Oregon Climate Protection Program: Modeling Study on Program Options

Oregon DEQ and ICF

State of Oregon Department of Environmental Quality

Modeling Analysis Study

- DEQ contracted with ICF to conduct a modeling study to assess different greenhouse gas emissions reduction program designs for information on:
  - Forecasted greenhouse gas emissions
  - Equity, air quality, and public health co-benefits
  - Macroeconomic effects on Oregon's economy
- Modeling analysis objectives:
  - Analyze options to inform overall program design and relationships between design elements
  - Provide information on directionality and magnitude of changes when adjusting parameters of discrete program elements
- Scenarios do not represent final or complete program design proposals and not all program design elements are represented in the modeling

Notice

- The following slides include results of the modeling study to support development of the Climate Protection Program
  - Another slide deck with more assumptions and background information is available on DEQ’s website
- Most of these results were presented at the sixth advisory committee meeting of the Greenhouse Gas Emissions Program 2021 Rulemaking

Last Updated: June 10, 2021

Revisions and Updates

- Initial reference case results have been updated since April 2021 RAC meeting
- Update is the result of a modeling correction for application of VISON model transportation fuel use estimates
- Reference case emissions are now higher than initially projected
  - Higher transportation sector emissions
- Since the policy scenarios look at differences from the reference case, the correction results in some emissions changes in some years for policy scenarios
  - Minor changes to co-benefits and equity analysis, which remain positive for all scenarios
  - Economic changes continue to be small overall, but now trend more positive
  - Health results are unchanged as the error was not made when applying the data in COBRA

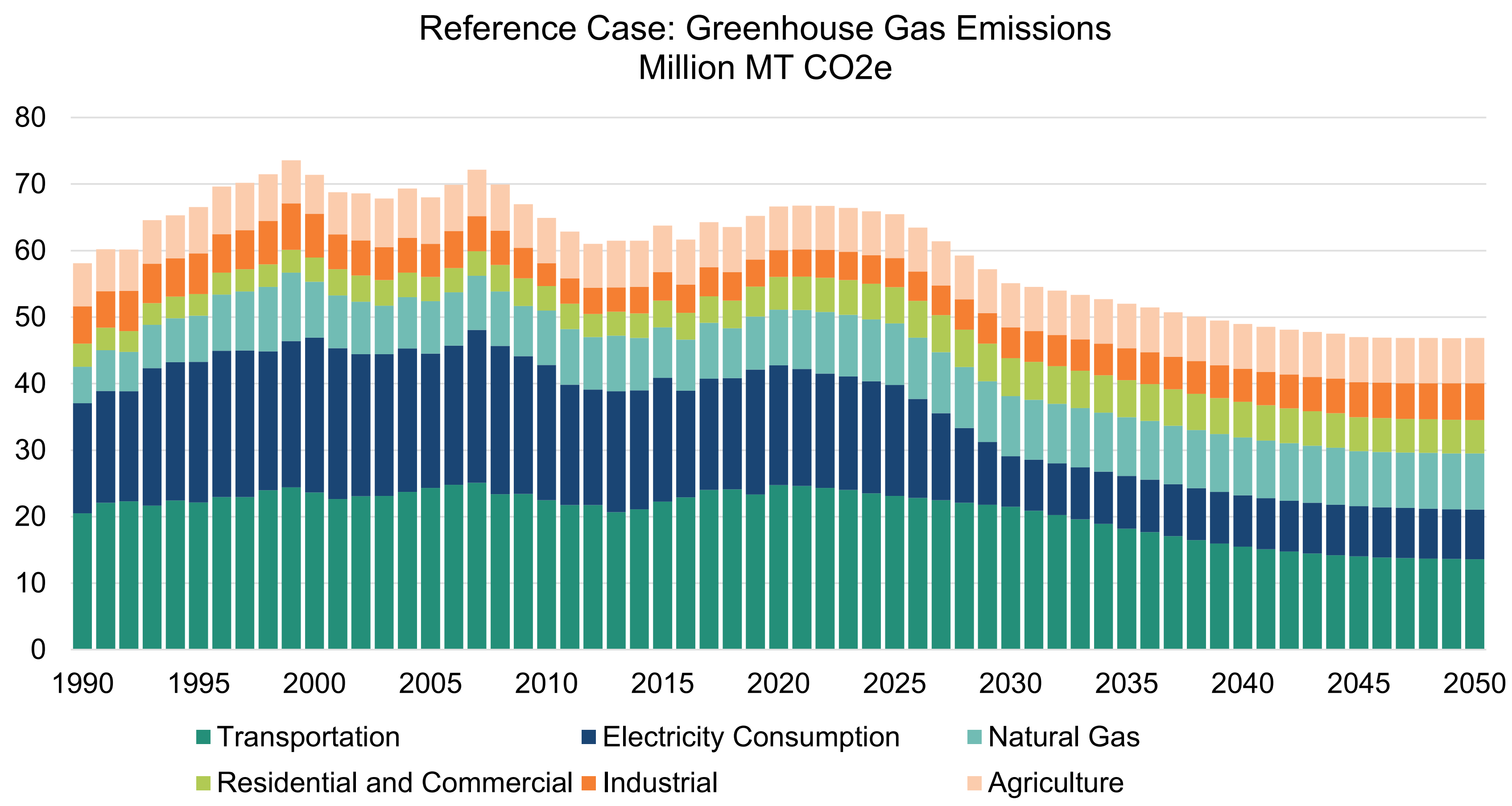
DEQ Reflections on Modeling

- Significantly reduce GHG emissions while maintaining overall health of economy
- Improve public health by reducing emissions and support equity
- Important to understand any relevant differences in scenario results
- All scenarios:
  - Significant reductions statewide in adverse health impacts
    - Cumulative monetized health benefit of approximately $2 billion (2020$)
  - Very little overall macroeconomic change
    - Small changes to economy, but net positive trends for GSP, income, and jobs
  - Increased co-benefits and benefits for identified communities of concern
    - Urban low-income households and communities of color experience the most benefits
    - Important for CCI design to effectively support and engage environmental justice and impacted communities in transition to a low-carbon future

Greenhouse Gas Emissions

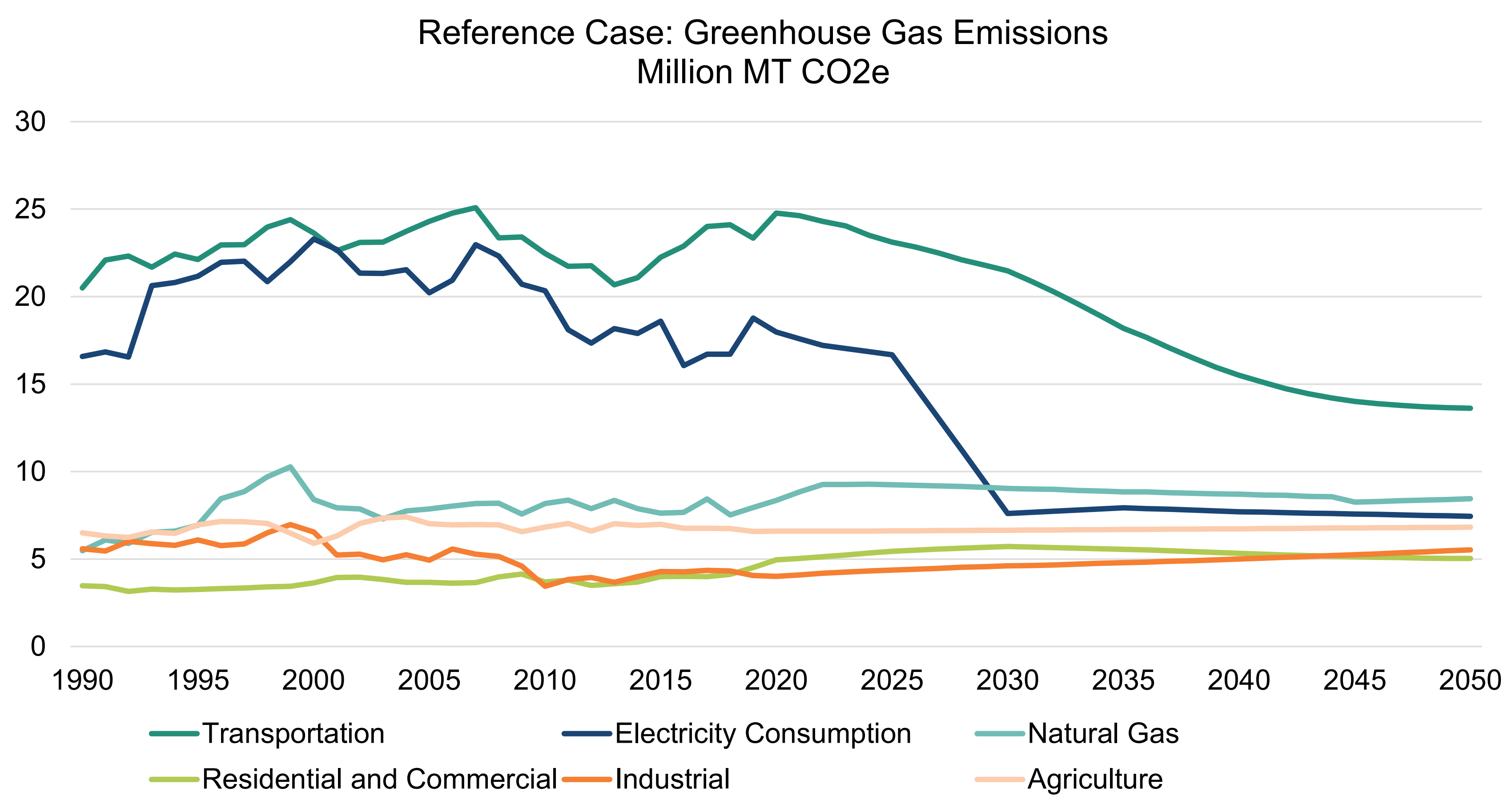
Results and key takeaways for four policy scenarios

Reference Case: Summary of Results



Note: See separate assumptions slide deck for descriptions of emissions included in each sector.

Reference Case: Summary of Results



Note: See separate assumptions slide deck for descriptions of emissions included in each sector.

