

# Modelling Results

## Policy analysis

October 24, 2022

SSG

# What is a Scenario?

A scenario is:

- (1) A representation of a policy, (or)
- (2) A combination of policies

We call this an  
*“integrated scenario”*



# What is a Scenario?

## **A scenario is a what if? question**

What if we limited allowable total carbon of buildings?

What if we decarbonized institutional/public buildings?

What if we enacted residential or expanded commercial PACE financing?

# Policies

1	Building performance standards	<i>1a</i>	<i>1b</i>	<i>1c</i>	<i>1d</i>
		Direct emissions need to reach 5% below 2035 levels in the BAP by 2035		Direct emissions need to reach 40% below 2035 levels in the BAP by 2035	
		Existing residential, commercial and multi-family buildings			
		All building sizes	Buildings ≥ 35,000 ft <sup>2</sup>	All building sizes	Buildings ≥ 35,000 ft <sup>2</sup>
2	Promote, incentivize and or subsidize energy efficiency and heating/cooling	<i>2a</i>	<i>2b</i>	<i>2c</i>	<i>2d</i>
		50% of buildings are retrofitted by 2050, thermal energy requirements reduced by 15%		100% of buildings are retrofitted by 2035, thermal energy requirements reduced by 50%	
		All building types			
		Buildings ≥ 50,000 ft <sup>2</sup>	Buildings ≥ 30,000 ft <sup>2</sup>	Buildings ≥ 50,000 ft <sup>2</sup>	Buildings ≥ 30,000 ft <sup>2</sup>

# Policies

3	Decarbonize institutional/public buildings	<b>3a</b>	<b>3b</b>
		New buildings after 2035 are carbon neutral	New buildings after 2023 are carbon neutral
		50% of buildings are retrofitted by 2045; thermal energy requirements reduced by 15%; plug load reduced by 15%	100% of buildings are retrofitted by 2035: thermal energy requirements reduced by 50%; Plug load reduced by 50%
4	Promote, incentivize, and/or subsidize heat pumps	<b>4a</b>	<b>4b</b>
		80% of covered buildings have a heat pump installed by 2040	100% of buildings that are covered have a heat pump installed by 2035
		New and existing residential and commercial buildings	

# Policies

5	Assess and disclose material-related emissions	<i>5a</i>	<i>5b</i>	<i>5c</i>		
		Reduce embodied carbon from construction by 20% by 2030, compared to 2015	Reduce embodied carbon from construction by 60% by 2030, compared to 2015	Reduce embodied carbon from construction by 100% by 2050, compared to 2015		
		Residential and commercial buildings				
6	Enact energy-efficient building codes- Existing	<i>6a</i>	<i>6b</i>	<i>6c</i>	<i>6d</i>	
		50% of existing buildings are retrofitted by 2050, thermal energy requirements reduced by 15%, plug load reduced by 15%		100% of existing buildings are retrofitted by 2035, thermal energy requirements reduced by 50%, plug load reduced by 50%		
		Existing residential and commercial buildings				
	Buildings ≥ 50,000 ft <sup>2</sup>	Buildings ≥ 30,000 ft <sup>2</sup>	Buildings ≥ 50,000 ft <sup>2</sup>	Buildings ≥ 30,000 ft <sup>2</sup>		
	Enact energy-efficient building codes- New	A 40% reduction in new building energy consumption from the 2006 Oregon codes		A 80% reduction in new building energy consumption from the 2006 Oregon codes		
New residential and commercial buildings						
Buildings ≥ 50,000 ft <sup>2</sup>		All buildings	Buildings ≥ 50,000 ft <sup>2</sup>	All buildings		

Policy number



Promote, incentivize and or subsidize energy efficiency and heating/cooling

Policy details

Target	50% of buildings are retrofitted by 2050, thermal energy requirements reduced by 15%
Building types	All buildings
Building sizes	Buildings ≥ 50,000 ft2

GHG rating bar



Indicators

Indicators

1. GHG emissions	↓ Decreases emissions	<b>-66,310 metric ton CO2e</b> average annual GHG emissions avoided emissions (2022-2050)
2. Economic impact-lifecycle abatement cost	↑ Costs money per ton of emissions reduced	<b>\$654</b> net present value of a metric ton of avoided GHG emissions with a 3% discount rate
3. Energy efficiency	↓ Decreases energy consumption	<b>-2,000,000 MMBTU</b> average annual avoided energy consumption (2022-2050)
4. Resiliency	↓ Increases resiliency	<b>877,000 homes</b> with retrofits that increase resiliency against heat, cold and severe weather events
5. Public health and air quality	↓ Decreases health costs	<b>-\$2,200 million</b> average annual avoided public health costs (2022-2050)

6. Household income	↑ Increases household energy costs	4.46%	household energy expenditures decrease from \$4,500 per household in 2022 to \$3,800 in 2050
7. Economic impact-employment	↑ Employment	415	person years of employment created (2022-2050)
8. Social cost of carbon	↓ Decreases the social cost of carbon	-\$5.1 million	in avoided damage as a result of climate change globally (2022-2050)

## Background

### 1. GHG Emissions

Cumulative avoided emissions

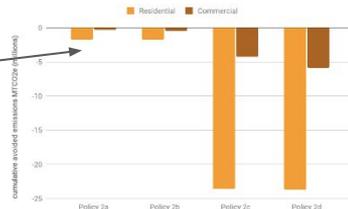


Figure 1: Energy Efficiency Policy scenarios, cumulative GHG emissions reduction by sector, 2022-2050

