The Impact of Climate Issues on the Energy Industry through 2050

Philip Grossweiler
M&H Energy Services

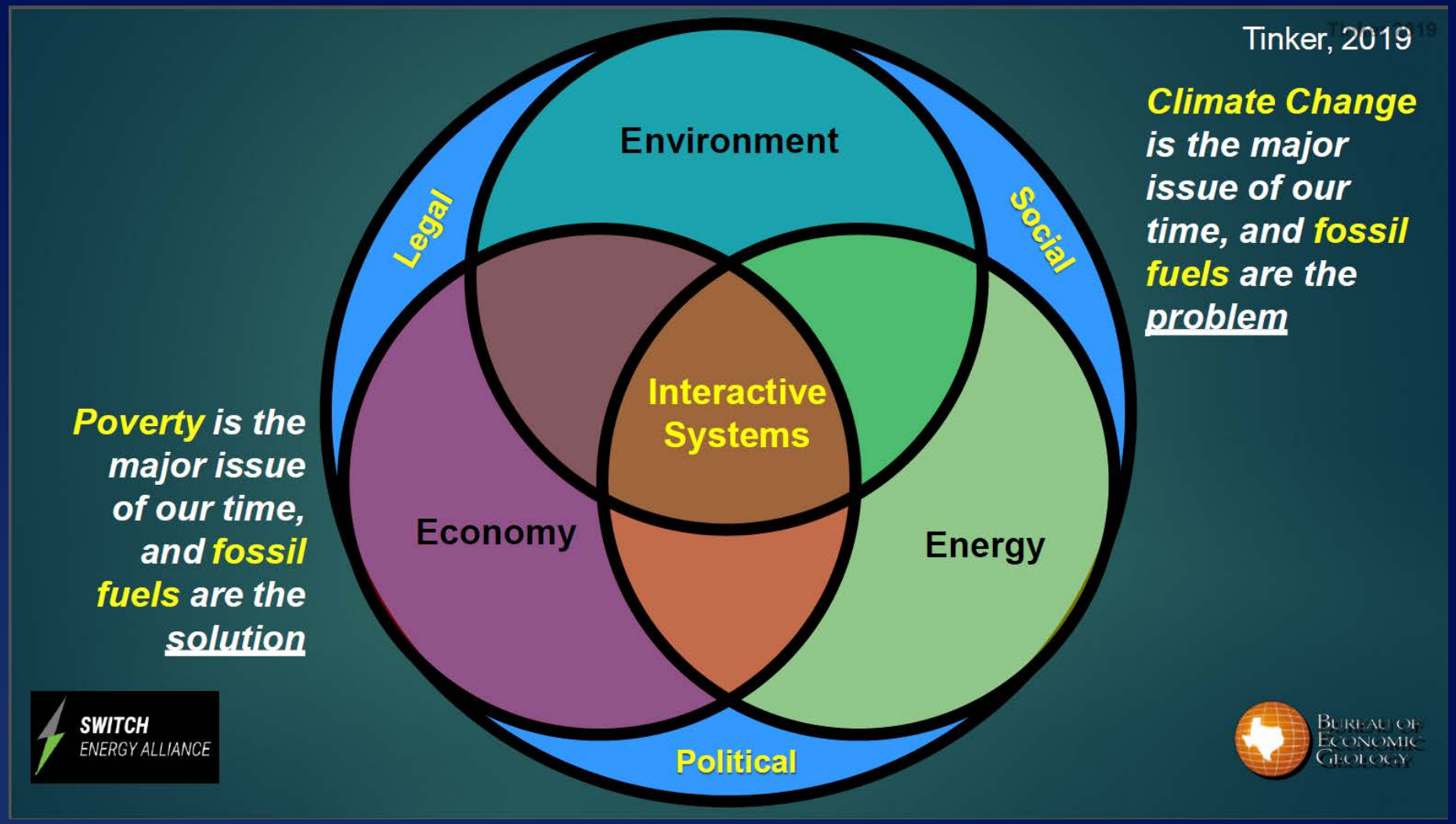




Society of Petroleum Engineers
Distinguished Lecturer Program
www.spe.org/dl

Climate Action – A Complex Systems Problem

(Scott Tinker's Paradigm)



Discussion Topics

- Anthropogenic Global Warming (AGW) Perspectives
- Limits of Climate Science
- Industry Engagement
- Strategic Forces Impacting the Energy Future

A SWOT[(1)] Perspective For SPE and Energy Industry

Threats

- Reduced worldwide investments in O&G
- “Headwinds” for getting future engineers into industry
- Increased Regulations including bans on hydraulic fracturing
- Greta Thunberg’s comments at Davos 2020 World Economic Forum
- Green New Deal (“War on Fossil Fuels”)

(1) A Strategic Planning Process – Strengths, Weaknesses, Opportunities, Threats

An SPE and Energy Industry SWOT Perspective

Opportunities

- Expand solutions beyond just “decarbonize energy”
- Create incremental and breakthrough technology innovations
- SPE members transfer skills to broader climate activities
- Collaborate on research and demonstration projects
- Develop and execute strategies for joint ventures in low/no carbon megaprojects

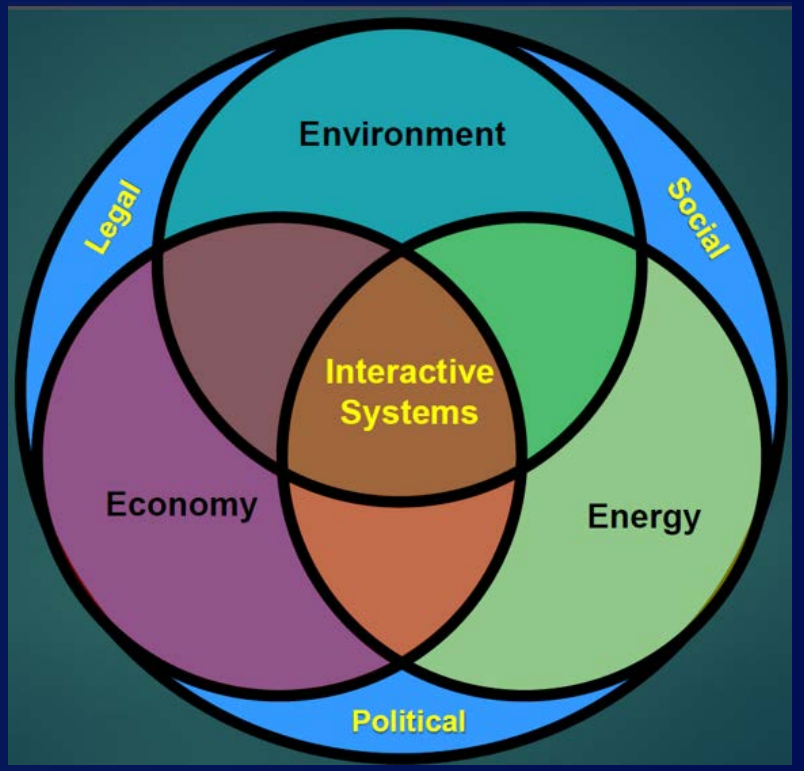
Avoid This Barrier to Engagement

"I am not a climate scientist"

Climate issues are too important to be left to the "climate scientists"

Broad stakeholder engagement needed from:

- Scientists
- Engineers
- Economists
- Financial Community
- Political Scientists and Policy Makers
- Informed Public