Reference Case: Summary of Results

	Emissions (Million MT CO_2e)					Percent Change			
Sector	**1990**	**2018**	**2030**	**2040**	**2050**	**1990-2030**	**1990-2050**	**2018-2030**	**2018-2050**
Transportation	20.5	24.1	21.5	15.5	13.6	5%	-34%	-11%	-44%
Natural Gas	5.5	7.5	9.0	8.7	8.4	65%	54%	20%	12%
Industrial	5.6	4.3	4.6	5.0	5.5	-17%	-1%	7%	28%
Electricity Consumption	16.6	16.7	7.6	7.7	7.4	-54%	-55%	-54%	-55%
Residential and Commercial	3.5	4.1	5.7	5.3	5.0	64%	45%	38%	22%
Agriculture	6.5	6.7	6.6	6.7	6.8	2%	5%	-2%	1%
Total	**58.1**	**63.5**	**55.1**	**49.0**	**46.9**	**-5%**	**-19%**	**-13%**	**-26%**

Note: columns may not sum to the total shown due to rounding.

Reference Case: Key Takeaways

- Transportation
  - Emissions declines due to Clean Fuels Program and CAFE standards
  - Still projected to be the largest source of in-state emissions by 2050
- Natural gas
  - Emissions remain relatively flat
  - Minor decline over time due to renewable natural gas procurement (Senate Bill 98)
- Industrial (non-electric or gas related)
  - Emissions relatively small
  - Minor increase over time due to increased energy use and process emissions as a result of manufacturing growth (e.g. for cement manufacturing and semiconductor manufacturing)

Reference Case: Key Takeaways

Key takeaways for emissions from other sectors:

- Electricity
  - Emissions continue to decline through 2035 due to increased renewables and coal no longer procured after 2030
  - After 2035, electric load increases from electric vehicles, though emissions remain relatively flat due to lower-emitting power
- Residential and commercial
  - Minor emissions increases driven by high global warming potential materials (refrigerants) and landfills

Policy Scenario Common Assumptions

Assumptions the same in each scenario

Key Topic	4 Policy Scenarios
Cap Application	One cap applied across all sectors using 2010 data for baseline with cap beginning in 2022 *(regulated sectors and therefore scopes of regulated emissions vary by scenario)*
Banking Allowed?	Yes; unlimited through time
Community Climate Investments (CCI) Allowed?	Yes, but allowable percentage for compliance varies by scenario
CCI Price (*see table*)	EPA Social Cost of Carbon using a 2.5% discount rate (starts at $76 and increases to $116 in 2020$)
Expanded Complementary Policies	Clean Fuels Program assumed to expand from current 10% by 2025 target to 25% by 2035*

*DEQ intends to open a rulemaking in 2021 to develop expanded Clean Fuels Program targets

Policy Scenario Differing Assumptions

Key Topic	Policy Scenario 1	Policy Scenario 2	Policy Scenario 3	Policy Scenario 4
Cap and Trajectory	Straight line to 80% by 2050	45% by 2035 80% by 2050	50% by 2035 90% by 2050	45% by 2035 80% by 2050
Trading Allowed?	Yes	Yes, excluding stationary sources	Yes	Yes
Regulated Sectors under the Cap	- Natural gas utilities - Non-natural gas fossil fuel suppliers - Large stationary sources with process emissions ≥ 25,000	- Natural gas utilities - Non-natural gas fossil fuel suppliers - Large stationary sources with process emissions plus natural gas emissions ≥ 25,000 (includes gas supplied by interstate pipeline companies to those above threshold)	- Natural gas utilities - Non-natural gas fuel suppliers with emissions ≥ 300,000 - Large stationary sources with process emissions ≥ 25,000	- Natural gas utilities - Non-natural gas fossil fuel suppliers
Emissions not included under the Cap	- Fuels used for aviation - Process emissions below threshold	- Fuels used for aviation - Process emissions below threshold	- Fuels used for aviation; - Emissions from fuel suppliers below threshold - Process emissions below threshold	- Fuels used for aviation - Large stationary sources assumed to be regulated under a separate best available emissions reduction approach
Natural Gas Point of Regulation	All natural gas regulated at utility, not at stationary source.	Natural gas regulated at stationary sources if emissions are above threshold. Otherwise, natural gas regulated at utility.	All natural gas regulated at utility, not at stationary source.	All natural gas regulated at utility, not at stationary source.
Use of CCIs	Up to 25% of compliance per year	Up to 5% of compliance per year	Up to 25% of compliance per year	Up to 20% of compliance per year

Modeling Community Climate Investments

- Community Climate Investments (CCIs) allowed in each policy scenario
- CCI price is assumed to be the EPA social cost of carbon using a 2.5% discount rate
  - Review of literature and ICF analyses on potential projects of interest informed the assumed modeling price

Social Cost of CO_2
$2020 per metric ton

Year	2.5% Average
2020	$76
2025	$83
2030	$89
2035	$96
2040	$103
2045	$110
2050	$116

Key Notes for Understanding Results (1/3)

- Technical potential emissions reductions and costs per ton rely on a variety of resources
- Modeled major drivers for reductions, including:
  - Energy efficiency
  - Fuel switching/electrification
  - Renewable natural gas
  - Destruction, removal, or recovery of industrial process emissions

Key Resources

- Natural gas utility IRPs
- Energy Trust of Oregon
- NREL Electrification Futures Study
- Oregon-specific data (population, number of homes, commercial square footage, OR GHG RP data)
- Cal ETC Comparison of Medium- and Heavy-duty Technologies in California
- U.S. EPA Global Non-CO_2 Greenhouse Gas Emission Projections & Mitigation Potential: 2015-2050
- U.S. DOE State Energy Database and Annual Energy Outlook
- McKinsey & Company abatement cost curve analyses for industrial processes (e.g., cement and iron and steel production)

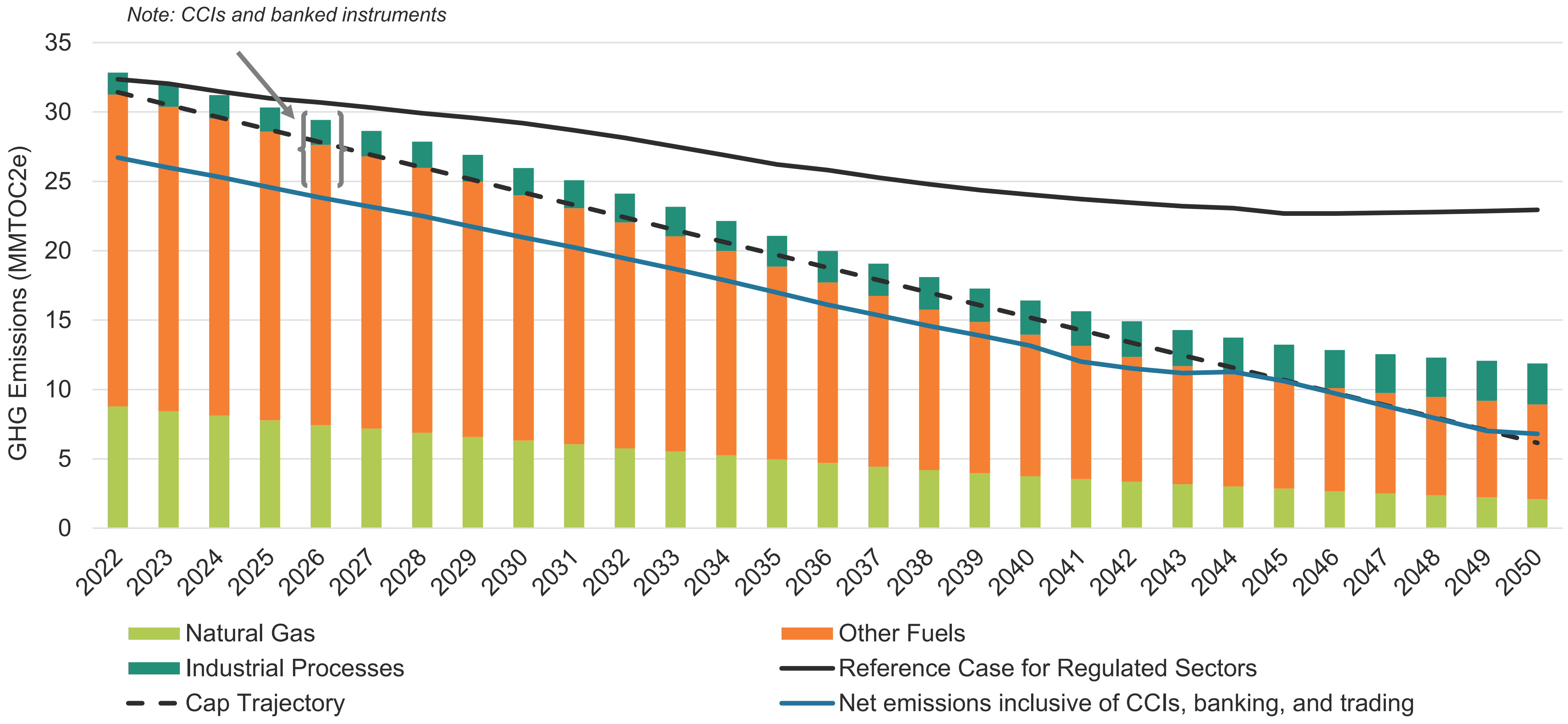
Key Notes for Understanding Results (2/3)

- 2019 greenhouse gas emissions and fuel supply data are used to determine if emissions were regulated in the policy scenarios
  - The scope of regulated emissions vary by scenario based on the assumptions for that scenario
- Interactions at the facility or business level are not captured; modeling is conducted at the sector level (i.e., natural gas, other fuels, industrial process) and sub-sector level (e.g., residential, cement manufacturing)
- In the model, caps are applied only to regulated sectors
  - The following charts only show emissions from regulated sectors, not statewide emissions

Key Notes for Understanding Results (3/3)

- Modeling assumes that the regulated entities have sufficient knowledge to make optimal decisions in the future
  - E.g., Banking versus trading
- Current technologies and costs are used in the modeling, but available technologies and their costs are likely to change and decline in the future, which would influence actual program outcomes
- For some years in some scenarios, net emissions inclusive of CCIs, banking, and trading may still be above the cap
- For two scenarios this only occurs near the end of the modeling time horizon
  - Important to remember that current technologies and costs are used in the modeling, but available technologies and their costs are likely to change and decline in the future, which would influence actual program outcomes along with program design features

Policy Scenario 1 Results



Policy Scenario 1 Results

Assumptions

- Trajectory: Steady annual reductions to 80% by 2050
- CCIs allowable up to 25% per year