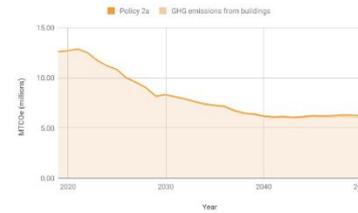


Figure 2: Energy Efficiency Policy scenario 2a, annual GHG emissions reductions resulting from scenario 2a relative to total projected GHG emissions from buildings in Oregon

Annual emissions

Net present value

### 2. Economic Impact, Costs and Savings

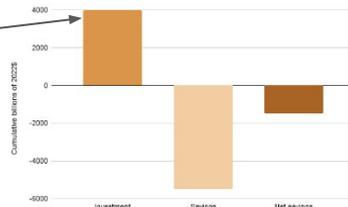


Figure 2: Building Performance scenario 1a, NPV over the study period

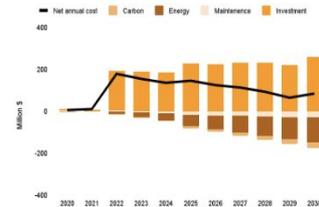


Figure 3: Building Performance scenario 1a, net annual costs or savings

Annual costs and savings

# Cumulative Avoided Emissions

## Background 1. GHG Emissions

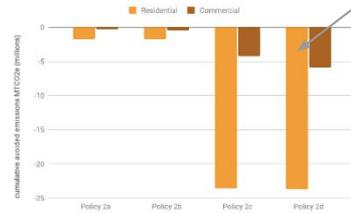
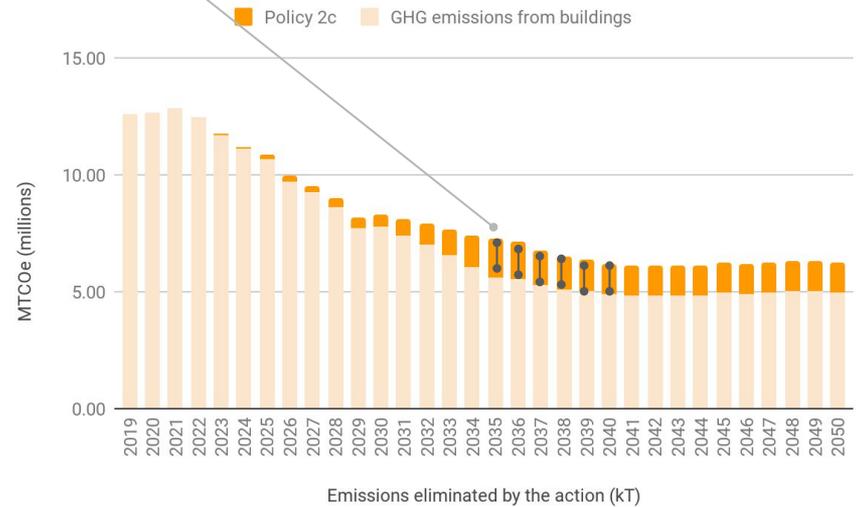


Figure 1: Energy Efficiency Policy scenarios, cumulative GHG emissions reduction by sector, 2022-2050

Sum of annual avoided emissions



# Net Present Value

## 2. Economic Impact, Costs and Savings

Discounted  
back to 2022\$

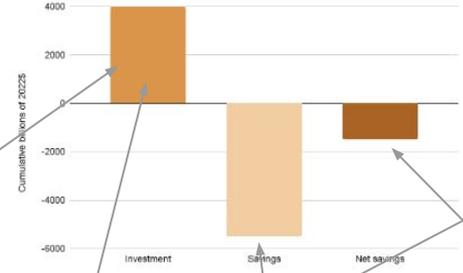


Figure 2: Building Performance scenario 1a, NPV over the study period

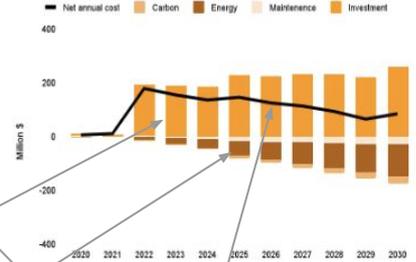


Figure 3: Building Performance scenario 1a, net annual costs of savings

$$\text{Costs} + \text{Savings} = \text{Net Costs (+)/Savings(-)}$$

# Abatement Cost

## 2. Economic Impact, Costs and Savings

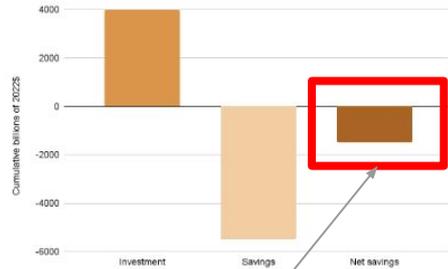


Figure 2: Building Performance scenario 1a, NPV over the study period

## Background 1. GHG Emissions



Figure 1: Energy Efficiency Policy scenarios, cumulative GHG emissions reduction by sector, 2022-2050

Net present value (+/-)

/

Cumulative avoided emissions

=

Abatement cost (\$/MtCO<sub>2e</sub>)

### 3. Energy Efficiency

Cumulative avoided energy

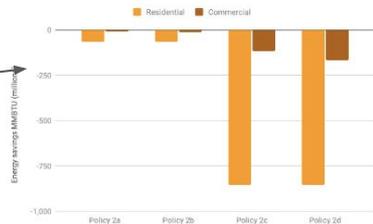


Figure 5: Energy Efficiency Policy scenarios, cumulative energy savings by sector, relative to the reference scenario