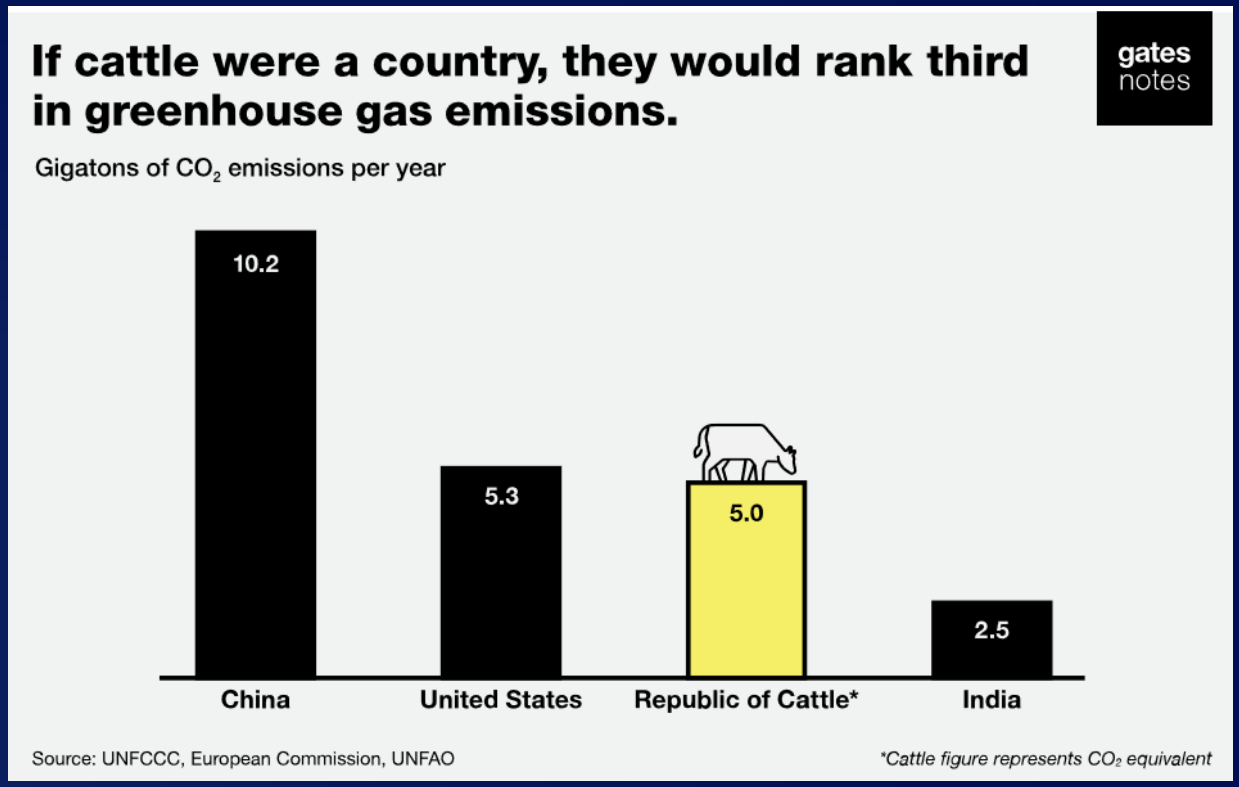
Scott Tinker – Bureau of Economic Geology

Power Thinkers on AGW and Climate Issues
Balanced Views and Broad Input

- Scott Tinker (Bureau of Economic Geology – University of Texas)
- Bill Gates (Founder Microsoft)
- Vaclav Smil (Environmental Science – University of Manitoba)
- Robert Socolow (Mechanical & Aerospace – Princeton University)

Bill Gates' Ideas

- Target is net zero in 50 years
- Key sectors driving GHG emissions:
  - Electricity (25%)
  - Agriculture (24%)
  - Manufacturing (21%)
  - Transportation (14%)
- Need technology breakthroughs
- Solutions require more than just addressing emissions from O&G



https://www.gatesnotes.com/Energy/My-plan-for-fighting-climate-change

Professor Vaclav Smil

Bill Gate's Scientist [1]

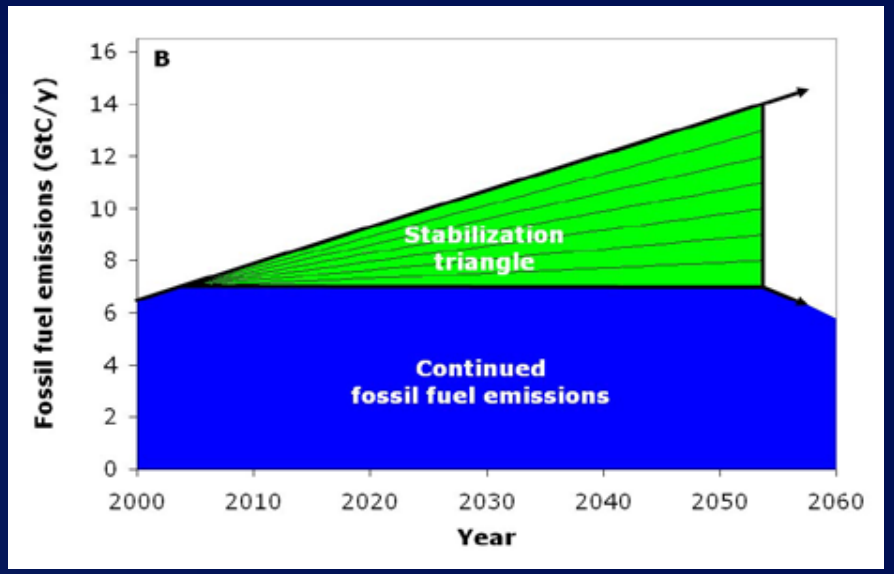
- Accepts reality of climate change, is dubious of much of climate modelling
- Power density of any energy source/carrier is a critical metric
- Transition from fossil fuels to renewables can only take place over decades
- Renewable energy options require significant land
- Major challenges ahead are not a justification for inaction
- Breakthrough in energy storage is a game changer

(1) Gates has written "I learn more by reading him than just about anyone else".

Socolow Wedges

(Activities to Reduce Emissions by 1 GT_C)

- Eliminate all deforestation worldwide
- Conserve tillage on all cropland
- Add 700 One GW nuclear plants
- Replace 1,400 coal plants (@ 1 GW) with gas
- CCS at 800 coal plants or 1,600 gas fired plants
- Increase fuel economy for 2 billion cars from 30 to 60 mpg
- Add 2 million 1 MW wind turbines on 115,000 sq miles
- Add 2,000 One GW solar PV plants on 7,700 sq miles



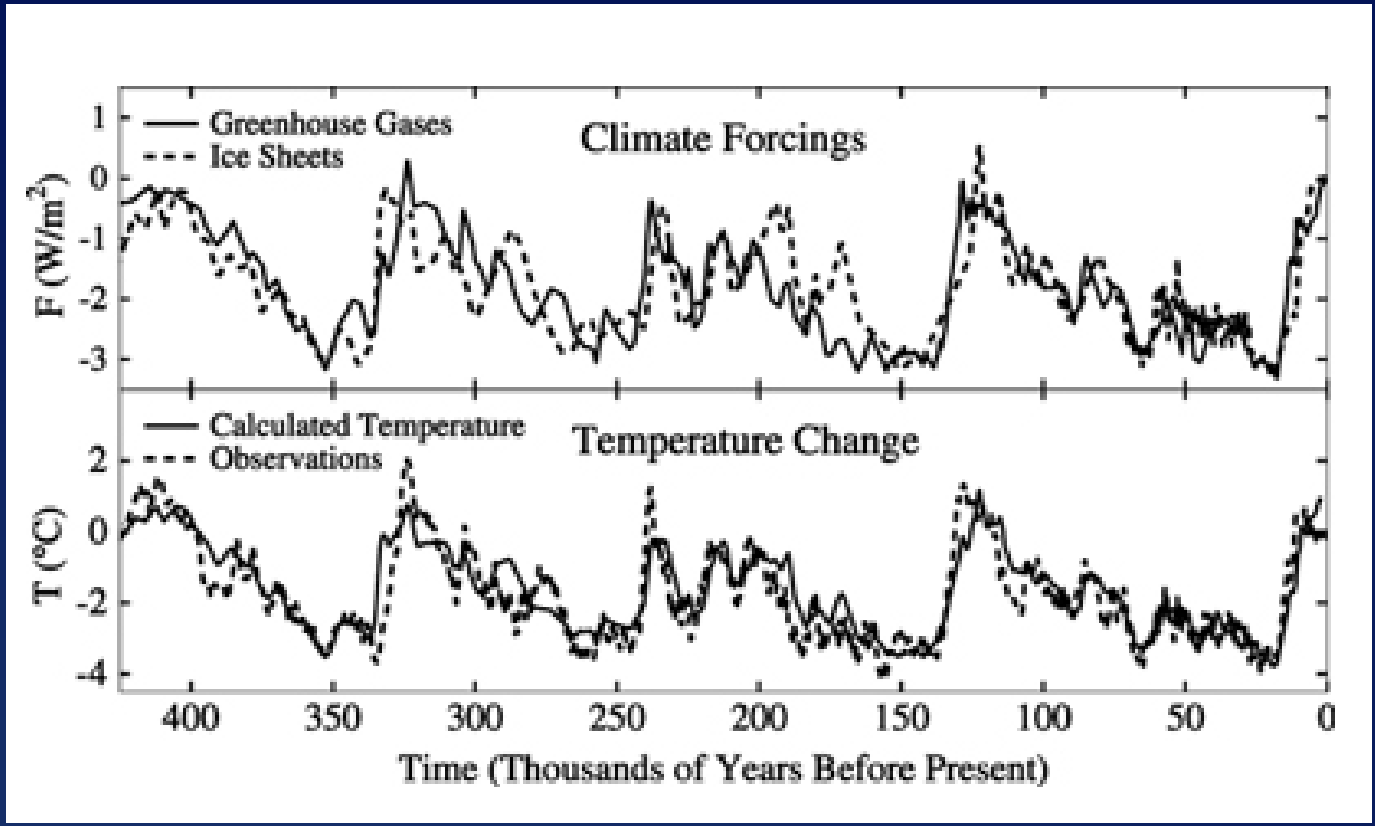
Source: http://cmi.princeton.edu/wedges/

