Hydropower – a Sustainable Source of Electricity Generation

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What causes Global Warming ?

Global warming is caused by massive increases of greenhouse gases in the atmosphere, resulting from the burning of fossil fuels and deforestation.

Is Global Warming Important ?

Global Warming is the world's most important and pressing environmental issue of the twenty first century.

Who produces global warming ?

- There is widespread scientific and political consensus that increases in CO_2 emissions in the atmosphere cause global warming.
- The first source of CO_2 emissions is from burning of fossil fuels for energy production, industrial processes and transportation. North America, Europe and Asia emit over 90% of the global CO_2, most of it since the beginning of the industrial revolution.
- The second source of CO_2 emission is a result of cutting down forests to make land available for agriculture and urbanization. South America, Asia and Africa produce over 90% of land-use change emissions.

Impact of Global Warming

- The Intergovernmental Panel on Climate Change (IPCC) indicated that there is evidence of a 0.6°C rise in global temperatures and 20 cm. rise in sea levels during the 20th century.
- IPCC also estimated a further increase in global temperature of 1.4 - 5.8°C (8°C in Canada) and a rise in sea levels by up to 88 cm. in the 21st century.
- These changes will be the largest and most rapid of the last 10,000 years and will have profound effects on our lives and the ecosystems that support us.

More on the impact of Global Warming

- It is predicted that climate changes will result in weather patterns being less predictable.
- The frequency and magnitude of extreme events such as storms, floods and draughts will increase.
- A widespread loss of permafrost will result in increased erosions, changes in hydrologic processes, reduced stability of slopes, and increases in landslides.
- A significant loss of land along coastlines and river deltas will affect populations of many countries.
- All above impacts will have a significant influence on the human society, health and water resources, agriculture, economic development and biodiversity.

Impacts of Global Warming in Canada

- Melting of the permafrost with detrimental impact on Northern infrastructures.
- Change in precipitation patterns and river flows. Example: The St. Lawrence River flow can decrease by over 30%.
- Significant reduction in boreal forests.
- Threaten northern species. Examples: Caribou, polar bear, beluga whales.
- Severe negative socio-economic effects on aboriginal communities.

What should we do NOW ?

- Reduce substantially CO_2 emissions.
- Use less energy.
- Switch to renewable energy sources.
- Plant more trees, grow more forests.
- Apply widely sustainable development concepts.
- Train the public on: impact of global warming, the need to cut CO_2 emissions, sustainable development, adaptation.
- Provide people with incentives to contribute at the individual level.
- Invest in scientific research.
- Continue conversations to reach an international agreement on Global Warming.

Advantages of Hydropower

- Renewable source of electricity.
- Helps fight climate change. Emits 60 times less GHG than coal fired plants and 18-30 times less than natural gas fired plants.
- Supports intermittent renewables such as wind and solar.
- Clean, doesn't pollute the air.
- Hydro reservoirs are beneficial to water supply, irrigation, flood control and recreational uses.
- Provides electricity price stability since it's not subject to fuel price volatility and is inflation-proof.
- Provides operating flexibility with quick starts and stops.
- Helps following the load via automatic generation control.

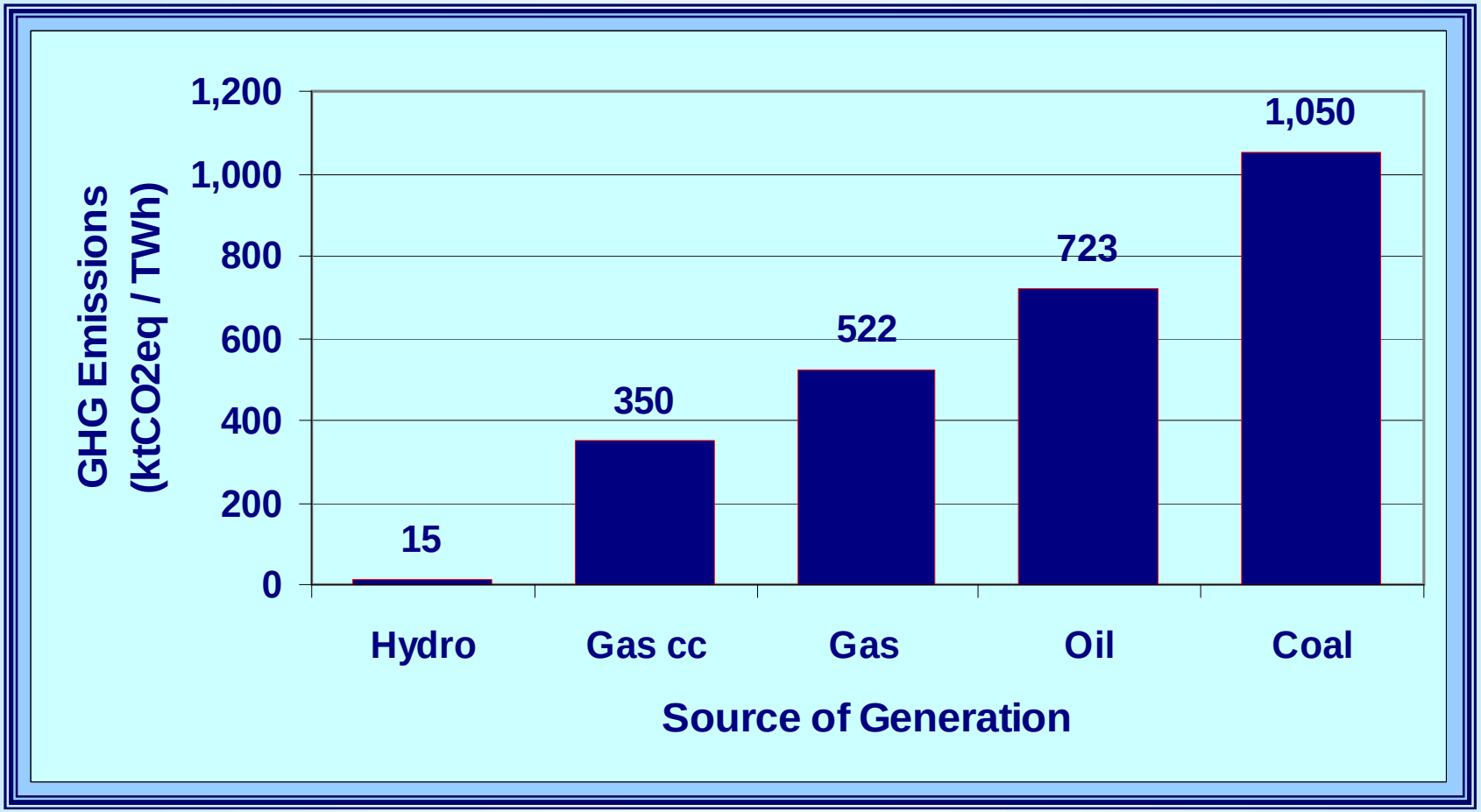
More Hydropower Advantages

- Established and reliable technology.
- Great return on initial investment.
- Contributes to the on-going security of the electricity generating systems.
- Vital in restoring the electricity systems in case of blackouts.
- Highly efficient. Converts 90% of available energy into electricity.
- Enhances the local economy and quality of life.
- Long life cycle, from 50 to over 100 years.
- Very low maintenance costs.
- Significant public support.

