PIER
PUEY UNGPHAKORN INSTITUTE FOR ECONOMIC RESEARCH

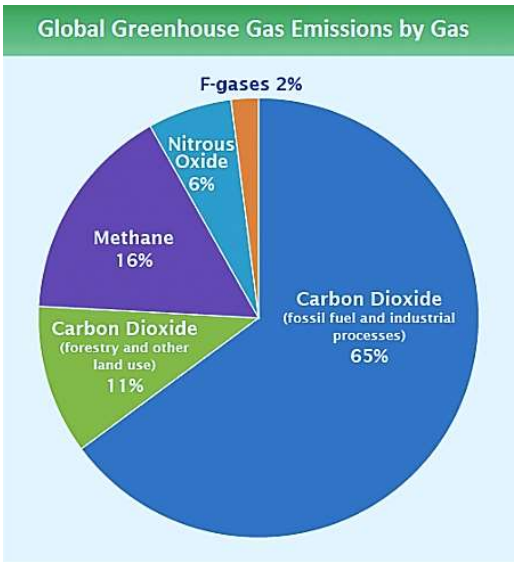
Long-term GHG Emissions

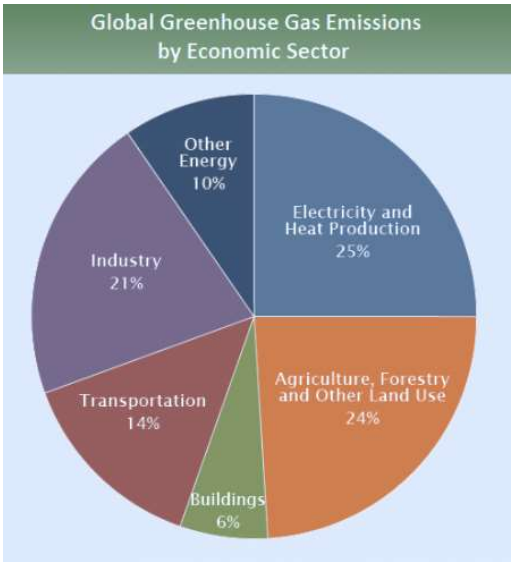
RCP x SSP x SPA Perspective

2 JUL 2021

Bundit LIMMEECHOKCHAI

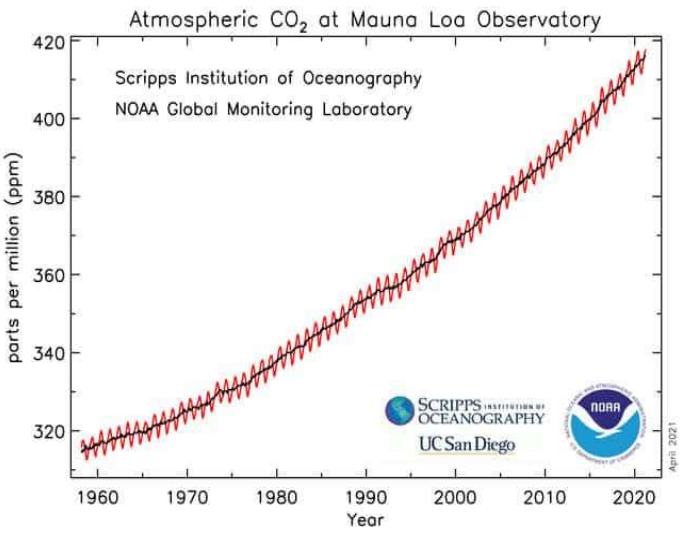
Global GHG Emissions

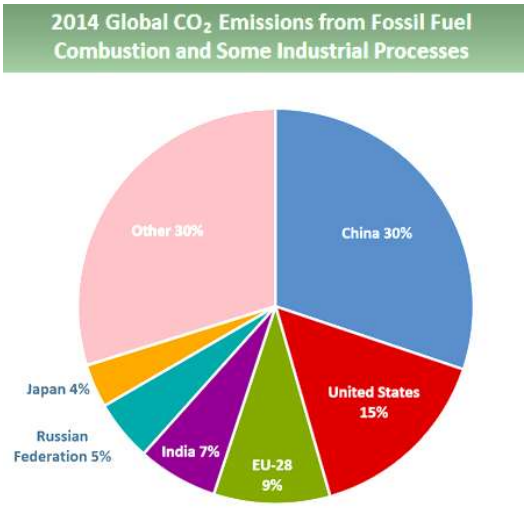




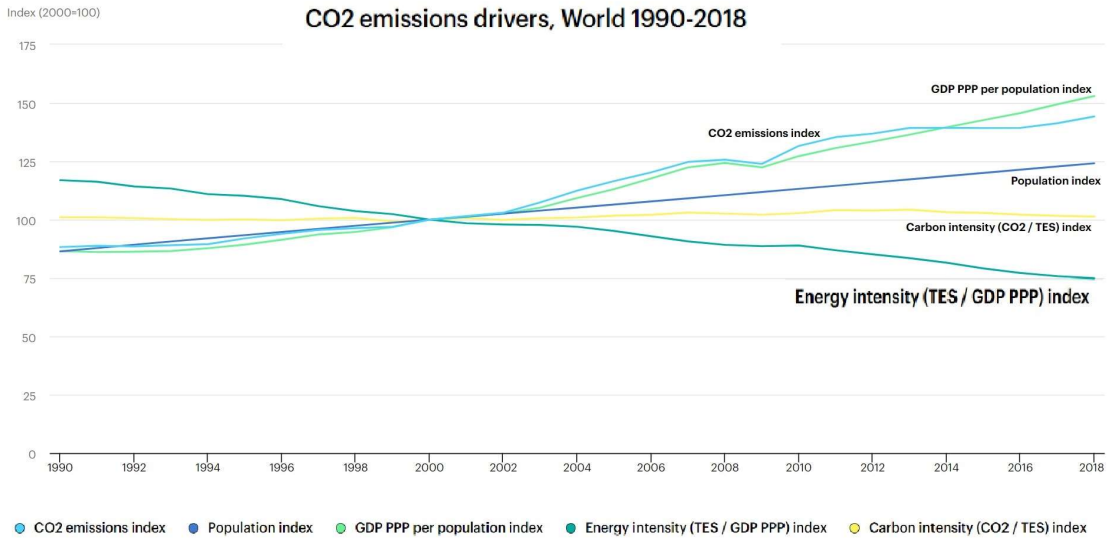
Source: IPCC (2014)

Global GHG Emissions





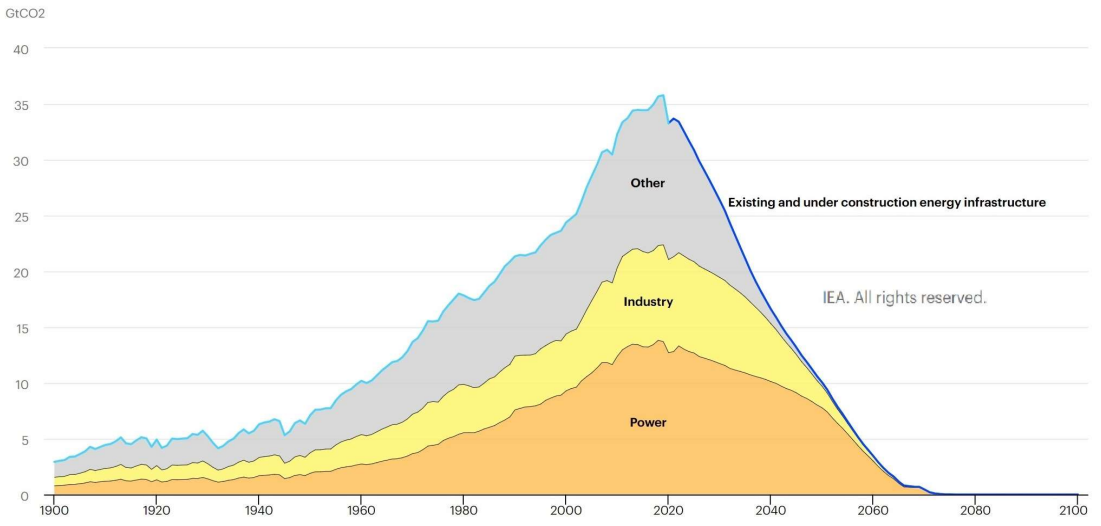
IEA Energy Outlook 2020



Source: WEO (IEA, 2021)

IEA Energy Outlook 2020

Historical CO2 emissions and projected emissions from operating energy infrastructure as it was used historically, 1900-2100



Source: WEO (IEA, 2021)

Paris Agreement

UNITED NATIONS
2015

Article 2 → Objective

1. This Agreement, in enhancing the implementation of the Convention, including its objective, aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by:

Mitigation →

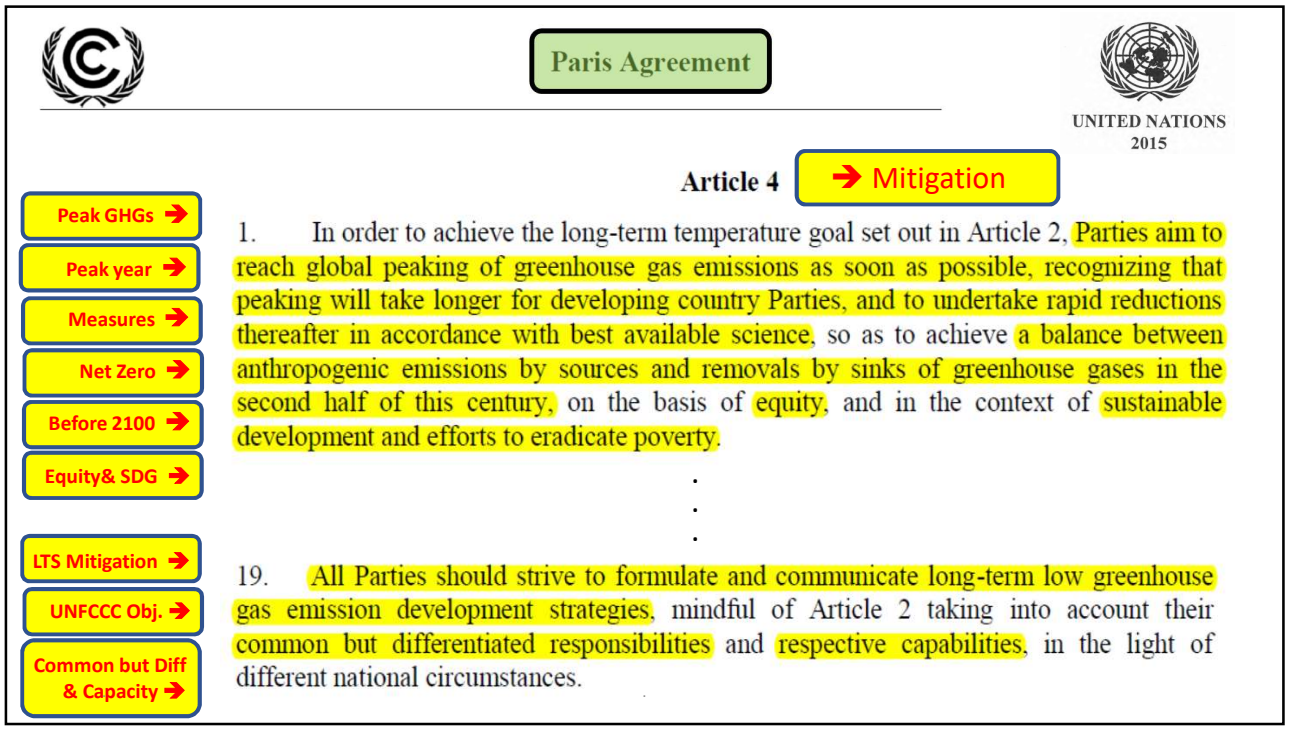
(a) Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;

Adaptation →

(b) Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production; and

Finance →

(c) Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.


