BIOCLEANTECH:
NEW OPPORTUNITIES FOR CANADA'S FOREST SECTOR

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BIOLOGICAL GHG MANAGEMENT PROGRAM
ALBERTA INNOVATES

HONOURING DOUG LITTLE

Senior VP Forest Operations, Northwood Pulp and Timber

Founding Supporter of UNBC

Respected for his dedication to forest sustainability

Honoured by an endowment from Northwood Pulp and Timber

ABOUT ERA AND AI

Emissions Reduction Alberta

Established to address GOA climate leadership priorities

Connects gov policy, industry needs, technology solutions

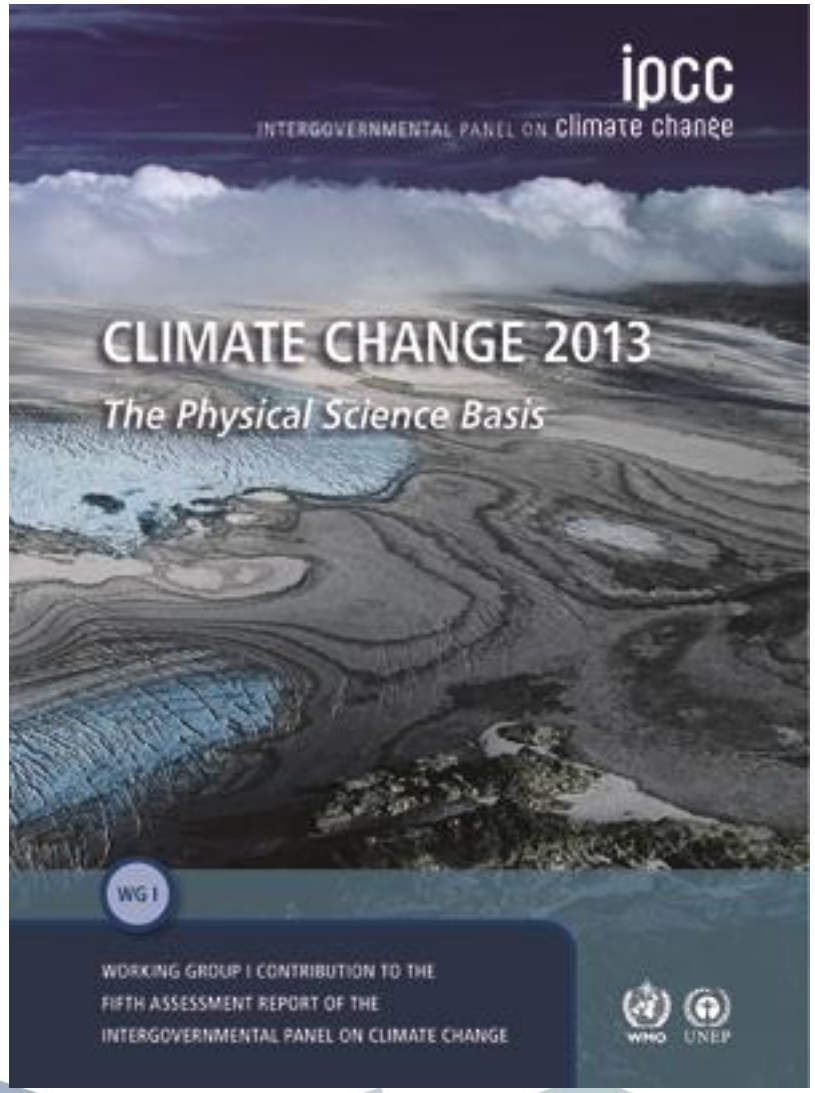
Alberta Innovates

Supports research for the growing global bio-economy

Biological GHG Management Program

Partnership program hosted by AI and supported by ERA

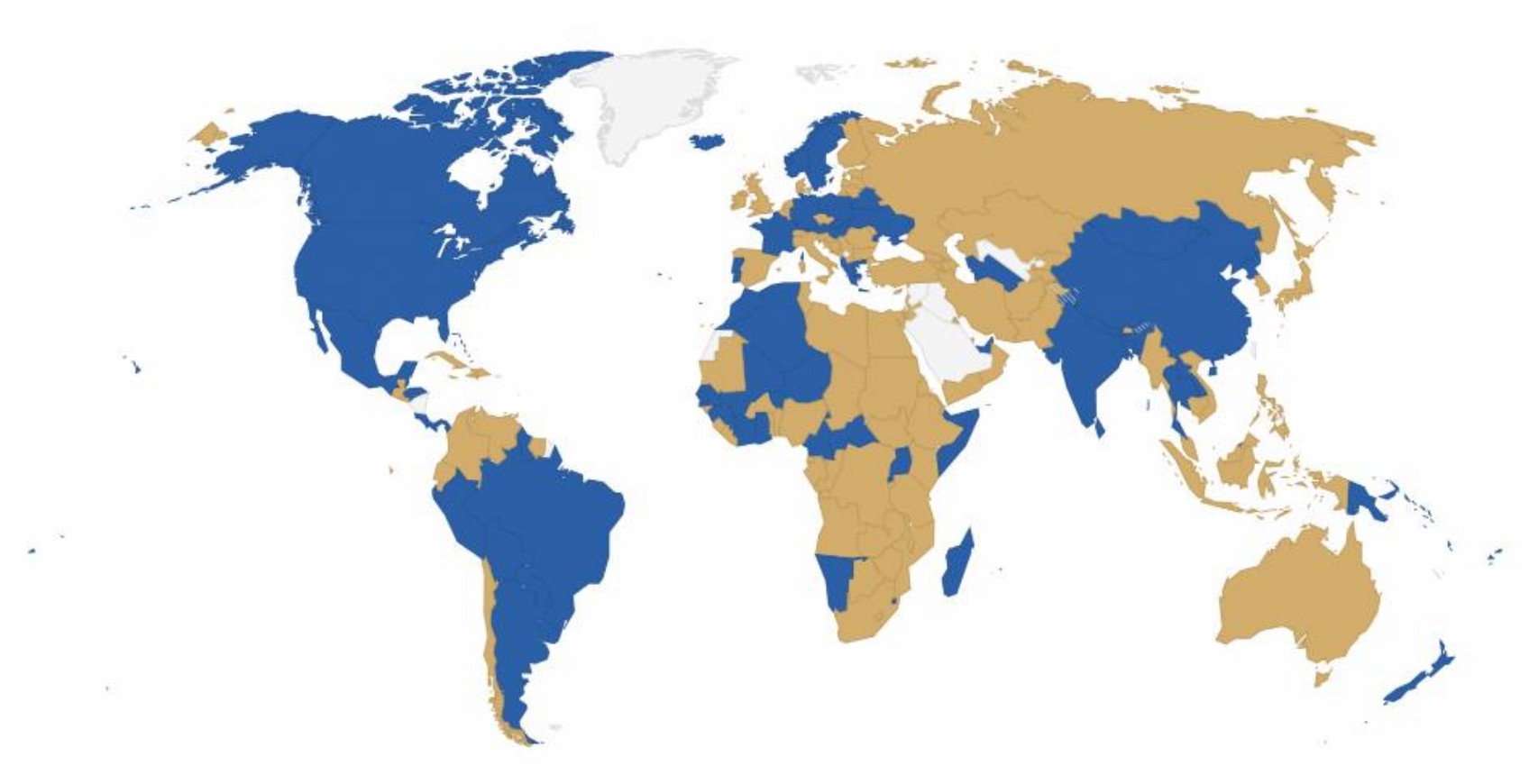
THE GLOBAL DISCUSSION ON CLIMATE



"Climate change has happened because of human behaviour, therefore it's only natural it should be us, human beings, to address this issue. It may not be too late if we take decisive actions today."

