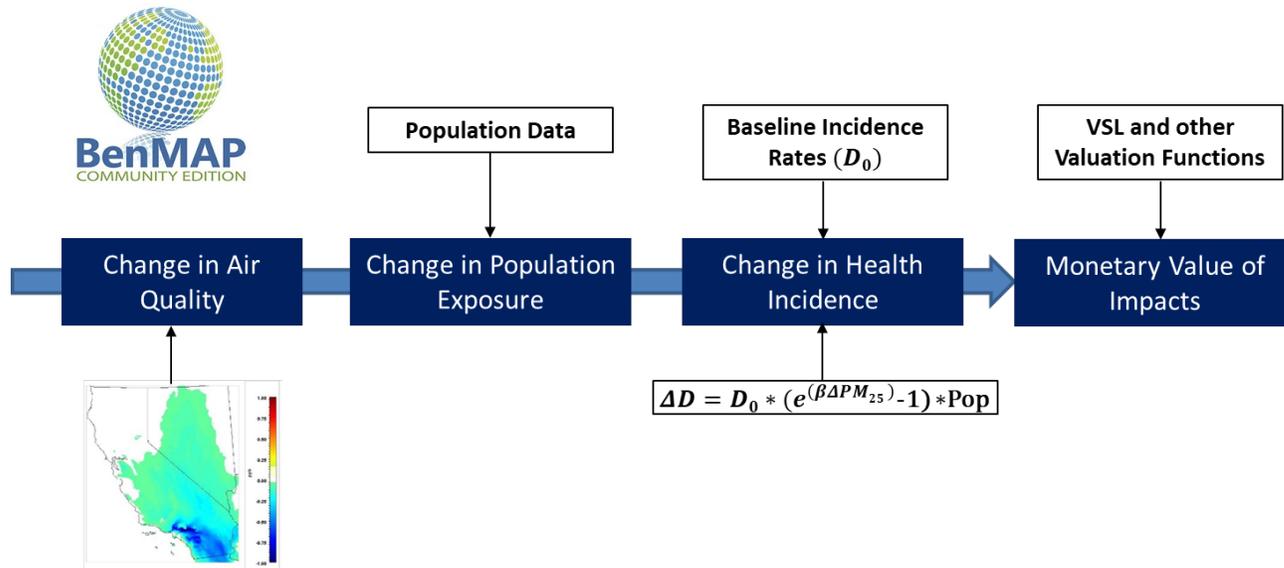


Δ MD8H Ozone (April-September)		
	Total Reductions	Pop-Weighted Reductions
2035	-8.8 ppb	-0.8 ppb
2045	-19.1 ppb	-2.7 ppb

MD8H NAAQS Exceedances (70 ppb)		
	Reference	Scoping Plan
2035	81,634	47,851
2045	73,549	27,739

UCI 3. Health Impact Assessment

- EPA's BenMAP v1.5.8 used to translate pollutant changes from CMAQ into health impacts
 - Total benefits that accrue in 2035 and 2045
- Health impacts estimated for PM_{2.5} and ground-level ozone
 - Selection of health impact functions represent the core functions in BenMAP v1.5.8
 - Annual modeling provides important improvement for PM_{2.5} mortality estimation