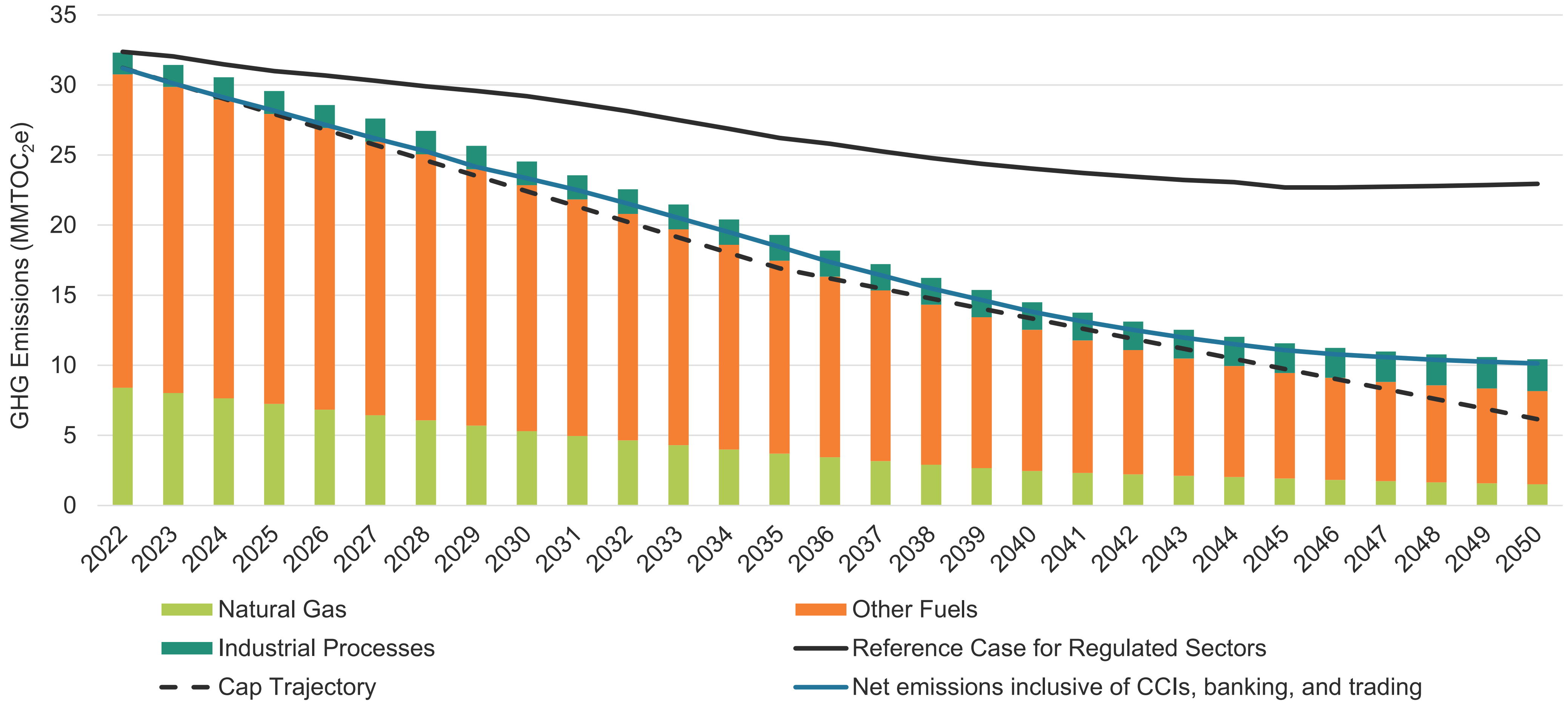
Compliance

- Cap is met in all years except 2050
- CCIs and banking make it possible to achieve the cap, particularly in later years
- Trading does not appear to have a significant impact

Emissions

- Largest emissions reductions come from fuels, driven by expanded CFP, energy efficiency, and electrification
- Natural gas emissions reductions driven by energy efficiency, electrification and RNG
- Though a smaller source of regulated emissions, reductions in industrial process emissions requires achieving technical potential

Policy Scenario 2 Results



Policy Scenario 2 Results

Assumptions

- Trajectory: 45% reduction by 2035 and 80% by 2050
- CCIs allowable up to 5% per year
- Greatest quantity of regulated emissions due to threshold for industrial facilities of combined process and natural gas

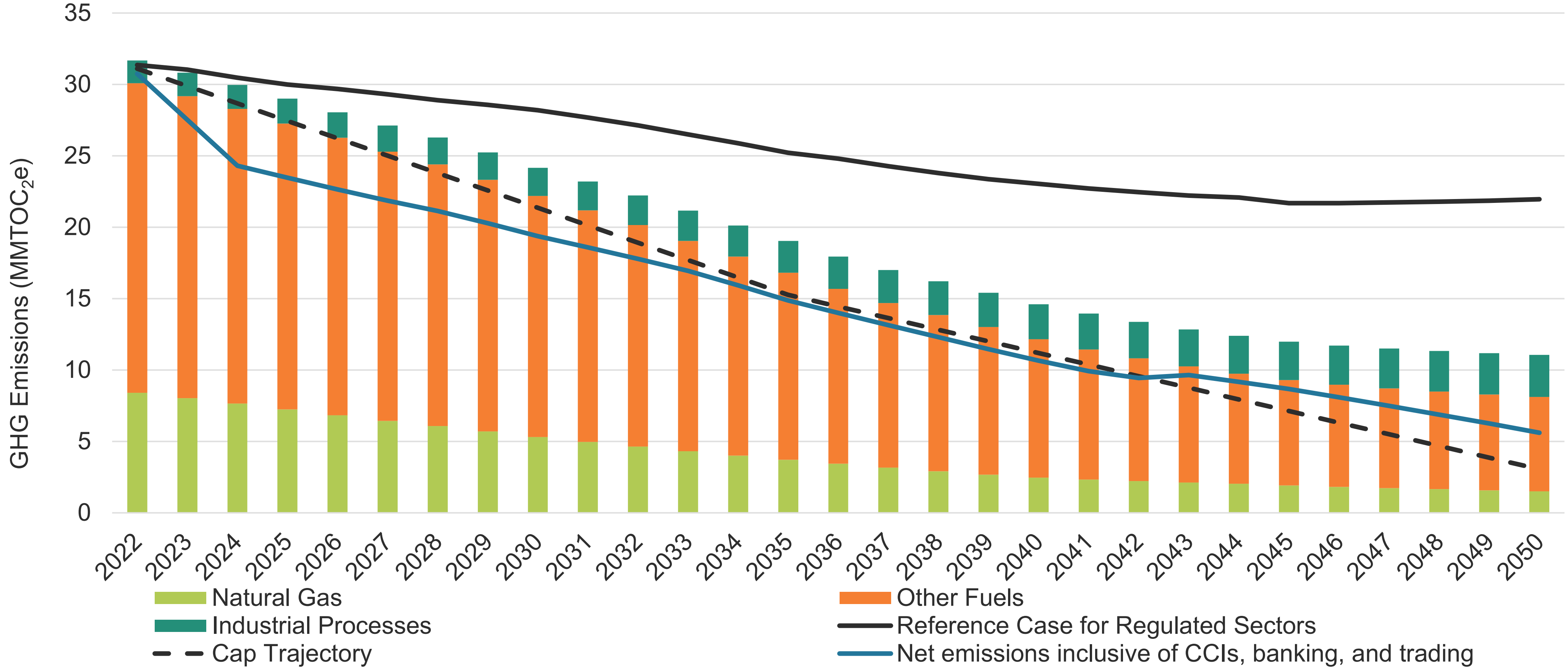
Compliance

- Cap is met through 2023; net emissions slightly above cap 2024-2050
- Maximum allowable CCIs used in most years
- Less availability of banked compliance instruments
- Net emissions above caps driven by combination of interim cap target, limit on use of CCIs, and largest quantity of regulated emissions

Emissions

- More extensive residential and commercial electrification driving reductions
- Increased reductions from energy efficiency for non-natural gas fuels
- Approaching maximum technical potential for RNG as replacement for natural gas

Policy Scenario 3 Results



Policy Scenario 3 Results

Assumptions

- Trajectory: 50% reduction by 2035 and 90% by 2050
- CCIs allowable up to 25% per year
- Lower quantity of regulated emissions (compared to Scenarios 1 and 2) due to threshold for non-natural gas fuel suppliers

