

# National Energy Board 2008 Energy Futures Workshop



## Panel on Alternative and Emerging Energy “Up and Coming” Energy and Environmental Technologies

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**22 January 2008**  
**Ottawa Ontario**



Natural Resources  
Canada

Ressources naturelles  
Canada

**Canada**

# Outline – Today’s Presentation



- **Setting the Stage – “Energy System” Context**
- **Emerging Consensus on Priorities - “Up and Coming” Technologies**
- **What Impacts Could New Technologies Have?**
- **Encouraging Technology Concepts and Drivers of Investment**
- **Energy S&T Initiatives**

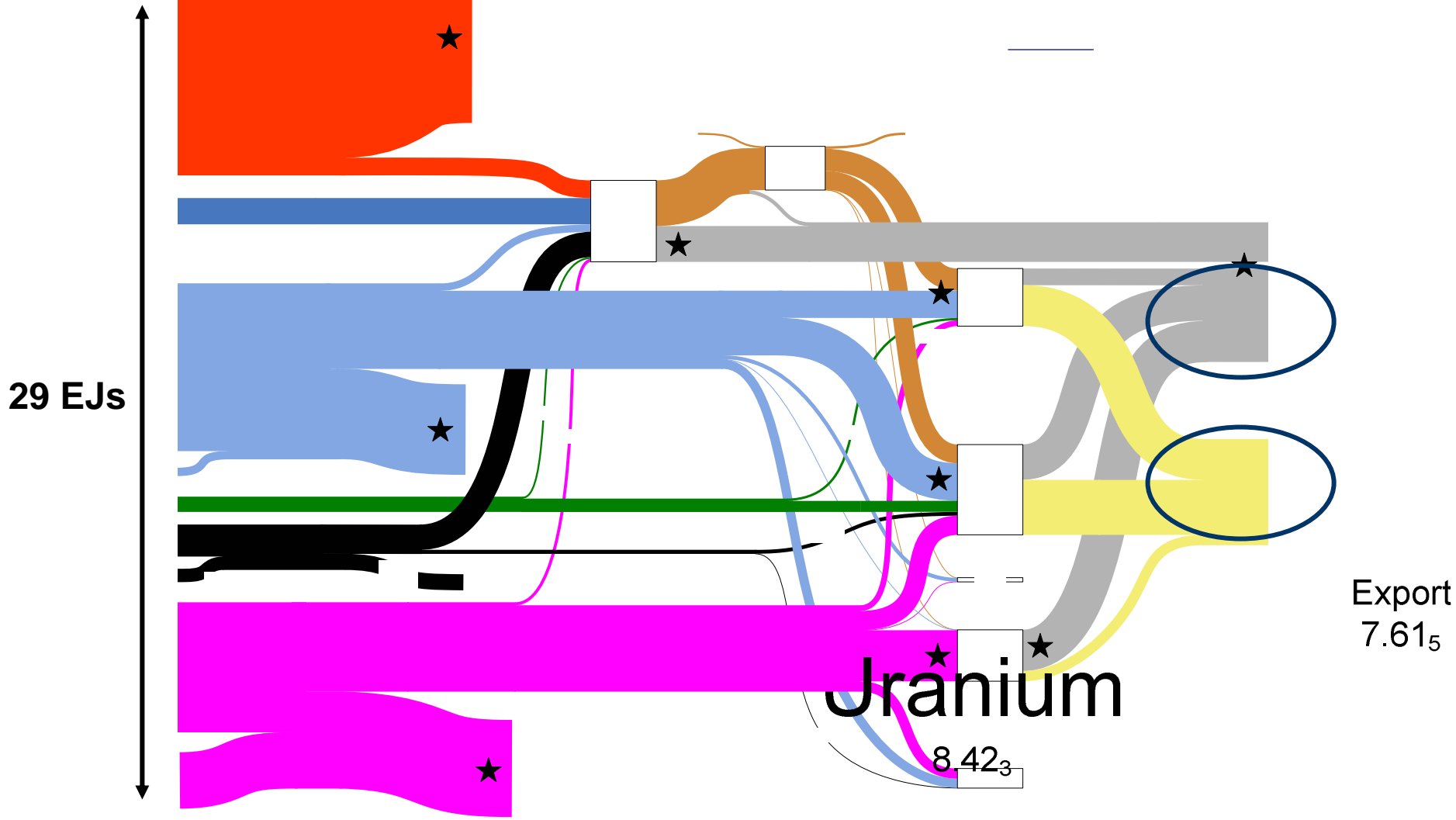


# Setting the Stage

## “Energy System” Context

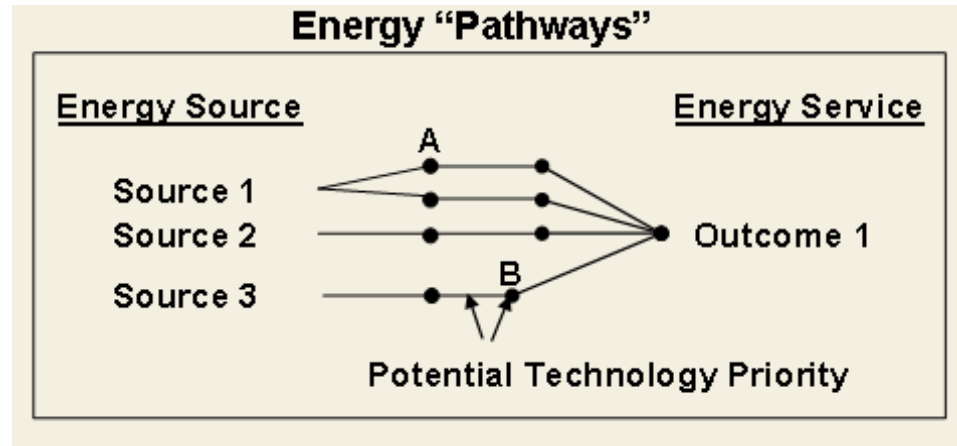
# Canada's Energy Flows - 2003


 Natural Resources Canada / Ressources naturelles Canada



Sources of Supply → Conversion → Energy Services

# “Energy Pathways” – Concept, Examples Alternative Routes to Energy Services



E.g., Coal-based (gasification/CSS) to produce hydrogen and supply it to a fuel cell vehicle



E.g., Wind-based, distributed generation to supply electricity to an electric vehicle



# Technology Solutions At Hand, Better Ones In The Making



- First action – put today’s best “on the shelf” technologies to use - ASAP

- Accelerate work on three categories of “up and coming” technologies - solutions “in the making”

- “emerging” technologies almost ready now – CO<sub>2</sub> capture and storage, cellulosic ethanol

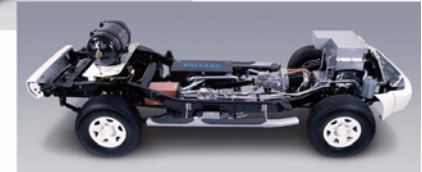
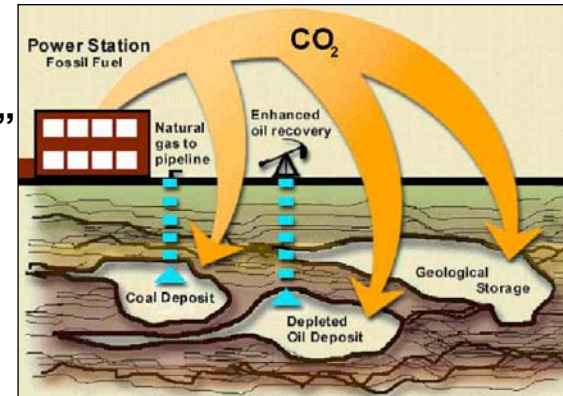
→ *need commercial-scale projects, codes & standards*