Paris Agreement
UNITED NATIONS
2015
Article 4
Mitigation
Peak GHGs
Peak year
Measures
Net Zero
Before 2100
Equity& SDG
LTS Mitigation
UNFCCC Obj.
Common but Diff & Capacity
1. In order to achieve the long-term temperature goal set out in Article 2, Parties aim to reach global peaking of greenhouse gas emissions as soon as possible, recognizing that peaking will take longer for developing country Parties, and to undertake rapid reductions thereafter in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty.
19. All Parties should strive to formulate and communicate long-term low greenhouse gas emission development strategies, mindful of Article 2 taking into account their common but differentiated responsibilities and respective capabilities, in the light of different national circumstances.


GLOBAL CLIMATE ACTION IN ACTION
The United Nations Framework Convention on Climate Change (UNFCCC)
global consensus on climate change.
150 signed, Brazil
Entered into force
COP1, Berlin 1995
KP COP3 1997
THAI ratified 2002
TGO est. 2007
1st KP ended 2012
1992 UNFCCC opens for signature at the Earth Summit in Rio. The objective was to bring the world together to curb GHG emissions and adapt to climate change.
1994 UNFCCC enters into force with near universal membership. Countries that sign the treaty - known as 'Parties' - meet annually at COP to negotiate multilateral responses to climate change.
1997 At COP3 in Kyoto, the conference agreed on the general framework on greenhouse gas emission reduction for industrialised countries, known as the Kyoto Protocol.
2001 At COP7 in Marrakesh, the Marrakesh Accords set the stage for ratification of the Kyoto Protocol. It formalised agreement on operational rules for International Emissions Trading, the Clean Development Mechanism (CDM) and Joint Implementation (JI).
2005 The Kyoto Protocol came into force. The European Union Emissions Trading Scheme, the first and largest emissions trading scheme in the world, was launched.
2006 The CDM, a key mechanism under the Kyoto Protocol, opens for business.
2008 The JI started, allowing countries with an emission reduction commitment to earn emission reduction units (ERUs) from emission-reduction project in another country with similar commitments.
2011 COP17 agreed to extend Kyoto Protocol to 2020, setting 2015 as a deadline for a successor document.
2012 Kyoto Protocol's first commitment expired.

PA Begin 2015 ➔

THAI 1st NDC 2015 ➔

PA Rulebook 2016 ➔

* * *

25th Chile in Madrid ➔

Missing COP 2020 ➔

26th UK 2021 ➔

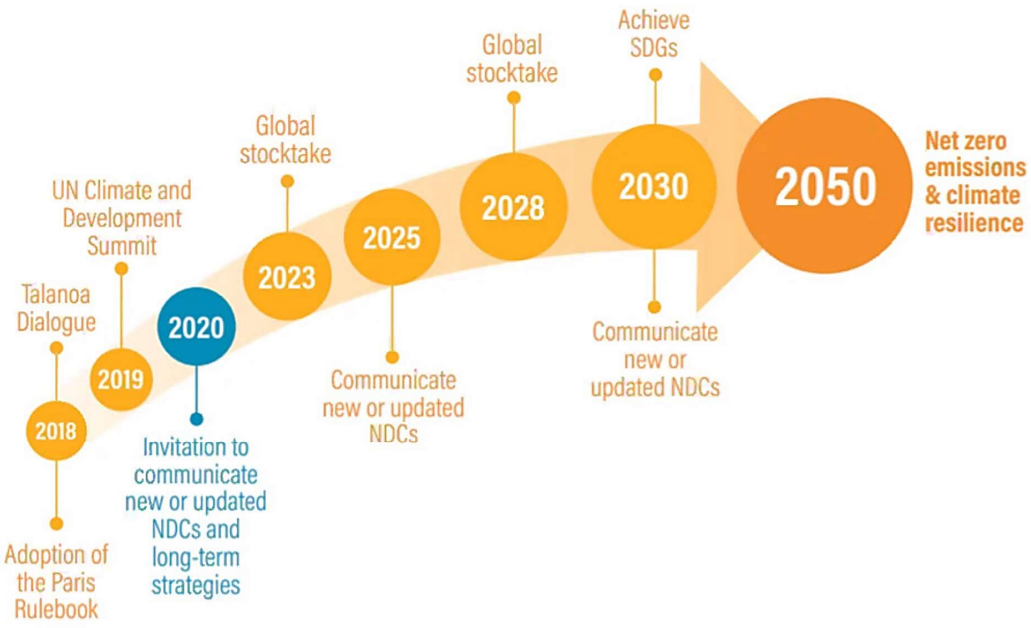
2015 At COP21, the historical Paris Agreement was adopted with the near universal agreement of 195 nations.

2016 At COP22, the Marrakech Partnership for Global Climate Action was launched, moving the Paris Rulebook writing forward.

2018 At COP24, the world will need to agree on the Paris Rulebook that will operationalise the Paris Agreement.

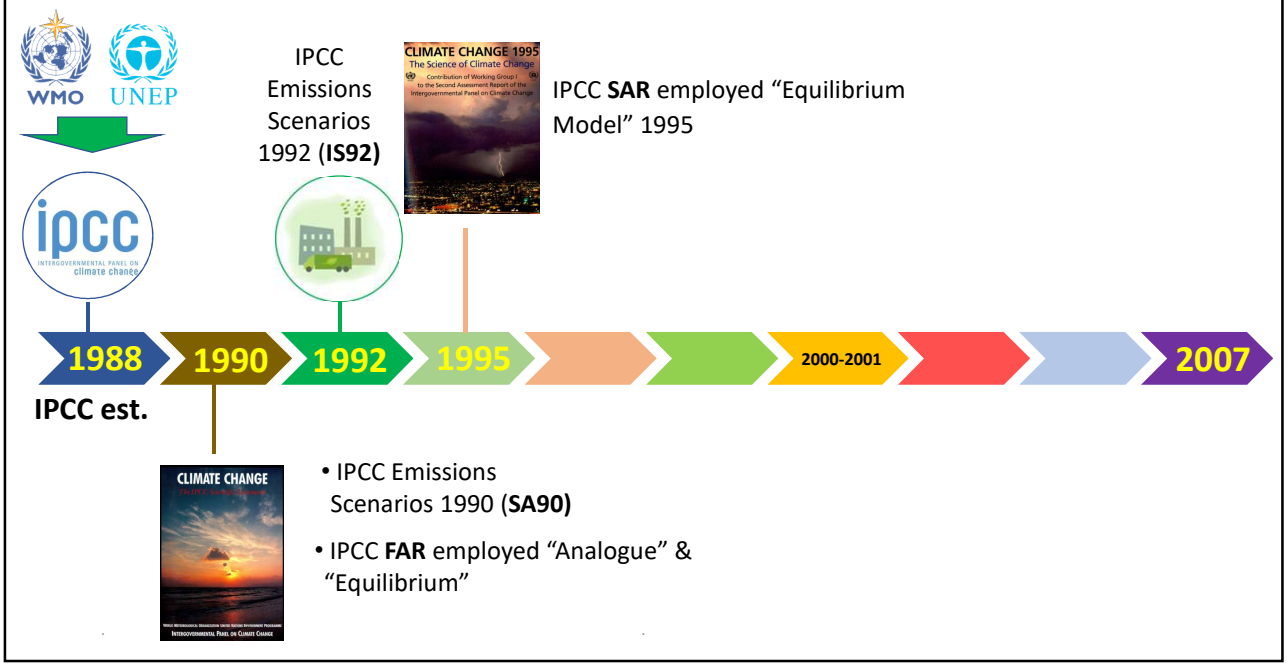
2019 COP25 CHILE MADRID 2019

2021



Source: WRI, NOV 2020

IPCC Emissions Scenarios



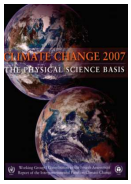
Global Warming Potential Values

Global warming potential (GWP) values relative to CO_2

Gas	Chemical formula	GWP values for 100-year time horizon		
		Second Assessment Report (SAR)	Fourth Assessment Report (AR4)	Fifth Assessment Report (AR5)
Carbon dioxide	CO_2	1	1	1
Methane	CH_4	21	25	28
Nitrous oxide	N_2O	310	298	265

IPCC Emissions Scenarios

- IPCC **TAR** employed **IS92**
- Emissions Scenarios included vulnerability and Social impacts

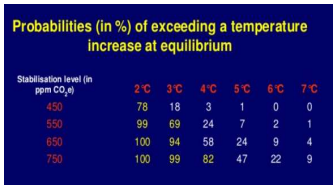


1988 | 1990 | 1992 | 1995 | 2000-2001 | 2007

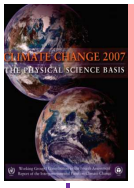
IPCC est.

IPCC AR4
=> SRES & IS92

Revised Emissions Scenarios IS92 => SRES



IPCC Emissions Scenarios



IPCC AR4 employed SRES & IS92 Assessment

- **Integrated assessment model (IAM)**
- **SSPs for Impact, adaptation and vulnerability**

2007 | 2010-2011 | 2013 | 2015 | 2016 | 2022

- **Future Socio-economic & Environment**
- **SSPs** integrated **RCPs** & Climate model

Emissions Scenarios employed **RCPs** in **AR5**

IPCC Emissions Scenarios

IPCC recommended keeping global warming well below 2-degree Celsius and pursuing to limit below 1.5-degree Celsius.
========== > > > >

AR6 ?

