CARBON FREE GROUP
CONNECTED INNOVATION

Electrification of British Columbia

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Carbon Free Group

We work to decarbonise the environment by managing projects, products, process and policy. Through the spirit of interdependence, we provide a platform for innovation. We deliver more sustainable, higher performance, lower cost solutions at a deferred risk and we unite diverse stakeholders at every level to network and engage.

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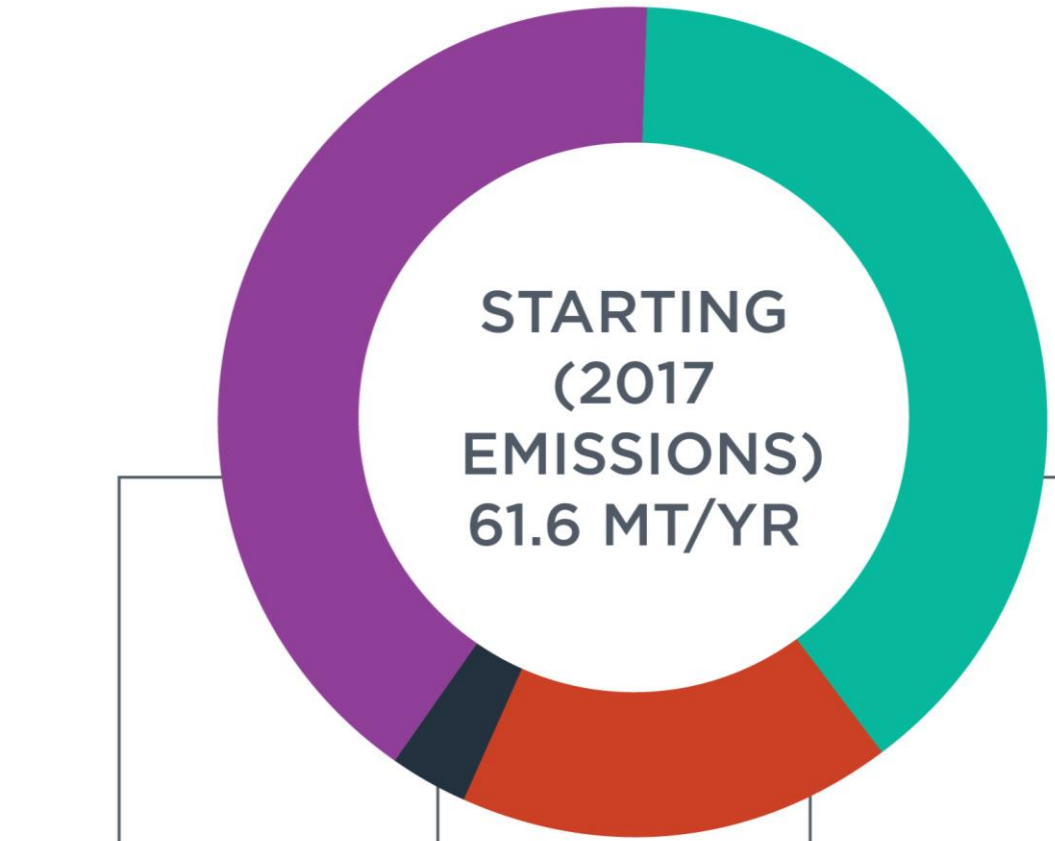
Even with the highest standards of energy efficiency and demand reduction;to meet our targets, we will need to greatly expand BC's electricity generation.

