

Welcome to this week's presentation & conversation hosted by the **Canadian Association for the Club of Rome**, a Club dedicated to intelligent debate & action on global issues.

The views and opinions expressed in this presentation are those of the speaker & do not necessarily reflect the views or positions of CACOR.

The Immoralities of Climate Change.

Our speaker today is Geoff Strong, an atmospheric/climate scientist who is a fellow & former president of the Canadian Meteorological & Oceanographic Society. He was nominated in 2023 for the prestigious Patterson Medal. Since retiring from Environment Canada in 1998, Geoff continued research on severe thunderstorm initiation, atmospheric moisture budgets, & prairie drought. He has provided public education on climate change by teaching environmental courses (at U of A, King's U, & VIU), given hundreds of public talks on climate issues, & writes newspaper & magazine articles.

DESCRIPTION: Canada has seen fatal heat domes, atmospheric moisture rivers, wildfires, & hurricanes, but deaths here paled in comparison to those in the subtropics. Oxfam says one person dies of hunger every 48 seconds in east Africa alone (> 650,000 deaths/y) from desertification caused by climate change. Industrial mid-latitude countries caused this climate crisis. That should trigger serious questions about our responsibilities to humanity & our shared biosphere. What do we owe Earth's future environment & descendants? This is the greatest moral cause of our time. We need to consider the shrinking but best possible solutions for reducing carbon emissions immediately. Will we act in time to ensure a habitable future for our descendants?

The presentation will be followed by a conversation, questions, & observations from the participants.

CACOR acknowledges that we all benefit from sharing the traditional territories of local Indigenous peoples (First Nations, Métis, & Inuit in Canada) and their descendants.



Website: canadiancor.com

Twitter: [@cacor1968](https://twitter.com/cacor1968)

YouTube: [Canadian Association for the Club of Rome](https://www.youtube.com/channel/UC...)

2024 Jan 10 Zoom #179

Immoralities of the Climate Crisis

G.S. Strong – to CACOR, Jan. 10, 2024

Atmospheric/Climate Scientist (unret)

geoff.strong45@gmail.com - for PDF copy of slides

Example Impacts of the
Climate Crisis

Heat Dome – BC, June/July 2021

Lytton BC - Temperatures of up to 49.6 °C over 3-day period



Wildfires, NS – late-May, 2023

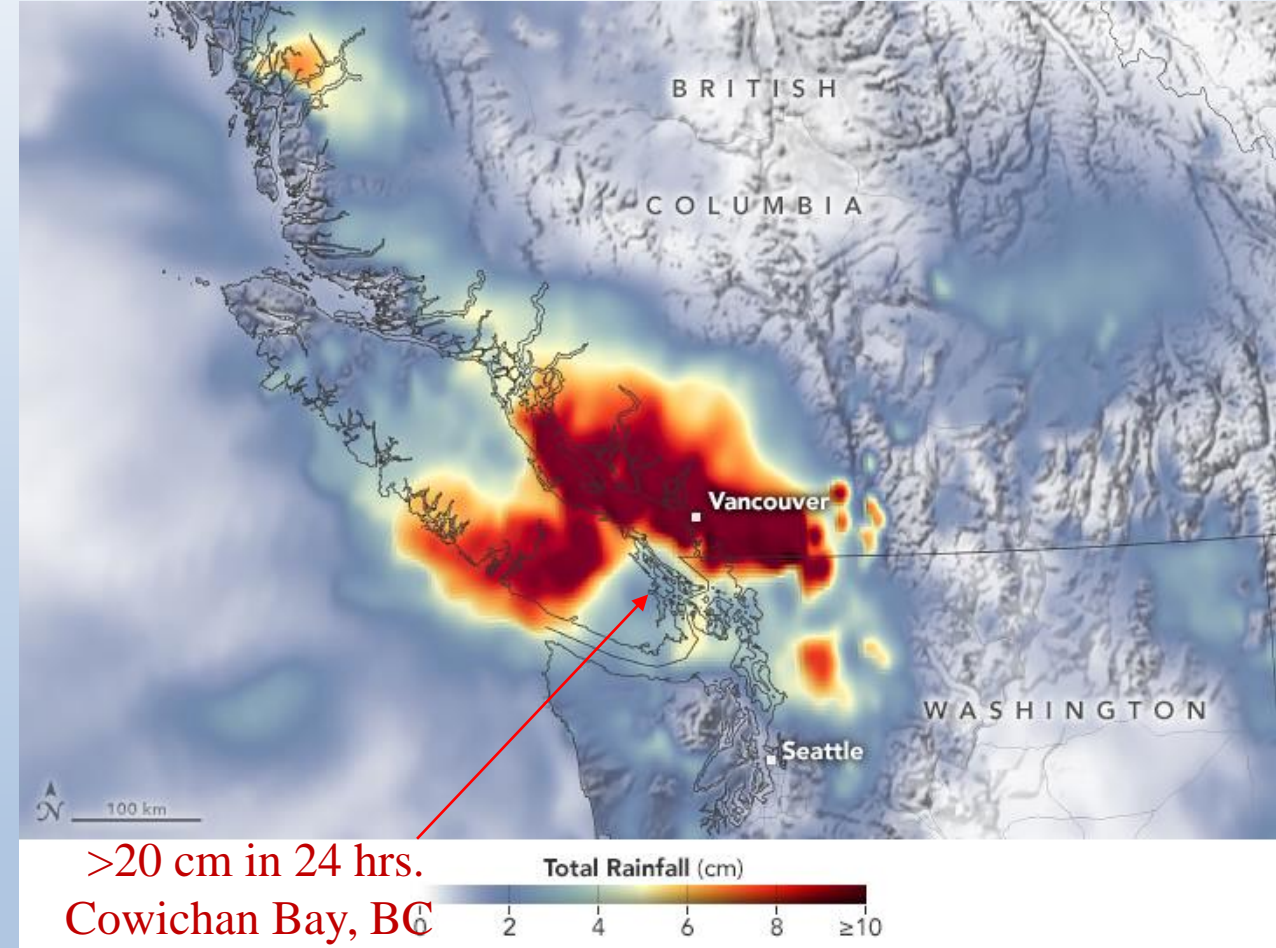


Lytton BC lost most homes in town.
- 619 deaths in BC, mostly from heat prostration

Atmospheric Moisture River, BC - November 15, 2021



\$450 million, 5 deaths



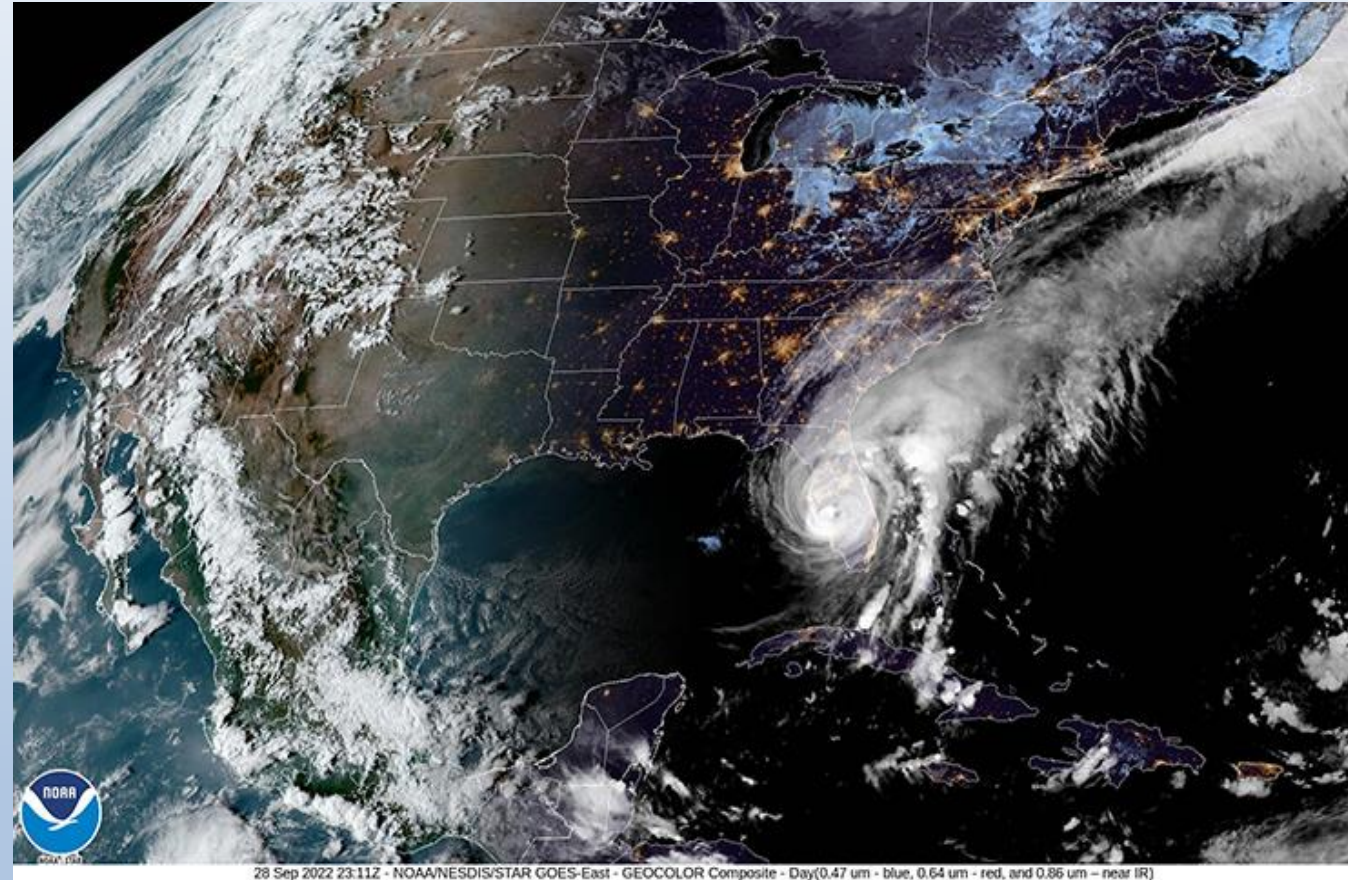
'Heat Dome' and 'Atmospheric River' – 2 new terms in operational use

Hurricane *Fiona*, Sept. 2022



\$4 billion, 25 deaths

Hurricane *Ian*, Sept. 2022



\$75 billion, 150 deaths

Worst Climate Change Impacts - Subtropics

Desertification, drought, loss of water & arable land, famines - 2000-2023

WHO (and other NGOs) report >500,000 famine deaths/year



Yemen, 2021



Somalia, 2023

Worst hit: Mali, Chad, Ethiopia, Sudan; Somalia, South Sudan, Syria, Afghanistan, and Yemen - Next: Uganda and Kenya.

Immoralities of the Climate Crisis

The Guilty Parties?

1) **Fossil Fuel Corporations** – profit-driven goals; cheat on emissions reporting, cover-up oil spills, and pay denialists to emphasize uncertainties and possible errors in climate change.

2) **Governments** – who listen to fossil fuel corporations, but often not to their own scientists.

