

Net Zero Emissions (#1): Climate Change Solution?

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International efforts to deal with climate change

1. 1988 – IPCC* came into existence

Objective: “to assess scientific, technical, and socioeconomic information that is relevant in understanding human-induced climate change, its potential impacts, and options for mitigation and adaptation.”

- Series of IPCC Assessment Reports; from 1990 with Fifth Report in 2014
- Sixth Report to be finalized in 2022

2. 1992 - Rio Earth Summit

- 1994 – UNFCCC** ratified → 197 parties

Objective: “stabilize GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system”

- Canada: Remain at 1990 levels

*International panel on climate change

** United Nations Framework Convention on Climate Change

International efforts to deal with climate change

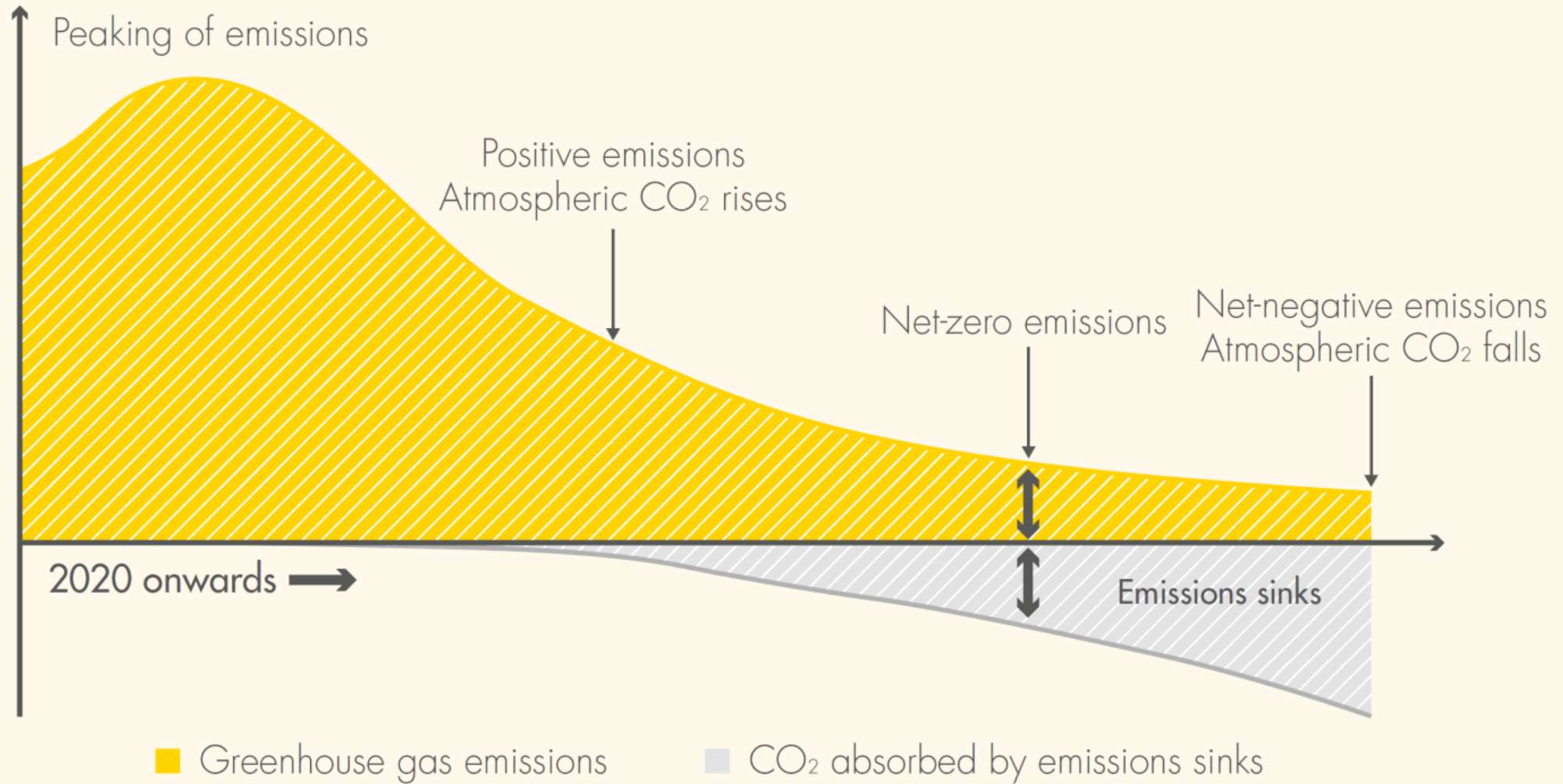
3. Kyoto Accord – 1997; ratified (2002); confirmed (2005)
 - Canada formally withdraws from Kyoto Accord – 2011
4. Copenhagen Climate Conference (2009)
 - Canada: 17% below 2005 by 2020
5. COP 21 Paris - 2015
 - Canada: 30% below 2005 by 2030
6. IPCC Special Report – 2018
 - Mitigation pathways to limit increase to 1.5°C
7. Many Countries & Industries commit to net zero by 2050
 - 2018 to 2020