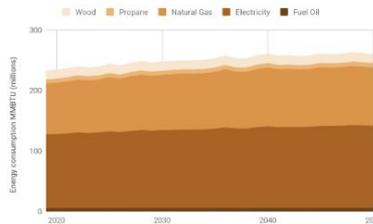


Figure 6: Energy Efficiency Policy scenario 2a, energy consumption by energy source

Annual energy by source

### 4. Resiliency

Cumulative # of dwellings retrofit

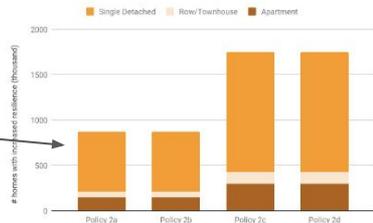


Figure 7: Energy Efficiency Policy scenarios, # of homes with increased resilience by 2050

### 5. Public Health and Air Quality

Cumulative avoided health costs

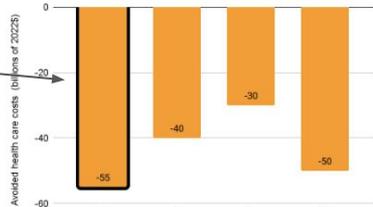


Figure 8: Building Performance Scenarios, avoided cumulative health costs

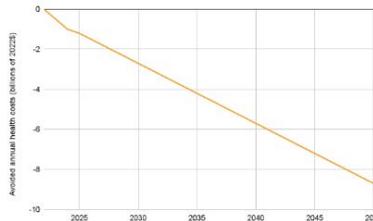


Figure 9: Building Performance Scenario 1a, avoided annual health costs

Annual avoided health costs

Household energy savings

## 6. Household Income

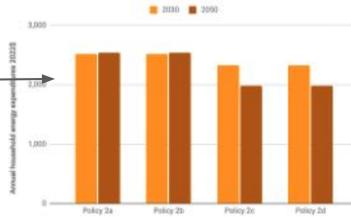


Figure 10: Building Performance Scenarios, annual household energy expenditures

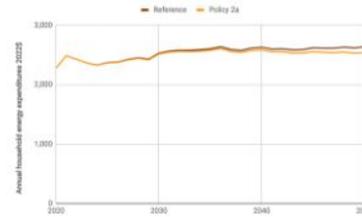


Figure 11: Building Performance scenario 2a, annual household energy expenditures relative to the reference scenario

Annual household energy costs

Person years of employment

## 7. Economic Impact, Employment

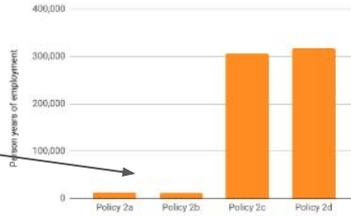


Figure 12: Building Performance scenarios, cumulative person years of employment

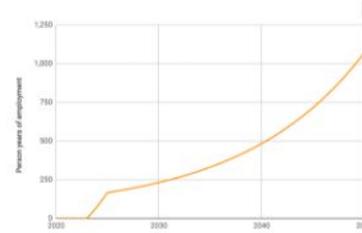


Figure 13: Building Performance scenario 2a, annual person years of employment

Annual person years of employment

Cumulative avoided social cost of carbon

## 8. Social Cost of Carbon

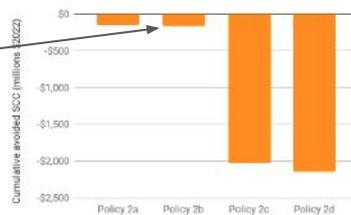


Figure 14: Energy Efficiency Policy scenarios, cumulative avoided social cost of carbon

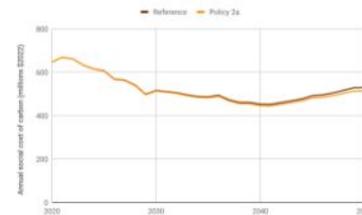
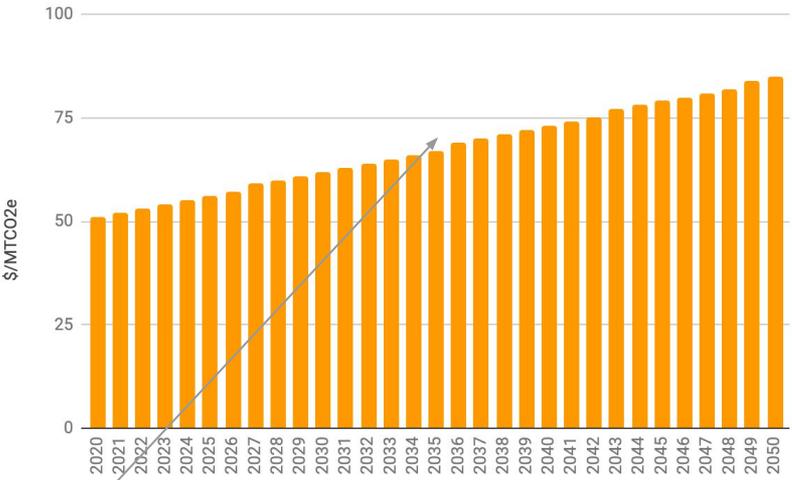
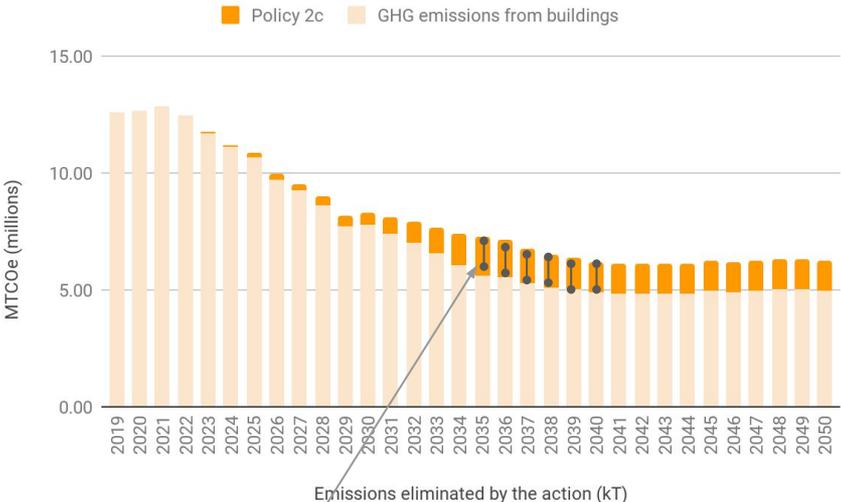