- “next generation” technologies – gasification/oxyfuel clean coal, electricity storage, hydrogen/fuel cells in transportation, hybrids and EVs

→ *need R&D, demonstration, networks, pre-competitive collaboration*

- “transformational” – “zero emission” coal, “next generation” nuclear, gas hydrates, fusion power

→ *need basic research*





# **Emerging Consensus Promising “Up and Coming” Technologies**

**National Advisory Panel on Sustainable Energy S&T Priorities**

**Canadian Academy of Engineering (Phase 2)**

**Energy Dialogue Group (18 Industry Associations)**

**Council of Canadian Academies**

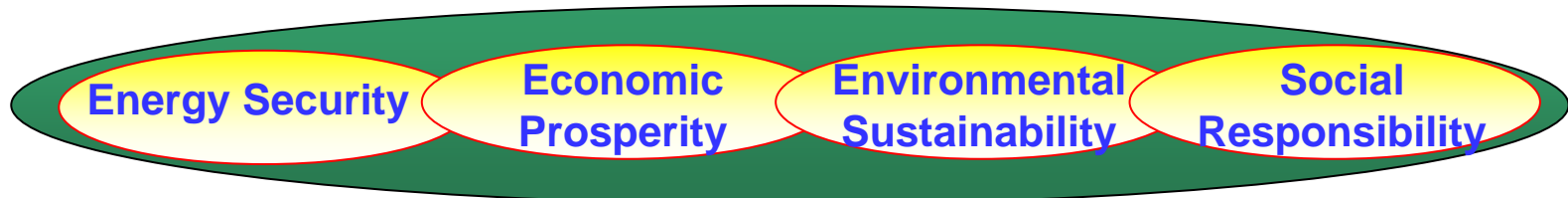
**Energy Technology Working Group (Federal-Provincial)**

# Compilation of Stakeholders' Priorities

## Emerging Consensus - Examples

<b>National Advisory Panel</b>	<b>Canadian Academy of Engineering (Phase 2)</b>	<b>Energy Dialogue Group</b>	<b>Council of Canadian Academies</b>
<p><b>Gasification</b></p> <p><b>Carbon Capture and Storage</b></p>	<p><b>Gasification of Coal and Biomass</b></p> <p><b>CO<sub>2</sub> Capture, Transportation, Storage and Use</b></p>	<p><b>Clean Coal</b></p>	<p><b>Clean Fossil Energy Technologies</b></p>
		<p><b>Oil Sands</b></p> <p><b>Conventional Oil and Natural Gas Propane</b></p> <p><b>Methane Hydrates</b></p> <p><b>Artic/Unconventional Natural Gas</b></p>	<p><b>Energy recovery technologies (oil sands, gas hydrates)</b></p>
<p><b>Bioenergy</b></p>		<p><b>Biomass</b></p> <p><b>Ethanol</b></p>	<p><b>Clean renewable energy</b></p>
<p><b>Electricity transmission, distribution and storage</b></p>	<p><b>Cross-Canada electrical highway, access by renewables</b></p>	<p><b>Hydroelectricity</b></p> <p><b>Wind</b></p> <p><b>Nuclear</b></p> <p><b>Geothermal</b></p>	
<p><b>Fuel cells</b></p>		<p><b>Hydrogen and Fuel Cells</b></p> <p><b>Sustainable Communities</b></p>	<p><b>Fuels Cells, Hydrogen</b></p>

# Priority Technologies, Three Tactics Energy Technology Working Group



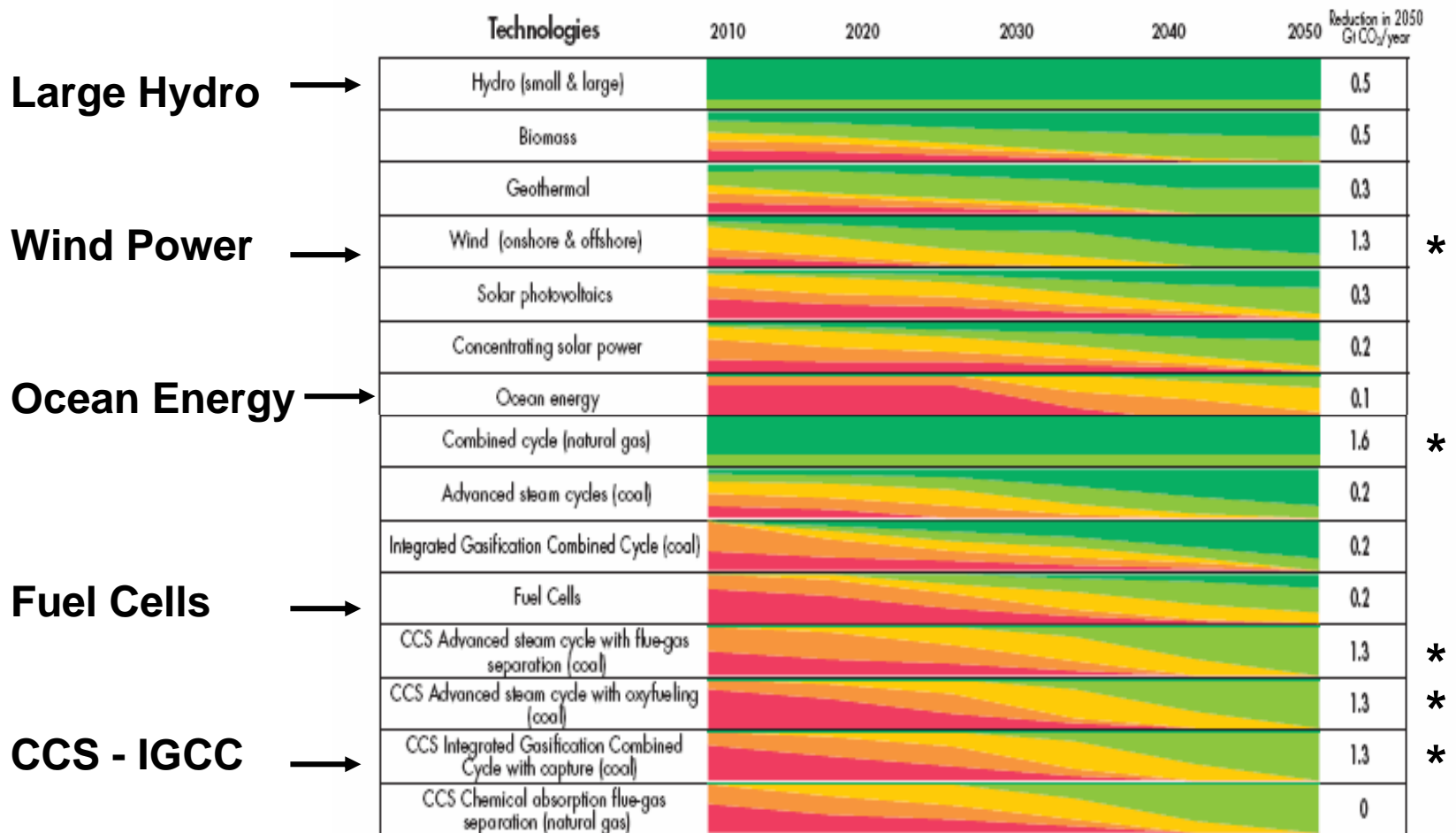
## F/P/T Discussion - Consultation with Industry & Technology Experts