Paris Agreement – Essential elements

Four main targets

1. “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 “ (article 2a,UNFCCC)
2. Countries must demonstrate increasing ambitions (5-year reviews)
3. Increase the capacity to adapt to the existing impacts of climate change
4. Mobilize funds from “developed countries” to support climate mitigation and adaptation in “developing countries”

THE PARIS AGREEMENT CALLS FOR AN EARLY PEAK IN EMISSIONS, THEN A DECLINE TO NET-ZERO EMISSIONS DURING THE SECOND HALF OF THE CENTURY



Source: Shell Schematic, "Meeting the Goals of the Paris Agreement",
<https://www.shell.com/energy-and-innovation/the-energy-future/scenarios/shell-scenario-sky.html>

Net zero emissions

- Net zero emissions refers to achieving an overall balance between greenhouse gas emissions produced and greenhouse gas emissions taken out of the atmosphere.
 - Equivalent terms: Carbon Neutral, Climate Neutral
- How to achieve?
 - Reduce human caused emissions (e.g., fossil fuel use) to as close to zero as possible
 - Remaining GHGs would be balanced with equivalent amount of carbon removal (forest management, CCS, direct air capture and storage, buying offsets).

Net-zero emissions: Countries

Country	Target year	Status
Suriname		Achieved
Bhutan		Achieved
Sweden	2045	In law
UK	2050	In law
France	2050	In law
Denmark	2050	In law
New Zealand	2050	In law
Hungary	2050	In law
EU	2050	Proposed legislation
Canada	2050	Proposed legislation
South Korea	2050	Proposed legislation
Spain	2050	Proposed legislation
Chile	2050	Proposed legislation
Fiji	2050	Proposed legislation

Data as of Dec. 7, 2020

Source: [Energy & Climate Intelligence Unit Net Zero Tracker](#)

Phase-out of fossil fuel vehicles


- **Norway** banning Internal Combustion Engines (ICE) by 2025
 - Market share of EVs 55% in 2020
 - Free charging stations and subsidies for EVs
- **UK** banning sale of petrol and diesel cars by 2035
 - No gas-emitting vehicles on the road by 2050
- **Iceland committed to ban ICE by 2030**
 - Part of Iceland's climate goal of reducing CO₂ emissions by half by 2030
 - Abolish gas-powered vehicles by 2050
- Other countries with plans to disallow gas-fuelled cars
 - China – no time commitment
 - Costa Rica – 2050
 - Denmark – 2030
 - France – 2040
 - Ireland – 2030
 - Netherlands – 2030
 - Singapore – 2040
 - Slovenia – 2030
 - Sri Lanka 2040
 - Sweden - 2030