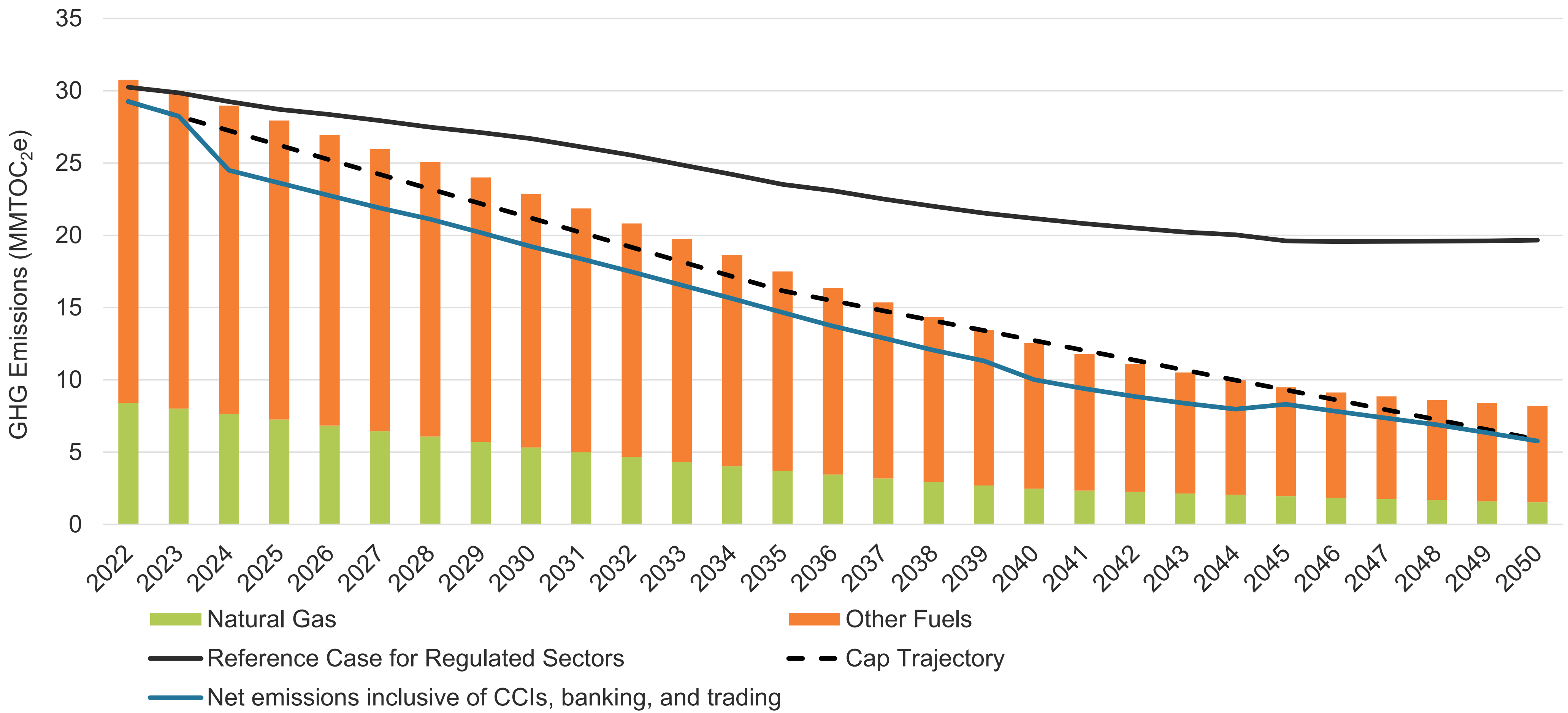
Compliance

- Cap is met 2022-2042; net emissions above cap 2043-2050
- Maximum allowable CCIs used in most years
- Net emissions above cap in later period mainly driven by combination of lower caps compared to other scenarios and earlier full use of banked compliance instruments
- Available CCIs supports achievement of cap into later years

Emissions

- Similar reductions (compared to Scenario 2) from electrification, RNG, energy efficiency, and industrial processes

Policy Scenario 4 Results



Policy Scenario 4 Results

Assumptions

- Trajectory: 45% reduction by 2035 and 80% reduction by 2050
- CCIs allowable up to 20% per year
- Least quantity of regulated emissions since stationary source emissions regulated under different program design mechanism

Compliance

- Cap is met in all years
- Use of allowable CCIs below maximum threshold, mostly in earlier years

Emissions

- Similar reductions (compared to Scenarios 2 & 3) from electrification, RNG, and energy efficiency

GHG Emissions Results Summary (1/2)

- All scenarios model significant emissions reductions
  - At least 80% emission reductions by 2050
- Compliance flexibility measures play an important role in achieving emissions reductions
  - Banking used in all scenarios
  - CCIs used to the almost fullest extent in scenarios
- Trading and point of regulation had minimal effects in modeling
- Emissions reductions are driven by transportation sector
- Other reductions are achieved with building energy efficiency, electrification, and renewable natural gas

GHG Emissions Results Summary (2/2)

- Reductions in other fuels are driven by the transportation sector, energy efficiency, and some electrification
  - Expanded CFP is achieved
  - Significant electrification and use of bio and renewable diesel for medium and heavy-duty trucks
- Reductions in natural gas emissions are driven by energy efficiency, electrification, and renewable natural gas
  - RNG use goes beyond SB 98 assumptions
  - Impacted the overall reductions across sectors in all scenarios
  - Electrification does increase emissions in electricity, though statewide emissions reductions are still achieved

Health

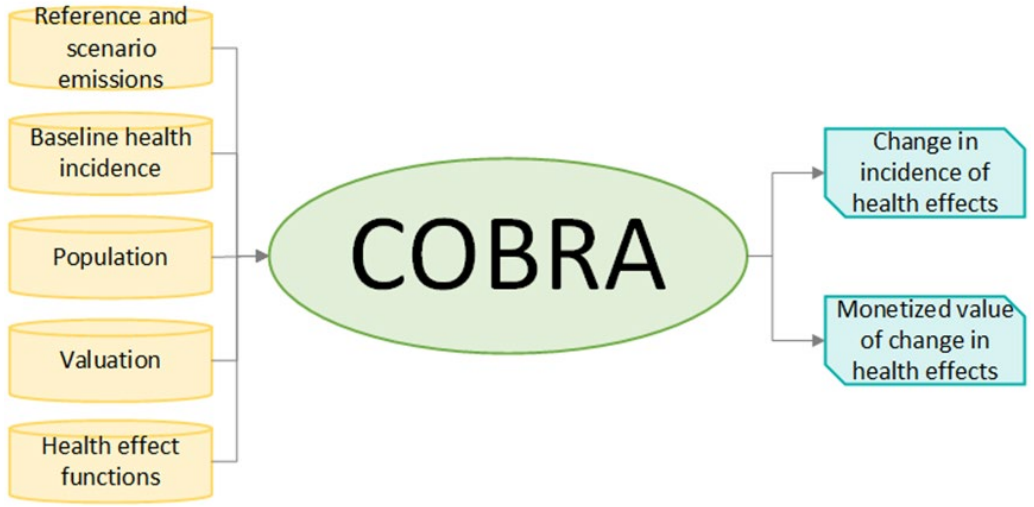
Results and key takeaways for four policy scenarios

Health Modeling Assumptions

- Health benefits of air quality improvements modeled using EPA's Co-Benefits Risk Assessment (COBRA) screening tool
  - COBRA estimates the public health impacts of changes in emissions of particulate matter (PM2.5) and its precursors (NOx, SO2, NH3, and VOC)
  - Changes in human health outcomes and their economic value are estimated at the county or state levels
- Monetized health benefits for scenarios as compared to reference case
  – Evaluated in comparison to a reference case for 3 years: near term (2025), mid-term (2035), and horizon (2050)

Health Modeling Assumptions

- Emission modeling results were mapped to COBRA categories
  - Sectors with no changes due to the policy scenarios (e.g. agriculture) are treated as having no change in emissions
- COBRA model captures emissions from fossil fuel combustion
  - Does not capture any industrial process emissions changes
- Health analysis also does not capture any potential benefits from CCIs



Health Modeling Assumptions & Data Sources

- Scenarios 1-3 state-level emissions apportioned to counties using the model's default proportions for 2023
- Scenario 4 emissions resolved at the county scale for all sectors
- COBRA population and incidence inputs customized with data from PSU/Metro and OHA
- Valuation of health endpoints scaled to future-year values, where possible[1]
- Future year benefits discounted to the start of the evaluation period (2022) at 3% and 7% discount rates[2]
  - Discounted to express future economic values in present terms
- Low and high estimates are reported separately to account for uncertainties

[1]Valuation projections available only for certain endpoints (mortality, acute bronchitis, asthma exacerbation, upper and lower respiratory symptoms)
[2]The discount rate accounts for the fact that people generally value future benefits and costs less than current costs and benefits. We discount the value of premature mortality occurring in future years using rates of 3% and a conservative 7%, consistent with EPA. (Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 17 Sectors, 2018; BenMAP User's Manual, 2018; Guidelines for Preparing Economic Analyses, 2010)

Scenario 1: Health Impact Results by Year

Health Endpoint	2025			2035			2050		
	Change in # of Cases	Monetary Health Benefits (2020$)		Change in # of Cases	Monetary Health Benefits (2020$)		Change in # of Cases	Monetary Health Benefits (2020$)	
		3% Discount	7% Discount		3% Discount	7% Discount		3% Discount	7% Discount
Mortality - low estimate	0.370	$3,440,000	$2,660,000	2.36	$17,000,000	$9,010,000	5.25	$26,600,000	$7,940,000
Mortality - high estimate	0.837	$7,780,000	$6,020,000	5.32	$38,500,000	$20,300,000	11.8	$60,000,000	$17,900,000
Infant Mortality	0.002	$19,700	$16,900	0.010	$84,500	$49,600	0.022	$116,000	$38,600
Nonfatal Heart Attacks - low estimate	5.00	$755,000	$630,000	35.9	$3,990,000	$2,280,000	88.8	$6,330,000	$2,040,000
Nonfatal Heart Attacks - high estimate	46.3	$7,000,000	$5,850,000	333	$37,000,000	$21,100,000	823	$58,700,000	$18,900,000
Hospital Admits - All Respiratory	6.66	$229,000	$197,000	47.2	$1,220,000	$714,000	118	$1,960,000	$648,000
Hospital Admits - Cardiovascular - except heart attacks	9.30	$448,000	$385,000	66.5	$2,380,000	$1,400,000	165	$3,800,000	$1,260,000
Acute Bronchitis	0.489	$257	$220	3.16	$1,260	$736	7.77	$2,050	$678
Upper Respiratory Symptoms	8.81	$319	$274	57	$1,560	$917	140	$2,550	$844
Lower Respiratory Symptoms	6.21	$142	$122	40.1	$695	$408	98.6	$1,130	$375
Emergency Room Visits - Asthma	19.1	$10,100	$8,660	129	$50,600	$29,700	318	$80,400	$26,600
Minor Restricted Activity Days	281	$22,900	$19,700	1,800	$109,000	$63,900	4,420	$172,000	$56,900
Work Loss Days	47.9	$9,000	$7,730	306	$42,800	$25,100	753	$67,500	$22,400
Asthma Exacerbation	9.14	$567	$487	59.2	$2,780	$1,630	145	$4,520	$1,500
Total, low estimate		**$4,940,000**	**$3,930,000**		**$24,900,000**	**$13,600,000**		**$39,100,000**	**$12,000,000**
Total, high estimate		**$15,500,000**	**$12,500,000**		**$79,400,000**	**$43,800,000**		**$125,000,000**	**$38,900,000**

Notes:

- Results shown represent $ values for that model year and do not represent cumulative changes.
- **Monetized health benefits**: in $2020. The discount rate expresses future economic values in present terms. Not all health effects and associated economic values occur in the year of analysis. Future year benefits are discounted to the start of the evaluation period (2022). Adult mortality valuation is based on a Value of a Statistical Life (VSL; grown from EPA 1990 VSL using standard income growth data) calculated by ICF and is lagged 20 years (per COBRA Model guidance), not the default valuation in COBRA.
- **Changes in number of cases**: All values rounded to the nearest integer.
- Mortality Low estimate based on Krewski et al. (2009); High estimate based on Lepeule et al. (2012)
- Nonfatal heart attacks Low estimate based on four acute myocardial infarction (AMI) studies; High estimate based on Peter et al. (2001)