Hydro Reservoirs and GHG Emissions

- Reservoirs emit CO_2 and CH_4
- These emissions result from:
  - flooded soil and vegetation, and
  - carbon being transported by rivers flowing into reservoirs.
- Reservoirs are also sinks of carbon through sedimentation of organic matter.
- The impacts of reservoirs on GHG emissions is determined by calculating their net emissions.
- Studies have shown that in Canadian climatic conditions, we can expect an emission factor of 15 $KtCO_2eq/TWh$.

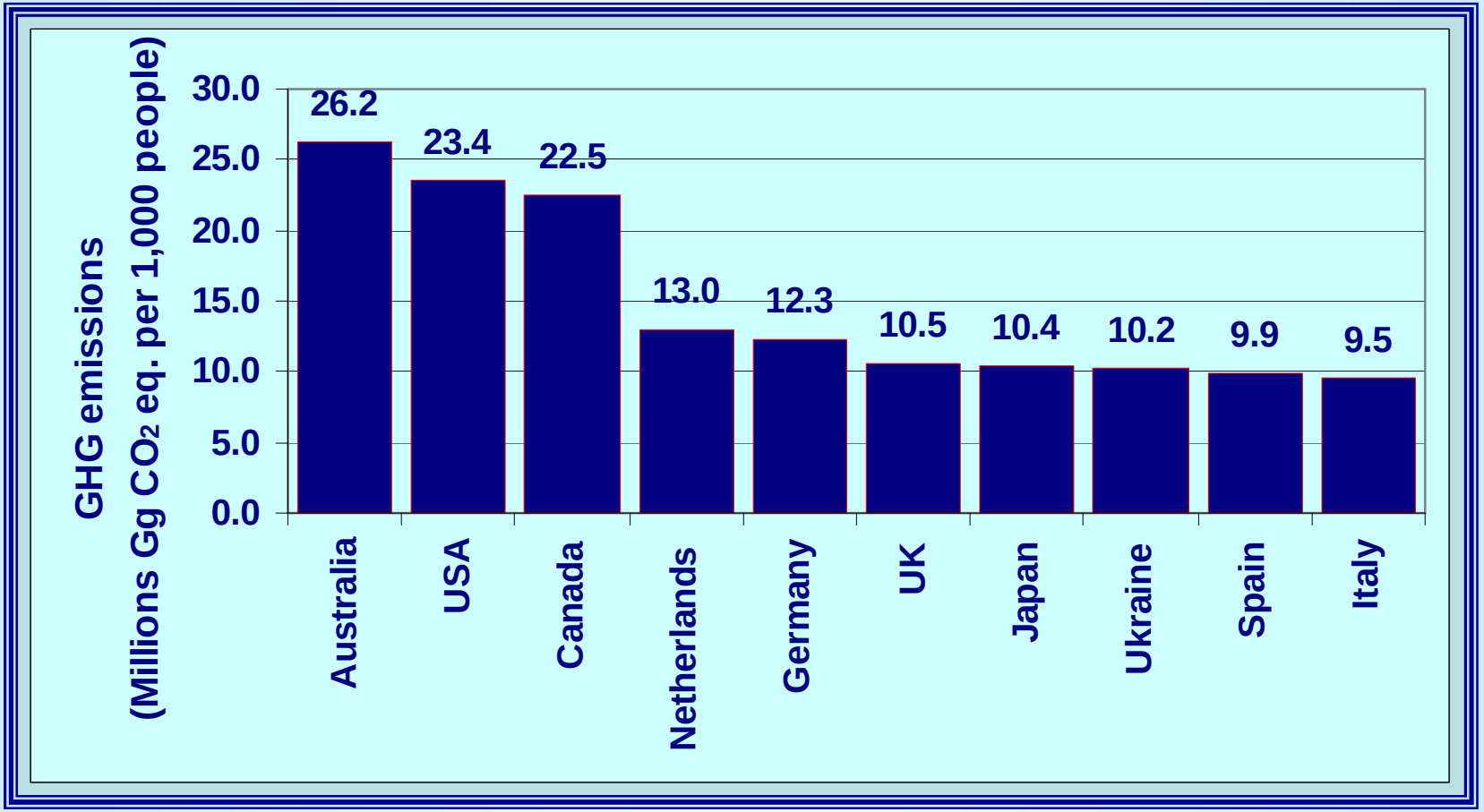
Typical GHG Emissions



Sources: US Environmental Protection Agency
Environment Canada

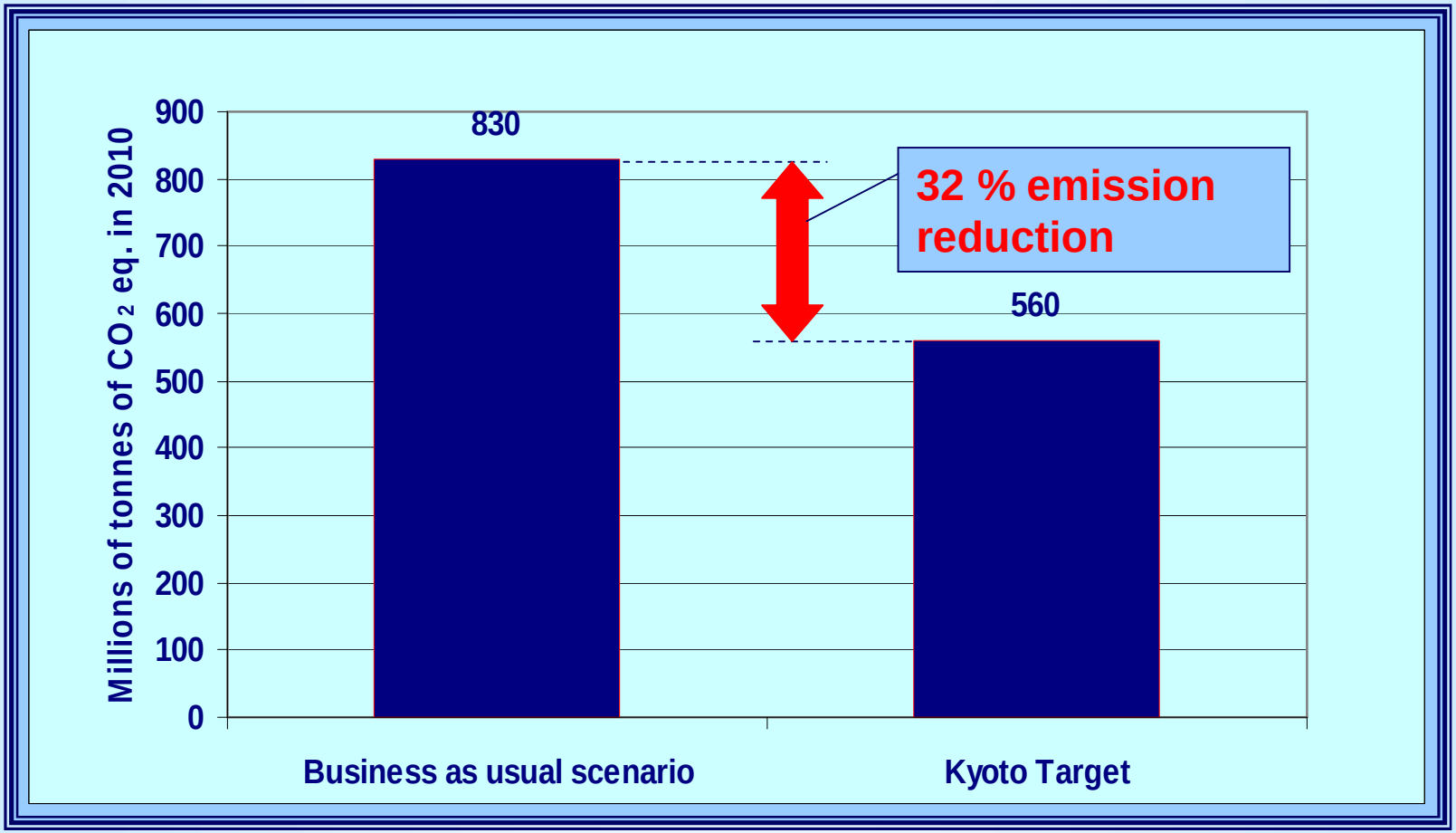
cc = combined cycle

Top 10 GHG Emitters



