



Symposium on 'Canada and the World of Ocean Renewable Energy' TRANSFORMATIVE ENERGY TECHNOLOGY

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Natural Resources
Canada

Ressources naturelles
Canada

Canada



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**Chairman - IEA Committee on Energy Research
& Technology**

**Director General - Office of Energy R&D
Natural Resources Canada**

**May 4th, 2006
Victoria, B.C.**

TODAY'S OUTLINE

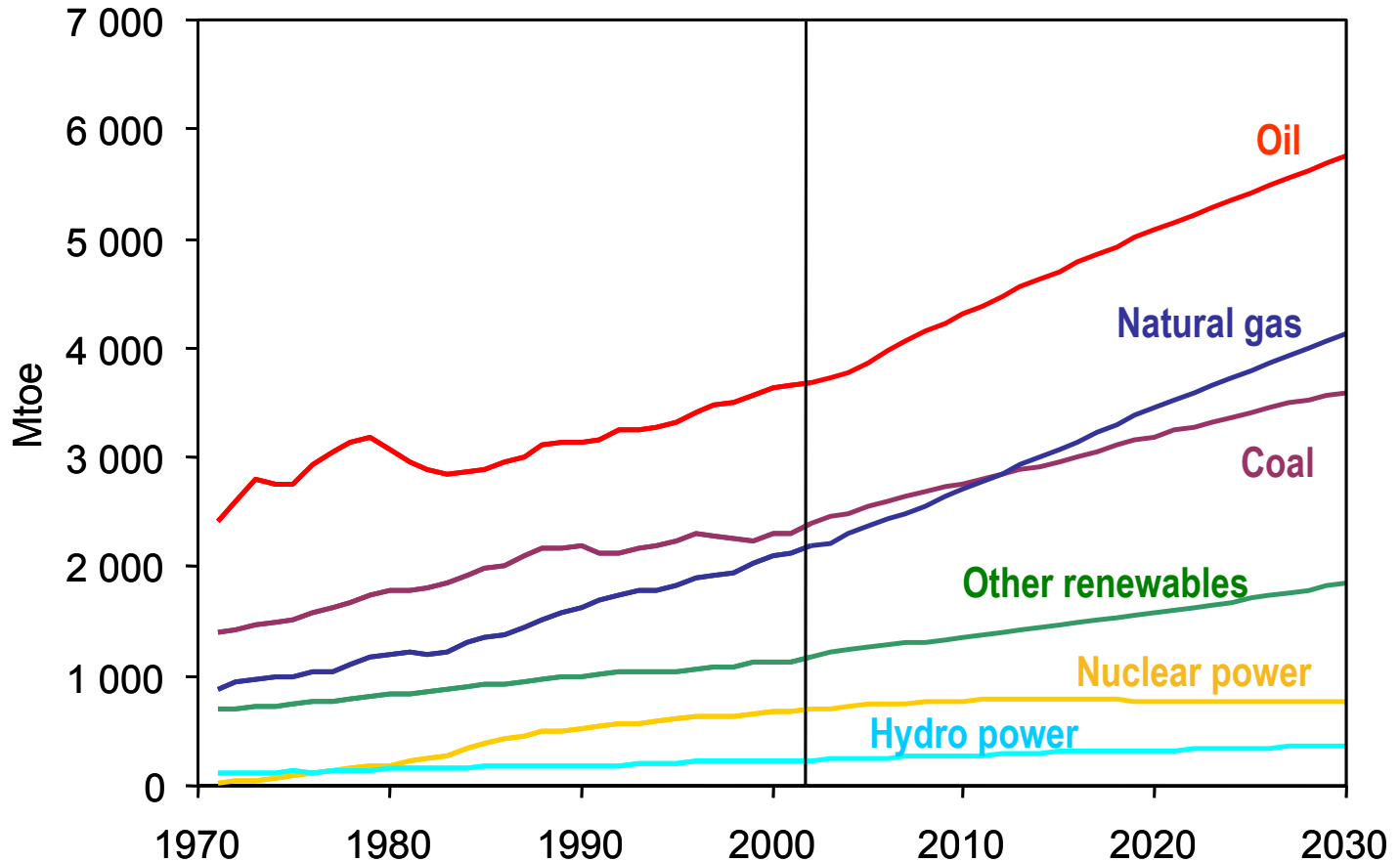


- **A Perspective on Energy Trends to 2030**
- **Transformative Technology Solutions**
- **Working Together on Technology**
 - **International Energy Agency**
- **Wave and Tidal Energy**
- **Closing Observations**