Figure 15: Energy Efficiency Policy scenario 2a, annual avoided social cost of carbon relative to the reference scenario

Annual social cost of carbon

# Social Cost of Carbon



Annual GHG reduction

x

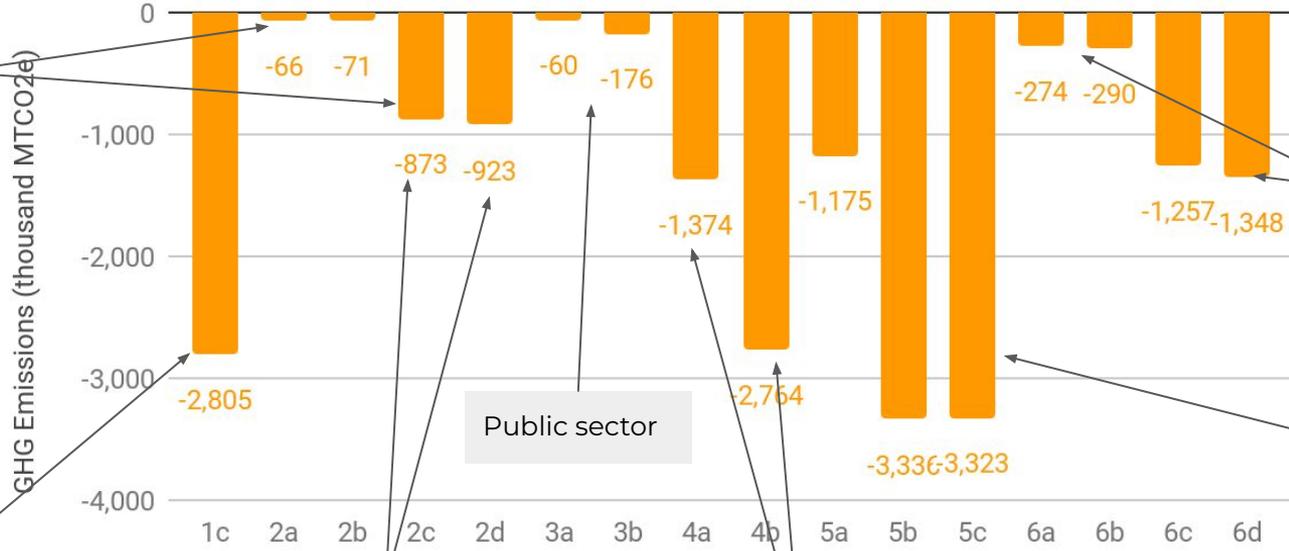
Annual Social Cost of Carbon (\$/MTCO<sub>2</sub>e)

## Key

Term/Acronym	Definition	Additional information
Cumulative		The sum of the annual costs or savings over the period. For example, if there were \$40 of savings in 2022, \$60 of savings in 2023 and \$120 of costs in 2024, the cumulative value would be $-\$40 + \$60 + \$120 = \$20$ .
GHG	Greenhouse gases	The three primary GHGs are carbon dioxide (CO <sub>2</sub> ), methane (CH <sub>4</sub> ), nitrous oxides (NOX).
Household energy expenditures		Cost of energy used in a house, calculated by summing total expenditures on energy in houses in Oregon divided by number of houses.
MMBtu	Million british thermal units	A measure of energy. 1 kWh of electricity is equivalent to 3,400 Btu 1 gallon of gasoline is equivalent to 120,000 Btu
MtCO <sub>2</sub> e	Metric tons of carbon dioxide equivalent	A measure that combines CO <sub>2</sub> , CH <sub>4</sub> , NO <sub>x</sub> into one measure. For example, 1 unit of CH <sub>4</sub> is equivalent to 28 units of CO <sub>2</sub> over 100 years. In other words, 1 unit of CH <sub>4</sub> causes 28 times more warming than 1 unit of CO <sub>2</sub> over 100 years, where the 28 is described as the Global Warming Potential (GWP). If a policy results in 2 Mt of CO <sub>2</sub> and 2 Mt of CH <sub>4</sub> , the total would be $2 + (2 \times 28) = 58$ MtCO <sub>2</sub> e.
NPV	Net present value	A method used to determine the current value of all future cash flows generated by a project, including the initial capital investment. Based on the idea that a future dollar is worth less than a current dollar, future costs and savings are discounted back to current dollars. The net present value is sensitive to the discounting rate.
Person years of employment		One person working full time for a year. For example, a job which lasts 10 years is equivalent to <u>10 person years</u> of employment.
Reference		The reference scenario includes: <ul style="list-style-type: none"> <li>• Population growth</li> <li>• Employment growth</li> <li>• Heating and cooling degree days projections</li> <li>• Community Renewable Energy Program</li> <li>• Energy efficiency standards for appliances</li> <li>• HB2021</li> <li>• Heat Pump Rebate Program</li> <li>• Implement Healthy Homes Repair Fund</li> <li>• Manufactured home replacement</li> <li>• Solar + Storage Rebate Program</li> </ul>
SCC	Social cost of carbon	The SCC is a comprehensive estimate of climate change damages and includes changes in net agricultural productivity, human health, property damages from increased flood risk, and changes in energy system costs, such as reduced costs for heating and increased costs for air conditioning.