Source: United Nations Framework Convention on Climate Change, 2004

The Canadian Challenge

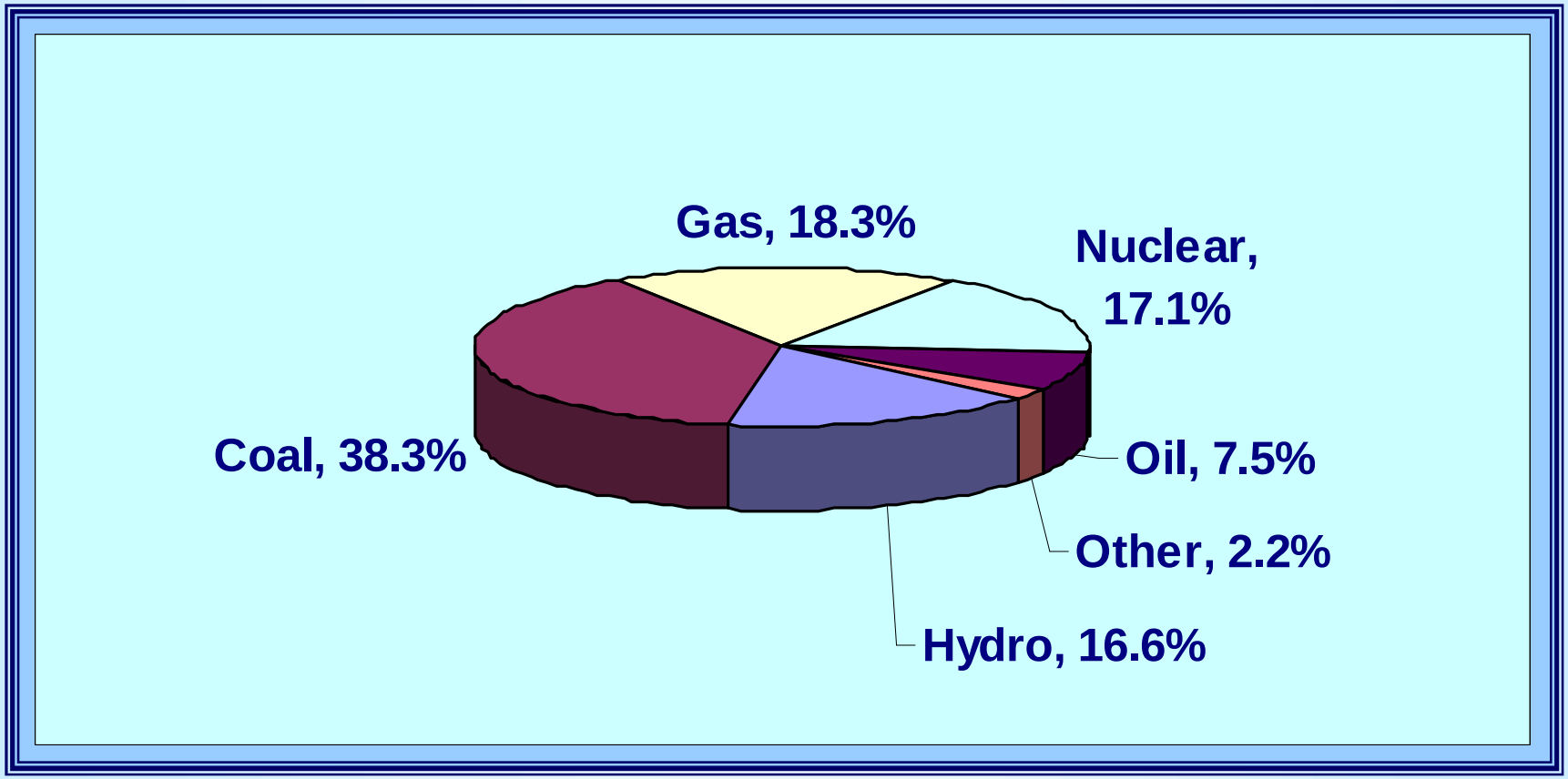


Source: Environment Canada, 2006

Air Pollution

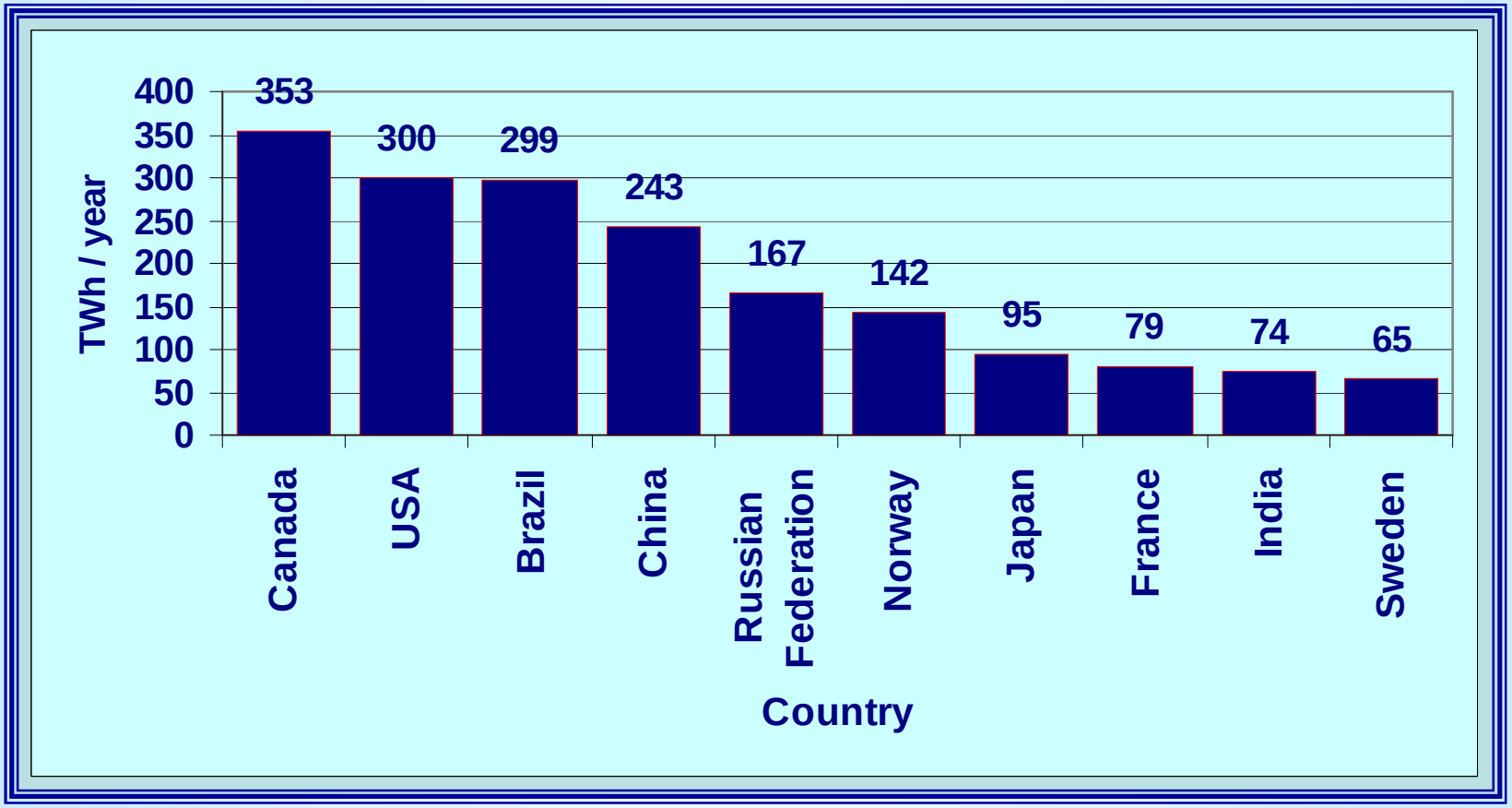
- There are 5,000 deaths in Canada attributed to air pollution.
- Acid rain, caused by NO_X and SO_2 emissions, has detrimental effects on fisheries and forests.
- Fossil generation contributes 10% and 20% in NO_X and SO_2 emissions, respectively.
- Joint programs with US resulted in a reduction of NO_X and SO_2 emissions. Further significant reductions are required if forests and aquatic ecosystems are to recover.
- Hydropower development does NOT produce air pollution.