GENERAL PERSPECTIVE ON ENERGY TO 2030

World Primary Energy Demand Steady Growth, Demand of Fossil

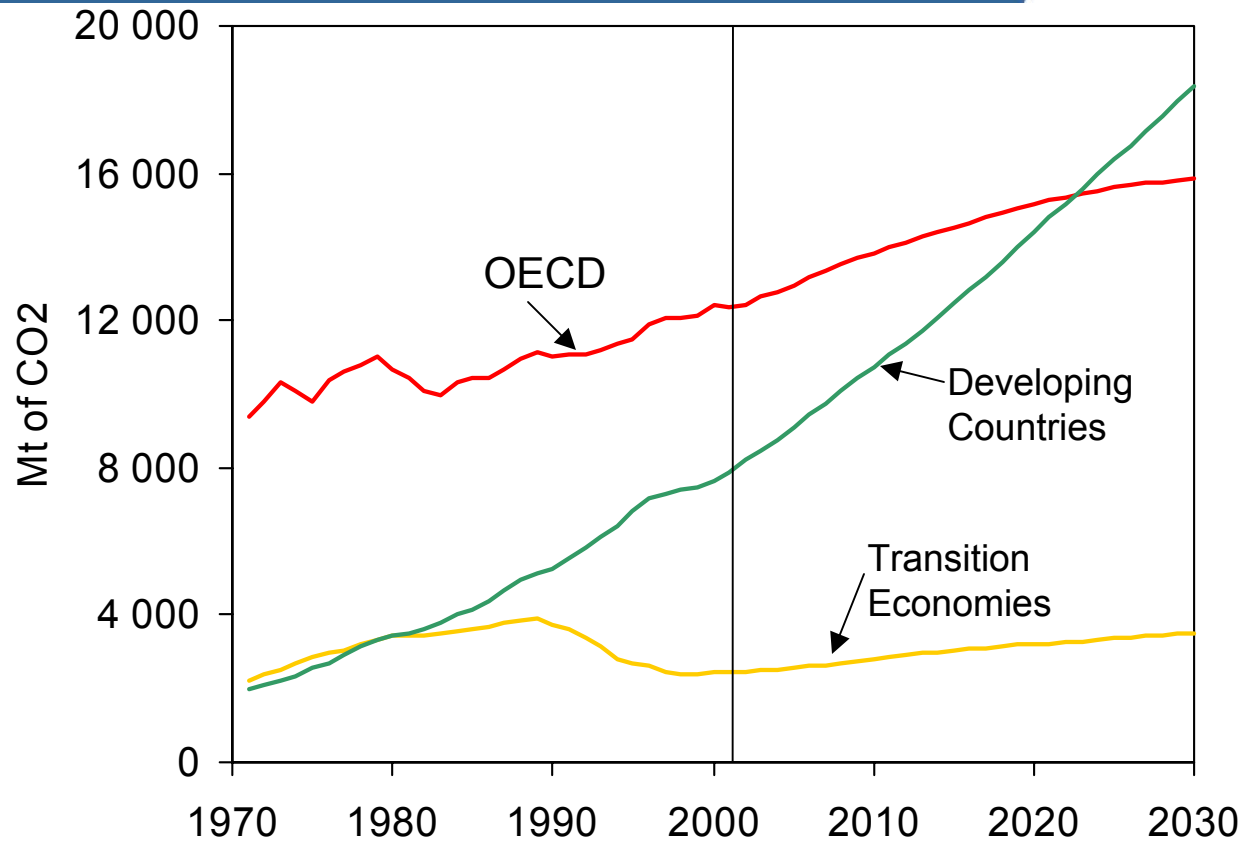


□ Fossil fuels account for almost 90% of the growth in energy demand between now and 2030

IEA, February, 2006

World Energy-Related CO₂ Emissions

Rapid Increase in Developing Countries

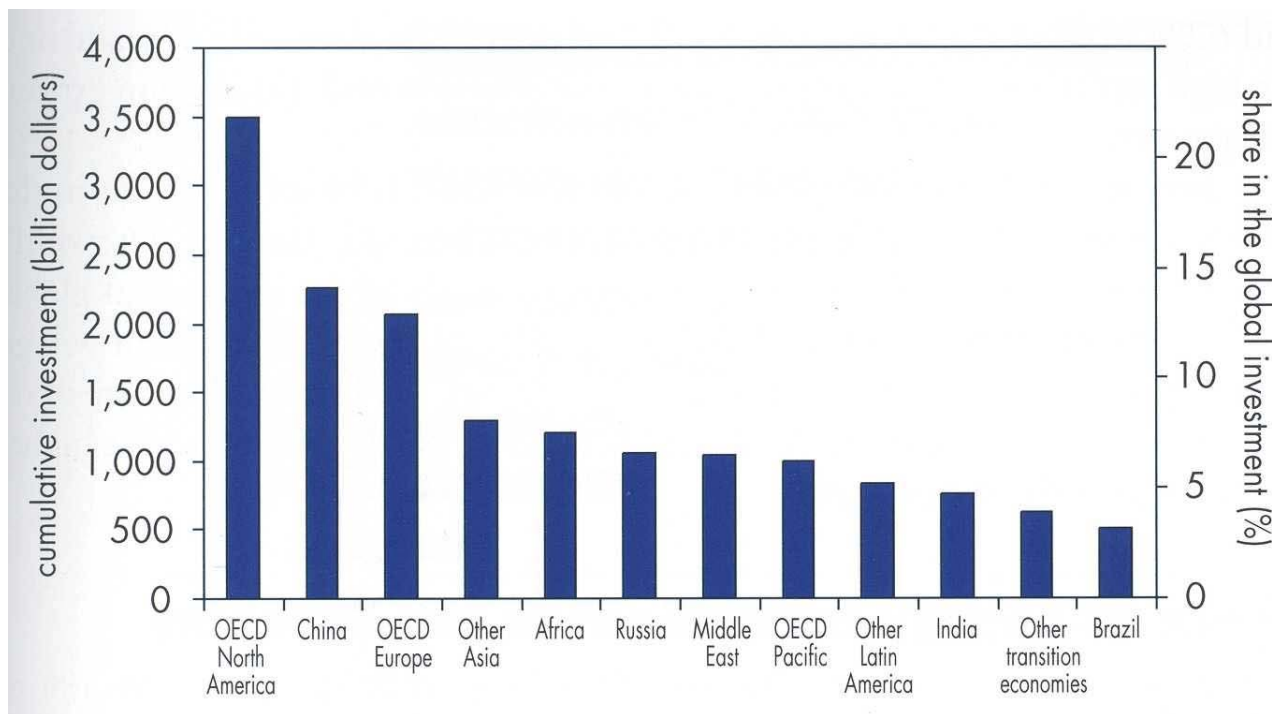


IEA, February, 2006

— OECD — Transition economies — Developing countries

Global emissions grow 50%+ between now and 2030, developing countries' emissions will overtake OECD's in the 2020's