CLIMATE SCIENCE PERSPECTIVES

IS “THE SCIENCE SETTLED”?

Relevant Climate Cycles and Timescales

From Geologic Time to Short Term



Climate Forcing Functions

- Earth Axis (cyclic)
- Earth Orbit (cyclic)
- Solar Radiation (random)
- Volcanoes (random)
- GHGs (natural)
- GHGs (Anthropogenic)

Source: IPCC AR5

Analyze AGW Separate From Geologic Time Cycles

- Climate in IPCC data sets varies in ~100,000 year cycles
- Linear superposition allows analyzing systems with multiple inputs and approximately linear behavior by analyzing each input independently
- Assess impact of AGW independent from changes over geologic time
- Analyze AGW over periods of several decades to a few centuries
- Key question: Sensitivity of climate to a doubling of CO_2 in atmosphere

Modelling Complex Systems

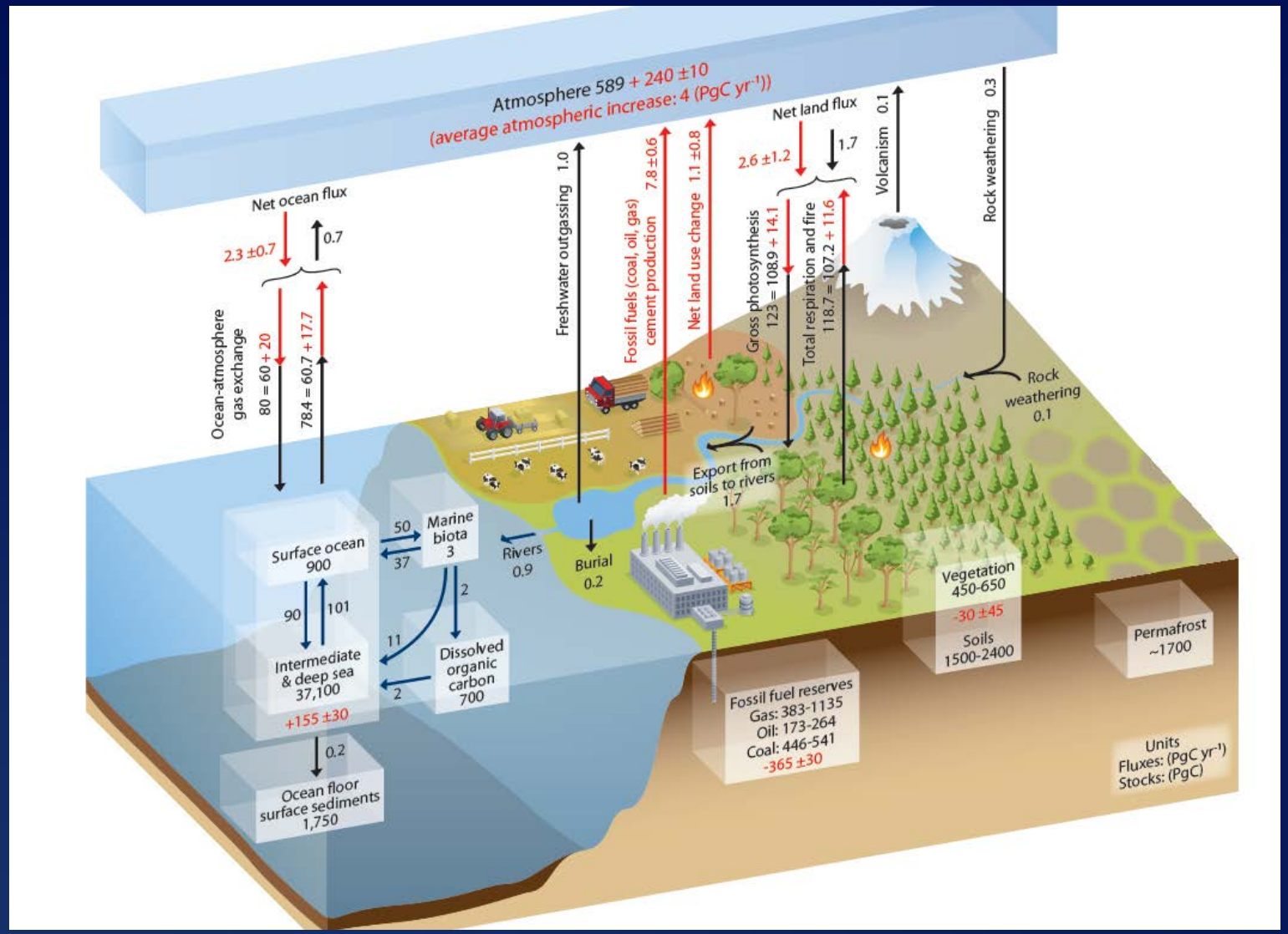
"Essentially, all models are wrong, but some are useful. The practical question is how wrong do they have to be to not be useful."

George E.P. Box

Detailed modelling results should not be taken literally. Modeling offers insights rather than single-digit accuracy.

William Nordhaus

Analyzing Carbon Cycle



- CO_2 stocks and flows
- Flows in geologic time and short term
- Identify the key flows to address in models

Notes:

Units – PgC = 10^{18} gC

Black – Stocks, Flows Pre Industrial

Red – Stocks, Flows Industrial Age

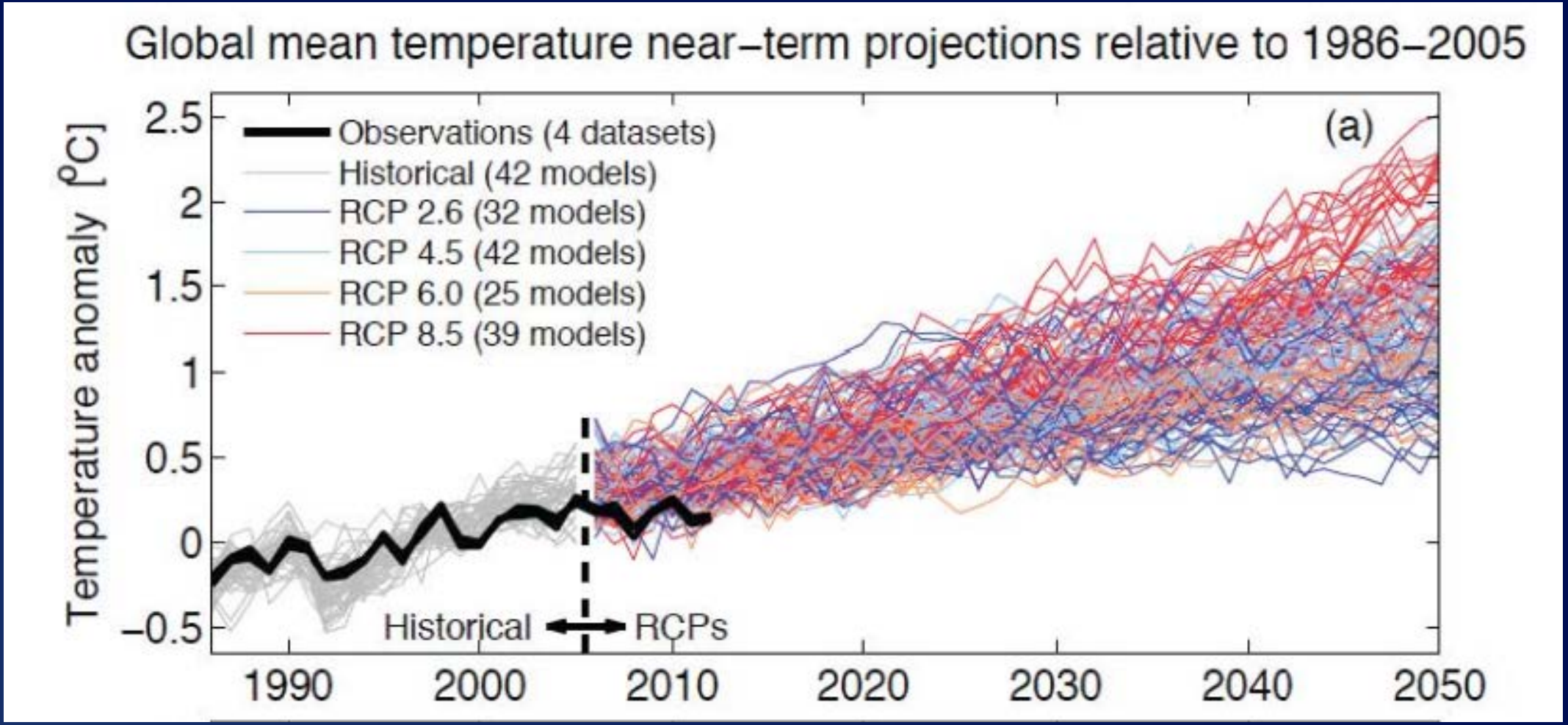
https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter06_FINAL.pdf

Key Elements in Various IPCC Models

Element	Characteristics and Issues
Atmosphere	Increase Vertical and Horizontal Resolution; Cloud Impacts
Ocean	CO_2 Uptake; Heat Sink; Ocean Currents
Sea Ice	Albedo; Reduced ice in Arctic Basin
Coupling	Heat, Mass, Momentum Transfers; Feedbacks (Pos/Neg); Transport Delays; Phase Changes
Land Surface	CO_2 Sinks and Sequestration; Permafrost
Biosphere	CO_2 Sinks
Ice Sheets	Albedo; Melting and Sea Level Rise

Ref: IPCC Fifth Assessment Report - Evaluation of Climate Models
https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter09_FINAL.pdf

Simulations – Various IPCC Models



https://judithcurry.com/2014/01/06/ipcc-ar5-weakens-the-case-for-agw/

Climate Science Boundaries

"Settled" Climate Science

- Carbon cycle
- Photosynthesis (Plant Life)
- Greenhouse effect
- CO_2 properties as a GHG
- Earth temperature without GHGs
- Increases in CO_2 increase average temperatures

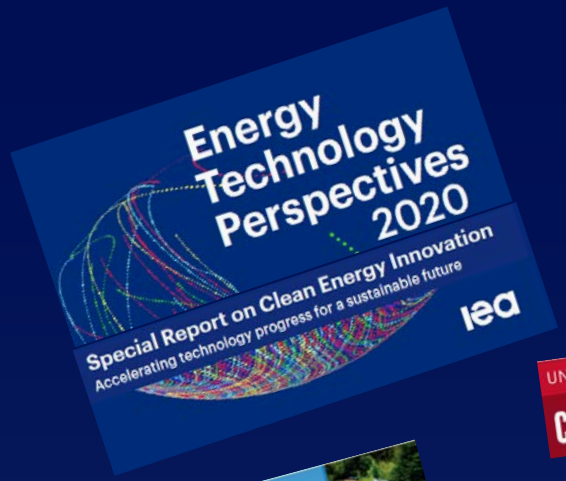
Beyond "Settled" Science

- Modelling complex systems (climate)
- Sensitivity of climate (average temperature) to doubling of CO_2 concentration
- Energy tradeoffs and policy options for mitigation scenarios (1.5°, 2°, etc.)

FRAMEWORKS FOR CLIMATE ACTION

Ongoing Climate Activities

"Soup Kitchen for the Mind"





UNIVERSITY of HOUSTON
CENTER FOR CARBON MANAGEMENT IN ENERGY

STANFORD UNIVERSITY
GLOBAL CLIMATE & ENERGY PROJECT

REPSOL WILL BE A NET ZERO EMISSIONS COMPANY BY 2050
REPSOL

MITei
MIT Energy Initiative

Princeton Environmental Institute | Carbon Mitigation Initiative

BUREAU OF ECONOMIC GEOLOGY

CSIS | CENTER FOR STRATEGIC & INTERNATIONAL STUDIES
Ranked #1 Think Tank in U.S. by Global Go To Think Tank Index
Climate Solutions Series

DDPP DEEP DECARBONIZATION PATHWAYS PROJECT

BP sets ambition for net zero by 2050, fundamentally changing organisation to deliver

OGCI
OIL AND GAS CLIMATE INITIATIVE

SHELL SCENARIOS
Sky
MEETING THE GOALS OF THE PARIS AGREEMENT

World Energy Outlook 2019
iea

Center for Climate Systems Research
EARTH INSTITUTE | COLUMBIA UNIVERSITY

TOTAL
ADOPTS A NEW CLIMATE AMBITION TO GET TO NET ZERO BY 2050

Political Boundaries and Interactions

- United Nations Sustainable Development Goals
- 2015 Paris accords, Continuing IPCC actions, COP26 (Nov 2021)
- National Policies of the largest emitting nations
- Market price on carbon
  + Cap and trade
  + Carbon tax
- IEA Scenarios (Stated Policies, Sustainable Development)
- Increasing emphasis on ESG (Environment, Social, Governance)

Realistic Timeline for Political Action

"The time may not be right now given how polarized our politics are. A cue from economist Milton Friedman" (1)

> *"Only a crisis – actual or perceived – produces change. When the crisis occurs, actions depend on ideas lying around. Our function is to develop policy alternatives and keep them alive until the politically impossible becomes politically inevitable".*

Key Point: Probably several more years before effective international climate policies are implemented.