World Electricity Generation



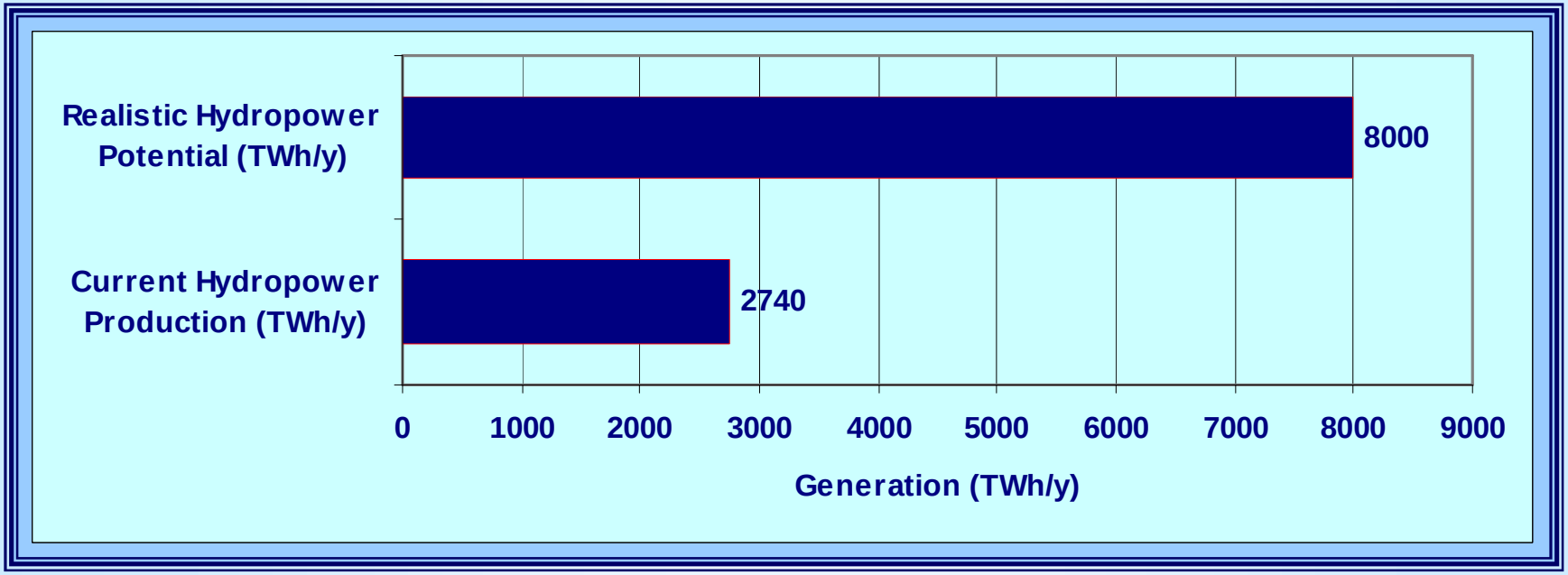
Source: International Energy Agency

Top 10 Producers of Hydropower



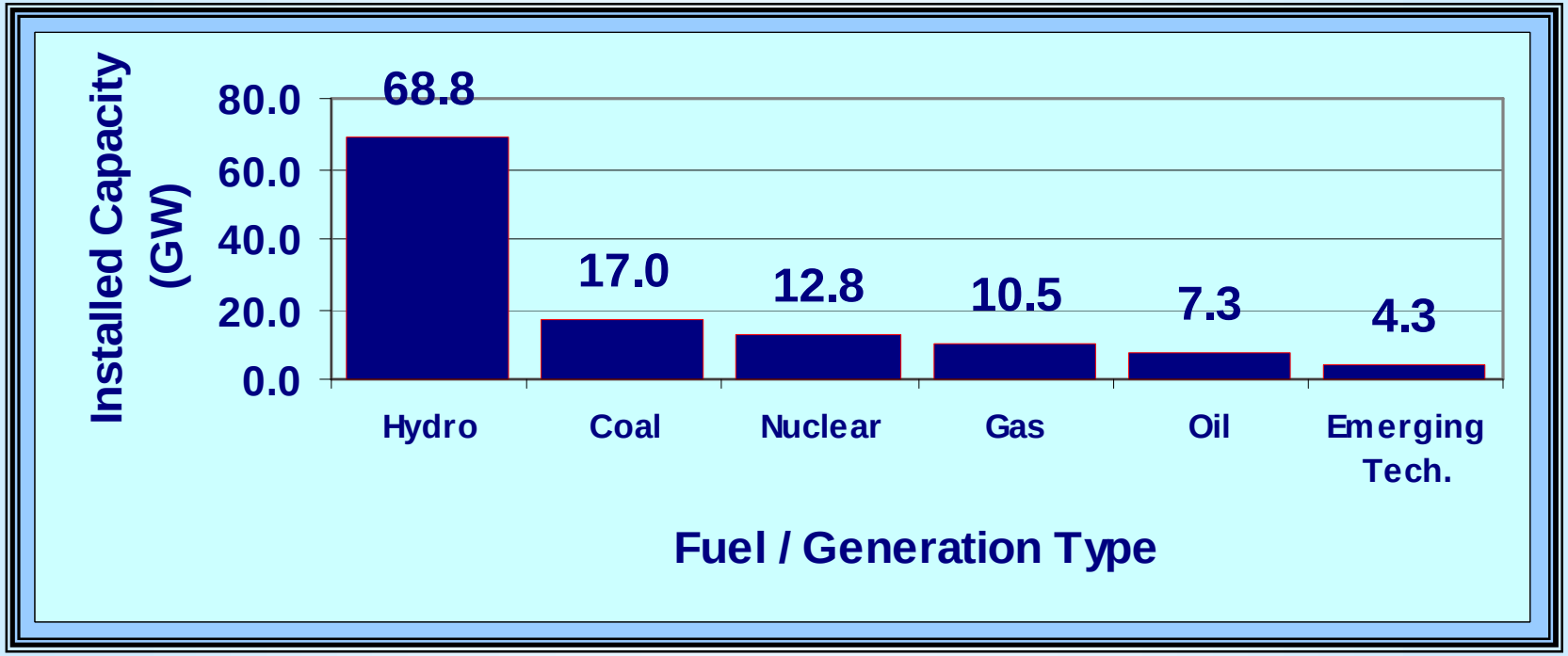
Source: Aqua Media International, Hydropower and Dams, 2003

