Evolving Energy Systems in Canada to meet the climate challenge

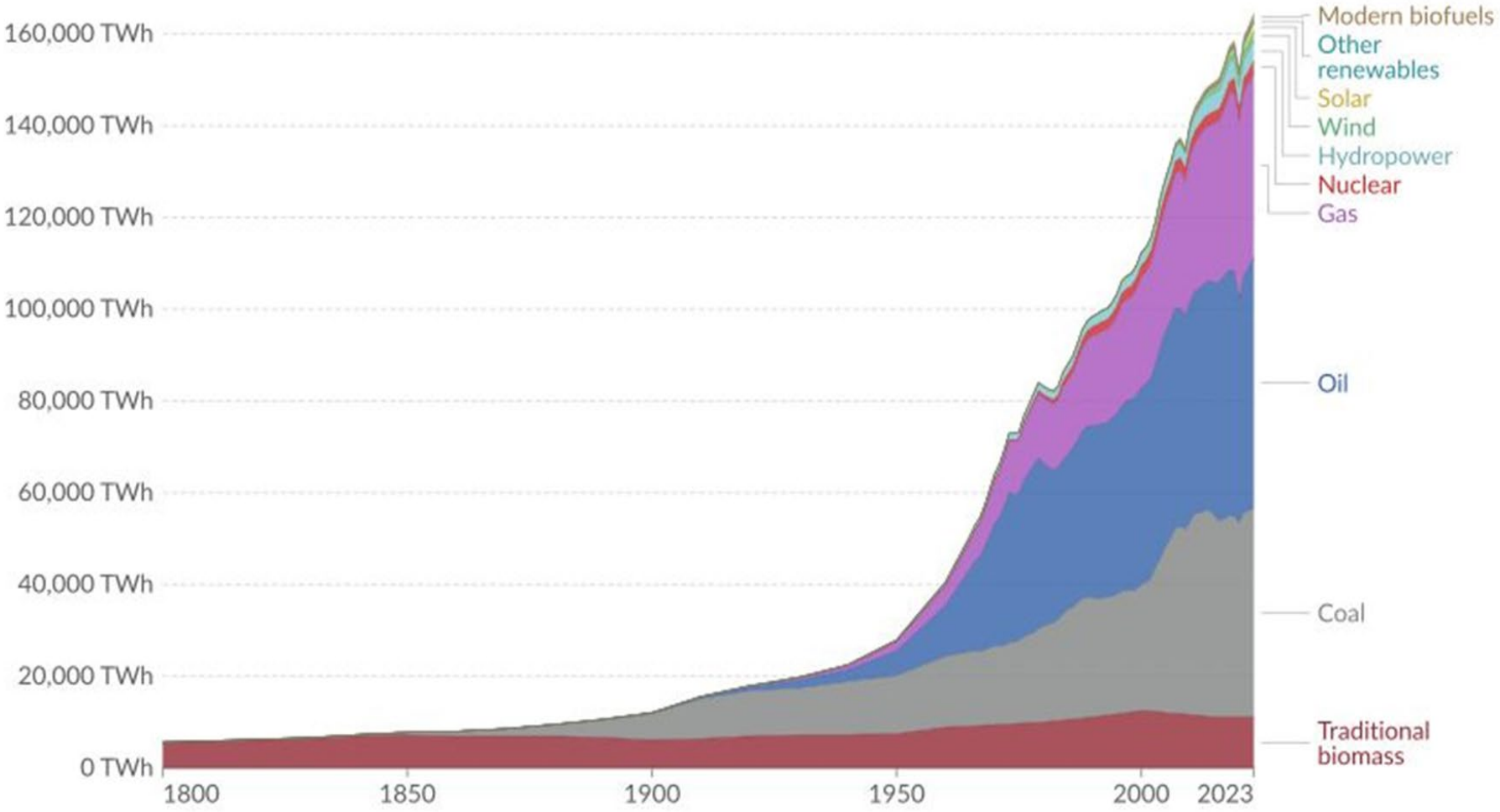
Allan Fogwill, May 2025

- ***The views and opinions expressed are those of the speaker in their personal capacity and do not necessarily reflect the official policy or position of any organization with which they are affiliated***

Global direct primary energy consumption

Our World in Data

Energy consumption is measured in terawatt-hours, in terms of direct primary energy. This means that fossil fuels include the energy lost due to inefficiencies in energy production.