2007 | 2010-2011 | 2013 | 2015 | 2016 | 2022

IPCC started AR6
(to be completed in 2022)

Intergovernmental Panel on Climate Change (IPCC)

WMO UNEP

IPCC Plenary
IPCC Bureau
Executive Committee

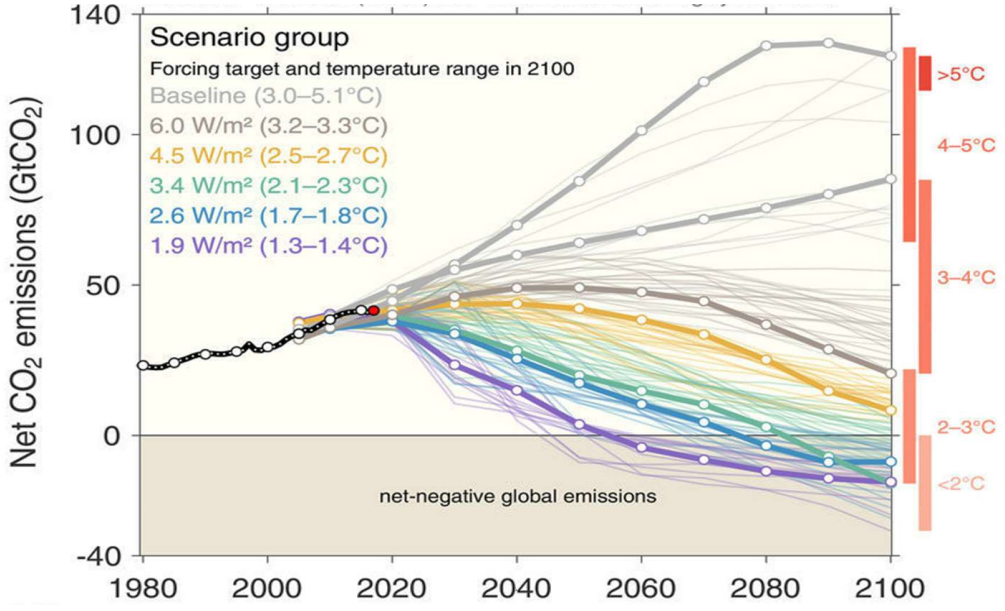
IPCC Secretariat

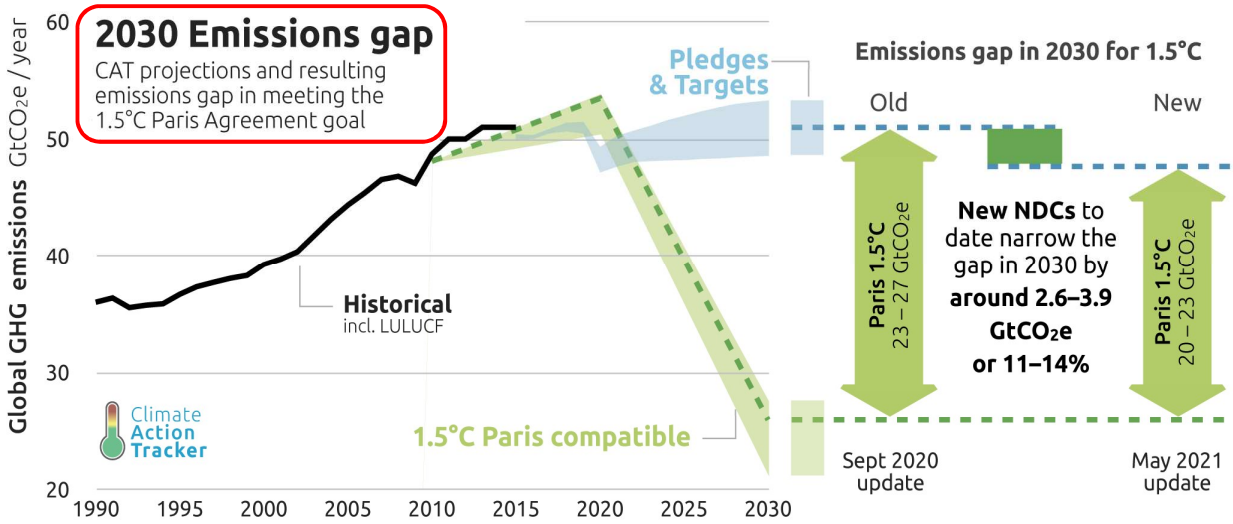
Working Group I	Working Group II	Working Group III	Task Force
The Physical Science Basis	Impacts, Adaptation, and Vulnerability	Mitigation of Climate Change	on National Greenhouse Gas Inventories
TSU	TSU	TSU	TSU

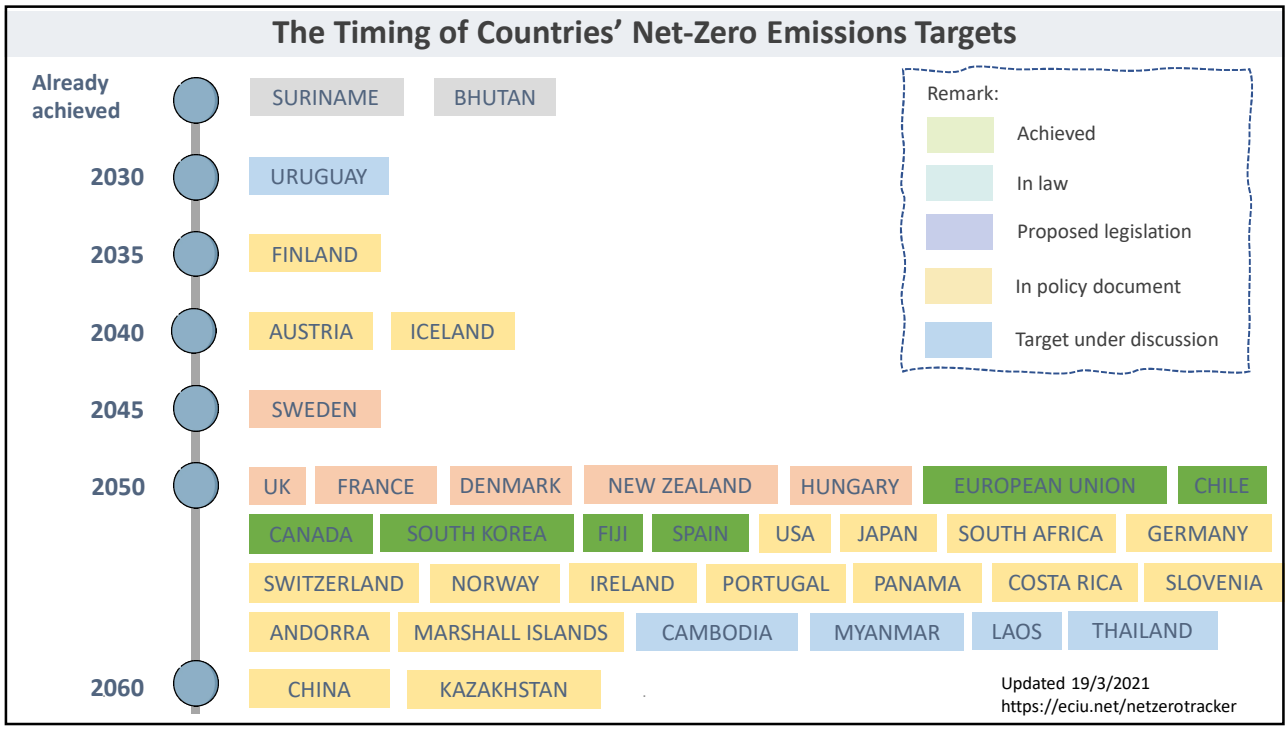
Authors, Contributors, Reviewers

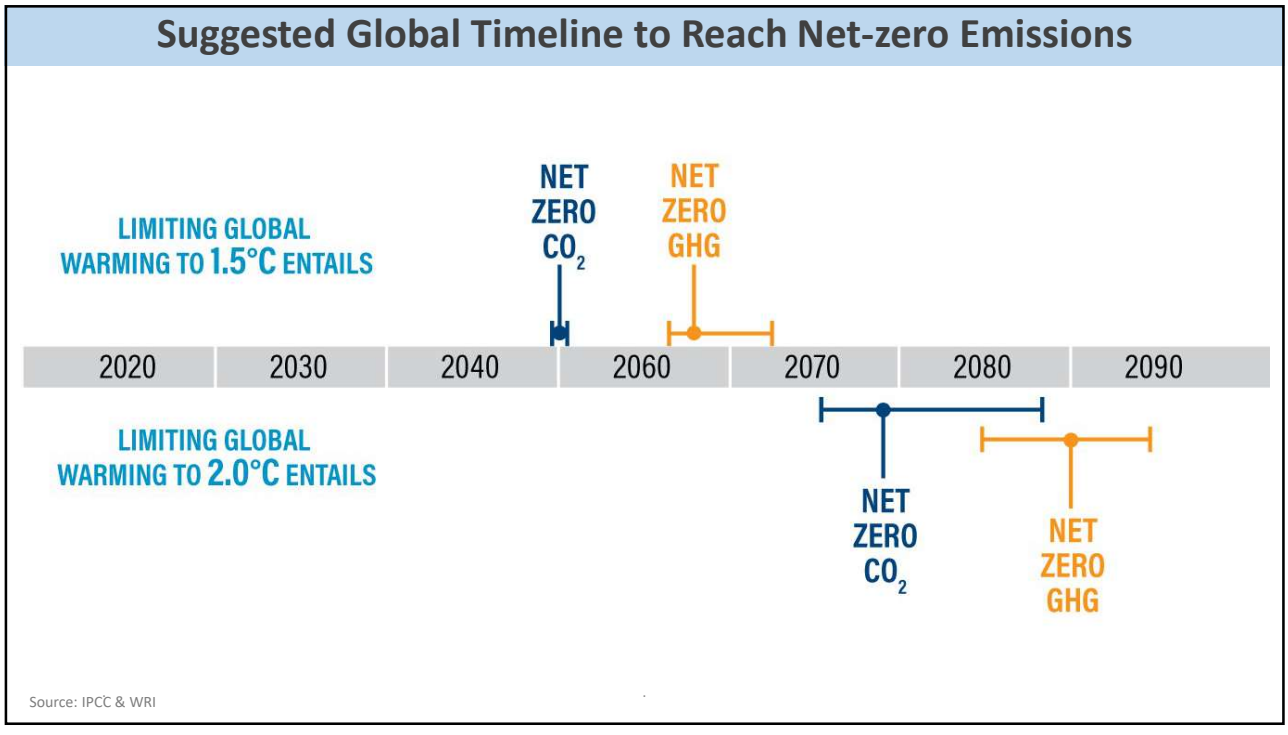
Source: (IPCC, 2021) https://www.ipcc.ch/

AR5 (IPCC, 2013)