(1) Testimony to U.S. Congress by Former EPA Administrator Reilly – 11 June 2019

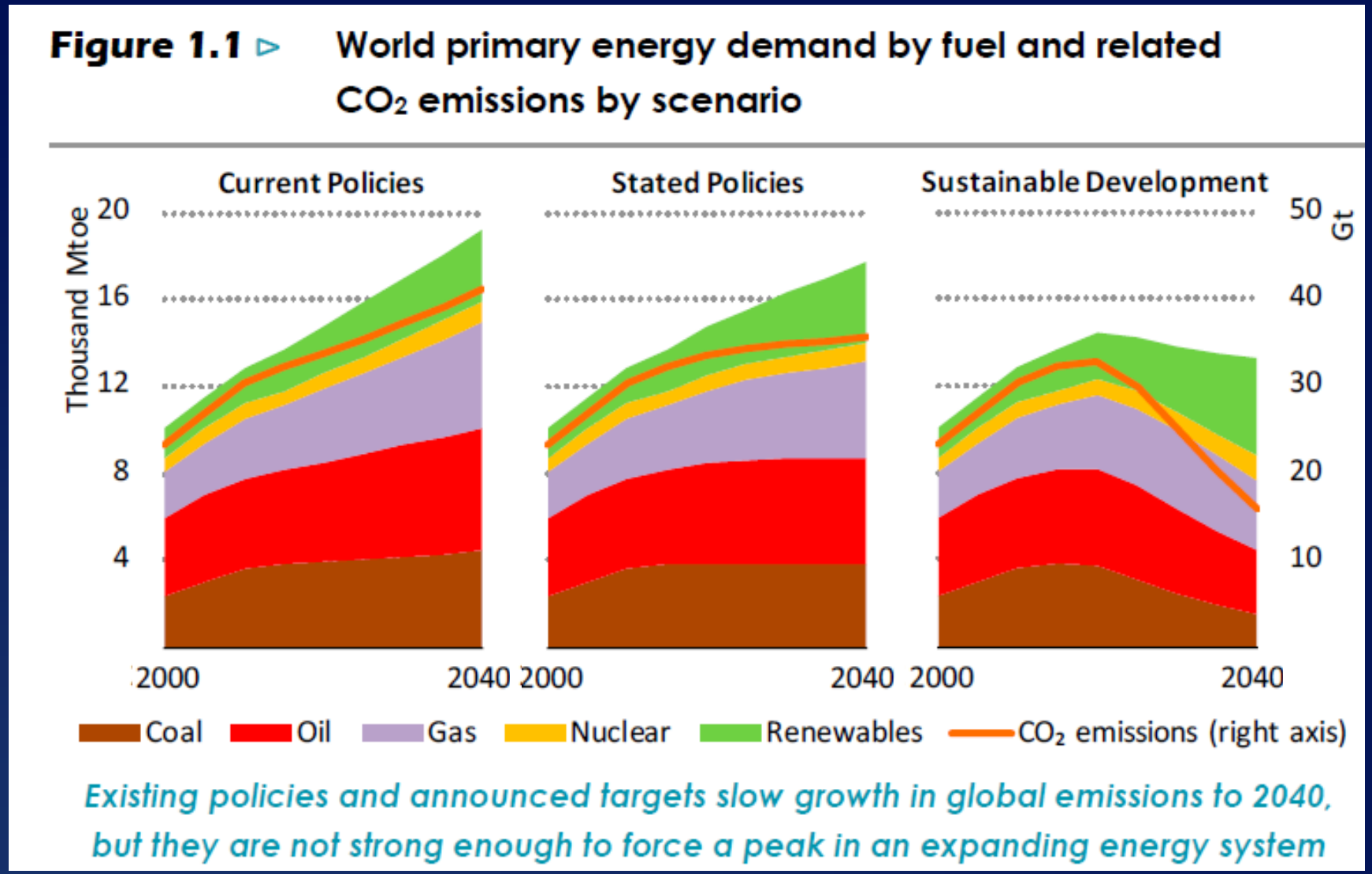
Essential to Define Scope of Responsibility for Emissions

Scope 1 - Direct emissions from producing oil and gas
(Responsibility of Energy Companies)

Scope 2 - Indirect emissions from suppliers to oil and gas companies
(Responsibility of Energy Companies)

Scope 3 - Emissions from consumption of oil and gas
(Beyond sole responsibility of energy companies)

International Energy Agency Scenarios



Three Scenarios

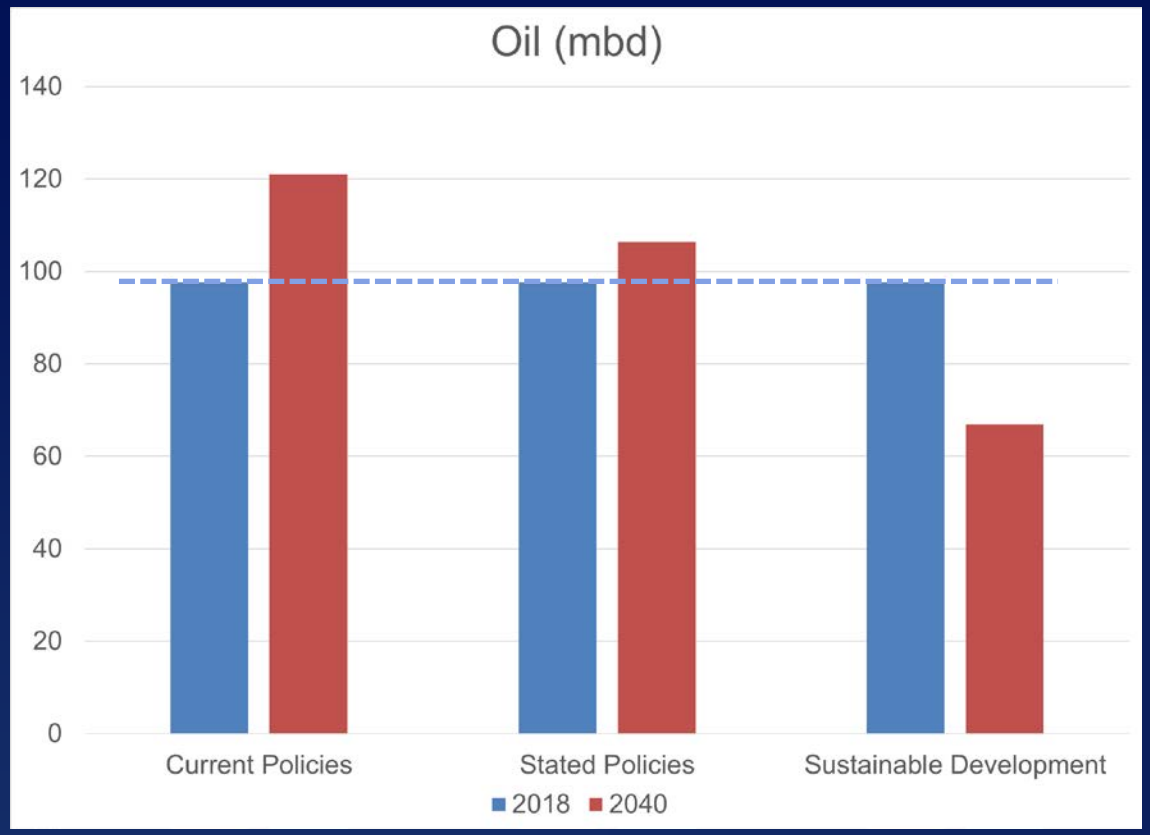
Current Policies
+ Prior laws and regs
+ "Business as usual"

Stated Policies
+ Announced new policies
+ Laws/regs not yet in place

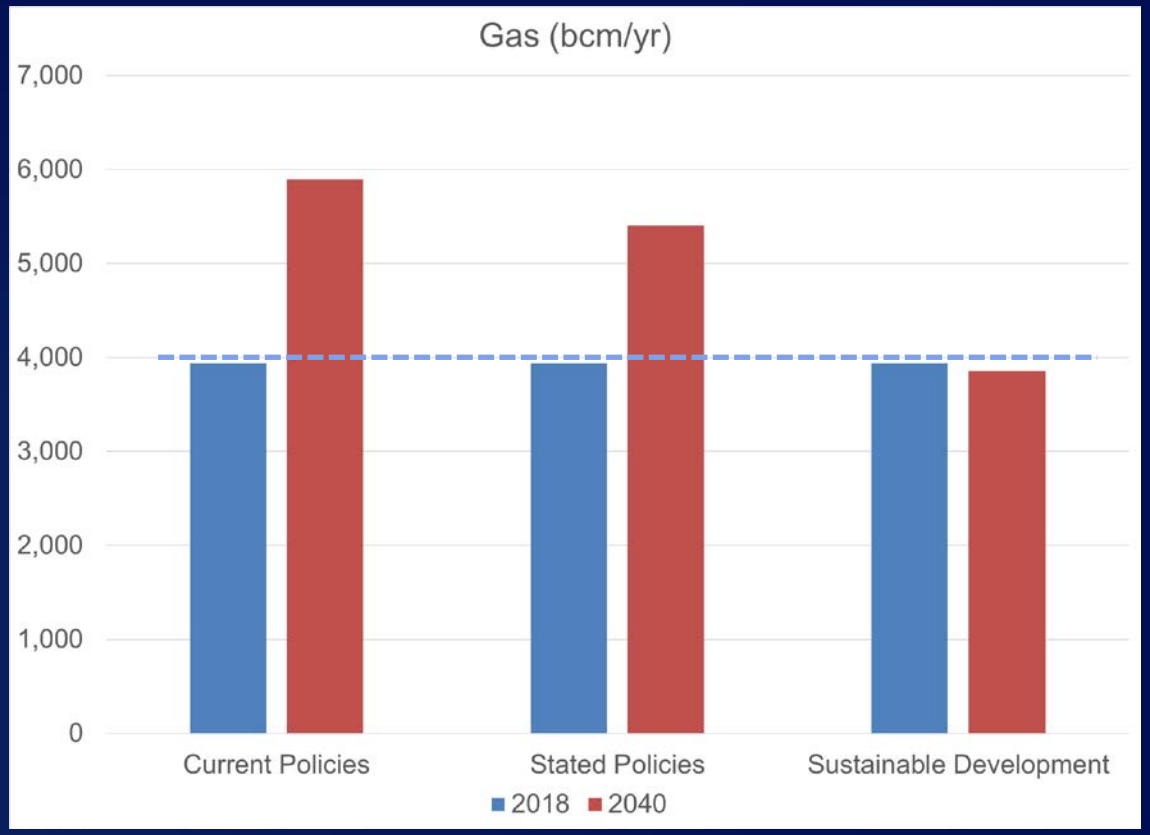
Sustainable Development
+ Sets desired outcome
  - UN SDG 7.1 Energy
  - UN SDG 13 Climate
  - Meet Paris Agreement
+ Identifies actions to meet target