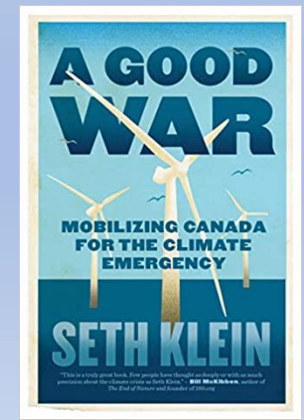
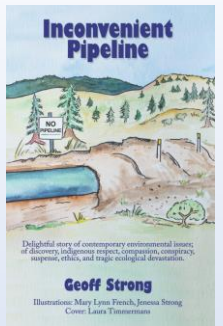
3) **Climate Denialists**

- a) those accepting pay (from fossil fuels) to deny climate change, blame it on other sources (e.g., solar cycle), or just to suggest uncertainties in climate science (that it's still under debate → see Arrhenius)
- b) those who deny climate change, refuse to accept scientific results, promote *disinformation*; same as people who believe contrails are 'chem trails'; the 'freedom truckers'; 'non-vaxers', etc.

4) **Inactivists** – Those who understand and see what is wrong but do not speak up (the 'new climate denialists').

– Those who say the world is doomed and action is futile.

'cherry-picking data'



Carbon Emissions, the Climate Crisis, and the roles that Industry, Government, and the Public play in it . . .

Three Wise Monkeys



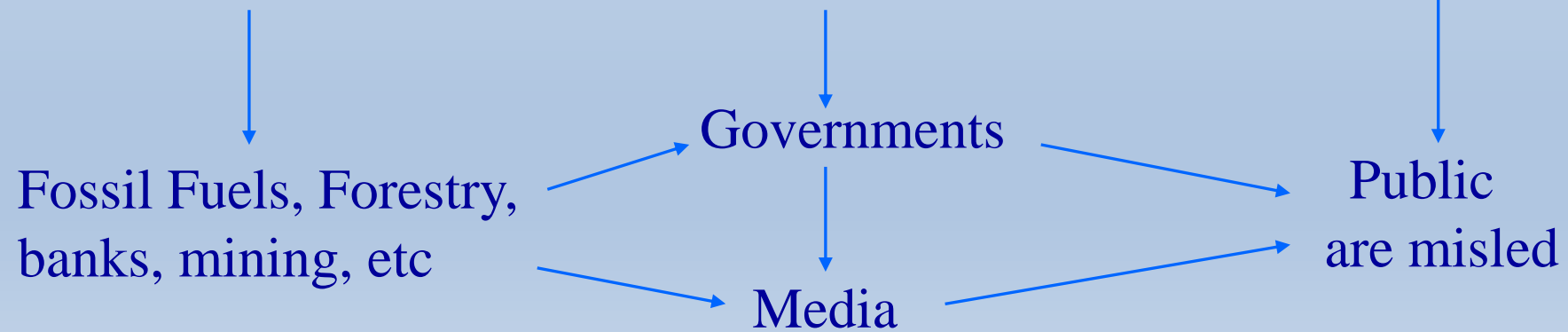
Speak no Evil



See no Evil



Hear no Evil

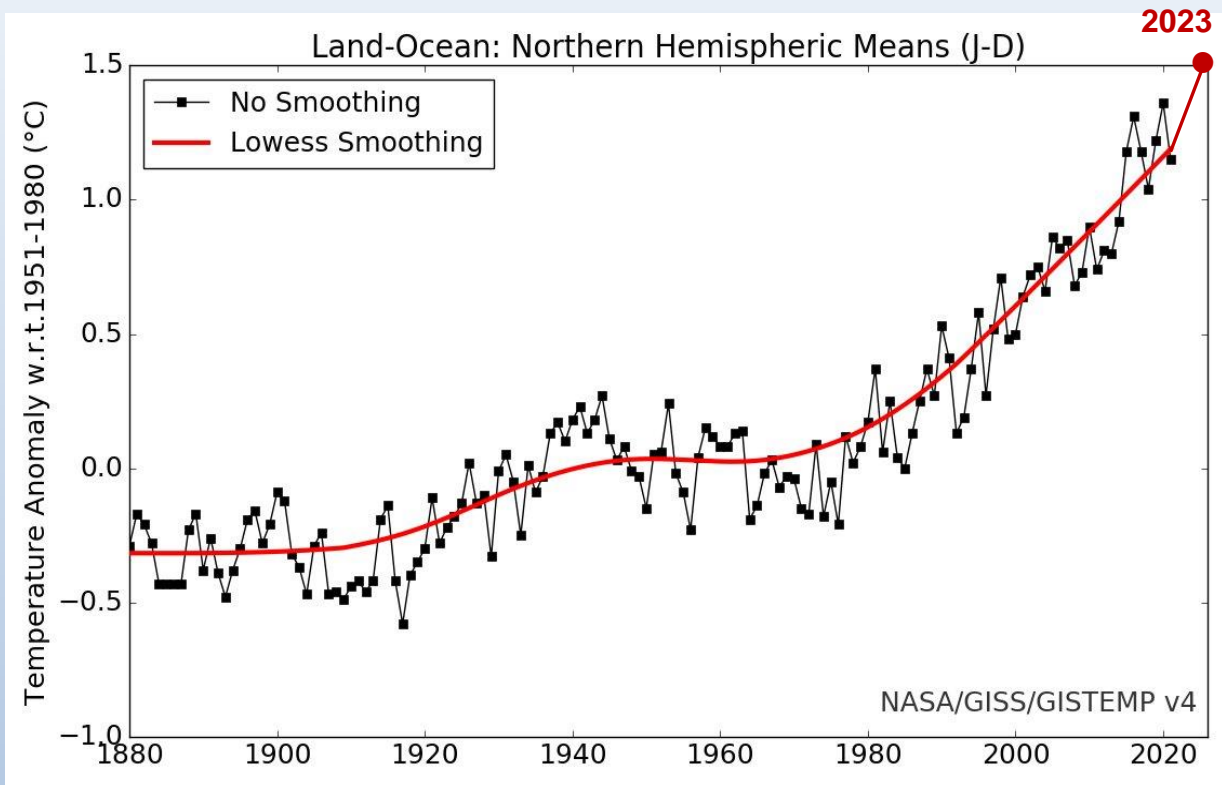
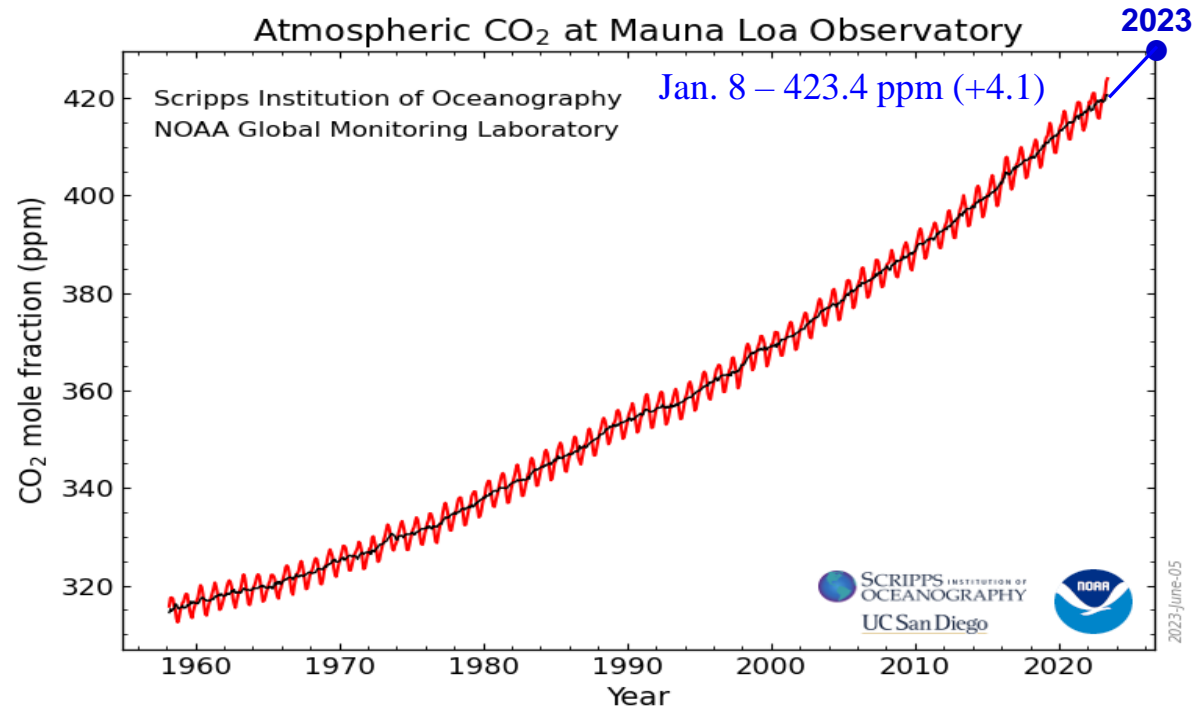


