



# The Future of Energy (and Climate) is Here!

21<sup>st</sup> Annual Rice Alliance Energy Tech Venture Forum

September 12, 2024

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**Energy enables  
modern life**



# Direct Correlation between Energy and Quality of Life

World Population

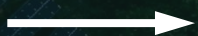
1.0B



7.8B

Average Life Expectancy

29yrs



73yrs

Global Energy Consumption

Global GDP

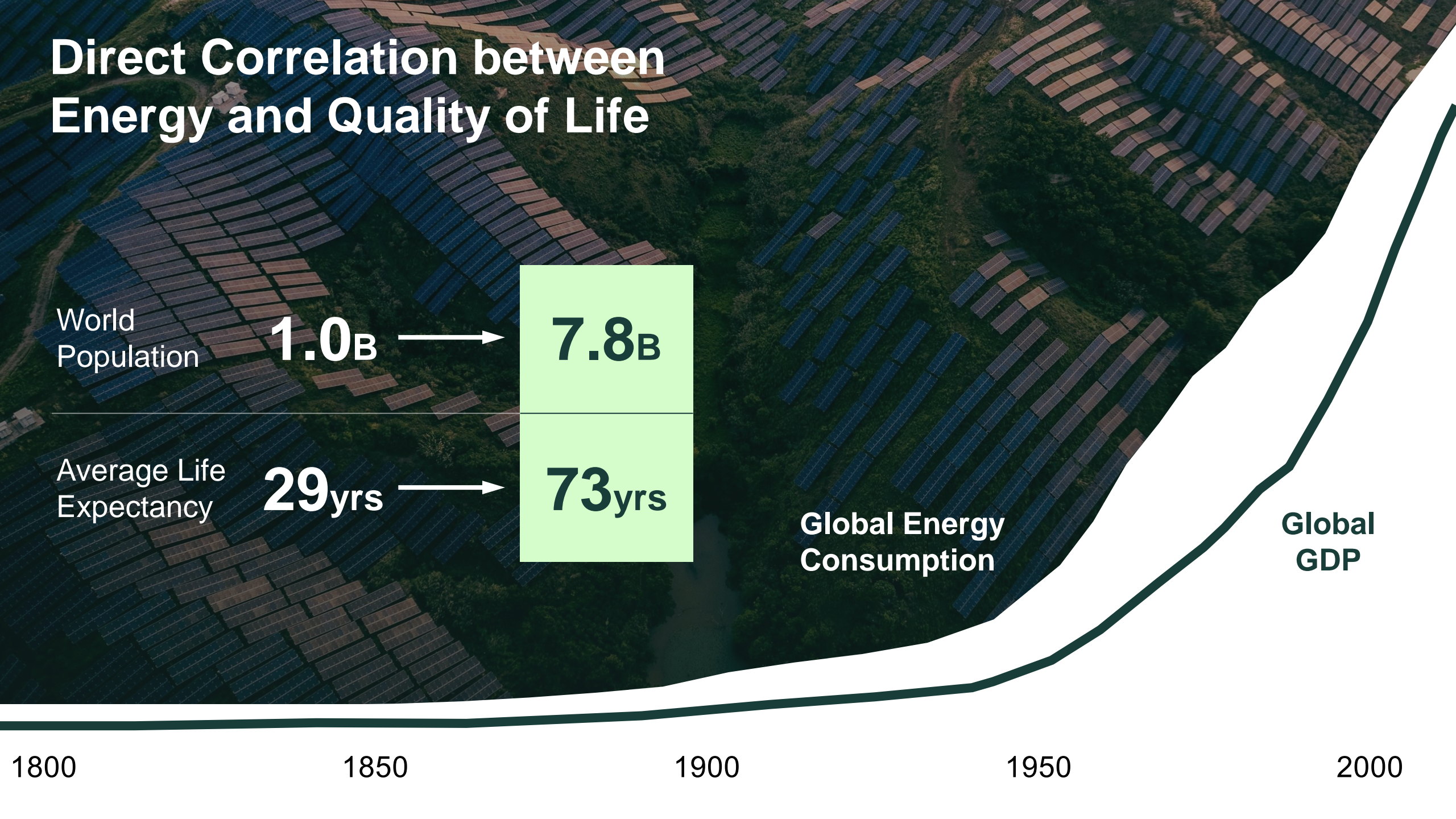
1800

1850

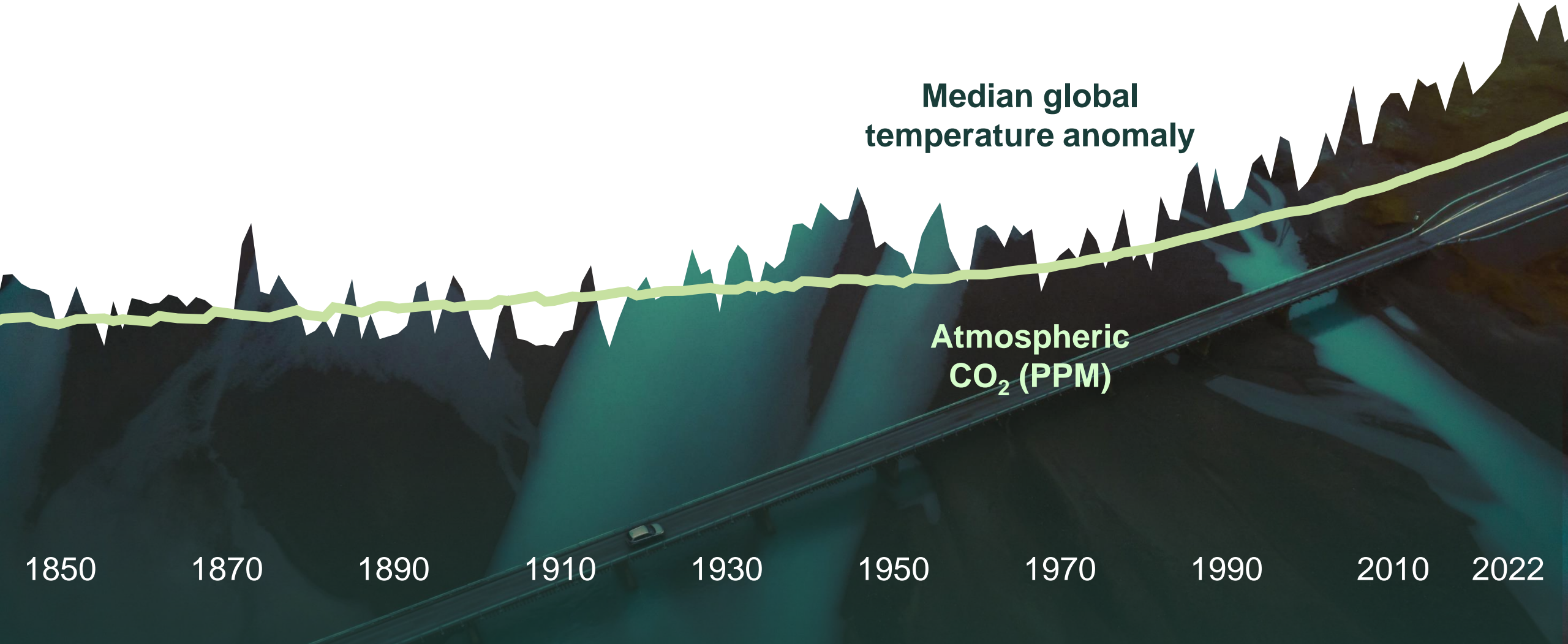
1900

1950

2000



