No Bioenergy, No Climate Goals

Why Bioheat and BECCS are Necessary for Canada's Climate Credibility

TorchLight Bioresources

Jamie Stephen, PhD
Managing Director
Jstephen@TLBio.com

Summary

No bioenergy

↓

No enhanced forest management or BECCS

↓

No way to achieve climate goals

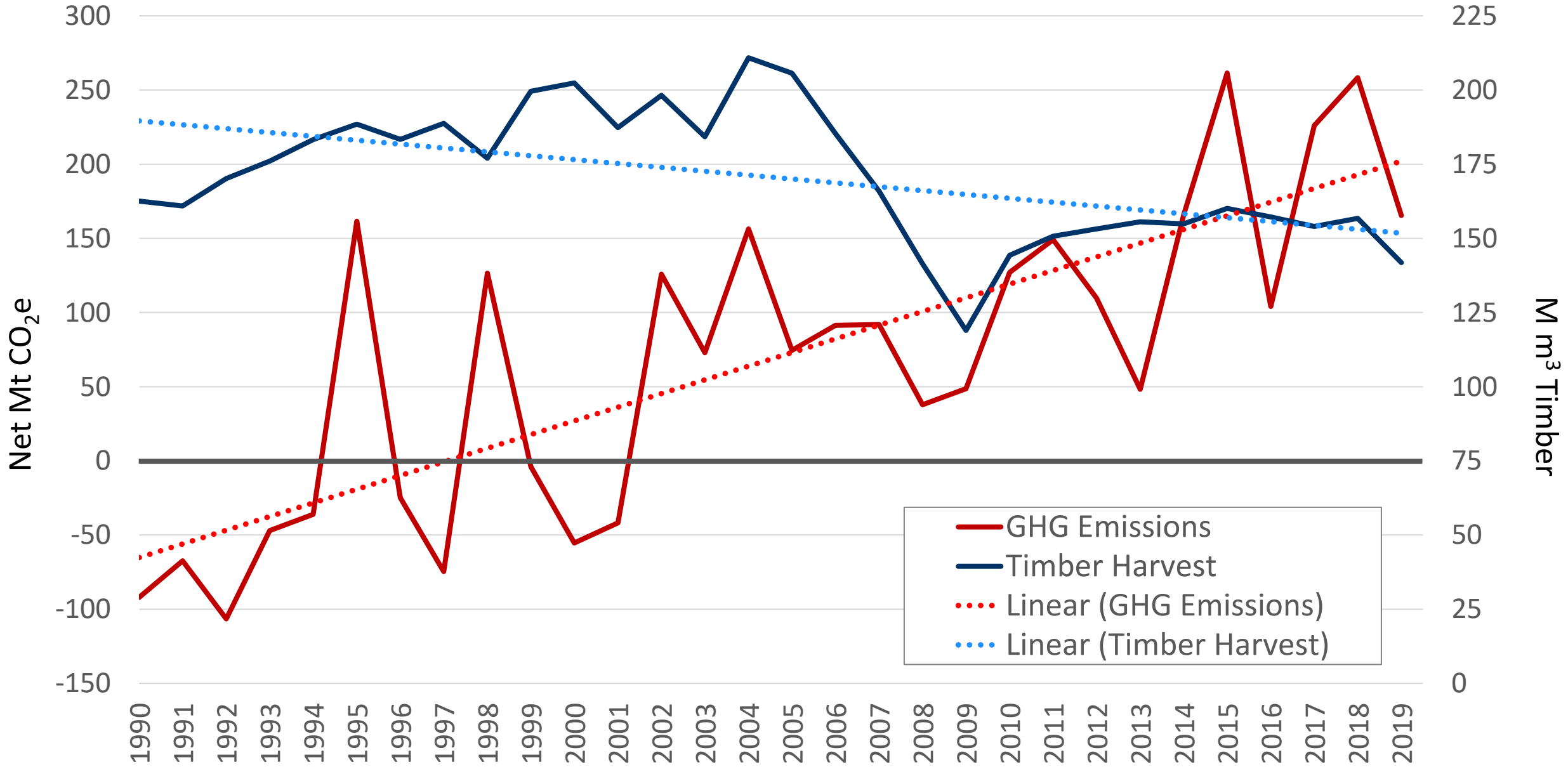
TorchLight Bioresources

The Facts

- Canada's 2019 anthropogenic GHG emissions were 738 Mt CO_2e
  - *Same at 2005*
- Canada has committed to a 40-45% reduction by 2030 (297-334 Mt CO_2e)
  - *Equivalent to eliminating ALL fossil fuel stationary combustion by 2030*
  - *Spain's TOTAL emissions are 275 Mt CO_2e (47 M people)*
  - *Nordic TOTAL emissions are 149 Mt CO_2e (27 M people, northern)*
- Canada's forests have shifted from Net Sink to Net Source (emitter)
  - *-20 Mt CO_2e/yr (1990-2000) to 120 t CO_2e/yr (2001-2019)*
- The annual carbon turnover of Canada's forests is 5x anthropogenic GHGs
  - *350,000 Mt CO_2e stored in forests (290,000 Mt CO_2e in managed)*