World Leader	Adapt & Lead in Development	Adapt & Use
Oilsands & Heavy Oil	Hydro	Efficiency in Industry
CO <sub>2</sub> Capture and Storage	Clean Coal	Efficiency in Transportation
PEM Fuel Cells & Hydrogen	Solid Oxide Fuel Cells	Wind Energy
Nuclear Fission	Ocean Energy	Solar & Geothermal
	Buildings and Communities	Conventional Oil & Gas
	Bioenergy	CNG & LNG
	Unconventional Oil & Gas	Water in Energy Production
	Cogeneration and CHP	Energy Storage
	Grid Integration	Electricity Transmission



# Electricity Generation Technologies

## IEA Energy Technology Perspectives, 2006

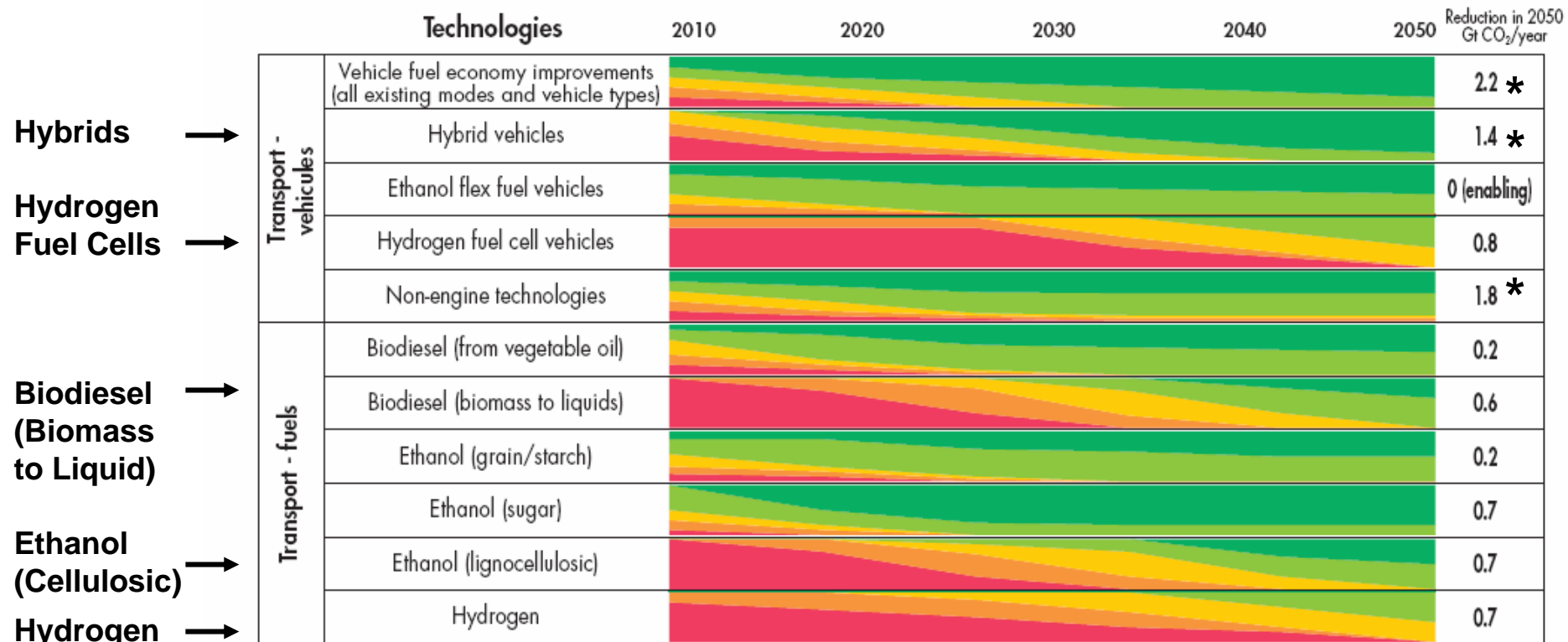


**Cost-Competitive Now** → the stage when the technology is cost-competitive without specific CO<sub>2</sub> reduction incentives  
**Ready for Demo** → the stage where the technology is cost-competitive with CO<sub>2</sub> reduction incentives  
 → the government support for deployment  
 → the demonstration stage  
**RD&D** → the R&D stage

\* Estimated Impact by 2050 of More Than 1 Gt/year

# Transportation Technologies and Fuels

## IEA Energy Technology Perspectives, 2006



Cost-Competitive Now →

the stage when the technology is cost-competitive without specific CO<sub>2</sub> reduction incentives

Ready for Demo →

the stage where the technology is cost-competitive with CO<sub>2</sub> reduction incentives

RD&D →

the government support for deployment

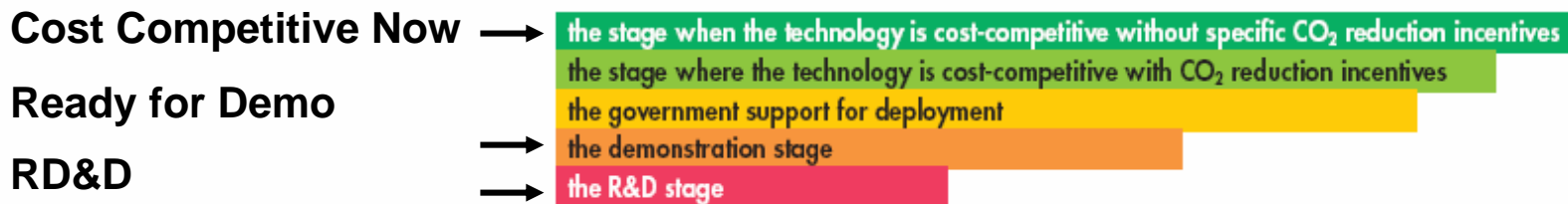
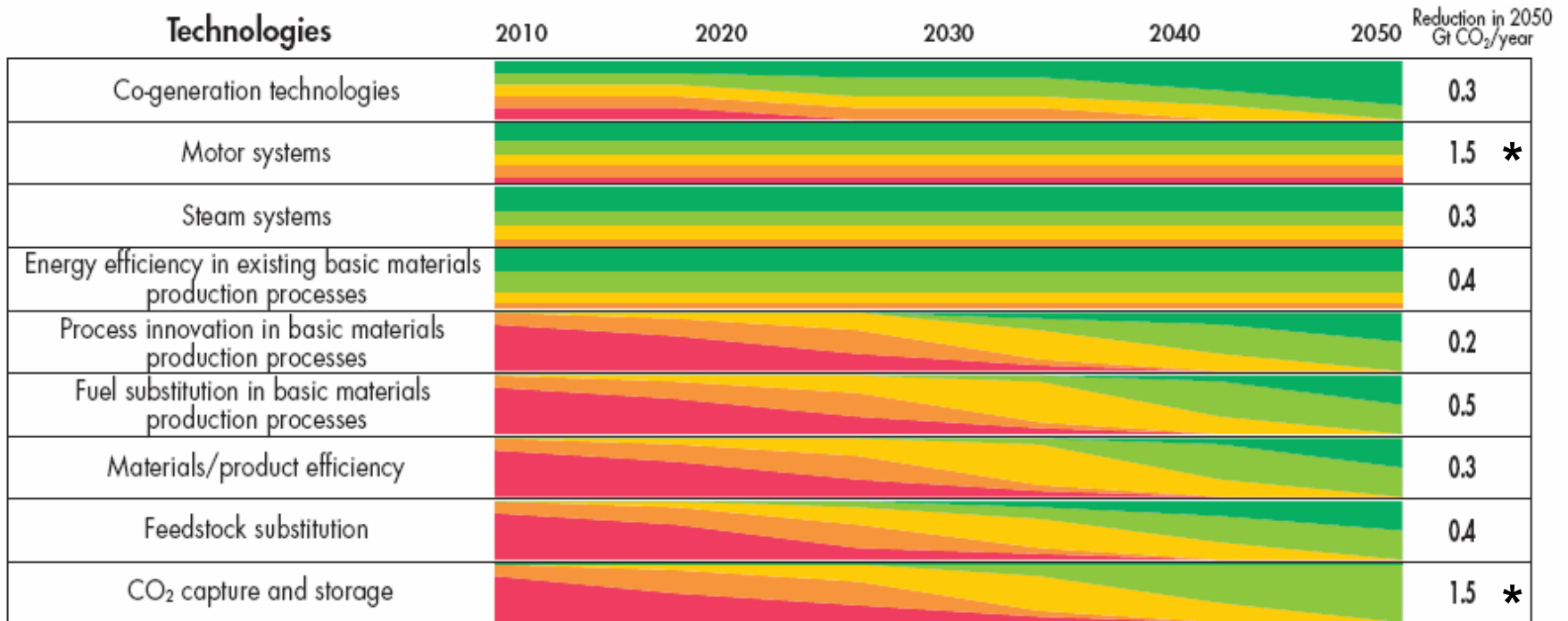
the demonstration stage