# However, 1.2°C Global Increase since Pre-Industrial Times



# Last ice age

when ~25% of Earth's land area was covered in glaciers



**6°C**

degrees **lower** than today

# Age of the dinosaurs

when crocodiles could be found above the Arctic Circle



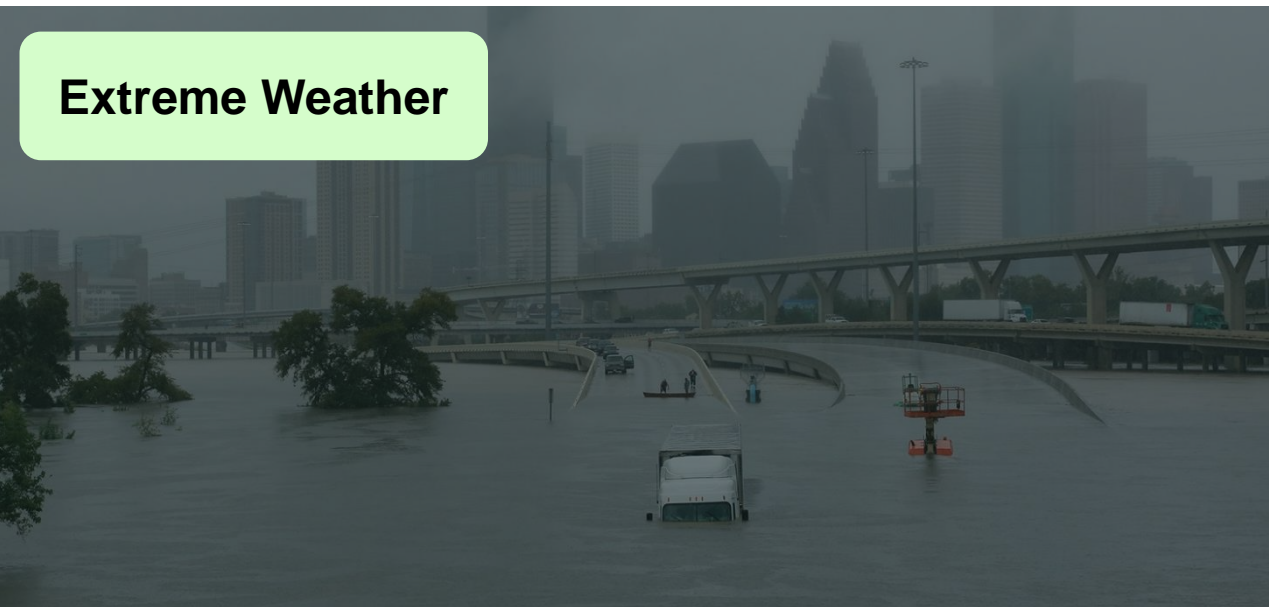
**4°C**

degrees **higher** than today

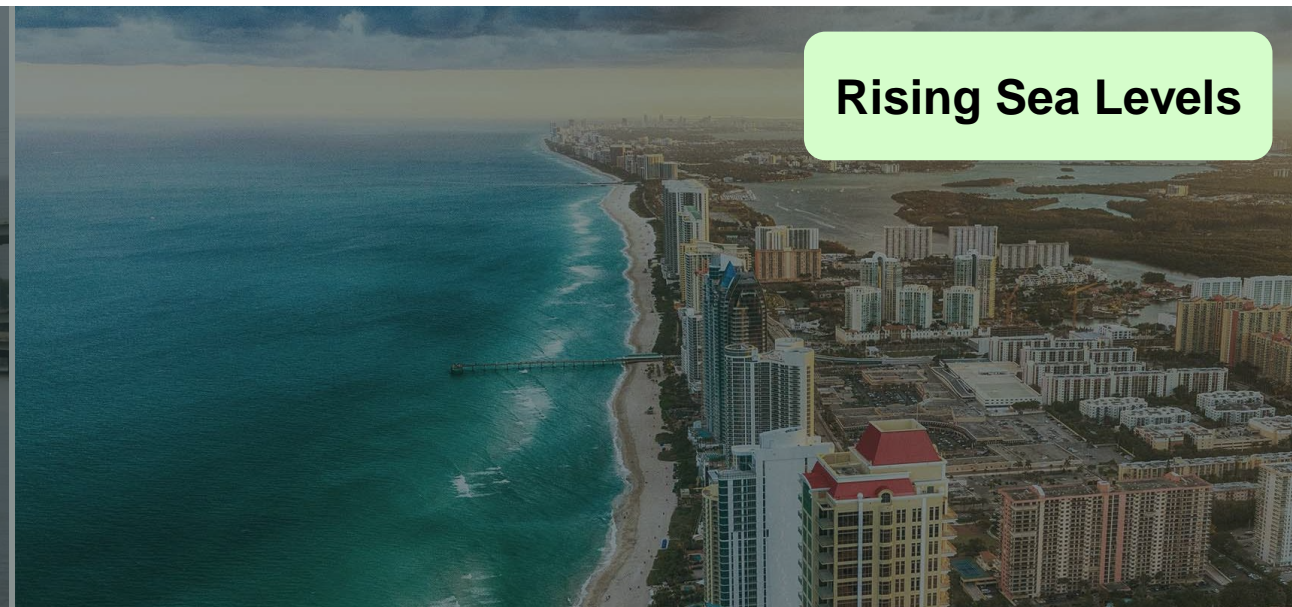
How much is  
**1.2°C?**

# Consequences of Warming are Real

**Extreme Weather**



**Rising Sea Levels**



**Economic Displacement**

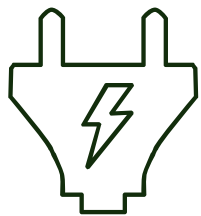


**Reduced Food & Water Security**





Human flourishing  
and economic growth  
require energy ...