# Average Annual Avoided GHG Emissions (2022-2050)

Retrofits  
50%x50x15%  
100%x35x50%



Building codes  
40%x50  
80%x35

Embodied carbon

Public sector

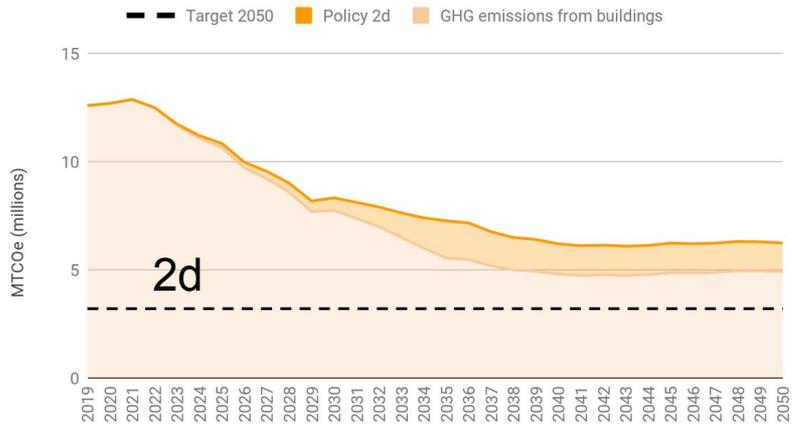
Policy  
Heat Pumps  
80%x40  
100%x35

The difference between buildings over 30k ft<sup>2</sup> and over 50k ft<sup>2</sup>

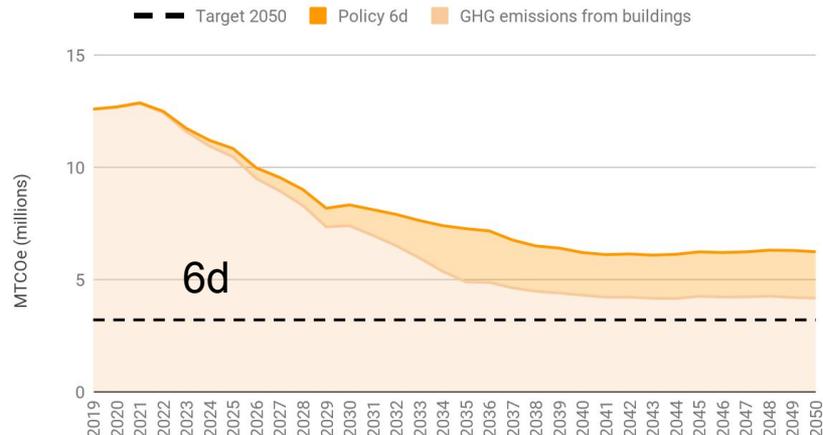
2019 buildings total:  
13,600 thousand MTCO<sub>2e</sub>

GHG intensity

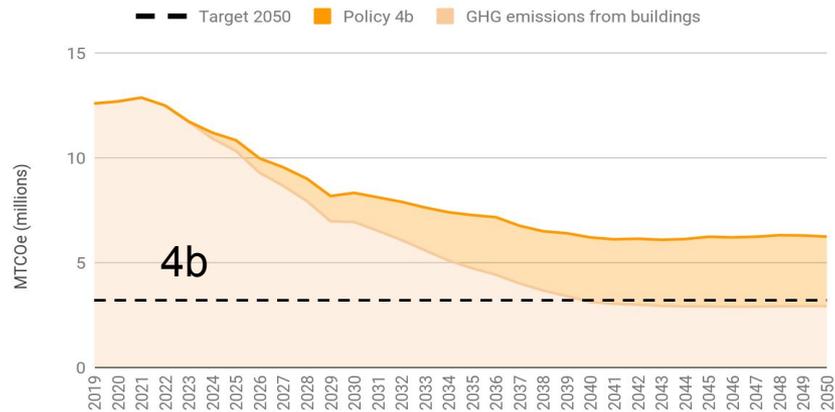
GHG Emissions (thousand MTCO<sub>2e</sub>)



Emissions eliminated by the action (kT)