Scenario 2: Health Impact Results by Year

Health Endpoint	2025			2035			2050		
	Change in # of Cases	Monetary Health Benefits (2020$)		Change in # of Cases	Monetary Health Benefits (2020$)		Change in # of Cases	Monetary Health Benefits (2020$)	
		3% Discount	7% Discount		3% Discount	7% Discount		3% Discount	7% Discount
Mortality - low estimate	0.415	$3,860,000	$2,990,000	2.42	$17,500,000	$9,240,000	5.47	$27,700,000	$8,270,000
Mortality - high estimate	0.939	$8,730,000	$6,750,000	5.46	$39,500,000	$20,900,000	12.3	$62,500,000	$18,700,000
Infant Mortality	0.002	$22,200	$19,000	0.011	$87,500	$51,400	0.023	$122,000	$40,200
Nonfatal Heart Attacks - low estimate	5.61	$848,000	$708,000	36.8	$4,090,000	$2,340,000	92.5	$6,600,000	$2,130,000
Nonfatal Heart Attacks - high estimate	52.1	$7,870,000	$6,570,000	342	$38,000,000	$21,700,000	858	$61,200,000	$19,700,000
Hospital Admits - All Respiratory	7.48	$257,000	$221,000	48.4	$1,250,000	$733,000	123	$2,040,000	$676,000
Hospital Admits - Cardiovascular - except heart attacks	10.5	$505,000	$433,000	68.0	$2,440,000	$1,430,000	172	$3,960,000	$1,310,000
Acute Bronchitis	0.552	$289	$249	3.27	$1,300	$762	8.11	$2,130	$707
Upper Respiratory Symptoms	9.94	$360	$309	59.0	$1,620	$949	146	$2,660	$880
Lower Respiratory Symptoms	7.00	$160	$138	41.6	$720	$422	103	$1,180	$392
Emergency Room Visits - Asthma	21.5	$11,400	$9,760	132	$52,100	$30,600	332	$83,900	$27,800
Minor Restricted Activity Days	317	$25,800	$22,200	1,870	$113,000	$66,300	4,620	$179,000	$59,400
Work Loss Days	54.1	$10,200	$8,720	318	$44,400	$26,000	786	$70,500	$23,300
Asthma Exacerbation	10.3	$639	$549	61.2	$2,870	$1,690	152	$4,720	$1,560
Total, low estimate		**$5,540,000**	**$4,410,000**		**$25,600,000**	**$13,900,000**		**$40,800,000**	**$12,500,000**
Total, high estimate		**$17,400,000**	**$14,000,000**		**$81,400,000**	**$44,900,000**		**$130,000,000**	**$40,500,000**

Notes:

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Scenario 3: Health Impact Results by Year

Health Endpoint	2025			2035			2050		
	Change in # of Cases	Monetary Health Benefits (2020$)		Change in # of Cases	Monetary Health Benefits (2020$)		Change in # of Cases	Monetary Health Benefits (2020$)	
		3% Discount	7% Discount		3% Discount	7% Discount		3% Discount	7% Discount
Mortality - low estimate	0.123	$1,140,000	$884,000	2.12	$15,400,000	$8,120,000	5.07	$25,700,000	$7,670,000
Mortality - high estimate	0.278	$2,580,000	$2,000,000	4.80	$34,700,000	$18,300,000	11.4	$58,000,000	$17,300,000
Infant Mortality	0.001	$6,760	$5,800	0.009	$76,400	$44,800	0.021	$112,000	$37,200
Nonfatal Heart Attacks - low estimate	1.88	$285,000	$238,000	32.6	$3,620,000	$2,070,000	86.2	$6,150,000	$1,980,000
Nonfatal Heart Attacks - high estimate	17.4	$2,640,000	$2,200,000	302	$33,600,000	$19,200,000	799	$57,000,000	$18,400,000
Hospital Admits - All Respiratory	2.38	$81,600	$70,100	42.7	$1,100,000	$646,000	114	$1,900,000	$628,000
Hospital Admits - Cardiovascular - except heart attacks	3.31	$160,000	$137,000	60.0	$2,150,000	$1,260,000	160	$3,680,000	$1,220,000
Acute Bronchitis	0.167	$88	$75	2.86	$1,130	$666	7.50	$1,980	$654
Upper Respiratory Symptoms	3.02	$109	$94	51.5	$1,410	$829	135	$2,460	$815
Lower Respiratory Symptoms	2.13	$49	$42	36.3	$629	$369	95.2	$1,090	$362
Emergency Room Visits - Asthma	7.12	$3,760	$3,230	117	$45,900	$26,900	309	$77,900	$25,800
Minor Restricted Activity Days	94.7	$7,710	$6,620	1,630	$98,500	$57,800	4,270	$166,000	$54,900
Work Loss Days	16.1	$3,030	$2,600	277	$38,700	$22,700	726	$65,100	$21,600
Asthma Exacerbation	3.13	$194	$167	53.5	$2,510	$1,470	140	$4,370	$1,450
Total, low estimate		**$1,690,000**	**$1,350,000**		**$22,500,000**	**$12,200,000**		**$37,900,000**	**$11,600,000**
Total, high estimate		**$5,490,000**	**$4,430,000**		**$71,800,000**	**$39,600,000**		**$121,000,000**	**$37,700,000**

Notes:

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- **Changes in number of cases**: All values rounded to the nearest integer.
- Mortality Low estimate based on Krewski et al. (2009); High estimate based on Lepeule et al. (2012)
- Nonfatal heart attacks Low estimate based on four acute myocardial infarction (AMI) studies; High estimate based on Peter et al. (2001)

Scenario 4: Health Impact Results by Year

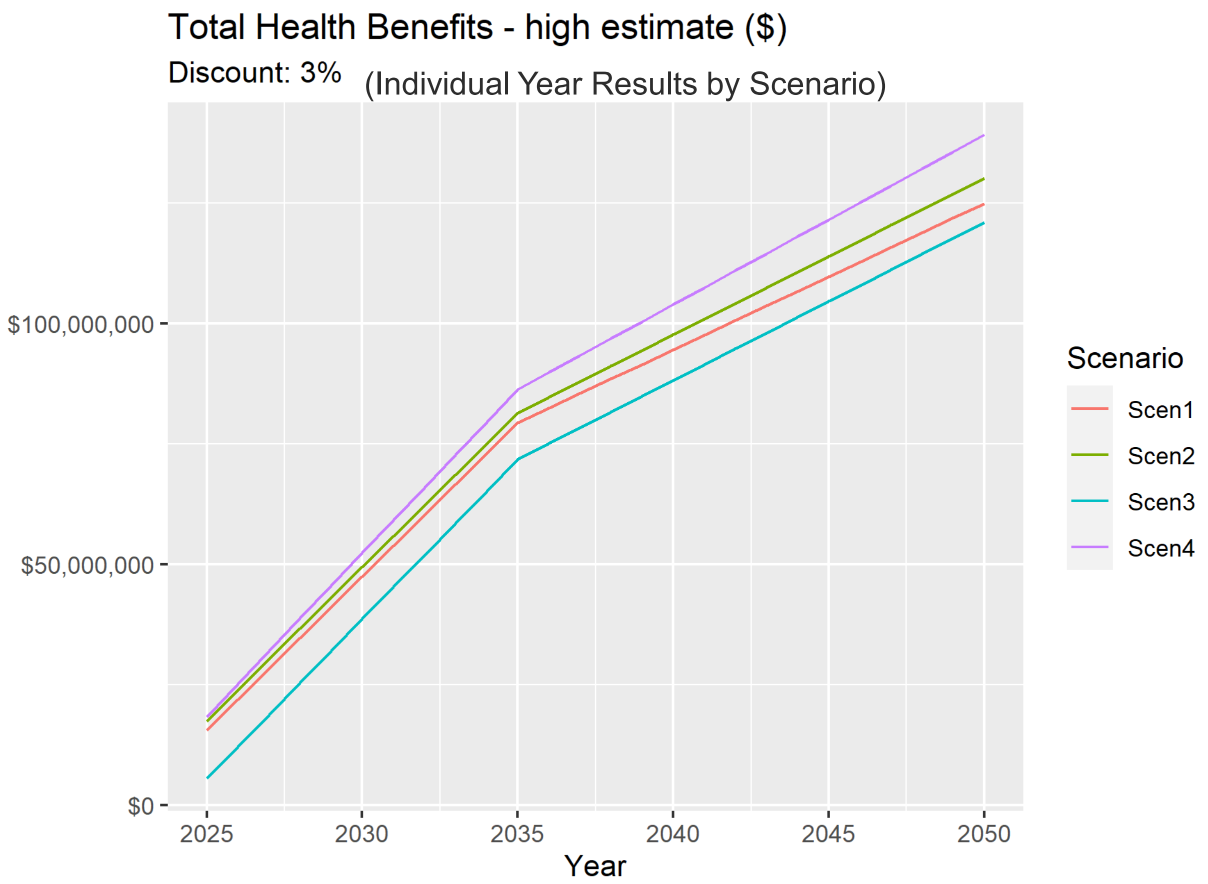
Health Endpoint	2025			2035			2050		
	Change in # of Cases	Monetary Health Benefits (2020$)		Change in # of Cases	Monetary Health Benefits (2020$)		Change in # of Cases	Monetary Health Benefits (2020$)	
		3% Discount	7% Discount		3% Discount	7% Discount		3% Discount	7% Discount
Mortality - low estimate	0.440	$4,090,000	$3,160,000	2.56	$18,500,000	$9,780,000	5.84	$29,600,000	$8,840,000
Mortality - high estimate	0.994	$9,240,000	$7,150,000	5.78	$41,800,000	$22,100,000	13.2	$66,800,000	$19,900,000
Infant Mortality	0.002	$23,700	$20,300	0.011	$94,200	$55,300	0.025	$132,000	$43,800
Nonfatal Heart Attacks - low estimate	5.87	$889,000	$742,000	39.0	$4,350,000	$2,480,000	98.8	$7,060,000	$2,280,000
Nonfatal Heart Attacks - high estimate	54.5	$8,240,000	$6,880,000	362	$40,300,000	$23,000,000	916	$65,500,000	$21,100,000
Hospital Admits - All Respiratory	7.92	$272,000	$234,000	51.6	$1,330,000	$779,000	132	$2,190,000	$725,000
Hospital Admits - Cardiovascular - except heart attacks	11.10	$533,000	$457,000	72.4	$2,590,000	$1,520,000	185	$4,250,000	$1,410,000
Acute Bronchitis	0.589	$309	$265	3.52	$1,400	$819	8.80	$2,320	$768
Upper Respiratory Symptoms	10.60	$384	$330	63.4	$1,740	$1,020	159	$2,890	$956
Lower Respiratory Symptoms	7.47	$171	$147	44.7	$773	$454	112.0	$1,280	$425
Emergency Room Visits - Asthma	22.70	$12,000	$10,300	142	$55,900	$32,800	360	$90,800	$30,100
Minor Restricted Activity Days	338.0	$27,500	$23,600	2,000	$121,000	$71,000	5,000	$194,000	$64,400
Work Loss Days	57.6	$10,800	$9,290	341	$47,600	$27,900	852	$76,400	$25,300
Asthma Exacerbation	11.00	$681	$585	65.8	$3,090	$1,810	165	$5,120	$1,700
Total, low estimate		**$5,860,000**	**$4,660,000**		**$27,100,000**	**$14,800,000**		**$43,600,000**	**$13,400,000**
Total, high estimate		**$18,400,000**	**$14,800,000**		**$86,400,000**	**$47,600,000**		**$139,000,000**	**$43,300,000**