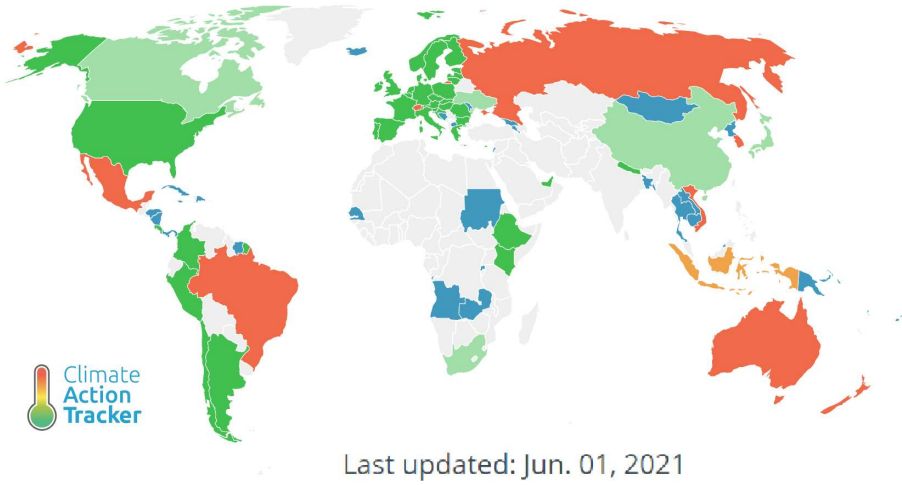





The Timing of Countries' Net-Zero Emissions Targets
Already achieved
SURINAME
BHUTAN
2030
URUGUAY
2035
FINLAND
2040
AUSTRIA
ICELAND
2045
SWEDEN
2050
UK
FRANCE
DENMARK
NEW ZEALAND
HUNGARY
EUROPEAN UNION
CHILE
CANADA
SOUTH KOREA
FIJI
SPAIN
USA
JAPAN
SOUTH AFRICA
GERMANY
SWITZERLAND
NORWAY
IRELAND
PORTUGAL
PANAMA
COSTA RICA
SLOVENIA
ANDORRA
MARSHALL ISLANDS
CAMBODIA
MYANMAR
LAOS
THAILAND
2060
CHINA
KAZAKHSTAN
Remark:
Achieved
In law
Proposed legislation
In policy document
Target under discussion
Updated 19/3/2021
https://eciu.net/netzerotracker


Suggested Global Timeline to Reach Net-zero Emissions
LIMITING GLOBAL WARMING TO 1.5°C ENTAILS
NET ZERO CO_2
NET ZERO GHG
2020
2030
2040
2060
2070
2080
2090
LIMITING GLOBAL WARMING TO 2.0°C ENTAILS
NET ZERO CO_2
NET ZERO GHG
Source: IPCC & WRI

Status of NDC Update



CLIMATE TARGETS
Status of the NDC update process

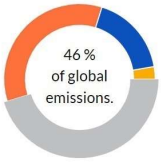
59 Countries have **submitted** new NDC targets (58 countries plus the EU27)
- **13** Countries we analyse have submitted **stronger NDC targets** (12 countries plus the EU27)
- **9** Countries we analyse **did not increase ambition**
- **37** Countries **we do not analyse** submitted new NDC targets

6 Countries have **proposed** new NDC targets
- **5** Countries we analyse have proposed **stronger NDC targets**
- **1** Country we analyse stated it **will not propose more ambitious targets**
- **0** Countries **we do not analyse** proposed new NDC targets

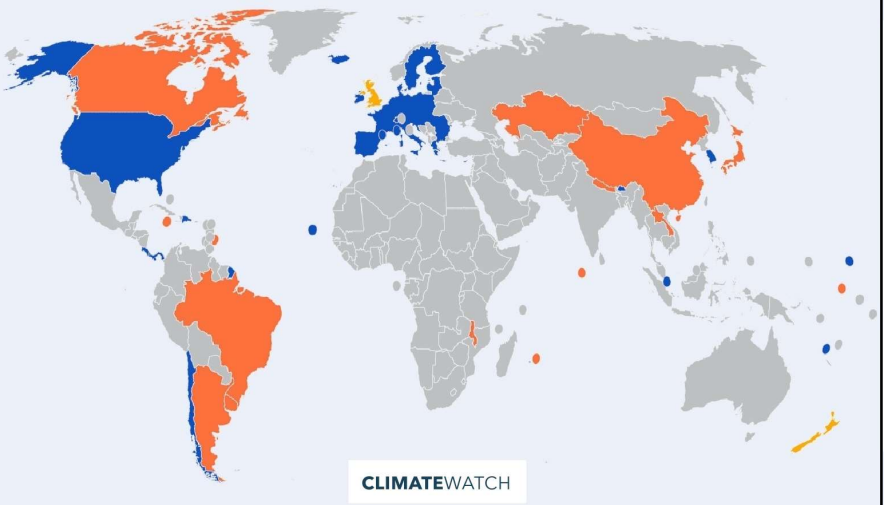
99 Countries have not updated targets

Net-zero targets by countries

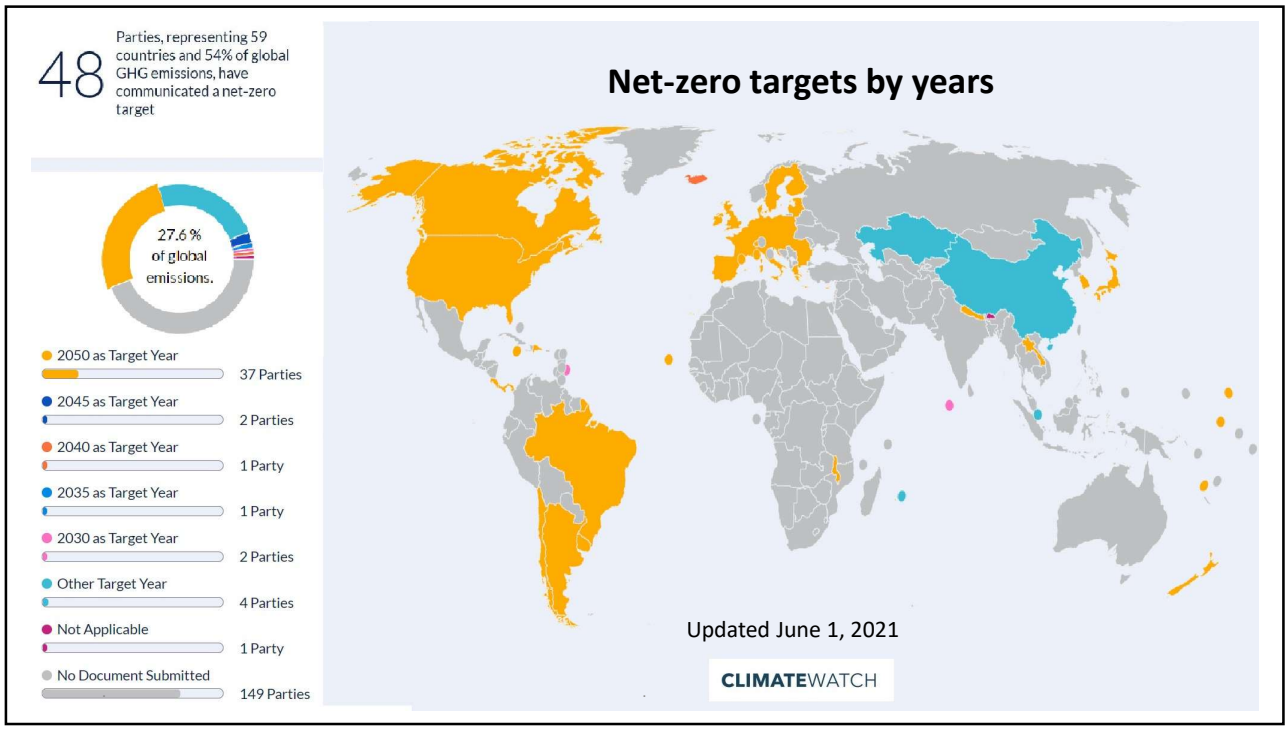
48 Parties, representing 59 countries and 54% of global GHG emissions, have communicated a net-zero target

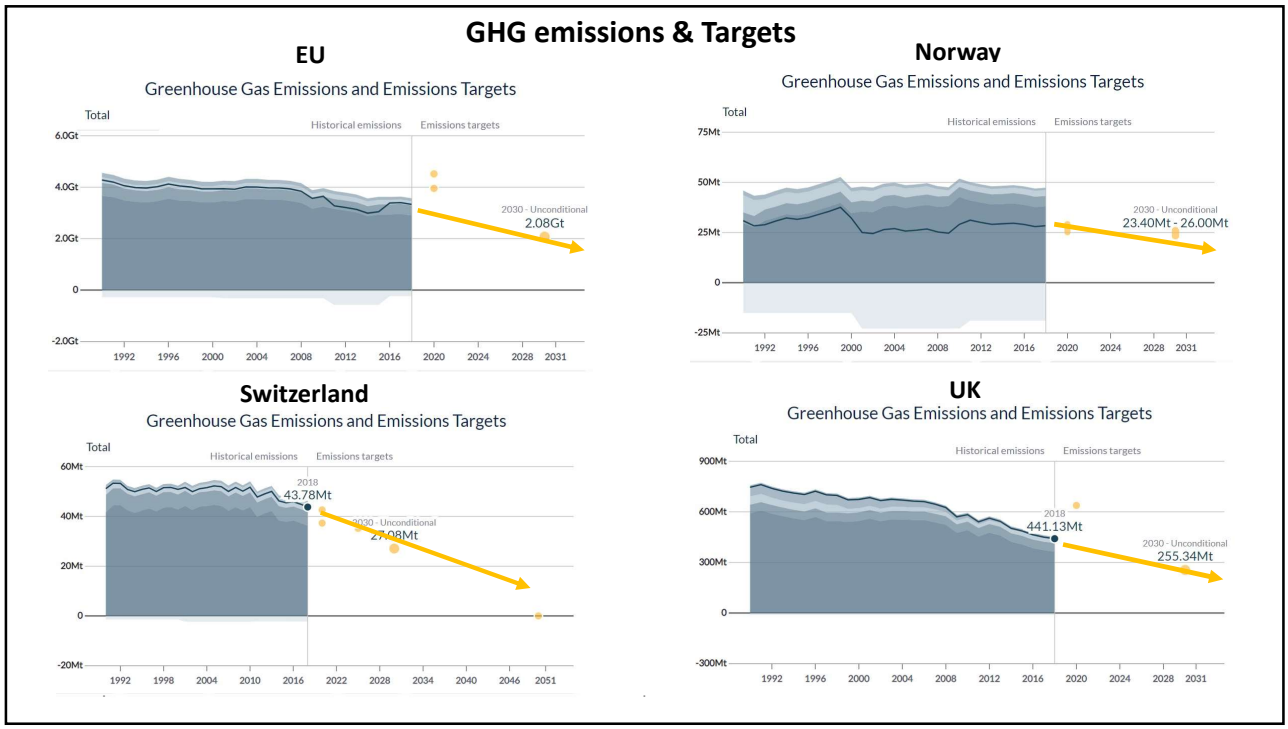


- Net-zero Target in Law — 5 Parties
- Net-zero Target in Policy Document — 26 Parties
- Net-zero Target in Political Pledge — 17 Parties
- No Document Submitted — 149 Parties



Updated June 1, 2021

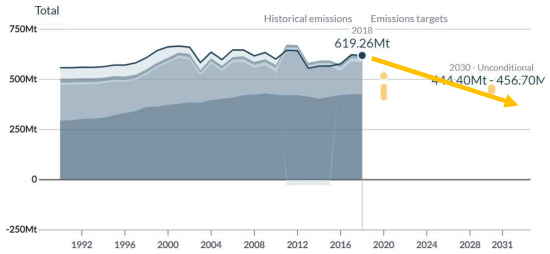

48
Parties, representing 59 countries and 54% of global GHG emissions, have communicated a net-zero target
27.6 % of global emissions.
2050 as Target Year
37 Parties
2045 as Target Year
2 Parties
2040 as Target Year
1 Party
2035 as Target Year
1 Party
2030 as Target Year
2 Parties
Other Target Year
4 Parties
Not Applicable
1 Party
No Document Submitted
149 Parties
Net-zero targets by years
Updated June 1, 2021
CLIMATEWATCH