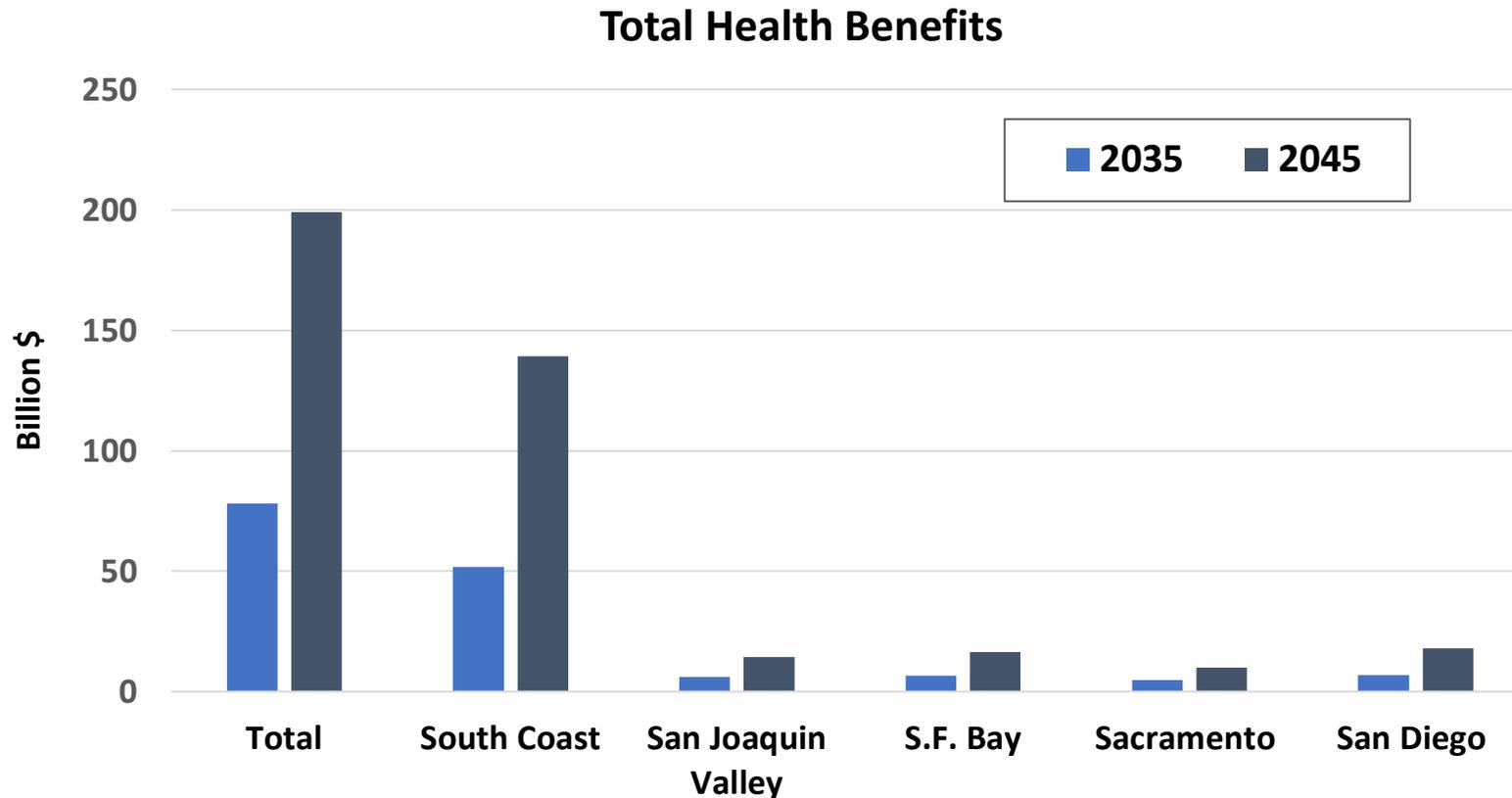


PM _{2.5} Health Endpoints	Ozone Health Endpoints
<ul style="list-style-type: none"> • Avoided Mortality • Hospital Admissions, Alzheimer's Disease • Hospital Admissions, Parkinson's Disease • Incidence, Lung Cancer • Incidence, Asthma Onset • Acute Myocardial Infarction, Nonfatal • Asthma Symptoms • Hospital Admissions, Cardiovascular • Emergency Room Visits, Cardiovascular • Hospital Admissions, Respiratory • Emergency Room Visits, Respiratory • Work Loss Days 	<ul style="list-style-type: none"> • Avoided Mortality • Emergency Room Visits, Respiratory • Hospital Admissions, Respiratory • Asthma Symptoms • Incidence, Asthma Onset

- **Air pollution improvements reduce incidence of harmful health outcomes**
 - Over 27,000 avoided incidence of premature mortality in 2035 and 2045 combined