Carbon Emissions, Atmospheric CO₂, and Global Temperature Trends

Errors of omission, cherry-picking

Nature does not lie

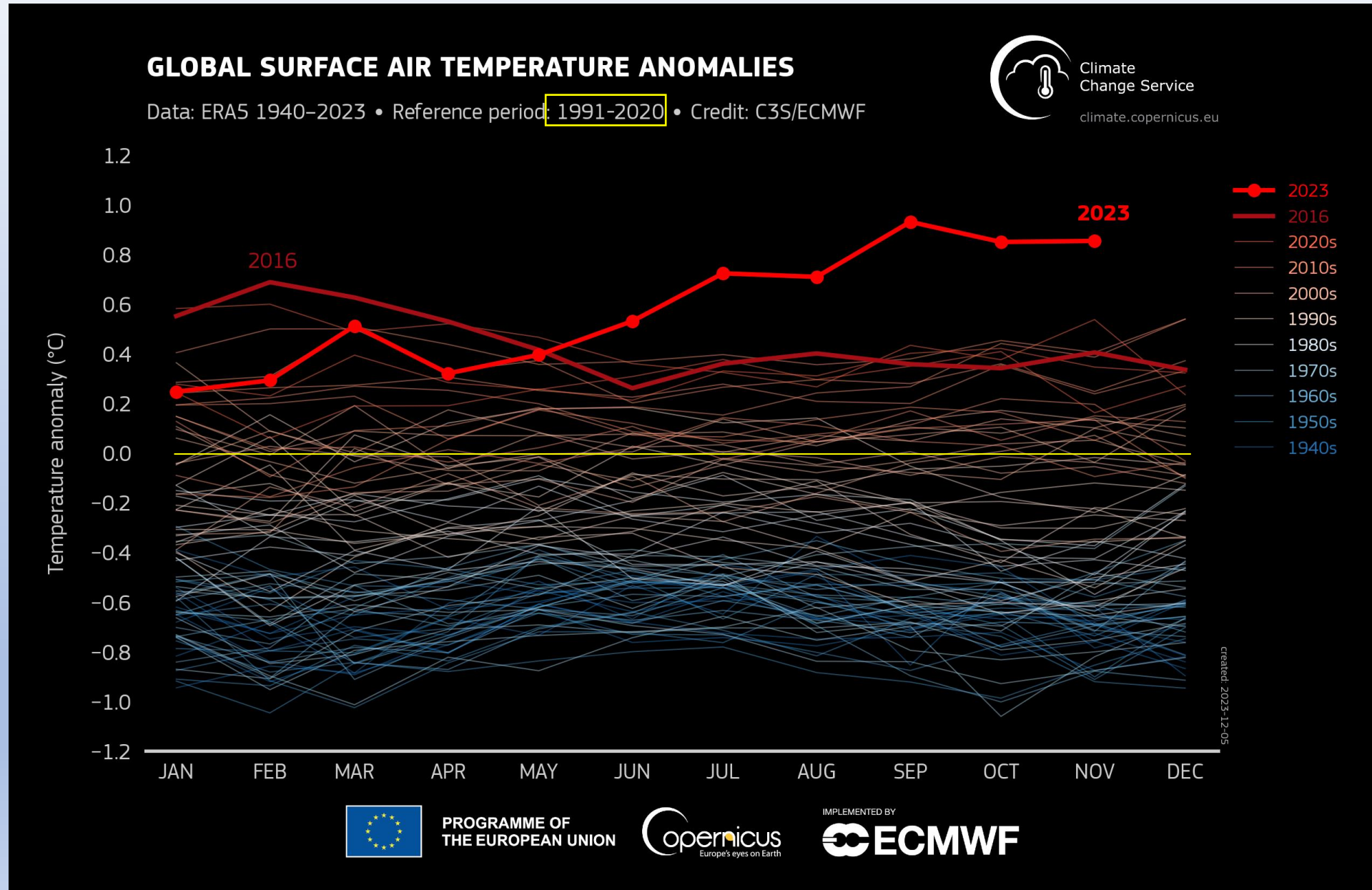
Climate science does not lie



- As carbon emissions increase, so too does atmospheric CO₂.
- As CO₂ increases, so have carbon emissions.
- Yet many countries (Canada) report decreasing emissions?
- Nature DOES NOT LIE.
- In 2023 monthly averages were 3ppm higher than same time in 2022.

- Global mean temperatures also increase.
- 2023 temperature anomaly will be ~ 1.5 °C level.
- 2024 expected to exceed 1.5 °C.

2023 was a significantly different (warmer) year than all previous years . . .



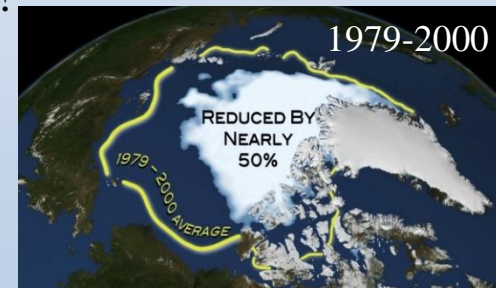
Positive Feedbacks and Tipping Point in the Climate

Q: Why has global warming accelerated in last 5-10 years?

A: Can happen through increased carbon emissions and/or 'Positive feedbacks' to the warming?

Examples of Tipping Points:

- 1) As atmosphere warms, by say 2°C, its capacity to hold water vapour (H₂O) increases (15-20%).
→ water vapour is the most potent greenhouse gas (GHG)!
- 2) As atmosphere warms, more ice melt in Arctic from land/ocean;
→ less ice reflection of solar radiation,
→ water/land then absorb more heat.
→ Melting land ice → increased sea-level rise.

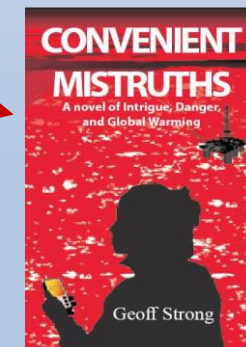


- ★ 3) As atmosphere warms, northern permafrost melts, peat bogs decompose,
→ release more **methane (CH₄)** and carbon dioxide (CO₂)

4) ...

5) ... Other positive feedbacks

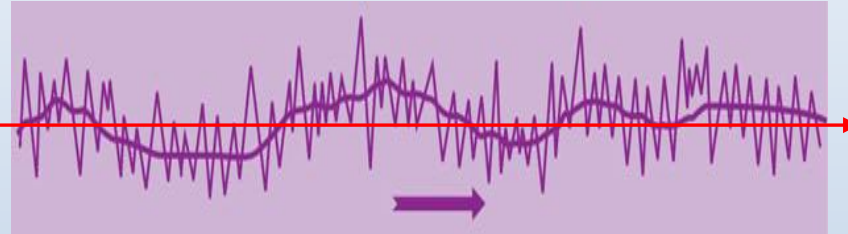
6) ...



Positive feedbacks occurring simultaneously can cause accelerated warming, and quite possibly result in a *tipping point* in the climate!

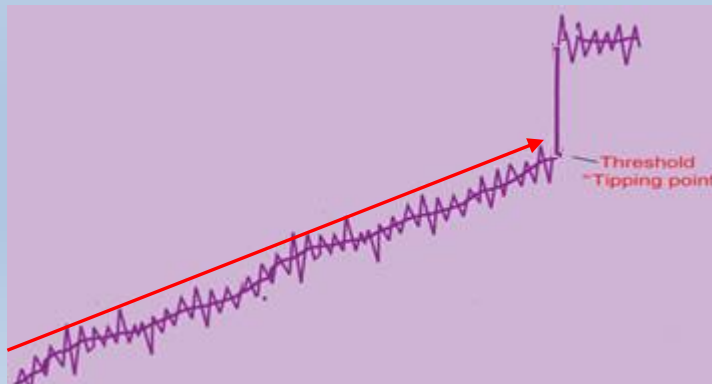
Q: What is a *Tipping Point* in Nature?

Dynamic Equilibrium – where the rate of gain = rate of loss, system returns to a stable condition.

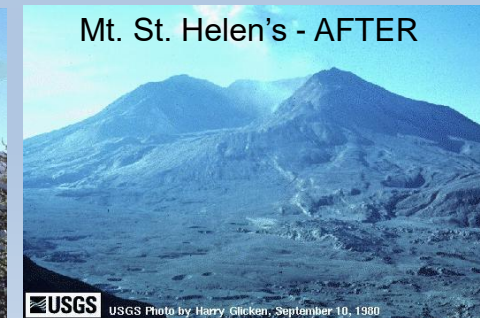


Example: Weather systems

Metastable Equilibrium - where the rate of gain > rate of loss, and the system reaches a threshold or a tipping point, where it can then no longer maintain its character, and so it lurches to some new operational level.



Examples: Explosive volcano - **Our climate?**



*The 'system'
(volcano) is
forever changed*

Everything in this century will be affected by, and to a large extent, controlled by climate change!

The IPCC states in its AR-6 Report, March 2023:

“To avoid a dangerous ‘*tipping point*’ in the climate, the world **must** reduce carbon emissions by 45% by 2030 or face a situation where feedbacks may combine to force a sudden rapid warming, with multiple lethal impacts all around the globe.”

I would add to that:

- 50% reduction in carbon emissions by 2030, and
- 90-95% reduction by 2040.

} i.e., **NET-zero** strategy
needs to be replaced by
NEAR-zero strategy!

The “NET-Zero Emissions strategy” is Deceptive and confusing!

It is based on the premise that carbon sequestration techniques can counter current emissions, while also drawing down CO₂ from the atmosphere.

Canada’s methods proposed: *planting trees* and *DAC* & *CCS* technologies.

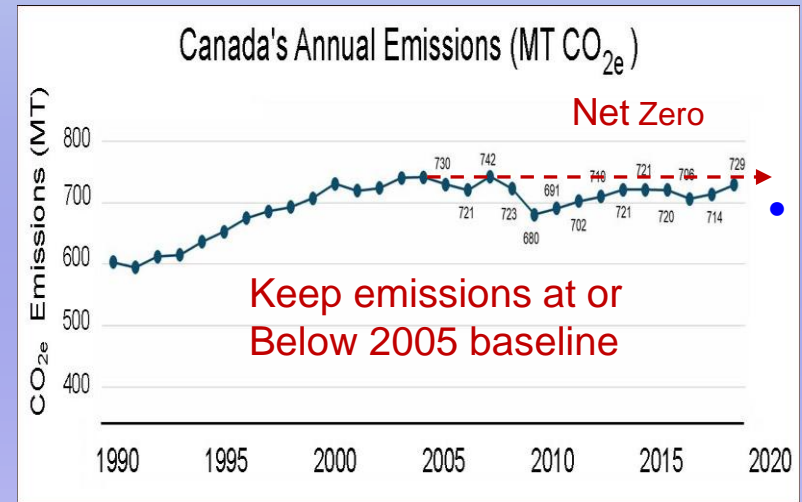
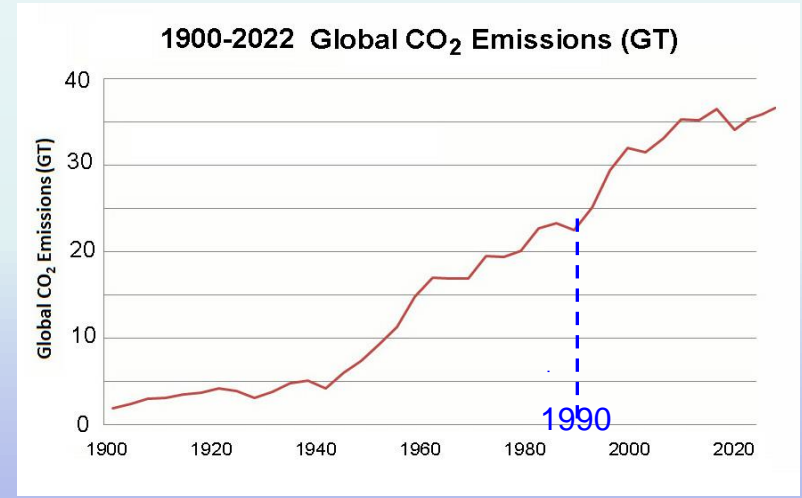
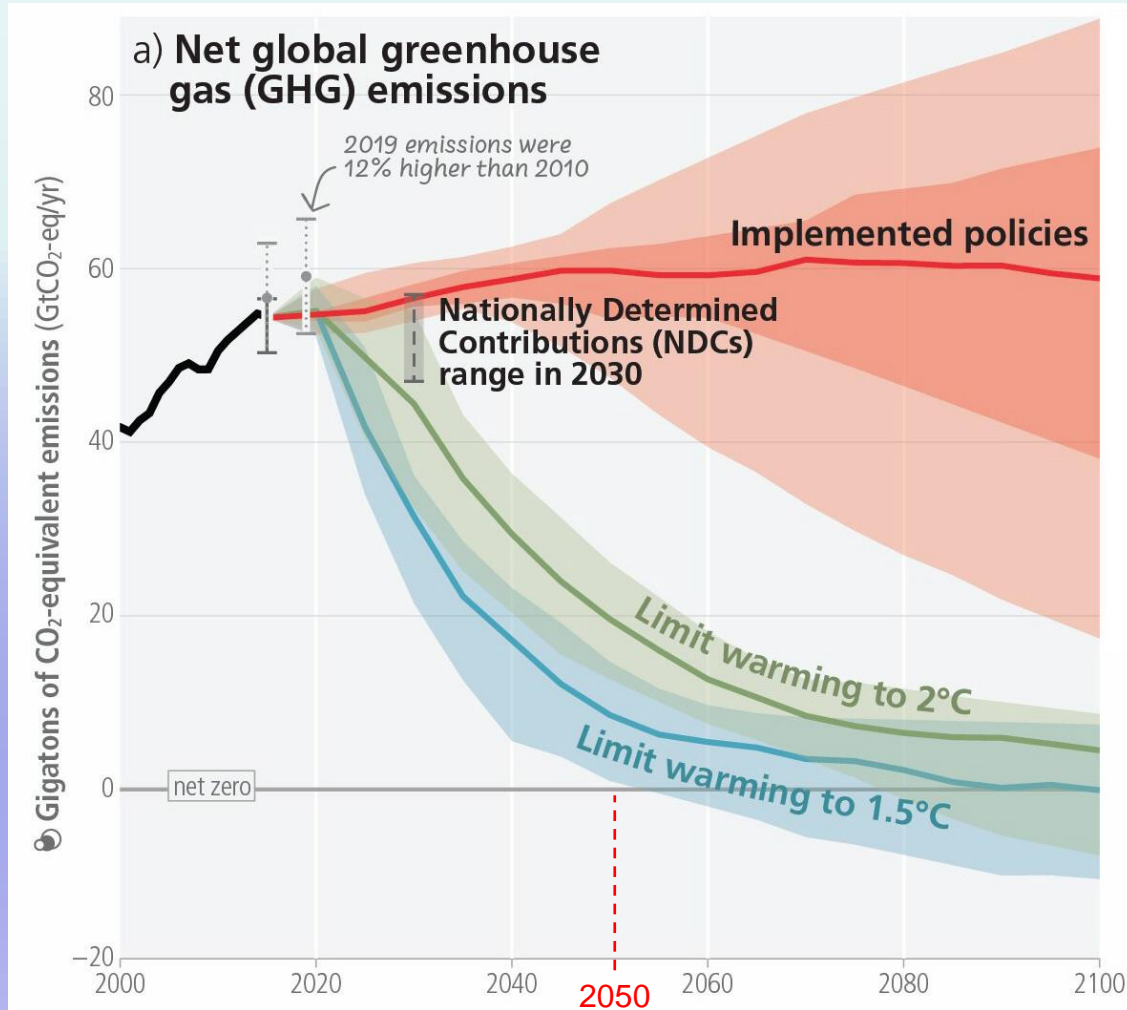
Why are these 3 sequestration techniques NOT GOING TO WORK?