the R&D stage

\* Estimated Impact by 2050 of More Than 1 Gt/year

# Industrial Technologies

## IEA Energy Technology Perspectives, 2006



\* Estimated Impact by 2050 of More Than 1 Gt/year

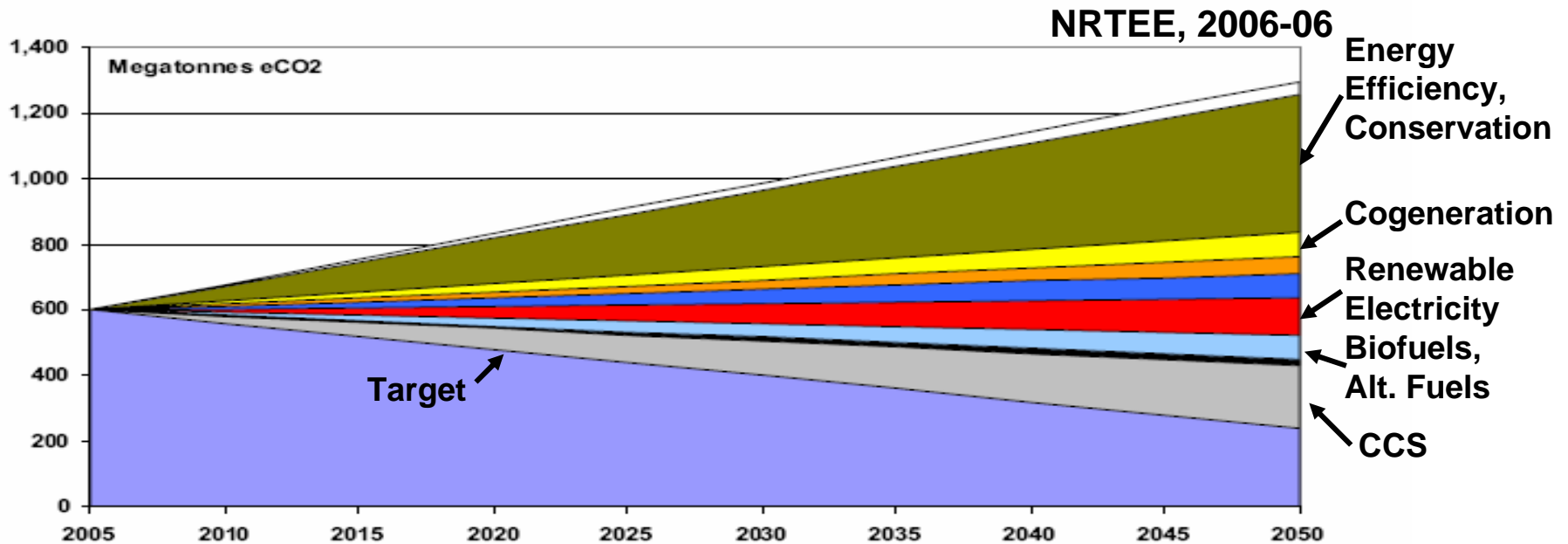


# What Impacts Could New Technologies Have?

# NRTEE's Projections of Possible GHG "Wedges" Major Contributions from Energy Efficiency, Renewables, CO<sub>2</sub> Capture and Storage



GHG Reduction Diagram for Canada – Aggregate Wedges



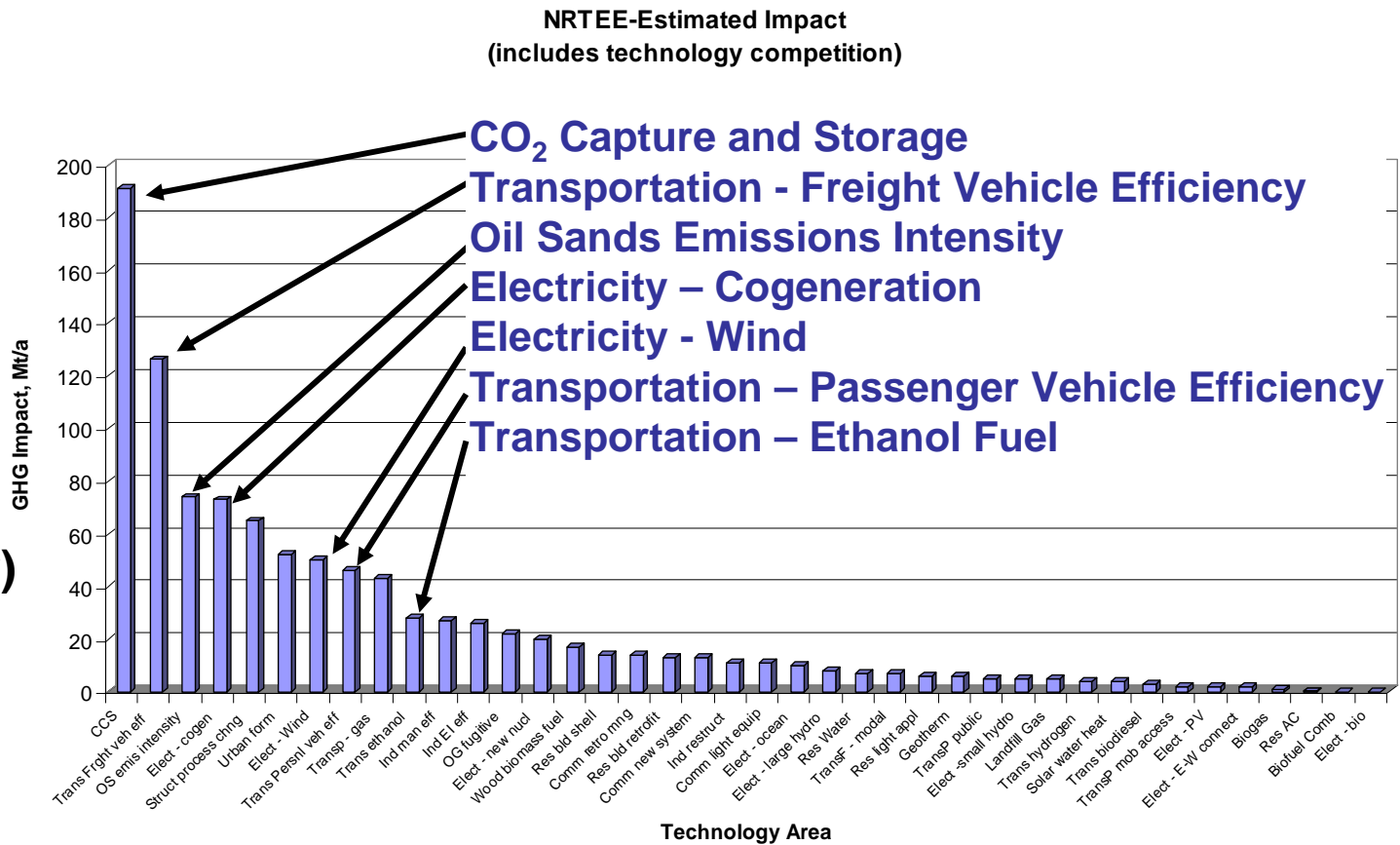
■ Target	□ Carbon Capture	■ Nuclear	□ Biofuels and alt fuels
■ Renewable Electricity	■ Energy Intensity	■ Urban Form	■ Cogeneration
■ Energy Eff and Conservation	□ Residual		