Data source: Energy Institute - Statistical Review of World Energy (2024); Smil (2017)

OurWorldInData.org/energy | CC BY

Note: In the absence of more recent data, traditional biomass is assumed constant since 2015.

NET-ZERO

4-PART SOLUTION

1. Electrification where possible, and decarbonize the grid
2. Decarbonize and Clean Oil and Gas Production
3. CCUS and energy efficiency
4. Access to an International CO2e credit trading framework

Canada's Climate Management Actions

2016 Pan-Canadian Framework on Clean Growth and Climate Change

- A National Climate Plan for Canada to achieve its Paris Agreement target.

Canada's 2030 Emissions Reduction Plan

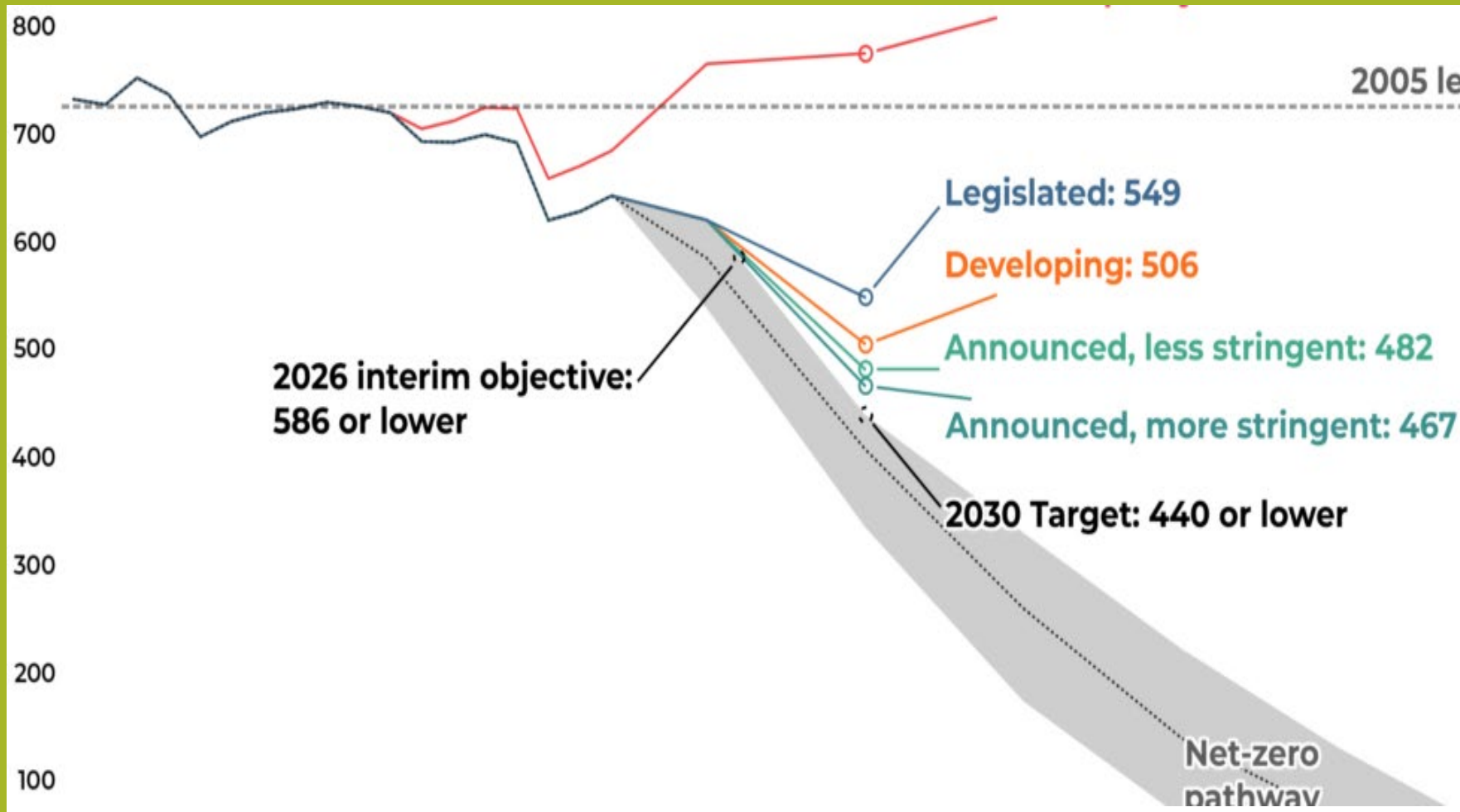
- a roadmap for the Canadian economy to achieve emissions reductions of 40-45% below 2005 levels by 2030.