The 'Net-Zero' Confusion - Misunderstanding, Deception or Lie?

- Figure SPM.5 from IPCC AR-6 Synthesis Report released March 20, 2023.

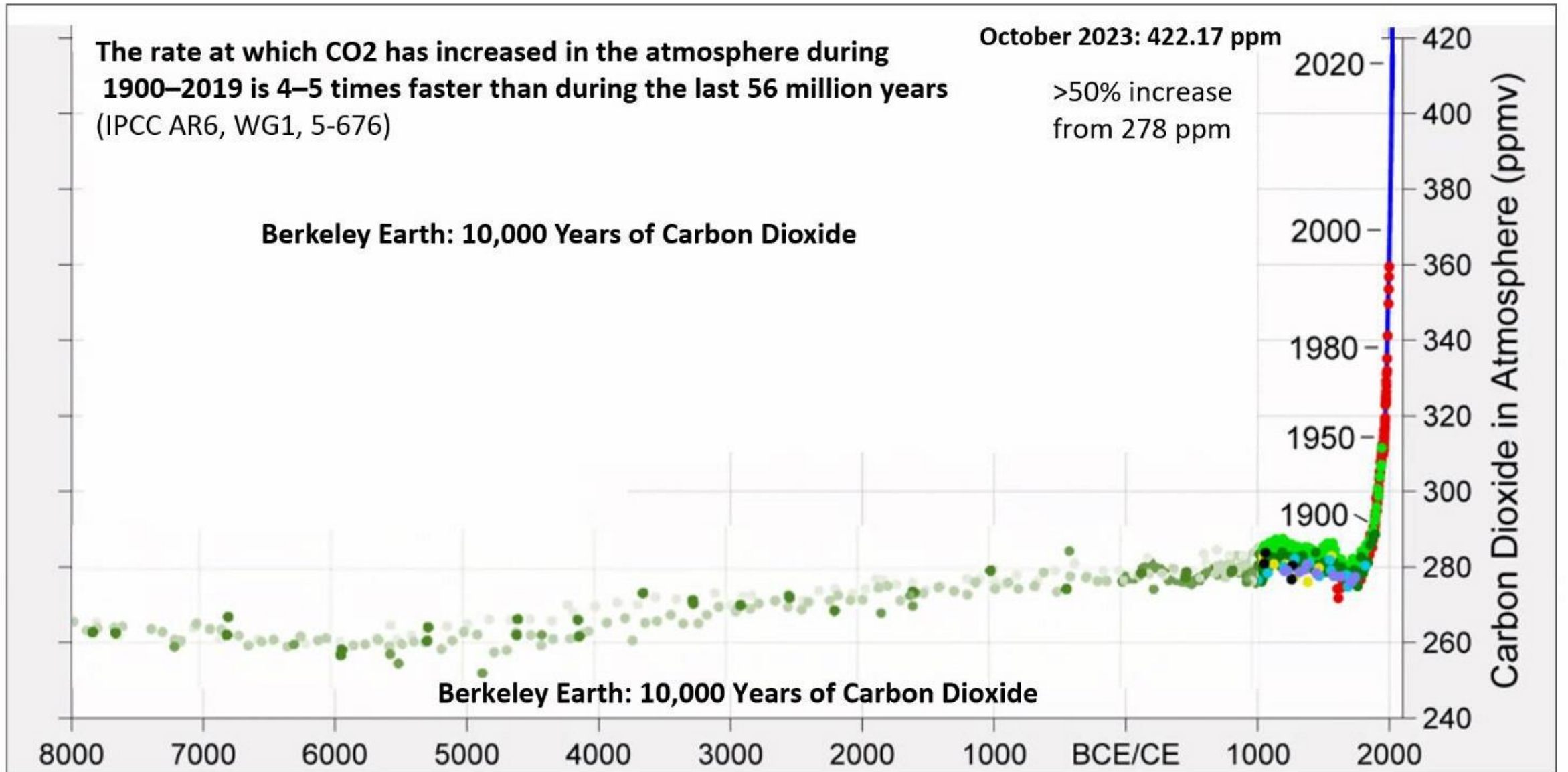
Industry Definition of 'Net-Zero':

- the difference between current emissions and a 'baseline' level.
- Convinced governments to use this definition.
- Canada chose 2005 as their baseline (730 MT).



- For IPCC, 'net-zero' emissions means zero-emissions (going carbon-neutral) by 2050.
- Implemented policies suggest that for most countries (including Canada) 'net-zero' means holding emissions at or below their baseline value (730 MT in 2005 – Canada).
- Canada (ECCC) reported 2021 emissions down to 670 MT.

Unprecedented Still Accelerating Rate of Atmospheric CO2 Increase



Canada's Climate Plan (Mar. 2022) – measures to Counter Carbon Emissions

1) Carbon tax (<4 cents/liter/year)* - 10,000 km, 10 km/liter → 1000 liters * 0.04 = \$40.00 extra first year, \$80 in 2nd, etc.

* Dec.2021-June 2022: price raised by \$0.80/liter + 0.04

May 2023: price raised by \$0.30/liter + 0.04

2) Mandating EVs by 2035 - 25% of Canada's emissions from vehicles

CO₂ Sequestration -

3) Planting 2 billion trees to sequester CO₂

4) DAC (Direct Air Capture of CO₂)

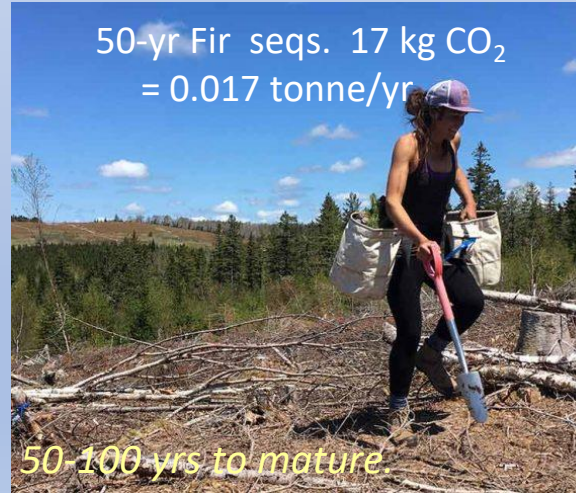
5) CCS (Carbon Capture at Source) } - underground storage of CO₂

Annual CO₂ Emissions

Global – 40 GT (40,000,000,000 tonnes)

Canada – 730 MT (730,000,000 tonnes)

3. Trees sequester CO₂ through photo-synthesis – a little less than 1/2 their dry weight is carbon.

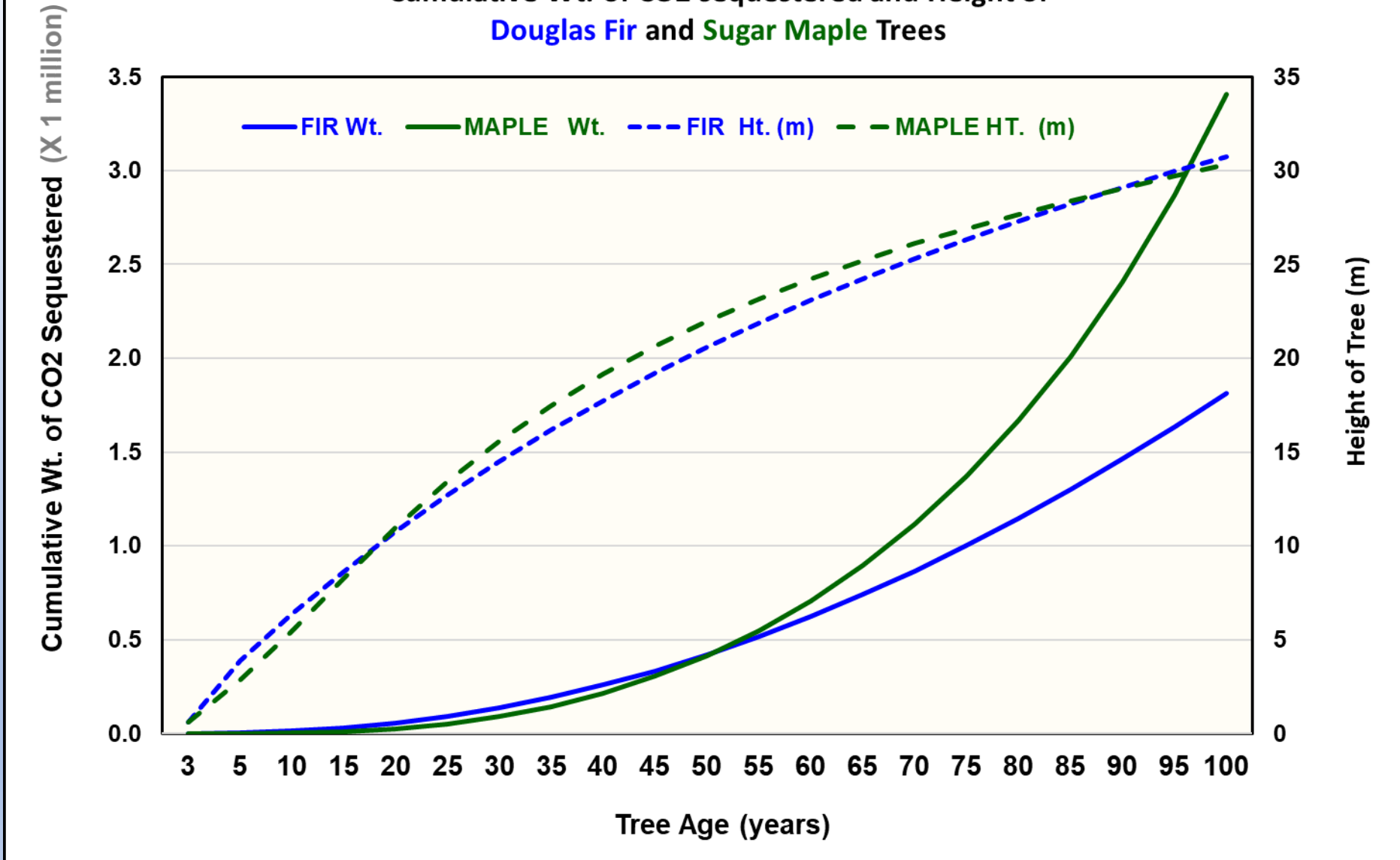


Number of 50-yr Firs to counter 730 MT CO₂
= 730,000,000/0.17 = **>4 trillion trees**