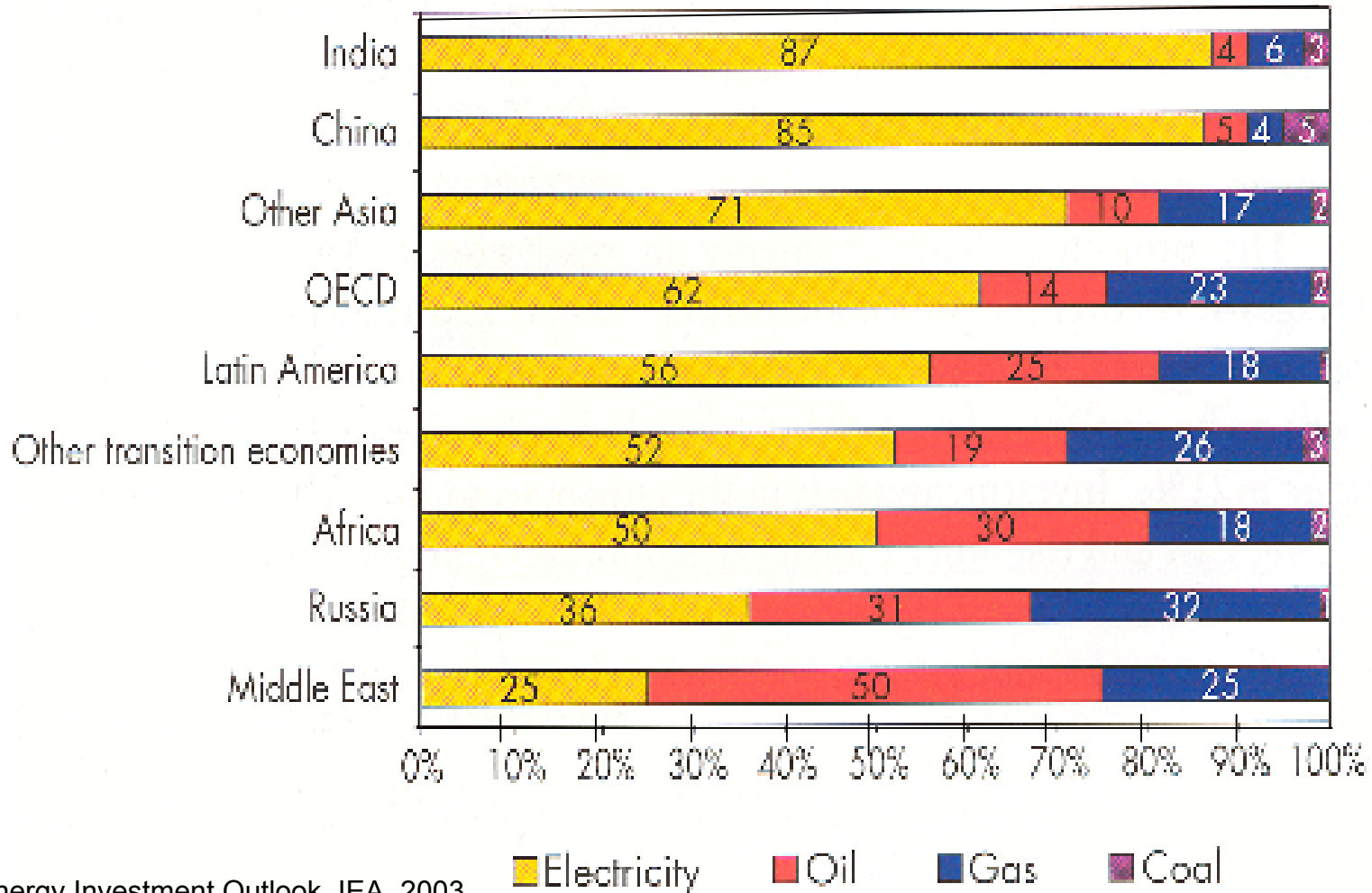
Cumulative Energy Investment by Region, 2001-2030



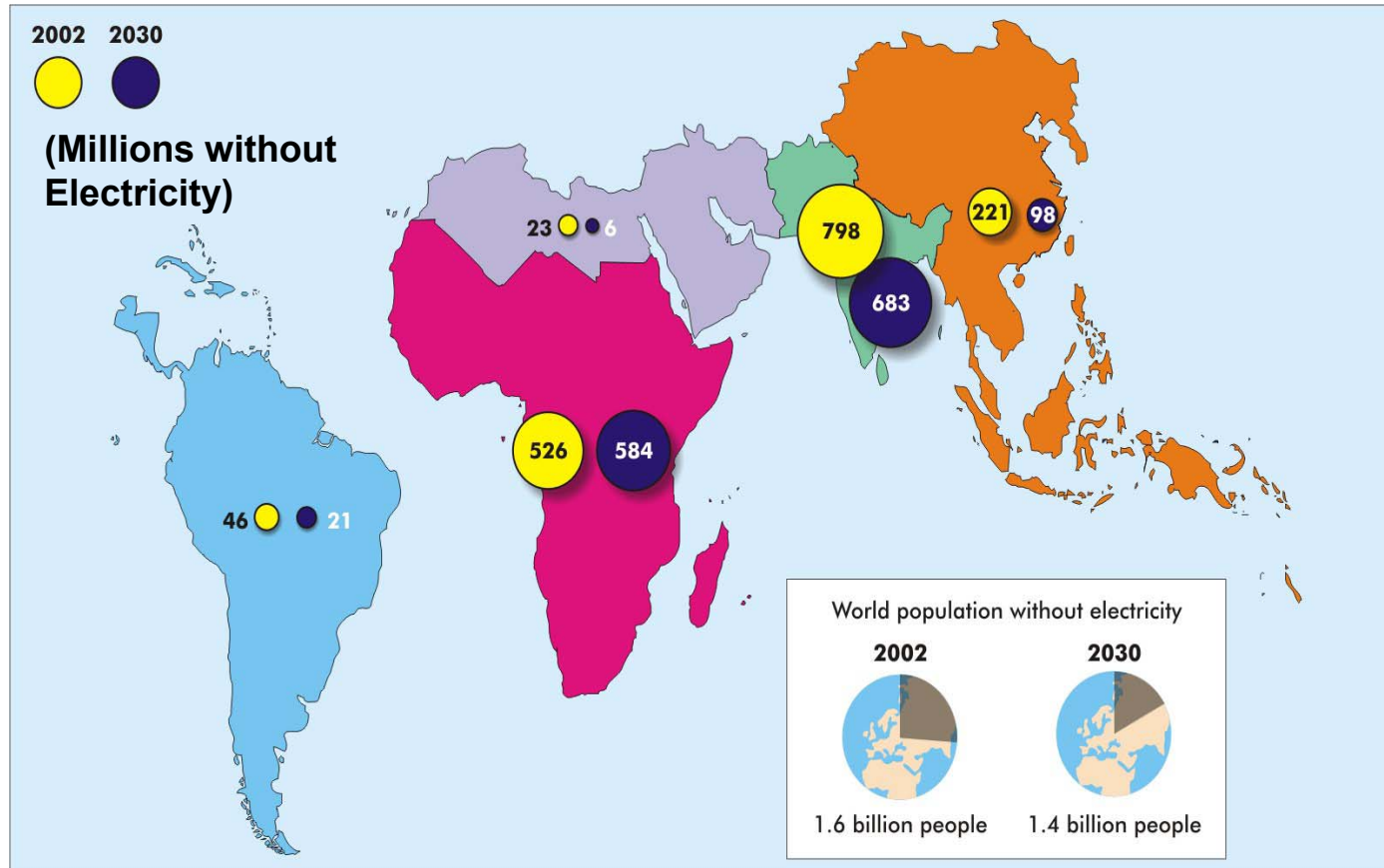
❑ **\$17 Trillion to 2030**

World Energy Investment Outlook, IEA, 2003

Fuel Shares in Cumulative Energy Investment by Region, 2002-2030



Electricity Deprivation



❑ In 2030, if no new policies are implemented, there will still be 1.4 billion people without electricity.