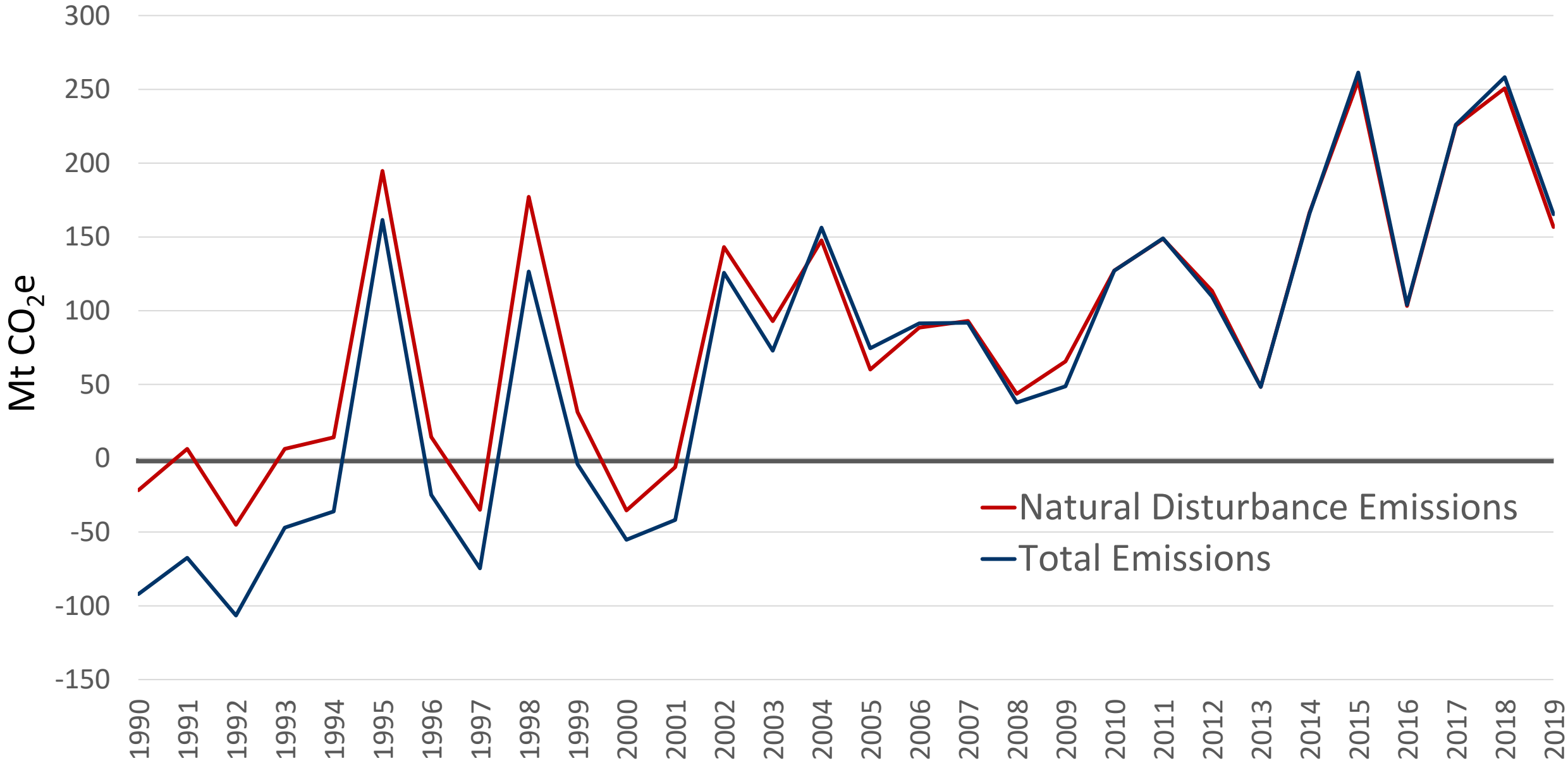
TorchLight Bioresources

GHGs from Canada's Forests Vs. Timber Harvest



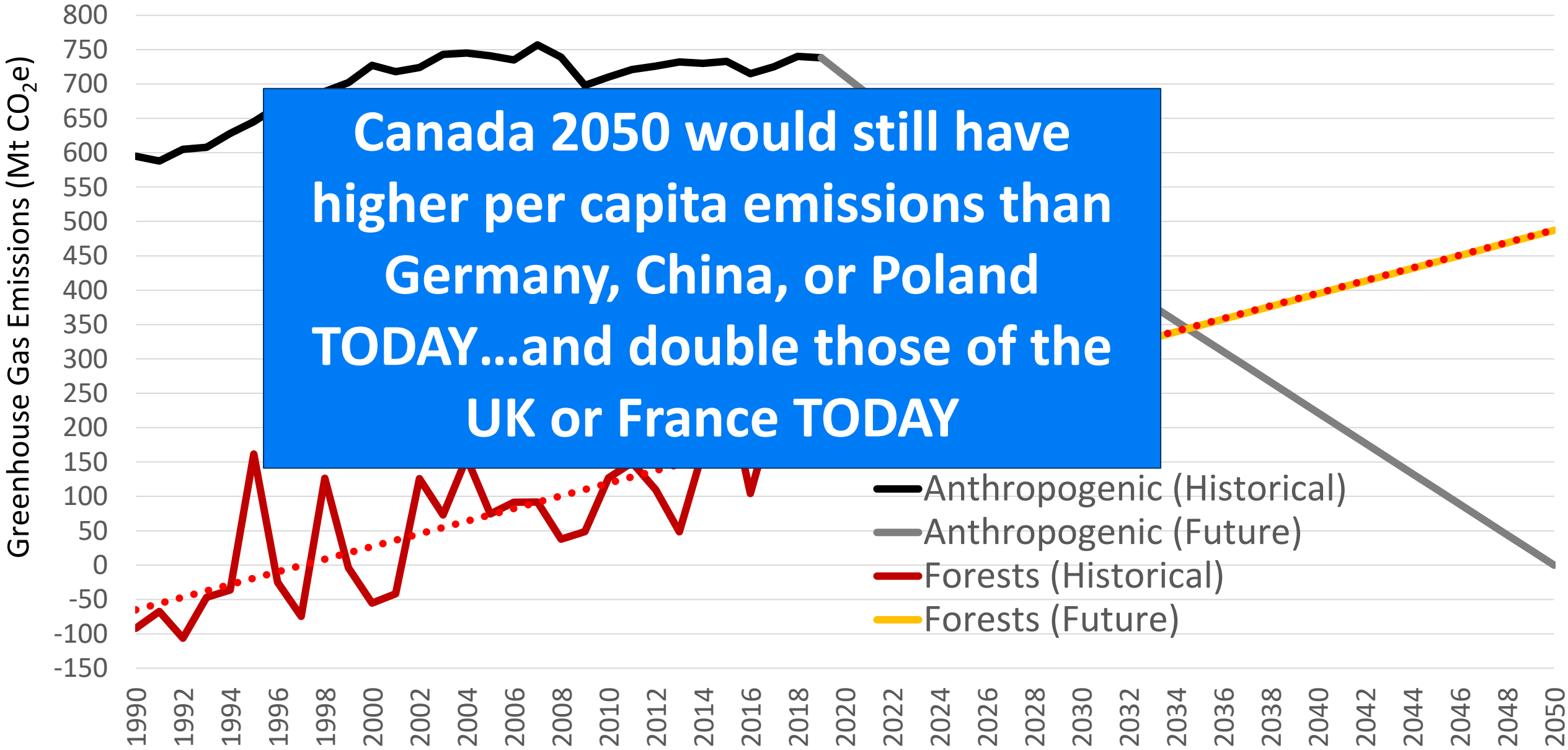
TorchLight Bioresources

Emissions: Natural Disturbance vs. Total

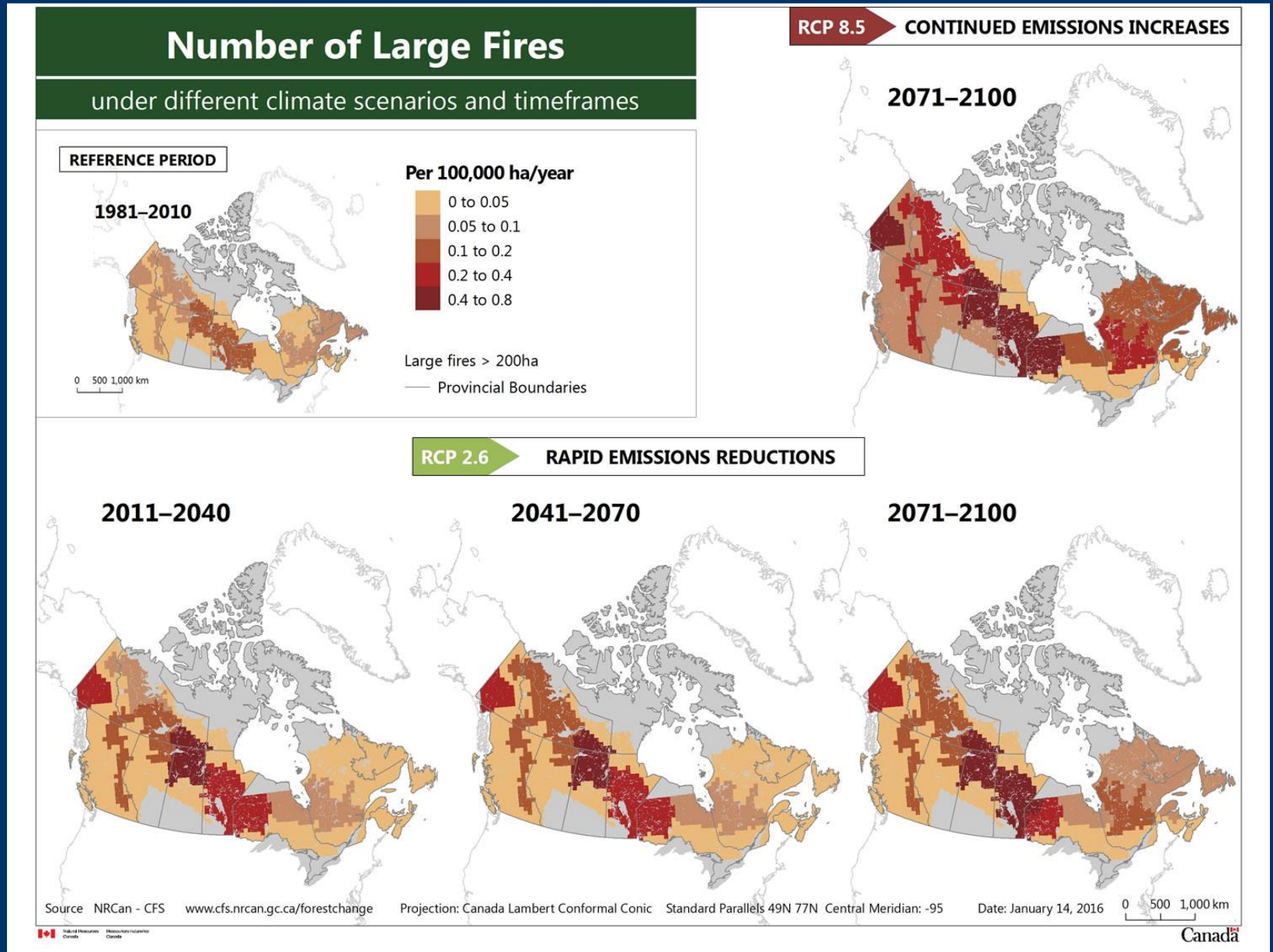


TorchLight Bioresources

The Future?