British Columbia



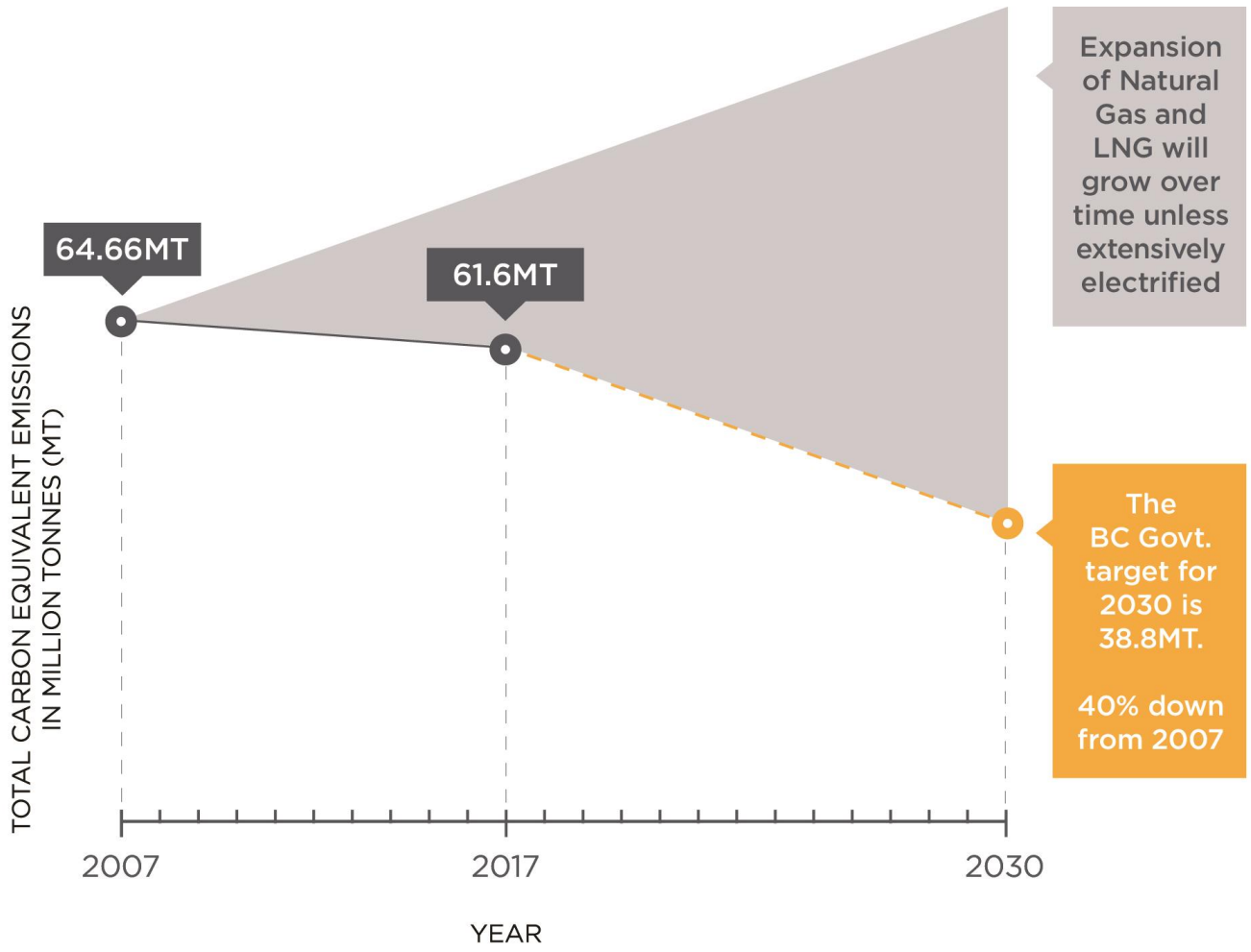
INDUSTRY
41% (25.5 MT)*

DEFORESTATION
3%*

BUILT ENVIRONMENT
17% (10.5 MT)*

TRANSPORT
39% (24 MT)*

*ANNUALLY



Emissions for 2017 were around 61.6 Mt, therefore the target is to find another 22.8Mt (37%) reduction over the next 12 years.

INDUSTRY

- Our greatest potential for GHG emission Prevention is with extensive electrification of Natural Gas and LNG.
  Depending on the scale of development by 2030, an additional 7 to 45 million Tonnes per year can be added to BC's carbon emissions.

INDUSTRY

LNG Canada recently announced that they are nearing the final investment decision on Phase 1 LNG facility

13 Million Tonnes Per Annum (MPTA) or 1.73 Billion Cubic Feet per Day (BCFD)

Segment	Conventional Approach (GHG Tonnes/yr)	Extensive Electrification (GHG Tonnes/yr)	% Reduction	Power Requirements (MW)	Power Requirements (GWhr)	% increase from 2017 BC electricity production
LNG Facility	3,380,000	975,000	71%	750	6,390	9.7%
Transmission	350,000	15,000	96%	100	852	1.3%
Upstream (1)	3,865,000	1,141,000	70%	310	2,180	3.3%
Total	**7,595,000**	**2,131,000**	**72%**	**1430**	**9,422**	**14.2%**

BUILT ENVIRONMENT

- Electrification of heating, an Air Source Heat Pump reduces the carbon emissions of conventional natural gas heating by 98%, a geoexchange system reduces emissions by over 99%.