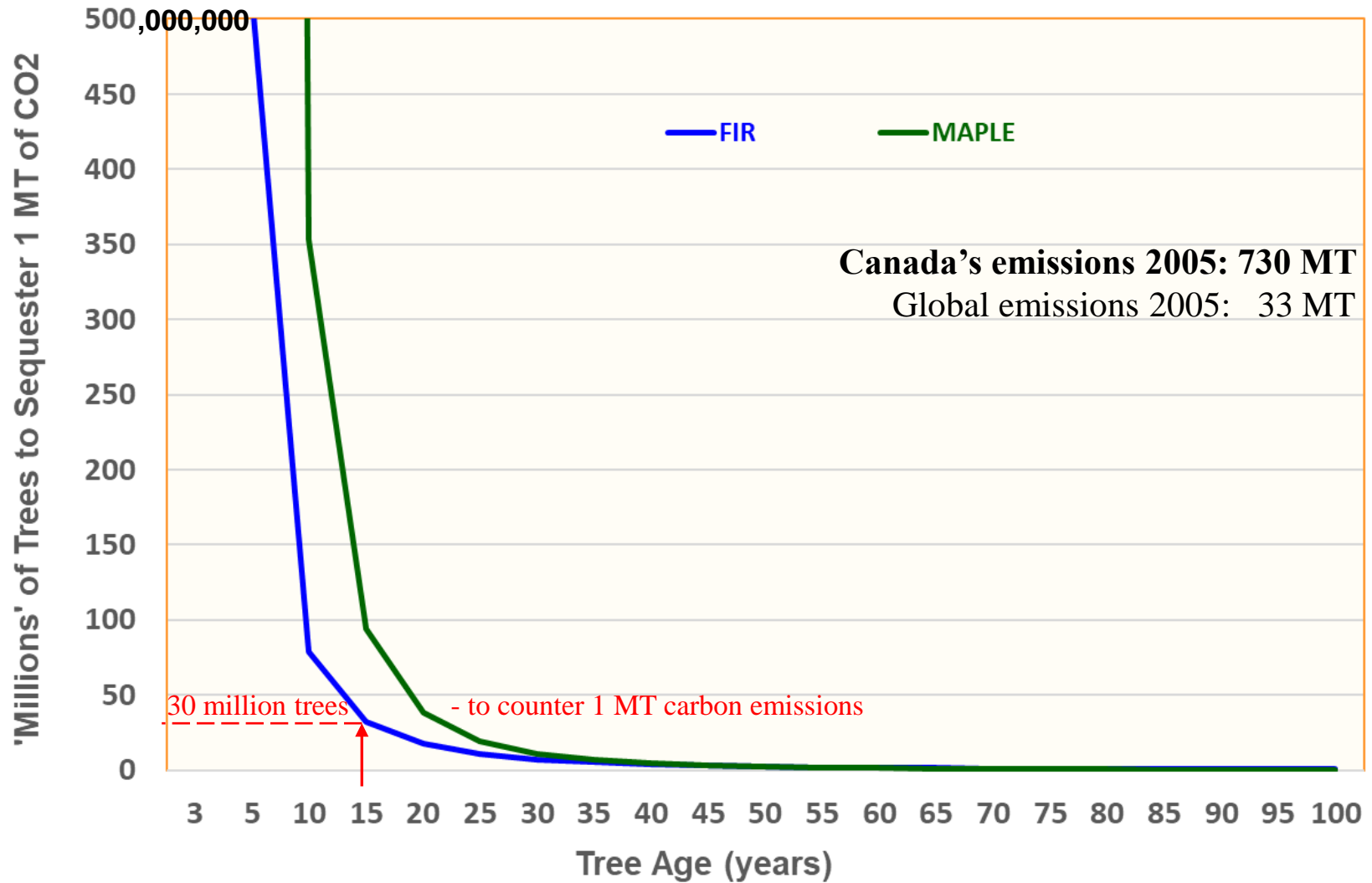
Number of 50-yr Firs to sequester 40 GT CO₂
= 40,000,000,000/0.17 = **>235 trillion trees**

Present number of trees on Earth ≈ only 3 trillion.

Cumulative Wt. of CO2 sequestered and Height of Douglas Fir and Sugar Maple Trees



No. Trees required to Sequester 1 MT CO2



4. Technology (Direct Air Capture - DAC):



How many *Mammoth* facilities are required to counter 40 GT global CO₂ emissions?

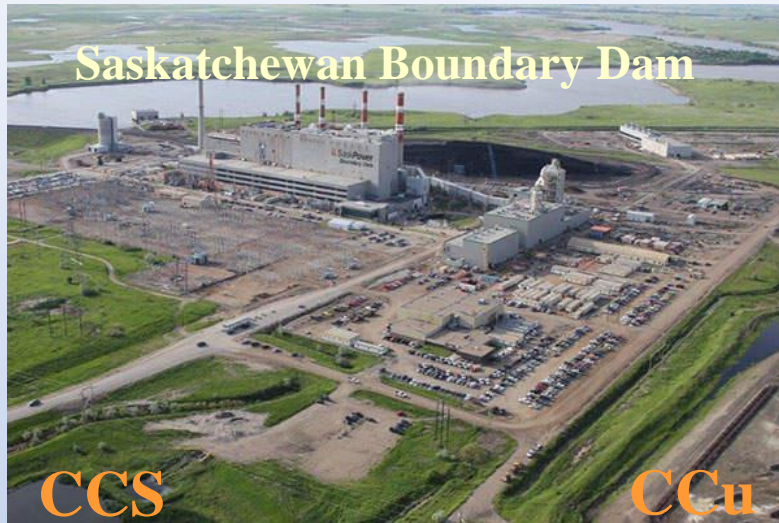
= 40,000,000,000/35,000 → **1 million Mammoths**

Est. construction costs / tonne CO₂ = \$400

Appreciate the fact that both *Orca* and *Mammoth* use geothermal energy to run - hence no emissions.

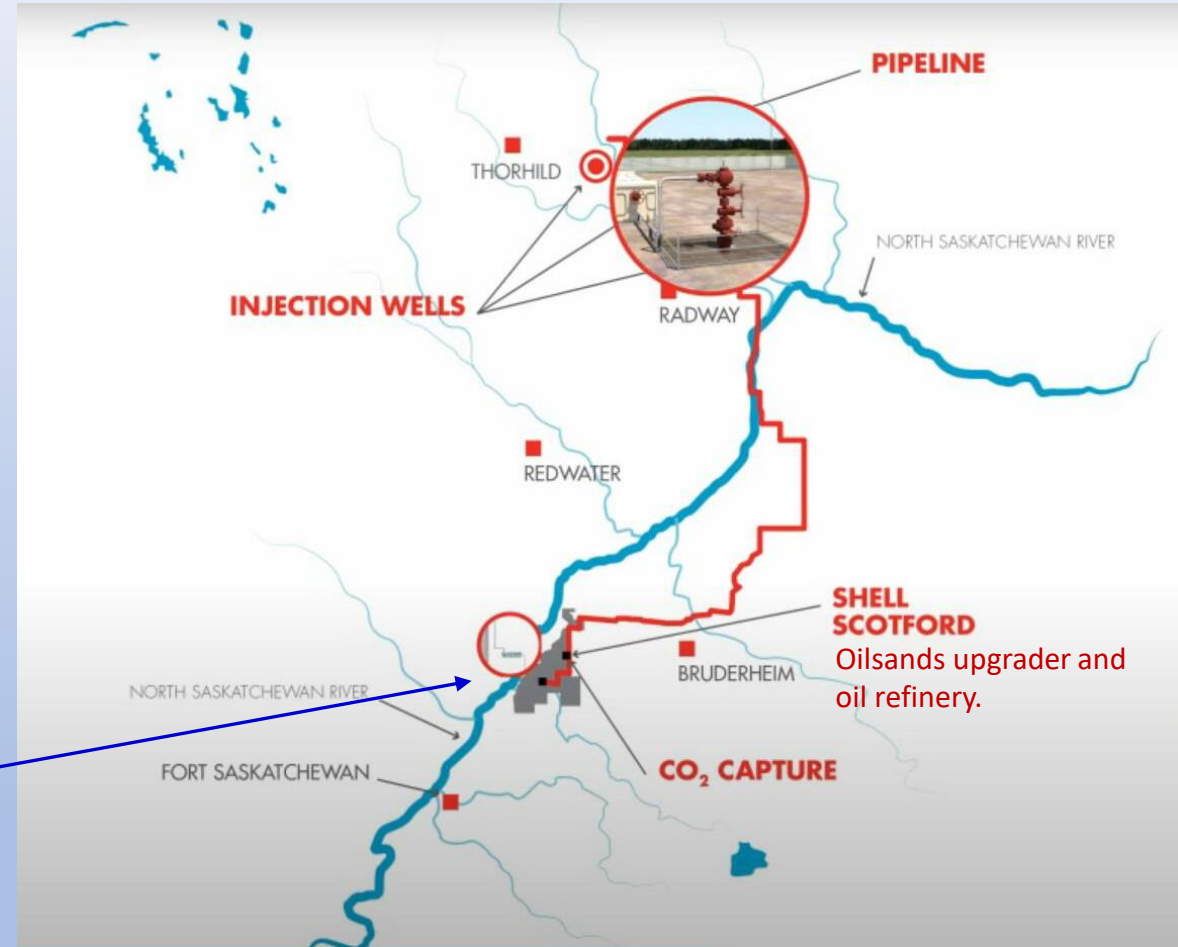
- But it makes no sense to build all these now.
- Need to do more research to raise capture rates to > 1-10 million tonnes/yr before building more.

5. Technology (Carbon Capture & Storage at Source – CCS):



Reported 15 tonnes/day \approx 5,500 tonnes/yr - shut down in 2018.