Ban Ki-moon, United Nations

THE GLOBAL RESPONSE: PARIS ACCORD



NOW THE REAL WORK BEGINS: MARRAKESH

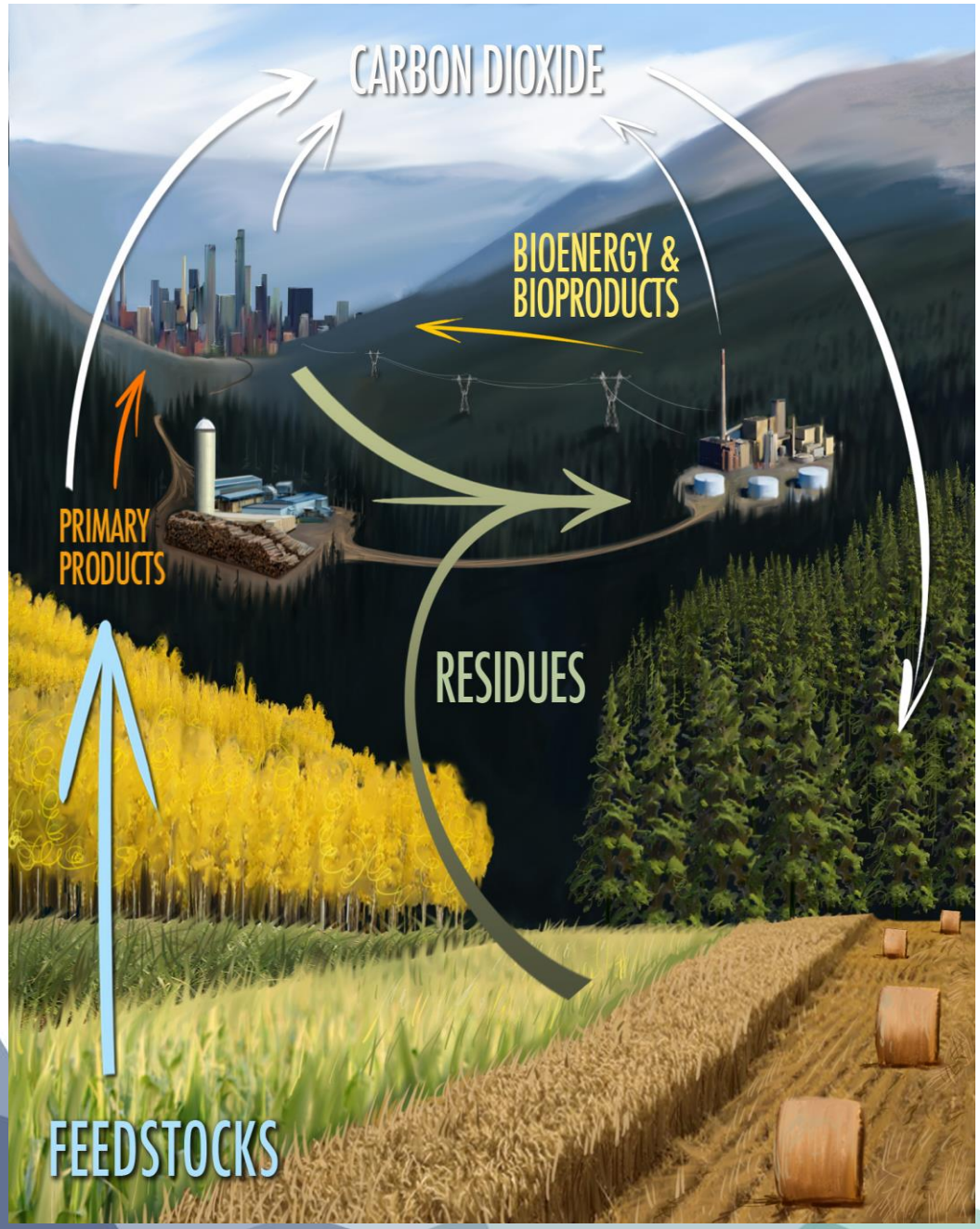
What is the significance of the Paris Accord?

1. Increasing ambition - We need deep and real emissions reductions that increase over time
   - To keep < 2C (450ppm CO2) = 80-90% GHG reduction
   - To keep < 1.5C (350ppm) = 95% GHG reduction
2. Enhanced international cooperation – through trading and finance (GCF)
3. Seize opportunity – for Green Growth and investment

ADDRESSING CLIMATE CHANGE THROUGH CARBON MANAGEMENT

If too much atmospheric carbon is the problem, what can we do?

- Reduce emissions of ancient carbon, and
- Increase sequestration for longer term storage



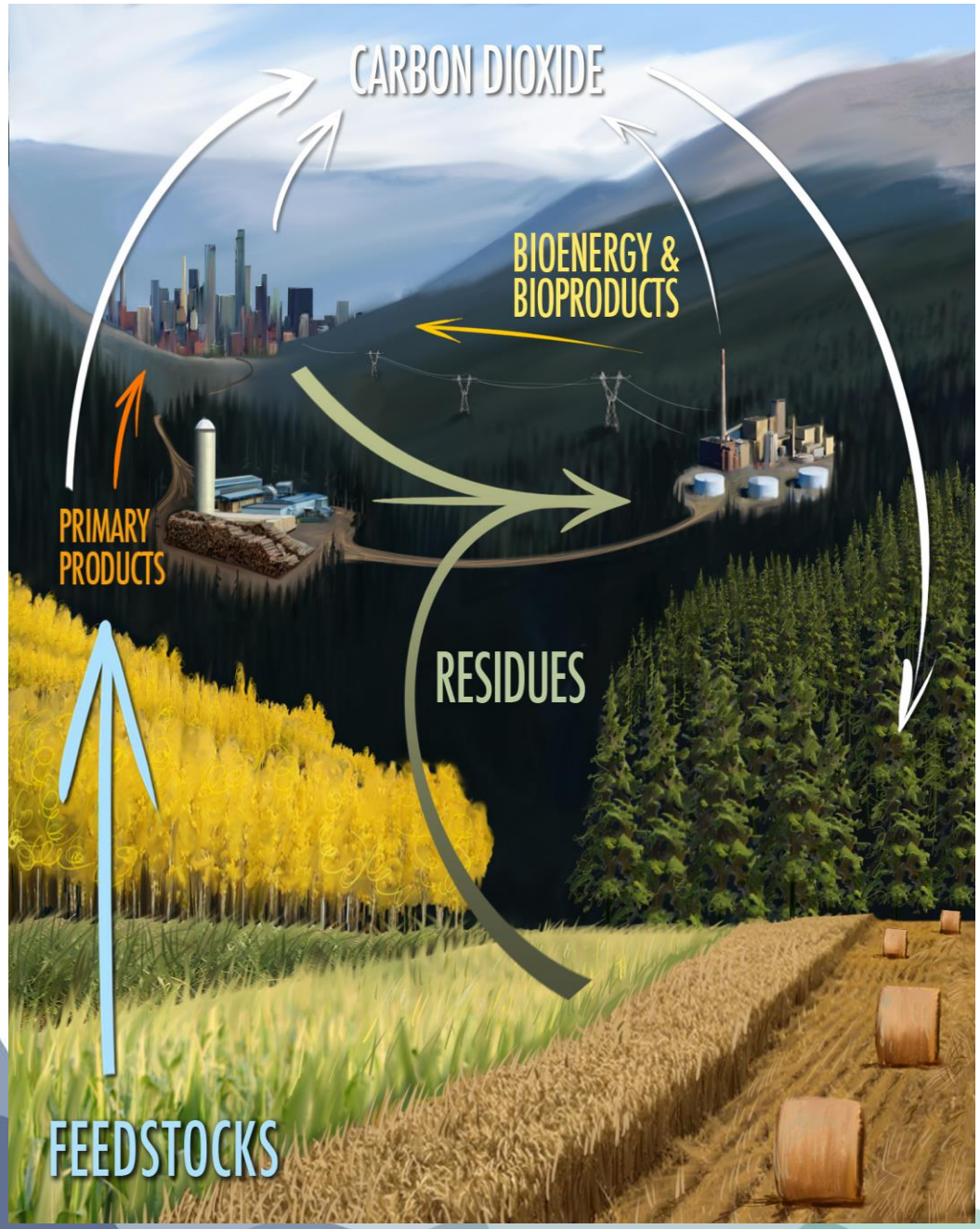
ABOUT GHGS

In natural systems

- Carbon is sequestered by plants through photosynthesis
- Carbon is lost through decay and combustion