2030	25 % of residential Homes and Multi family dwells Air Source Heat Pumps or Exchange HP.
	30% of private sector office buildings and retail, wholesale and warehousing buildings and 15% of all other commercial and institutional building stock have been retrofitted with heat pumps for space heating by 2030.

Segment	Conventional Approach (Natural Gas displaced by Electricity GWh)	Natural Gas GHG emissions (Tonnes CO2e/yr)	Electrification Power Requirements (GWhr)	% increase from 2017 BC electricity production	Extensive Electrification (Tonnes CO2e/yr)	% reduction
Residential	6,806	1,392,587	2,084	3.1%	22,231	98.4%
Commercial	38,667	7,912,231	11,838	17.9%	126,309	98.4%
Total	**45,472**	**9,304,817**	**13,921**	**21.0%**	**148,540**	**98.4%**

TRANSPORT

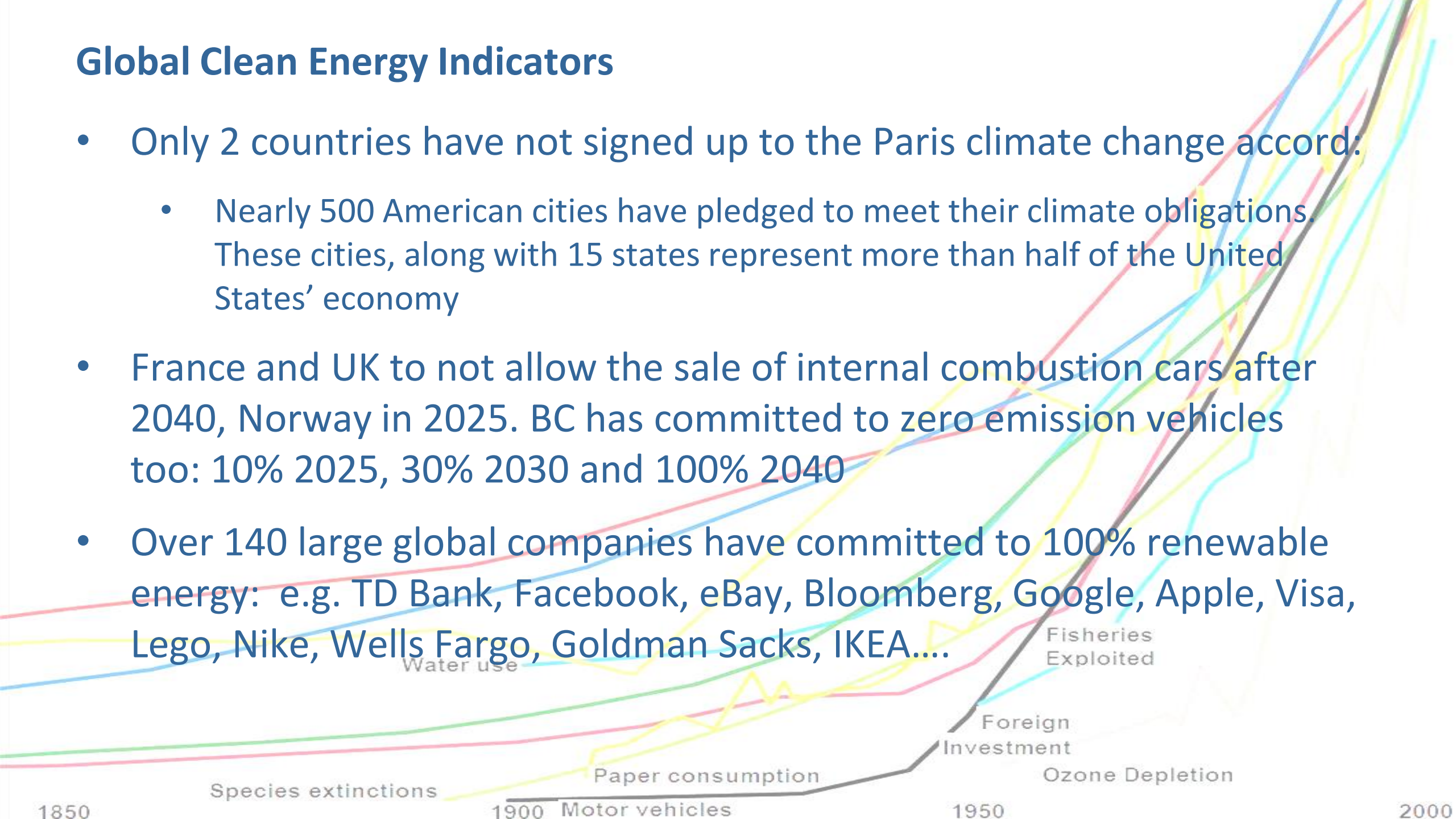
- Early adoption of EV transportation is important, however we will not see most of the benefits until past 2030. Electrification of transport serves to prevent additional emissions that would have otherwise moved us away from our goals.