World's Potential Hydropower Generation



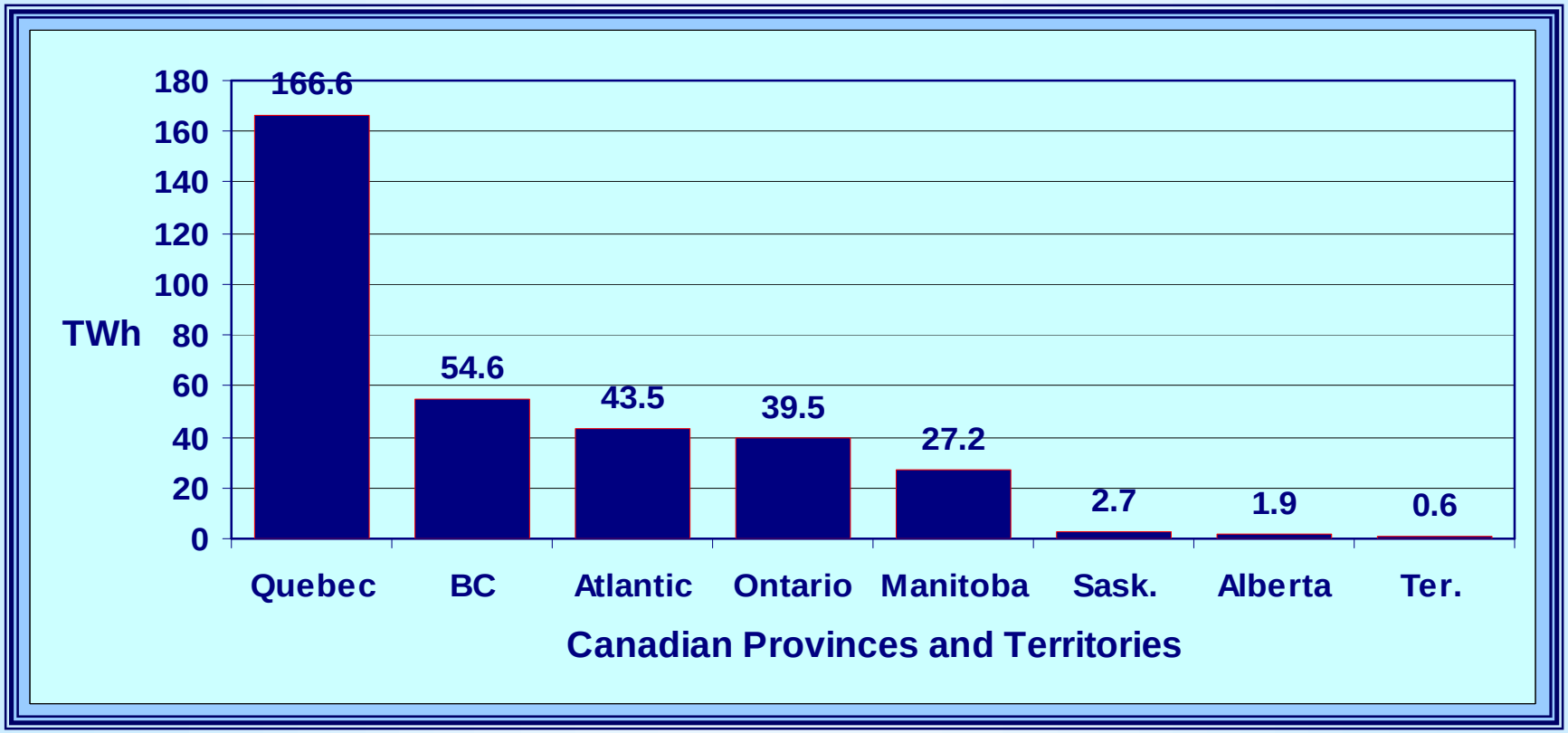
Source: International Hydropower Association