Key GHGs/GWP

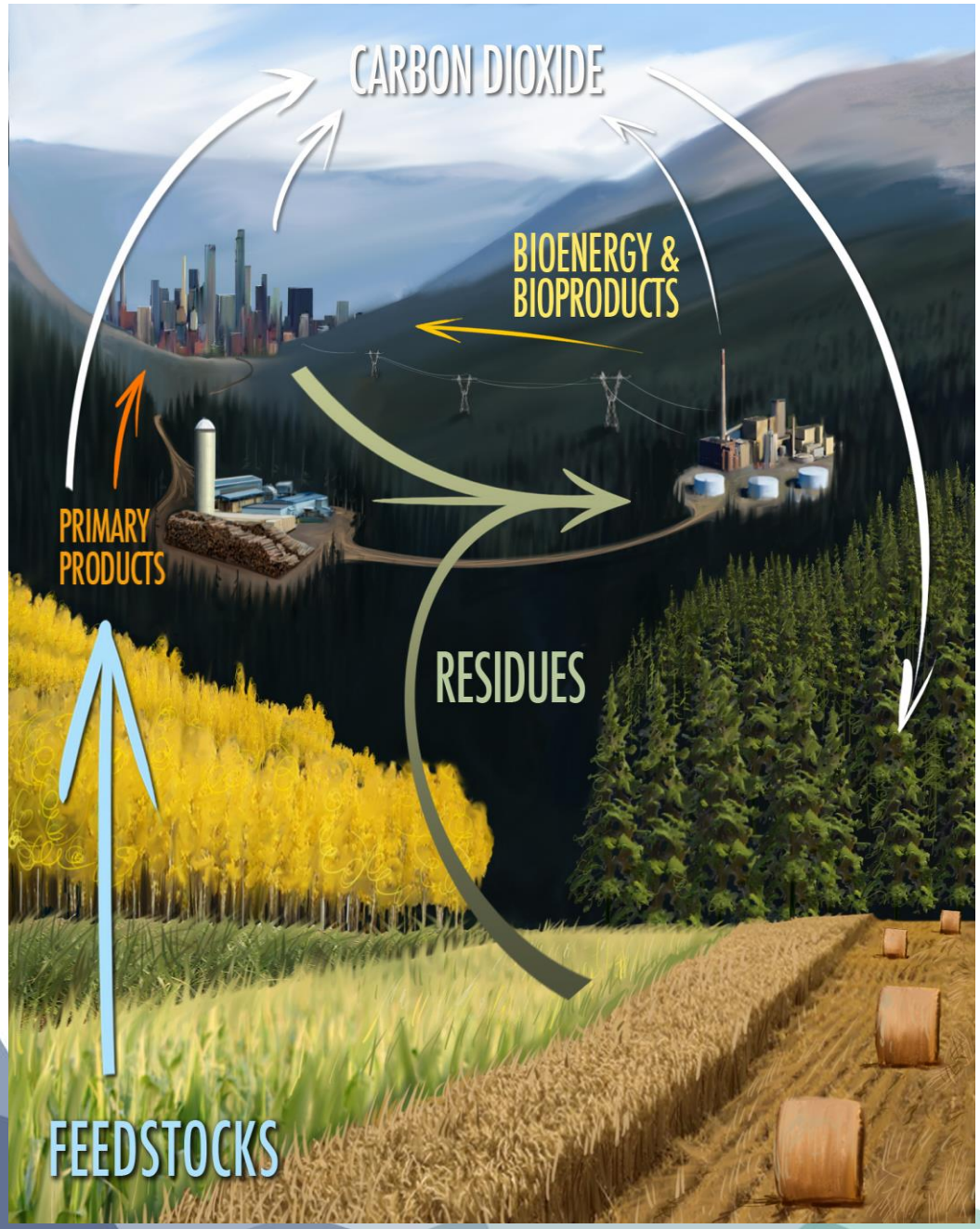
- **CO_2 = 1 = CO_2eq (Mt)**
- **CH_4 = 21**
- **N_2O = 310**



ABOUT GHGS

In managed systems

- Carbon is sequestered by forests and crops through photosynthesis
- Carbon is lost through decay and combustion
- Harvested carbon is used to manufacture products; some stabilized for long term storage, some lost almost immediately



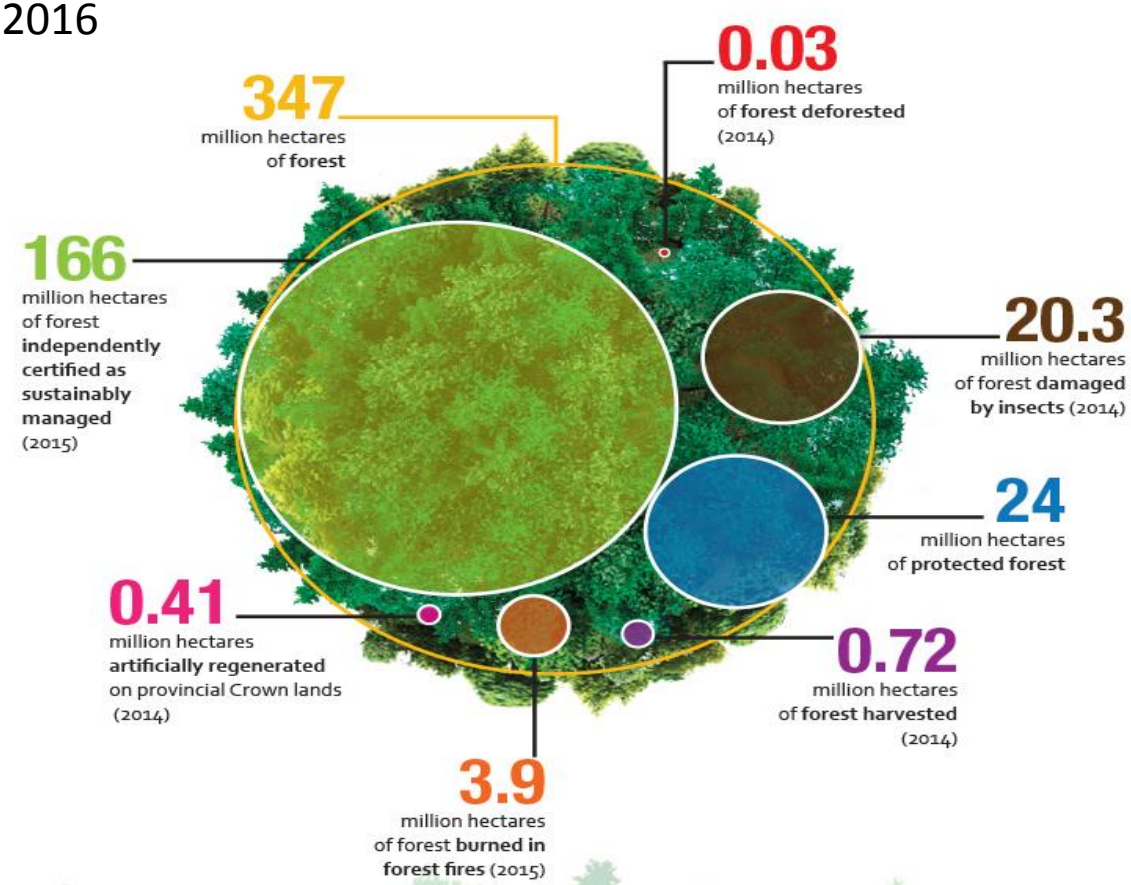
ABOUT GHGS

In current energy systems

- Ancient carbon from fossil resources is used for energy, releasing long-stored carbon
- Losses from ancient carbon tip the natural seasonal cycle

