

Save the planet; grow more trees and use more wood



Market Outlook for Forest-Based Bioproducts – A Canadian Perspective

Northwest Wood-based Biofuels &
Co-products Conference
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Topics that I'll cover today include.....

- 1. Global drivers and trends shaping the clean energy and bio-economy agendas**
- 2. Wood fiber supply and demand**
- 3. Technology maturity and market readiness**
- 4. General observations and take home messages**

Global concern about Climate Change.... Probably the biggest factor driving the move towards the clean energy economy



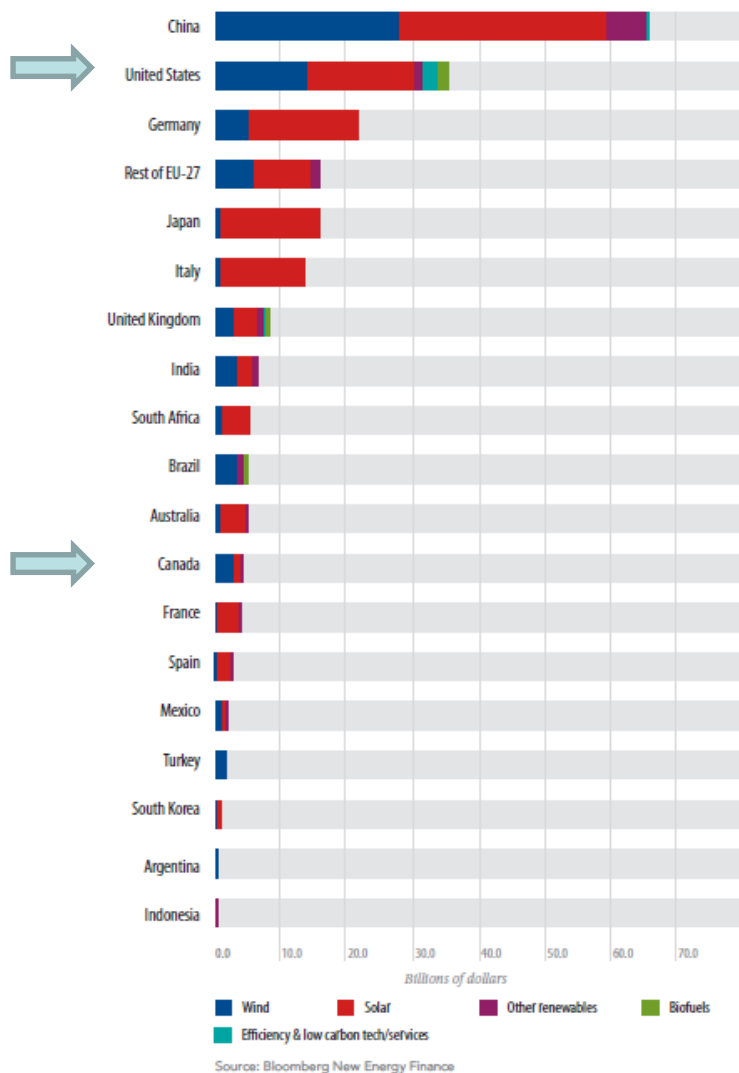
Drivers that are shaping the clean energy economy.....

- 1. Climate Change**
- 2. Depletion of Non-Renewable Resources**
- 3. Globalization of Trade and Supply Chains**
- 4. Population Growth**
- 5. More Affluent and Demanding Consumers**
- 6. New Technologies**

While the goal of reducing green house gases is common, the motivation by countries is different

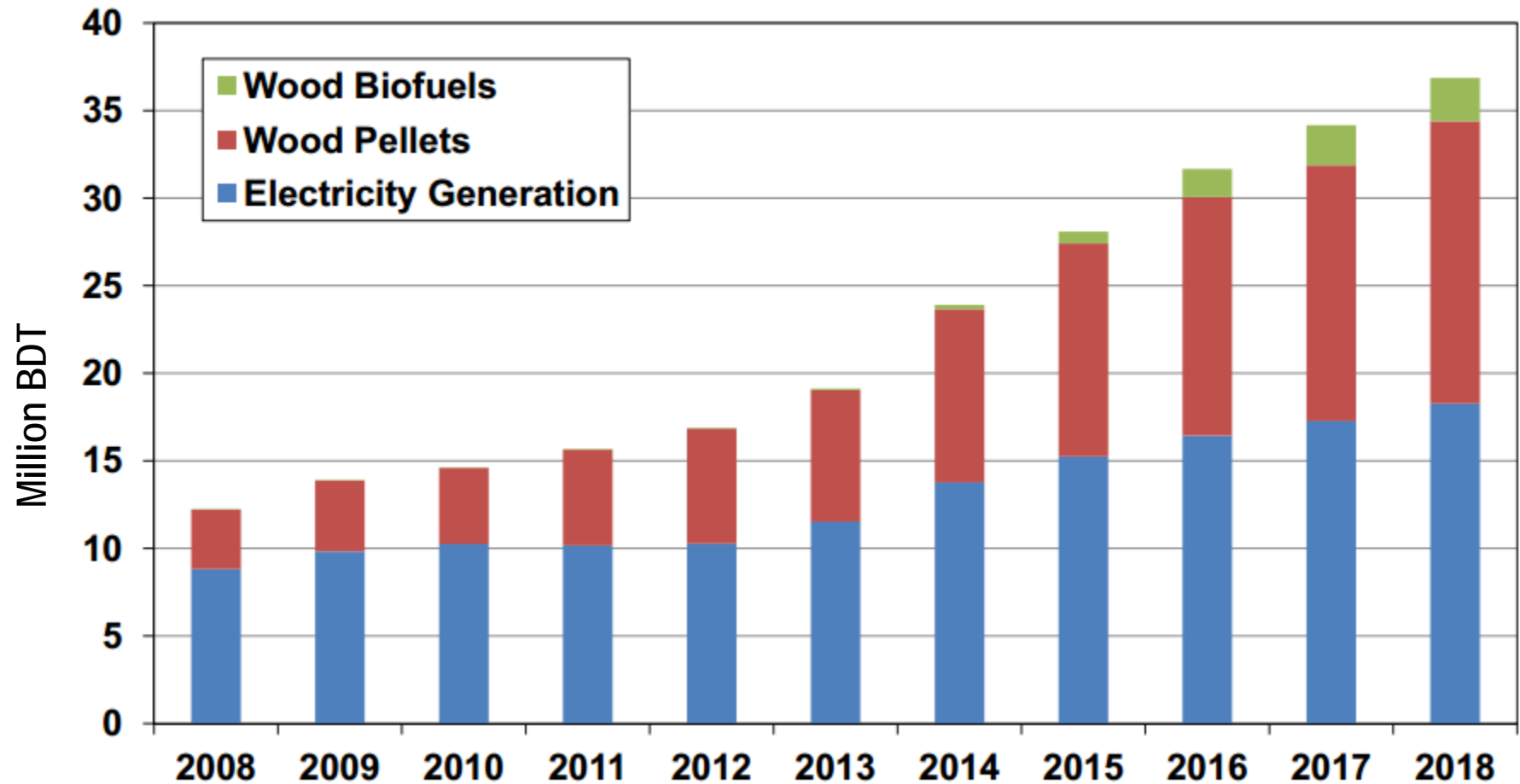
Europe	United States	Canada
Mitigation of Green House Gases for Climate Change	Security of Supply for Transportation leads to National Security Concerns	Mitigation of Green House Gases for Climate Change
Security of Fossil Fuels from Russia and Middle East	Economic risks with petroleum imports- has represented ~50% of current account deficit	Net exporter – environmentally responsible in support of market access (Keystone)
Response to public pressure	Green house gas subordinated	Reactive to US renewable energy policy direction
Coherent Pan European strategy	Patchwork quilt of state-driven incentive programs	Patchwork quilt of provincially-driven incentive programs
Green Collar Jobs	Green Collar Jobs	Green Collar Jobs
	Technology advances in oil and gas drilling combined with increasing fuel efficiency standards leading to “net” energy independence	
Heavy on regulation and EU-directed targets	Free market bias with incentives to influence actions	Less aggressive response but in lock-step with US