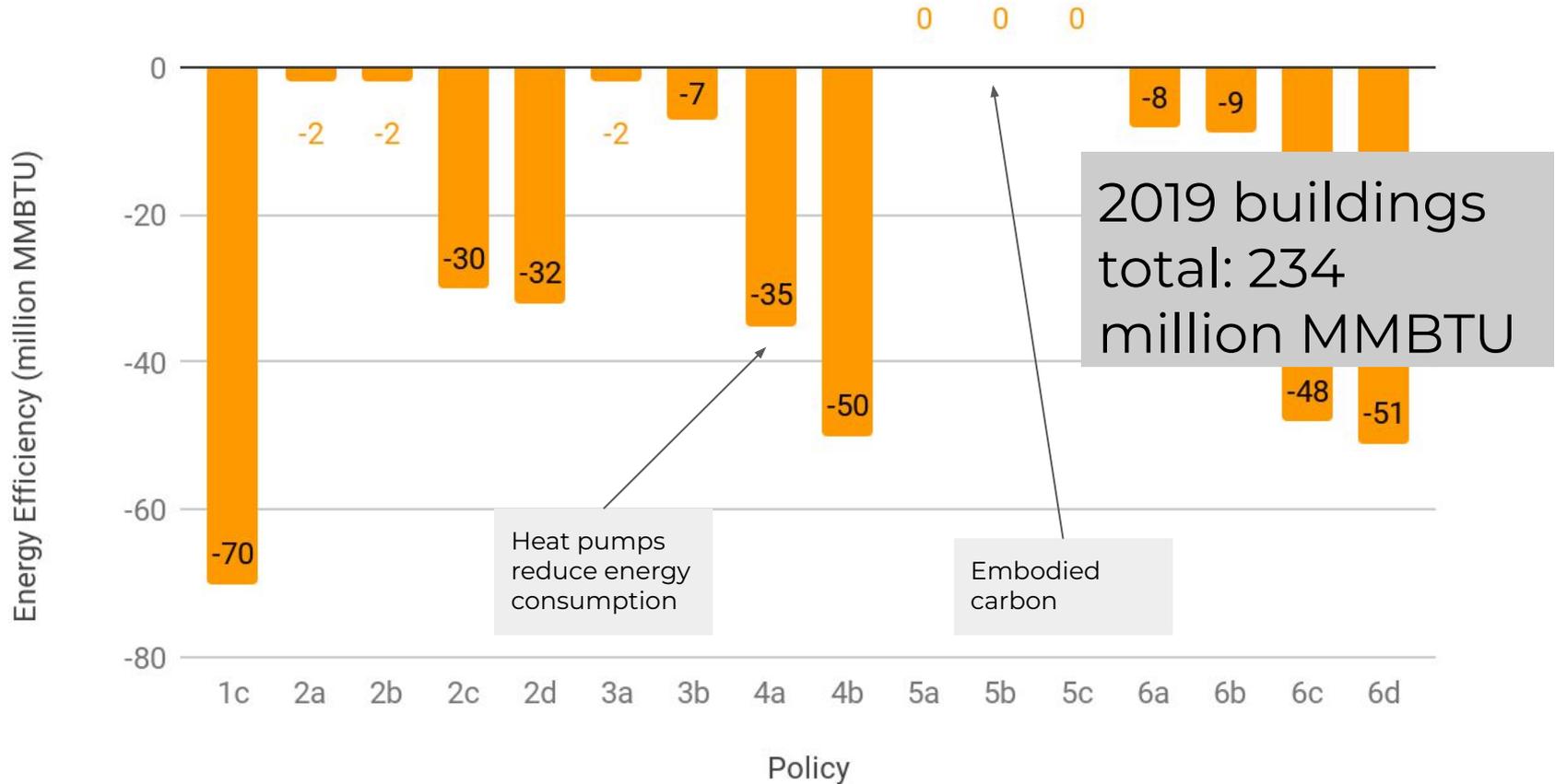


Emissions eliminated by the action (kT)

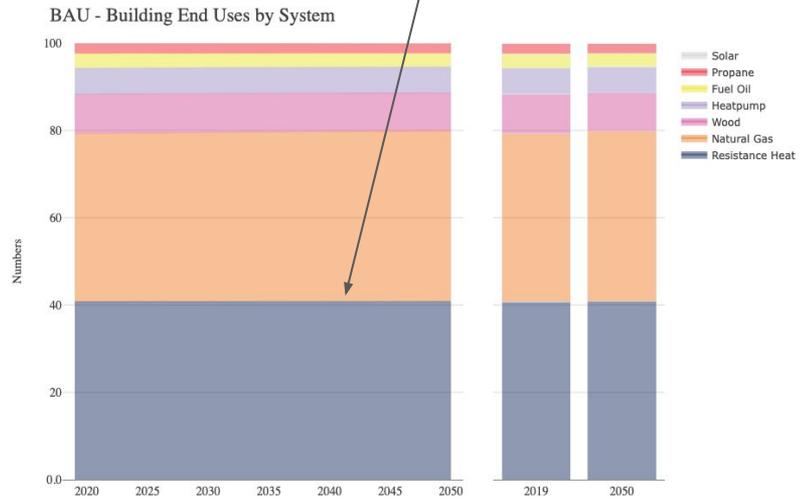
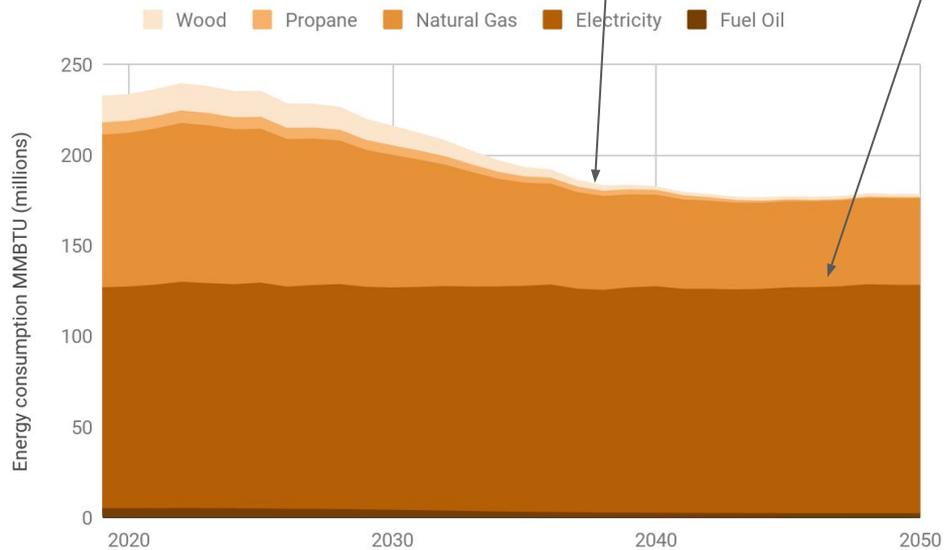