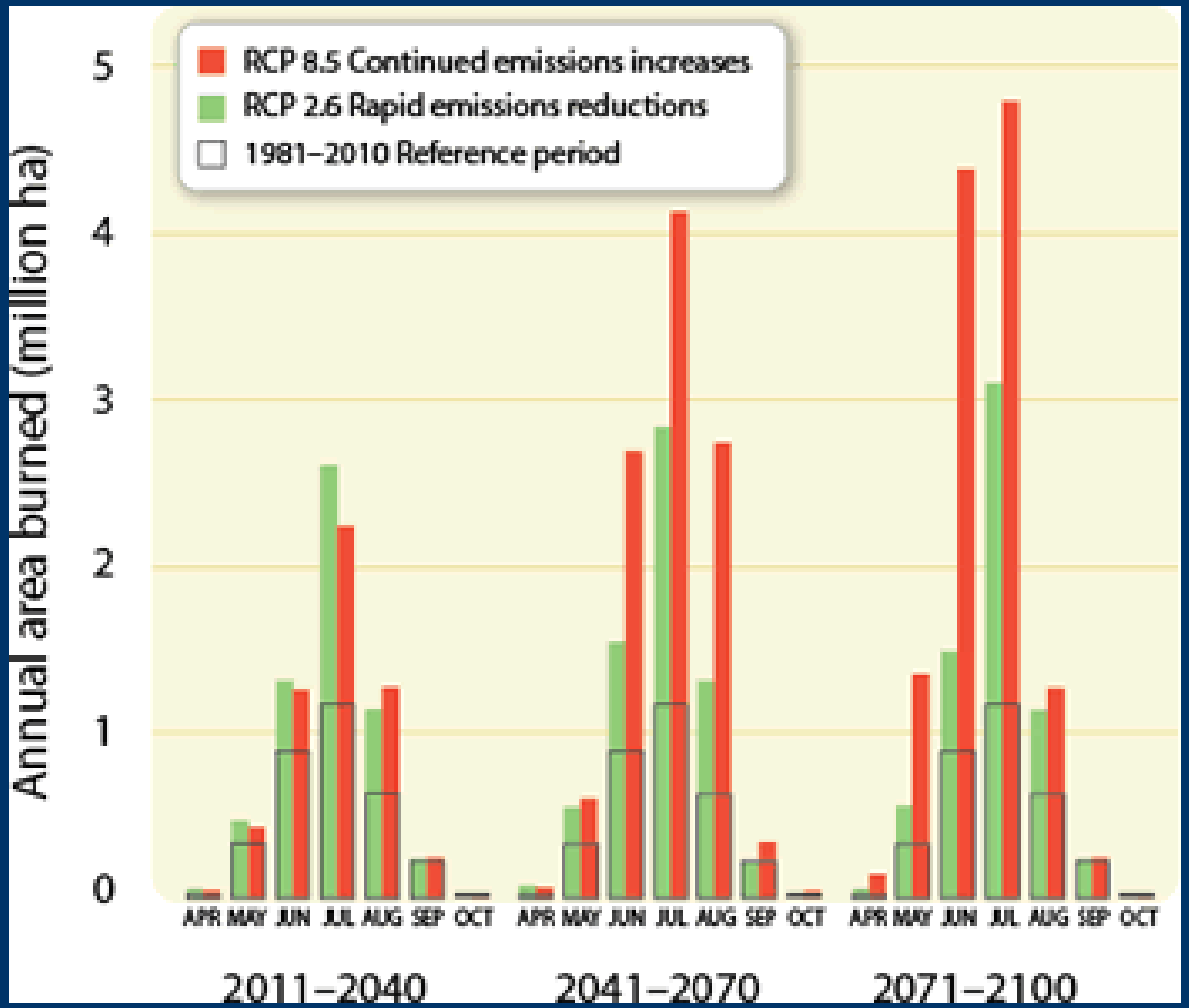


Trends Say More Emissions



TorchLight Bioresources

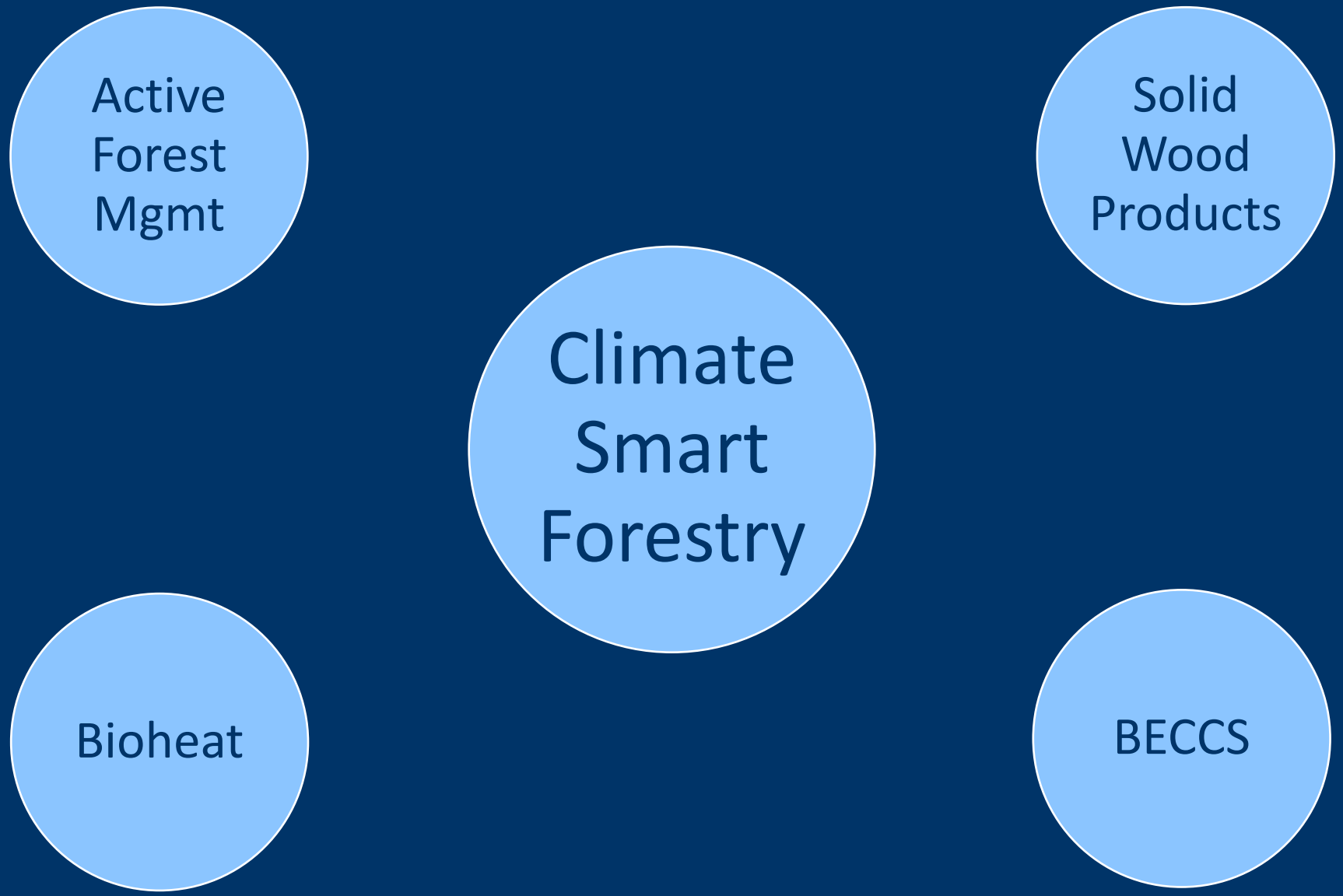
Trends Say More Emissions



What Does this Mean?

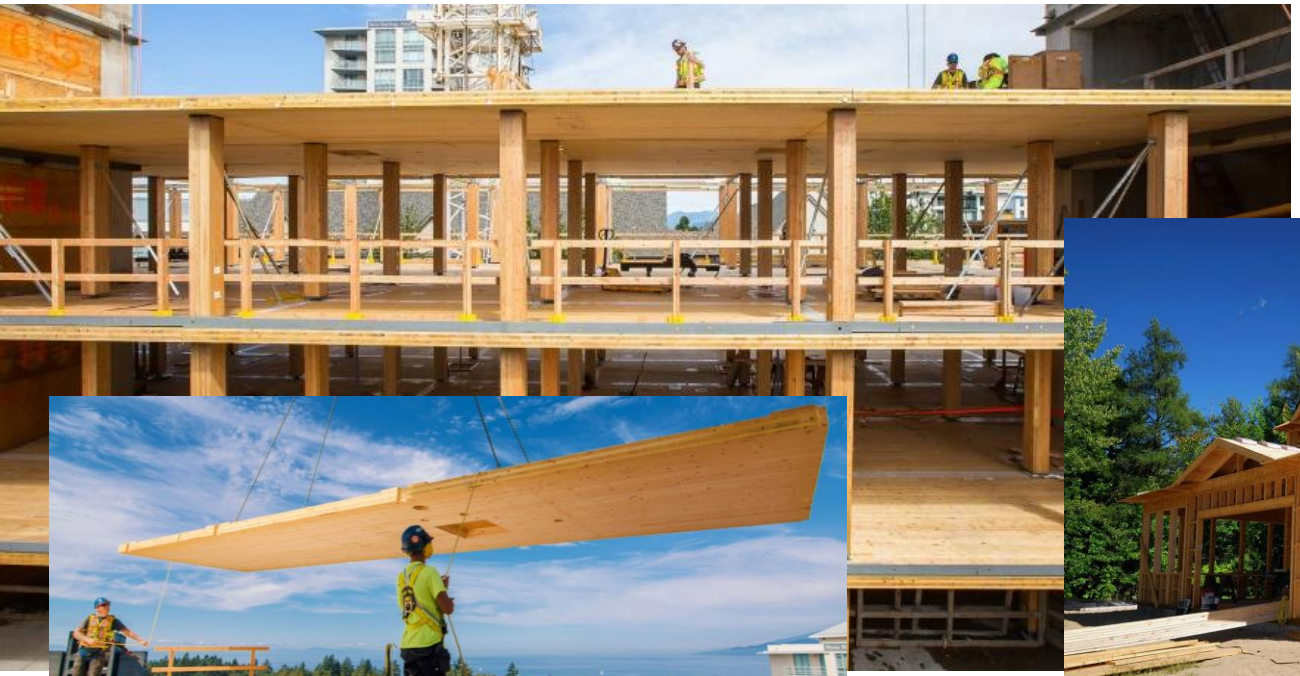
- IF Canada meets its climate commitments, but forest trends continue:
  - 2050 Canada forest GHGs equal to >60% of current anthropogenic GHGs
  - 2050 Canada forest GHGs will be 10% more than UK's current emissions
- This excludes black carbon impacts of wildfires
  - Could add another 100-200 Mt CO_2e/yr in climate impact
- Current net forest GHG emissions <5% of annual forest carbon turnover
  - Small changes in forest carbon turnover have large absolute impact
- **Inhibits use of forest biomass for decarbonization under SBTi**

What To Do?