Source: IEA 2019 Energy Outlook

Impacts of the IEA Scenarios

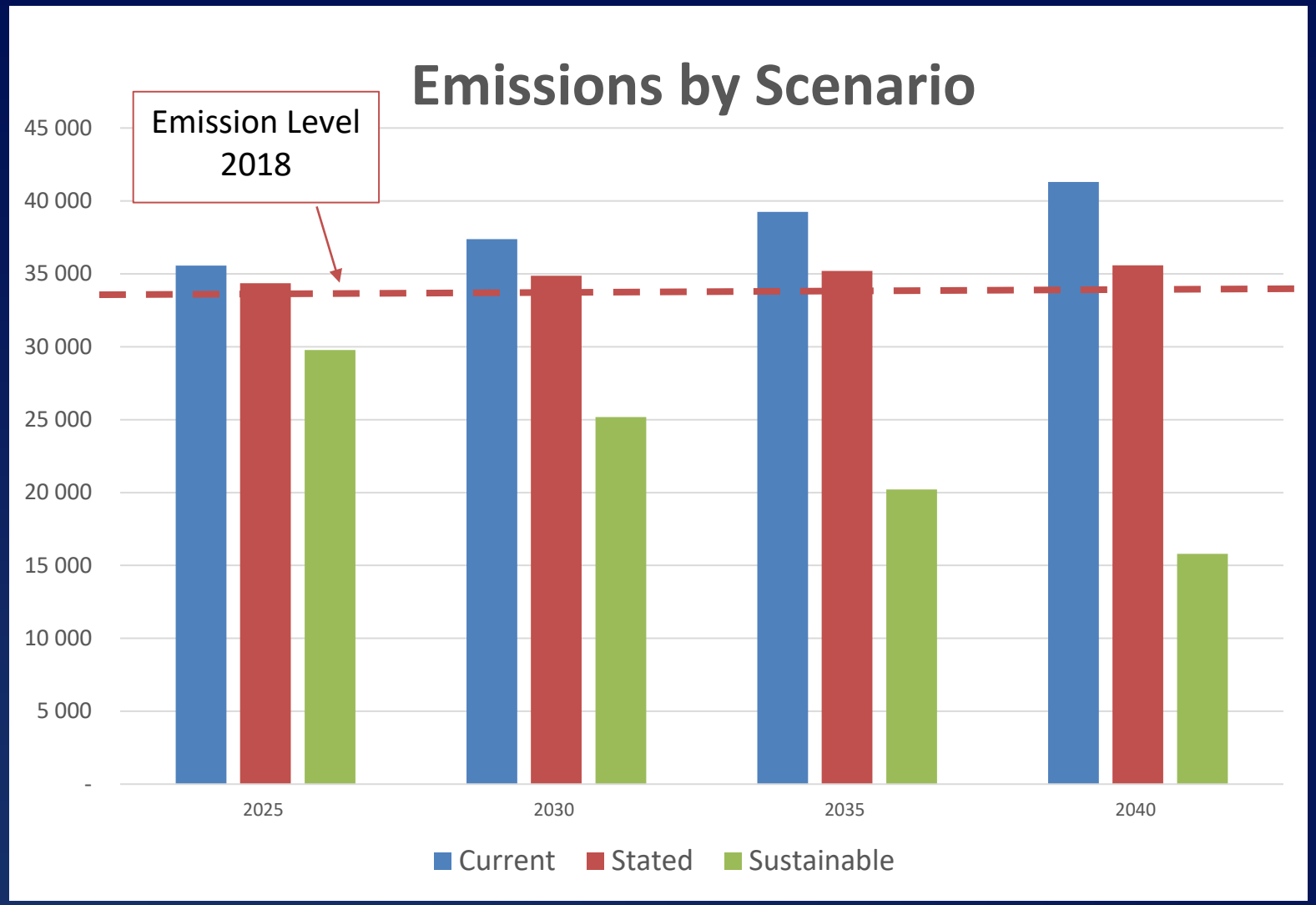


Production (Demand) grows 9% by 2040 under Stated policies. If world achieves Sustainable Develop targets, oil production is reduced ~30%.



Natural gas production is at or above 2018 levels under all scenarios. Production grows ~35% by 2040 under Stated policies.

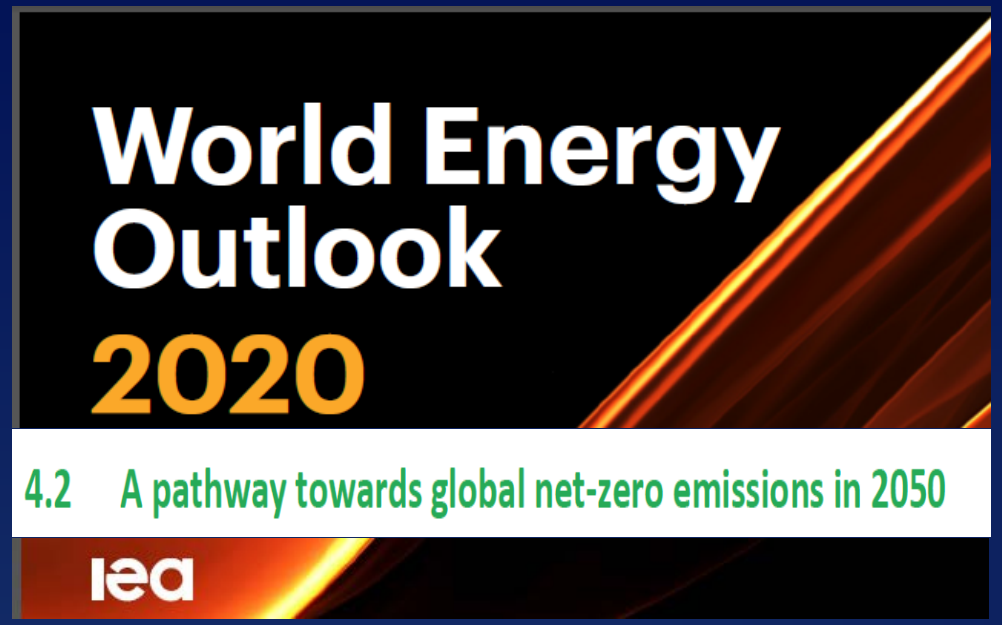
International Energy Agency



No emission reduction by 2040 under Stated Policies.

If world could achieve SD Scenario, world possibly on track to limit temperature rise to 2°C.