Emissions eliminated by the action (kT)

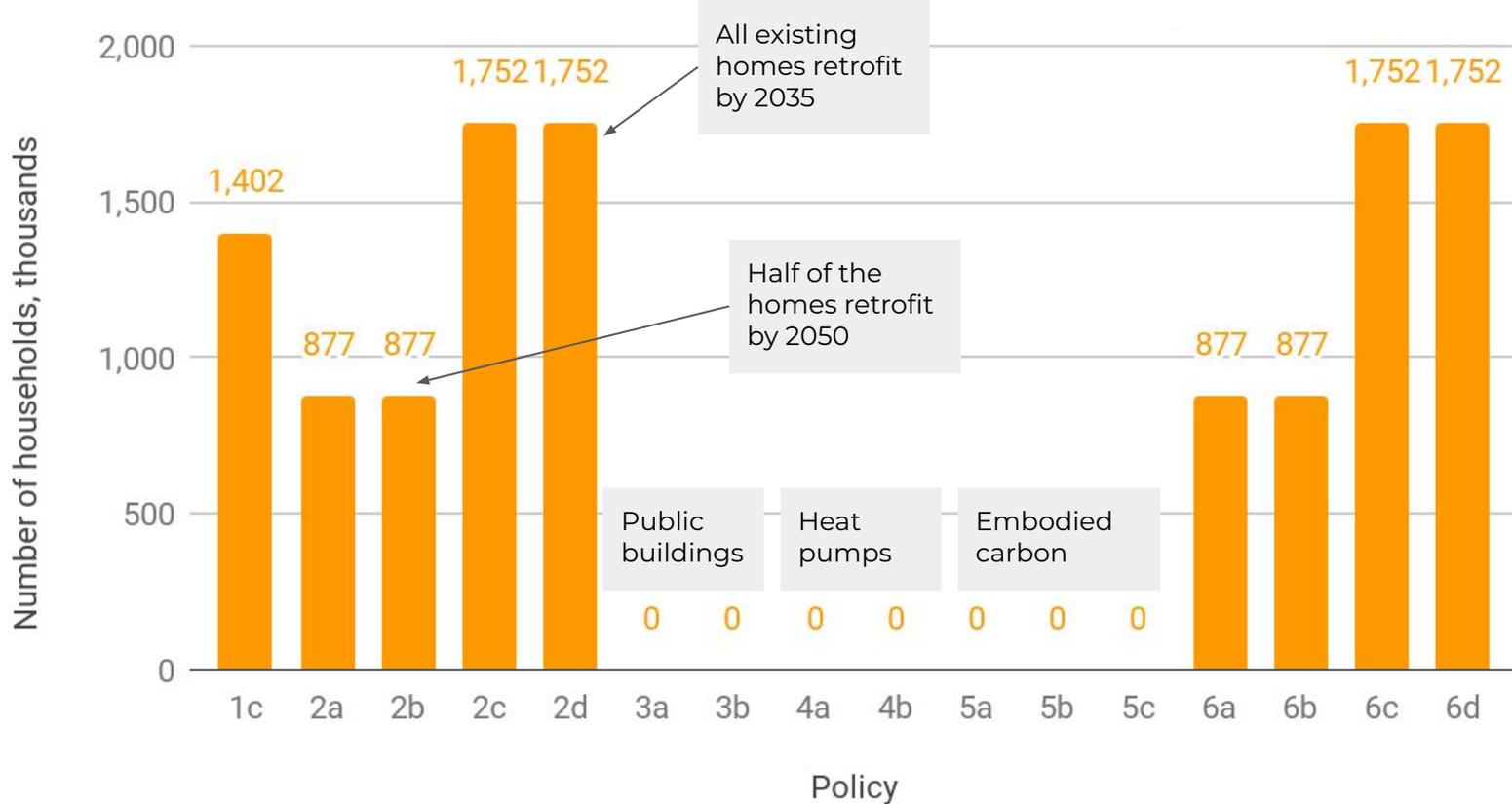
# Average Annual Avoided Energy Consumption (2022-2050)