Year 2030 (HYPOTHETICAL SCENARIO	Mean (GWh)	GHG Reductions (Mt of CO2e)	Total GHG Reductions (Mt of CO2e)	%	% increase from 2017 BC electricity production
Electric Cars	1,185	0.43	0.43	14.9%	1.8%
Electric passenger light trucks	1,178	0.55			
Electric freight light trucks	443	0.21			
Electric medium duty trucks	2,563	1.29	2.44	84.0%	8.0%
Electric heavy-duty trucks	1,130	0.39			
Electric school buses	4	0.00			
Electric transit	44	0.03	0.03	1.1%	0.1%
Electric Inter city buses	7	0.00			
TOTAL	**6,554**	**2.9**			**7.9%**

Year 2040 (HYPOTHETICAL SCENARIO	Mean (GWh)	GHG Reductions (Mill. of Tonnes of CO2e)	Total GHG Reductions (Mt of CO2e)	%	% increase from 2017 BC electricity production
Electric Cars	4,297	1.51	1.51	13.4%	6.5%
Electric passenger light trucks	4,334	1.99			
Electric freight light trucks	1,584	0.75			
Electric medium duty trucks	11,500	5.51	9.6	85.7%	32.7%
Electric heavy-duty trucks	4,211	1.36			
Electric school buses	10	0.01			
Electric transit	160	0.06	0.1	0.9%	0.3%
Electric Inter city buses	30	0.03			
TOTAL	**26,127**	**11.2**			**39.5%**

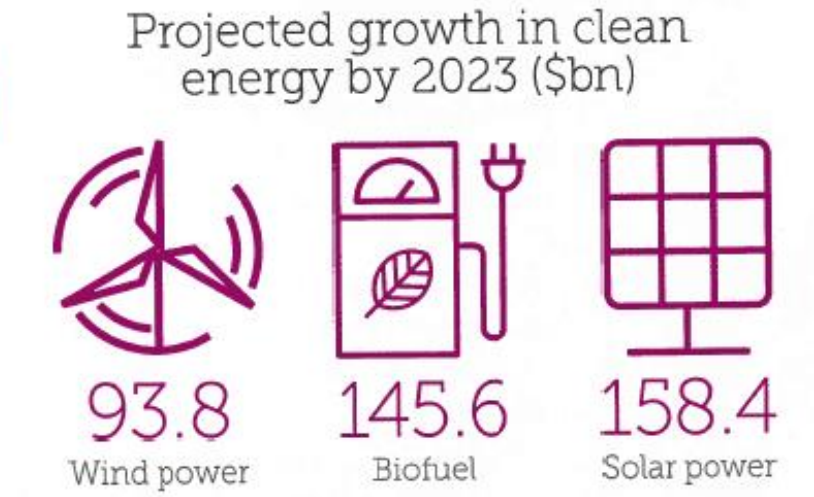
Global Clean Energy Indicators

- Only 2 countries have not signed up to the Paris climate change accord:
  - Nearly 500 American cities have pledged to meet their climate obligations. These cities, along with 15 states represent more than half of the United States' economy
- France and UK to not allow the sale of internal combustion cars after 2040, Norway in 2025. BC has committed to zero emission vehicles too: 10% 2025, 30% 2030 and 100% 2040
- Over 140 large global companies have committed to 100% renewable energy: e.g. TD Bank, Facebook, eBay, Bloomberg, Google, Apple, Visa, Lego, Nike, Wells Fargo, Goldman Sacks, IKEA….



Renewable Energy Trends

- Wind Power cost has fallen by over 50% in the last 5 years
- Solar PV (Photovoltaic) has fallen by 55% over the last 5 years
- Electricity storage (batteries) in the midst of a renaissance with costs falling over 77% since 2010
- Geothermal power has fallen by over 60% in the last 10 years



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Technology & Energy Trends

- Direct Air Capture of CO2

- Hydrogen and RNG
  - Energy storage as food

- Power Transition (DLT)

power transition

- Wireless Solar (and much more!)

No wires. Anywhere. Ever.

Making wireless power transmission and fast-charging a reality.