Countries differ in the mix and magnitude of their investment portfolio for clean and renewable energy



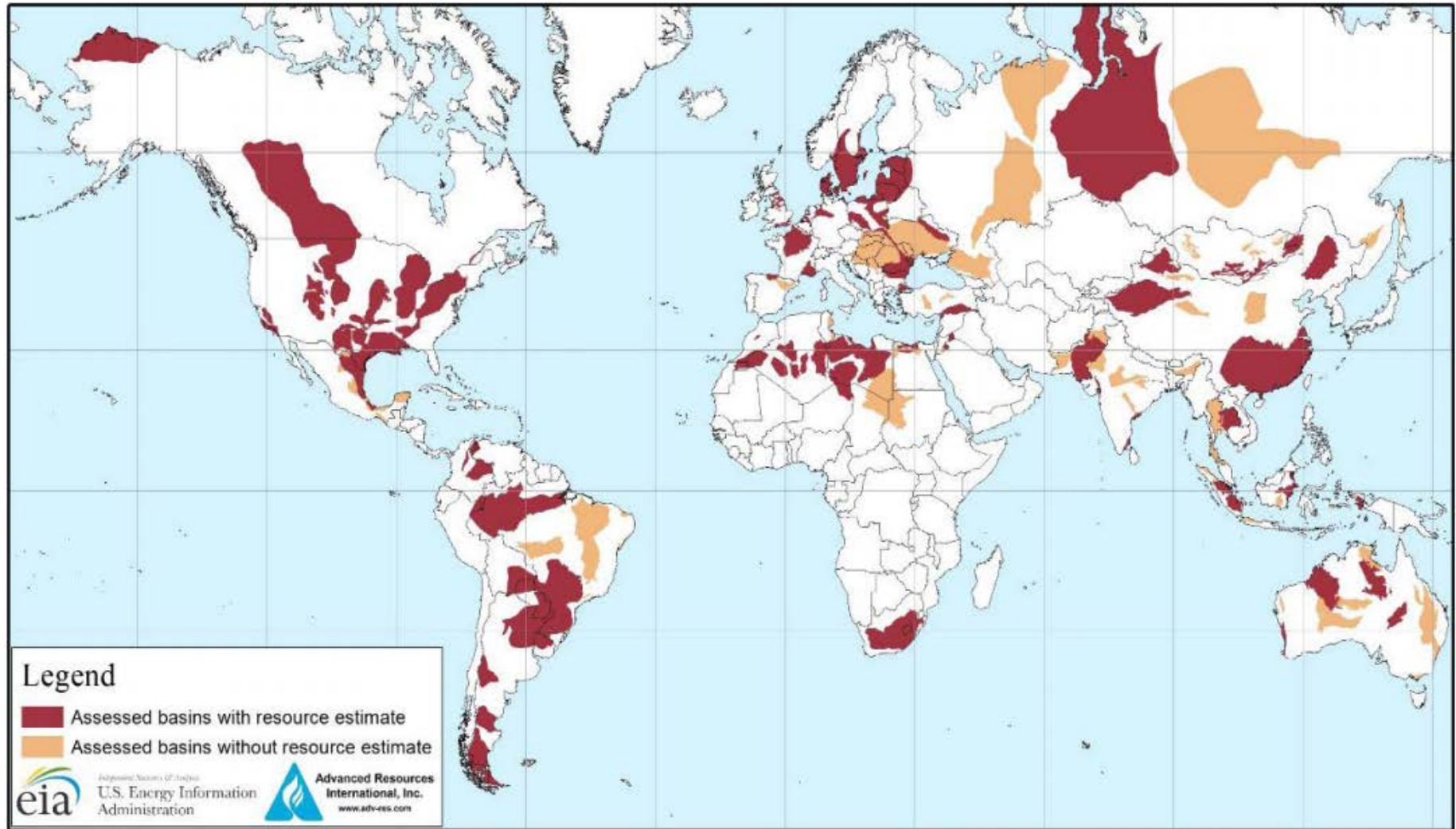
- Asia is becoming the clean energy hub with China the world leader overtaking the US
- China position will increase as it addresses public pressure for pollution abatement and the need to ensure energy security.
- Investments in biomass to energy and biofuels represent a small component of the Clean energy portfolio
- Europe and China are the major investors in biomass and waste conversion to energy
- US and Brazil lead in biofuel investments at \$4.6B and \$2.3B, respectively.
- Canada trails with a 2012 investment of \$230 million.

Bioenergy growth in North America mainly in biomass for domestic energy and pellets for export; 2G biofuels remain a small play



Source: S. Walker, RISI, October 2013 (Sten Nilsson).

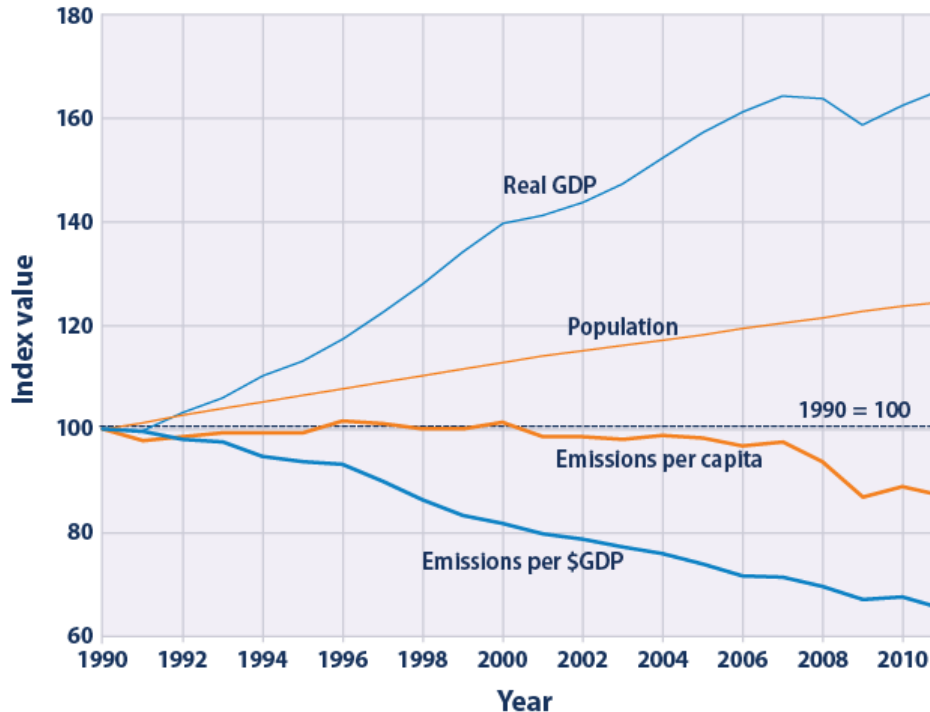
Shale oil and gas have the potential to dramatically alter world energy markets – game changer



Source: A. Sieminski, IEO July 25, 2013

The US is on track to meet its Copenhagen target of a 17% reduction of 2005 levels by 2020.