**More  
energy**



... but our largest  
sources of energy drive  
global warming



**Less  
emissions**



**This is the  
Dual Challenge**

# OpenMinds' Mission & Identity

OPENMINDS



## OUR MISSION

**More energy. Less emissions.**

Accelerate progress against the Dual Challenge by 203X

- 100+ volunteer experts
- 501(c)(3)
- Disciplined non-partisan selection process
- 360° systems engineering approach

## WHAT MAKES US UNIQUE



**Energy AND climate**



**Cross-functional expert team**



**Detailed solutions framework**



**Impact progress by 203X**



# Aligning Academia, Industry, Government and NGOs for Impact

OPENMINDS

1

## Academia Leaders



## Government Leaders



3

2

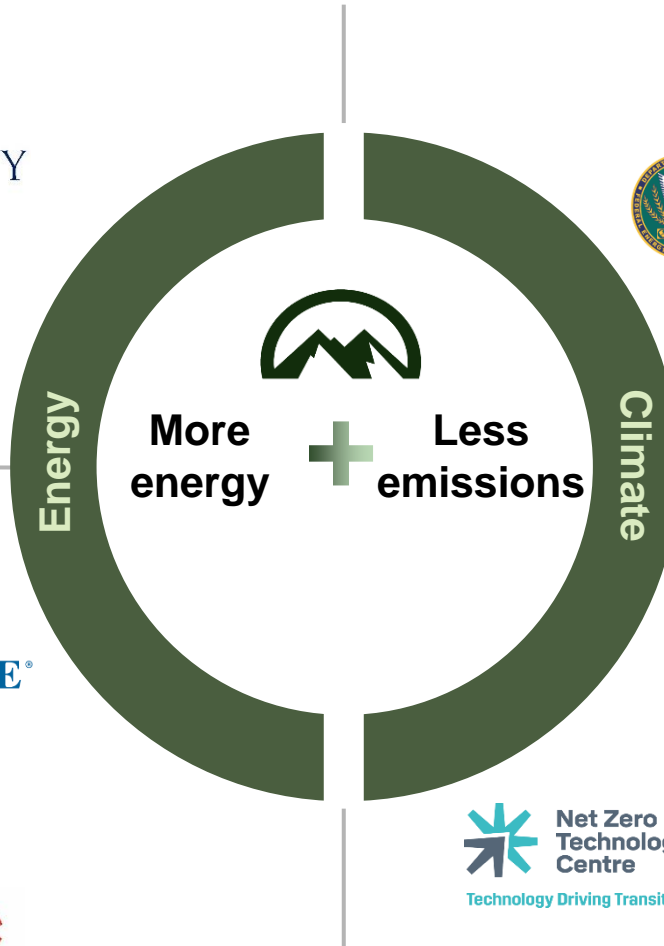
## Industry Leaders



## NGO Leaders



4



# OpenMinds + Bain = Differentiated Impact

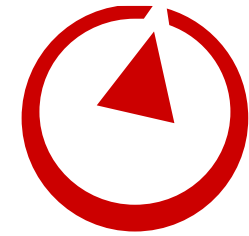
OPENMINDS



Energy and Climate



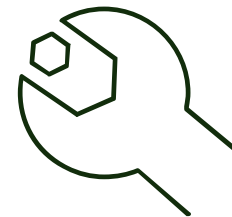
125 Experts Across Key  
Energy and Climate Sectors