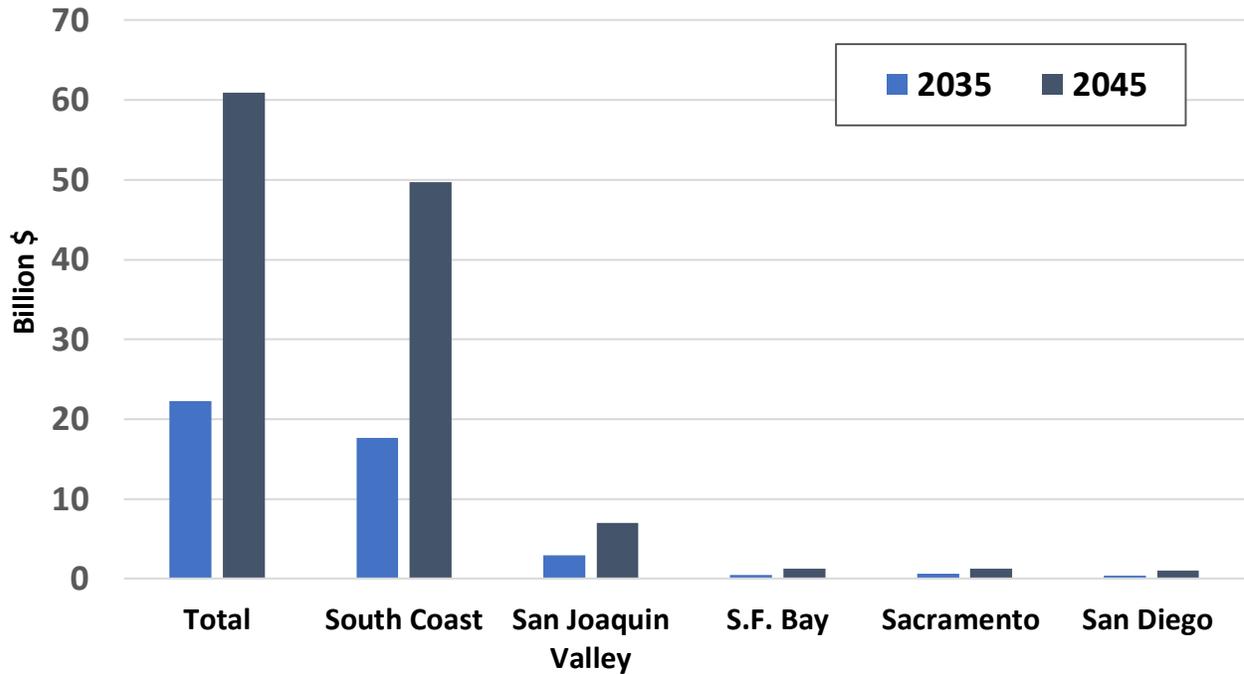
Endpoint	Pollutant	Avoided Incidence		Valuation Million \$2021	
		2035	2045	2035	2045
Avoided Mortality, All Cause	PM _{2.5}	8,117	19,578	\$74,797.49	\$188,981.74
Hospital Admissions, Alzheimer’s Disease	PM _{2.5}	3,129	5,956	\$720.98	\$1,519.84
Hospital Admissions, Parkinson’s Disease	PM _{2.5}	277	580	\$195.18	\$452.01
Incidence, Lung Cancer	PM _{2.5}	478	1,020	\$11.38	\$26.89
Incidence, Asthma Onset	PM _{2.5}	12,731	24,007	\$454.29	\$897.90
Acute Myocardial Infarction, Nonfatal	PM _{2.5}	381	911	\$197.67	\$504.64
Asthma Symptoms	PM _{2.5}	980,780	2,044,296	\$0.54	\$1.24
Hospital Admissions, Cardiovascular	PM _{2.5}	602	1,505	\$15.80	\$43.60
Emergency Room Visits, Cardiovascular	PM _{2.5}	992	2,360	\$1.82	\$4.79
Hospital Admissions, Respiratory	PM _{2.5}	94	235	\$5.34	\$14.78
Emergency Room Visits, Respiratory	PM _{2.5}	1,526	3,388	\$2.11	\$5.18
Work Loss Days	PM _{2.5}	342,333	710,803	\$62.94	\$130.69
Avoided Mortality, Respiratory	Ozone	145	603	\$1,338.20	\$5,555.88
Incidence, Asthma Onset	Ozone	2,135	6,910	\$76.35	\$258.44
Emergency Room Visits, Respiratory	Ozone	1,343	4,650	\$1.85	\$7.11
Asthma Symptoms	Ozone	951,637	3,110,619	\$2.05	\$912.57
Hospital Admissions, Respiratory	Ozone	76	327	\$4.33	\$20.61