Hydropower in Canada



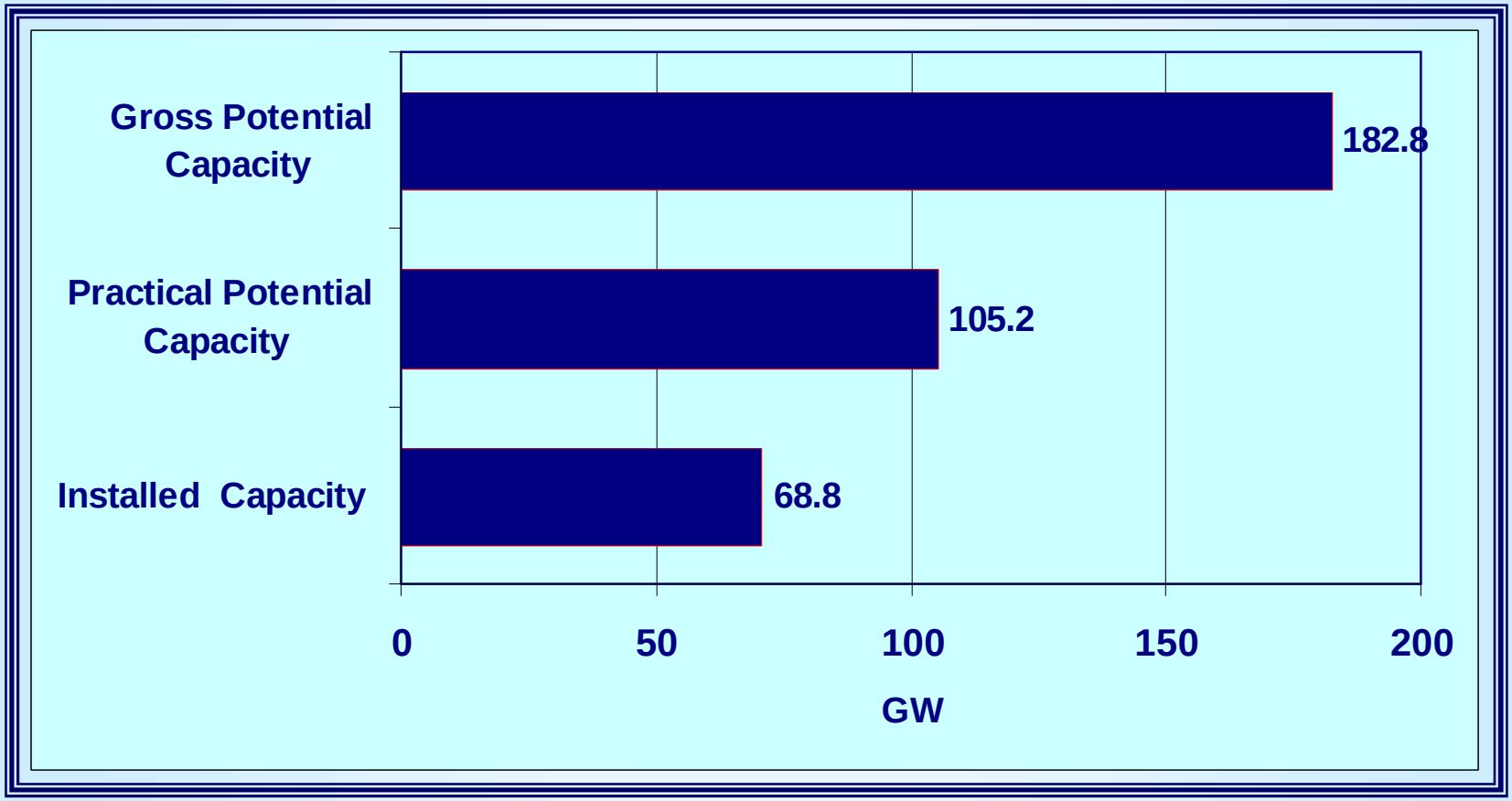
Source: Statistics Canada, 2004

Hydropower Generation by Province



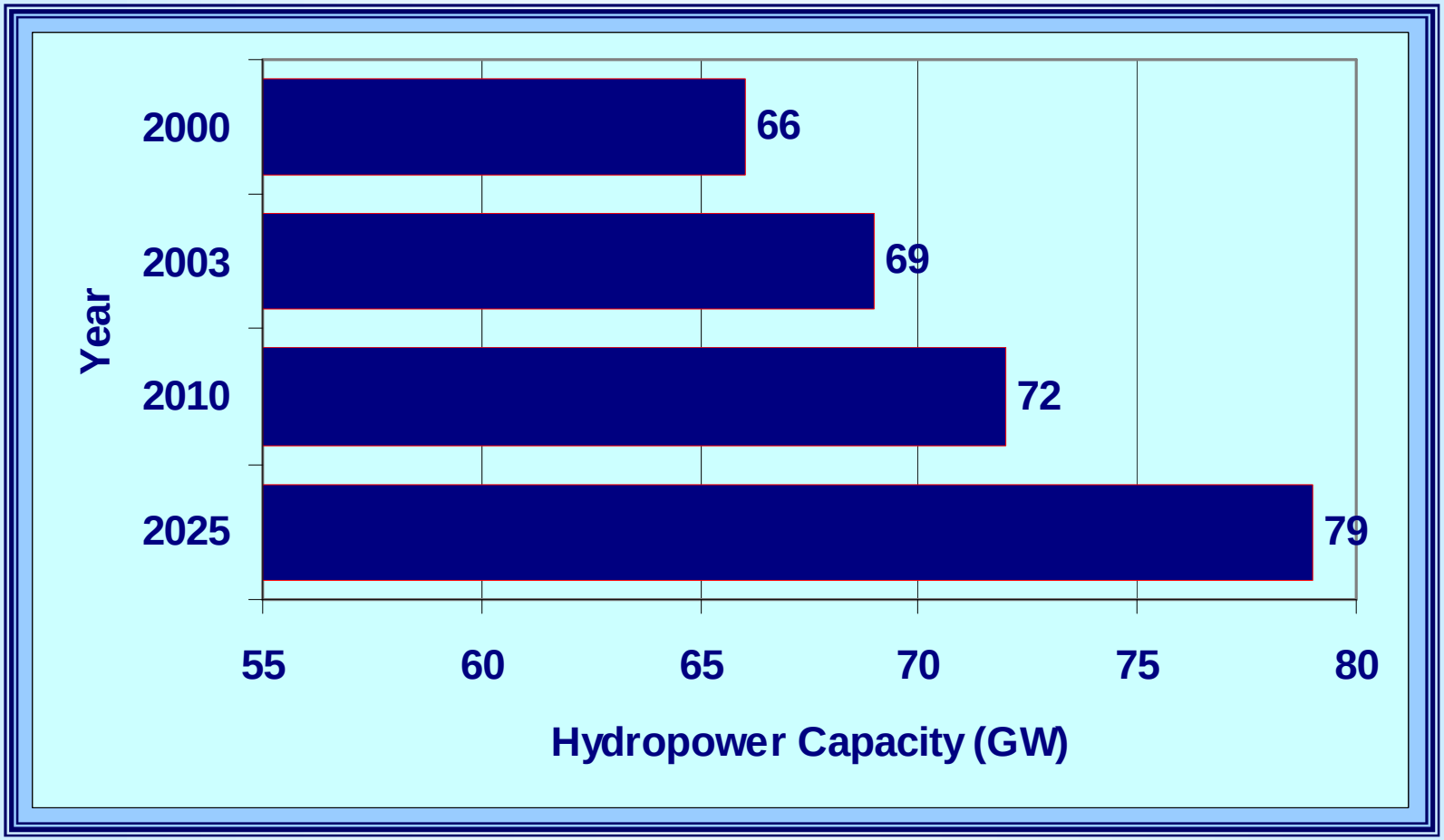
Source: Statistics Canada, 2004

Canadian Hydropower Capacity



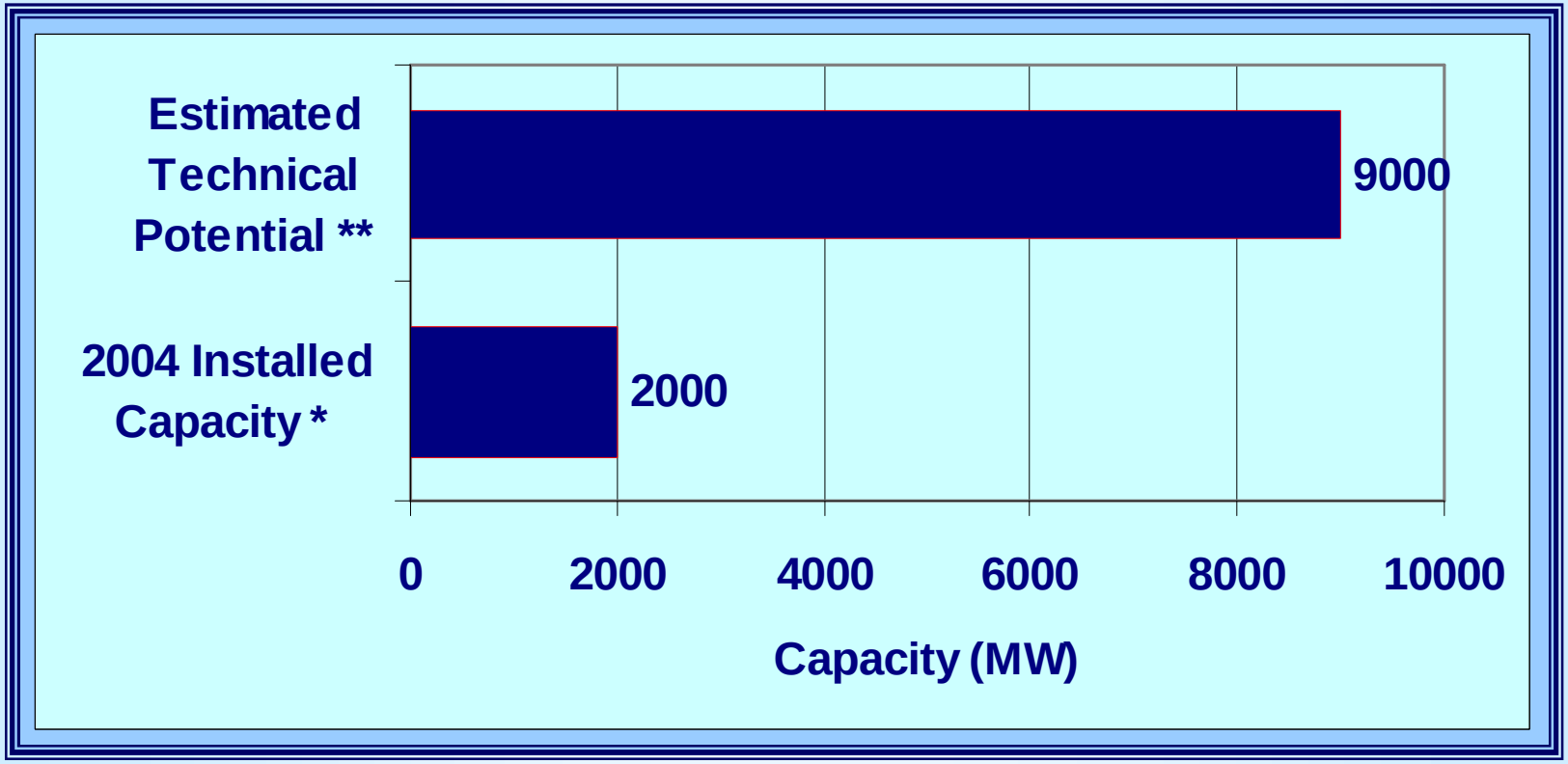
Sources: Installed Capacity - Statistics Canada, 2004
Gross / Practical Potential Capacity – Natural Resources Canada