National Adaptation Strategy

- Disaster Resilience and increased resiliency of Canada's natural and infrastructure systems

Carbon pricing

- Consumer price – recently moved from $80 to zero
- Industrial price – pricing in the range of $80 to $100.



CANADA'S SUCCESS – SO FAR

CONTEXT

The idea of a transition is that the electricity grid will be able to supply:

- All space heating needs
- All industrial process needs
- All transportation needs

WHAT IF IT CAN'T? WHAT DO WE DO?

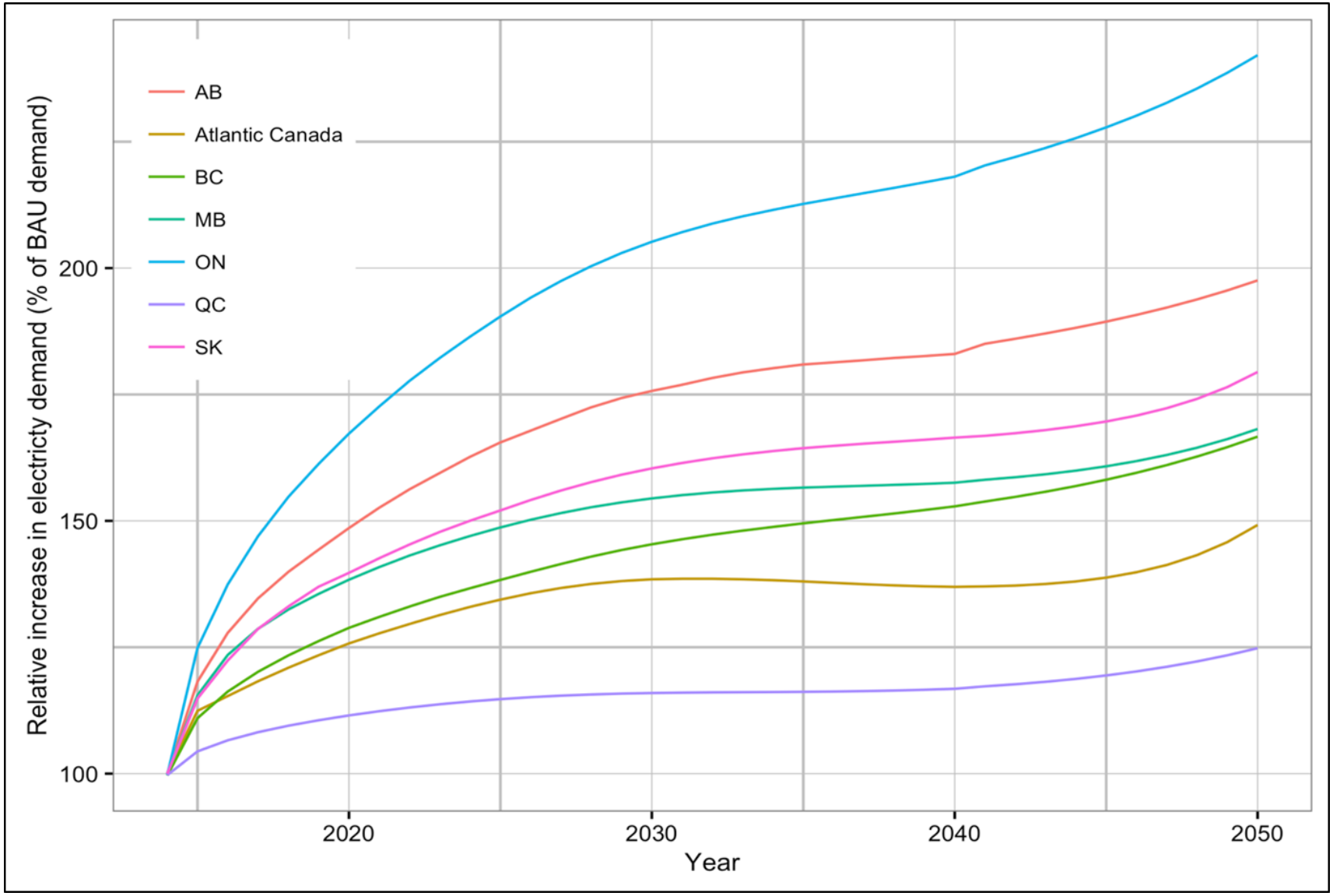
Canada is realising that we will be unable to electrify everything, therefore, more emphasis is shifting to