IPCC Special Report: Modelling to limit the increase to 1.5°C

Required Outcomes in 2050 to hold to 1.5°C	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Final energy demand (rel. to 2010)	-32%	-5%	+21%	+44%
CO ₂ emission change (rel. to 2010)	-93%	-95%	-91%	-97%

What increases (rel. to 2010)?	
Nuclear	100% to 500%
Renewables (non-biomass)	830% to 1140%
Biomass	-11% to 418%
Renewable shares in electricity	70% to 81%
Cumulative CCS/BECCS until 2100 (GtCO ₂)	350 to 1190

2018 IPCC special report: Analysis of the technology solutions


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SPP Briefing Paper

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**CLIMATE CHANGE SOLUTIONS -
SENSIBLE OR MISGUIDED?**

Eddy Isaacs

Available at: <https://www.policyschool.ca/authors/eddy-isaacs/>

Key Elements of a climate change plan – limit to 1.5°C

1. Conservation and energy efficiency
2. Fuel switching to renewable energy
 - Several countries have wind and solar targets
 - Biomass for heat and power?
3. Transport, buildings and industrial electrification (low carbon sources)
 - Biofuels?
 - Nuclear
 - Hydrogen
 - Other (hydro, tidal etc.)

Key Elements of a climate change plan – limit to 1.5°C

4. 'Greening' fossil fuels production

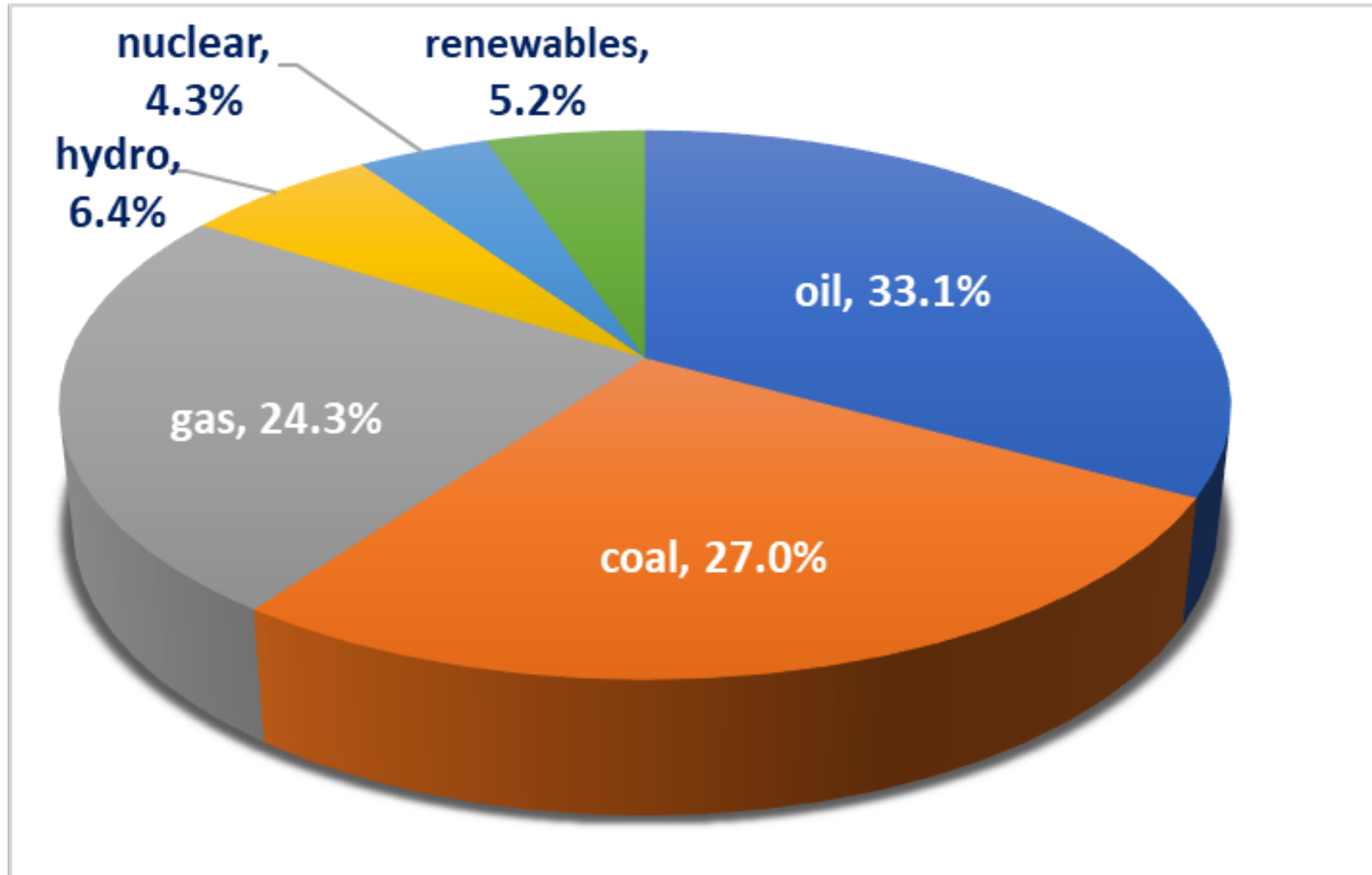
- Reduction in energy intensity
- Leaving the fossil fuels in the ground