Growth in Canadian Hydropower Capacity



Source: National Energy Board, 2006

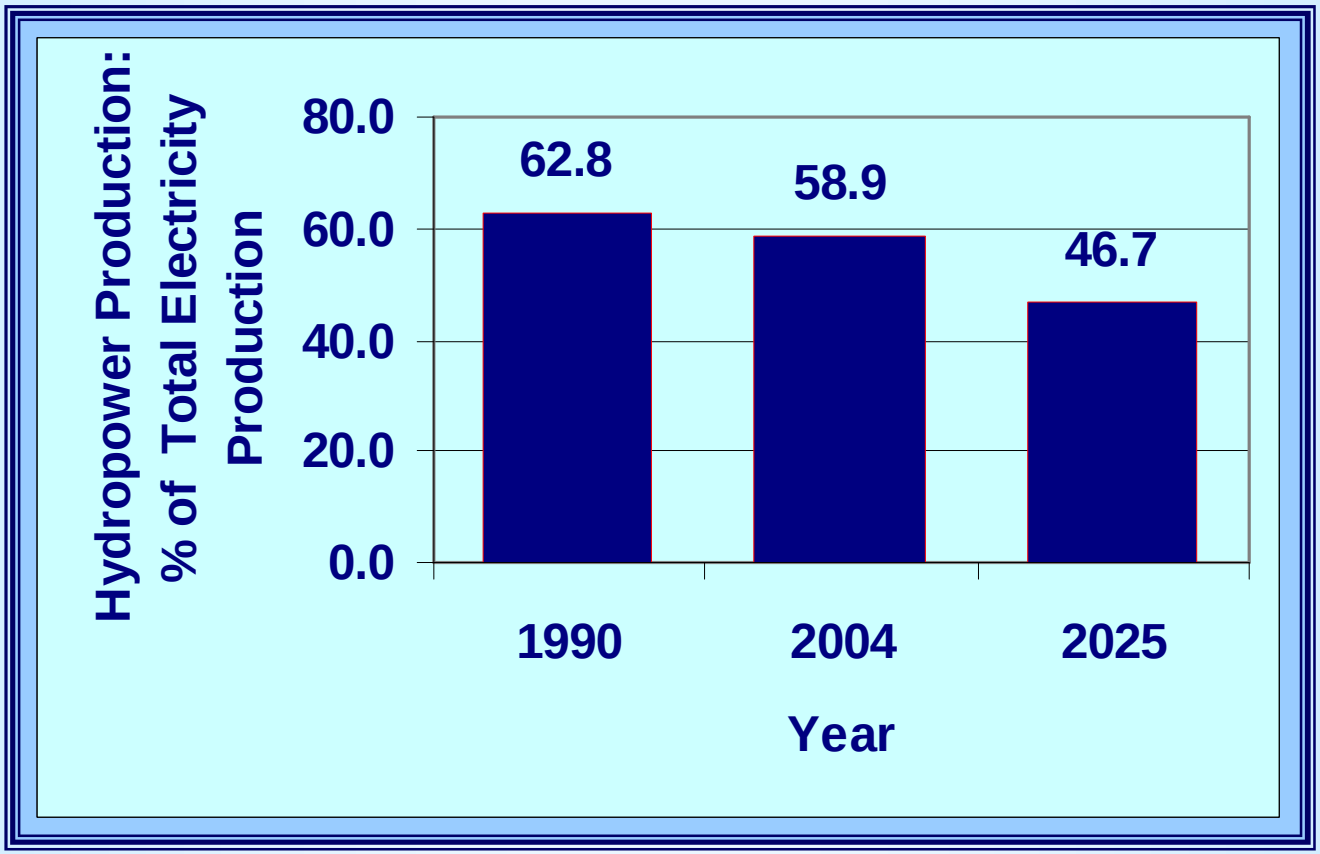
Canadian Small Hydro Capacity



Source: * Statistics Canada, 2004
** Natural Resources Canada

Small Hydro = < 25MW

Canadian Hydropower Production (%)



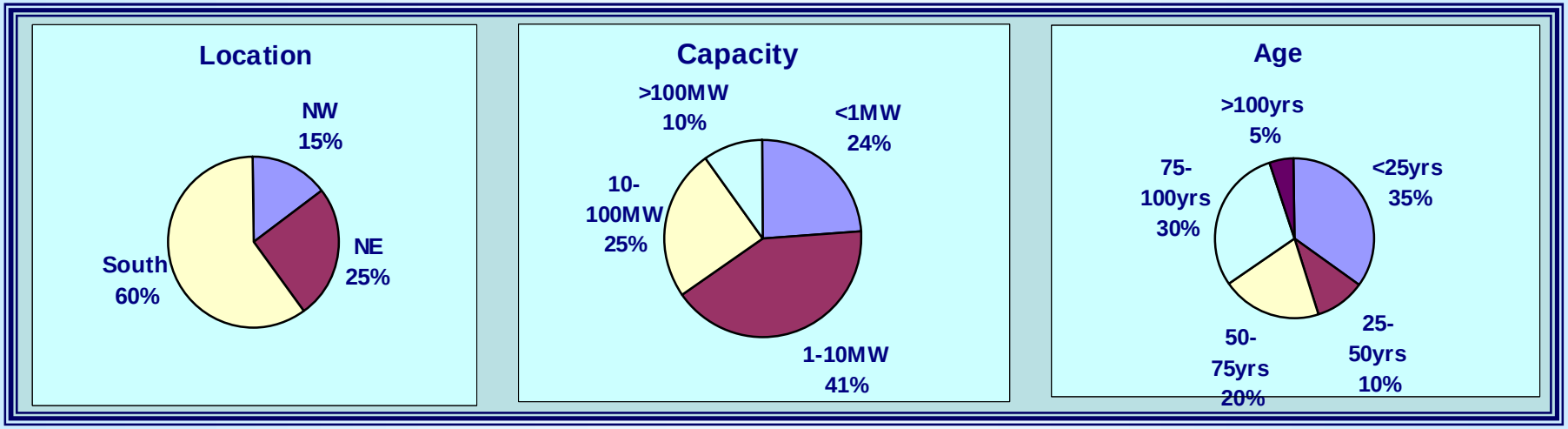
Source: Actual production: Statistics Canada, 2004
Forecast: National Energy Board, 2003