- Oil and gas clean tech
- CCUS
- International trading exchanges

SOLUTION PART 1: ELECTRIFICATION

- Electrification of end-use energy services is seen as a "technology path" to economy-wide GHG emissions reductions
- Manage emissions in hundreds of point sources – not several thousands of distributed emitters (buildings, vehicles, etc.)
- Proven technology exists to decarbonize power generation
- Such an economy-wide energy transition requires:
  - Changing the existing infrastructure across all sectors of the economy (infrastructure inertia)
  - Much larger electricity generation and transmission infrastructure than today
  - More expensive infrastructure than historical customer experiences (rates or taxes)

ELECTRICITY GRID IMPACTS



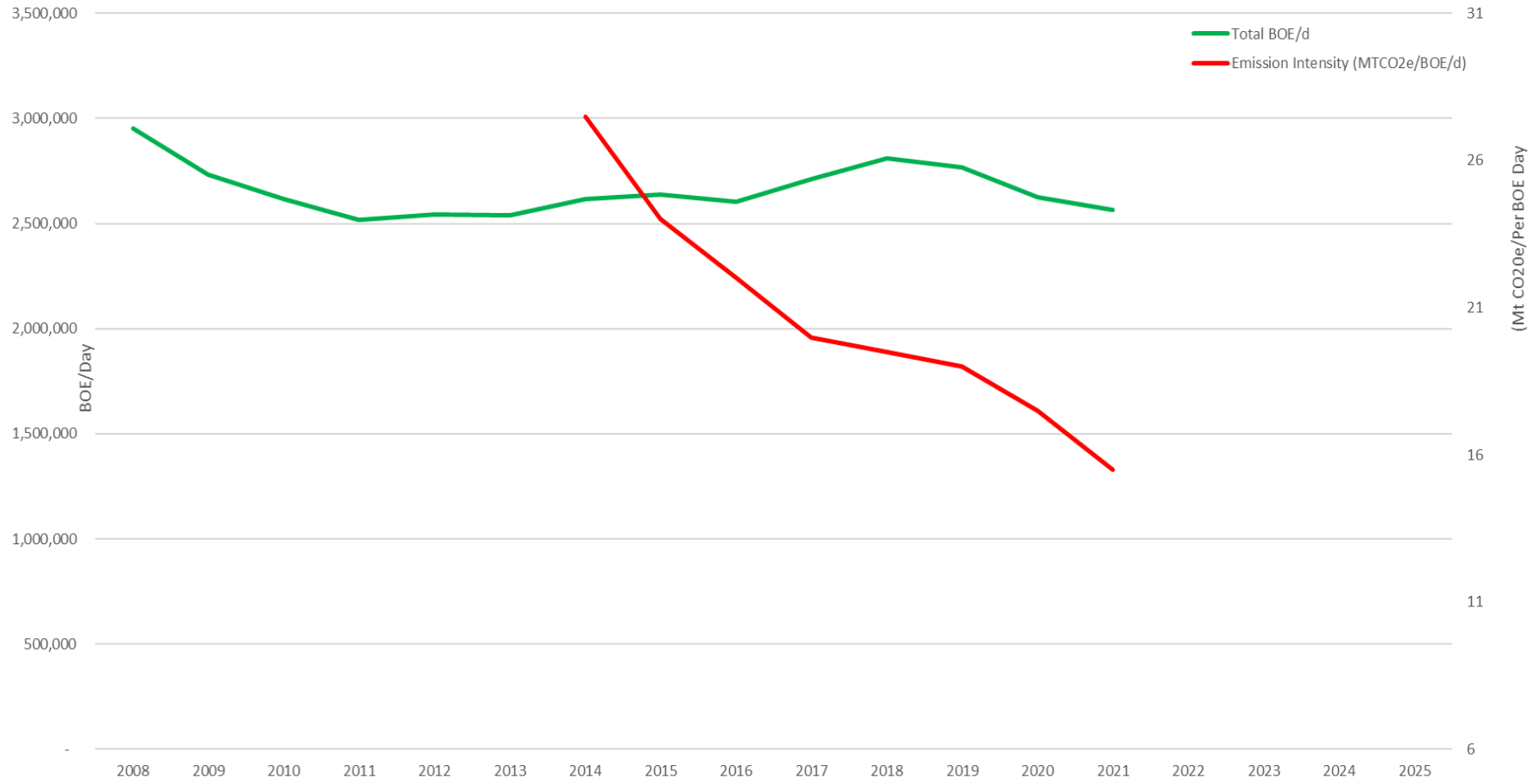
It is unlikely that the electricity system can achieve a net-zero solution by 2050 without continuing to use significant amounts of fossil fuels.