- **The implementation of the Scoping Plan achieves important public health benefits**
 - Total combined benefits are \$78 billion in 2035 and \$199 billion in 2045
 - Communities in Southern California benefit more due to pre-existing air quality challenges, significant emission sources and activity, and large, dense populations

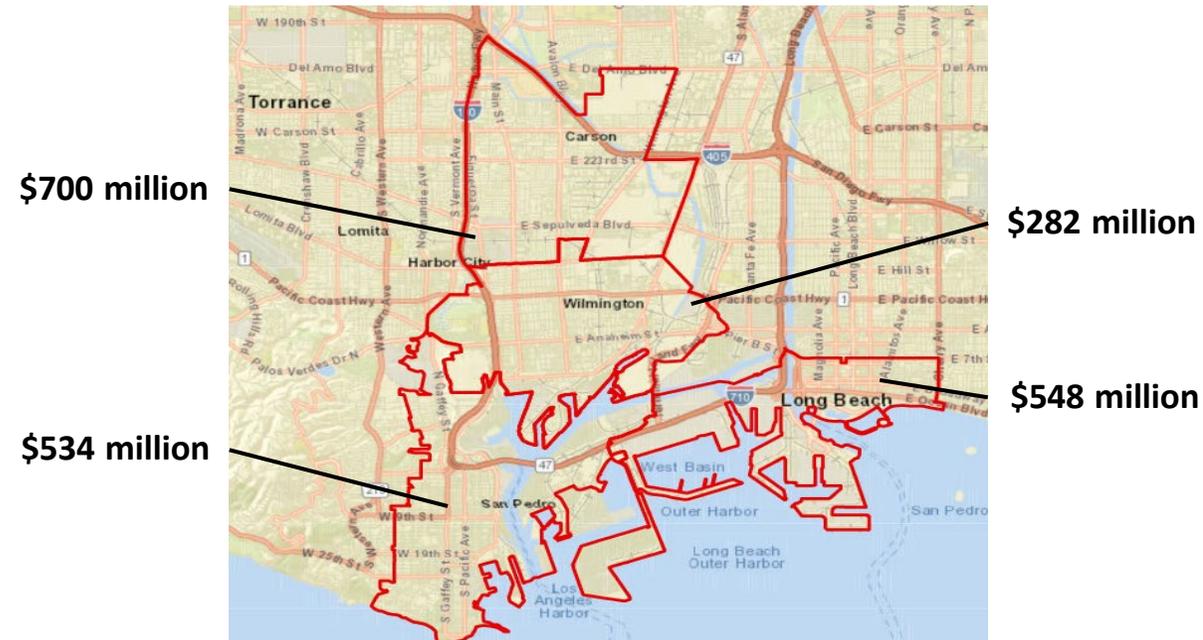


- **CalEnviroScreen 4.0 used to quantify health benefits within census tracts identified as socially and economically disadvantaged communities**
 - Benefits within disadvantaged communities are approximately \$22 billion in 2035 and \$61 billion in 2045
 - Disadvantaged communities in Southern California experience the highest benefits