TRANSFORMATIVE ENERGY TECHNOLOGY

A Part of the Solution

Transformative Energy Technologies Toward A Sustainable Energy Future

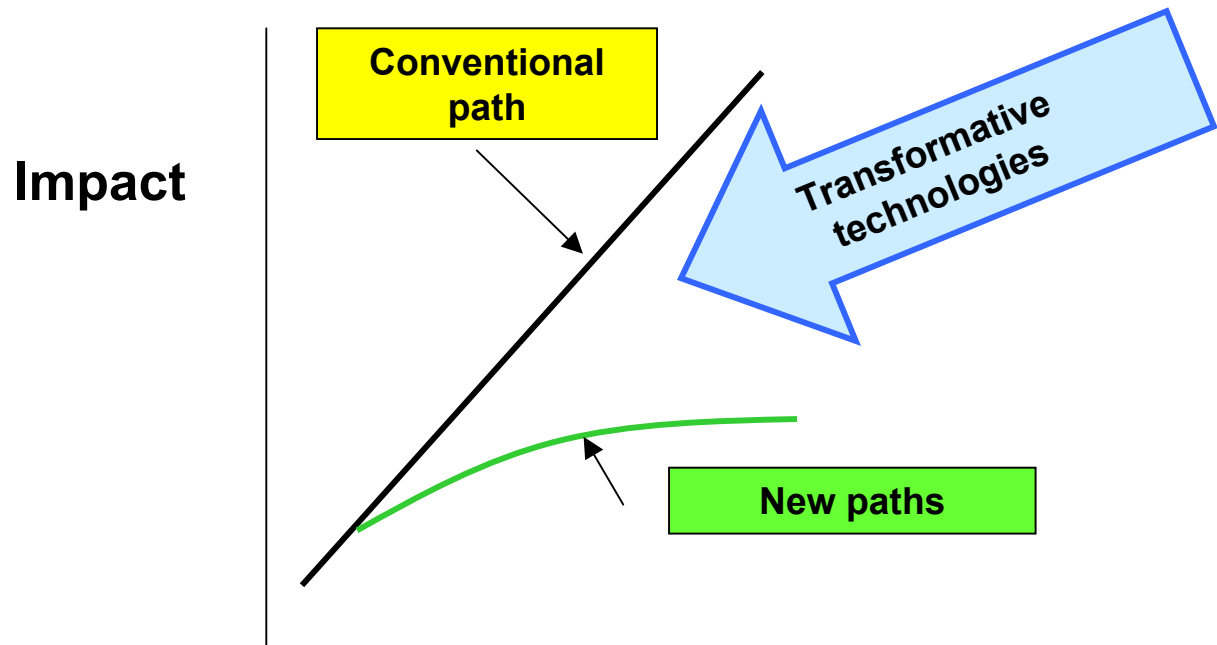


- Key policy objective is sustainable development and responsible end-use of energy resources
 - goals - sustainability, security, prosperity
- Many of today's issues are closely linked to the supply, conversion and end-use of energy, examples are
 - long-term security of supply, environmental “footprint” of supply activities, impacts of energy end-use on urban air quality, increasing GHG emissions, foreign oil dependence
- Solution calls for both ...
 - transformative behaviour and practices, and
 - transformative energy technologies for energy supply, conversion and end-use efficiency

Why invest in Energy S&T?



- Energy sector is important to Canada
 - 6% of GDP, 16% of BoP
- Today's technologies are inadequate
- Transformative technologies are needed to address challenges facing the energy sector



Transformative Technologies

A Part of the Solution



- Fundamentally-different ways of supplying, converting and using energy
- Transformative technologies can break link between increased use of energy and environmental impacts
- Transformative technologies, by their nature, require or lead to: new infrastructure, displacement of current technologies, new skills, new expertise, new environmental impacts
- Importantly, new technologies trigger public interest and concerns
 - *These need to be addressed up front*

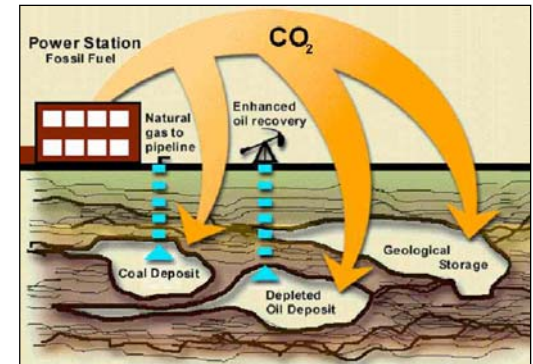
Examples – biofuels, near zero emission coal, zero-net houses, decentralized generation

Examples of Transformative Technologies Creating Solutions to Energy Challenges



Weyburn – Midale CO₂ Project – CO₂ Storage

- Major international project. Governments, universities and industry are partners
- Phase 1 - determined that long-term underground storage of CO₂ is safe and secure
- Final Phase – now underway to resolve remaining technical issues, provide knowledge for regulation of long-term CO₂ storage



Flaring

- Flaring from crude oil extraction can produce toxic and greenhouse gas emissions
- Methodologies developed to ensure efficient combustion of flare gas with negligible toxic emissions
- The World Bank is promoting Canadian reduction strategies in the developing world where flaring is widely practiced