Active Forest Mgmt
Solid Wood Products
Climate Smart Forestry
Bioheat
BECCS

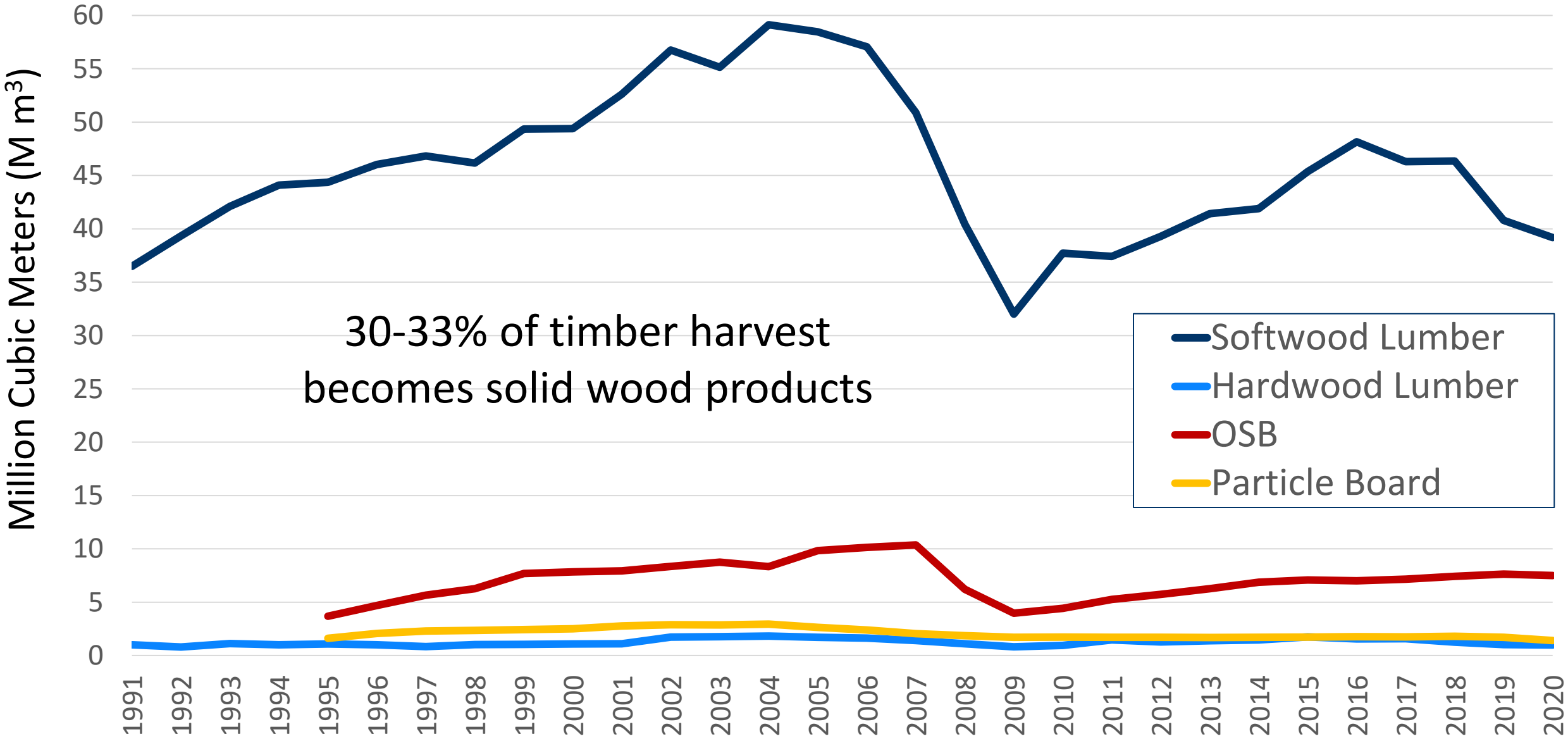
TorchLight Bioresources

Store that Carbon



TorchLight Bioresources

Canada Solid Wood Products Production



Active Forest Management

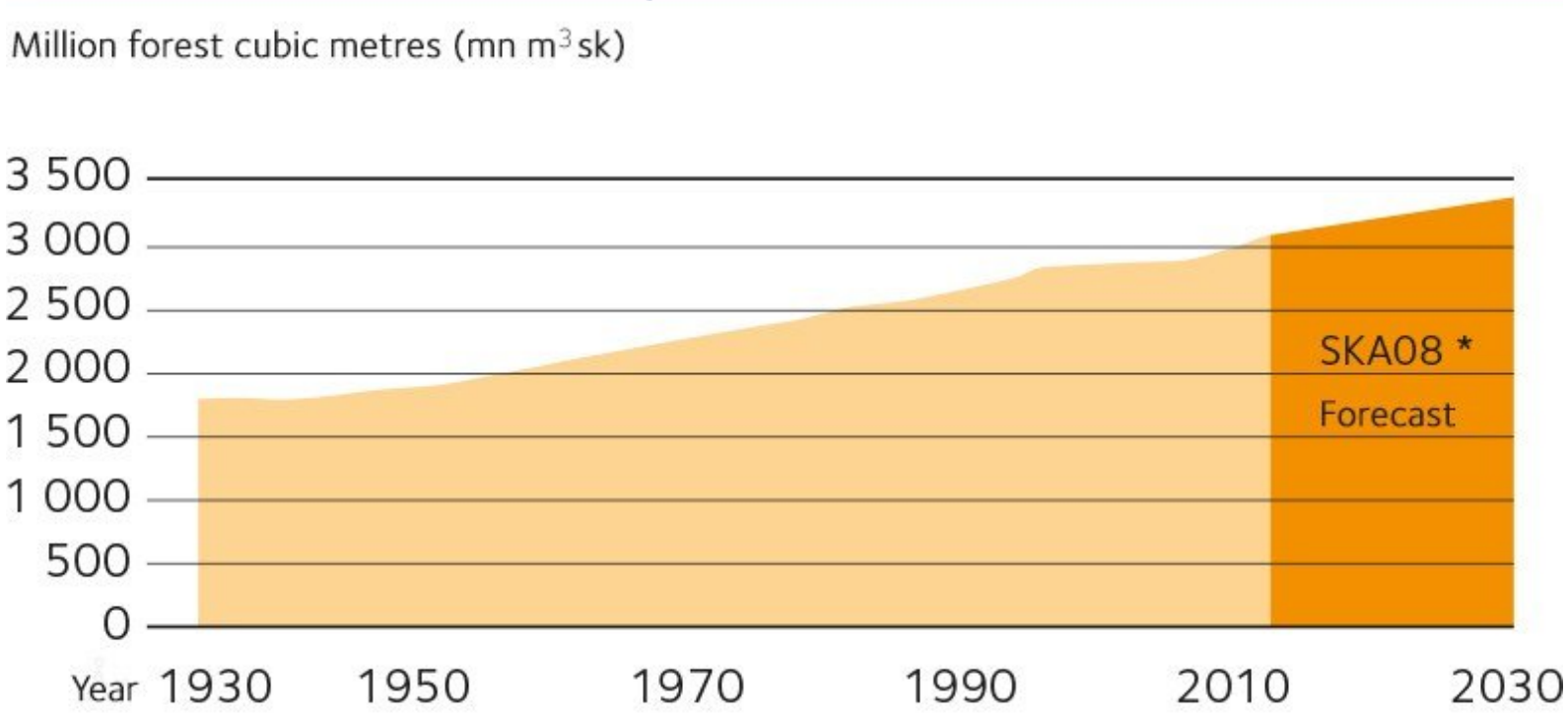
- Canada (and its provinces) must take responsibility for its forests
  - Credibility of Canada's climate strategy
  - Actual **climate performance**
- Active forest management means MORE harvest, not less
  - Driver must be MACRO climate performance ('carbon debt' is largely a scale issue)
  - Reduce wildfire and insect risk
  - Much greater **frequency of treatments**
  - Essential for adaptation in a changing climate
- Dramatically increase extent and intensity of forest management in Canada
  - This will generate a very **large volume of low-grade wood fibre**
  - It will be higher cost fibre relative to traditional forestry but low cost on a carbon basis

In Comparison

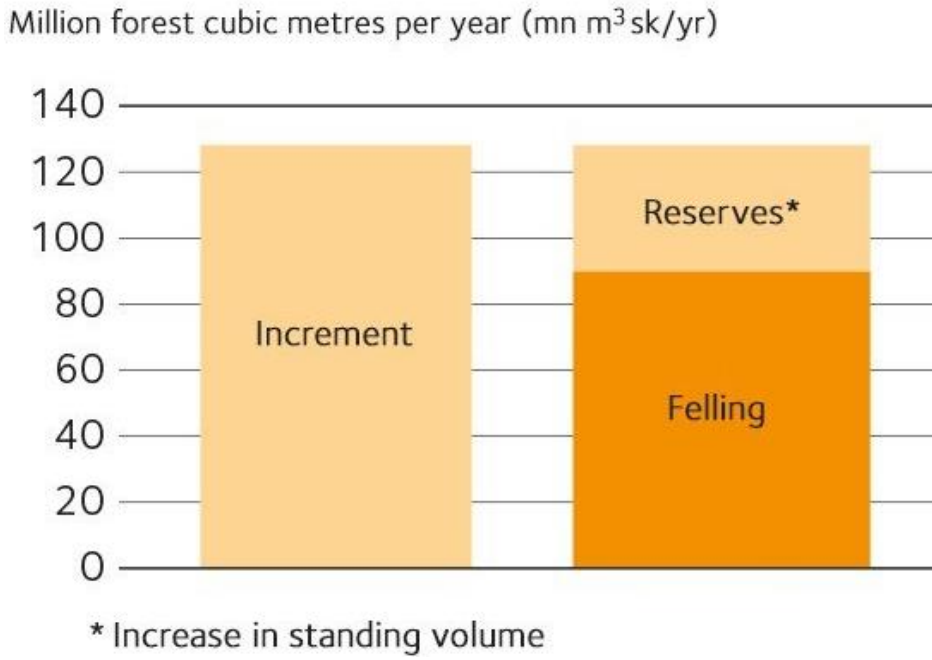
- Canada has 60x the disturbance losses per forested hectare as the Nordics
- Sweden harvests 7x the volume per hectare of productive forest land as Canada
- NET carbon uptake (increase in standing volume) reduces Sweden's national GHG emissions by 70%
- Per Capita GHG Emissions:
  - Sweden = 1.4 t CO_2e/pp
  - Canada = 24.0 t CO_2e/pp

Forests in Sweden (22.5 M ha)

Standing Timber



Growth & Removals



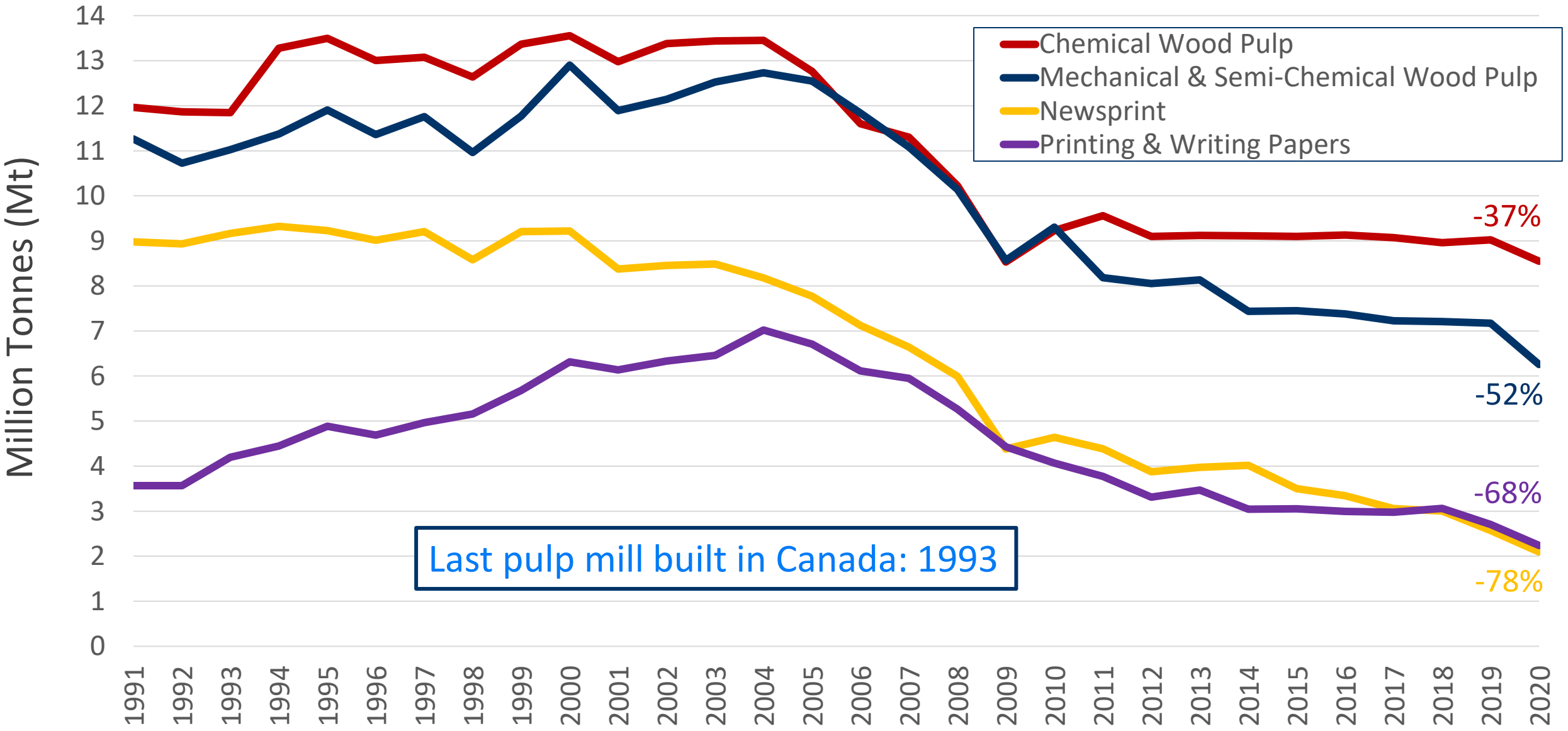
- Canada has ~3x commercial forest area per capita as Sweden
- If Canada managed and harvested its forests like Sweden, timber harvest would be 940 Mm^3/yr, not 140 Mm^3/yr
- 800 Mm^3 is ~800 Mt CO_2/yr