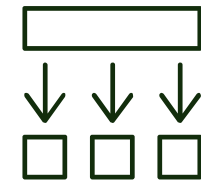
Bain Partnership



Data-Driven



Practical Solutions  
Framework and 10-Year  
Horizon





Impact Projects Targeting  
Key Bottlenecks

# 'P50' Outlook – Forecasting Our Current Path

## GLOBAL OUTLOOK

2035 forecasts included in the 'P50' Outlook

	 Global	 US
Energy Demand	✓	✓
Supply Mix	✓	✓
Emissions	✓	✓

Developed and reviewed by industry leaders

### MODEL CREATION

Intersect<sup>SM</sup>  
BAIN & COMPANY

Copenhagen  
Economics

CE

### EXPERT REVIEW


 GE VERNOVA


 CLEAN AIR  
TASK FORCE


 tpi

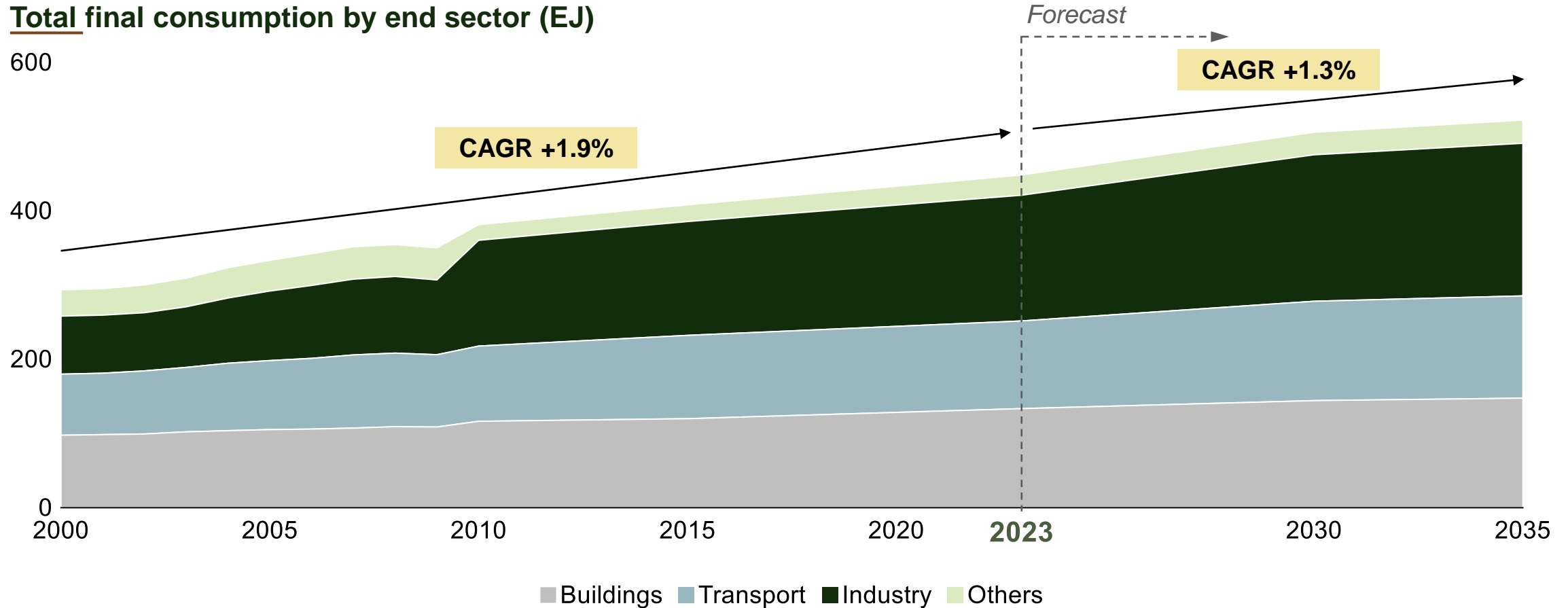

 SCF PARTNERS  
HOUSTON | CALGARY | ABERDEEN | SINGAPORE


 NEW ENERGY CAPITAL

# Global Energy Demand is Expected to Rise Driven by Consumption Growth in Buildings and Industry Sectors

## GLOBAL OUTLOOK

Total final consumption by end sector (EJ)



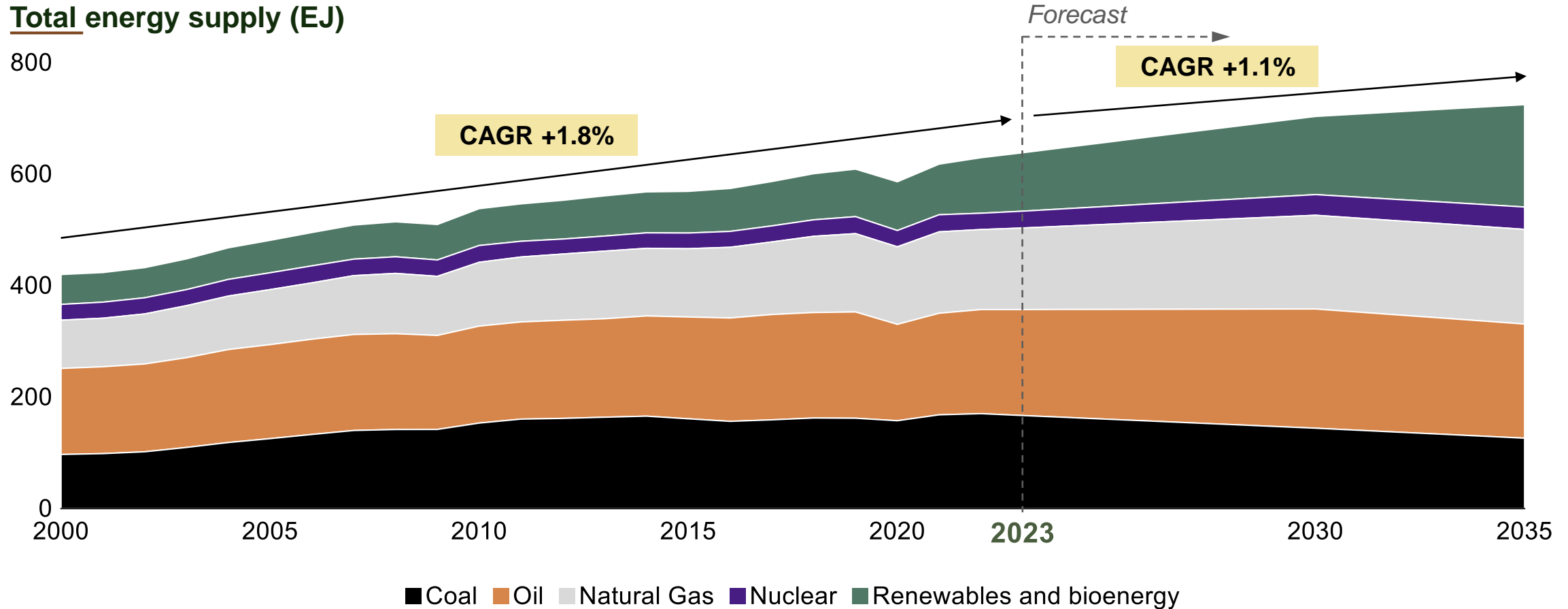
Source: Intersect<sub>SM</sub> Carbon & Energy Transition CGE Model; IEA WEO 2023

<https://openminds203x.org/>

# Renewables are Forecast to Continue to Phase Out Coal in Global Energy Supply Mix

GLOBAL OUTLOOK

Total energy supply (EJ)



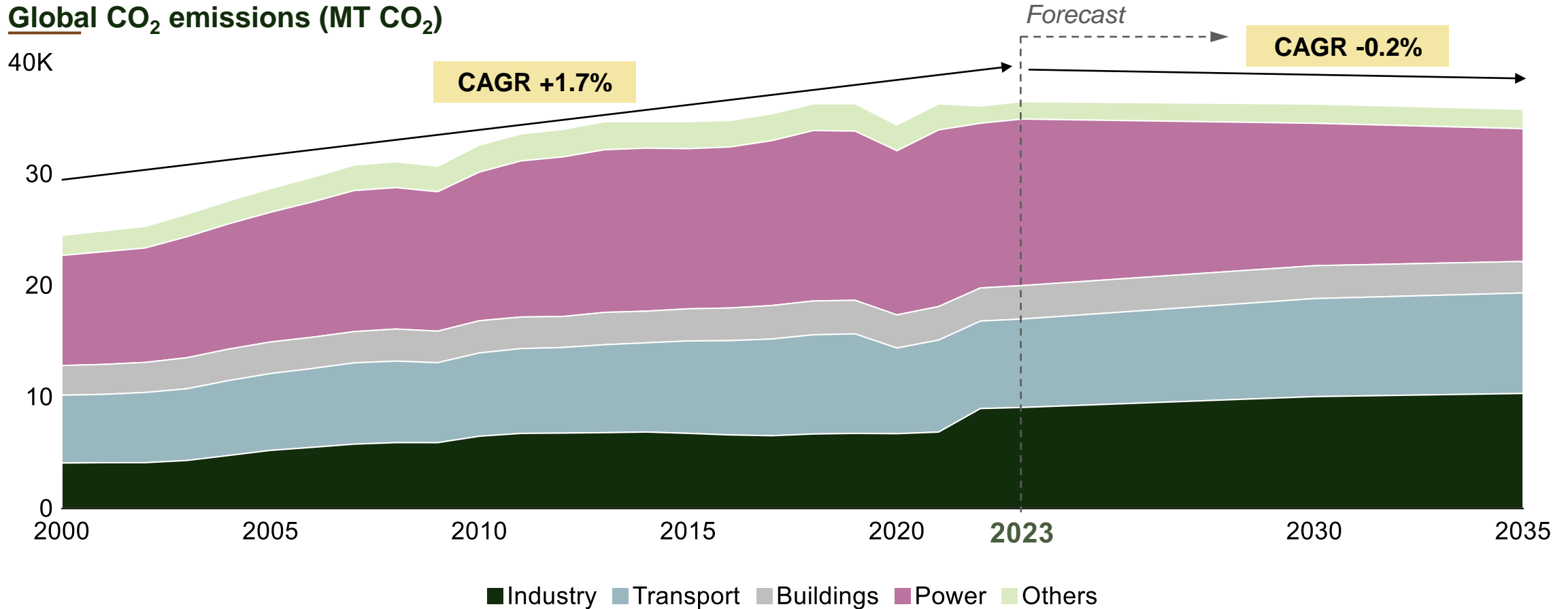
Source: Intersect<sub>SM</sub> Carbon & Energy Transition CGE Model; IEA WEO 2023