**NRTEE Report: *Advice on a Long-term Strategy on Energy and Climate Change***

# NRTEE Impacts of Selected Technologies



**GHG  
Impact  
(Mt/year)**

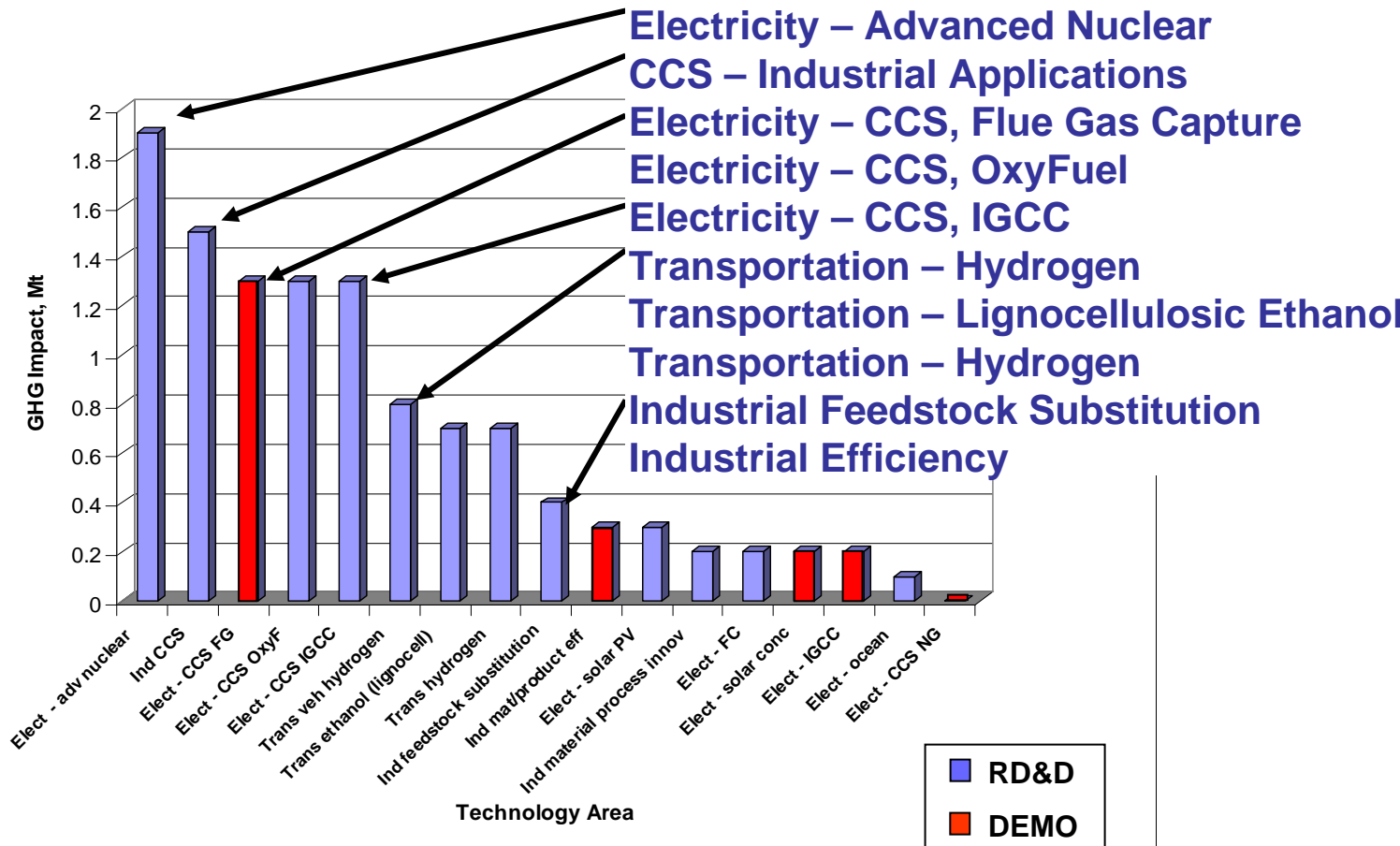


# IEA Energy Technology Perspectives – Phase I Actions - RD&D, Demonstration

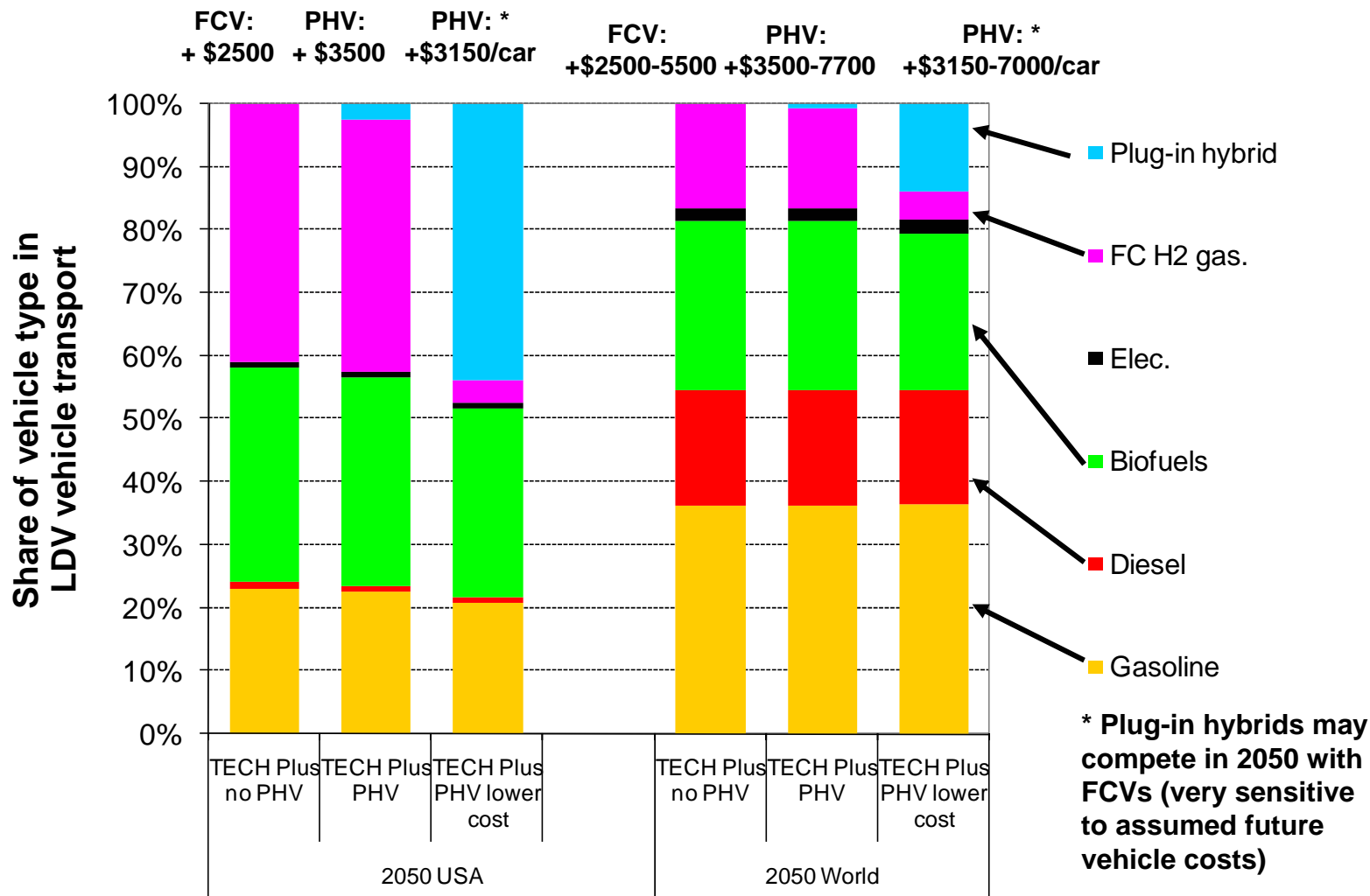


GHG Impact of Up and Coming Technologies

GHG  
Impact  
(Mt)



# Impact of New Transportation Technologies Fuel Cell Vehicles and Plug-In Hybrids - IEA





# Encouraging Technology Concepts

## Drivers of Investment

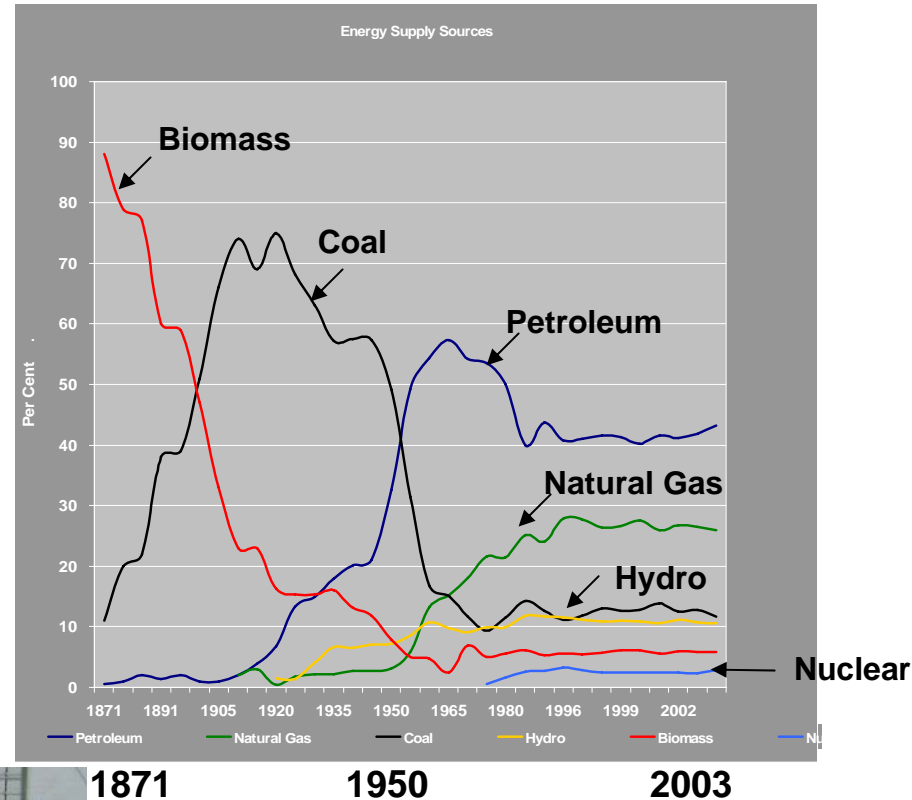