GHG emissions & Targets
EU
Greenhouse Gas Emissions and Emissions Targets
Total
Historical emissions
Emissions targets
2030 - Unconditional
2.08Gt
Norway
Greenhouse Gas Emissions and Emissions Targets
2030 - Unconditional
23.40Mt - 26.00Mt
Switzerland
Greenhouse Gas Emissions and Emissions Targets
2018
43.78Mt
2030 - Unconditional
UK
Greenhouse Gas Emissions and Emissions Targets
2018
441.13Mt
2030 - Unconditional
255.34Mt

GHG emissions & Targets

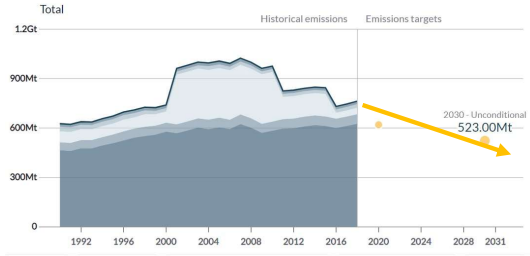
AUSTRALIA

Greenhouse Gas Emissions and Emissions Targets



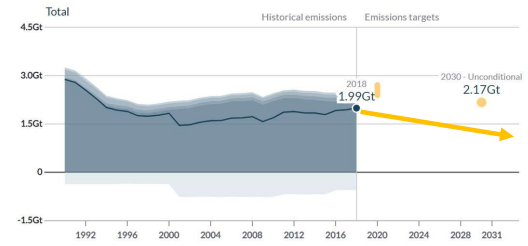
CANADA

Greenhouse Gas Emissions and Emissions Targets



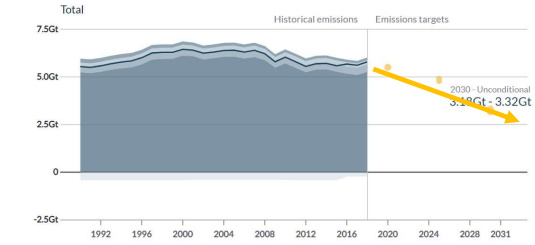
RUSSIA

Greenhouse Gas Emissions and Emissions Targets



USA

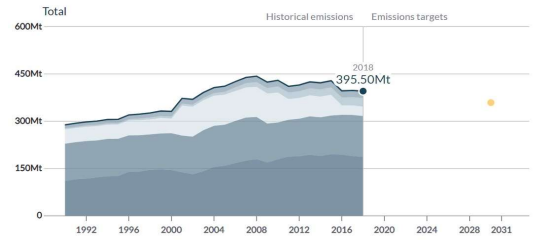
Greenhouse Gas Emissions and Emissions Targets



GHG emissions & Targets

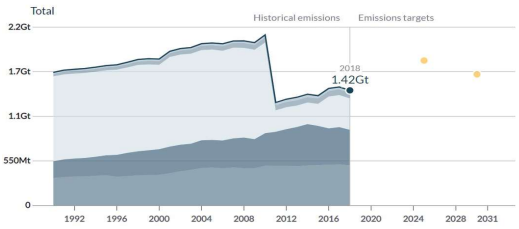
AGENTINA

Greenhouse Gas Emissions and Emissions Targets



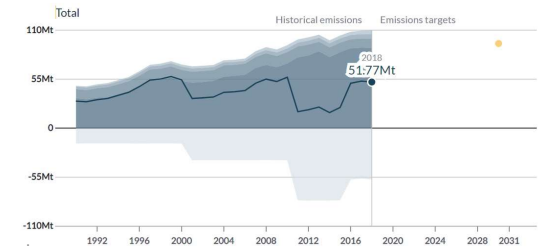
BRAZIL

Greenhouse Gas Emissions and Emissions Targets



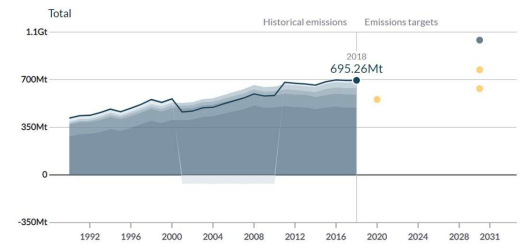
CHILE

Greenhouse Gas Emissions and Emissions Targets



MAXICO

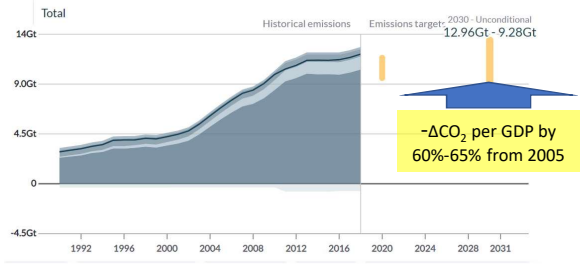
Greenhouse Gas Emissions and Emissions Targets



GHG emissions & Targets

CHINA

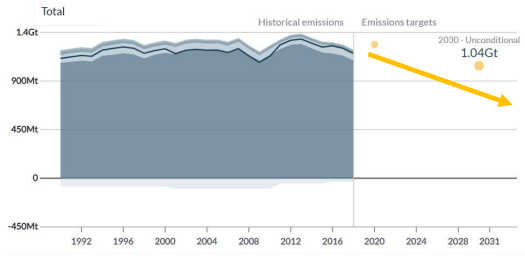
Greenhouse Gas Emissions and Emissions Targets



-ΔCO_2 per GDP by 60%-65% from 2005

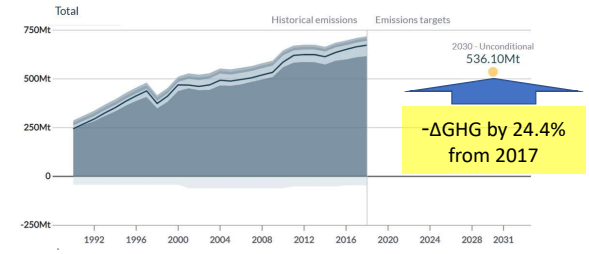
JAPAN

Greenhouse Gas Emissions and Emissions Targets



KOREA

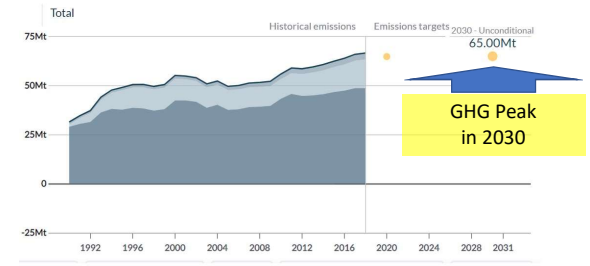
Greenhouse Gas Emissions and Emissions Targets



-ΔGHG by 24.4% from 2017

SINGAPORE

Greenhouse Gas Emissions and Emissions Targets

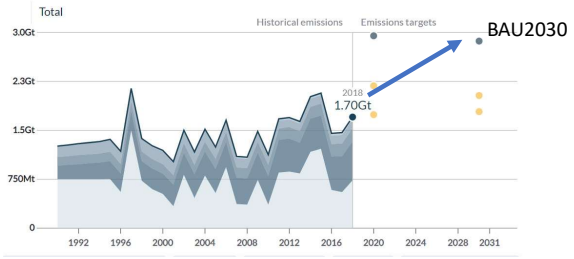


GHG Peak in 2030

GHG emissions & Targets

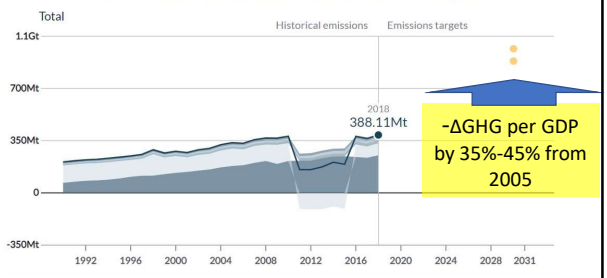
INDONESIA

Greenhouse Gas Emissions and Emissions Targets



MALAYSIA

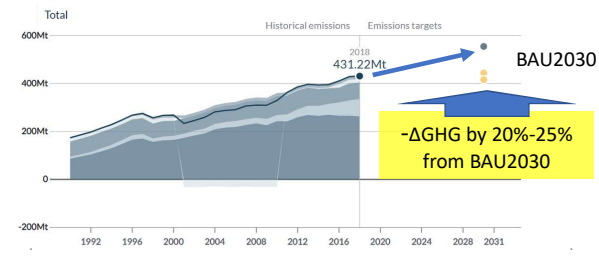
Greenhouse Gas Emissions and Emissions Targets



-ΔGHG per GDP by 35%-45% from 2005

THAILAND

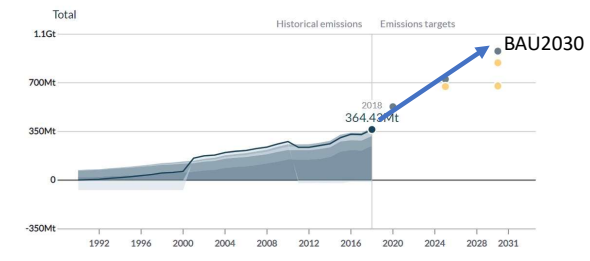
Greenhouse Gas Emissions and Emissions Targets