Carbon Budget

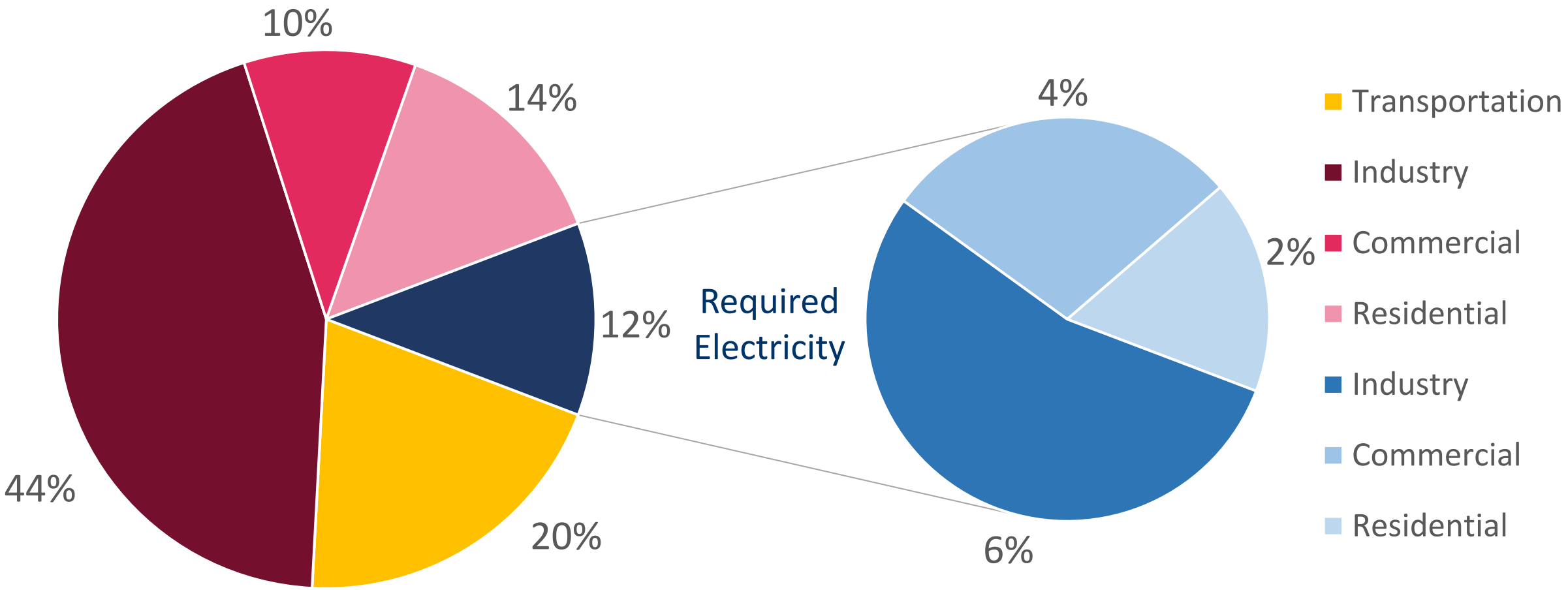
- Philips et al., 2022 in Science Advances
- North American boreal forest could contribute NET 12 Gt CO_2 by 2050
  - 3% of carbon budget for meeting 1.5 C
  - Costs of mitigating emissions less than alternatives
  - Average cost of C$25/t CO_2 to keep emissions at historical levels
- Extrapolating to future Canada emissions
  - $5 B/yr now, rising to $12 B/yr by 2050

TorchLight Bioresources

Not All Wood is Solid Wood Product Material…



Energy Demand in Canada



- **<u>Thermal energy (red shades)</u>** is approximately 60-65% of Canada's energy demand
- Excluding existing electrical heating, electricity (blue shades) is 12% of Canada's energy demand
- Heating residential buildings requires more energy than ALL of Canada's electricity demand