<https://openminds203x.org/>

# Developing Economies' Fossil Fuel-Powered Industrialization Offsets Developed Economies' Decarbonization

## GLOBAL OUTLOOK

**Global CO<sub>2</sub> emissions (MT CO<sub>2</sub>)**



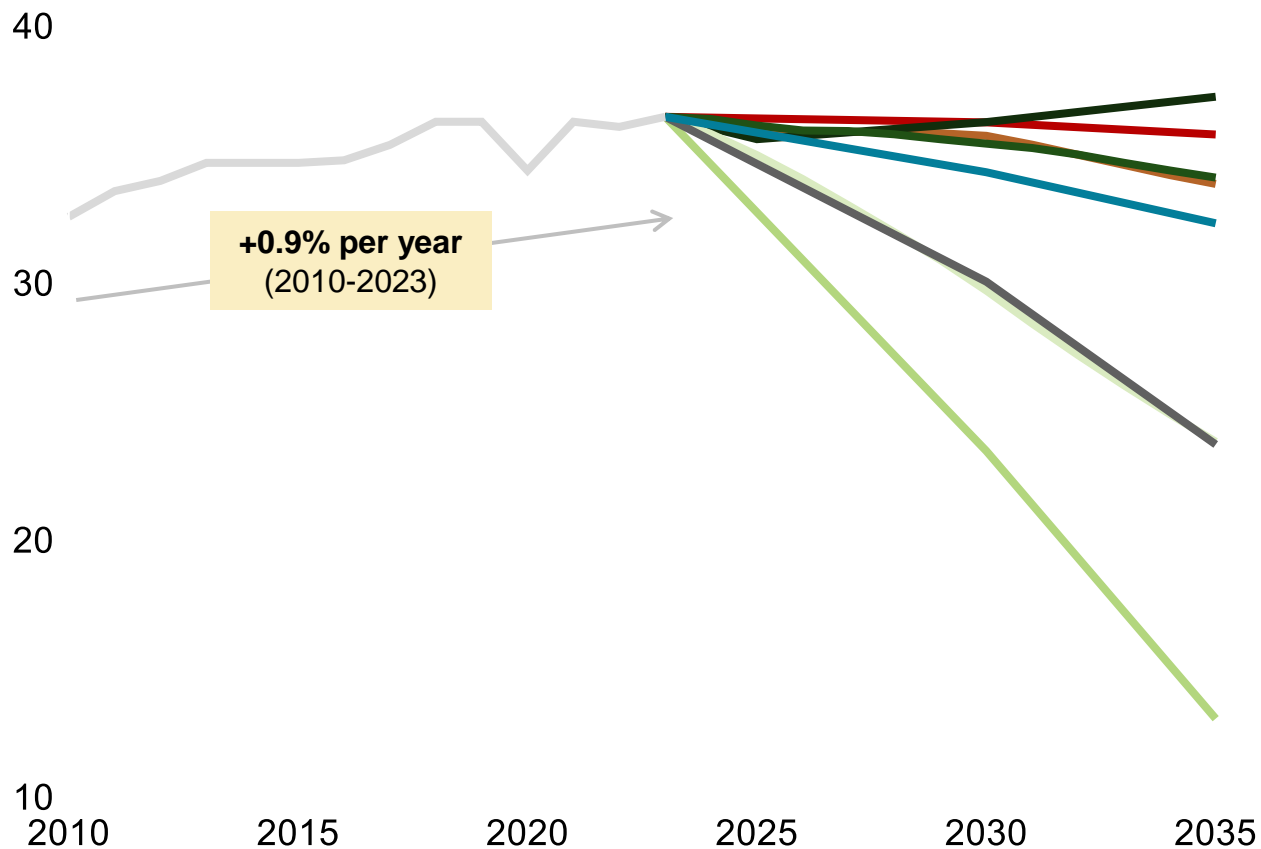
Source: Intersect<sub>SM</sub> Carbon & Energy Transition CGE Model; IEA WEO 2023

<https://openminds203x.org/>

# Global Carbon Emissions Likely to Decline Slightly by 2035

## GLOBAL OUTLOOK

**Global emissions by scenario (Gt CO<sub>2</sub>)**



Growth per year  
2023-2035

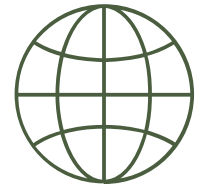
### Scenarios without significant policy or tech shifts

EIA: International Energy Outlook 2023	+0.2%
<b>OpenMinds 'P50' Outlook 2024</b>	<b>(0.2%)</b>
ExxonMobil: 2023 Outlook for Energy	(0.6%)
BP: 2024 Energy Outlook	(0.6%)
IEA: Stated Policies Scenario (STEPS) 2023	(1.0%)
IEA: Announced Pledges Scenario (APS) 2023	(3.4%)

### Scenarios with significant policy and tech shifts

IEA: Sustainable Dev. Scenario (SDS) 2023	(3.5%)
IEA: Net Zero Emissions by 2050 (NZE)	(8.2%)

Source: BP Energy Outlook, 2021; ExxonMobil 2023 Outlook for Energy; International Energy Agency, World Energy Outlook 2023; EIA International Energy Outlook 2023