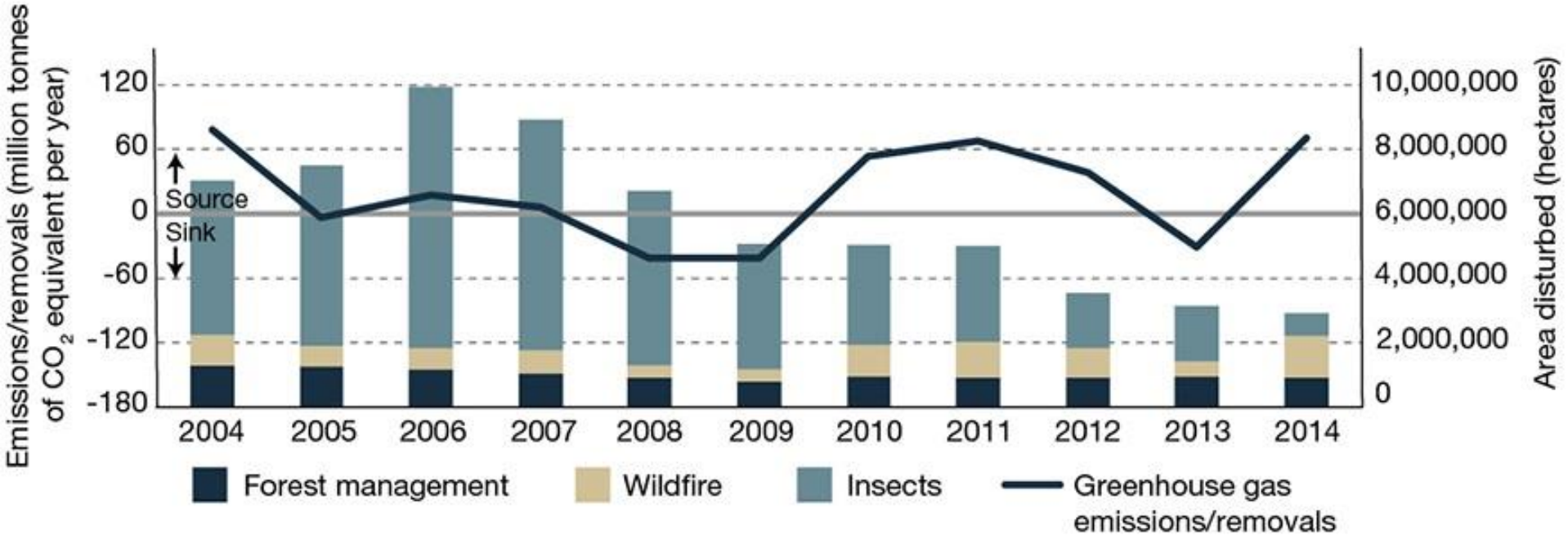
Canada's forests by numbers

2016

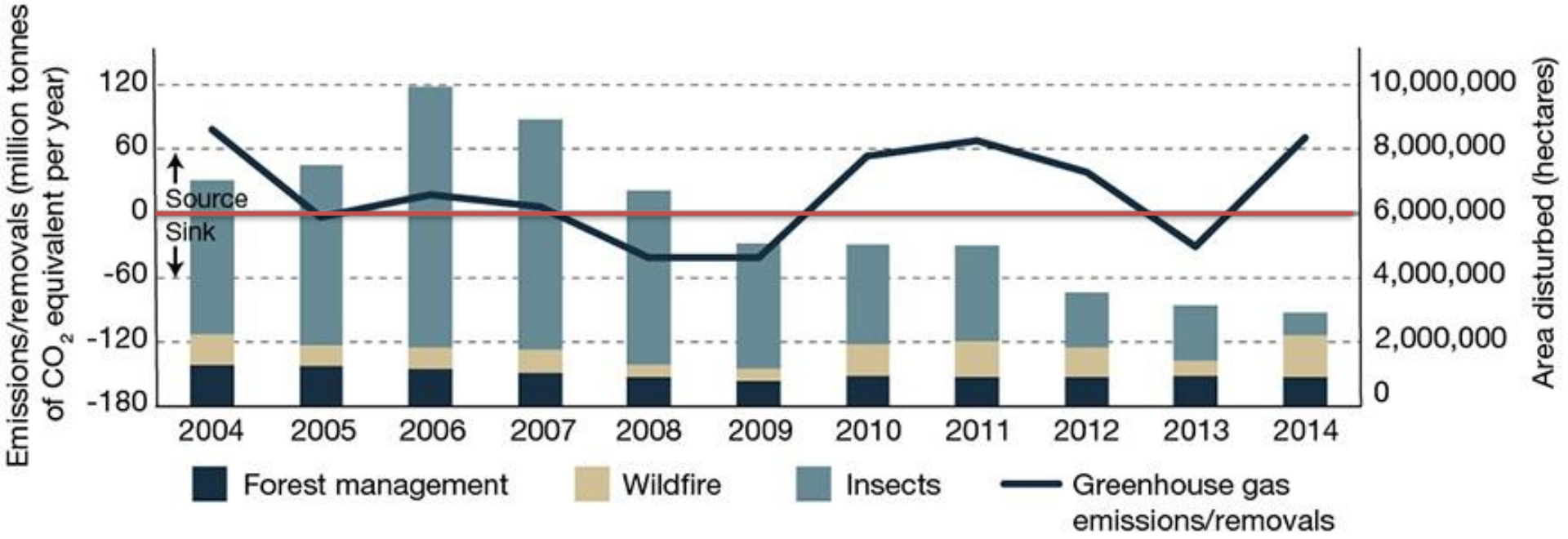


Canada

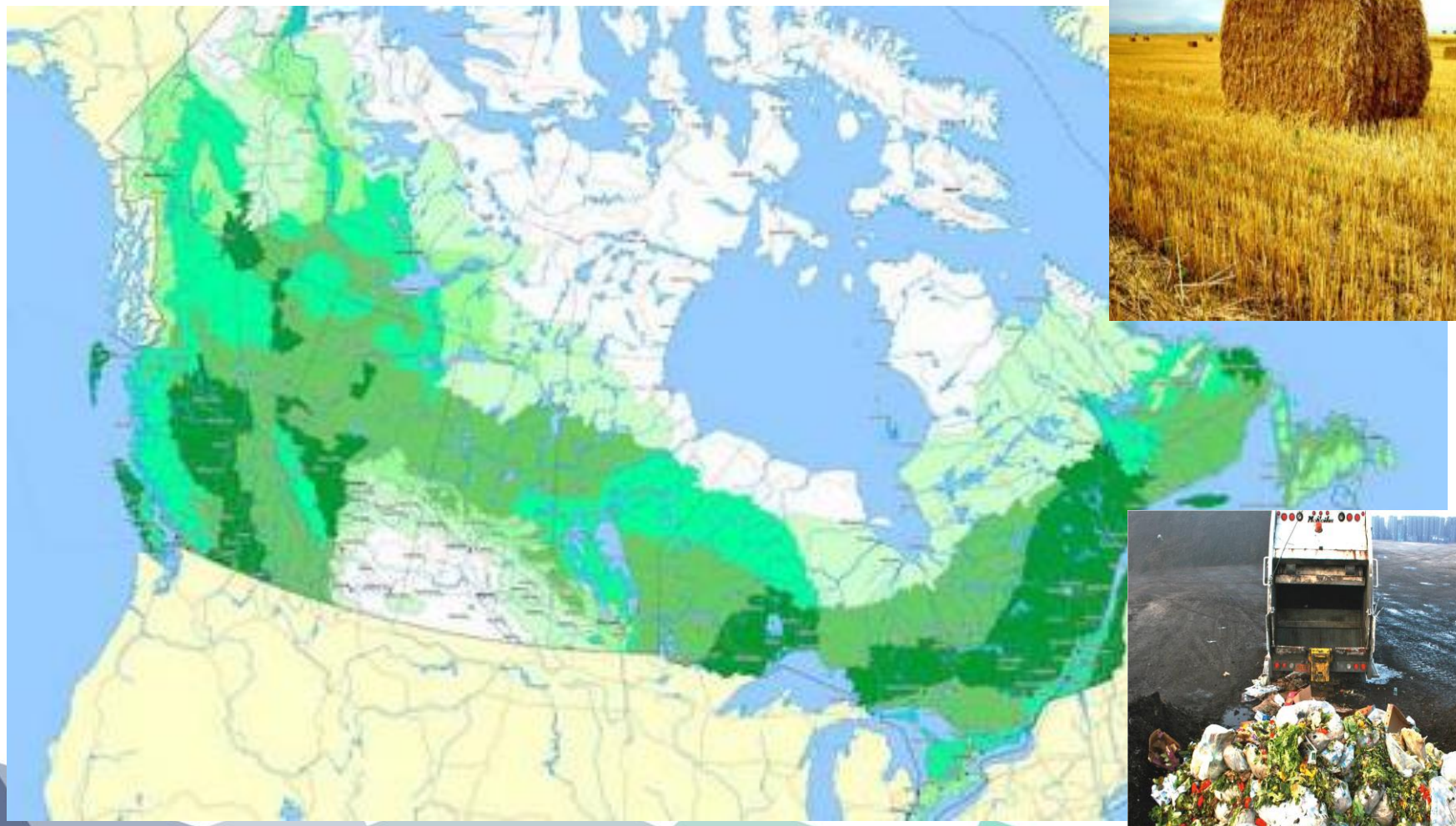
CANADIAN FOREST CARBON REMOVALS



CANADIAN FOREST CARBON REMOVALS