# New Energy Sources Are Nothing New

## Canada's Energy Mix – 130+ Years of History



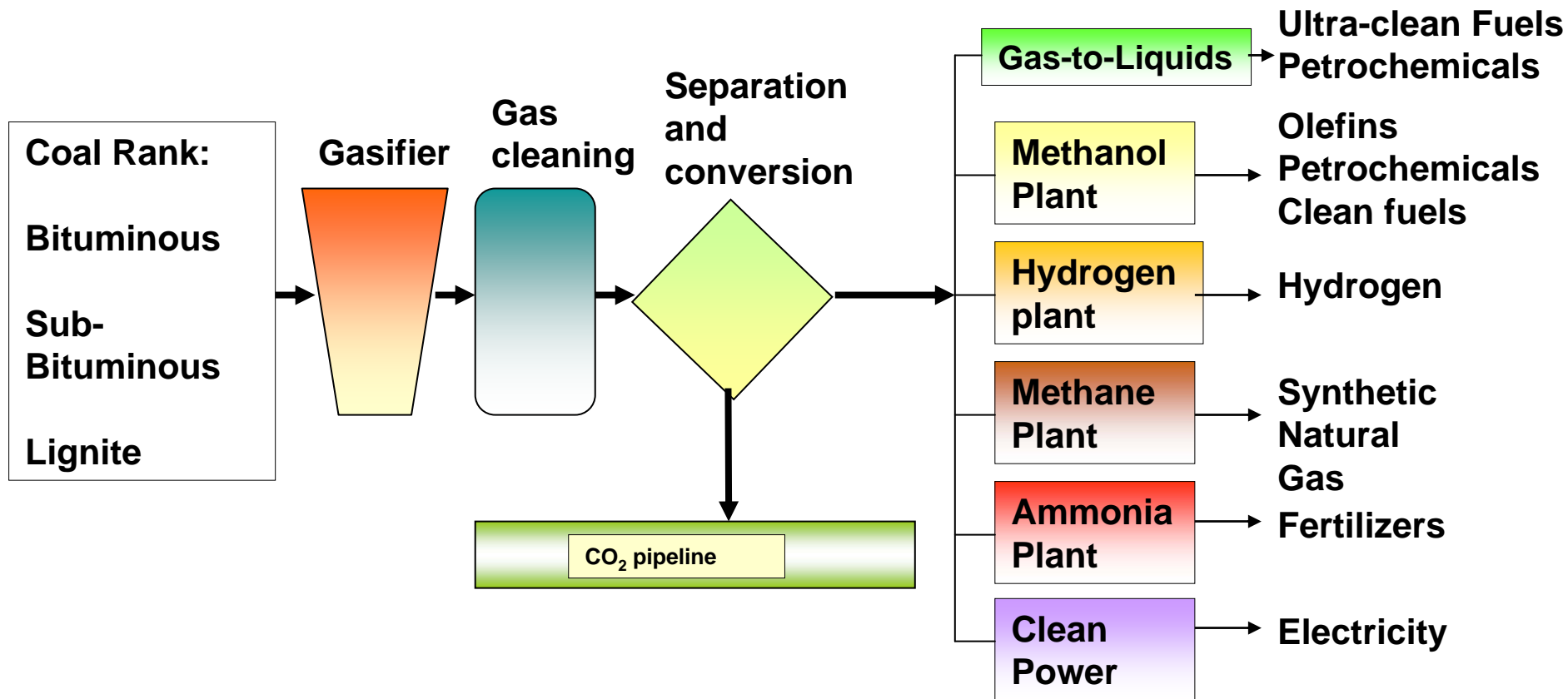
- Energy mix is driven by resource endowment, government intervention, new technologies, new infrastructure
- Energy mix is always changing, occasionally suddenly, as new commodities become available
- Canada's energy history shows a progressive evolution of energy sources – never a more diverse mix than now
- Projections show a much more diverse mix in the future