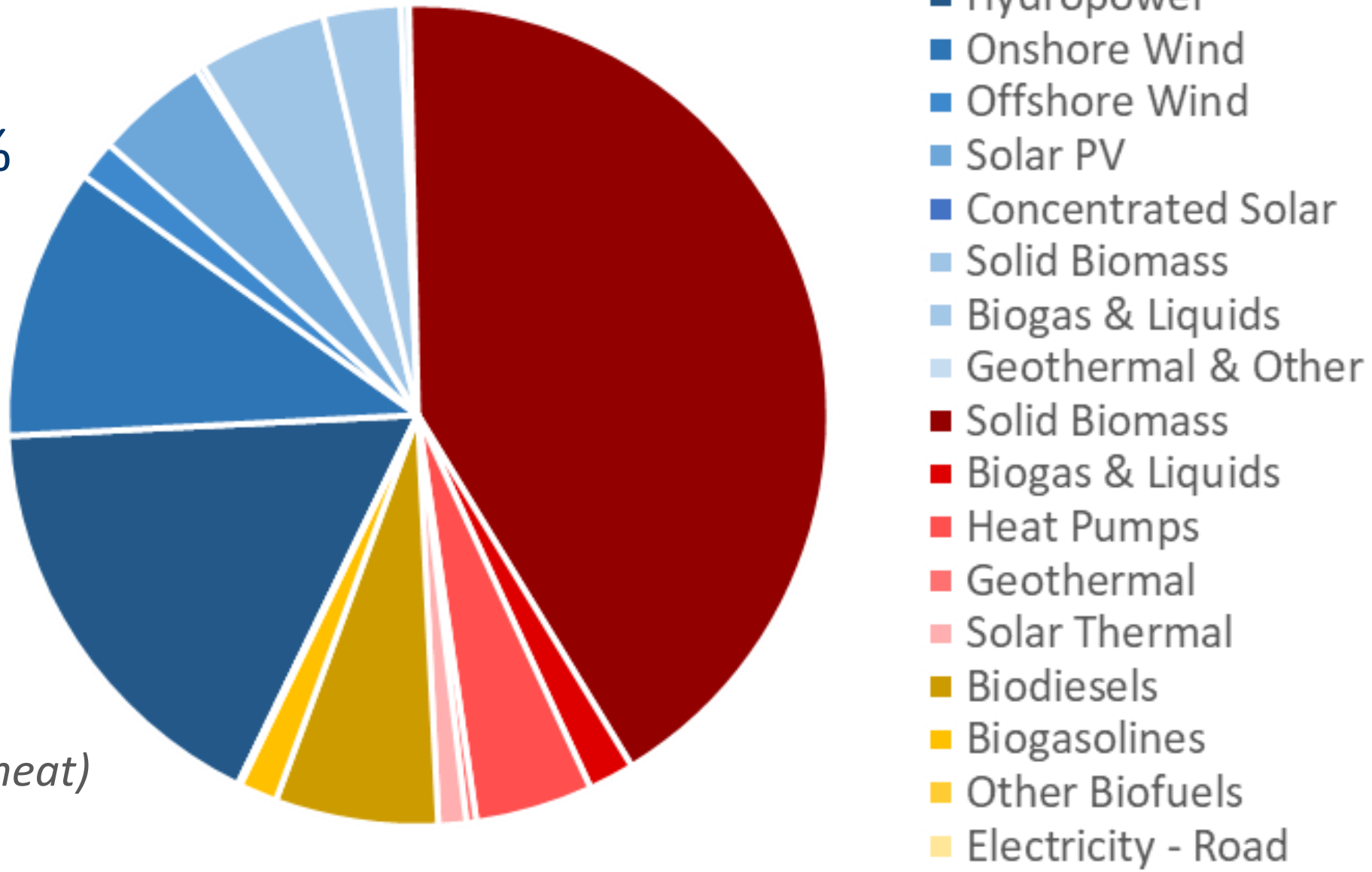
Renewable Energy in the EU

Total: 8.5 EJ

Bioenergy has 90% renewable heat market share

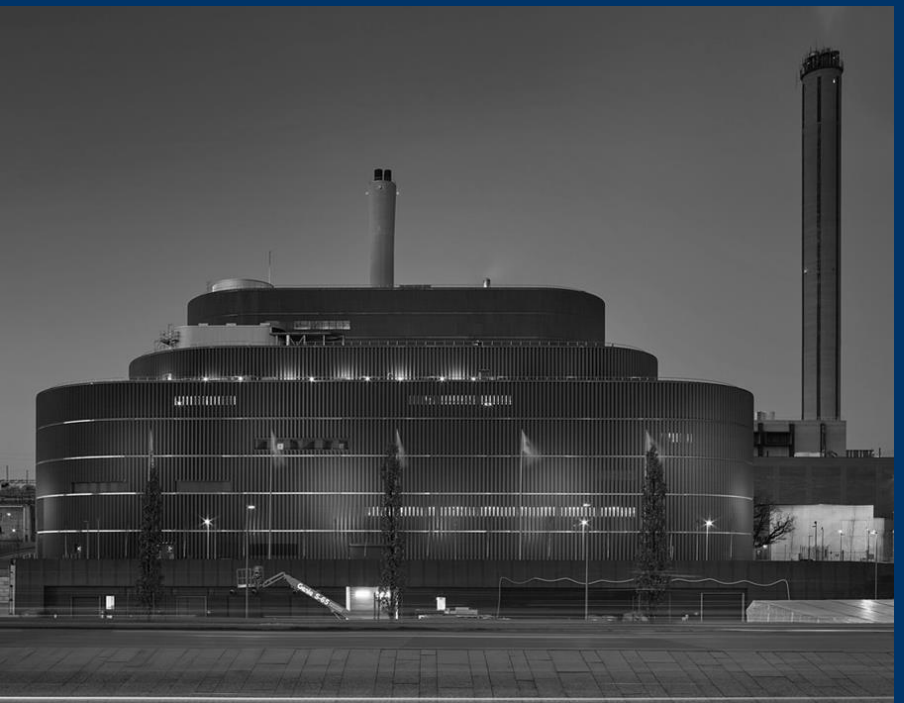
60% of EU renewable energy is bioenergy

- *Blue: Electricity*
- *Red: Thermal Energy (heat)*
- *Yellow: Transportation*



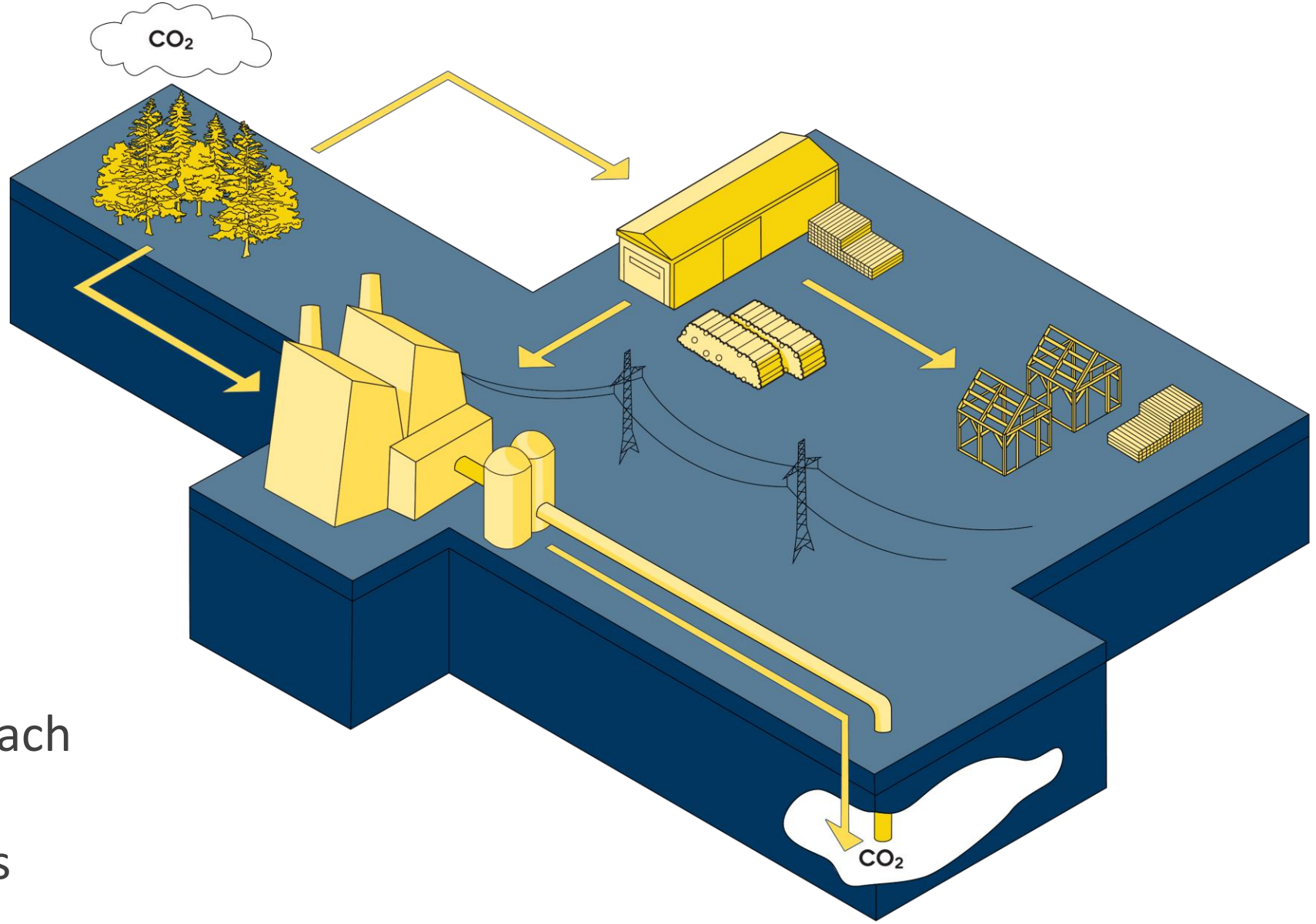
TorchLight Bioresources

Bioheat



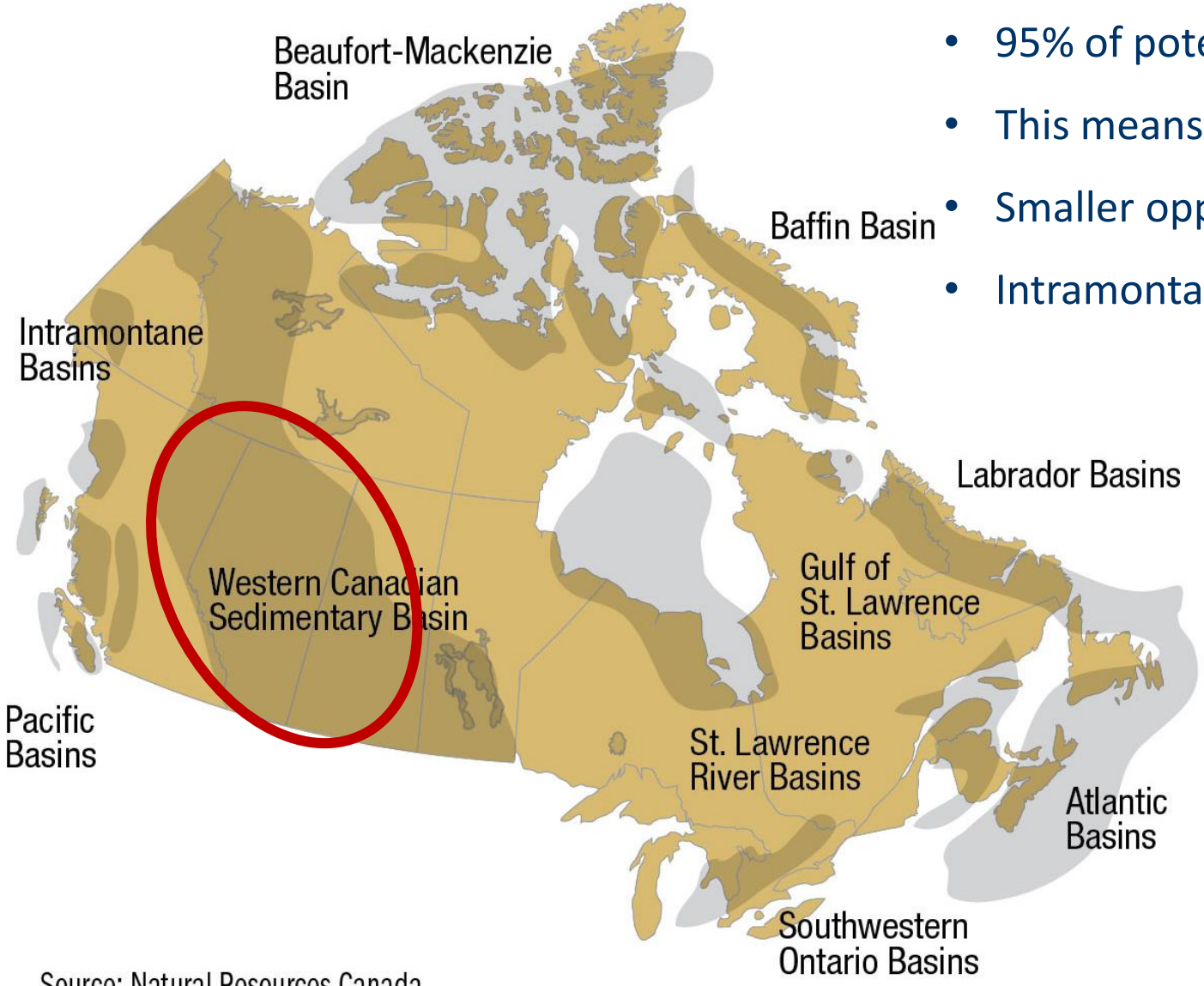
Dow/Energias Renováveis do Brasil

Bioenergy Carbon Capture & Storage



- Lowest cost approach for permanent negative emissions

CO_2 Storage Potential in Canada



Source: Natural Resources Canada

- 95% of potential is in Western Canadian Sedimentary Basin
- This means getting wood fuel to AB & SK
- Smaller opportunities in Atlantic Basins; greater uncertainty
- Intramontane and Pacific Basins very difficult/uncertain