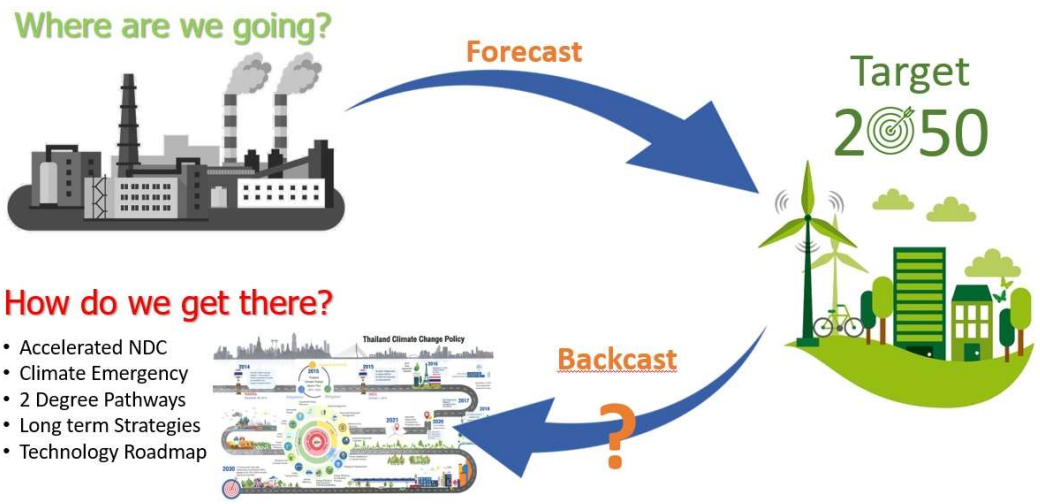
-ΔGHG by 20%-25% from BAU2030

VIETNAM

Greenhouse Gas Emissions and Emissions Targets

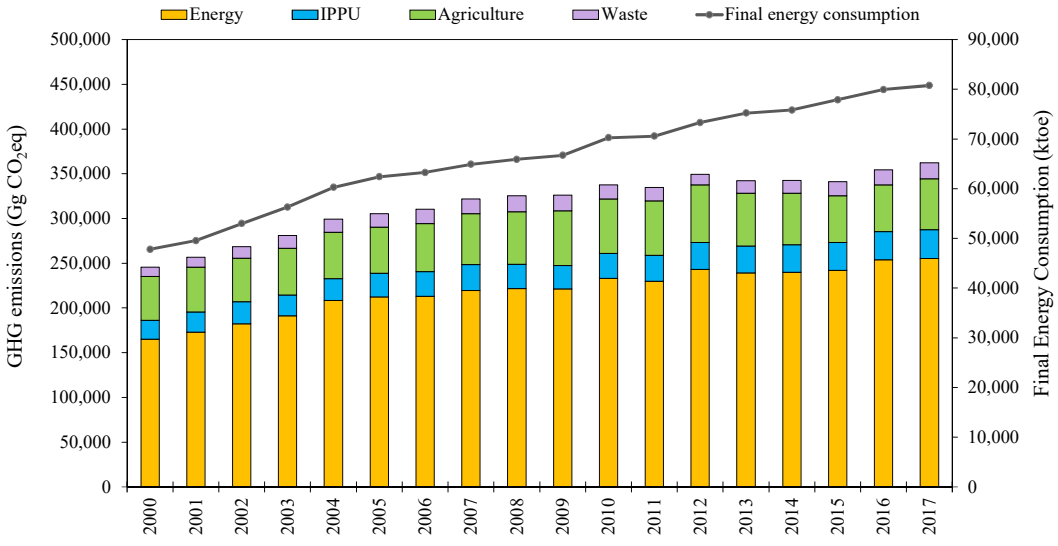


Deep Decarbonization Perspective



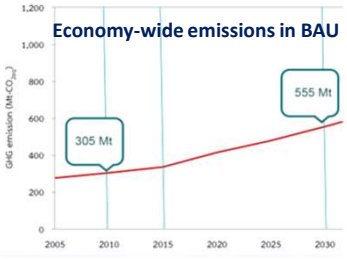
Net-zero Emissions Pathways

Trends of GHG emissions and Total Final Energy Consumption 2000-2017

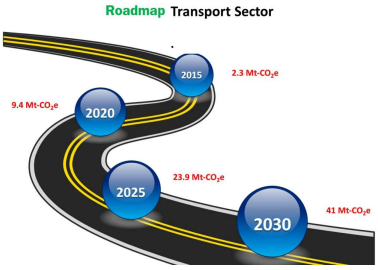


Source: BUR3 (ONEP, 2020)

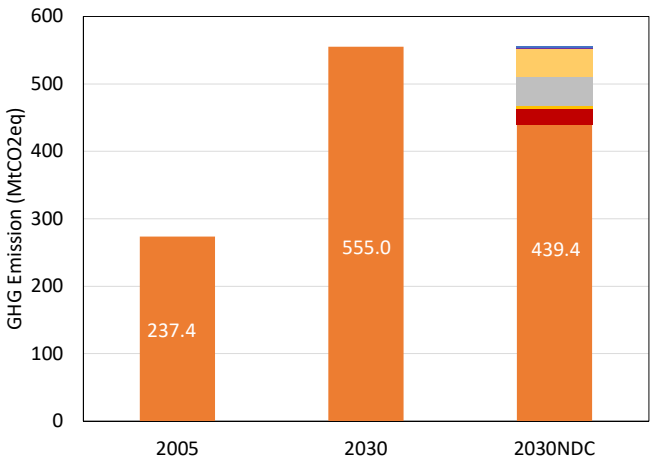
Thailand's PM Delivered National Climate Pledge at Paris Summit



"The 20% is a goal to be achieved by the country's resources alone while the additional 5% will require international support in terms of finance, knowhow and technology"



THAILAND'S GHG EMISSIONS & MITIGATION NDC 2030



GHG mitigation 20%

- Power 24 $MtCO_{2eq}$
- Industry 43 $MtCO_{2eq}$
- Transport 41 $MtCO_{2eq}$
- Residential 4 $MtCO_{2eq}$
- Commercial 1 $MtCO_{2eq}$
- IPPU 0.6 $MtCO_{2eq}$
- Waste 2 $MtCO_{2eq}$

Total GHG mitigation

115.6 $MtCO_{2eq}$

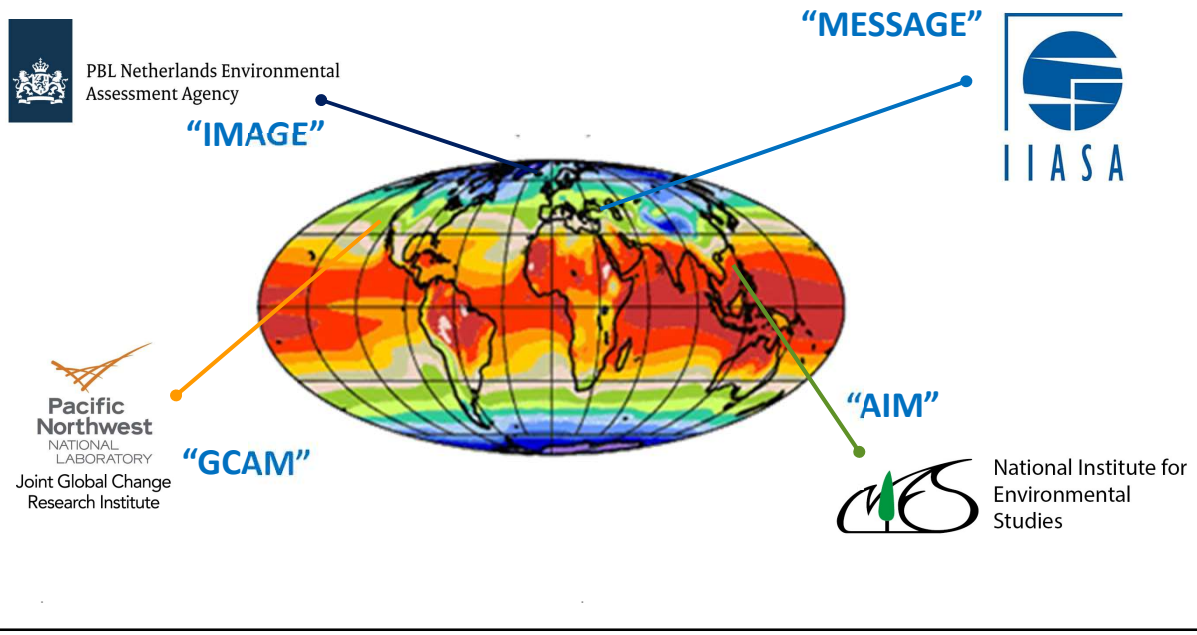
IPCC Emissions Scenarios

Process#1
Representative Concentration Pathways (RCPs)

Process#2
Shared Socio-economic Pathways (SSPs)

Process#3
Integrated Assessment Modeling
RCPs x SSPs x SPAs

Research Institutes: RCPs

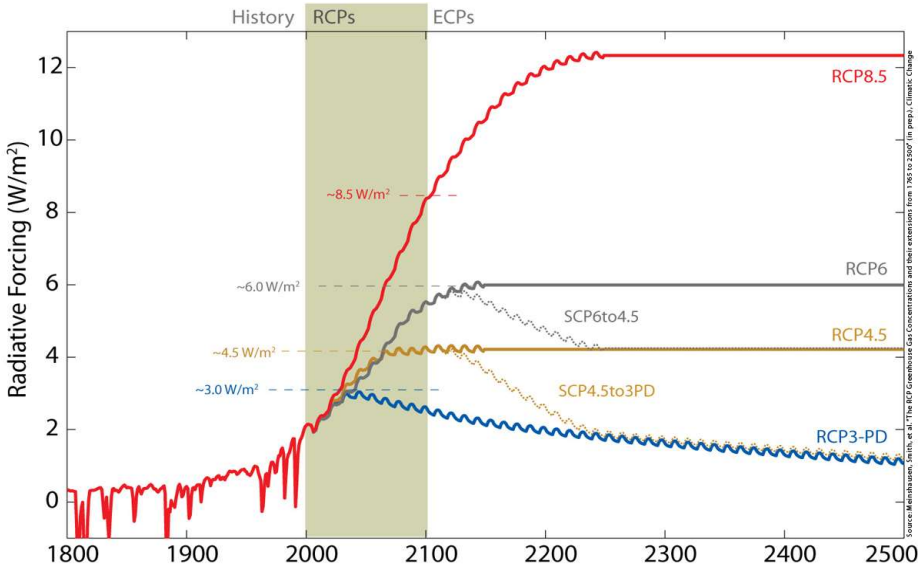


RCPs in 2100

RCP	Radiative forcing	CO_{2eq} concentration	Temp. (°C)	Rate of change in radiative forcing	Model
RCP8.5	8.5 W/m^2	1350 ppm	4.9	Rising	MESSAGE by IIASA
RCP6.0	6.0 W/m^2	850 ppm	3.0	Stabilizing without shooting	AIM by NIES
RCP4.5	4.5 W/m^2	650 ppm	2.4	Stabilizing without shooting	GCAM by JGCRI
RCP2.6	2.6 W/m^2	450 ppm	1.5	Peak and decline	IMAGE by PBL

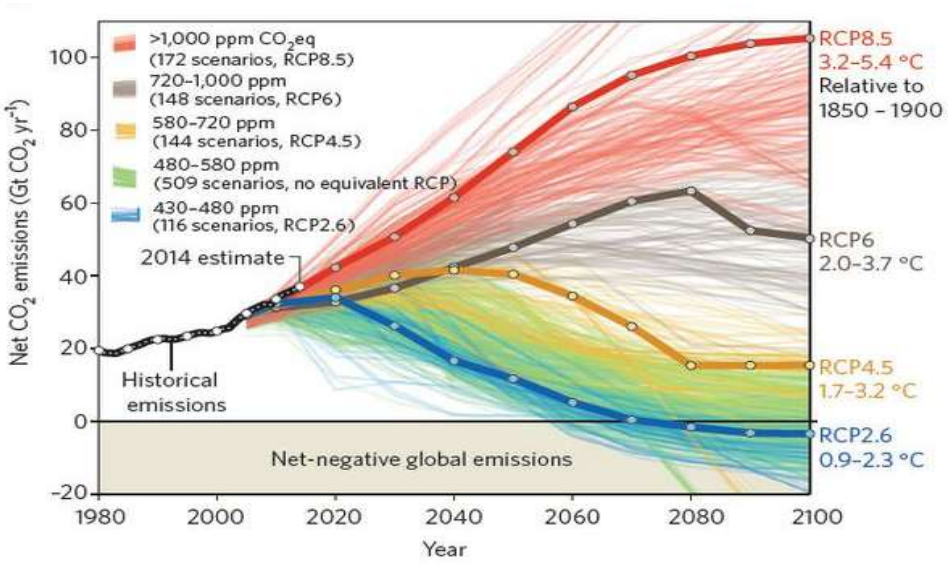
Source: Moss et al. 2010 and Vuuren et al. 2014