U.S. Greenhouse Gas Emissions per Capita and per Dollar of GDP, 1990–2011



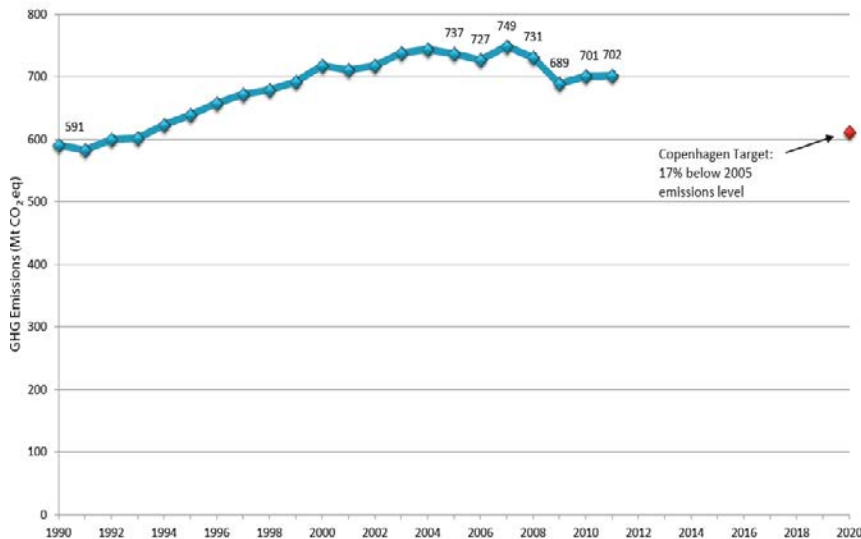
Data source: U.S. EPA (U.S. Environmental Protection Agency). 2013. Inventory of U.S. greenhouse gas emissions and sinks: 1990–2011. USEPA #EPA 430-R-13-001. www.epa.gov/climatechange/ghgemissions/usinventoryreport.html.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climatechange/indicators.

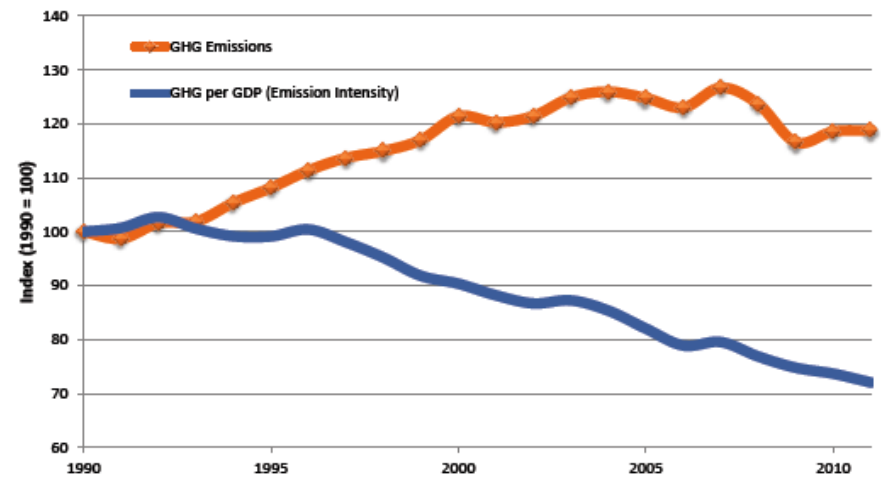
- US strategy on reducing its carbon footprint has been balanced
- Reduce consumption through energy efficiency measures (vehicles and buildings)
- Reducing footprint of fossil fuels through mitigation and substitution (e.g., natural gas for coal, Carbon Capture and Storage technologies)
- Renewable clean energy (stand alone or integrated)

Canada continues to be a laggard when it comes to meeting its Copenhagen commitment