Developing Climate Strategies
Key IEA Building Blocks



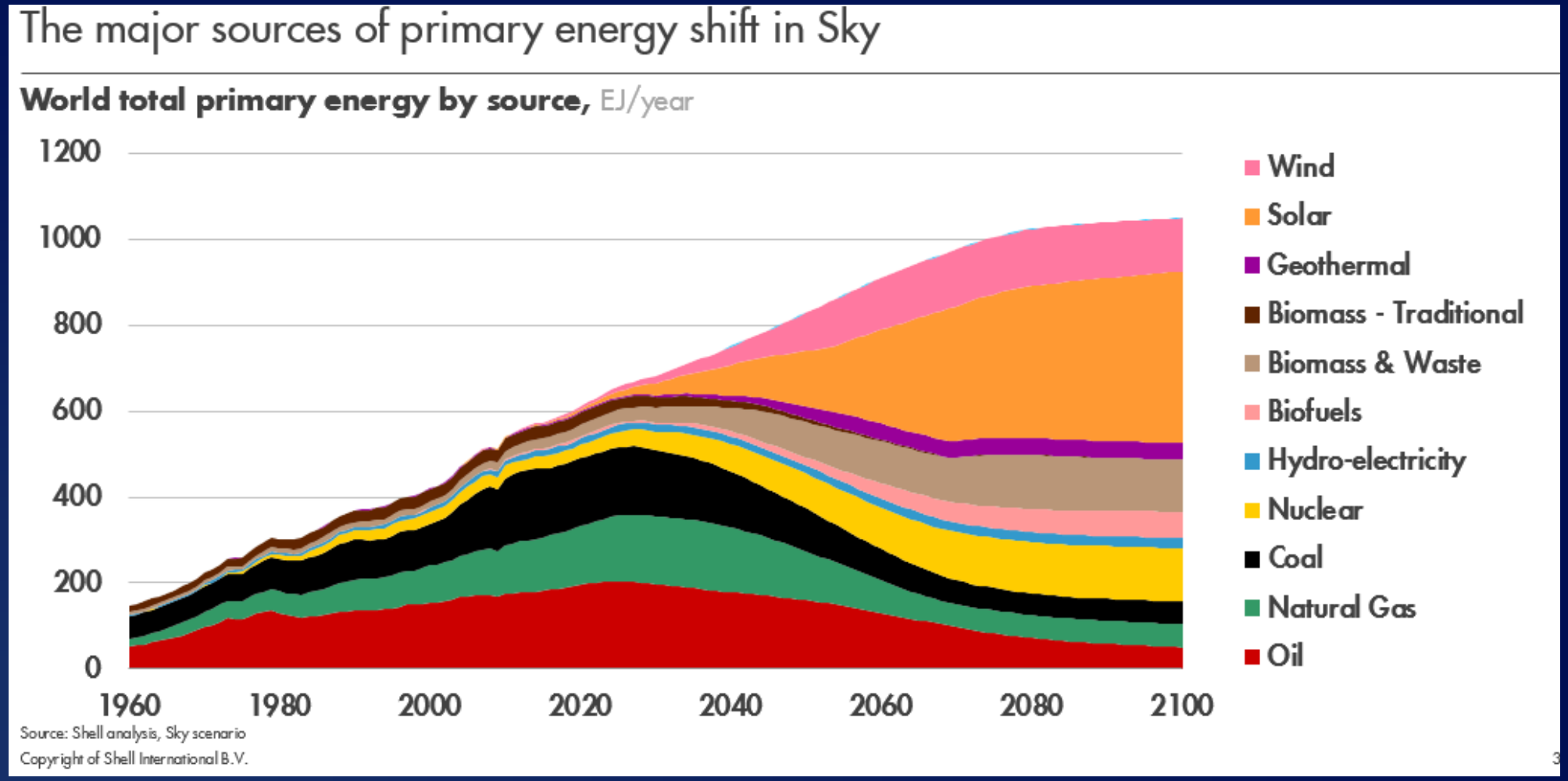


Press release

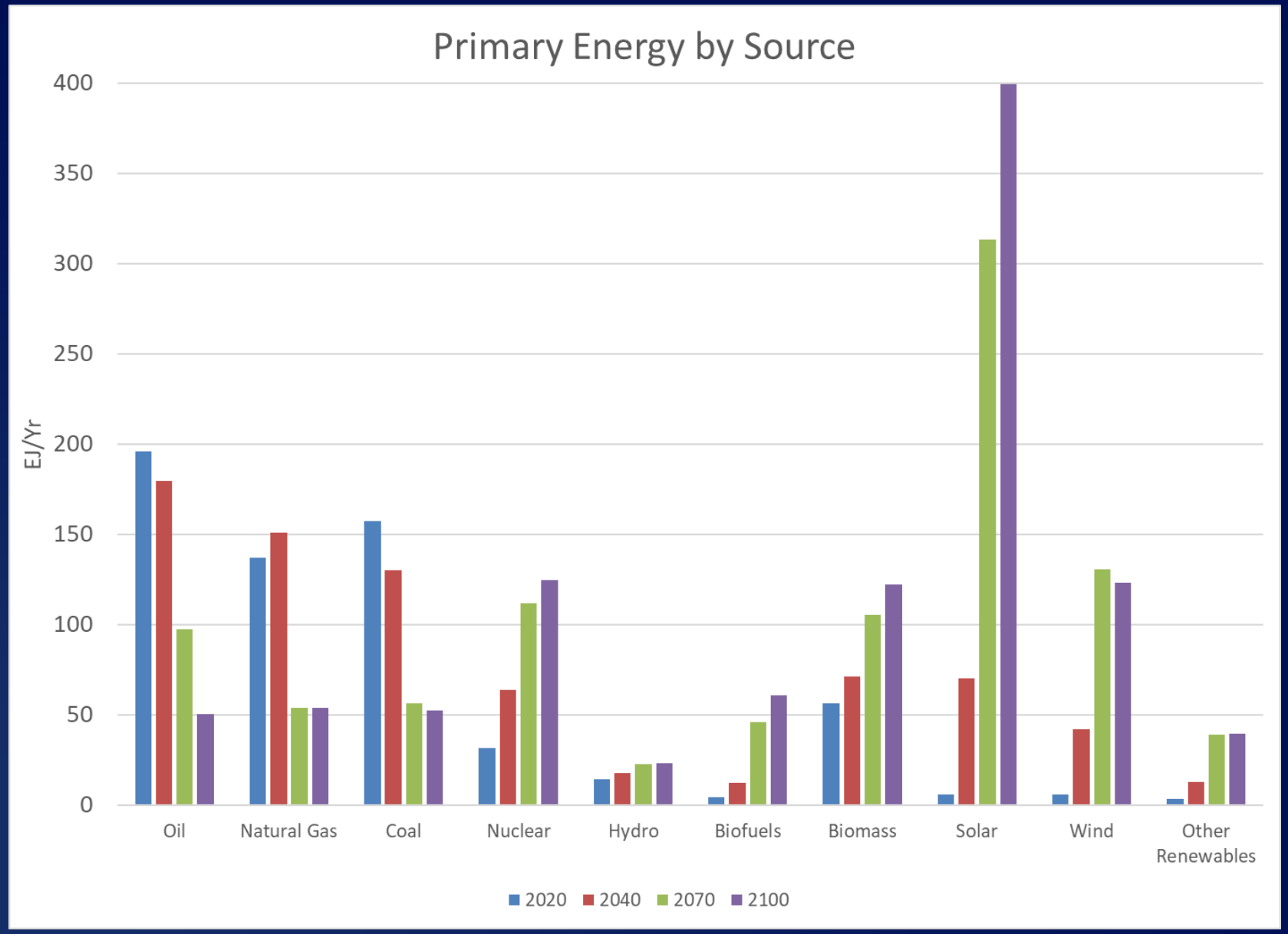
IEA to produce world's first comprehensive roadmap to net-zero emissions by 2050 (May 2021)

11 January 2021

Shell Sky Scenario
A Challenging Roadmap to 2100



Shell Sky Scenario – Shifts in Energy Supply



Shell Sky 1.5 Scenario – Shifts in Energy Supply

		2019	2020	2050	2070	2100
5-1	Total primary energy - by key sources	EJ / year				
1	**Oil**	**192**	**172**	**160**	**97**	**50**
2	Natural gas	140	135	115	54	54
3	Coal	159	151	100	56	52
4	Nuclear	30	29	80	112	124
10	Solar	4	4	127	313	399
11	Wind	5	5	88	130	123
	Total	**607**	**570**	**828**	**975**	**1,049**
	Oil EJ/Yr Converted to MBD					
1	**Oil - MB/D**	**96**	**86**	**80**	**49**	**25**
	Percentages of Total Energy Supply					
	Oil and Natural Gas	54.8%	53.9%	33.2%	15.5%	9.9%
	Solar	0.7%	0.7%	15.4%	32.1%	38.1%
	Wind	0.9%	0.9%	10.7%	13.4%	11.7%

- Oil supplies ~20% of energy in 2050 and 5% at end of century.
- Natural Gas supplies ~14% energy in 2050 and 5% in 2100.
- Solar and wind supply 50% of energy in 2100.
- Nuclear grows 400% by end of century.