5. Carbon capture and geological storage

6. Negative emissions

- Forestation, forest products
- Increase soil carbon
- Bioenergy with carbon capture and storage
- Direct air capture

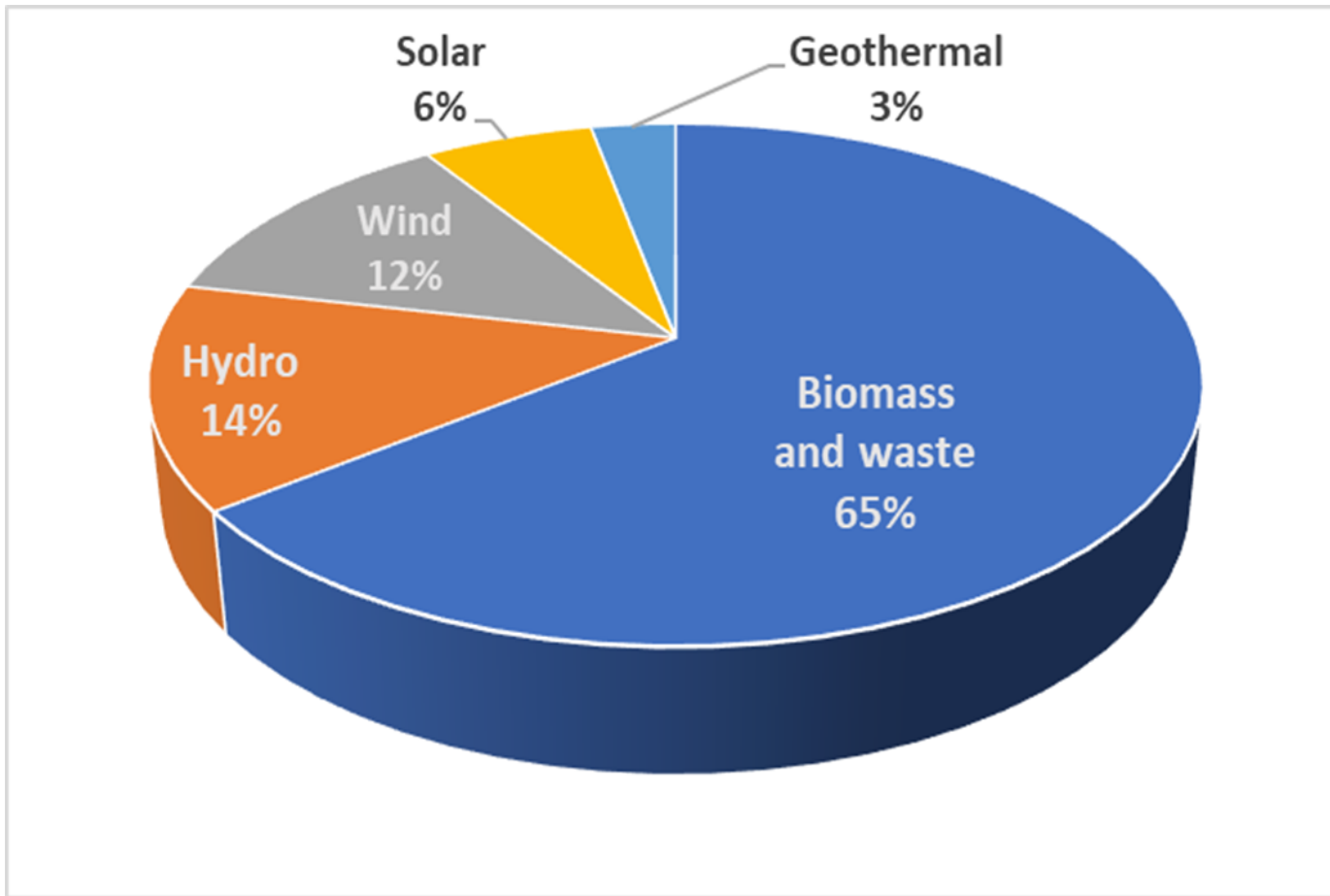
Fossil fuels still supply 84% of world energy