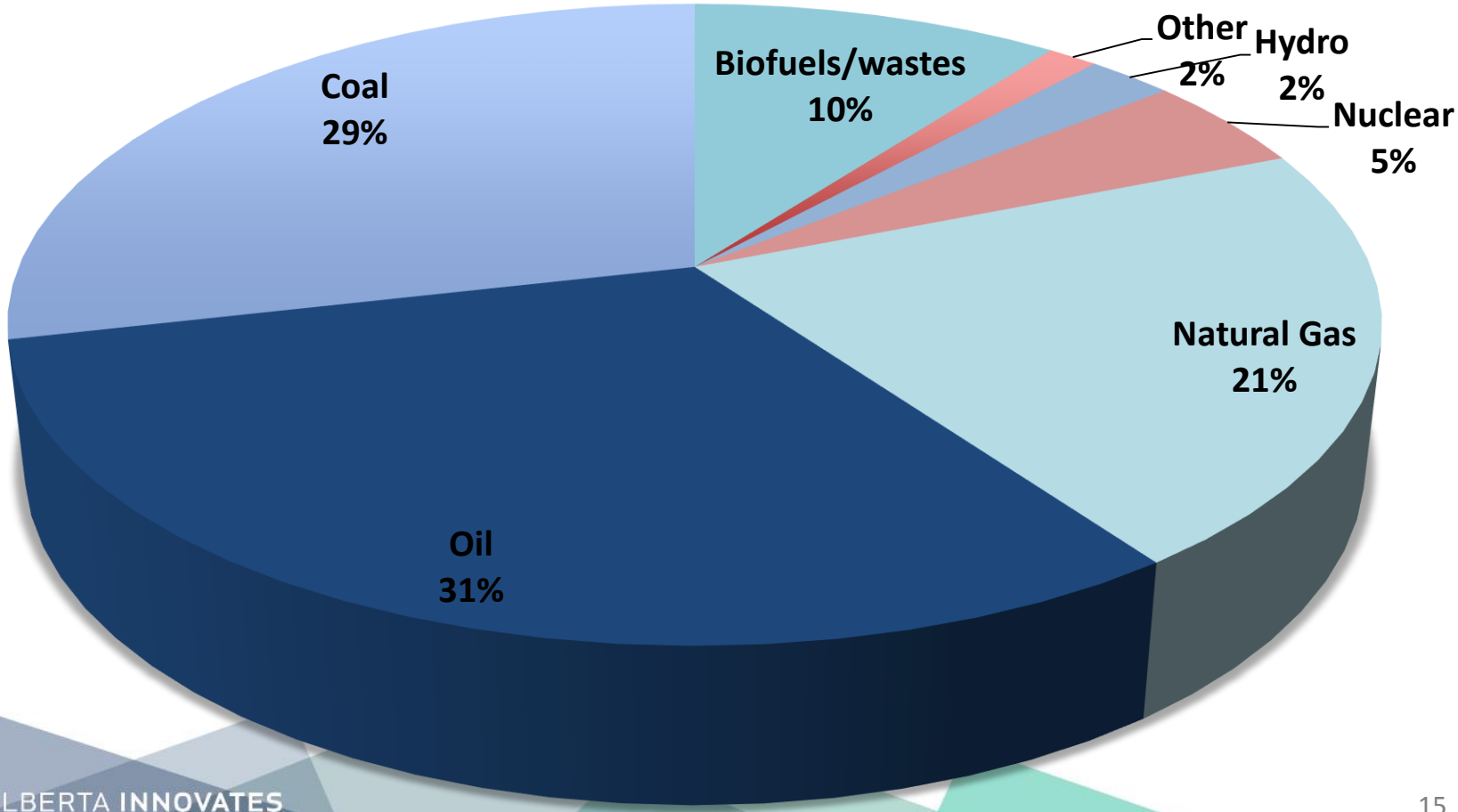


CANADA'S ABUNDANT SUPPLY OF BIOMASS (NOT FORESTS ALONE)



WHY IS BIOGENIC CARBON IMPORTANT?

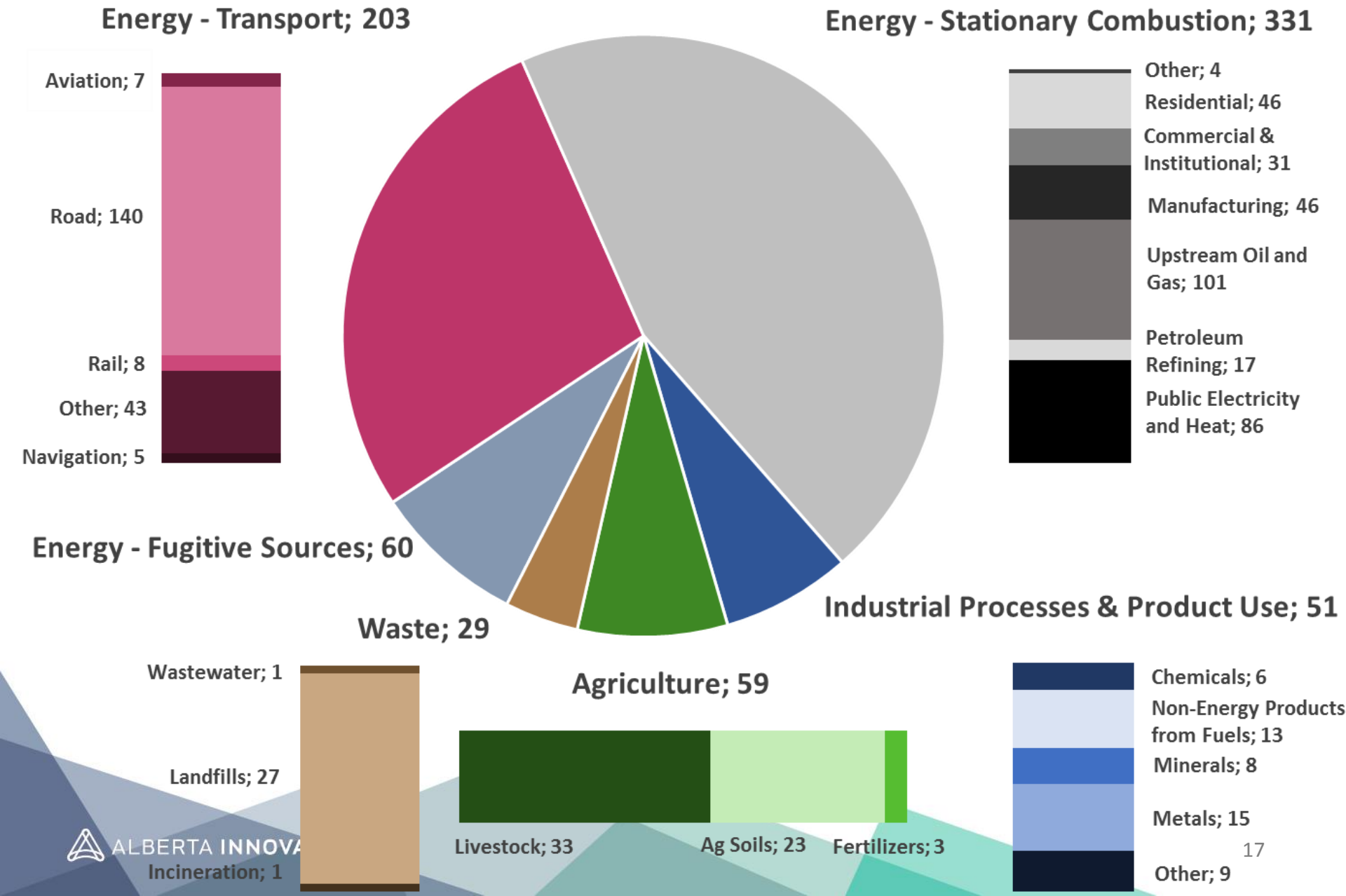
Global energy supply is dominated by carbon