BECCS at Canada's Coal-Fired GS

Station	Owner	Location	Capacity (MW_e)	2019 Emissions (Mt CO_2)	BECCS Potential @ 80% capacity (Mt CO_2)
Battle River	Heartland Generation	Forestburg, AB	540	2.2	3.8
Genesee	Capital Power, TransAlta	Genesee, AB	1,376	8.8	9.6
H.R. Milner	Maxim Power	Grande Cache, AB	150	Laid up	1.1
Keephills	TransAlta	Duffield, AB	1,303	7.6	9.1
Sheerness	Heartland Generation, TransAlta	Hanna, AB	800	4.7	5.6
Sundance	TransAlta	Wabamun, AB	1,213	2.2	8.5
Boundary Dam	SaskPower	Estevan, SK	701	5.0	5.0
Shand	SaskPower	Estevan, SK	276	2.3	1.9
Poplar River	SaskPower	Coronach, SK	582	3.5	4.1
Belledune	NB Power	Belledune, NB	450	2.5	3.2
Lingan	Nova Scotia Power	Lingan, NS	620	2.5	4.3
Point Tupper	Nova Scotia Power	Point Tupper, NS	150	0.8	1.1
Point Aconi	Nova Scotia Power	Point Aconi, NS	165	1.0	1.2
Total	-	-	**8,326**	**43.1**	**58.5**

100 Mt CO_2e Reduction is Impossible

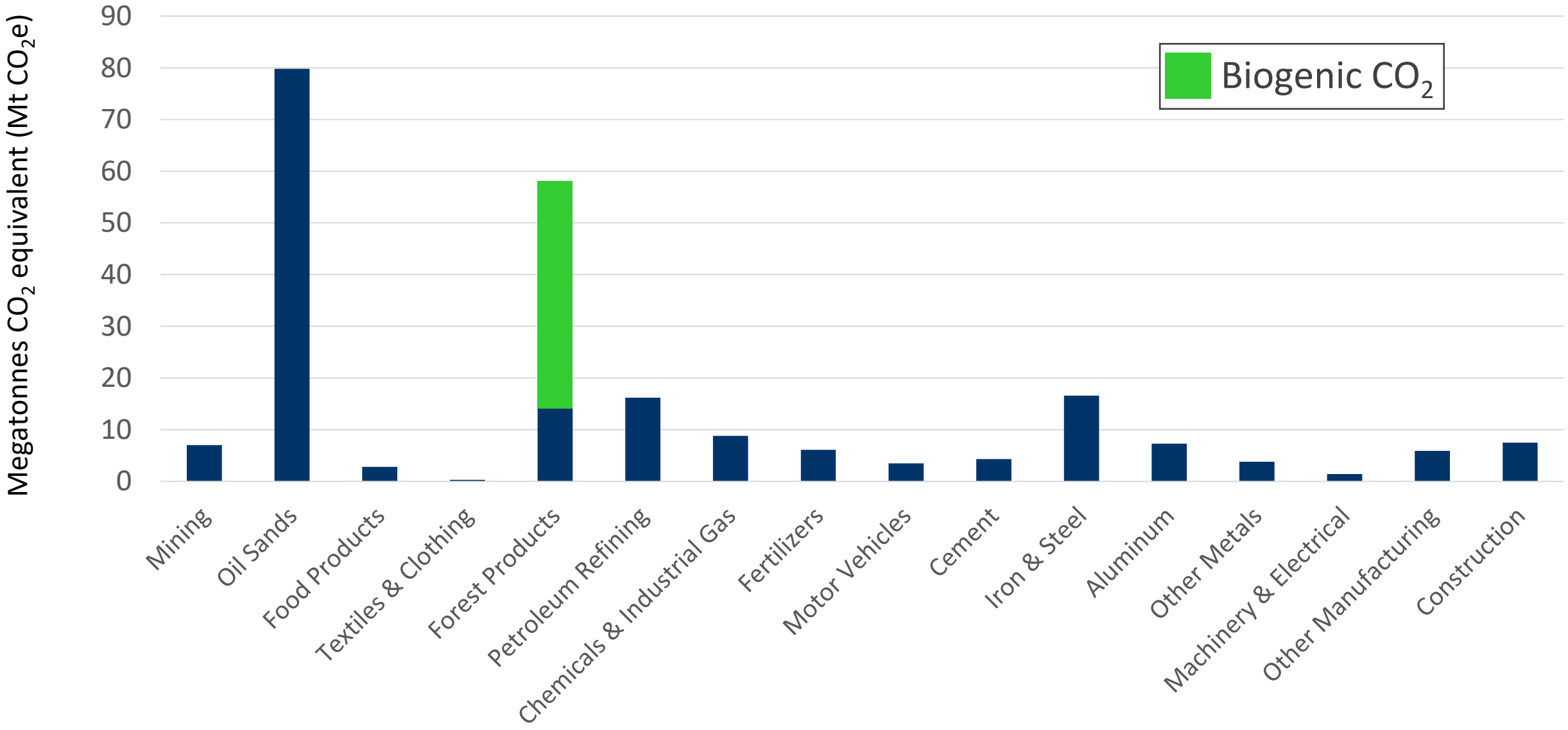
- Approximately 70 Mm^3 is required to realize this reduction
  - Canada's timber harvest is 60 Mm^3 below AAC (supply) and 50 Mm^3 below 2004 level
  - This excludes harvest residues and non-merchantable timber
  - Does not consider active forest management opportunity
  - Are pulp trends going to reverse?
- CapEx of $40-50 B
  - Annualized CapEx of $10-20/t CO_2, depending upon amortization
  - Commodity AB natural gas + $170/t CO_2e = $245/t for wood pellets
- 140,000 jobs lost in forest sector since 2000
  - Reconciliation and indigenous opportunity is a federal priority
  - Support for climate action is much lower in rural than urban areas

Electricity is Just the Start

- 60-65% of Canada's energy consumption is heat: industry & buildings
- Canada has a large number of large thermal (steam) facilities for industrial producers
  - Oil sands, chemicals, pulp and paper, etc.
- Alberta and Saskatchewan are ~55% of industrial thermal market in Canada
  - CCS opportunity is largely in WCSB – AB/SK
- BECCS being added to biomass/waste-to-energy CHP plants in Nordic cities
- Edmonton: first Canadian city to include a city-wide district energy system in its climate plan
  - Central biomass & solid waste CHP facilities
- Theoretical bioheat-based BECCS opportunity in AB/SK is >300 Mt CO_2/yr in reductions

TorchLight BioResources

Industrial CO_2 Emissions



ROCKY MOUNTAIN CARBON

- 1.3 Mt CO_2/yr of carbon dioxide removals (CDRs)
- Hinton, Alberta
- Renewable materials facility (unbleached NSKP)
- $16 M FEED study funded by NRCan, ERA, & partners
- Pore space in Alberta secured – RMC Vault
- Need Carbon CfD or other valuation of removals for FID