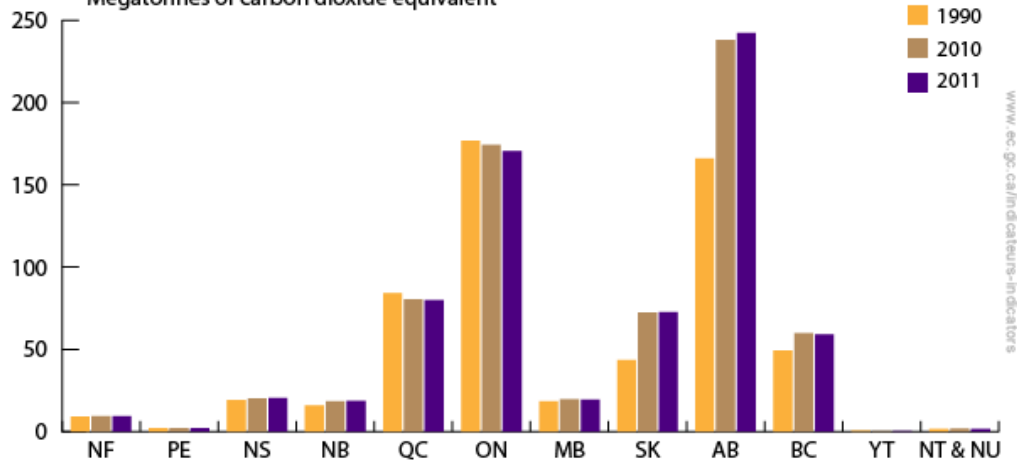
Canadian Emissions in 1990-2011



Indexed trend in GHG Emissions and GHG Emission intensity 1990-2011



Megatonnes of carbon dioxide equivalent

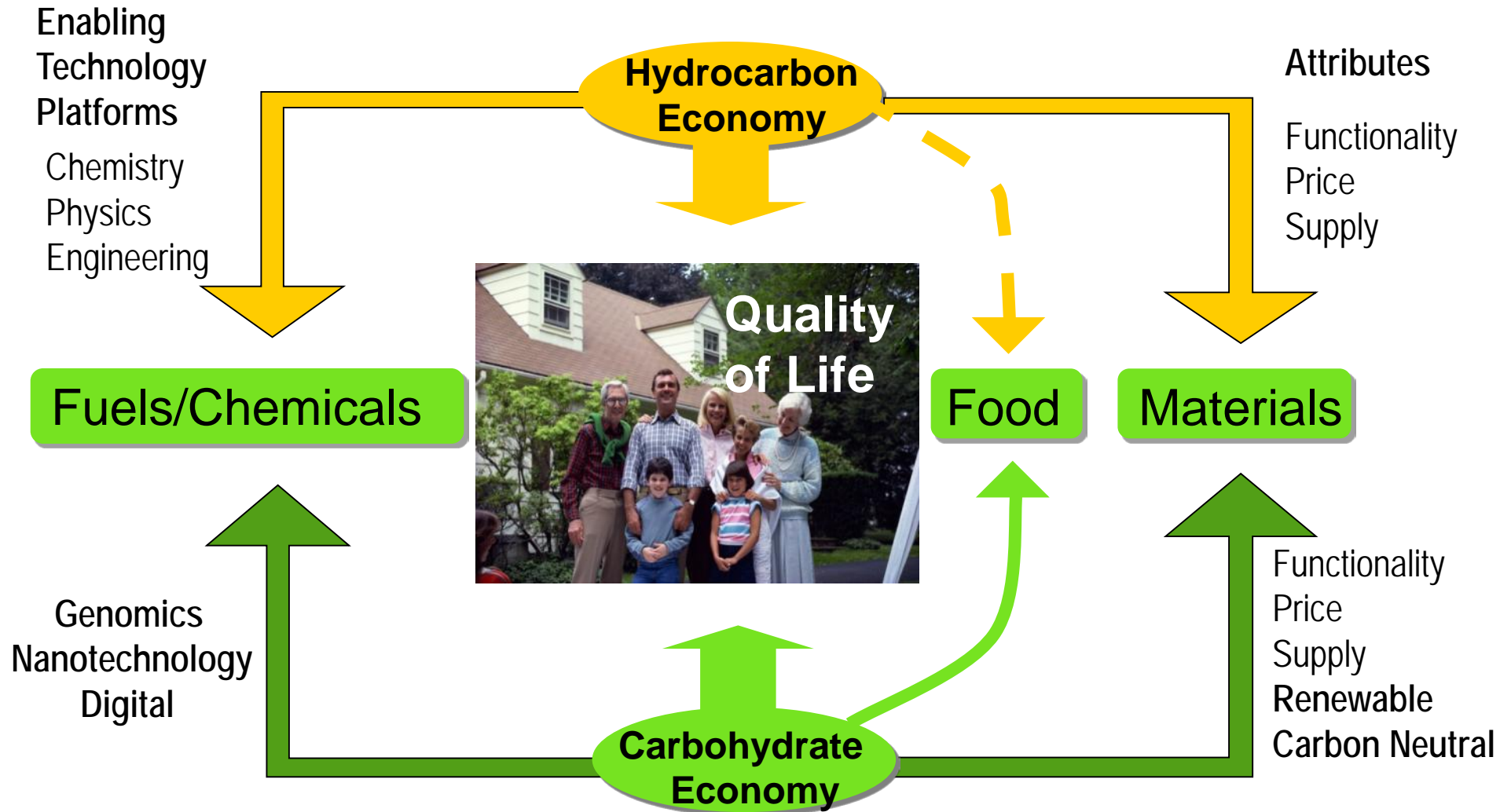


Canada not expected to meet its Copenhagen target of 612MT in 2020; 2013 projections have been revised to 734 megatonnes for 2020. Will get worse unless there are changes.

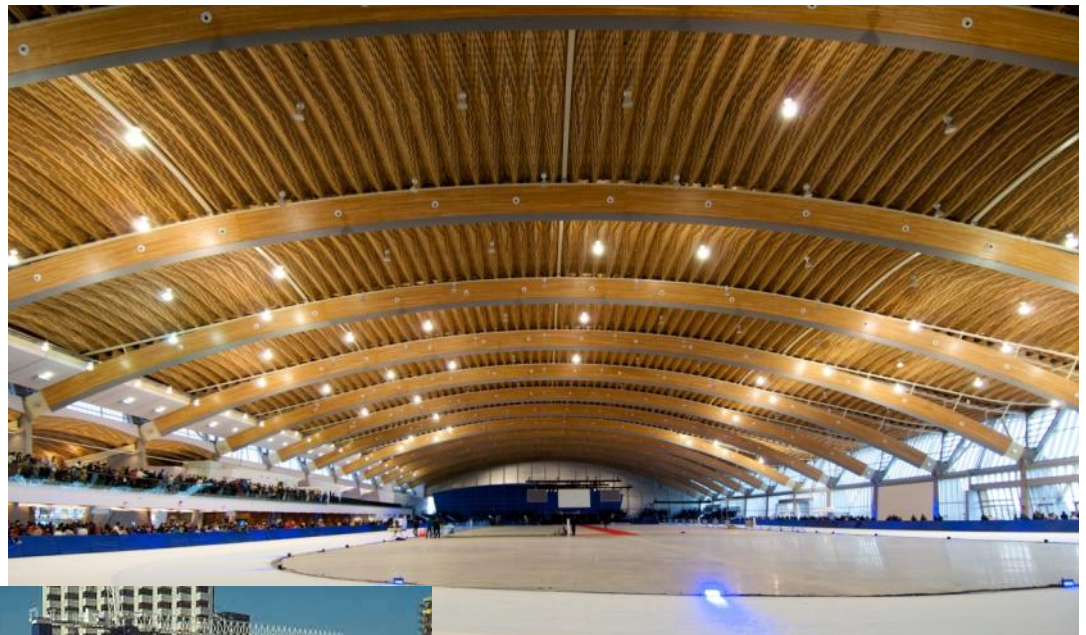
Western Canada is more heavily resource-focused, continues to increase its GHG emissions.

Alberta's Oil Sands largest contributor; is expected to grow from 1.1MB in 2011 to 3.3MB in 2020.

Sustainable Living and Environmental Stewardship underpins today's emerging Bio-economy



Wood products a major component of the Bio-economy going forward



U.S. supply of biomass could replace one-third of its petroleum consumption by 2030 – but what are the 2nd & 3rd order impacts?

Mn. dry ton	
Forest-Based Resource	368
Fuel Wood from Forest	52
Mill Residues	145
Construction & Demolition Sites	47
Logging & Site Clearing	64
Fire Smart Treatments	64
Agri-Based Resource	998
Total Potential Biomass	1366

- Numbers represent a seven-fold increase in production of the biomass currently consumed for bioenergy & bio-based products.
- Available agri-based biomass is almost 3X greater than Forest-based biomass and is usually more accessible and at lower cost.
- Most of the early entrants into bio-refineries are agri-based (POET DSM, Dupont, Abengoa, BioAmber)