# Implications for Global Energy & Climate Outlook

## GLOBAL OUTLOOK



### Energy Demand...

is set to grow 15% by 2035, largely driven by developing economies

### Oil Demand...

peaks in 2030, as the world passes a tipping point in EV adoption

### Natural Gas Demand...

will grow in-line with total energy demand, maintaining its ~23% share through 2035

### Renewable Energy...

share of energy mix is forecast to increase from ~15% to ~25% in 2035, as strong growth continues

### Carbon Emissions...

will largely remain flat, decreasing ~0.2% p.a. to reach ~35 Gt in 2035

### Differing Priorities...

in developing and developed world, with former focused on energy access, latter on climate change

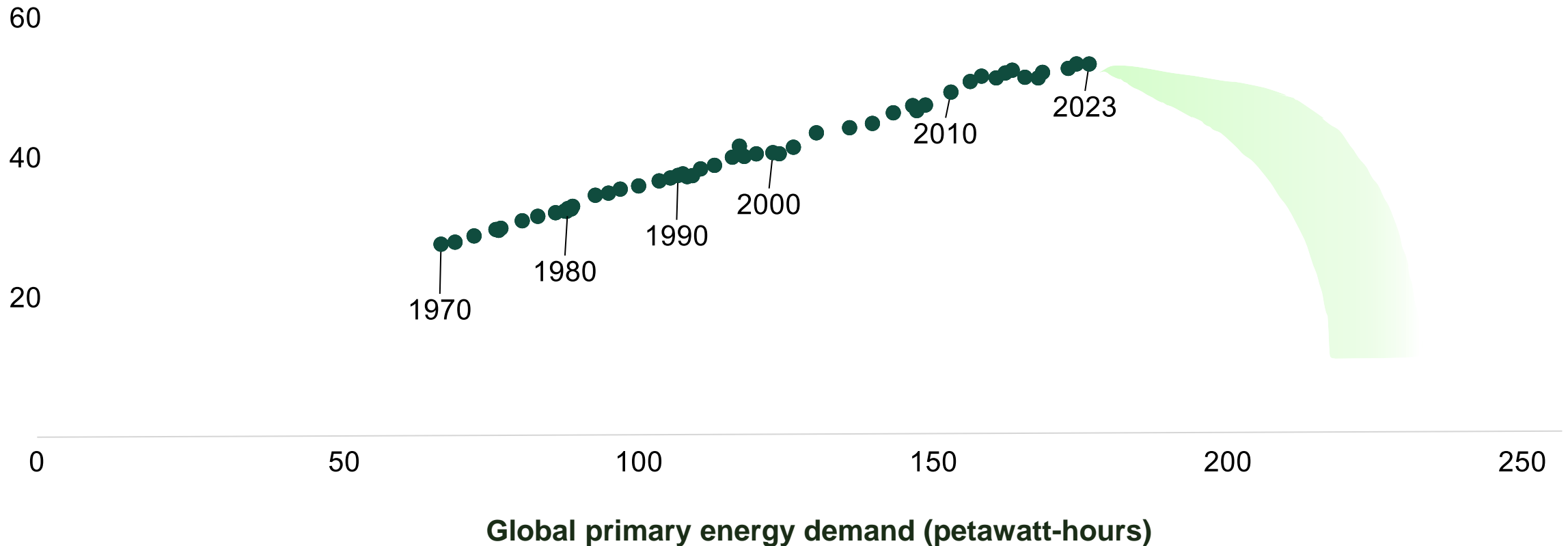




# Our Challenge: We Must Reverse the Growth in Emissions

## GLOBAL OUTLOOK

Global CO<sub>2</sub>e emissions (Gt CO<sub>2</sub>e)

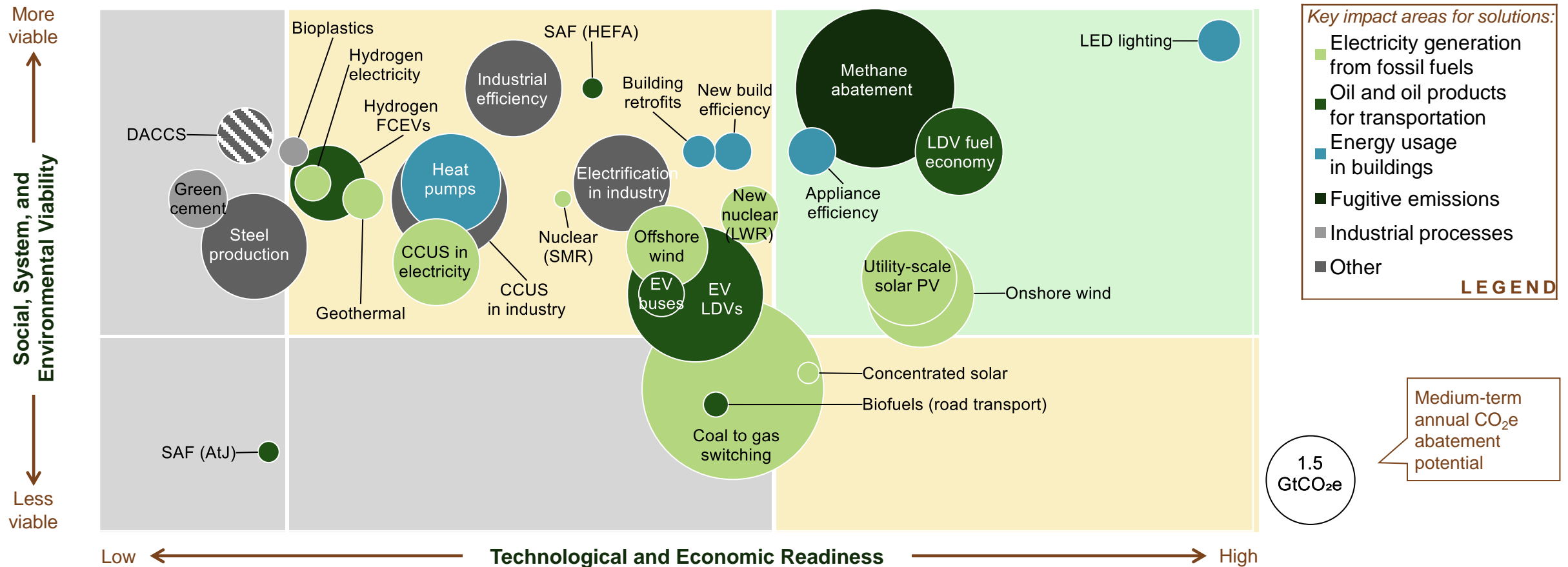


Source: Our World in Data

<https://openminds203x.org/>

# Prioritization of Potential Solutions

## SOLUTIONS



Note: Abatement potential refers to medium-term annual CO<sub>2e</sub> emissions reduction; building efficiency and retrofits refers to insulation and HVAC only; DACCS abatement potential virtually infinite; industrial efficiency includes solutions such as waste to heat recovery; renewable solutions include battery component in cost and abatement potential; geothermal represents enhanced geothermal systems; assumes methane has global warming potential 30 times that of CO<sub>2</sub>