Energy Supply Source (%)



# Integrated Energy Systems

## Polygeneration - Vision for the Future



# A Bio-Refinery System

## Fully Integrated from Feedstock to Products



- Fuels:
- Ethanol
- Renewable Diesel
- Electricity
- Heat
- Chemicals
- Plastics
- Solvents
- Pharmaceuticals
- Chemical Intermediates
- Phenolics
- Adhesives
- Furfural
- Fatty acids
- Acetic Acid
- Carbon black
- Paints
- Dyes, Pigments, and Ink
- Detergents
- Materials
- Food and Feed

### Biomass Feedstocks

- Trees
- Grasses
- Agricultural Crops
- Agricultural Residues*
- Animal Wastes
- Municipal Solid Waste

### Bioconversion Biorefinings

- Enzymatic Fermentation*
- Gas/liquid Fermentation
- Acid Hydrolysis/Fermentation
- Gasification
- Combustion
- Co-firing
- Extraction-purification*

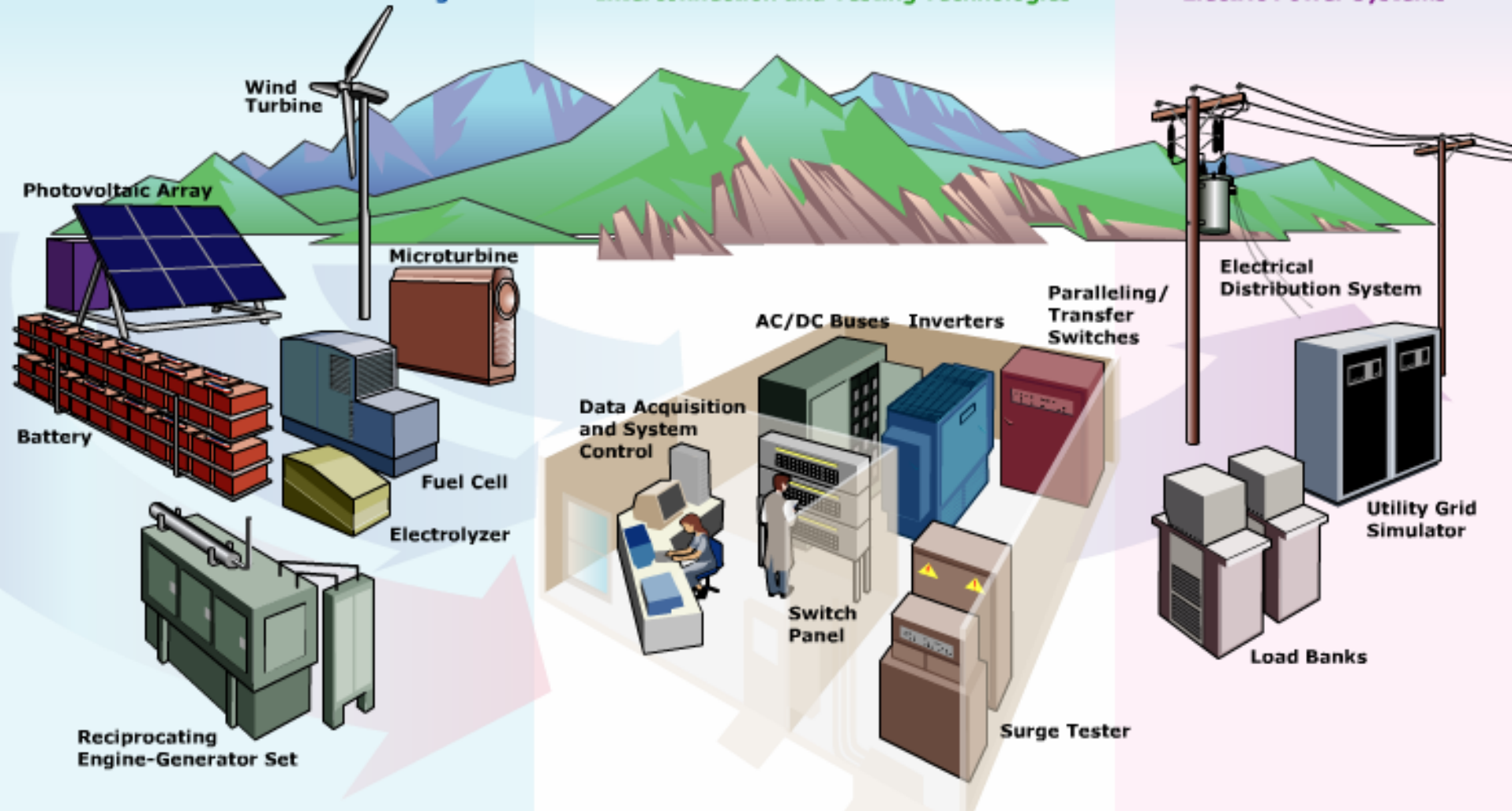
Mark Stumborg, P.Eng., Agriculture and Agri-Food Canada, Swift Current, Saskatchewan