Notes:

- Results shown represent $ values for that model year and do not represent cumulative changes.
- **Monetized health benefits**: in $2020. The discount rate expresses future economic values in present terms. Not all health effects and associated economic values occur in the year of analysis. Future year benefits are discounted to the start of the evaluation period (2022). Adult mortality valuation is based on a Value of a Statistical Life (VSL; grown from EPA 1990 VSL using standard income growth data) calculated by ICF and is lagged 20 years (per COBRA Model guidance), not the default valuation in COBRA.
- **Changes in number of cases**: All values rounded to the nearest integer.
- Mortality Low estimate based on Krewski et al. (2009); High estimate based on Lepeule et al. (2012)
- Nonfatal heart attacks Low estimate based on four acute myocardial infarction (AMI) studies; High estimate based on Peter et al. (2001)

Health Results Monetized Values, All Outcomes by Year

- Total state-wide $ health benefits by year for the 3 modeled years
  - High estimates,[1] 2020$, discounted to the start of the evaluation period (2022) at a 3% rate[2]
- Roughly half the monetized avoided health costs are attributable to avoided mortality
- Reduced incidence of heart attacks and hospital admissions are the leading contributors to avoided morbidity costs



[1]High estimate reflects health impact functions for mortality and non-fatal heart attacks that result in larger benefits
[2]The discount rate expresses future economic values in present terms. Not all health effects and associated economic values occur in the year of analysis.

Health Results Mortality Cost Drill Down

Total Monetized Benefits by Year, Mortality, Discount = 3%, 2020$ (high estimates)

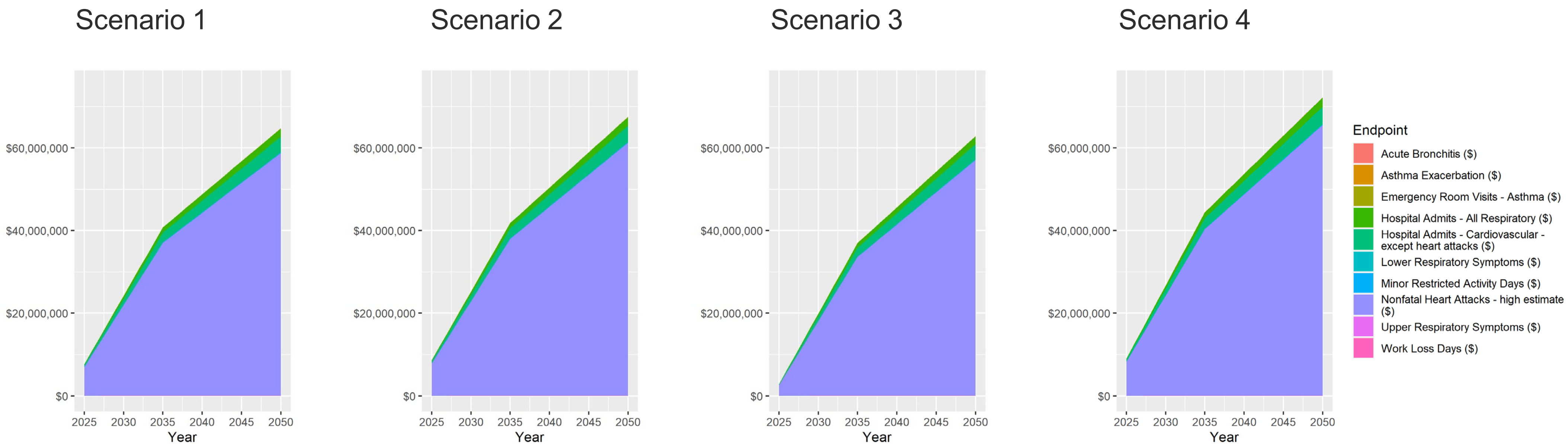
Cumulative avoided deaths and corresponding mortality valuation over the life of the program [1]

Scenario 1	Scenario 2	Scenario 3	Scenario 4
166	172	153	183
$1.01B	$1.05B	$0.916B	$1.11B

[1] Integrated from 2025-2050. Assumes linear trend between modeled years and no savings before 2025. Considers both adult and infant mortalities.

Health Results Morbidity Cost Drill Down by Endpoint

Total Monetized Benefits by Year, Morbidity (all effects), Discount = 3%, 2020$ (high estimates)



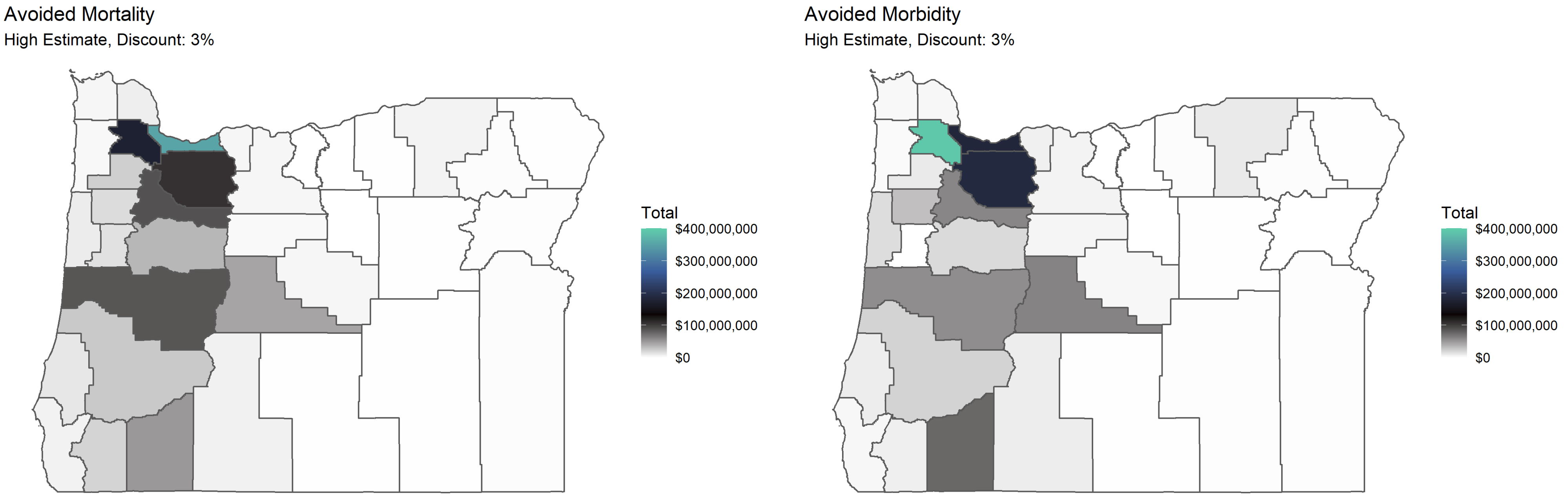
Cumulative avoided morbidity benefit valuation over the life of the program[1]:

Scenario 1	Scenario 2	Scenario 3	Scenario 4
$1.07B	$1.11B	$0.984B	$1.18B

[1] Integrated from 2025-2050. Assumes linear trend between modeled years and no savings before 2025. Considers all non-mortality endpoints.

Scenario 4: County-Level Health Impacts

Scenario 4: Distribution of Avoided Adverse Health Outcomes



Total monetized benefits from avoided adverse health outcomes.
Cumulative from 2025-2050, by county

Avoided mortality estimates include both infants and adults.
Discount = 3%, 2020$. High estimates reflect mortality and nonfatal myocardial infarction health impact functions from Lepeule et al. (2012) and Peter et al. (2001), respectively.

For the health modeling, Scenario 4 used a different resolution (more detailed county-level data). Differences from Scenarios 1-3 will be due to both changes in the methodology and the underlying data.

Health Results Summary

- All Scenarios show significant reduction statewide in adverse health impacts
  - Due to changes in criteria pollutant emissions from all modeled sectors statewide, including on-road mobile sources, electricity generation, and other sources
  - Avoided statewide due to reduced exposure to air pollution from 2025-2050 from the program[1,2,3]
- Relatively small differences between scenarios.
- Examples:
  - Scenario 2 statewide results: 172 mortalities and monetized values of $2.16B (2020$)
  - Scenario 4 statewide results: 183 mortalities and monetized values of $2.29B (2020$)

[1] High estimates, monetized at 3% discount. All monetary values discounted to 2022.
[2] Our approach to allocating emissions to COBRA values by county and source's "stack height" preferred preserving all emissions over preserving default county stack heights. A sensitivity analysis showed the latter could increase benefits very modestly (<1.5%).
[3] COBRA valuation component aims to monetize public health benefits, not calculate healthcare cost savings. Many endpoints (e.g., mortality, acute bronchitis) are valued using non-market valuation based on willingness to pay (WTP) estimates. Endpoints for which WTP is not available, valuation is approximated using healthcare cost savings and lost productivity. The valuation estimates represent an approximate value residents of Oregon would place on avoiding the statistical cases of characterized endpoints; these estimates are not comparable with market impact estimates generated by the economic analysis component.