RCPs



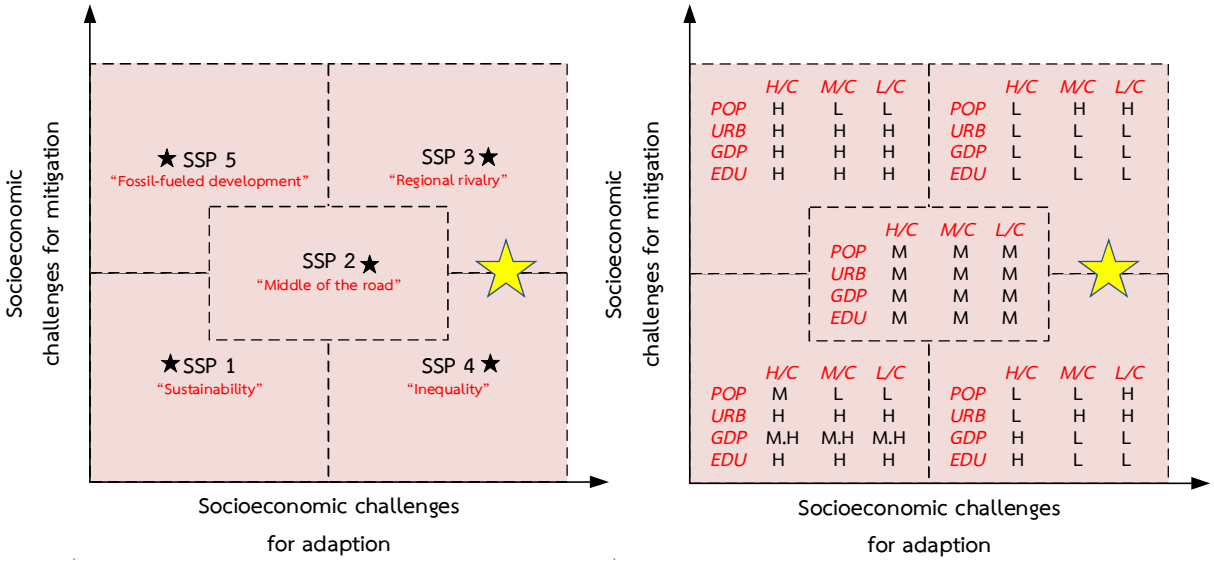
Source: Meinshausen et al. 2011

GHG emissions & “spaghetti-like” RCPs

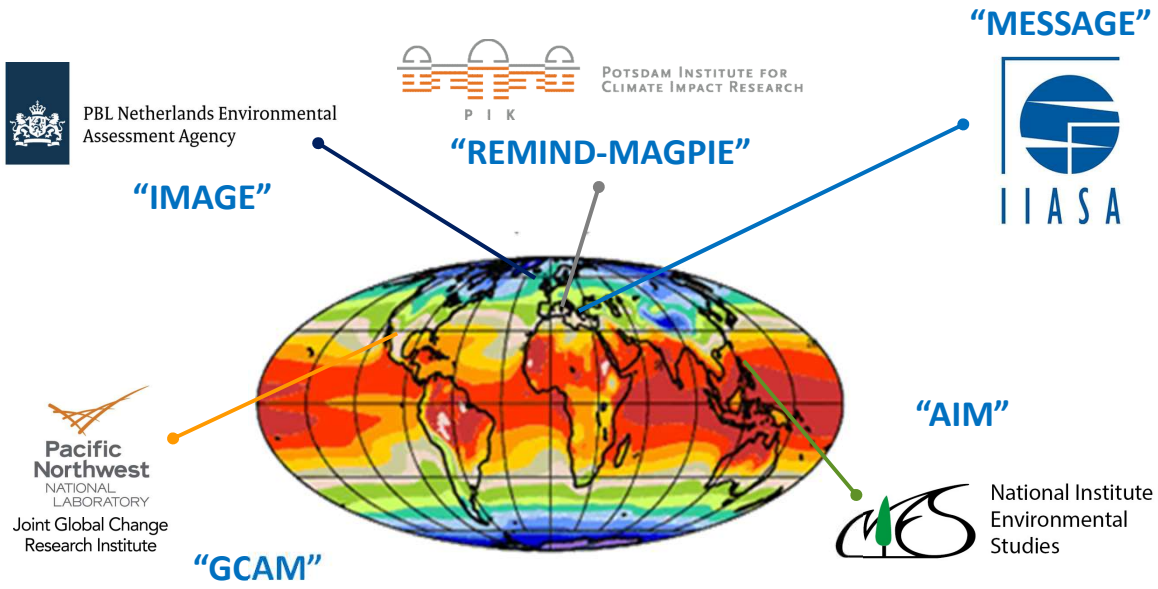


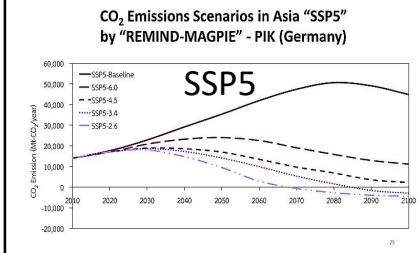
Source: Mann and Maher, 2015

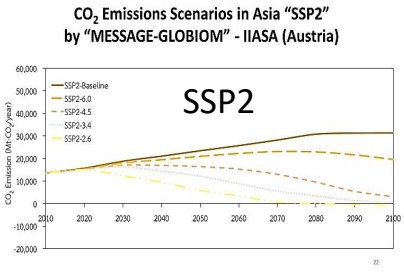
Shared Socio-economic Pathways (SSPs)

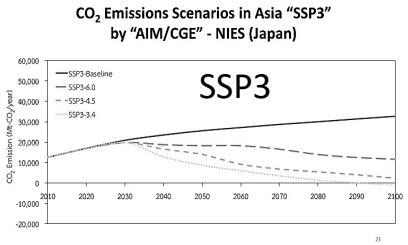


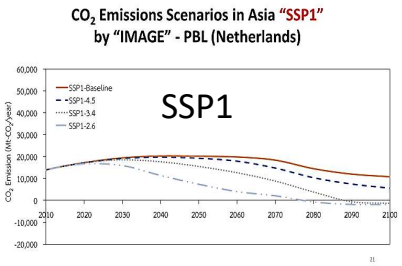
Research Institutes: IAMs

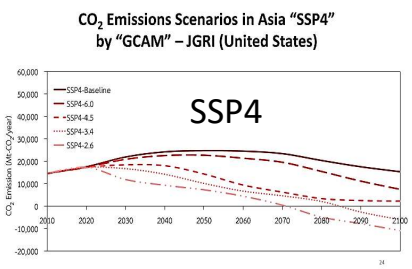




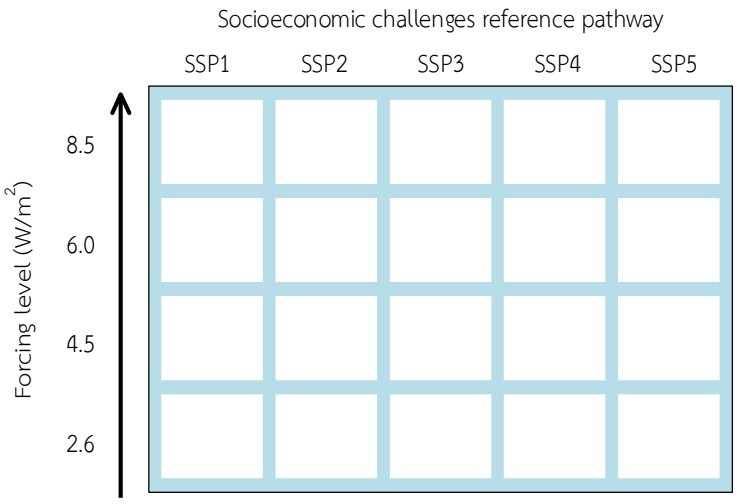








Integrated Assessment Modeling: Scenario matrix approach



Source: Riahi et al., 2015

Social Cost of Carbon (SCC)

1. Socioeconomic Module
2. Climate Module
3. Damage Module
4. Discounting Module

Step 1: Predict future emissions based on population, economic growth, and others

Step 2: Model future climate responses, such as temperature increase and sea level rise.

Step 3: Assess the economic impact from climatic changes on agriculture, health, energy use, and others.

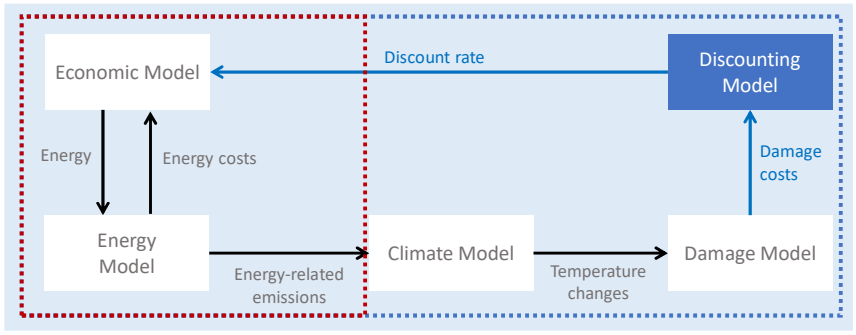
Step 4: Convert future damages into present value and add them up to determine total damage cost.

Integrated Assessment Models: IAMs

- GCAM
- IGSM
- EPPA
- AIM
- IMAGE
- WITCH
- MESSAGE
- etc.