Shell's 'QUEST' CCS Facility near Edmonton



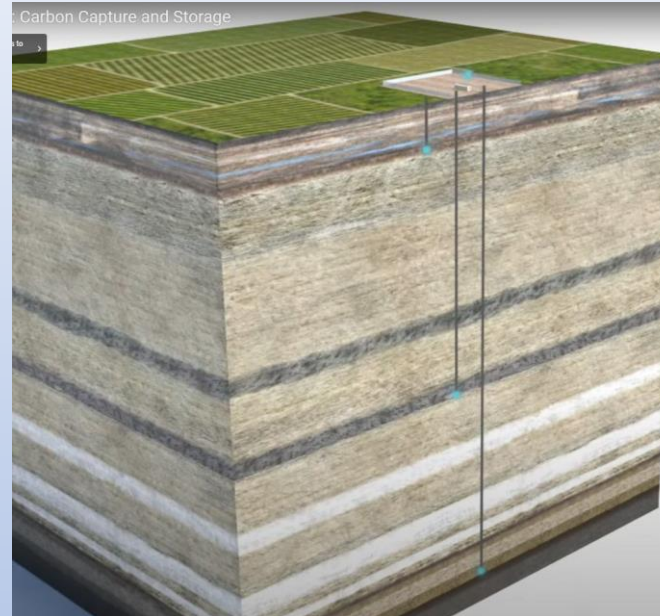
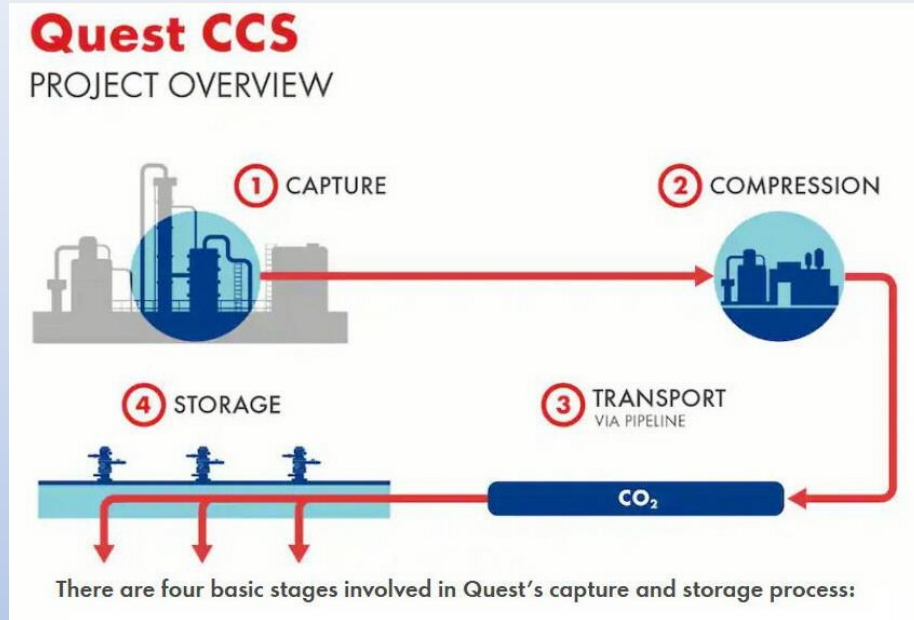
https://www.shell.ca/en_ca/about-us/projects-and-sites/quest-carbon-capture-and-storage-project.html



Oilsands oil upgrader and oil refinery near Ft. Saskatchewan, AB.

5. Technology - Carbon Capture & Storage Source – CCS aka CCu:

Quest Claims by Shell – and an Independent Review:



CLAIM: captured 5 million tonnes of CO₂ in the 5 years, 2017-22

REVIEW (by Global Witness):

- The facility has emitted 7.5 million tonnes of CO₂ during the same period.
- Shell's plant has the same carbon footprint as 1.2 million ICE vehicles.

Global Witness - international NGO – 1993; works to break the links between natural resource exploitation, conflict, poverty, corruption, and human rights abuses worldwide.
- offices in London and Washington, D.C.

<https://www.globalwitness.org/en/campaigns/fossil-gas/shell-hydrogen-true-emissions/>

5. Technology (*Carbon Capture & Storage Source – CCS*):

CCS Facilities

- 27 (20-30) similar CCS(?) facilities globally (150 others being constructed?)
- Most have been built primarily with government grants
- All are owned and operated by the fossil fuel industry (conflict of interest?)
- Most have been used as CCu (*utilization* to improve efficiency of oil/gas wells)
- Claim they can increase carbon capture to 1 million tonnes/yr

CCS Cost (\$1.35 Billion for Quest)

- Federal subsidies ~ \$655 Million
- Alberta subsidies ~ \$745 Million
- Shell cost ~ \$0

Who would build these, and how long in construction?

What would you do with them if/when carbon emissions are eliminated?

CCS Operations

- Let's assume capture 1 million tonnes/year.

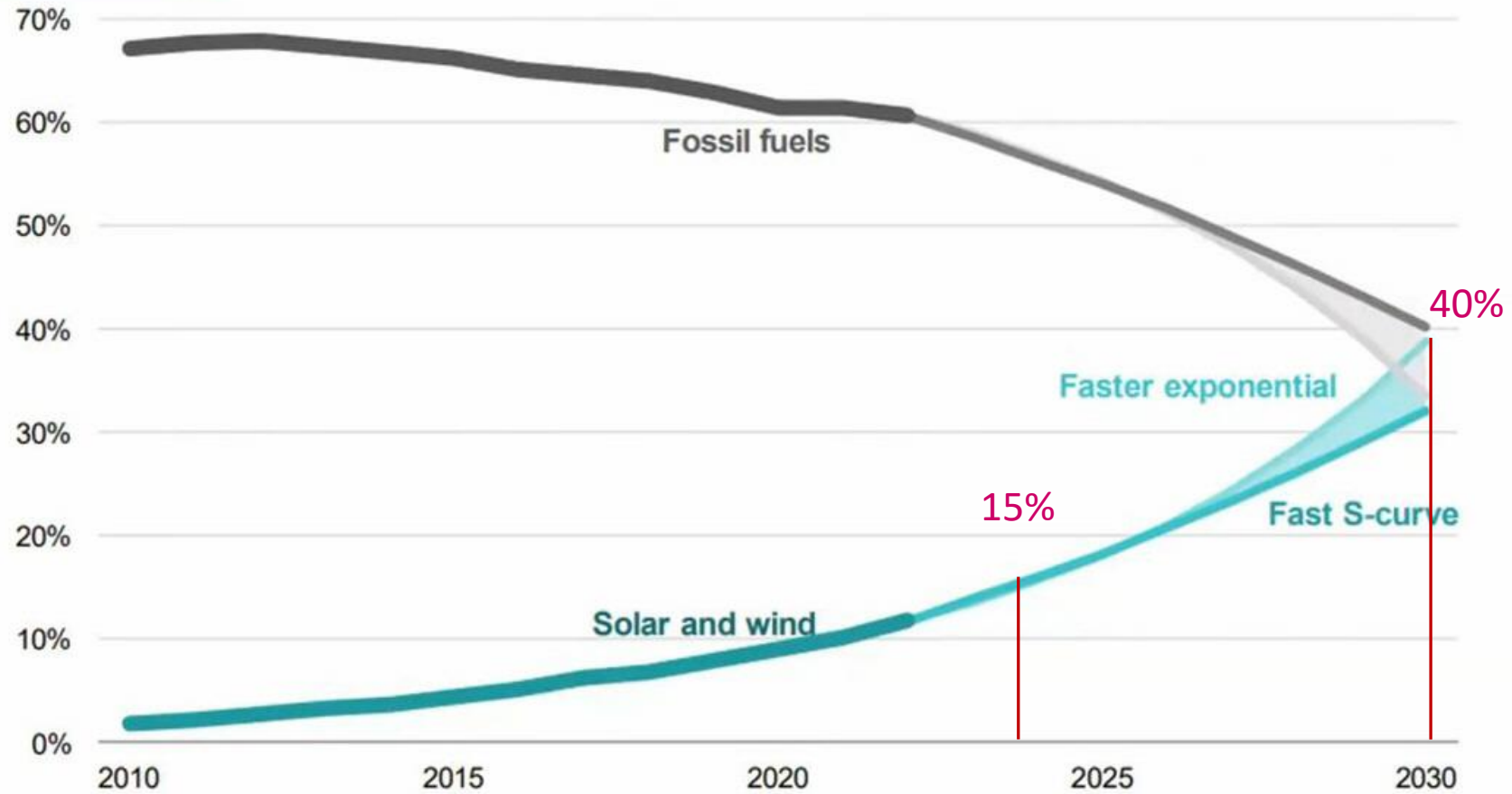
Number CCS facilities to capture and store annual global emissions (40 GT)

= 40,000,000,000 tonnes/1 million tonnes

= 40,000 facilities to counter global emissions!

Global Share of Electricity by source

Figure 15: Global share of electricity generation by source



Source: Energy Institute (past),⁷⁶ RMI forward

Source: <https://rmi.org/insight/x-change-electricity/>

SUMMARY - the wrong approach

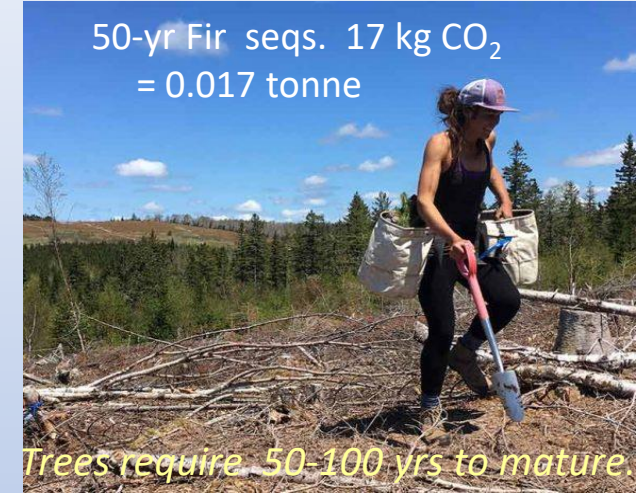
IPCC Warning At least 45% reductions in emissions by 2030!



Legislate Emission Caps?
How much of a cap? 10%? 90%



Sequestration – plant trees?



Sequestration – DAC?