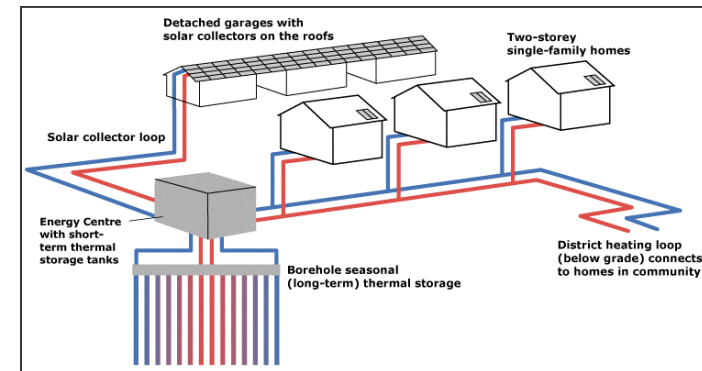


Examples of Transformative Technologies, Solutions to Energy Challenges



Solar Thermal Energy – Okotoks, AB

- North America's first large-scale solar storage project
- Provide over 90% of space heating requirements for 52 homes
- GHG reductions of up to 5 tonnes per home



Renewable Energy Technology Software - RETScreen

- State-of-the-art software program helps users assess clean energy options
- Saved users \$240M in Canada and \$600M worldwide
- Facilitated installation of \$750M of clean energy technology in Canada
- Available in over 20 languages



WORKING TOGETHER ON TECHNOLOGY

The International Energy Agency

INTERNATIONAL ENERGY AGENCY



- **IEA's Goals:**
 - **Energy security**
 - **Environmental protection**
 - **Economic growth**

- **Activities:**
 - **Co-ordinates efforts to ensure Members' continuing energy security**
 - **Conducts policy analysis**
 - **Compiles energy statistics**
 - **Convenes, mobilizes experts – e.g., IEA's technology program**
 - **Review Member countries' policies and programs**

IEA MEMBER COUNTRIES



Australia

Austria

Belgium

Canada

Czech Rep.

Denmark

Finland

France

Germany

Greece

Hungary

Ireland

Italy

Japan

Korea

Luxembourg

Netherlands

New Zealand

Norway

Portugal

Spain

Sweden

Switzerland

Turkey

United Kingdom

United States

The EC

***participates in the
work of the IEA***

IEA's Energy Technology Program

A Model of Collaboration



- **Technology scope - energy research and technology development, demonstration and deployment**
 - **Four Working Parties**
 - Fossil Fuels
 - Renewable energy
 - Efficient End-Use
 - Fusion Power
 - **Information Centres**
 - **Implementing Agreements are key – 40+/-**
- **Programs, networks and analysis brings together:**
 - **Scientists and engineers – government, industry, academics**
 - **Policy makers**
 - **Industry experts and decision-makers**
- **Participants from IEA member and non-member countries**

IEA's Energy Technology Program



- ❑ **The only structure in the world that ...**
 - **Covers such a wide range of energy technologies**
 - **Facilitates exchange of technical and related policy expertise and information**
 - **Links researchers and research managers with policy makers**
 - **Has a time-tested structure for formalizing agreements**

The IEA Energy Technology Network

IEA GOVERNING BOARD

CERT - Committee on Energy Research and Technology

Fusion Power
Co-ordinating
Committee

IMPLEMENTING AGREEMENTS

Env. Safety, Econ. Aspects
Fusion Materials
Large Tokamaks
Nuclear Tech. of Fusion
Textor
Reversed Field Pinches
Stellarator
ASDEX Upgrade
Spherical Tori (forthcoming)

Working Party
on Fossil Fuels

IMPLEMENTING AGREEMENTS

Clean Coal Centre
Clean Coal Science
Enhanced Oil Recovery
Fluidised Bed Conversion
Greenhouse Gas R&D
Mutiphase Flow Science

Advisory Group
on Oil & Gas
Technology

Working Party on
Renewable Energy
Technologies

IMPLEMENTING AGREEMENTS

Hydrogen
Bioenergy
Geothermal
Hydropower
Ocean Energy ←
Photovoltaic Power
Solar Heating/Cooling
SolarPACES
Wind Turbines

Working Party on
Energy End-Use
Technologies

IMPLEMENTING AGREEMENTS

Advanced Fuel Cells
Advanced Materials Transp.
Advanced Motor Fuels
Hybrid/Electric Vehicles
Demand Side Management
Buildings/Communities
District Heating/Cooling
Energy Storage
Heat Pumps
Energy Cons./Emissions Red.
Process Integration
Pulp & Paper
Superconductivity

Hydrogen
Co-ordination
Group

Experts Group
on R&D Priority-
Setting and
Evaluation

Ad Hoc Group
on Science and
Energy
Technologies

INTER-SECTORAL IMPLEMENTING AGREEMENTS

- Climate Technology Initiative (CTI)
- Energy and Environmental Technologies Information Centre (EETIC)
- Energy Technology Systems Analysis Programme (ETSAP)
- Energy Technology Data Exchange (ETDE)

Committee on Energy Research and Technology (CERT)



CERT's mission is to support the goals of the IEA by

“ ... promoting the development and deployment of clean and advanced energy technologies through international networking, co-operation, collaboration, analysis and policy advice.”

CERT's Strategic Objectives



- **CERT's four-part strategy**
 1. **Identify and promote effective and innovative technology policies to stimulate energy technology RDD&D**
 2. **Clearly define and analyze energy technology issues and opportunities, to enhance analytical tools**
 3. **Vigorously foster international networking and collaboration in energy technology RDD&D**
 4. **Effectively communicate the key lessons learned through the CERT's activities**
- **Excellent support and advice provided by the IEA's Energy Technology Office (ETO)**