US Billion Ton Update 2011, DOE

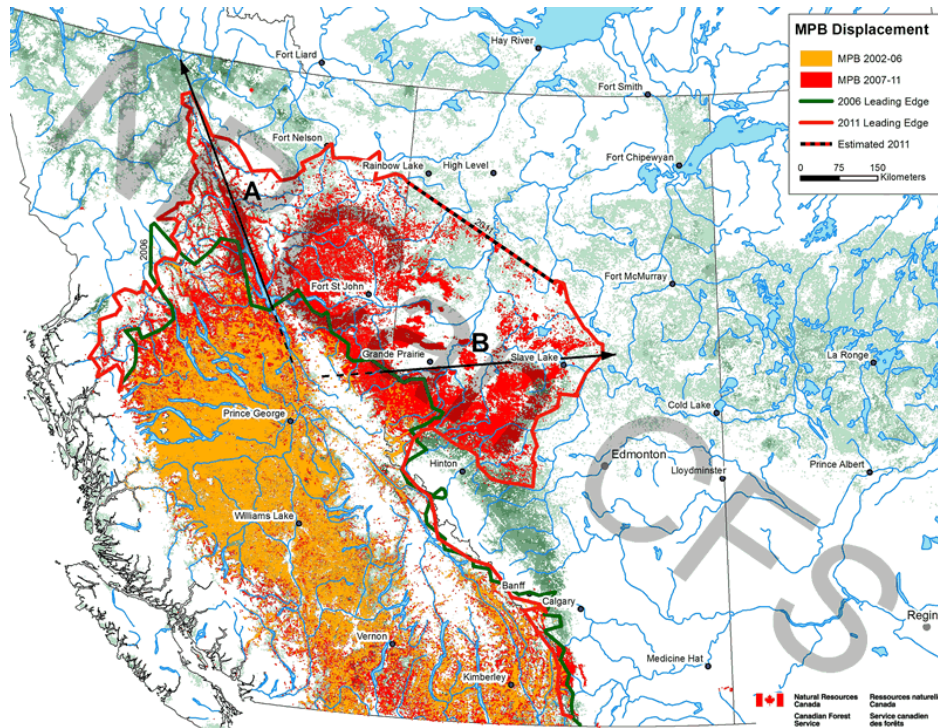
Canada has 60+ million oven dry tons (Odt) per year surplus of Biomass, but it is a long way from market

Mn. dry ton	
Forest-Based Resource	
Mill Residue	2.3
Bark	1.8
Roadside Waste	12
Agri-Based Resource	44
Total Potential Biomass	60.1

- Canada has considerable forest residual biomass that could be extracted
 - Access is difficult and cost of harvest and transportation is high and problematic when the end use is a low value product (white pellets)
- Crown ownership with long term tenure system provides little benefit for existing tenure holders to extract residuals
- Dynamics could change in Eastern Canada where the shut down of Pulp & Newsprint mills has resulted in a surplus of sawmill chips.
 - Challenge will be how well these sawmill operators will adjust with the lower price these residues are expected to fetch in the pellet market.

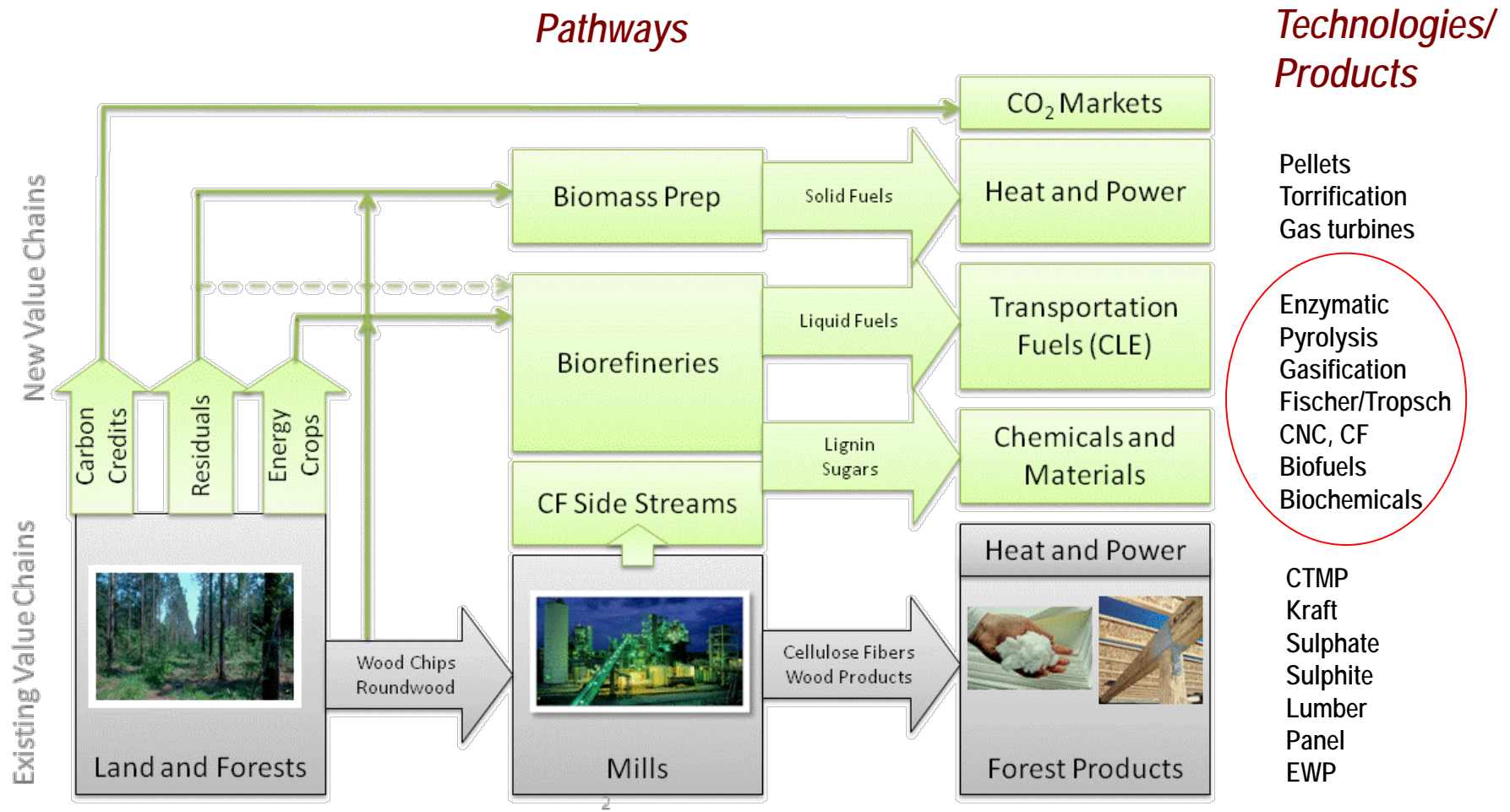
Compilation from various Provincial Government sources

The Mountain Pine Beetle has infected and/or killed over 17.5 million hectares of Western Canadian Pine Forests



- 53% of merchantable pine in BC (~770 million m³) has been killed.
- AAC drops from 78 million m³ to ~ 50 - 60 million m³ by 2023-25
- Ramp up to past levels after 2050
- Alberta AAC expected to drop by 5 million m³ as infestation advances east
- Other pine species have been shown to be susceptible to attack.
 - Spread to Jack pine could affect the whole boreal forest across Canada.
- Shelf- life shorter than predicted for pulp and lumber quality: fall back options are pellet production and power generation