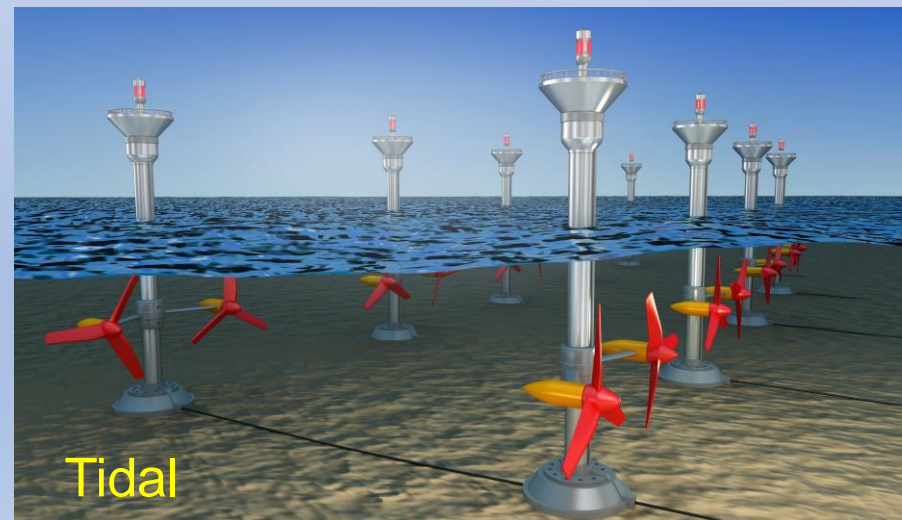
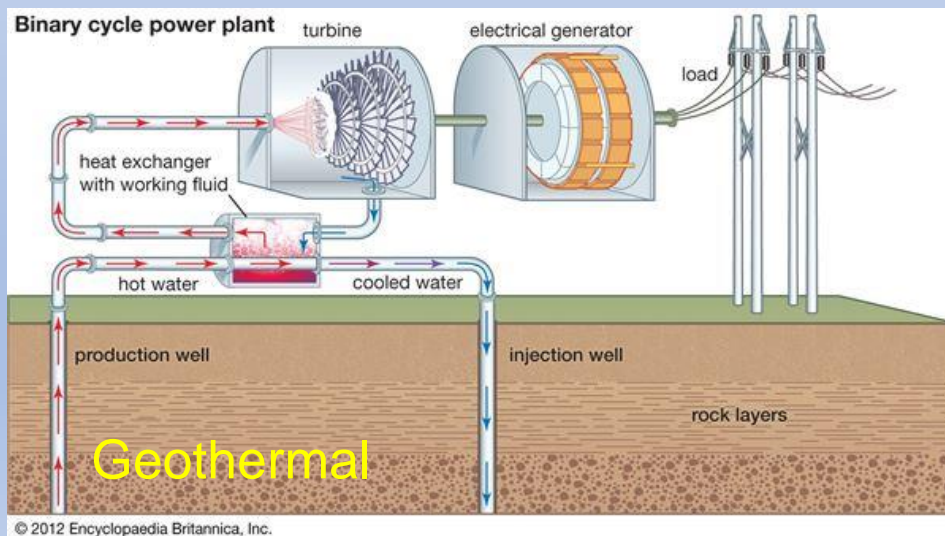
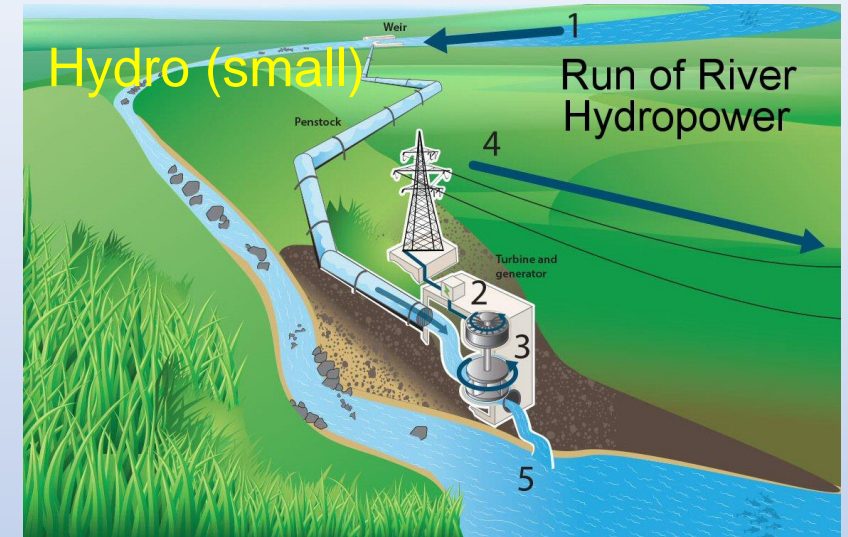
Sequestration – CCS?



None of these will work to counter emissions!

What other options do we have?

SUMMARY – getting on the right track with Renewable Energy



Work with Nature?

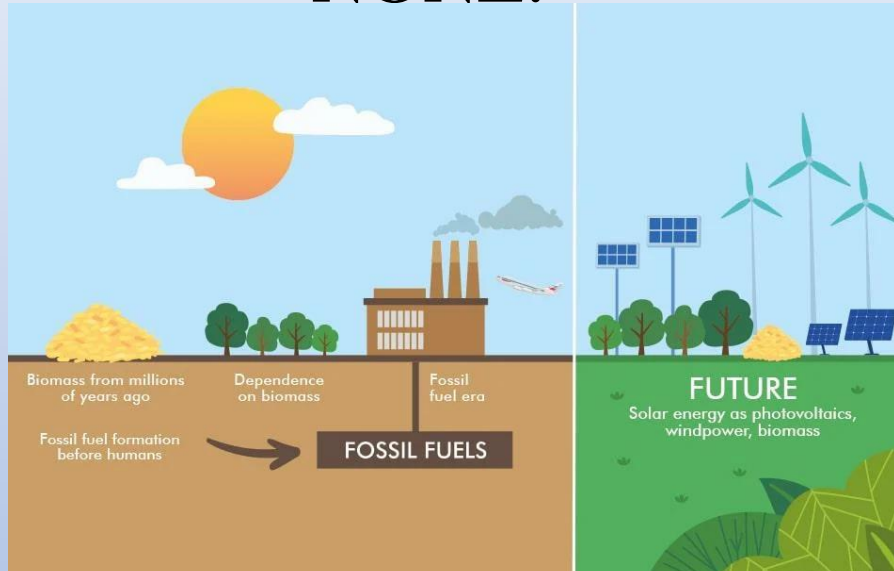


Combine 2 or 3 renewables in a microgrid

SUMMARY - Renewable 'clean' Energy

Reasons NOT to convert to Renewables:

- **NONE!**



Renewables will (are) catch(ing) on quickly because:

- Renewables work 'with' nature rather than 'fighting' against nature as fossil fuels do.
- The technologies are well-known.
- For any given renewable, technicians know exactly what power it will provide.
- Renewables are (relatively) cheap, quick/easy to construct.
- They have low maintenance costs.
- All provide clean, cheap energy.
- Zero GHGs and no air pollutants!

Ignore pressures from fossil fuels, and let Market Forces reduce fossil fuel Demand, then Supply:

- Renewables will drive *fossil fuel demand* down, which will
- *force fuel supply* down, which will
- *reduce carbon emissions*
 - to 50% by 2030;
 - to 90-95% by 2040.
- Would give a fighting chance to combat the climate crisis.



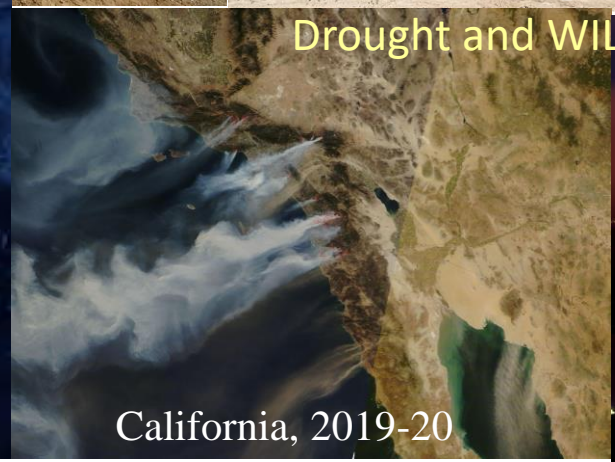
Some say a solar or wind farm are not very pleasing esthetically (NIMBYs).

For those people, we offer them Fort McMurray.



"I'd put my money on the Sun and Solar Energy, what a source of Power! I hope we don't have to wait until oil and coal run out, before we tackle that."

-Thomas Edison, 1900



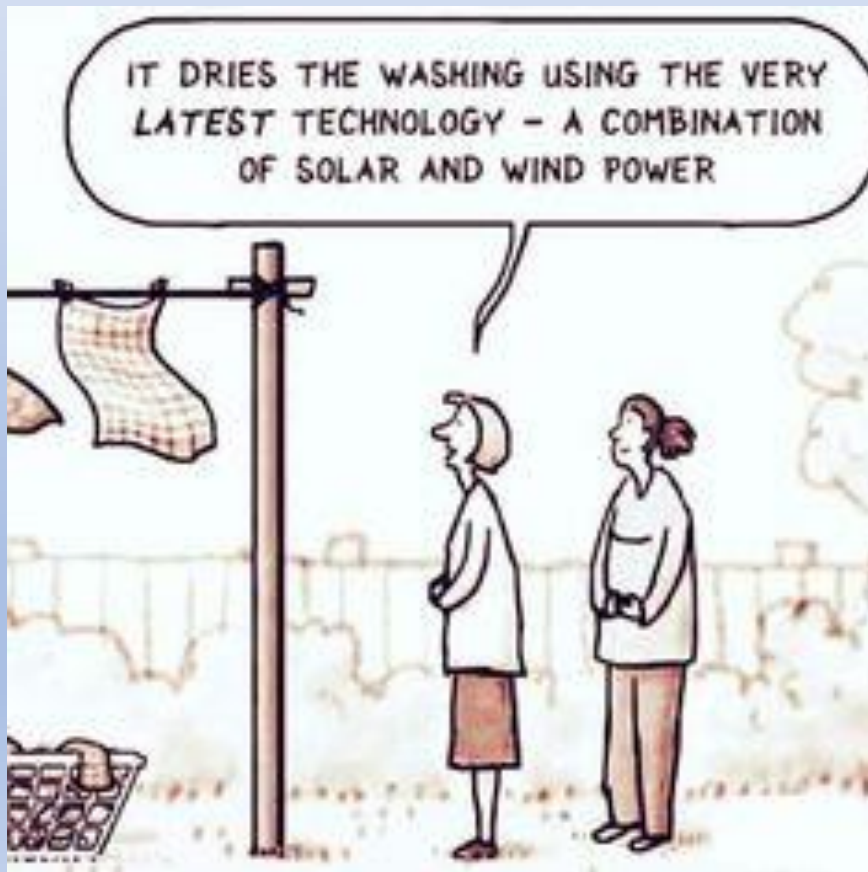
Climate IMPACTS

“What will be our (climate) legacy to future generations?”

CAUTION

Don't put much reliance on governments and/or new technology to solve the climate crisis!

- Recall the last 28 COP meetings, where most governments failed every one of their promises.
- We need to re-learn how to work with nature instead of fighting against it.
- Renewable energy systems are being initiated at **local levels** with microgrids.



Thank you!

Questions/Comments?

Extra Slides

Calculated Data from statistical formulae provided by various forestry departments, Canada & U.S.