Global Energy Consumption in 2019

Source: BP Statistical Review 2020

'Renewable' energy in the 28 E.U. countries in 2015 and IPCC guidelines



IPCC guidelines for biomass and biofuels:

- Emissions going to the atmosphere are not counted
- Count emissions from
 - harvesting and regrowth
 - land-use changes
 - use of fertilizers,
 - processing of the feedstock
 - transportation
 - methane and nitrous oxide emissions

The biomass loophole

- Declaration that biofuels are carbon neutral
 - Surge in wood use in EU countries
- Good or bad assumption?
 - Wood emits more CO₂ than fossil fuel per unit of energy released (3x more emissions than natural gas)
 - + loss of future carbon sequestration from the growing trees
 - + loss of soil carbon consequent to disturbance.
 - + Processing efficiency of biomass less than coal

Time horizon: instantaneous CO₂ release vs decades of re-growth
→ carbon debt ranges from 44 – 104 years

Conclusion: Use of forestry biomass releases higher levels of emissions than coal

Sterman et al. Environ. Res. Lett. 13 (2018); <https://doi.org/10.1088/1748-9326/aaa512>

Article from the Guardian

'Carbon-neutrality is a fairy tale': how the race for renewables is burning Europe's forests

A

Wood pellets are sold as a clean alternative to coal. But is the subsidised bioenergy boom accelerating the climate crisis?

by Hazel Sheffield January 14, 2021

- Subsidies for biomass energy in the 27 EU states increased 143% between 2008 and 2018
 - Consumption of biomass has increased by 65 per cent in the past 10 years (Eurostat 2019)
 - U.K. more than tripled its consumption primarily due to the conversion of coal plants to biomass-fired power generation

Status of nuclear energy

- 440 nuclear power reactors operating in 32 countries (2020)
- China 1990: 0 operating nuclear power plants
- China 2019: 46 nuclear plants in operation, 11 under construction
- Worldwide (2020): 186 nuclear reactors shut down permanently; replacement mainly by natural gas
- Germany shutting all nuclear plants by 2022
- France's electricity is 75% from nuclear energy
 - No new plants built for over 20 years
 - Government policy is to reduce the share of nuclear to 50% by 2035
- In Canada last nuclear plant (Darlington) came into service in 1993 – 5 years later than scheduled and at a cost of \$14.4 billion more than triple the initial estimate of \$3.9 billion