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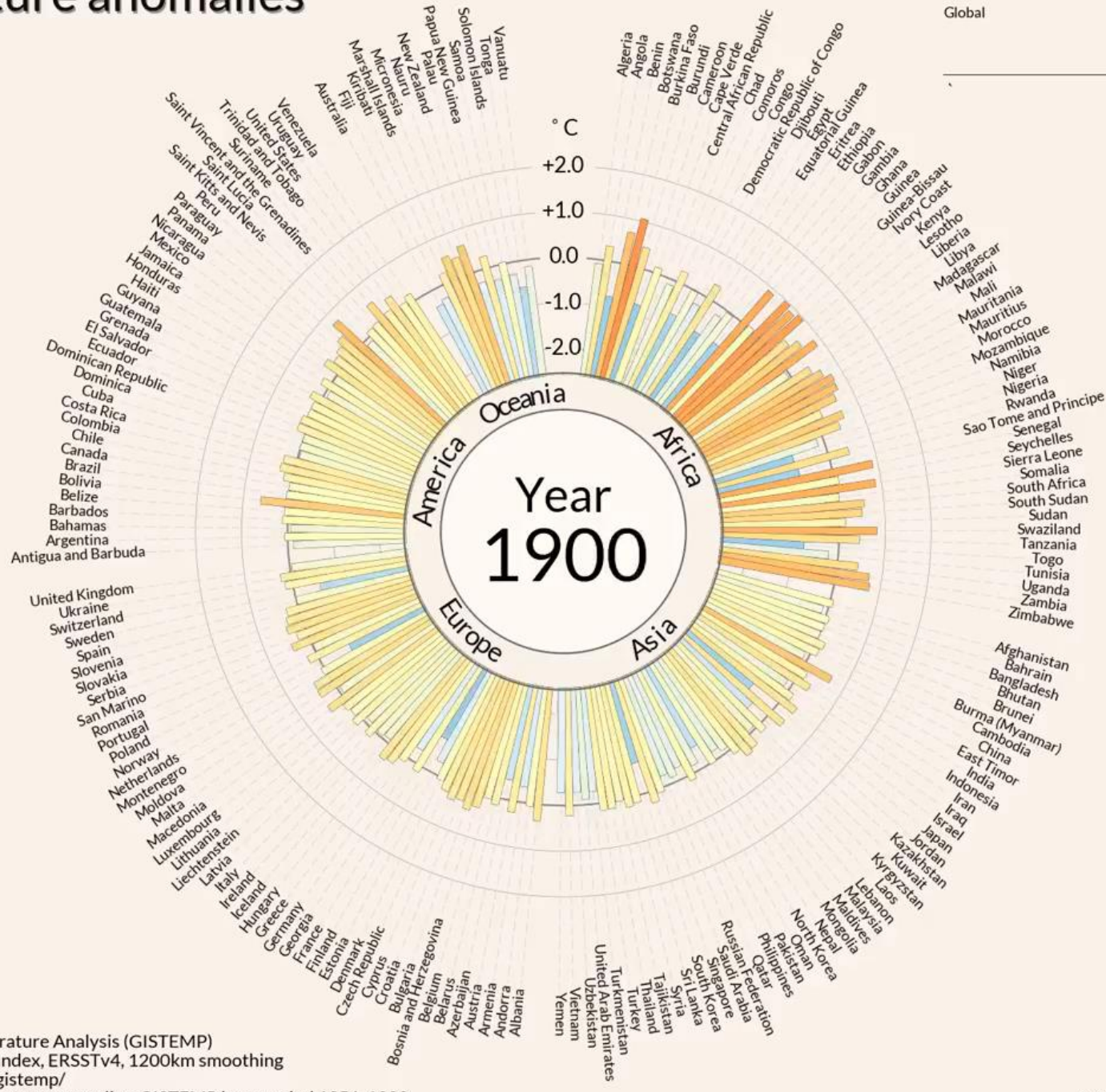
Temperature anomalies



Data source:
NASA GISS Surface Temperature Analysis (GISTEMP)
Land-Ocean Temperature Index, ERSSTv4, 1200km smoothing
https://data.giss.nasa.gov/gistemp/
Average of monthly temperature anomalies. GISTEMP base period 1951-1980.