BENEFITS: AVOIDING STRANDED ASSETS

Renewable carbon fits existing fossil-fuel infrastructure

CANADA'S GHG EMISSIONS (2014)



CANADA'S UNIQUE GHG PROFILE

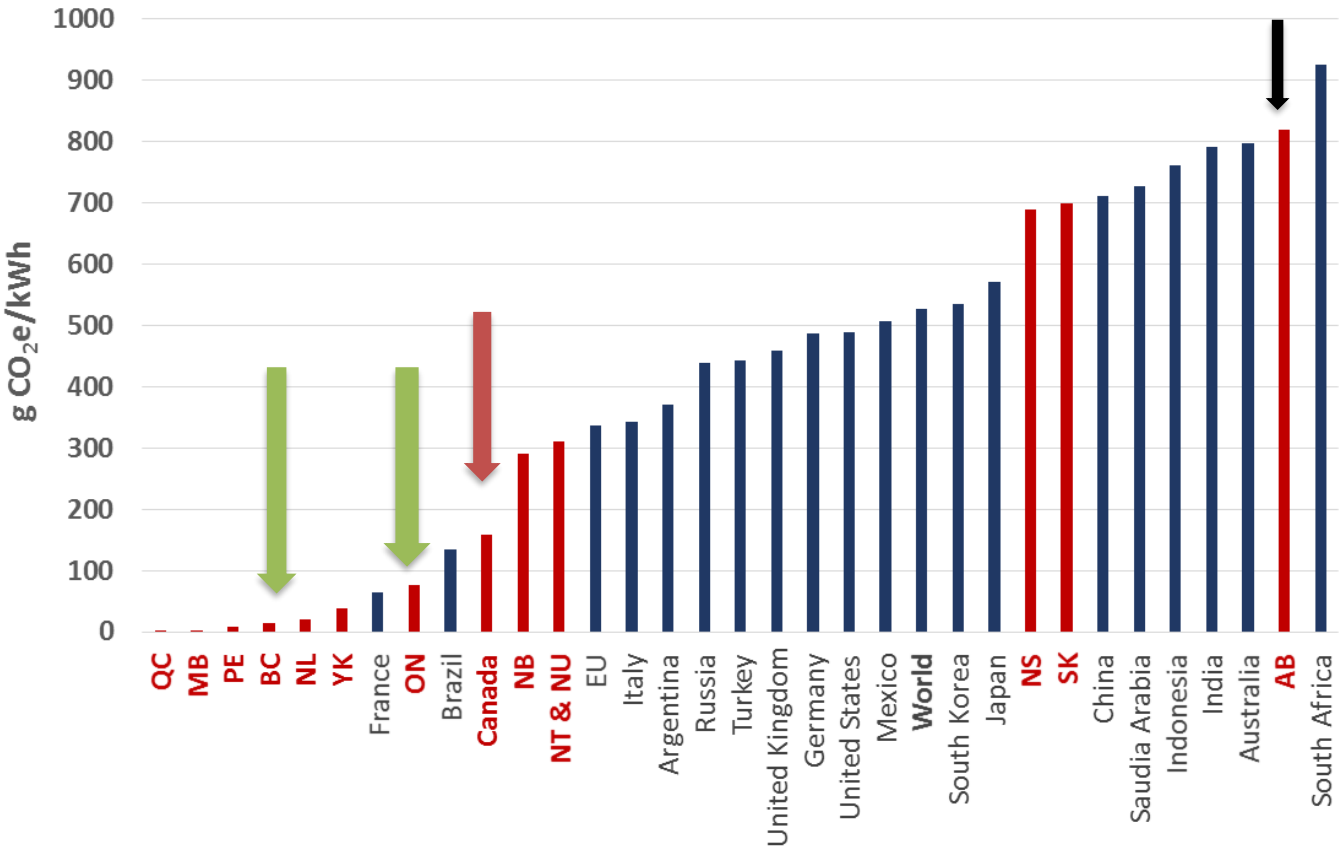
Biomass addresses largest and fastest growing GHG sources

- **Large landmass** results in transportation emissions
- **Northern climate** demands space heating
- **Resource-based economy** requires process heat

Canada has a low electricity GHG intensity

CANADA'S ELECTRICAL GRID INTENSITY

A regional challenge, not a national challenge

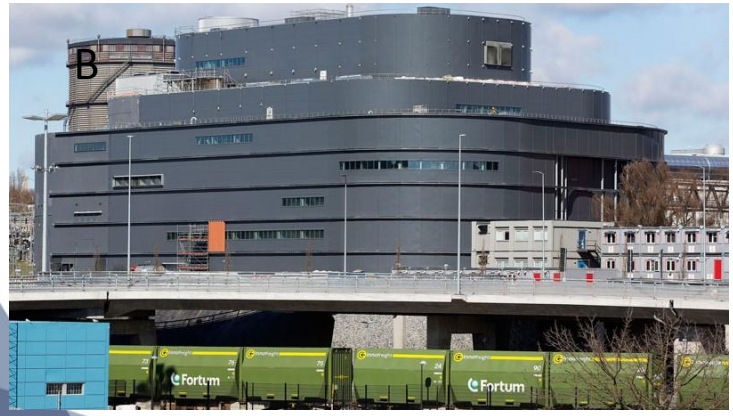


Forest companies as bioenergy producers - recognizing the value of behind the fence production and feeding the grid

LARGE IMPACT OPPORTUNITIES

1. Bioheat including District Energy
2. Renewable Natural Gas in Pipelines
3. Liquid Transportation Fuels
4. Co-Processing Biocrude in Upgraders & Oil Refineries
5. Firing in Coal-fired Power Plants – AB, SK, NS, NB
6. Process Heat for Cement Production

BIOHEAT FOR DISTRICT ENERGY



A. Pellet Boiler
B. Fortum Värtan
C. Spittelau
D. Creative Energy

BIOHEAT FOR DISTRICT ENERGY

UNBC Bioenergy Project

Forest residues to heat, with GHGs saved

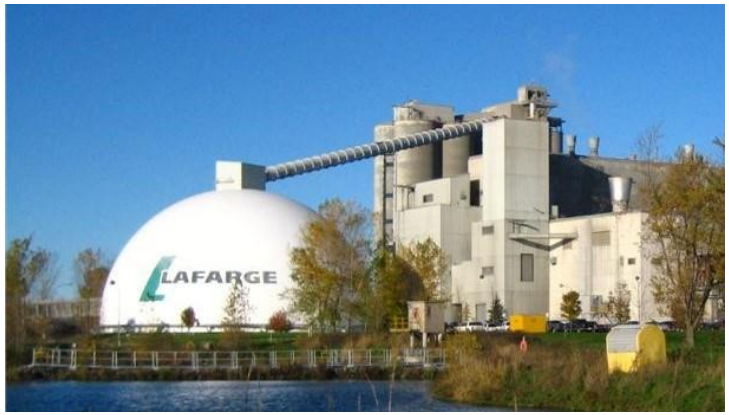
RENEWABLE NATURAL GAS

A. Manure Biogas
B. Hamburg
C. GoBiGas
D. Biotransport

TRANSPORTATION FUELS AND CO-PROCESSING

A. DuPont Nevada
B. Neste Rotterdam
C. Great Green Fleet
D. Biojet

CO-FIRING AND PROCESS HEAT



A. Drax
B. Vaasa - Valmet
C. Lafarge Bath
D. ArcelorMittal BR

BIOMASS INNOVATION* (BIOCLEANTECH)