Renewed hope for nuclear power

	Small modular reactors	Advanced fission	Fusion
	<p>SMRs are a slimmed-down version of conventional fission reactors</p> <ul style="list-style-type: none"> - less power - use off-the-shelf components 	<p>Safer than traditional water-cooled reactors;</p> <ul style="list-style-type: none"> - coolants such as liquid sodium or molten salts - Most advanced “pebble bed” reactor, cooled by helium 	<p>Technical progress is still slow after decades of investment</p> <p>Containing the plasma</p> <ul style="list-style-type: none"> - magnetic confinement - inertial confinement - magnetized target fusion
Companies	NuScale Power	China National Nuclear Corporation, TerraPower, Terrestrial Energy	ITER, TAE Technologies, General Fusion, Commonwealth Fusion Systems
Power output	50-200 megawatts	190-600 megawatts	100-500 megawatts
Available	2026	<p>Pebble bed in 2020</p> <p>sodium-cooled by 2025</p> <p>molten salt by 2030</p>	No earlier than 2035

Industrial and transport electrification - Hydrogen

- Grey H₂ – Steam methane reforming (SMR) of natural gas ~ \$1/kg
 - 98% of world production
- Blue H₂ – SMR plus carbon capture and storage (CCS) ~ \$1.50/kg
 - Alberta's focus
- Green H₂ – electrolysis ~ \$4.50/kg
 - Push by E.U. and Middle East
 - Works for cheap wind and solar
- Use: long distance trucking, fuel for cargo ships and aircraft



Hydrogen – Highs and lows

- Alberta one of the largest producers and users of H₂ (grey)
- Alberta can become a world leader in blue H₂
- Can be shipped as ammonia
 - Burned in power plants with no emissions
- Green H₂ from renewable energy creates no emissions
 - Quebec, BC, Manitoba - Provinces with excess hydro
- Requires plenty of energy to produce
- Difficult to transport
- Difficult to store
- Market is uncertain
- Transportation use dependent on success of fuel cell technology
- There is a limit to the % CO₂ that can be captured from blue H₂