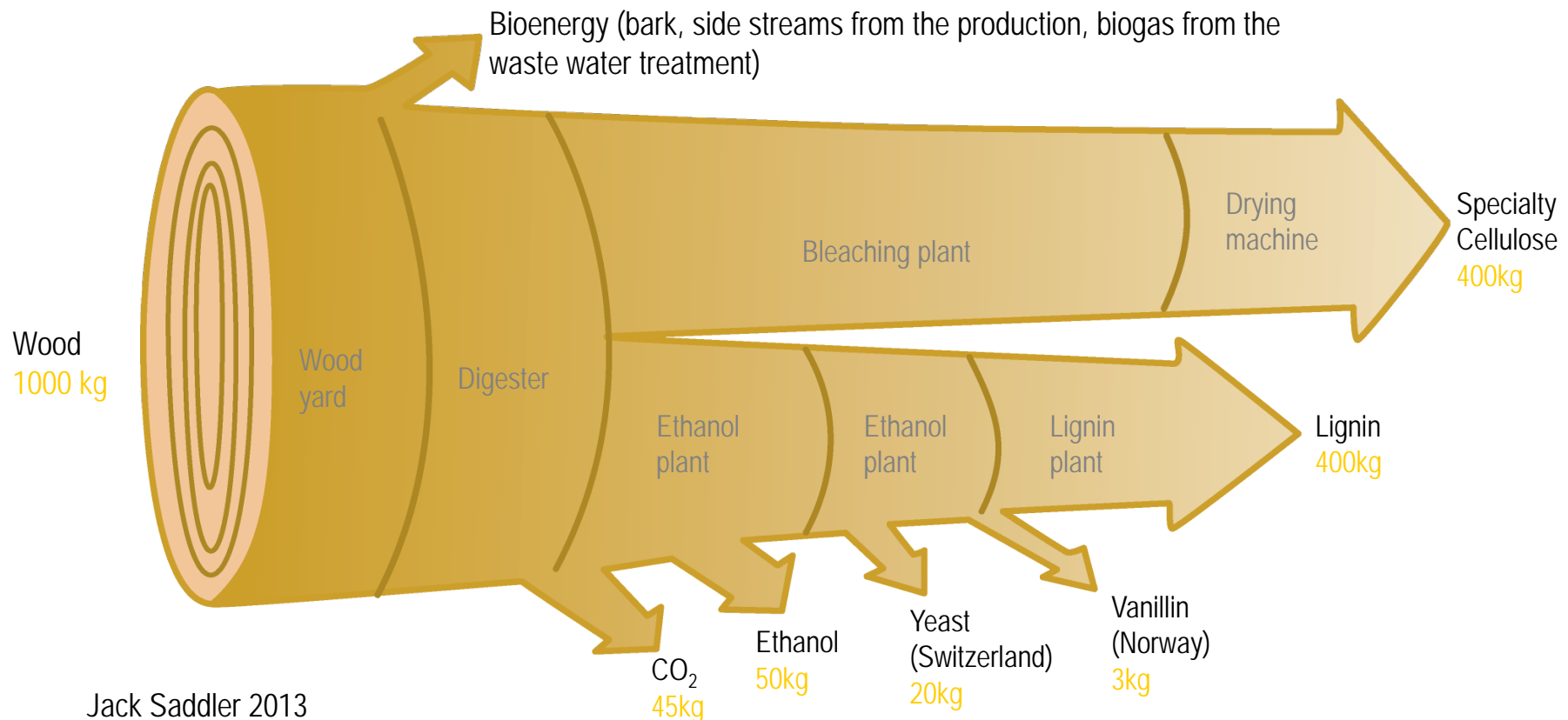
Many pathways and technologies exist for the development of Biorefineries – from “Bolt-On” to “Stand-Alone”



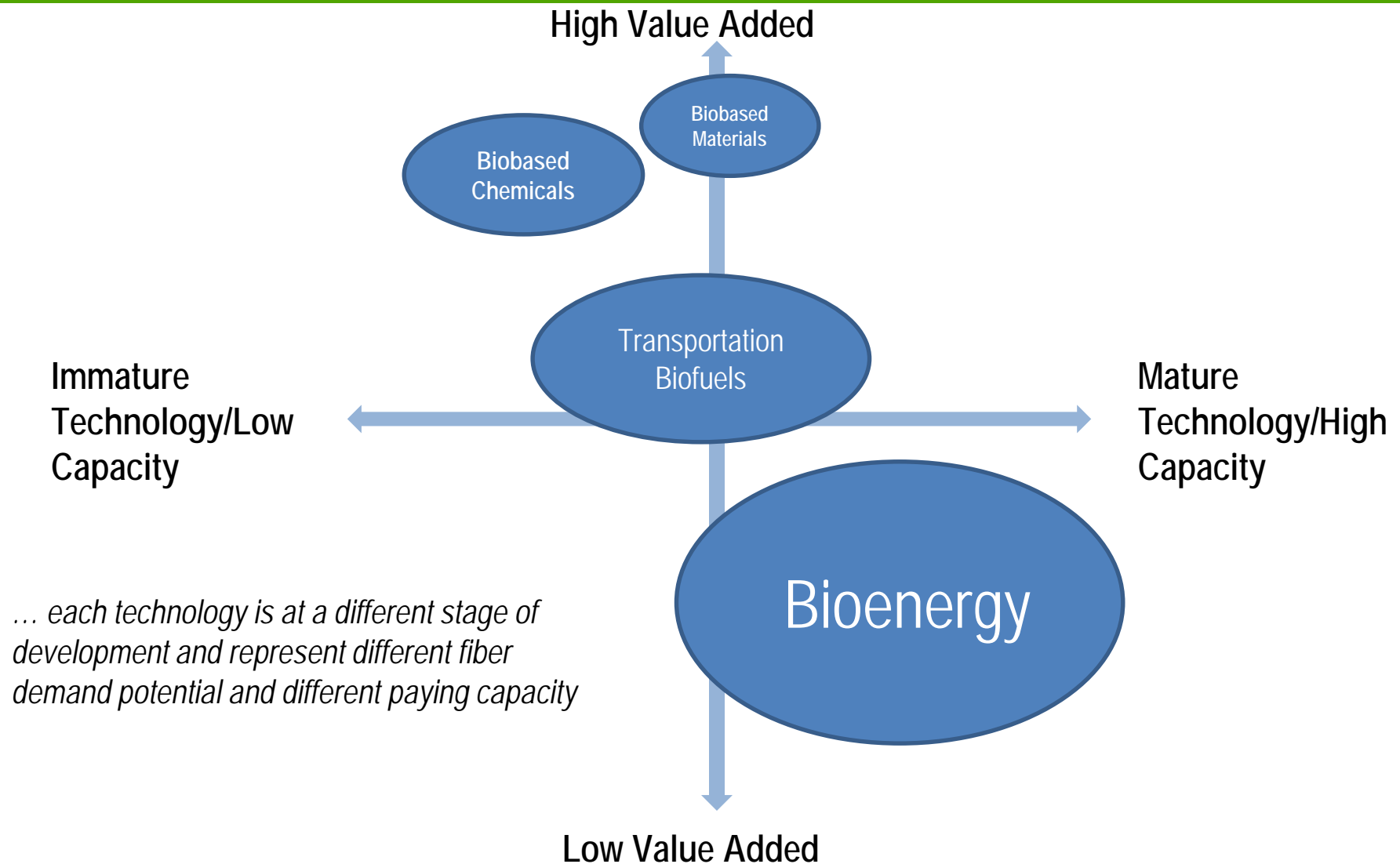
Modified from Weyerhaeuser, Federal Way, WA