Economic

Results and key takeaways for final four policy scenarios

Economic Analysis Overview & Data Sources

- Economic analysis conducted using the IMPLAN economic model
- IMPLAN analyzes regional economic effects of policy scenarios on a single, pre-specified region
  - Model used here is for the entire state of Oregon
  - Data vintage: 2019
- Results are typically report in terms of common economic metrics
  - Jobs/employment impacts
  - Gross State Product (GSP)
  - Labor Income
- Monetary values reported in 2020$

Economic Analysis Overview & Data Sources

- Three primary types of impacts (multipliers) used in IMPLAN
  - **Direct**: Construction employment, direct procurement of materials, equipment rentals, etc.
  - **Indirect**: Supply-chain inputs such as supplies, parts, materials, third-party services, etc.
  - **Induced**: Increased consumption spending on housing, healthcare, goods and services, etc.
- Total impact is the sum of multiple rounds of secondary indirect and induced impacts that remain in the region
  - Accounting for shifts to other regions or states
  - IMPLAN then uses this total impact to calculate subsequent impacts

Economic Analysis Methodology

- Positive economic impacts associated with investments in various clean energy options that affect various industries
  - Energy efficiency, electrification, and electric vehicle adoption
- Long-term, these investments lead to energy savings for OR residents
- Negative economic impacts associated with sectors bearing losses
  - Mostly fossil fuel related sectors
- Modeling also accounts for budgetary implications of the investments
  - Assuming limited resources (for businesses) and budget constraints (for households)
  - Economic results do not incorporate CCI investments or the monetized health benefits
- Modeling results provide a holistic picture of total impacts

Economic Analysis Data Inputs

- Main modeling inputs used in IMPLAN include
  - Investments in energy efficiency
  - Investments in electrification
  - Changes in fuel savings costs
  - Impacts on energy producing sectors
    - Positive impacts of electrification
    - Negative impacts on fossil fuel
  - Budgetary impacts of investments on OR residents and businesses

Economic Results Considerations

- Economic modeling distinguishes between gross and net changes
- Gross impacts represent the economic benefits derived from the various clean energy investments
- Net impacts factor in the costs of making those investments
- Presented results are for net changes

Results: Employment, Net

- Net job changes are small compared to the overall economy but generally positive
  - Changes are small, ranging from -0.1% to 0.6% of total workforce
- Multiple drivers of impacts:
  - Positive impacts driven by electrification and clean transportation investments as well as fuel cost savings from transition in fuel consumption
  - Negative impacts driven by fossil fuel sector changes and opportunity costs of investments

	Scenario 1			Scenario 2			Scenario 3			Scenario 4		
	2025	2035	2050	2025	2035	2050	2025	2035	2050	2025	2035	2050
Direct	(400)	2,100	13,500	(800)	300	12,500	(1,000)	300	9,700	(900)	1,400	13,700
Indirect	(400)	(760)	(30)	(700)	(1,400)	(400)	(700)	(1,400)	(600)	(700)	(1,400)	(300)
Induced	(200)	1,400	6,100	(800)	400	6,000	(800)	400	5,000	(800)	700	6,300
Total	**(1,000)**	**2,700**	**19,600**	**(2,300)**	**(700)**	**18,000**	**(2,600)**	**(700)**	**14,100**	**(2,400)**	**700**	**19,700**

Results: GSP (2035 & 2050), Net

- Net Gross State Product (GSP) changes are small but positive generally, especially in the long run
  - Investments and consumer energy cost savings have larger positive impacts than opportunity costs have negative impacts

	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
($2020 Million)	**2035**	**2050**	**2035**	**2050**	**2035**	**2050**	**2035**	**2050**
Direct	410	1,060	450	1,030	450	880	520	1,100
Indirect	(10)	50	(20)	30	(20)	10	(10)	40
Induced	130	560	30	550	30	460	60	580
Total	**530**	**1,700**	**460**	**1,610**	**460**	**1,350**	**560**	**1,730**

Results: Income (2035 & 2050), Net

- Net income changes are small and trend upward in later years
  - Scenario 4 has the highest net income by 2050, but the other scenarios are comparable
  - Results driven by consumer cost changes from energy and fuel consumption
  - Over time, consumers save money on these costs and accumulated savings compensate other losses

	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
($2020 Million)	**2035**	**2050**	**2035**	**2050**	**2035**	**2050**	**2035**	**2050**
Direct	220	790	170	750	170	610	220	800
Indirect	(50)	(20)	(80)	(40)	(80)	(50)	(80)	(30)
Induced	70	310	20	300	20	260	30	330
Total	**240**	**1,080**	**110**	**1,010**	**110**	**820**	**180**	**1,100**

Economic Results Summary (1/2)

- All scenarios show very little overall economic change but generally positive for GSP, income and jobs
  - Job changes are small, ranging from -0.1% to 0.6% of total workforce
- Results are similar and comparable across the scenarios
- Drivers of results in modeled years (2025, 2035, 2050)
  - Accumulated savings from reduced energy costs outweigh costs of investments in the long run
  - Largest driver of economic results comes from transportation sector changes
  - Investments in clean transportation expands both consumer energy cost savings and fossil sector impacts
    - Clean transportation investments are the largest driver of impacts in 2035 and 2050
    - Electric vehicle manufacturing occurs mostly out of state
  - Electrification and energy efficiency investments

Economic Results Summary (2/2)

- Significant investments in clean transportation, followed by smaller investments in energy efficiency, and electrification
  - Early investments in light-duty EVs, switching to mix of LD/MD/HD by 2050
- Construction and manufacturing sectors see job gains, while trade and transportation sectors see job losses
  - Mostly due to installation of EE equipment and electrification measures
  - Mostly driven by changes in the fueling infrastructure as well as reduced repair and maintenance demand

Co-benefits and Equity

Results and key takeaways for final four policy scenarios

Co-Benefits and Equity Analysis: Overview

- **Objective:** For each scenario, assess potential **co-benefits** and positive or negative impacts to **equity**
- **Approach:**
  - **Qualitative assessment** of policy scenarios against identified indicators.
  - **Two assessments:**
    - Co-benefits: *Overall* scenario co-benefits (or damages)
    - Equity: *Distribution* of benefits (or damages) among communities of concern

Indicators:

- Local air quality (health)
- Ecosystem health & resilience
- Energy Security
- Employment & workforce development
- Housing burden

Communities of Concern:

- Communities of color
- Tribal nations
- Elderly populations
- Low-income urban communities
- Low-income rural communities

Co-Benefits and Equity Analysis: Methodology

- **Qualitative rankings:**

1	**Negative**	The policy will have a *significant negative effect* on associated indicators.
2	**Slightly Negative**	The policy will have a *modest negative effect* on associated indicators.
3	**Neutral**	The policy will not have a *net neutral effect* for associated indicators.
4	**Slightly Positive**	The policy will have a *modest positive effect* on associated indicators.
5	**Positive**	The policy will have a *significant positive effect* on associated indicators.

- **Key information sources:**
  – Model results from the health and economic analyses
  – Academic literature & white papers specific to the indicators
  – DEQ provided assumptions for possible CCI project types

Co-Benefits and Equity Analysis: Key Assumptions/Considerations

- **Timeframe:** Cumulative to 2050, with consideration of potential near-term impacts.
- **External variables:** Constant environmental & economic conditions across scenarios (e.g., climate change).
- **Geographic differentiation:** Co-benefit rankings reflect generalization across state/community.
- **Overlapping communities:** Does not take into account compounding effects of community overlap (e.g., elderly, low-income person of color).
- **CCIs:** Assumed CCIs include funding for transit expansion/electrification; home electrification; energy efficiency improvements; freight fleet conversion.

Co-Benefits Analysis Results: Summary

- Overall, all policy scenarios see increased co-benefits over reference case
- Highest benefits around public and ecosystem health
  – Significant statewide reduction in adverse health impacts
- Housing burden benefits are mixed depending on policy scenario
- GHG reductions, CCIs and other compliance flexibility play an important role in equity and co-benefits

Indicator	Reference Case	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Local air quality	2.5	4	4	3.5	4.5
Ecosystem health & resilience	3	4	4	3.5	4.5
Energy security	2	4	3	4	4
Employment & workforce development	2.5	4.5	4	3.5	4
Housing burden	2	2.5	1.5	2.5	2.5
TOTAL SCORE	**12**	**19**	**16.5**	**17**	**19.5**

Equity Analysis Results: Summary

- Overall, all policy scenarios are projected to benefit identified communities of concern as compared to the reference case
- Compared to other communities of concern:
  - Urban low-income households and communities of color experience most benefits
    - Benefits from CCIs projects and health benefits from emissions reductions from regulated sectors
  - Elderly populations experience the fewest benefits
- Key policy scenario drivers of results include:
  - Type and extent of regulated sectors
  - Allowance of compliance flexibility options like banking and CCIs
  - Associated distribution of impacts across geographies and communities
- Equity benefits of CCIs will rely on targeting areas with communities of concern and GHG and other air pollutant emissions

Equity Analysis Results: Scenarios 1-2

Indicator Category	Indicator	Reference Case (Total = 50.5)				
		Comm. of Color	Tribes	Urban Low-Income	Rural Low-Income	Elderly
Health	Local air quality	2	2.5	2	2.5	2
Environmental	Ecosystem health & resilience	2	2	2	2	2
Economic	Energy security	2	1.5	2	1.5	1.5
	Employment & workforce development	2	2	2	2	1
Social	Housing burden	2.5	2.5	2	2.5	2.5
	TOTAL SCORE	**10.5**	**10.5**	**10**	**10.5**	**9**

Indicator Category	Indicator	Scenario 1 (Total = 79.5)					Scenario 2 (Total = 72)				
		Comm. of Color	Tribes	Urban Low-Income	Rural Low-Income	Elderly	Comm. of Color	Tribes	Urban Low-Income	Rural Low-Income	Elderly
Health	Local air quality	4	4	4	4	3.5	4	3.5	4	3.5	3.5
Environmental	Ecosystem health & resilience	4	4	4.5	4	4	4.5	3.5	4.5	3.5	3.5
Economic	Energy security	2.5	2	2.5	2	2.5	2	1.5	2	1.5	2
	Employment & workforce development	3.5	3.5	4	4	1	3	3	3.5	3.5	1
Social	Housing burden	2.5	2.5	2	2.5	2.5	2	2.5	1.5	2.5	2.5
	TOTAL SCORE	**16.5**	**16**	**17**	**16.5**	**13.5**	**15.5**	**14**	**15.5**	**14.5**	**12.5**

Equity Analysis Results: Scenarios 3-4

Indicator Category	Indicator	Reference Case (Total = 50.5)				
		Comm. of Color	Tribes	Urban Low-Income	Rural Low-Income	Elderly
Health	Local air quality	2	2.5	2	2.5	2
Environmental	Ecosystem health & resilience	2	2	2	2	2
Economic	Energy security	2	1.5	2	1.5	1.5
	Employment & workforce development	2	2	2	2	1
Social	Housing burden	2.5	2.5	2	2.5	2.5
	TOTAL SCORE	**10.5**	**10.5**	**10**	**10.5**	**9**