Detailed-structure IAMs | *Reduced-form IAMs*

- DICE
- FUND
- PAGE



Cost-effective analyses | **Cost-benefit analyses**

(Susandi, 2004)

GCAM: Global Change Assessment Model
IGSM: The Integrated Global System Modeling Framework of the Massachusetts Institute of Technology
EPPA: Anthropogenic Emission Prediction and Policy Analysis
AIM: The Asia-Pacific Integrated Model
IMAGE: Integrated Model of Assess the Greenhouse Effect
WITCH: The World Induced Technical Change Hybrid Model
MESSAGE: The Model for Energy Supply Strategy Alternatives and their General Environment Impact

DICE: The Dynamic Integrated Climate-Economy
FUND: The Climate Framework for Uncertainty, Negotiation and Distribution
PAGE: Policy analysis of the greenhouse effect

Social Cost of Carbon (SCC)

Baseline Emissions

Policy A
Increasing Emissions
+ ΔEM x SCC ($/t-CO2e)
Increased cost of Policy A due to added emissions

Policy B
Decreasing Emissions
- ΔEM x SCC ($/t-CO2e)
Decreased cost of Policy B due to less emissions

Cumulative Global Warming Under Various Policy Options, According to DICE-2016

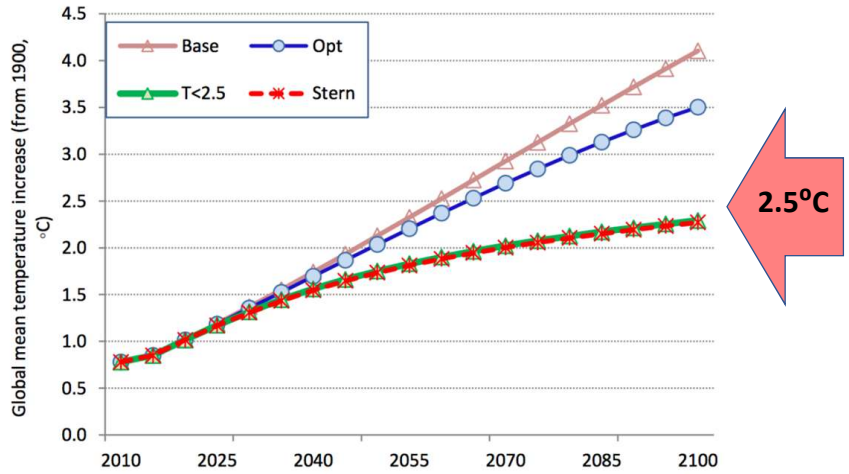


Figure 4. Temperature change in different scenarios
The most ambitious scenarios cannot limit temperature to 2 ½ °C, and the cost-benefit optimum with standard parameters has sharply rising temperatures.[iii]

Source: Nordhaus (2017).

2018 Nobel Prize in Economic Sciences is awarded jointly to **William Nordhaus** "for **integrating climate change into long-run macroecoomic analysis**" and **Paul Romer** "for **integrating technological innovations into long-run macroeconomic analysis**"

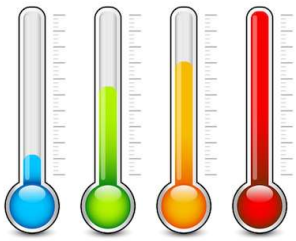
Time Value of Money (TVM)

William Nordhaus (2018), believes that when considering climate change, we should use a discount rate of 3% while in Stern Review on economics of climate change (2006), Nicholas Stern uses a discount rate of 0.1%.

- This rate may not seem very high.
- If we save money today, we will have a lot more to pour into **adaptation** strategies in 100 years.

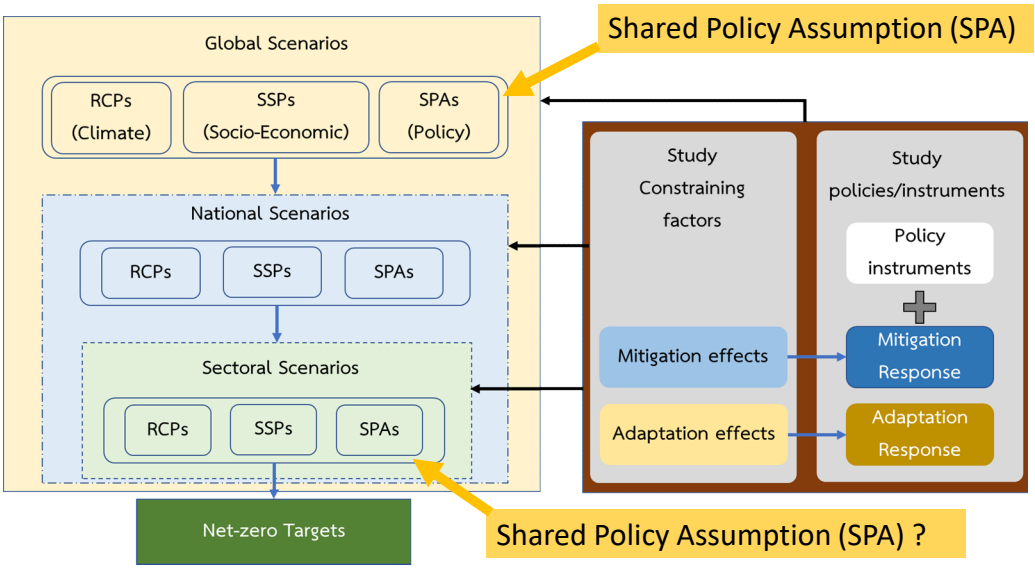
- Future dollars are not worth so much more than present ones.
- $100 in 2020 equals $111 in 2120. at a 0.1% discount rate.

2018 Nobel in Economics Is Awarded to William Nordhaus



1. William Nordhaus says quite plainly that the UN's special report on climate change is full of proposals that are ludicrously expensive.
2. After Nordhaus accepted his prize, he diplomatically handled the situation by saying that the 1.5°C target is impossible to achieve at this point.
3. Nordhaus's work shows that such an aggressive goal would make humanity much worse off than if we simply adapted to climate change with no government measures.
4. A paper published after awarded the prize in 2018 claimed that 3°C of warming would reduce global GDP by just 2.1%, compared to what it would be in the total absence of climate change.

IAM scales of interest



Source: ONEP, TGO, SIIT-TU (2019)

IAM scales of interest

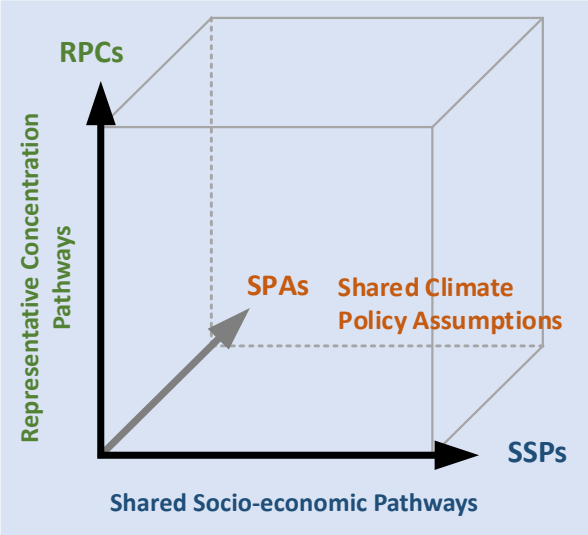
Mitigation Policy Instruments:

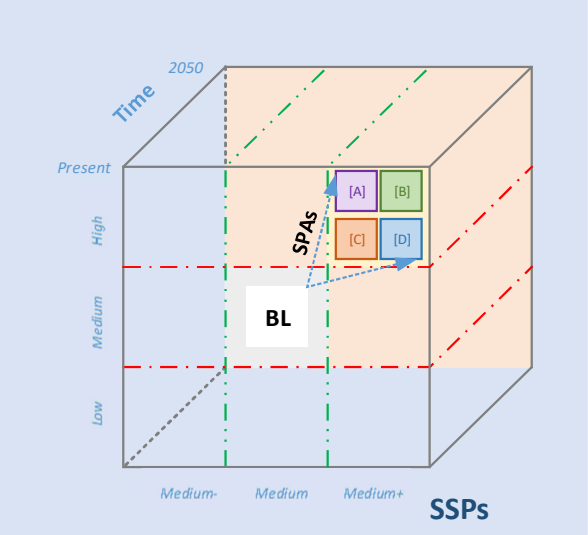
- Integrated climate policies
- Regulations and standards
- Taxes and charges
- Tradable permits
- Financial incentives (subsidies, tax credits)
- Voluntary agreements
- Information instruments
- RD&D

Project-based Mitigation

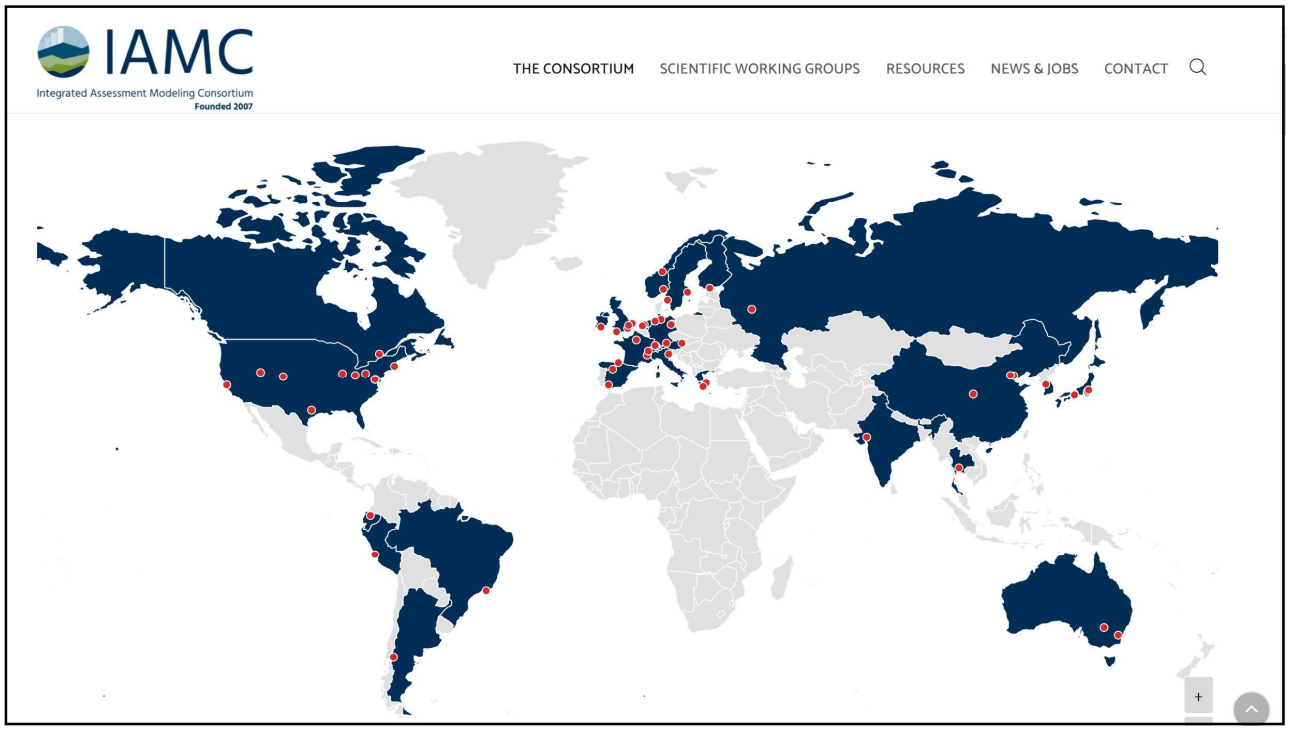
- Net Present Value (NPV)
- Internal Rate of Return (IRR)
- Benefit-Cost Ratio (BCR)
- Payback Period (PBP)
- Sensitivity Analysis
- Risk Analysis

Thailand's scenario matrix approach of RCPs x SSPs x SPAs





Source: ONEP, TGO, SIIT-TU (2019)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