- Not enough time (approx. 10 years for a TX line)
- Not enough people (labour shortages in skilled trades and regulatory organizations)
- Not enough money (increase in heating bills)
- Not enough land (urban centres)

Solution Part 2: Decarbonize Fossil Fuels

- Focus on supply-side R&D, as the consensus on the demand side is substitution, not efficiency improvements (i.e. EVs instead of CAFÉ standards)
- Focus on methane emissions as CO2 is a smaller element of emissions upstream.
- Oil demand to be about 60 M to 70 M bbls per day under the 1.5-degree scenario (IEA)
- Heavy Oil demand will be maintained longer than light oil demand due to a larger number of value-added streams (e.g. plastics and lubricants)

Methane Emissions Reduction by Canadian Upstream Oil and Gas Producers



Solution Part 3: CCUS

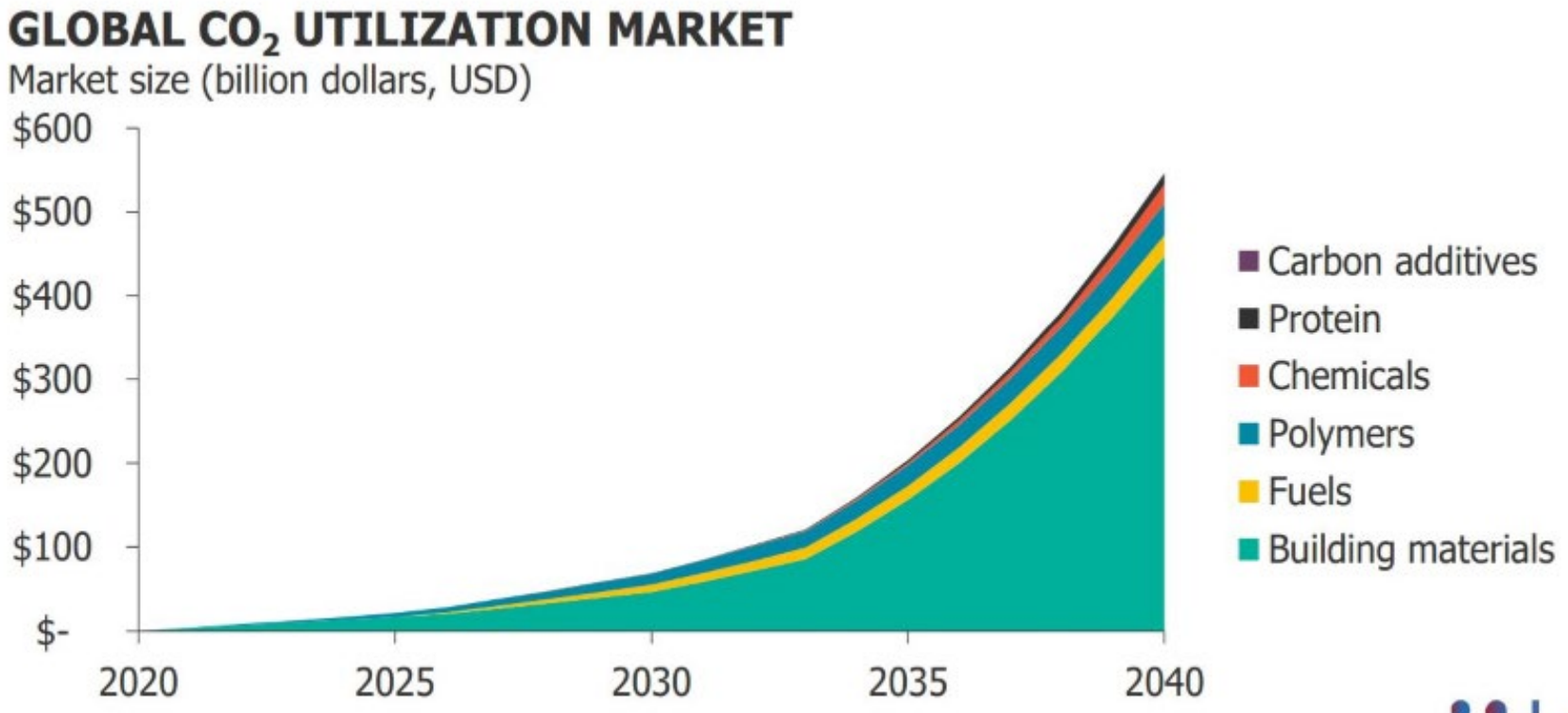
Emissions Reduction Costs $/tonne CO2e

- CCUS - $50 to $200
- Electrification - $100 to $150
- Methane capture - $negative to $50
- Energy Efficiency - $negative to $75

What could be the other economic benefits?

- Match investment to the local jurisdiction
- Avoid sunk costs and unnecessary reinvestment
- Utilization becomes a revenue stream to reduce costs.

Canada has numerous sequestration and utilization projects underway, with the first-ever global CCS facility built in Saskatchewan in 2012



CCUS REQUIRES AN ACTIVE UTILIZATION MARKET TO BE BROADLY ACCESSIBLE

The key to making Carbon Capture more affordable is the U, not the S.