TIDAL AND WAVE ENERGY

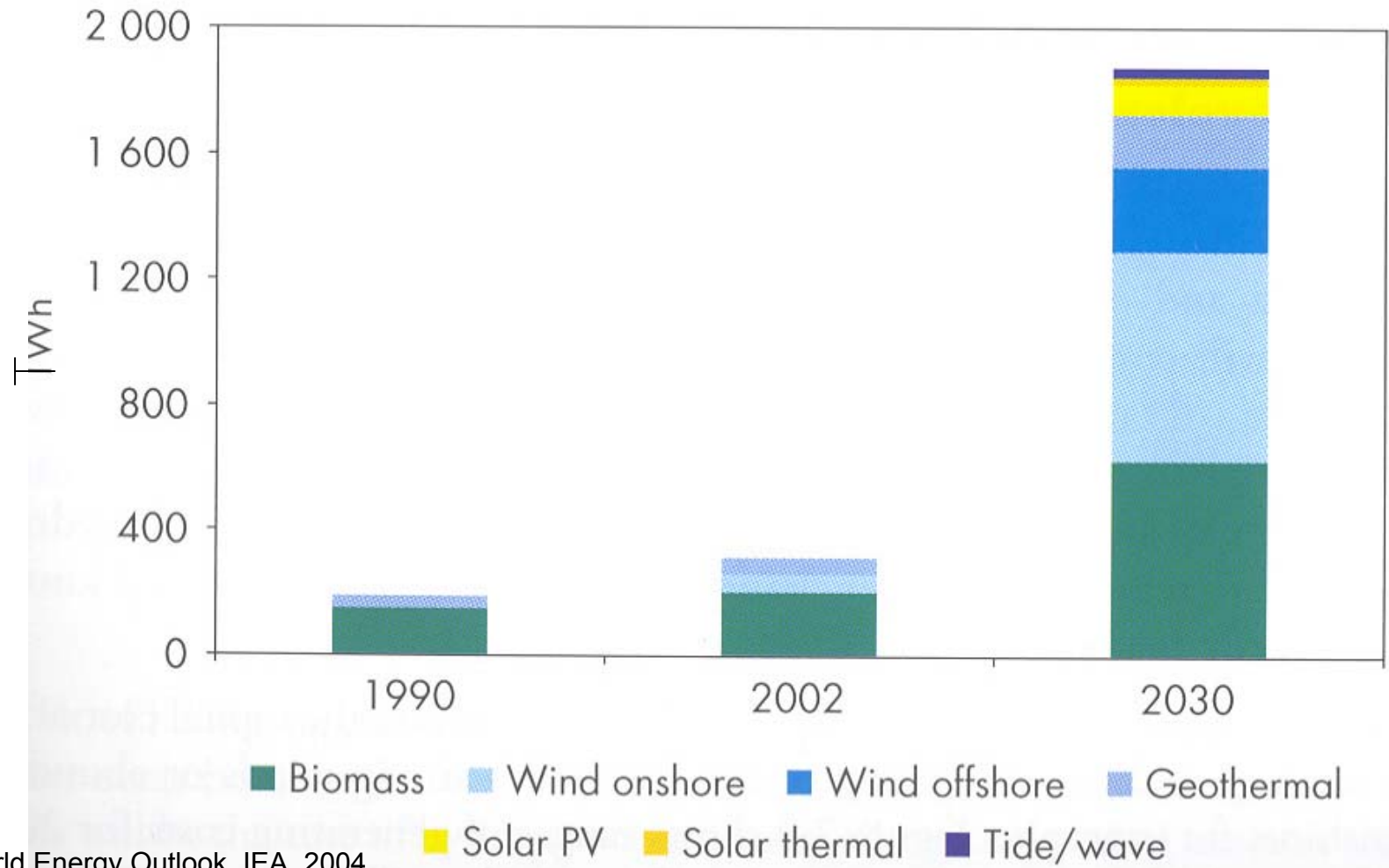
A Transformative Technology Solution

Tidal and Wave Energy



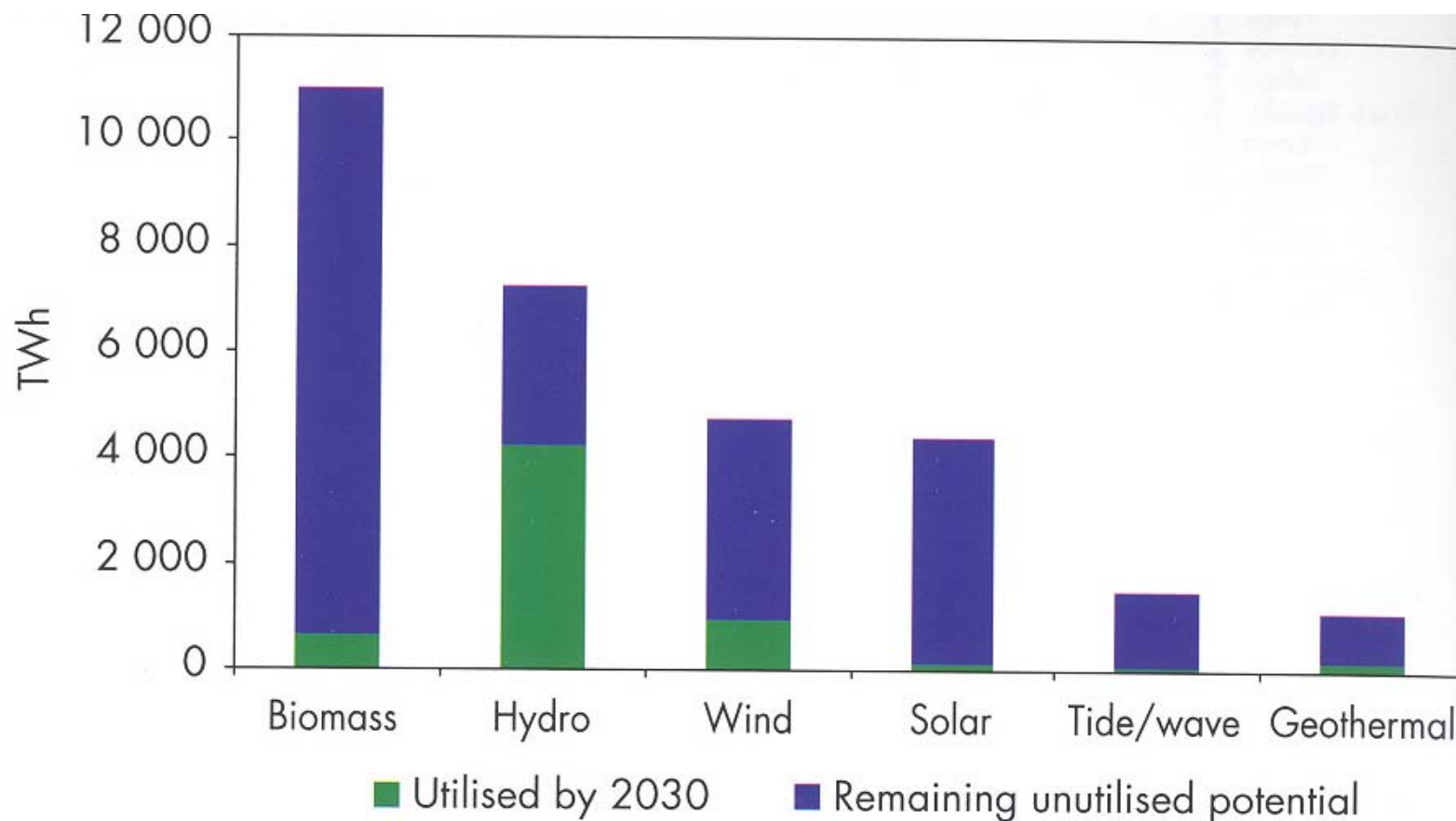
- **Resource:** is theoretically much greater than world energy demand
- **Electricity potential:** could reach 35 TWh in 2030, compared with just 1 TWh now
- **Technologies** are in an early stage of development (except tidal barrages)
- **What's needed:** concerted RD&D efforts are needed to tackle a range of technical and non-technical barriers, plus demonstrations
- **Ocean energy technologies face challenges**
 - proving the energy conversion potential, overcoming very high technical risks associated with a harsh environment, costs