VAULT 44.01

West Fraser

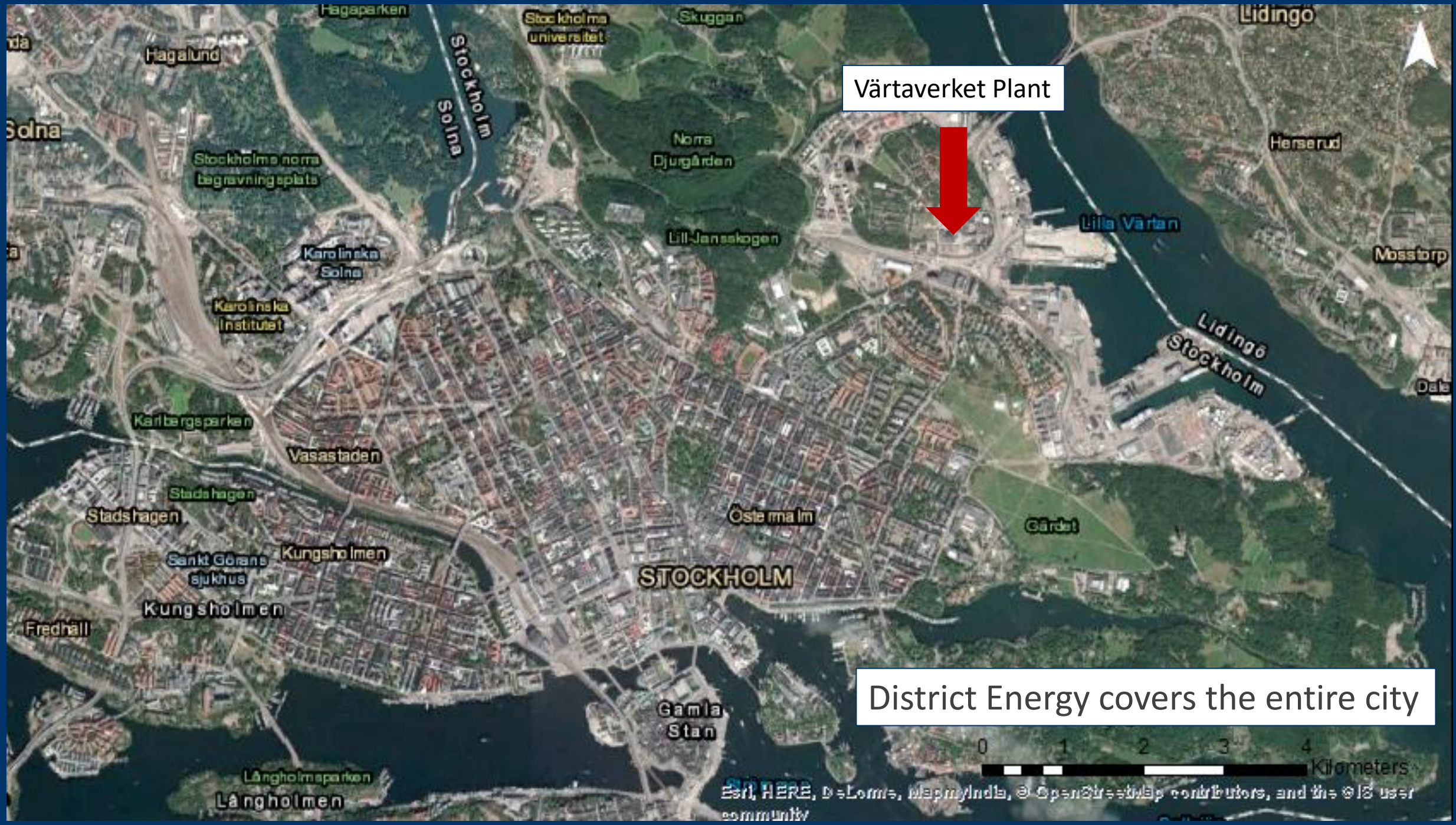
TorchLight Bioresources

In Summary

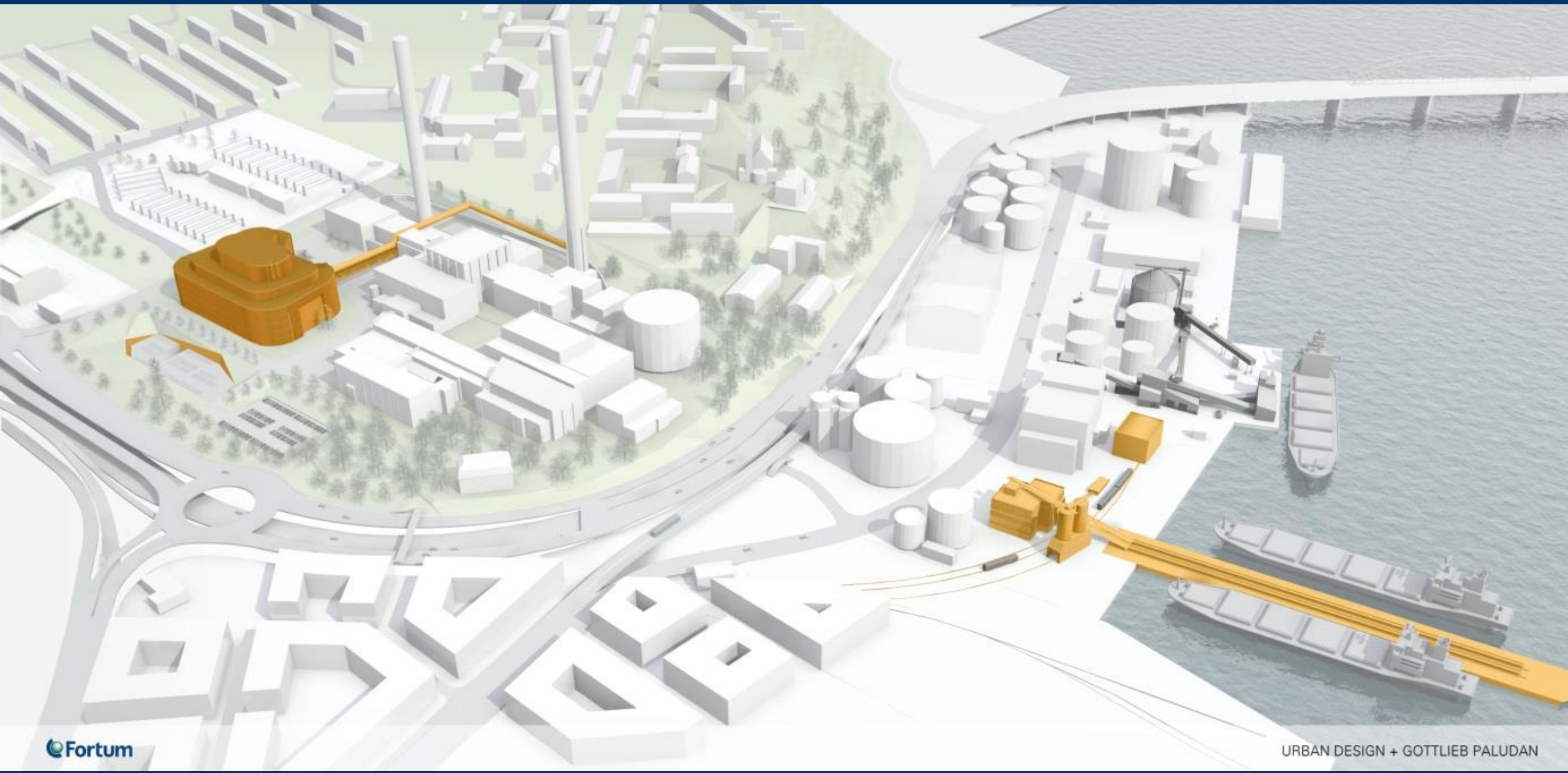
- Canada's largest climate liability and opportunity is its forests
  - 2% of the world's anthropogenic GHG emissions, 9% of the world's forests
- A re-envisioning of forests and forest management is required
  - 60 years of GHG emissions stored in wood in Canada's managed forests
  - 400 years of GHG emissions stored in forests (incl. soils)
- Bioenergy must be viewed as BOTH a climate mitigation & adaptation necessity
- District heating system are required to deliver thermal energy from biomass to urban areas
- Near-term BECCS opportunities are plentiful, but valuation of removals required
- Net Zero will not be reached without large-scale BECCS AND Active Forest Management

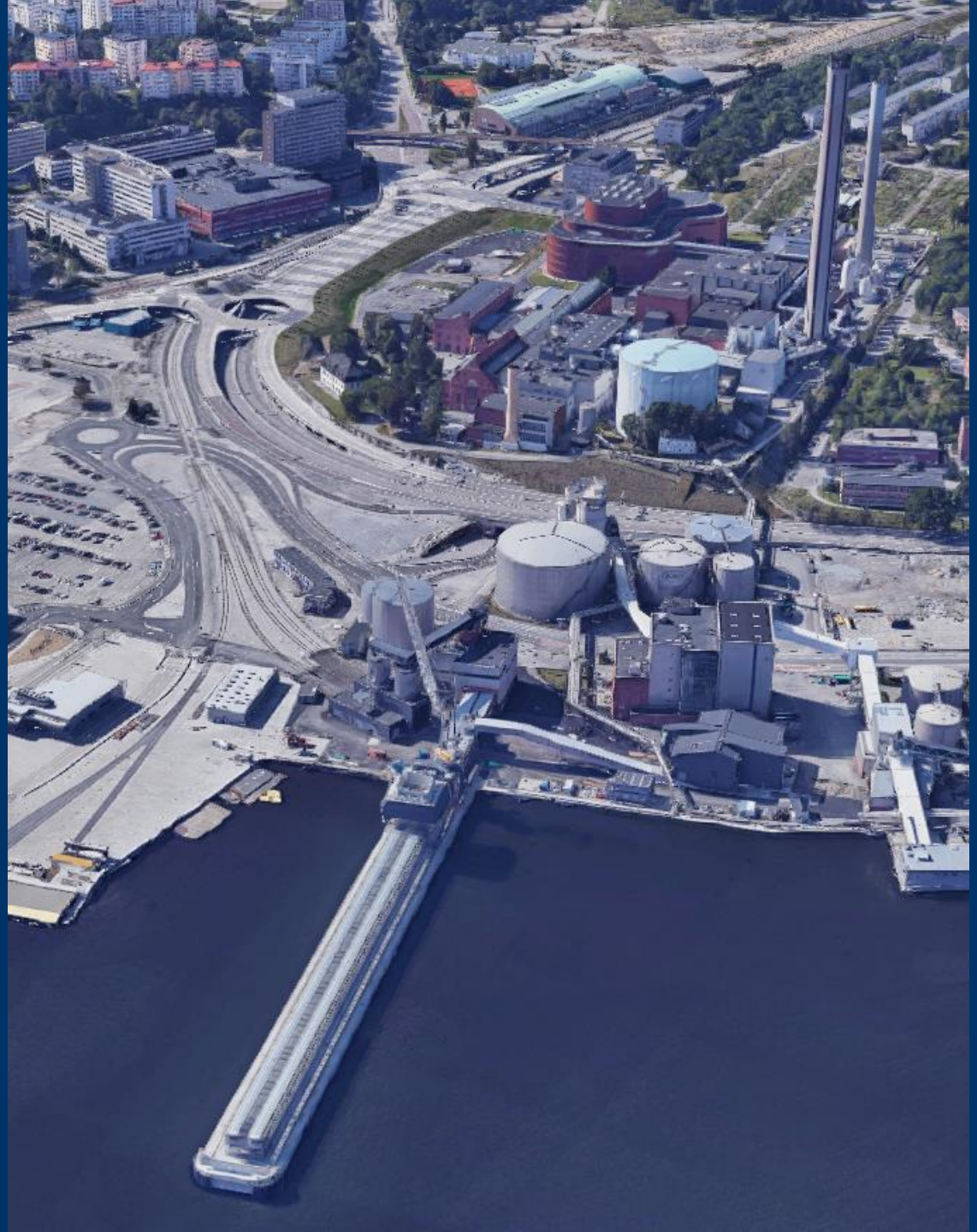
Stockholm Värtaverket CHP Plant

- 450 MW_{th}
- Heats 190,000 homes via DE
- 100% wood chips (3,500 t/day)
- Commissioned in 2016
- CapEx: C$750 M
- 1,700 GWh heat (>2x Enwave)
- 750 GWh electricity
- 60% marine/40% rail
- Reduce: 650,000 t CO_2e/yr
- Footprint: 6,000 m^2
- PM emissions < natural gas


Värtaverket Plant
District Energy covers the entire city
Hagaparken
Stockholms universitet
Skuggan
Lidingö
Hagalund
Solna
Stockholm
Solna
Norra Djurgården
Herserud
Stockholms norra begravningsplats
Lill-Jansskogen
Lilla Värtan
Karolinska Solna
Karolinska Institutet
Mossbrp
Lidingö
Stockholm
Karlbergsparken
Vasastaden
Stadshagen
Stadshagen
Östermalm
Gärdet
Sankt Görans sjukhus
Kungsholmen
STOCKHOLM
Kungsholmen
Fredhäll
Gamla Stan
Långholmsparken
Långholmen
0
1
2
3
4
Kilometers
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community


N
Residential
Stack
Värtaverket Plant
0
250
500
750
1,000
Meters


Fortum
URBAN DESIGN + GOTTLIEB PALUDAN




Fortum
85
innofreight


green cargo


innofreight
green cargo


innofreight


innofreight
sappi


innofreight
green cargo


innofreight
KR 200
WOODY...stephan

No Bioenergy, No Climate Goals

Why Bioheat and BECCS are Necessary for Canada's Climate Credibility

TorchLight Bioresources

Jamie Stephen, PhD
Managing Director
Jstephen@TLBio.com