(50 MT/18% REDUCTION IN ALBERTA)

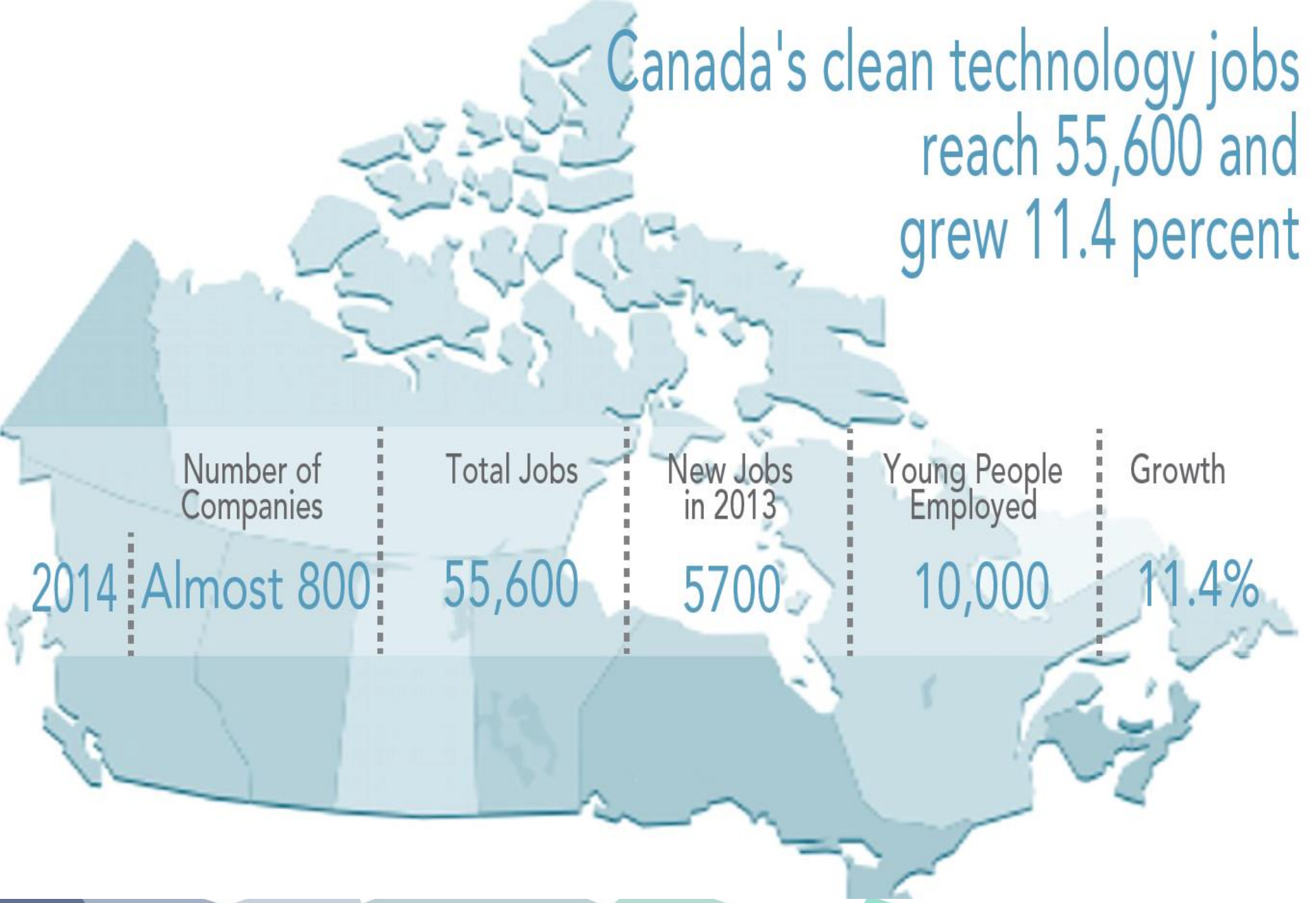
- Displace Coal in Generating Stations: 15.5 Mt CO_2 eq
- RNG & Biogas Management: 6 Mt CO_2 eq
- Bioheat: 5 Mt CO_2 eq
- Co-generation at Oil Sands *In Situ* sites: 11 Mt CO_2 eq
- Cellulosic Ethanol & Renewable Diesel: 2.5 Mt CO_2 eq
- Biocrude Co-Processing: 6 Mt CO_2 eq
- Biomass for Cement Process Heat: 0.5 Mt CO_2 eq
- Agricultural Management Practices: 3.5 Mt CO_2 eq

*Biomass Innovation
http://biocleantech.ca/Biomass_GHGEconomy_Canada_2016.pdf

BENEFITS: JOBS AND COMMUNITIES

- Job opportunities related to biocleantech
  - Higher quality jobs in resource management
  - Operational rather than installation
- Linked to production of higher-value products, such as lumber, agricultural products, chemicals
- Requires services of high tech sectors for GIS, mapping, remote sensing, drones, autonomous vehicles, research