Canada's GHG Emissions and International Commitments, 1990 to 2030

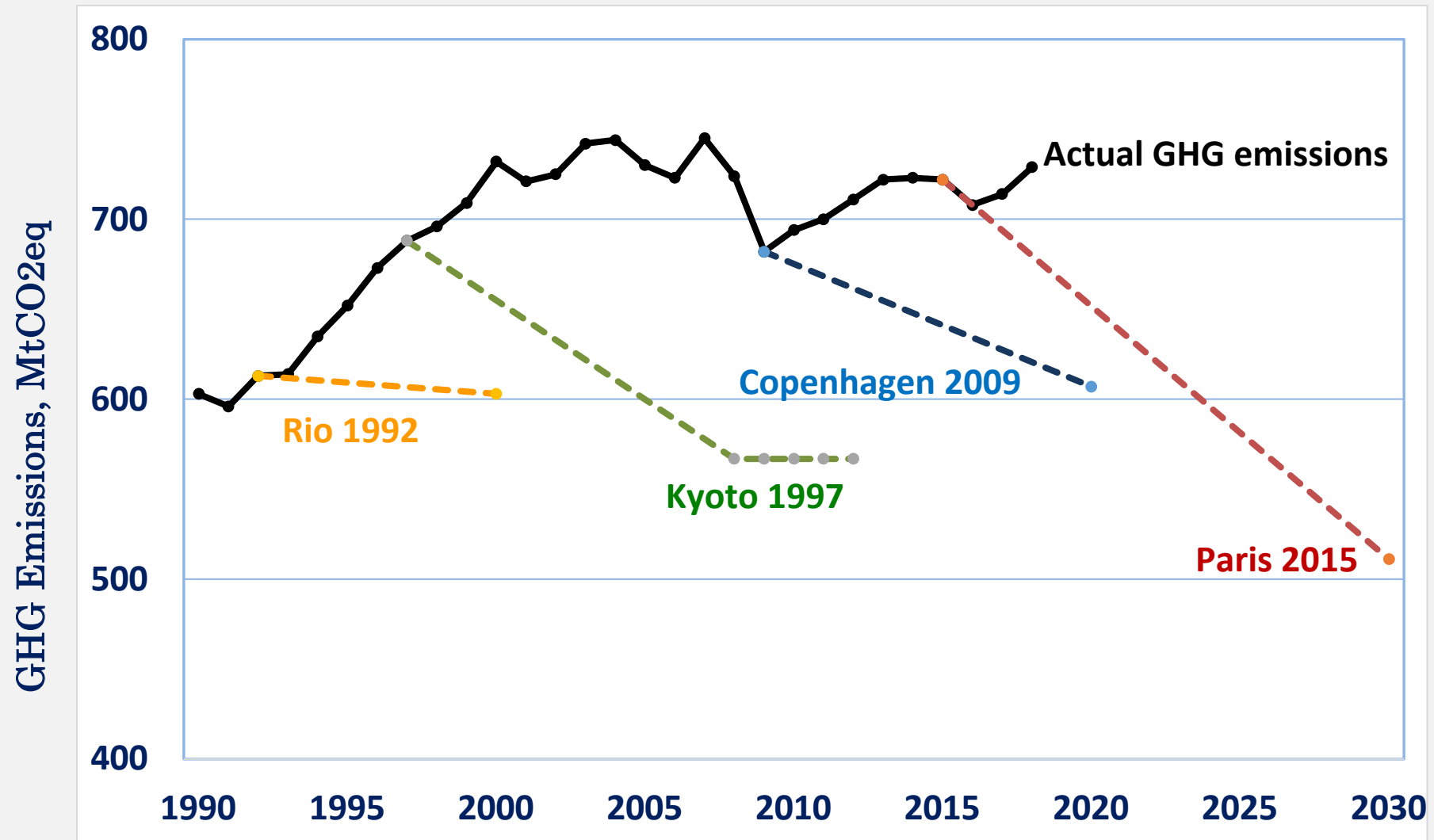


Figure produced by Positive Energy (U. of Ottawa). Data from National Inventory Report 1990-2018: Greenhouse Gas Sources and Sinks in Canada, 2020.

Canada determined to achieve new commitments (net zero)