Age Years	Douglas FIR Wt.				Sugar MAPLE Wt.			
	FIR Ht. (m)	CO2 sequestered per tree per year (tonnes)	Cumul. Wt. CO2 sequestered (tonnes)	Millions of FIRs to Sequester 1 MT per year	MAPLE HT. (m)	CO2 sequestered per tree per year (tonnes)	Cumul. wt. CO2 sequestered (tonnes)	Millions of MAPLEs to Sequester 1 MT per year
3	0.61	0.00001	0.00003	30,401.1	0.61	0.00001	0.00004	24,332.5
5	3.86	0.00096	0.00196	511.4	2.84	0.00006	0.00016	6,233.5
10	6.34	0.00215	0.01272	78.6	5.40	0.00053	0.00283	352.9
15	8.62	0.00361	0.03077	32.5	8.25	0.00156	0.01062	94.2
20	10.73	0.00527	0.05714	17.5	10.96	0.00312	0.02624	38.1
25	12.67	0.00709	0.09261	10.8	13.41	0.00519	0.05220	19.2
30	14.48	0.00902	0.13774	7.3	15.58	0.00772	0.09080	11.0
35	16.17	0.01103	0.19289	5.2	17.49	0.01068	0.14419	6.9
40	17.74	0.01308	0.25830	3.9	19.17	0.01405	0.21442	4.7
45	19.21	0.01516	0.33409	3.0	20.66	0.01783	0.30359	3.3
50	20.59	0.01723	0.42024	2.4	21.98	0.02205	0.41384	2.4
55	21.88	0.01929	0.51669	1.9	23.17	0.02672	0.54746	1.8
60	23.10	0.02132	0.62330	1.6	24.24	0.03190	0.70694	1.4
65	24.24	0.02331	0.73987	1.4	25.21	0.03763	0.89511	1.1
70	25.33	0.02526	0.86617	1.2	26.10	0.04402	1.11520	0.9
75	26.35	0.02715	1.00193	1.0	26.92	0.05117	1.37104	0.7
80	27.32	0.02899	1.14686	0.9	27.68	0.05924	1.66725	0.6
85	28.24	0.03076	1.30066	0.8	28.39	0.06848	2.00964	0.5
90	29.12	0.03247	1.46301	0.7	29.06	0.07923	2.40579	0.4
95	29.95	0.03411	1.63359	0.6	29.71	0.09206	2.86609	0.3
100	30.74	0.03569	1.81206	0.6	30.35	0.10797	3.40592	0.3

- from Strong and Barge, 2022

Following a recent criticism in the Guardian about the Shell CCS facility:

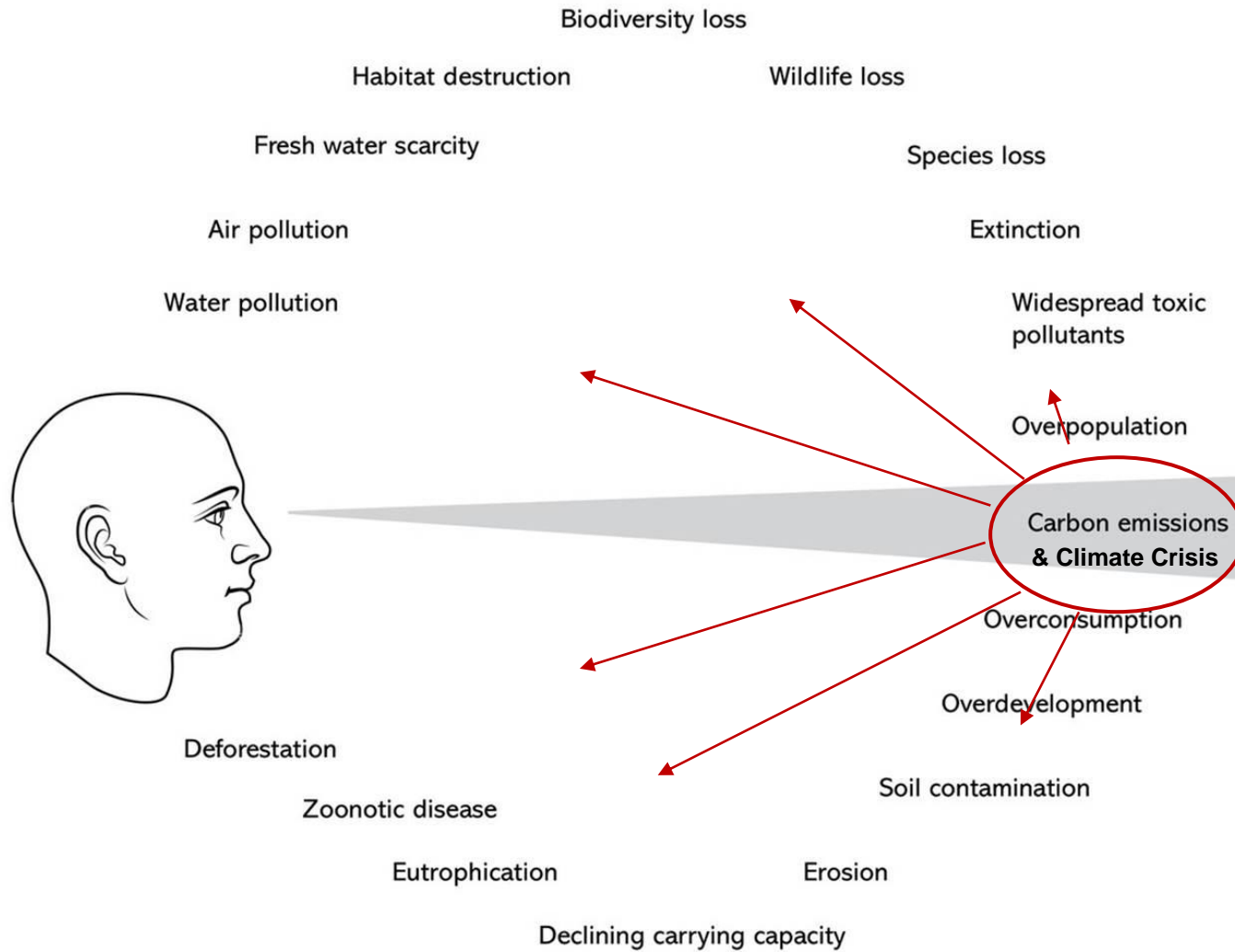
A Shell spokesperson responded with: *“It remains our view that global energy demand will continue to grow and be met by different types of energy – including oil and gas,”* he said. *“In that scenario, a balanced energy transition plays well into our portfolio – one that delivers more value, with less emissions by focusing on performance, discipline and simplification.”*

Right! - less emissions by focusing on performance, discipline and simplification. Brilliant!

Carbon Tunnel Vision

Missing the big picture

- from Dave Dougherty's email



*Carbon emissions and the
Climate Crisis affect
ALL things on Earth*

Its INERTIA and momentum sank the great ship Titanic, despite repeated warnings of ice ahead

It was believed to be unsinkable.



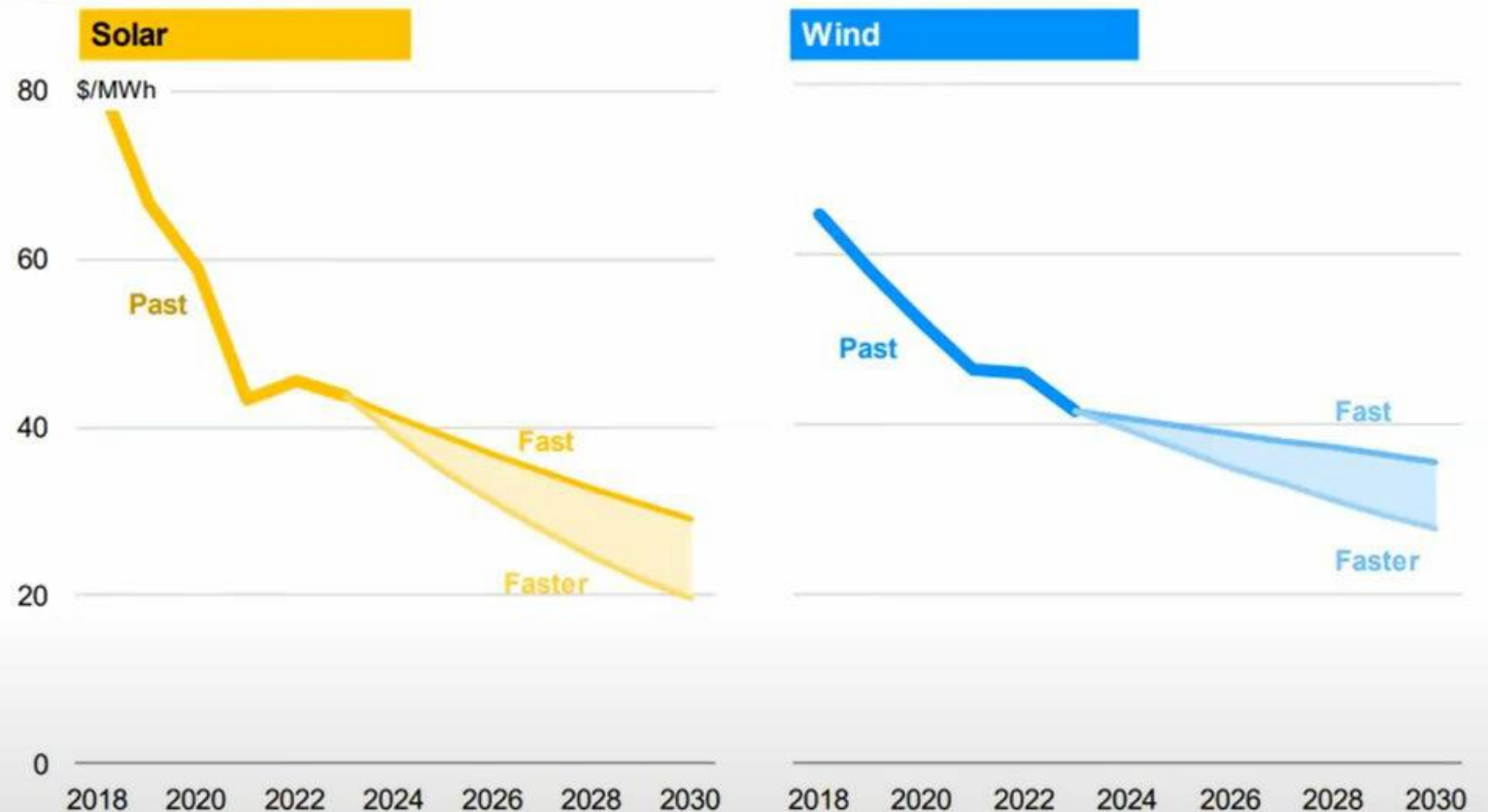
When Wayne Gretzky was growing up, his dad, Walter told him to “*skate to where the puck is going, not where it is now.*”

Where will the puck be?

- Lower costs
- Same applies to batteries
- Same applies to EVs

➔ economics alone will drive adoption

Figure 9: Expected solar and wind costs at different learning rates, \$/MWh



Source: BNEF.⁴⁴ RMI analysis

To be Covered . . .

- Significant climate impact events. 2021-23
- Immoralities
- Trends in Carbon Emissions, Atmospheric CO₂, and Global Temperature
- Positive feedbacks to the climate, and Tipping Point
- Misunderstandings, deceptions and mistruths of climate change
 - Net-zero, and carbon emissions reporting
 - Sequestering CO₂ from the atmosphere and industry source (trees, DAC, and CCS)
 - About renewable energy, EVs, etc.
- Renewable Energy
 - Types
 - Global trends
 - Potential for converting from fossil fuel energy
- Our Options for solving the Climate Crisis