Canada's clean technology jobs reach 55,600 and grew 11.4 percent



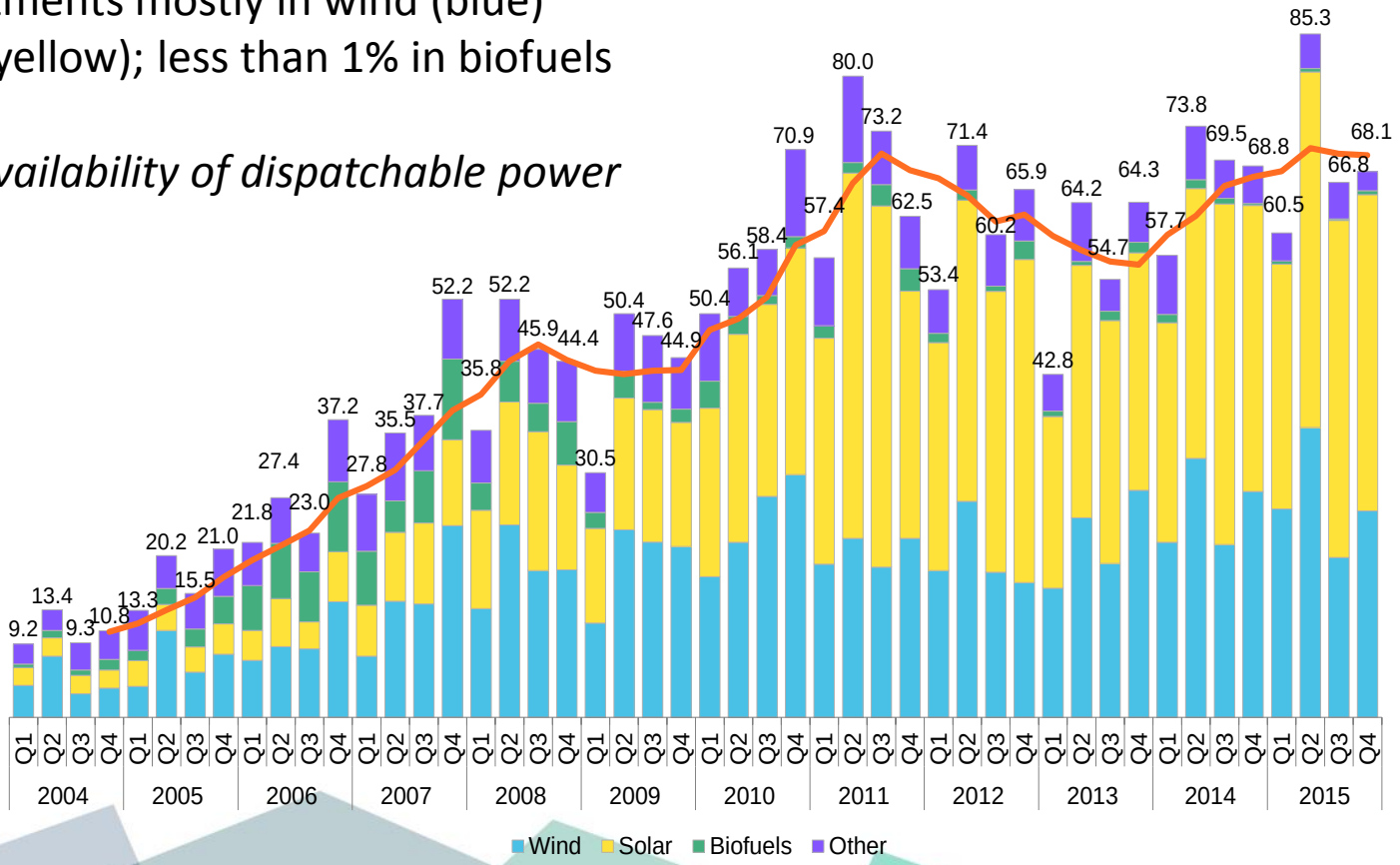
BENEFITS: JOBS AND COMMUNITIES

- Engagement of First Nations essential
- Local energy prevents drain of financial resources

THE ECONOMICS

Global Investment in the Renewables Sector 2004-2015 ($BN)

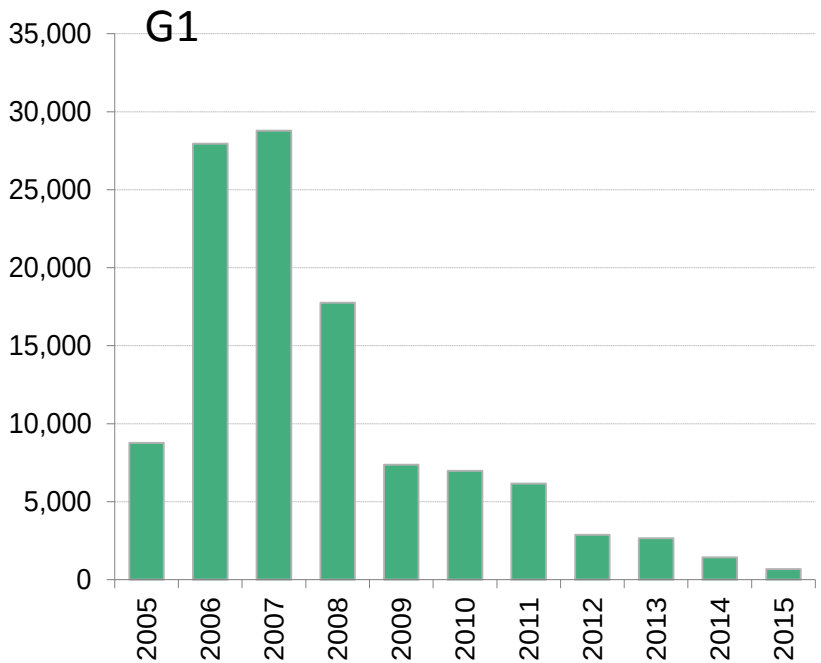
- New investments mostly in wind (blue) and solar (yellow); less than 1% in biofuels since 2004
- *Assumes availability of dispatchable power*

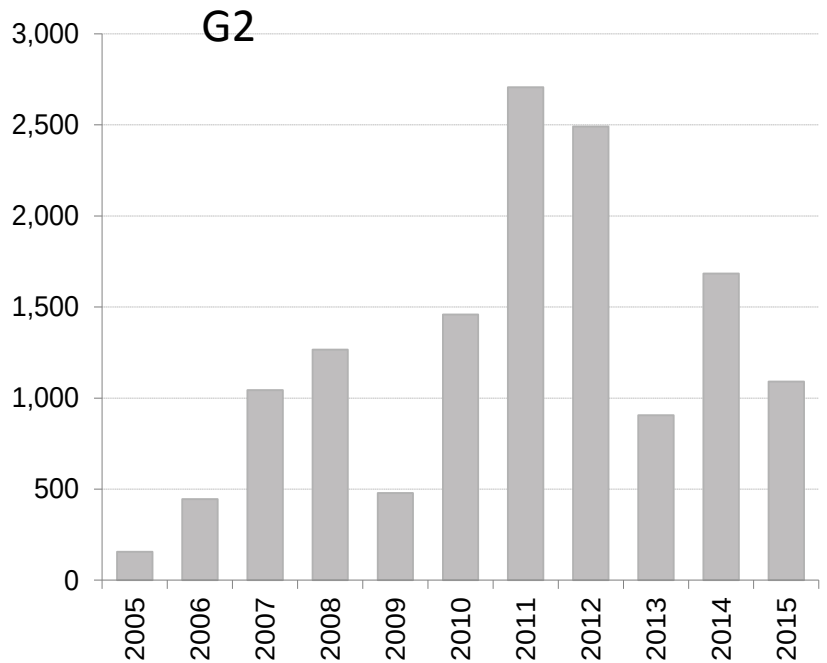


Source: Bloomberg New Energy Finance, Nawitka

THE ECONOMICS

Global Investment in Biofuels by Technology Q1 2005 – Q2 2015 ($M)

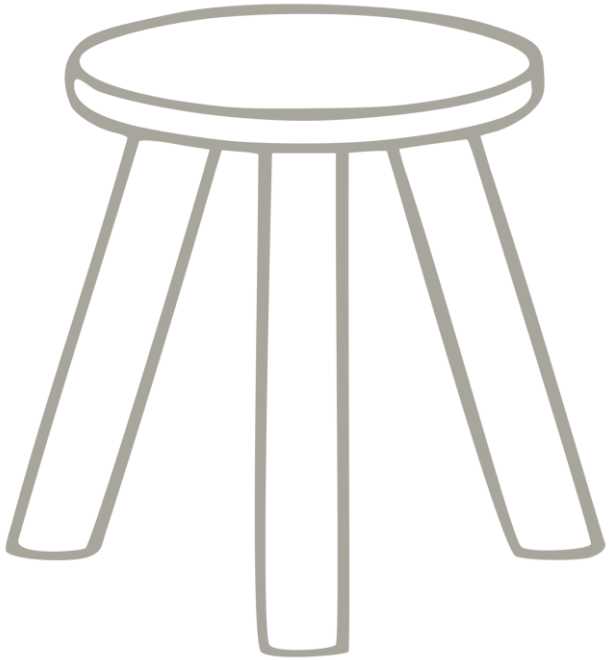




Source: Bloomberg New Energy Finance, Nawitka

ENSURING SUSTAINABILITY

- Environmental sustainability
  - Forest certification, understanding CC impacts, management for multiple markets
- Economically sustainable
  - Access to patient capital
  - Enabling policy
- Social sustainability
  - Community engagement, jobs
  - Public assurance



Balance of affordability and effectiveness

"Canadians understand that a healthy environment and a strong economy are not competing priorities. Now is the time for Canadian companies to capture their share of the global market for clean technology. From waste management to biofuels to greener solutions for the oil and gas industry, these Canadian companies are leading the world in intelligent, environmentally responsible and economically sound solutions in a number of key economic sectors.“

The Honourable Navdeep Bains, Minister of Innovation, Science and Economic Development, 2016

THANK YOU

SUSAN WOOD-BOHM

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SHIFT TO A LOW CARBON ECONOMY

- Definition of term
- Time frame
- Requirements – reduction of emissions, shift away from fossil fuels
- Enhanced interest in sustainability – forest sector has much to teach in this regard sustainability certification/measurement and modeling as well as certification
- We need to understand carbon in natural cycles, managed cycles, as part of our energy system