Antti Lipponen (@anttilip)

1850

2000

The Big Picture
Climate Change

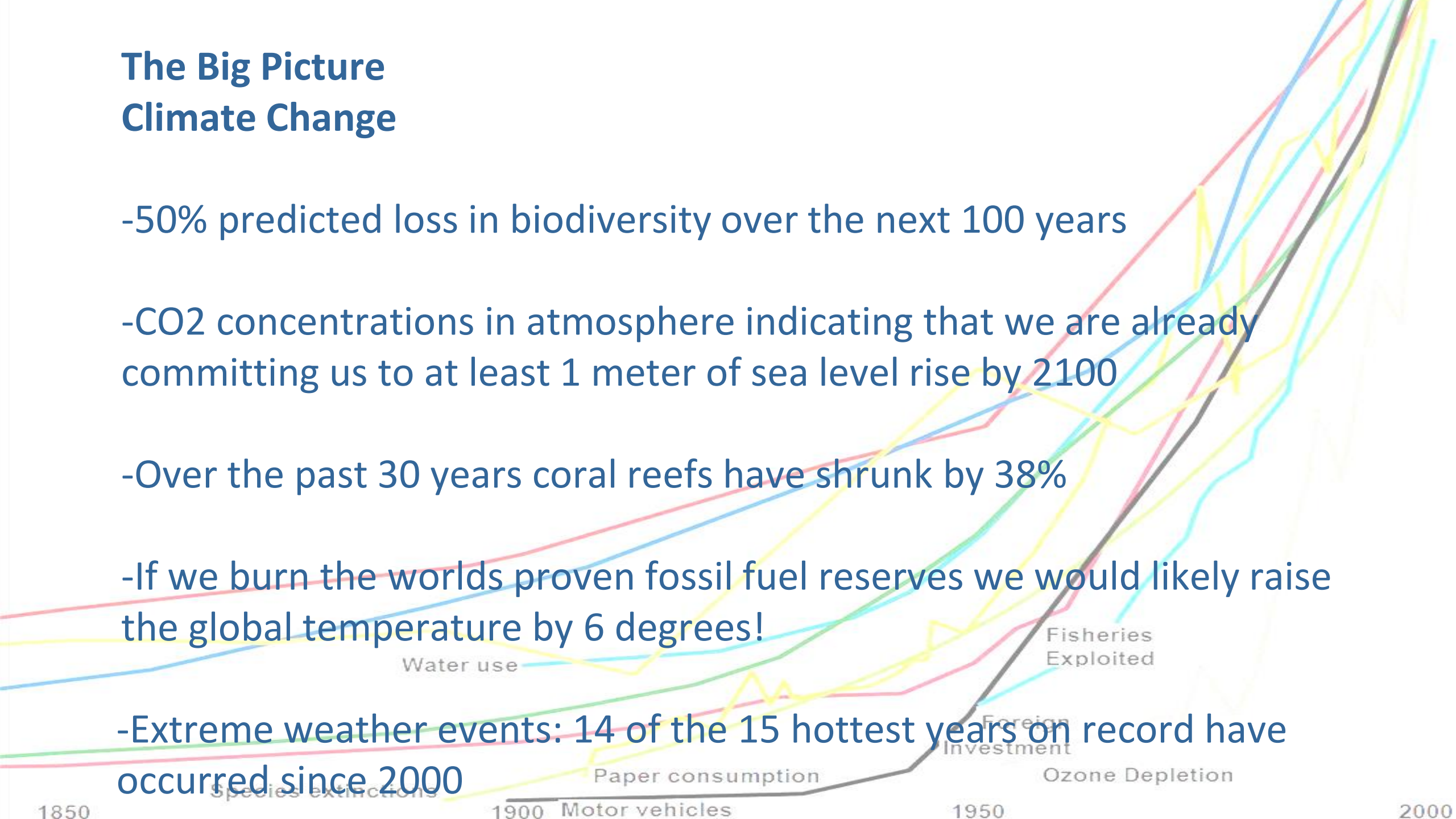
-50% predicted loss in biodiversity over the next 100 years

-CO2 concentrations in atmosphere indicating that we are already committing us to at least 1 meter of sea level rise by 2100

-Over the past 30 years coral reefs have shrunk by 38%

-If we burn the worlds proven fossil fuel reserves we would likely raise the global temperature by 6 degrees!

-Extreme weather events: 14 of the 15 hottest years on record have occurred since 2000



Some favourite Quotes

“It is not an investment if its destroying the planet”
-Bill McKibben

"For an organisation to survive, its rate of learning must be at least equal to the rate of change in its external environment"
-Revans' Law

“Civilization needs energy but energy use must not destroy civilization"
-Pope Francis

“Our goal is to fundamentally change the way the world uses energy...we want to change the entire energy infrastructure of the world to zero carbon”
-Elon Musk (Tesla)

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