Source: IEA; IRENA; Goldman Sachs; Project Drawdown; OpenMinds research and lit. scan

# OpenMinds' Top 10 Solutions

## SOLUTIONS

### 'Top 10' solutions

Prioritized set of solutions with high viability and sufficient technological and economic readiness to “bend the curve” by 203X

#### Big 4 opportunities

Abating methane emissions from energy	Renewables (i.e., solar and wind)	Coal-to-X switching	CCUS in electricity and industry
Transportation energy efficiency	Industrial efficiency and electrification	Electric LDVs	Heat pumps
		New and existing nuclear	Buildings efficiency

### Other important solutions

Solutions that **may be critically important** but are assessed as having less overall impact potential by 203X relative to our list of ‘top 10’ solutions

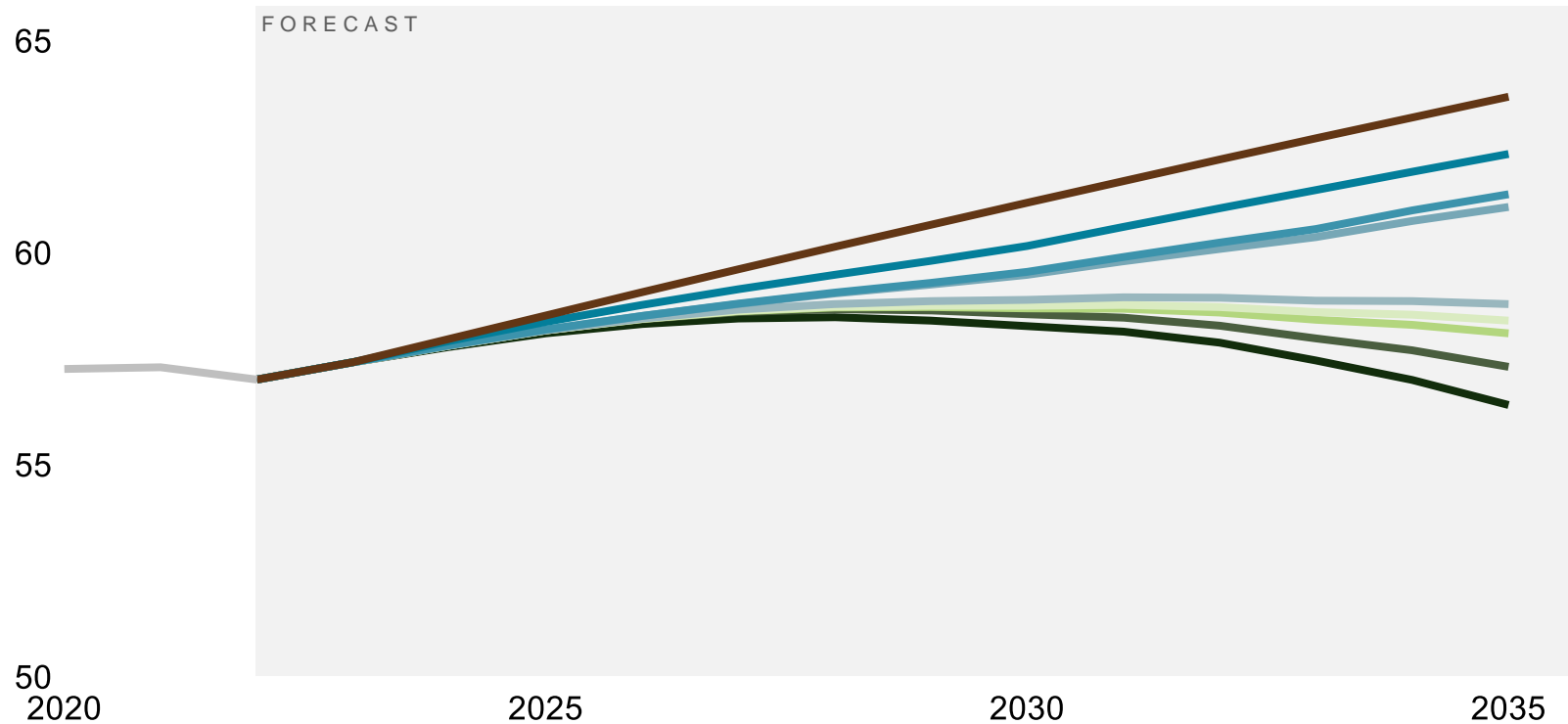
Behavioral change	Adaptation	We are considering whether and how to incorporate these more fully into our efforts	
Distributed generation	Green steel and cement	Nature-based solutions	Hydrogen
LED lighting	Direct air capture	Geothermal	Circular economy

# Impact of Implementing Key Solutions

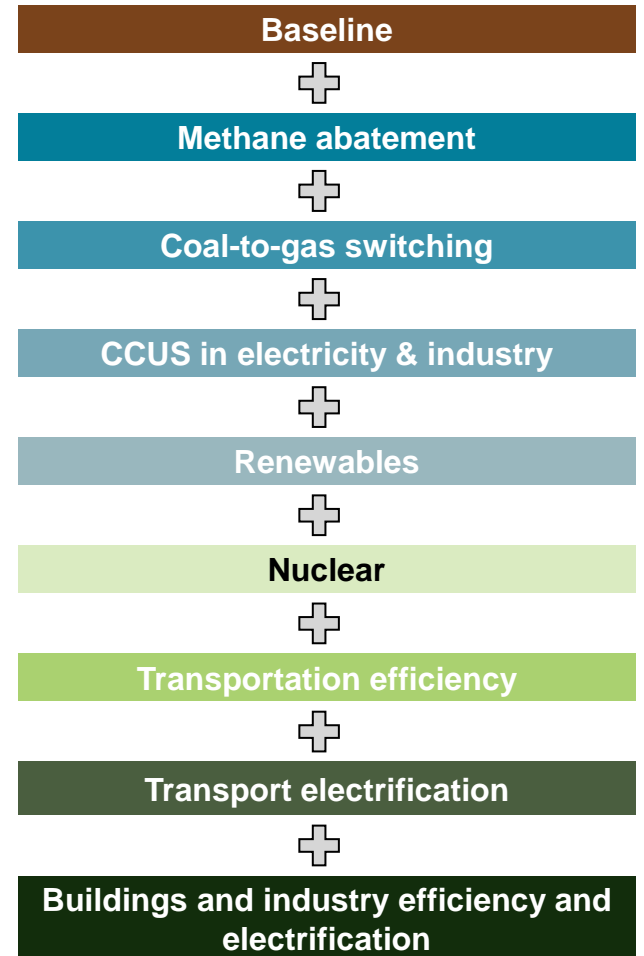
## SOLUTIONS

### Projected emissions impact

Global annual net GHG emissions (Gt CO<sub>2</sub>e per year)