Total Health Benefits in Disadvantaged Communities



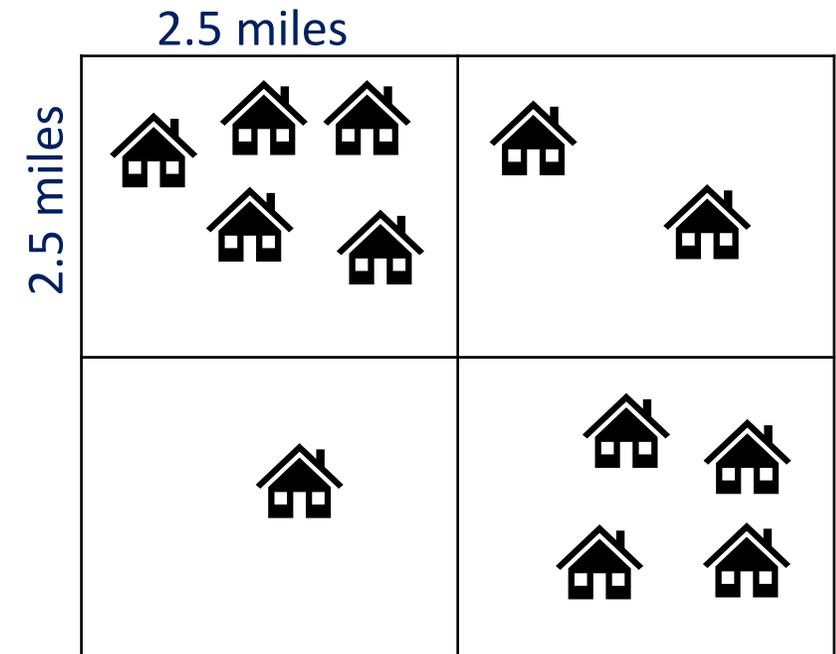
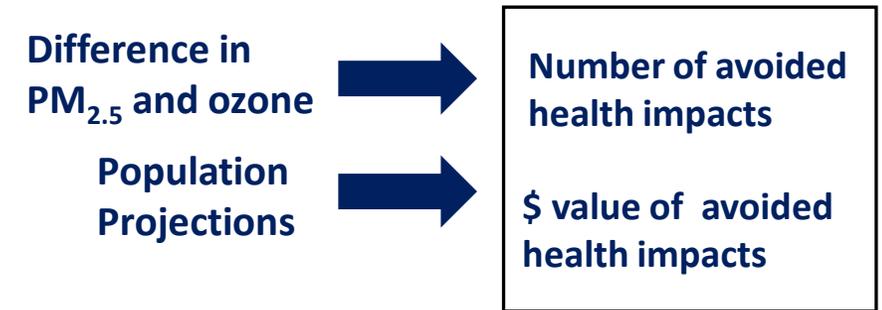
Disadvantaged communities adjacent to the Ports of LA and Long Beach*



**Total health benefits in 2045*

- **Air Quality and Health Impact Modeling Caveats**

- Meteorology and other factors including boundary conditions are held constant to the base year to ensure all impacts occur from changes in emissions from Scoping Plan measures
 - **Does not account for climate-impacted meteorology**
 - **Does not account for wildfire impacts**
- Health savings are calculated with the same resolution as the air quality and can be reasonably downscaled to the census tract level
 - **Does not allow for individual source impacts to be resolved**
 - **Does not allow for neighborhood level impacts to be resolved**



- **Evaluation of the air quality and public health impacts demonstrates that the implementation of the Scoping Plan Scenario will achieve important benefits in California**
 - Health benefits total approximately \$78 billion in 2035 and \$199 billion in 2045
- **Health benefits are most pronounced in the Southern California due to pre-existing air quality challenges, the presence of significant emission sources, and large, dense urban populations**
 - Notable benefits also occur in the Central Valley, S.F. Bay, Sacramento, and San Diego regions
- **The Scoping Plan attains important benefits within socially and economically disadvantaged communities that are most impacted by, and vulnerable to, degraded air quality**
 - Benefits within disadvantaged communities reach \$22 billion in 2035 and \$61 billion in 2045