Borregaard's biorefinery was a repurposed sulfite pulp mill that evolved over time

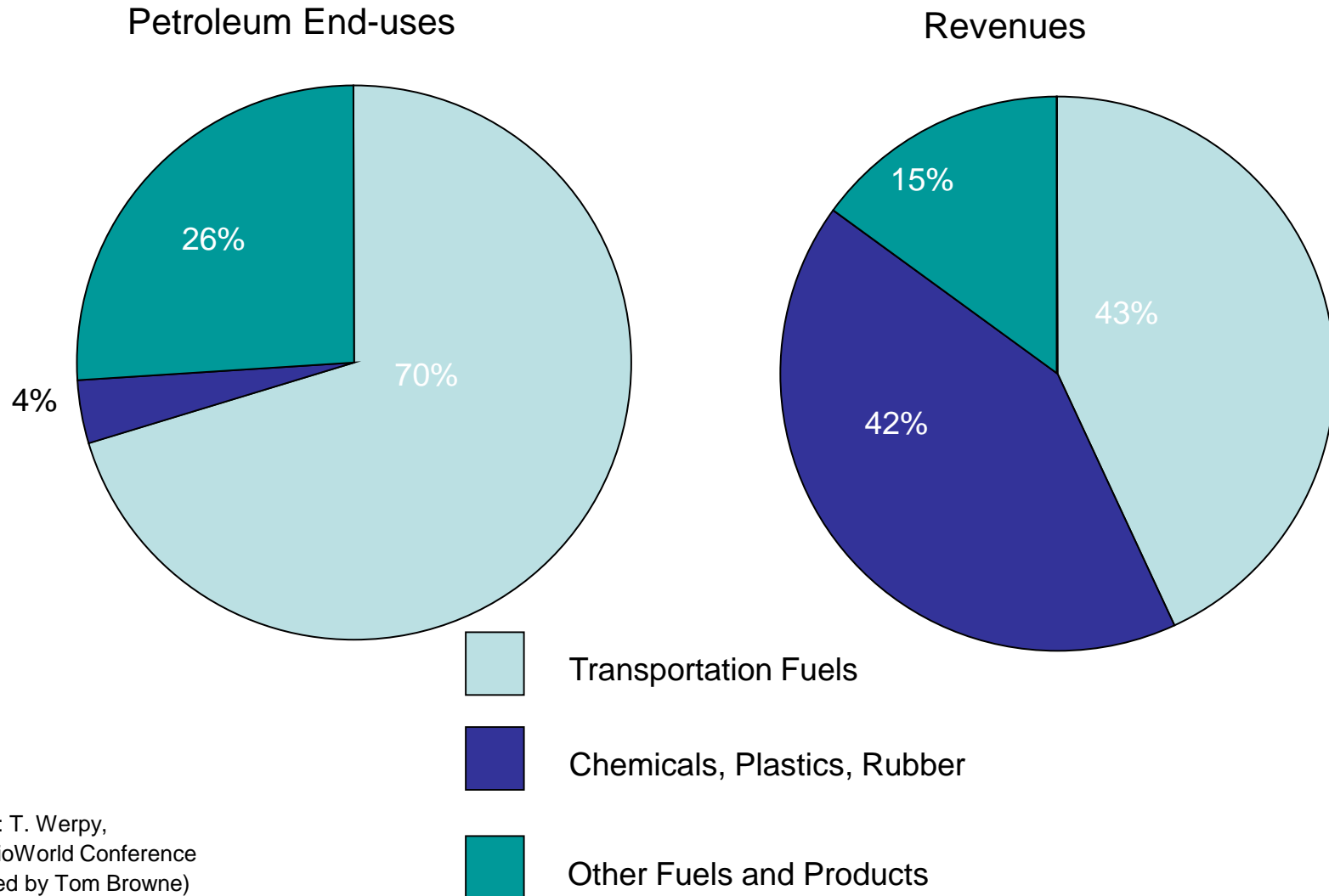
- Specialty cellulose, lignin products, ethanol, yeast, yeast extracts, vanillin, diphenols, fine chemicals
- Two biorefineries: Sapsborg, Norway & Solothurn, Switzerland



Several pathways and technologies drive development of Bioenergy and other Bio-products... sweet spot likely in higher value & less volume



Will Bio-Refineries be similar to Petroleum Refineries with 40% of revenues coming from 4% of production volumes?



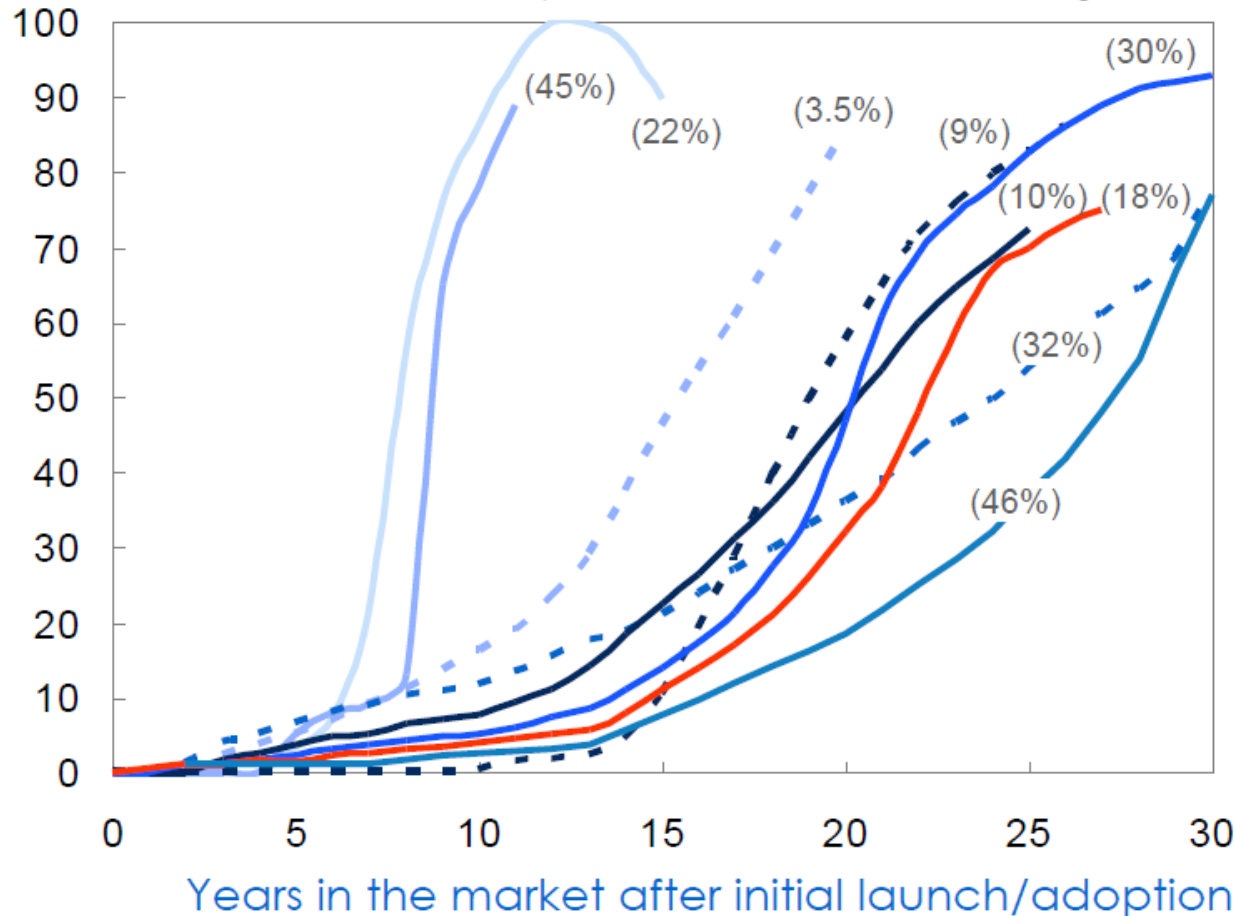
Source: T. Werpy,
2009 BioWorld Conference
(Modified by Tom Browne)