Potential Canadian Hydropower Projects

- Newfoundland:
  Lower Churchill River: 2,000 MW Gull Island and 824 MW Muskrat Falls.
- Quebec:
  Eastmain 1A, Rupert diversion: 768 MW Eastmain 1A and 120 MW Sarcelle.
- Manitoba:
  Burntwood River: 200 MW Wuskwatim; Nelson River: 623 MW Gull Rapids; Lower Nelson River: 1,380 MW Conawapa
- BC:
  Peace River Site C: 900MW; Elaho: 200MW; Murphy Creek: 275 MW; Border Dam: 275 MW; McGregor Lower Canyon: 360MW.

Hydropower in Ontario

- **Current Status**

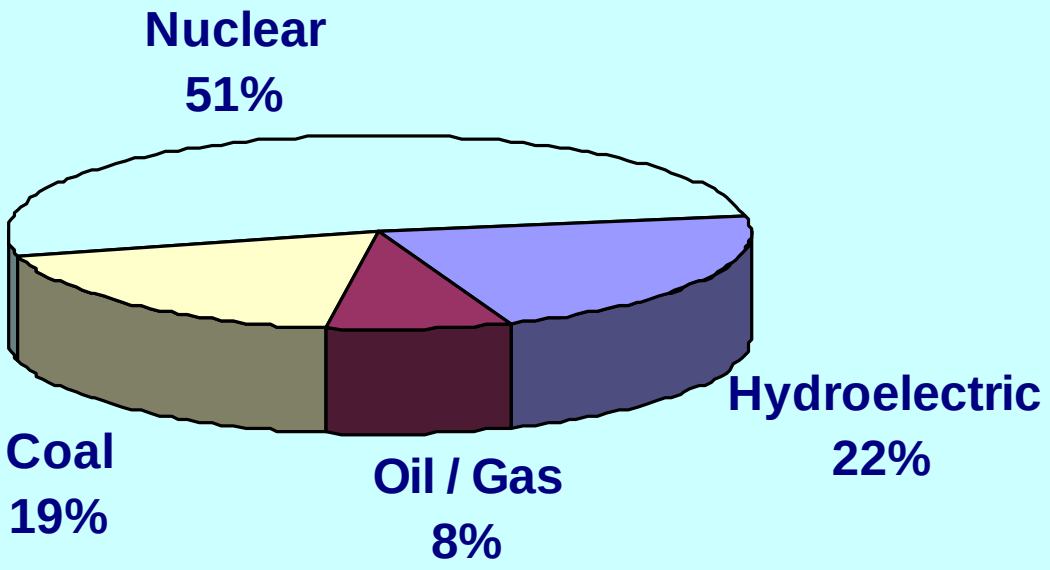


Source: OWA

- **Future potential[1]**
  - Theoretical potential: 20,600 MW (includes expansion sites)
  - Practical potential: 5,500MW
  - Most future sites are in Northern Ontario

1- Source: OWA / MNR / HATCH ACRES

Generation Mix in Ontario (2005)



Source: OPG

OPA Supply Mix Report

- By 2009 all coal generating plants will be shut down.
- By 2020 nuclear units will have to be either retired or upgraded.
- Demand growth and generation retirement will create a gap of 24,000 MW by 2025.
- Most hydropower sites were already developed.
- Remaining practical hydropower potential was estimated at 1,447 MW.
- Hydropower sites within parks and conservation areas and sites subject to negotiations with the First Nations and the federal government were not included (total: 6,138 MW).
- New hydropower sites are mostly run-of-the-river.
- More studies required for pump-storage sites.
- There are hydropower import opportunities from Newfoundland & Labrador, and Manitoba.

NOLUM Report

- Northern Ontario Large Urban Mayors (NOLUM) representing Kenora, Sudbury, North Bay, Sault Ste. Marie, Thunder Bay and Timmins have recommended to the minister of energy that 9,750 MW of new generation be developed in Northern Ontario:
  - 6,500 MW from waterpower
  - 1,500 MW from wind
  - 1,000MW from biomass, and
  - 250 MW from conservation and demand management

OPG Hydropower Activities

- Strategy: Expand and redevelop existing sites and pursue new projects where feasible.
- Completed the refurbishing of Beck 2 Plant resulting in an additional 280MW.
- Initiated the construction of the Niagara tunnel that will allow generating 1.6 billion KWh / year.
- Signed MOU with First Nations for the development of a 3-9 MW GS at Mattagami Lake Control Dam. Total potential on Lower Mattagami: 150-450MW.
- Initiated the redevelopment of the Upper Mattagami GSs: Wawaitin, Sandy Falls, Lower Sturgeon. Additional capacity: 27MW.
- Started pre-construction activities for the 12.5 MW Lac Seul GS on the English River.
- New investigations of the 130 MW Little Jackfish GS.

What is Sustainable Development ?

- "Development that meets the need of the people today without compromising the ability of future generations to meet their own needs."

  Source: World Commission on Environment and Development.

- Hydropower development and operation should be fully consistent with the social, economic, and environmental needs of present and future generations.
- It is critical to anticipate social and environmental impacts and to take steps to avoid, mitigate and compensate for impacts.

Environmental Aspects

- Flooding
- Change in natural flow regimes
- Bank erosion
- Fish habitat
- Sedimentation
- Wildlife and endangered species
- Water quality in the reservoir or downstream
- Infrastructure impacts: roads, transmission lines, etc.
- Optimum utilization of water resources and operation of hydropower facilities
- Life cycle environmental impacts

Social Aspects

- Securing local community support for the new projects
- Transformation of land use
- Relocation of people and communities
- Employment opportunities
- Training for new skills
- Improved public health benefits
- Improved schooling for children
- Improved housing
- Preservation of cultural, historic and indigenous heritage values
- Emergency preparedness
- Public safety
- Long-term monitoring program of social improvements

Hydropower and Sustainability

The International Hydropower Associations (IHA) is a strong promoter of sustainability. It has:

- issued international Standards (Sustainability Guidelines).
- provided project assessment tools to measure sustainability (Compliance Protocol).
  - new energy options
  - new hydropower projects, and
  - operation of hydropower facilities
- introduced a program for the recognition of excellence (Blue Planet Prize).
- proposed a certification process for sustainability.

Improvements needed in Canada

- Political recognition that hydropower is a major tool in the fight to reduce greenhouse gas emissions.
- Streamline the environmental assessment approval process for hydro projects.
- Ensure consistent application of the environmental assessment process including impacts caused by global warming, acid rain, smog and public health factors for all electricity generation projects.

Conclusions

- Canada has large undeveloped hydropower generation resources.
- Sustainable development of these resources can contribute greatly to reducing GHG and to the economic development of the country.
- Federal and provincial governments should consider introducing policies for the fast track sustainable development of these clean and renewable resources.