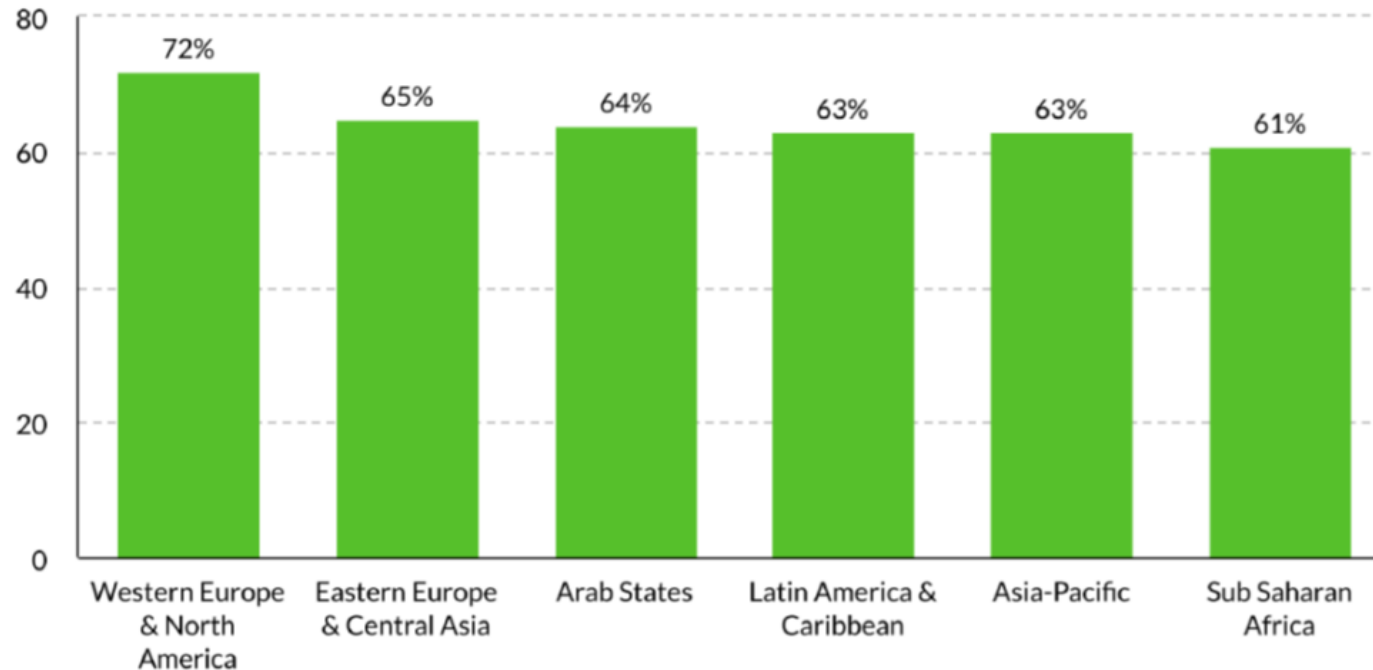
- *Canadian Net-Zero Emissions Accountability Act (Nov. 2020)*
 - Achieve net-zero emissions by 2050 in law
 - five-year milestones for interim emissions reduction targets
- *Canada's Climate Plan (A Healthy Environment and a Healthy Economy)*
 - Increase carbon price to reach \$170 per tonne of CO₂e in 2030
 - \$1.5-billion to increase the production and use of low-carbon fuels
 - Added \$287 million/2 yr. for incentives for zero-emission vehicles
 - Added \$150 million in vehicle charging and refueling stations
- **Federal Clean Fuel Regulations (CFR)**
 - Liquid fossil fuel suppliers required to reduce the carbon intensity of the fuels by 13% by 2030 (from 2016 levels)
- **More coming**

Summary

- Paris Agreement: A global signal that climate change is a serious issue that needs to be addressed
 - Seeks to phase out fossil fuels as rapidly as possible
 - Ignores proper accounting for biomass and biofuel burning
- Global survey - Public belief in the climate emergency ↑

“People’s Climate Vote”: UNDP Survey (Jan. 2021)

Figure 2. Public Belief in the Climate Emergency, by Region



- 1.2 million in 40 countries: 64% of people said that climate change was an emergency
- UK: 81%, Canada: 75%, US: 65%

■ Policy priorities:

1. Conservation of forests and land (54% support)
 2. Solar, wind and renewable power (53%)
 3. Climate-friendly farming techniques (52%)
 4. Investing more in green businesses and jobs (50%)
- Least popular: Plant based diets (30%)

Summary

- Paris Agreement: A global signal that climate change is a serious issue that needs to be addressed
 - Seeks to phase out fossil fuels as rapidly as possible
 - Ignores proper accounting for biomass and biofuel burning
- A serious shortfall in meeting pledged emissions reductions by 2030 (UN Emissions Gap Report 2019)
 - temperatures can be expected to rise to 3.2°C this century based on pledges in Paris
- Goal of limiting the temperature increase to “well below 2 degrees” not on sound technical and engineering footing

Summary Continued

Opportunities

- Build on Canada's competitive advantage and pursue a distinct strategy
 - Planning based on rigorous scientific and engineering data and modelling - consider the structure of the country's economy
- Electrification focus – hydrogen, nuclear, expand renewables, hydro
- Strategies for forest sector, soil carbon sequestration
- Focus also on adapting to a warmer world
 - increase investments in infrastructure to protect communities from the threat of sea-level rise and those at risk from extreme weather events



Thank you

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