World Electricity Generation Non-hydro Renewable Energy Sources



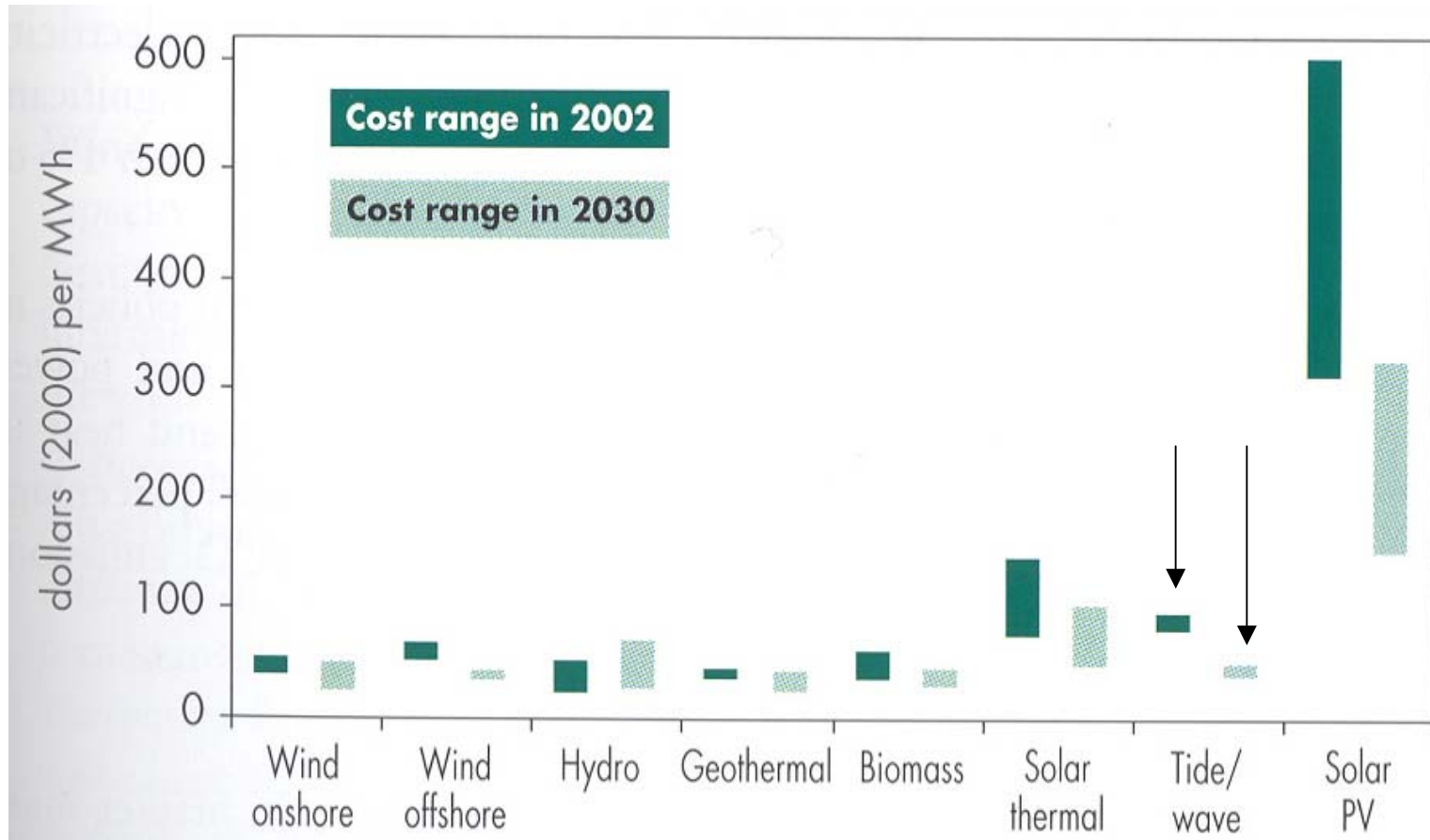
World Energy Outlook, IEA, 2004

World Long-term Renewable Energy Potential for Electricity Generation



World Energy Outlook, IEA, 2004

Electricity-generating Cost for Renewable Energy Technologies



World Energy Outlook, IEA, 2004

Challenges

Ocean Energy Development



- **Social acceptance by local population**
- **Costs – of technologies, of installation**
- **Financing**
- **Regulatory issues, environmental impacts**
- **Risks – technical, incidents, environmental**

Addressing Public Concerns



- **Even if all technology needs and economic hurdles are overcome, widespread deployment could be delayed by public concerns**
- **Public aspects:**
 - **Describing complex technology in objective, understandable terms – how the technology works, what would it look like**
 - **Perceptions of risk, tolerance for risk**
 - **Long-term aspects**
 - **Climate change overall**
- **Social science research needed now**
- **Interesting comparison other transformative technologies**
 - **CO₂ Capture and Storage**