# A Grid-Integrated, Clean Distributed Power Generation System

## Distributed Generation and Storage

## Interconnection and Testing Technologies

## Electric Power Systems



**Generation,  
Storage**

**Control**

**Distribution**

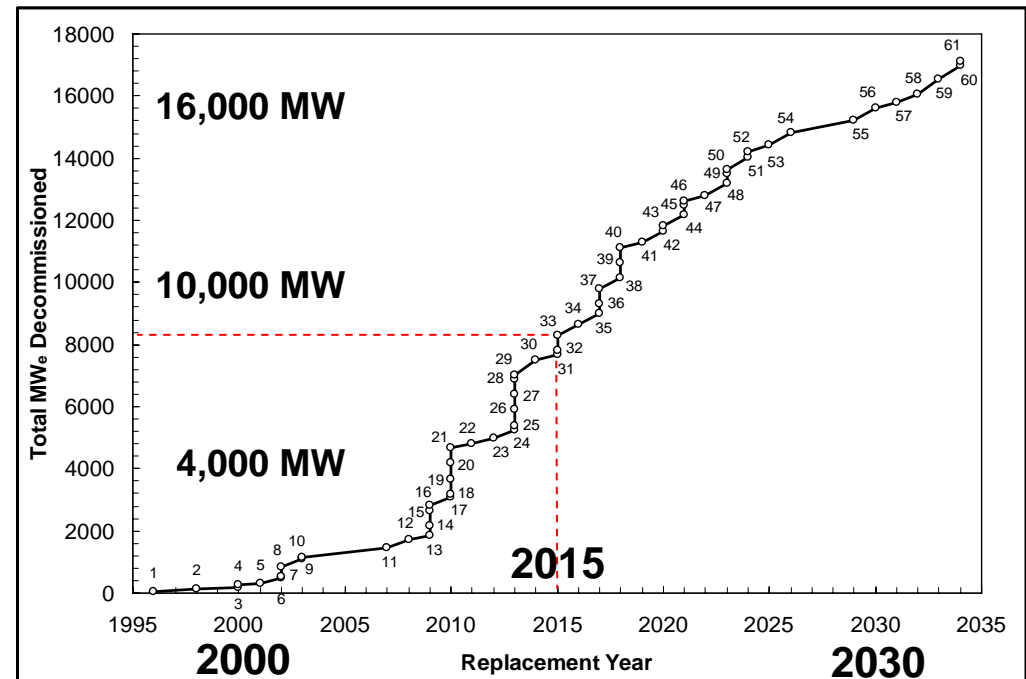
# Drivers for New Technologies Upcoming Investment Cycles



- **Example in Electricity Sector:  
Capital Replacement, New  
Capacity To Match Demand**

- Existing coal-fired generation assets are aging
- Assuming a 40-year life, about 50% of today's capacity will have reached economic maturity by 2015 in Canada
- Defines the "natural cycle" for industry to invest
- Large investments ahead, with several technology options

## MW to be decommissioned



(Source: Pearson, 2006)



# Energy S&T Initiatives

## NRCan

# NRCan Initiatives in Energy S&T

## Federal Programs, Labs, International



### NRCan – Office of Energy Research and Development (OERD)

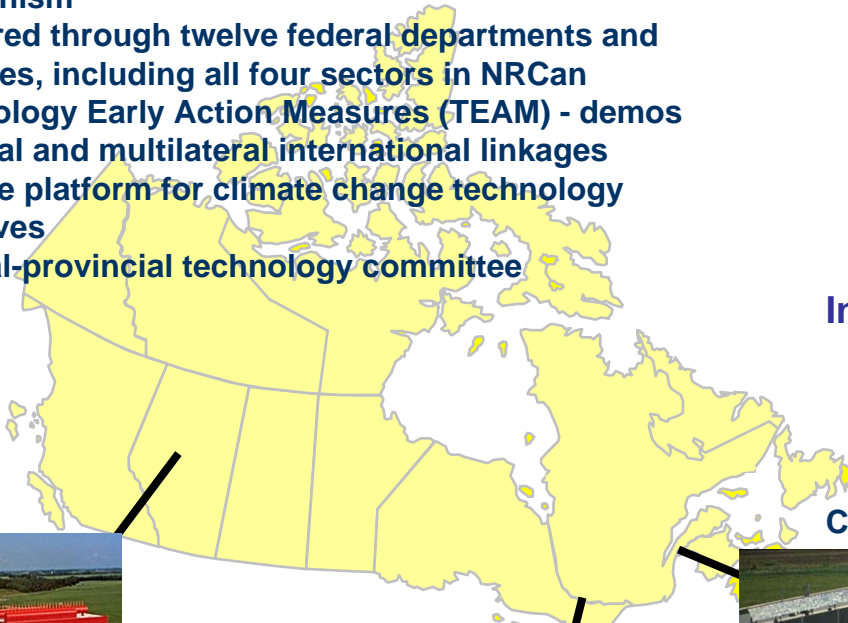
- Strategic planning, horizontal funding and governance mechanism
- Delivered through twelve federal departments and agencies, including all four sectors in NRCan
- Technology Early Action Measures (TEAM) - demos
- Bilateral and multilateral international linkages
- Provide platform for climate change technology initiatives
- Federal-provincial technology committee

### NRCan - CANMET Energy Technology Centre (CETC)

- Leading Canadian performer of energy S&T
- Labs in Varennes – QC, Bell's Corners – ON, Devon - AB
- Technology research, development
- International engagement, networks
- Technology road-mapping

### International Collaboration

- 
- International Energy Agency
  - APEC
  - European Union
  - Bilateral projects USA, India, China, Europe



CETC Devon



CETC Ottawa



CETC Varennes

# New ecoENERGY Technology Initiative

## NRCan's Energy S&T Priorities



*" ... Our real challenge is to be a clean energy superpower. To do this, we must address the fact that the greatest source of untapped energy is the energy we waste. We must also increase our use of renewable energy and develop the S and T to make conventional energy cleaner."*

- ecoENERGY Technology Initiative announced, along with parallel initiatives in renewables, energy efficiency

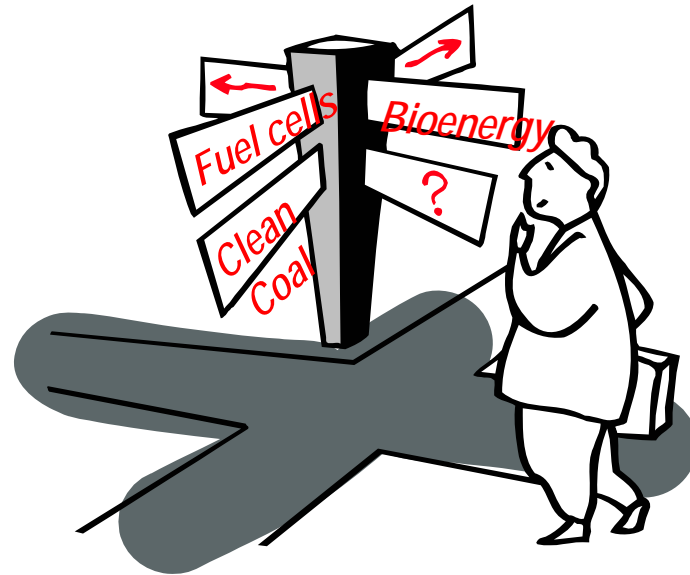
Three ecoENERGY Tracks  
- Increase energy efficiency  
- Clean sources of supply  
- Reduce impacts of fossil fuels

- Key priorities identified, to be confirmed through consultation with industry, provinces
  - CO<sub>2</sub> Capture and Storage
  - Clean Coal
  - Clean Oil Sands Production
  - Bioenergy
  - Renewable energy, other clean energy sources
  - Next generation nuclear - GenIV
  - Energy efficient industry
  - Advanced vehicles – Hydrogen, pHEVs
  - Clean Buildings – Zero-Net Buildings
- Targeted investment of \$230m in research, development and demonstration of clean energy technologies





# Some Closing Observations



# Energy Innovation, Science and Technology

## Main Messages Today



- Think “energy systems”, not one technology in isolation
- Experts are saying - be selective, address both energy supply and energy end-use, partnerships are key
- Energy mix is evolving in the right directions – more diverse, more distributed, greener
- Promising “up and coming” technology solutions in the making – consensus is emerging on technology priorities
- Widespread commitment to technology – industry for new capital investment, ecoENERGY initiatives, provincial initiatives
- Technology and innovation offer one promising pathway to achieving policy goals



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