Shell Sky 1.5 Scenario – One Path to 2100

		2019	2020	2050	2070	2100
5-1	Total primary energy - by key sources	EJ / year				
	Total	607	570	828	975	1,049
15-1	World - greenhouse gas emissions	Gt CO_2e / year				
1	CO_2 - energy	35.2	32.5	18.2	-0.2	-6.8
2	CO_2 - land	6.6	5.9	-5.9	-10.5	-3.7
3	CO_2 - process	1.8	1.8	1.9	1.5	0.4
4	Methane	10.7	10.8	7.2	5.3	5.2
	Total CO_2	43.6	40.2	14.2	-9.2	-10.1
	Total GHGs	58.6	55.4	25.1	-1.2	-3.3

Note: Total GHGs include Nitrous Oxide, PFCs, HFCs and Sulphur hexafluorides.

BP Sets Ambition for Net Zero by 2050[(1)]

Corporate Strategy

- Organizational changes
- Net zero for Scope 1 & 2 Emissions
- Reduce methane emissions
- Shift investments toward low carbon ventures
- 50% reduction in carbon intensity of products sold

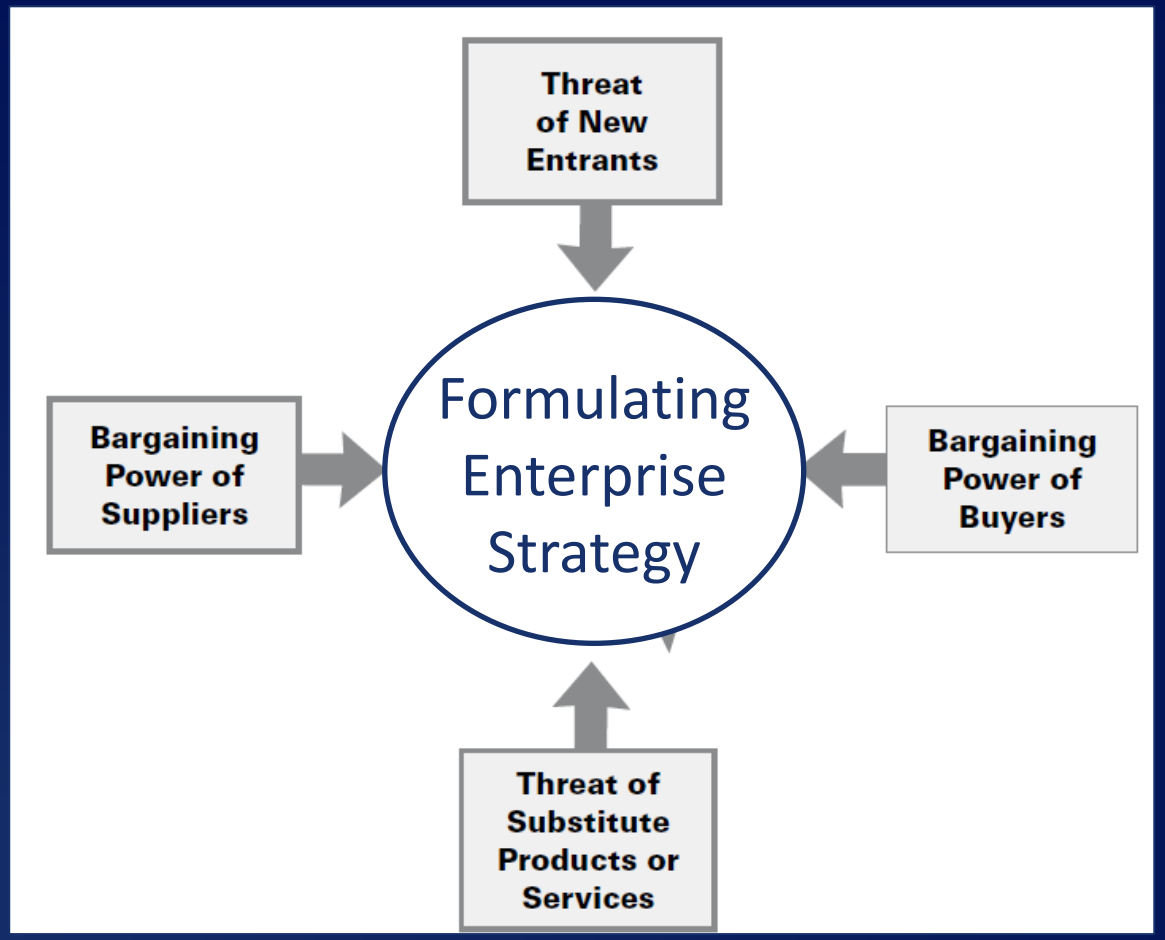
External Collaboration

- Advocate for climate action
- Demand climate action in relations with Industry Associations
- Help countries, cities, and corporations to decarbonize
- Create carbon sinks to offset Scope 3 emissions

(1) Corporate Announcement 12Feb2020

Developing an Enterprise Strategy

Five Forces Model (1)



(1) Michael Porter – Professor Harvard Business School

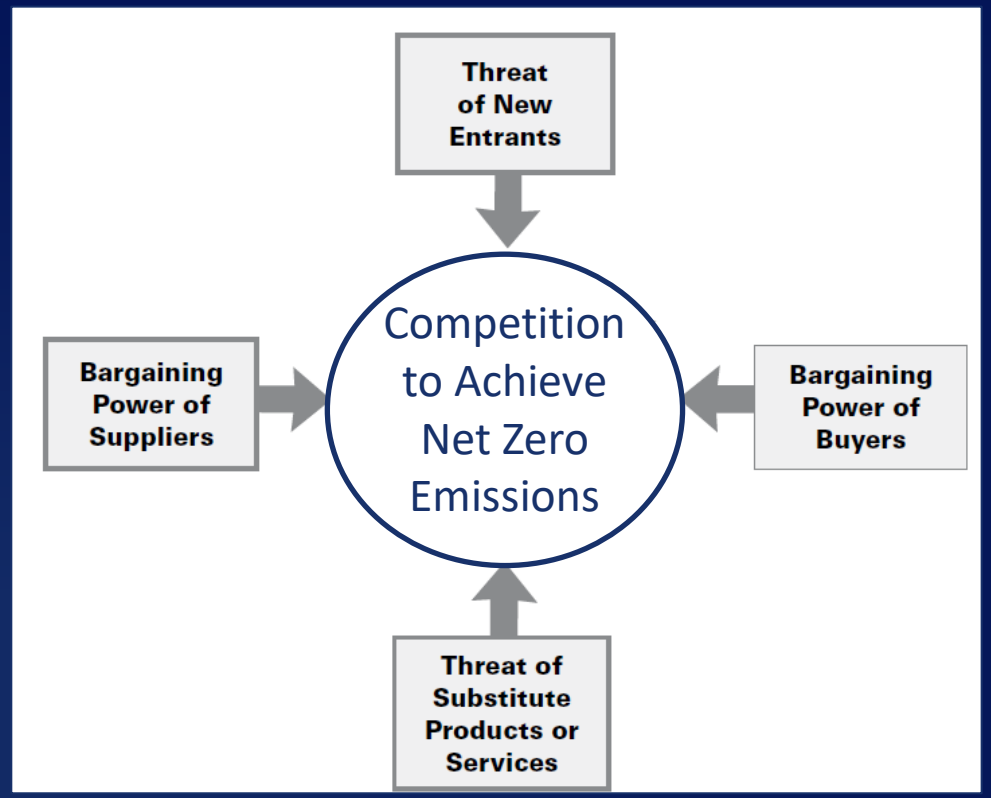
Forces Impacting Energy Future

Energy (Non O&G) Companies; Tesla; Amazon

Access to Resources

Service Companies

Control of Rare Earth Metals and Critical Materials



Aggressive climate policies

Growing Energy Demand

(Un)Willingness to Pay Carbon Price

Accept Responsibility for Scope 3 Emissions

Address all Emissions, not just energy

H_2; NH_3; Electrification; Solar; Wind; Bio Fuels; Breakthrough Technologies

Key Messages

- Climate issues – An existential threat to Society AND to Energy Industry
- O&G remains an essential and viable energy source for several decades
- Energy Industry Professionals must educate themselves on climate issues *(Spirit of Lifelong Learning!)*
- *“If you don’t have a seat at the policy table – you will be part of the meal”*
- “Scientists discover the world that exists; engineers create the world that never was.” T. von Karman