* source: LUX Research

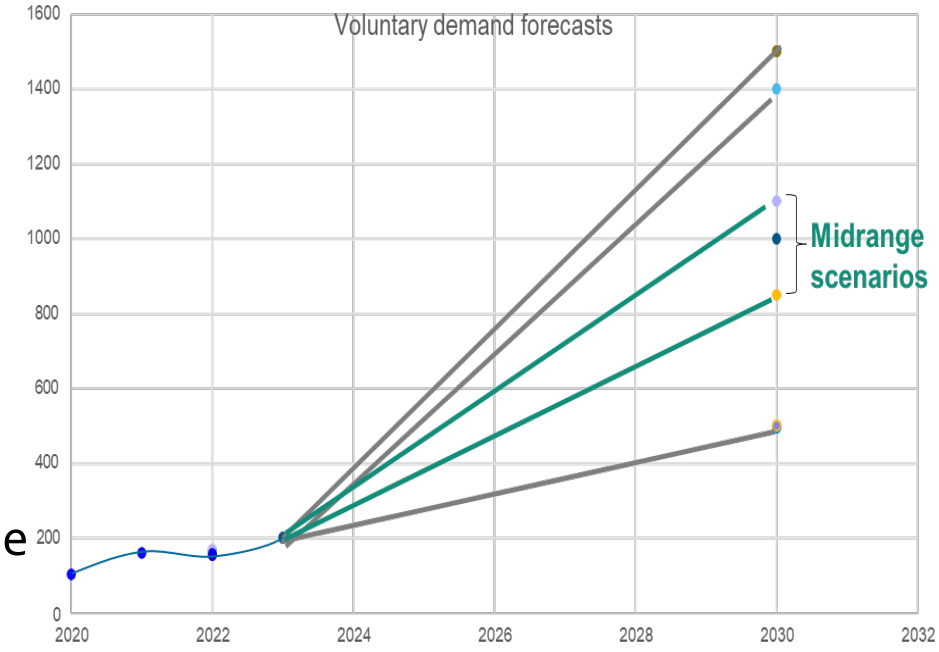
Solution Part 4: International Carbon Marekts

Financing gaps to fund the move to 1) electrification, 2) fossil fuel decarbonization, and 3) CCUS is likely greater than public funds

Voluntary markets are a good option for freeing up private capital for investments

Key challenges:

- Credibility of the credit
  (verification protocols)
- Minimizing compliance rules
  (Cap and trade? Voluntary?).
- Minimizing rule changes over time
  (Avoid undermining the market by making rule changes for a specific outcome)



Final thoughts: Least-Cost Planning

Moving past the debate about needing to reduce emissions to a focus on reducing emissions at the lowest cost. Build up the integrated plan via nested steps

1. Cost of options along the supply and demand for energy
   - Low emissions energy sources – fuel switching
   - Energy efficiency in systems with significant average CO_2 emissions
   - Carbon Capture Utilization and Sequestration
2. Add in: cost of options in other areas, including industry, agriculture, forestry, and land use
   - Process efficiency options
   - Resource and product efficiency (e.g. reducing food waste)
3. Add in: how options in other jurisdictions may be cheaper than the home jurisdiction
4. Then, what levers need to be used to realize implementation
   - Government policies and taxes
   - Market mechanisms
   - International agreements