“Creating the Conditions” For a CO₂ Market in Canada



**IEA Weyburn
Storage,
Monitoring**

**Storage
Regulations**

**Working
Together**

**Assessment
of Storage
Potential**

**Measure,
Monitoring,
Verification**

**Capacity
Building,
Transport'n**

**Enhanced
Recovery
Oil, Gas**

**Risk
Assessment**

**Strategic
Planning**

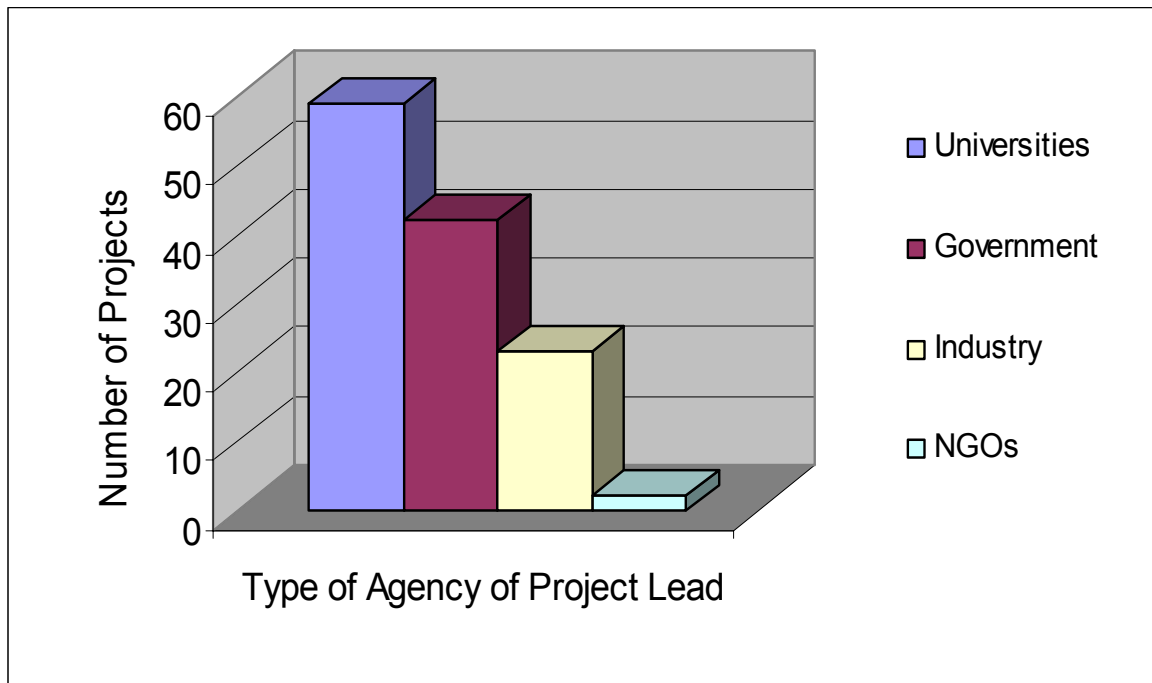
**CO₂
Capture
Technologies**

**Public
Attitudes,
Acceptance**

**International
Collaboration
Partnerships**

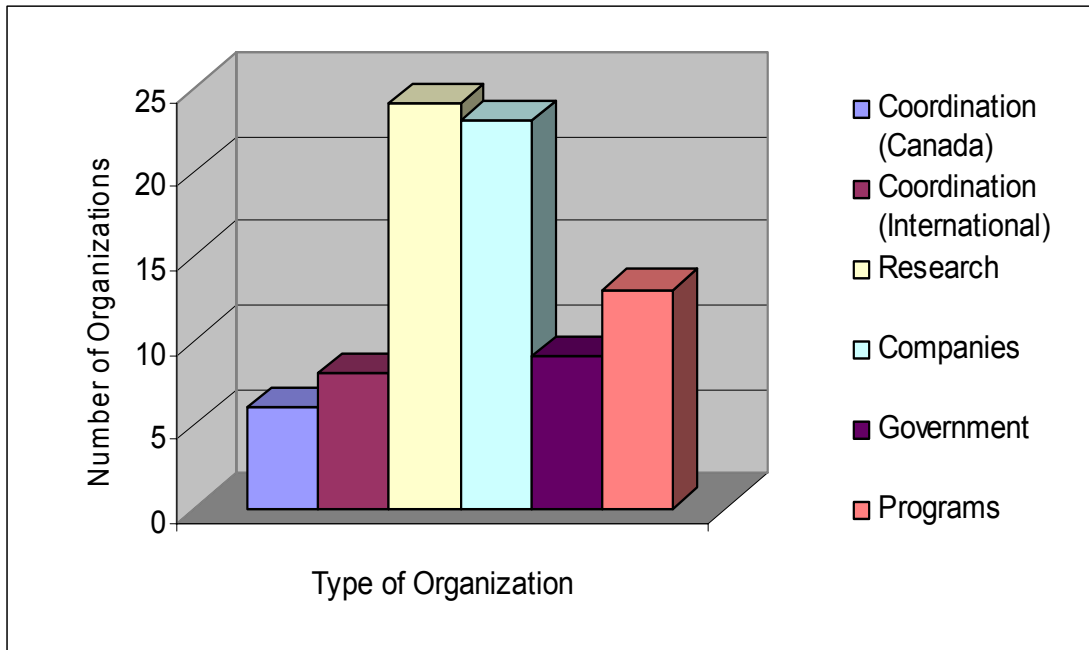
Canada's 10-Year Track Record in CCS

Canadian CCS Projects by Organization



- **Most active are universities, government departments and agencies, industry**
- **Total projects = 126**

CO₂ Capture and Storage's Activities Since 2003 Network over 10 years



- Most active are research centres, funding programs, international mechanisms, industry, government agencies

- Total organizations = 83

Transformative Technology Potential Pathways



- **Many new technologies are at a critical juncture**
- **Does a country:**
 - **Develop new technology?**
 - **Adapt technology to local conditions?**
 - **Buy and plug in?**
- **Looking forward to insights, directions and strategy from this symposium**

Some Closing Observations



- **Energy issues, significant challenges ahead**
- **Technology part of the solution**
- **Ocean energy – an emerging transformative technology, action needed to make it viable**

- **To make it happen:**
 - **Ideas – technologies, demonstrations**
 - **Collaboration is key**
 - **Not just about technology**



THANK YOU / MERCI

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