/ PRELIMINARY



Source: Climate Interactive

<https://openminds203x.org/>

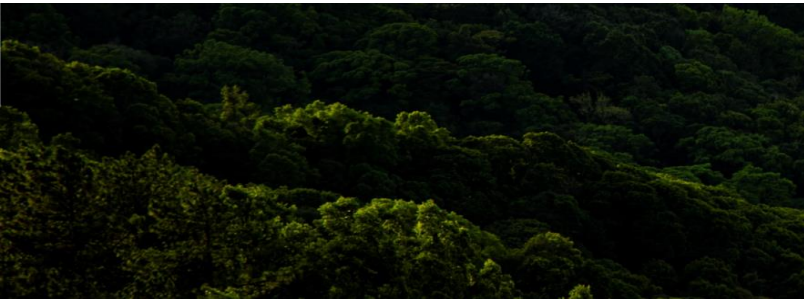
# This will Require a Step-Change in Global Energy Investment

## SOLUTIONS



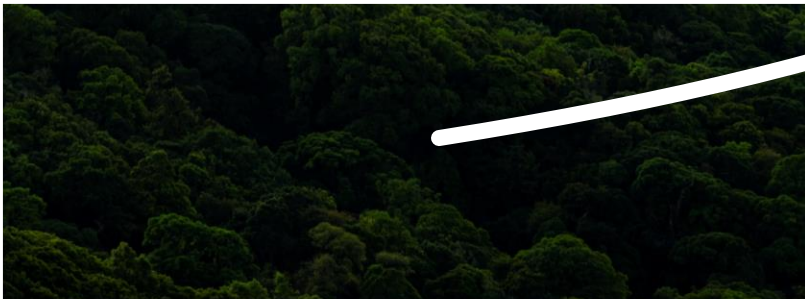
**Fossil fuel**  
per year

**\$1T**



**Clean energy**  
per year

**\$1T**



**\$5T**



**\$100T**  
by 2050

# Houston's Energy Leadership

1900

TOMORROW

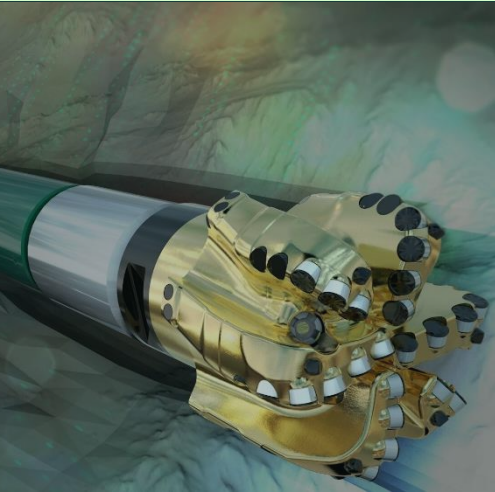
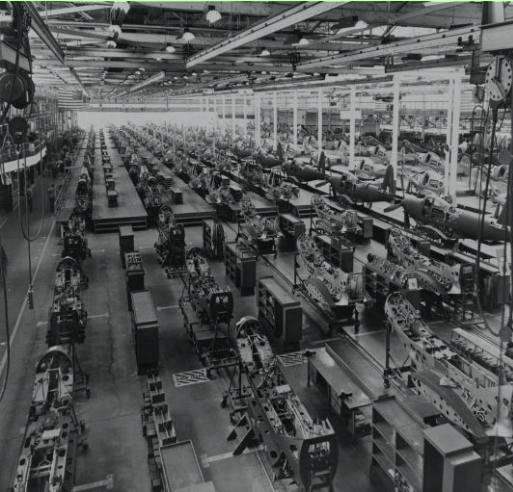
Discovery

Scale

Technology

Innovation

Next?



Spindletop

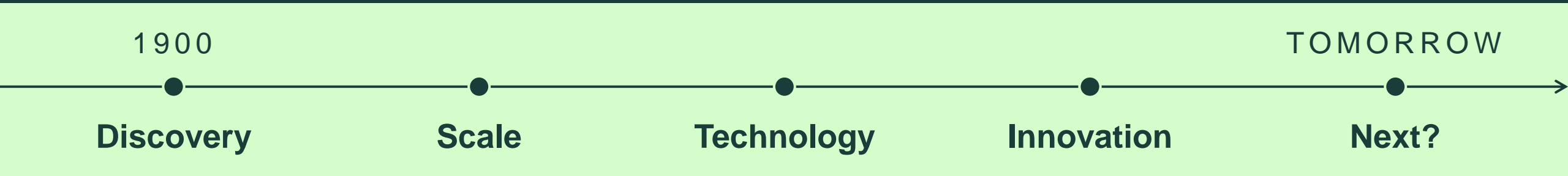
Fueling the World Wars

Deepwater Pioneering

Shale Revolution

Energy & Climate

# Energy's Contributions to the Houston Economy



Supported by



# We've Done it before in Medical Innovation



1947



1969



Today



# We're Off to a Great Start and In Great Company!!!

21ST ANNUAL RICE ALLIANCE

## ENERGY TECH VENTURE FORUM

The Premier Energy Tech VC Conference | September 12, 2024 | [ETVF.RICE.EDU](https://ETVF.RICE.EDU)



Past Energy Tech Venture Forum companies have raised more than \$8.7 billion in funding.



This year's ETVF companies have already raised more than \$1.0 billion in funding. Good luck!

# Future of Energy, Houston, Entrepreneurship, and Rice is Here!

## TAKEAWAYS

- 1 Energy Demand** Will Continue to Grow
- 2 Climate Impacts** and Urgency to Act Will Increase
- 3 New, Cost-Effective Technologies** that Address Climate and Energy Will Thrive
- 4** Houston Can Become an **Epicenter** for Energy and Climate Innovation
- 5** Today's **Innovators** will Become Tomorrow's **Industry Leaders**



**OpenMinds**

Solving for the  
**Dual Challenge.**