With a few exceptions, it takes 10 or more years to make significant market penetration with a new product or substitution

Normalized adoption curves for nine technologies (with max penetration)

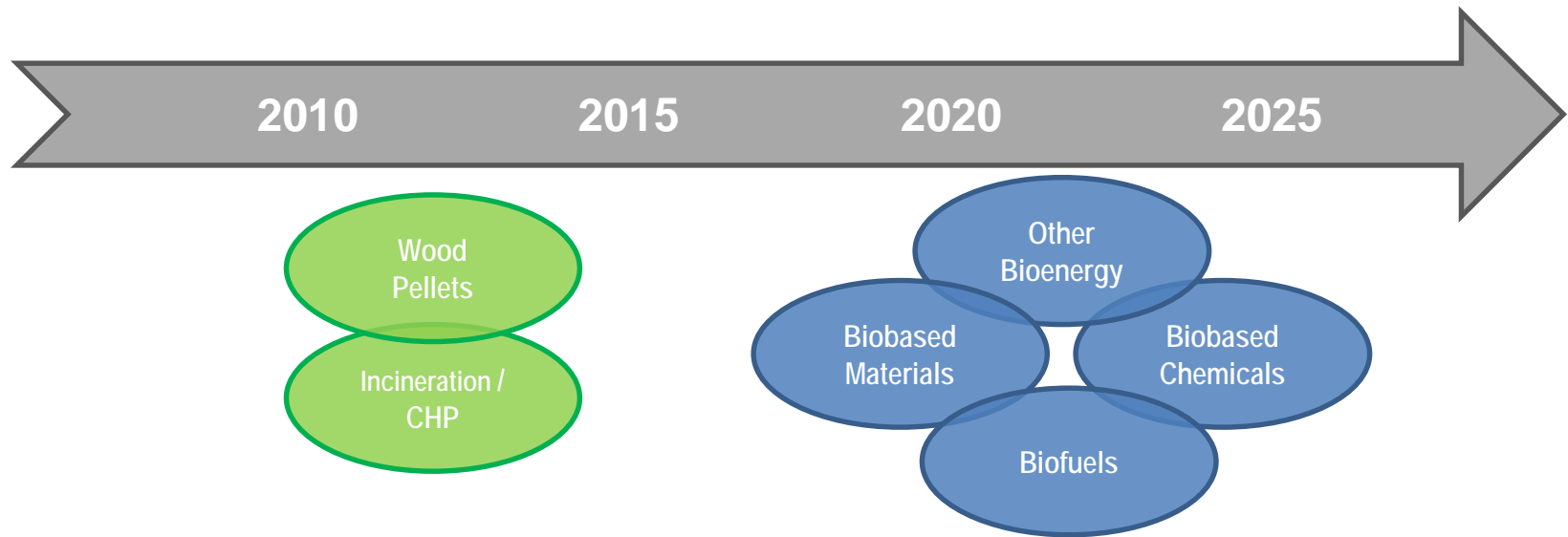
100% = terminal penetration rate
(with share of addressable market)

Composite decking	Vinyl siding	I-Joists
PEX	Superior Wall	Hardie Board
Structural glass	ICF	PVC



McKinsey, NAHB

Significant market penetration of next generation bio based products is at least 5 to 10 years away



- **Drivers of bio product development are many:**
 - Innovation – technology development from tree genetics to conversion of fiber for bio products
 - Market – growing global demand for energy, decreased supply of “easy” energy, fears over nuclear, increased demand for renewable demand, etc...
 - Government policy – energy security, environmental / climate change, balance of trade, etc...
- **Near-term risks to the development of the next generation of bio based products include:**
 - Reduced biofuel investments in recent years
 - Lower cost natural gas as a result of fracking and horizontal drilling
 - Government policies and incentives (sovereign debt and public pushback)

Canada's Forest Sector Transformation effort is small but well targeted

Innovation Strategy	Funding Level	Federal \$	BC \$
FPAC Bio-pathways		√	√
Transformative Technologies	\$100 million from 2007 - 2012	√	
Regional BC Initiatives	\$15 million from 2007 - 2012	√	√
Pilot Scale Demonstration (PSD) (6 of the 15 projects in BC)	\$58.8 million in BC (total Industry, Federal & Provincial)	√	√
Green Transformation Program	\$1 billion (\$440 million in BC)	√	
Investments in Forest Industry Transformation (IFIT)	\$100 million over 4 years	√	
NSERC Forest Sector R&D Initiative (FIBRE)	\$34 million over 5 years	√	
BC Bioenergy Network	\$25 million grant from BC		√

IFIT program was allocated \$90.4 million over 2014-2018
Forest Innovation program \$92 million over 2014 -16 for R&D (Transformative Technologies)

BC focus has been on beetle killed biomass and sawmill residues for pellets, CHP and gasification (WtE); major effort in capitalizing on wood products as a key component of Bioeconomy strategy

Ontario's Bio-based cluster focused on production of bioethanol, specialty biochemicals , bioplastics, resins and biomaterials for automotive sectors, ((Greencore, Vertichem, Bioamber, Woodland Biofuels, Suncor Ethanol, etc.).

Quebec has major effort on biorefinery demos (CNC, CF)

Farrell and Goodison 2012

Some take home messages.....

1. Bio-economy a small piece of the renewable energy agenda
2. Biorefinery momentum coming from Agri-food sector; slow start for Forest sector
3. Exploit all Bio-refinery options - bolt-ons, greenfields and greyfields
4. Sweet spot is with medium value-added bio-products and biomass requirement
5. Importance of partnership with end-user; early engagement
6. Commercial success always takes longer than projected
7. Too much research push and too little market pull
8. Demo projects in mill environment critical:
 - Test bed for robustness of technology
 - Production of materials for market development
 - Opportunity for new entrants and generating momentum
 - Move from technology push to more market pull
9. Build on region's competitive advantage – NARA and aviation biofuel in the PNW, Southern Ontario's manufacturing capacity in automotive and petro-chemical products and the potential for biorefinery, bioenergy and wood products in BC
10. Patience, focused effort and partnerships