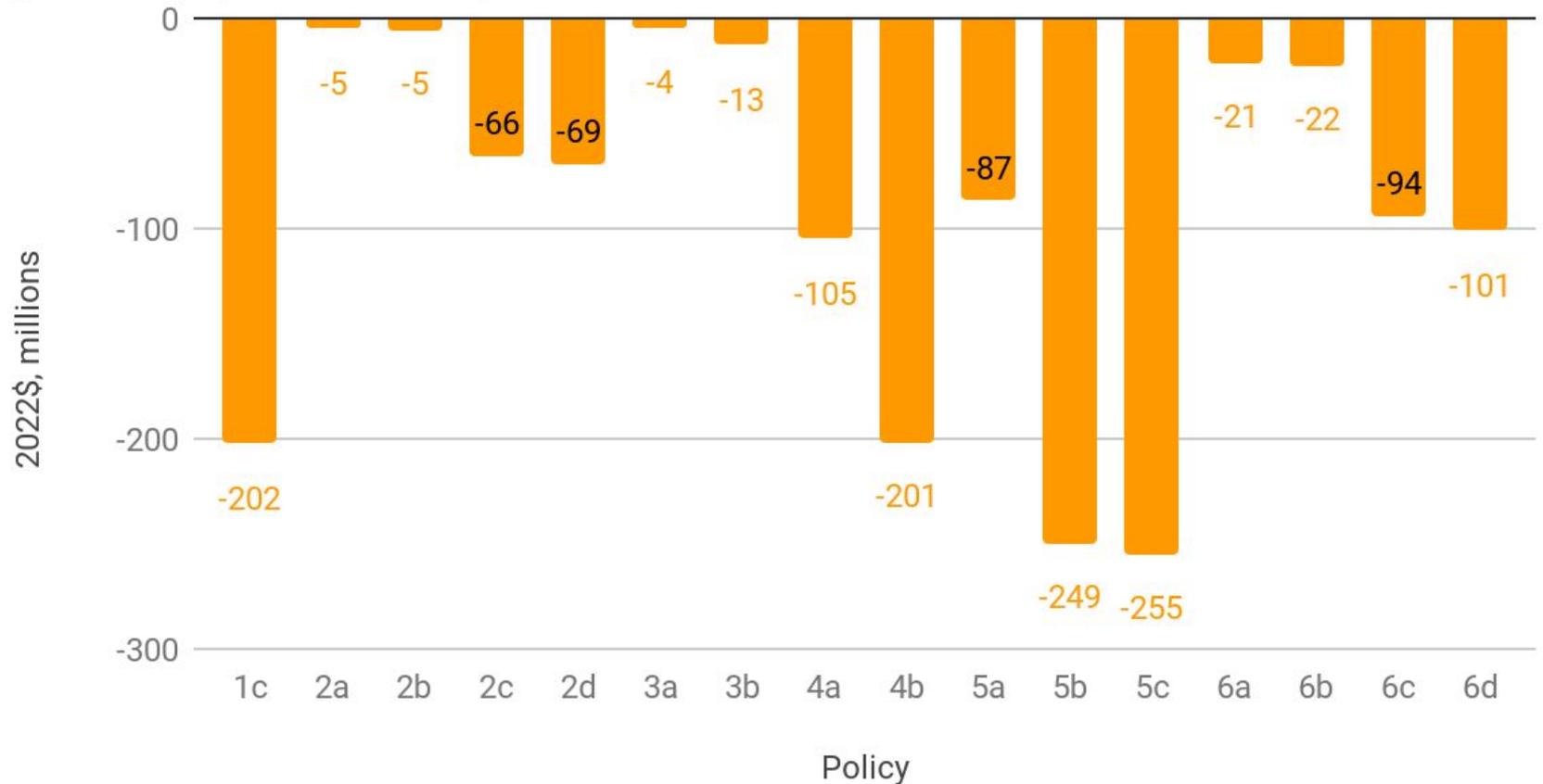
# Policy 4b



# Number of Household Retrofits that Increase Resiliency Against Heat, Cold and Severe Weather Events (2022-2050)



# Average Annual Avoided Damage as a Result of Climate Change (2022-2050)



# Integrated Scenarios

<b>Rationale</b>	<b>Description</b>
Synergies/feedback	When one policy changes the conditions for another policy: thermal envelope and heat pumps.
Avoid double counting	When two policies act on the same building: retrofit of public sector building and retrofit of commercial buildings.
Policy impact	The impact of one policy in the context of another policy: A heat pump displacing the emissions associated with a furnace powered by RNG.
Total impact	The addition of two policies in time; ensuring coherence in time and space.

# Integrated Scenarios

A	B	C	D	E
Go slow, focus on large buildings	Medium efficiency, focus on large buildings	Medium GHG reductions, non-prescriptive	Maximum efficiency	Maximum GHG reductions, non-prescriptive
<ul style="list-style-type: none"> <li>• Enact energy-efficient building codes 6a</li> <li>• Promote, incentivize, and/or subsidize heat pumps 4a</li> <li>• Decarbonise public buildings 3a</li> <li>• Assess and disclose material-related emissions 5a*</li> </ul>	<ul style="list-style-type: none"> <li>• Promote, incentivize and or subsidize energy efficiency and heating/cooling 2a</li> <li>• Promote, incentivize, and/or subsidize heat pumps 4a</li> <li>• Enact energy-efficient building codes 6a</li> </ul>	<ul style="list-style-type: none"> <li>• Building Performance Standard 1d</li> <li>• Decarbonise public buildings 3b</li> <li>• Assess and disclose material-related emissions 5b*</li> </ul>	<ul style="list-style-type: none"> <li>• Promote, incentivize and or subsidize energy efficiency and heating/cooling 2d</li> <li>• Promote, incentivize, and/or subsidize heat pumps 4b</li> <li>• Enact energy-efficient building codes 6d</li> </ul>	<ul style="list-style-type: none"> <li>• Building Performance Standard 1c</li> <li>• Decarbonise public buildings 3b</li> <li>• Assess and disclose material-related emissions 5c*</li> </ul>

\*Embodied emissions reductions require a different accounting approach

# Next steps