Indicator Category	Indicator	Scenario 3 (Total = 70)					Scenario 4 (Total = 79)				
		Comm. of Color	Tribes	Urban Low-Income	Rural Low-Income	Elderly	Comm. of Color	Tribes	Urban Low-Income	Rural Low-Income	Elderly
Health	Local air quality	3.5	3	3.5	3	3	4.5	4	4.5	4	3.5
Environmental	Ecosystem health & resilience	3.5	3	3.5	3	3	4.5	4	4.5	4	4
Economic	Energy security	3	2.5	3	2.5	3	2.5	2	2.5	2	2.5
	Employment & workforce development	2.5	2.5	3	3	1	3	3	3.5	3.5	1
Social	Housing burden	2.5	2.5	2	2.5	2.5	2.5	2.5	2	2.5	2.5
	TOTAL SCORE	**15**	**13.5**	**15**	**14**	**12.5**	**17**	**15.5**	**17**	**16**	**13.5**

Indicator Summary: Ecosystem Health

Co-benefits Outcomes

Indicator	Ref. Case	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Ecosystem Health	3	4	4	3.5	4.5

Equity Outcomes

	Ref. Case	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Comm. of Color	2	4	4.5	3.5	4.5
Tribes	2	4	3.5	3	4
Urban low-income	2	4.5	4.5	3.5	4.5
Rural low-income	2	4	3.5	3	4
Elderly	2	4	3.5	3	4
Total	**10**	**20.5**	**19.5**	**16**	**21**

Key results considerations

- Criteria air pollutants: lowest in Scenario 4
- Reduced impacts from fossil fuel (but solar could have land use implications)
- CCIs could bring air pollutant benefits

Indicator Summary: Energy Security

Co-benefits Outcomes

Indicator	Ref. Case	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Energy Security	2	4	3	4	4

Equity Outcomes

	Ref. Case	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Comm. of Color	2	2.5	2	3	2.5
Tribes	1.5	2	1.5	2.5	2
Urban low-income	2	2.5	2	3	2.5
Rural low-income	1.5	2	1.5	2.5	2
Elderly	1.5	2.5	2	3	2.5
Total	**8.5**	**11.5**	**9**	**14**	**11.5**

Key results considerations

- Increased reliance on renewable energy and any reliability considerations
- Energy costs may increase in near-term but decrease in long-term
- Energy costs may be higher in scenarios with greater emissions reduction caps and less compliance flexibility

Indicator Summary: Housing Burden

Co-benefits Outcomes

Indicator	Ref. Case	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Housing Burden	2	2.5	1.5	2.5	2.5

Equity Outcomes

	Ref. Case	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Comm. of Color	2.5	2.5	2	2.5	2.5
Tribes	2.5	2.5	2.5	2.5	2.5
Urban low-income	2	2	1.5	2	2
Rural low-income	2.5	2.5	2.5	2.5	2.5
Elderly	2.5	2.5	2.5	2.5	2.5
Total	**12**	**12**	**11**	**12**	**12**

Key results considerations

- Related to energy burden – may see short-term increases but long-term savings
- Generally, more significant emission caps increase energy prices & housing burden in short term
- Trading and CCIs can alleviate energy price increases and reduce financial burdens
- Net job gains over time can results in improvement in housing burden

Indicator Summary: Employment & Workforce Del.

Co-benefits Outcomes

Indicator	Ref. Case	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Empl. & Workf.	2.5	4.5	4	3.5	4

Equity Outcomes

	Ref. Case	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Comm. of Color	2	3.5	3	2.5	3
Tribes	2	3.5	3	2.5	3
Urban low-income	2	4	3.5	3	3.5
Rural low-income	2	4	3.5	3	3.5
Elderly	1	1	1	1	1
Total	**9**	**16**	**14**	**12**	**14**

Key results considerations

- Small portion of traditional energy sectors jobs associated with fossil fuels. Coal-related jobs phased out by 2035 in reference case
- Net job impacts positive across all scenarios. In particular, direct and induced net job impacts will be positive in long-term for all scenarios, with scenario 1, 2, and 4 showing the highest benefits.
- Near-term job loss in regulated sectors, but jobs reallocated to other sectors so net impacts positive

Indicator Summary: Air Quality

Co-benefits Outcomes

Indicator	Ref. Case	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Local air quality	2.5	4	4	3.5	4.5

Equity Outcomes

	Ref. Case	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Comm. of Color	2	4	4	3.5	4.5
Tribes	2.5	4	3.5	3	4
Urban low-income	2	4	4	3.5	4.5
Rural low-income	2.5	4	3.5	3	4
Elderly	2	3.5	3.5	3	3.5
Total	**11**	**19.5**	**18.5**	**16**	**20.5**

Key results considerations

- Criteria air pollutants: lowest in Scenario 4
- Non-natural gas fuel suppliers: smaller scope of emissions regulated in Scenario 3
- CCIs could bring indoor and outdoor air quality benefits

Scenario 4: County-Level Air Quality Health Impacts

Top 10 Counties:
Total Cumulative Health Benefits

Rank	County	Benefit
1	Multnomah	$198,719,786
2	Washington	$148,324,101
3	Clackamas	$78,751,928
4	Marion	$51,454,952
5	Lane	$50,013,634
6	Jackson	$36,925,130
7	Deschutes	$29,358,364
8	Linn	$19,306,242
9	Douglas	$14,820,548
10	Polk	$14,174,545

Top 10 Counties:
Per-Capita Cumulative Health Benefits

Rank	County	Benefit
1	Multnomah	$240
2	Washington	$239
3	Clackamas	$185
4	Polk	$169
5	Jackson	$165
6	Curry	$154
7	Linn	$152
8	Deschutes	$149
9	Marion	$147
10	Lincoln	$140

Key:
Both lists
Only one list

- Many counties projected to receive higher overall health benefits are also projected to experience relatively higher health benefits on a per-capita basis
- Curry and Lincoln counties are projected to experience relatively higher health benefits on a per-capita basis

For the health modeling, Scenario 4 used a different resolution (more detailed county-level data). Differences from Scenarios 1-3 will be due to both changes in the methodology and the underlying data.

Scenario 4: County-Level Air Quality Health Impacts

Bottom 10 Counties:
Total Cumulative Health Benefits

Rank	County	Benefit
1	Wheeler	$62,897
2	Sherman	$81,877
3	Gilliam	$85,812
4	Wallowa	$160,288
5	Grant	$314,601
6	Baker	$354,028
7	Lake	$386,149
8	Harney	$399,939
9	Morrow	$549,802
10	Malheur	$865,203

Bottom 10 Counties:
Per-Capita Cumulative Health Benefits

Rank	County	Benefit
1	Baker	$21
2	Wallowa	$22
3	Malheur	$27
4	Union	$36
5	Morrow	$43
6	Grant	$43
7	Gilliam	$43
8	Wheeler	$44
9	Sherman	$46
10	Lake	$48

Key:

Both lists

Only one list

- Many counties projected to receive lower overall health benefits are also projected to experience relatively lower health benefits on a per-capita basis
- Union and Lake counties are projected to experience relatively lower health benefits on a per-capita basis

For the health modeling, Scenario 4 used a different resolution (more detailed county-level data). Differences from Scenarios 1-3 will be due to both changes in the methodology and the underlying data.

Scenario 4: County-Level Air Quality Health Impacts

Top 10: % Non-White (most diverse)

Rank	County	% Non-White
1	Jefferson	25
2	Multnomah	21
3	Washington	20
4	Benton	14
5	Klamath	12
6	Marion	11
7	Lane	11
8	Clackamas	11
9	Lincoln	10
10	Polk	10

Top 10: % Below Poverty Line (least affluent)

Rank	County	% Below
1	Malheur	21
2	Wheeler	19
3	Klamath	19
4	Lake	18
5	Lane	18
6	Josephine	17
7	Grant	16
8	Jefferson	16
9	Coos	16
10	Benton	16

Top 10: % of Pop. over 65

Rank	County	% Over 65
1	Wheeler	35
2	Curry	34
3	Grant	30
4	Wallowa	29
5	Lincoln	28
6	Gilliam	28
7	Sherman	27
8	Baker	26
9	Josephine	26
10	Coos	26

Per-Capita Health Benefits (previous slides):

- in Top 10
- in Bottom 10

- Communities of color projected to experience relatively higher per-capita health benefits compared to other communities of concern
- Orange highlighted counties have higher proportions of communities of concern and are projected to receive among the lowest per-capita health benefits
  - These counties could benefit from CCIs

For the health modeling, Scenario 4 used a different resolution (more detailed county-level data). Differences from Scenarios 1-3 will be due to both changes in the methodology and the underlying data.

Modeling Results Summary: All Scenarios

	Metric	Scenario 1	Scenario 2	Scenario 3	Scenario 4
GHG Emissions	Cap compliance	All years except 2050	Met through 2023; slightly above 2024-2050	Met through 2042; slightly above 2043-2050	All years
	Cumulative GHG reductions statewide from Ref. Case, including use of CCIs: 2022-2050 (Mil. MTCO2e)	-298	-210	-309	-269
Health	Cumulative premature deaths avoided	166	172	153	183**
	Cumulative monetary valuation of avoided adverse health outcomes ($Bil)	2.08	2.16	1.90	2.29**
Economics*	Net employment impacts in 2050	19,600	18,000	14,100	19,700
	Net GSP impacts in 2050 ($Mil)	1,700	1,610	1,350	1,730
	Net income impacts in 2050 ($Mil)	1,080	1,010	820	1,100
Co-benefits & Equity	Co-benefits analysis score	19	16.5	17	19.5
	Equity analysis score	79.5	72	70	79

*Emissions and health impacts shown here are cumulative. Economic impacts represent annual impacts in 2050 (i.e., a snapshot of that year).

**For the health modeling, Scenario 4 used a different resolution (more detailed county-level data). Differences from Scenarios 1-3 will be due to both changes in the methodology and the underlying data.

Contracted Study Resources

Modeling study webpage: www.oregon.gov/deq/ghgp/Pages/modelingstudy.aspx

Rulemaking webpage to develop Oregon's Climate Protection Program:
www.oregon.gov/deq/Regulations/rulemaking/Pages/rghgcr2021.aspx

Submit questions to GHGCR2021@deq.state.or.us