Evaluating Multiple Emission Reduction Measures

Federal Decision Maker

Policy Analysis Tool

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Presentation Overview

- Background
- Purpose
- The Tool
- The Nuts and Bolts
- Example Analysis

Introduction

- We've come along way
- Move from reaction to prevention
- Moving towards multiple pollutant focus
- Role of technologies
  - Resource efficiency
  - Pollution production

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Research Purpose

- Pollutant groups: GHGs, CACs
- Evaluate federal level, GHG policies in terms of
  - Impact on criteria air contaminants (CACs)

WHY?

- Contribute to understanding full costs & benefits
- Aid in crafting the most cost-effective policies

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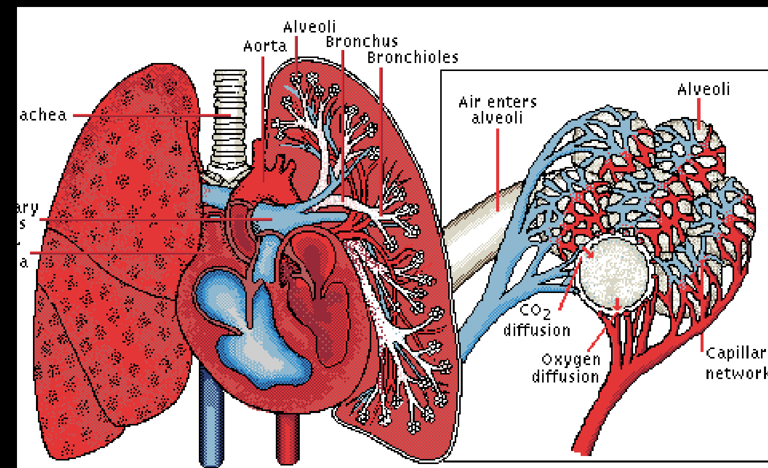
Why GHGs and CACs?

Energy



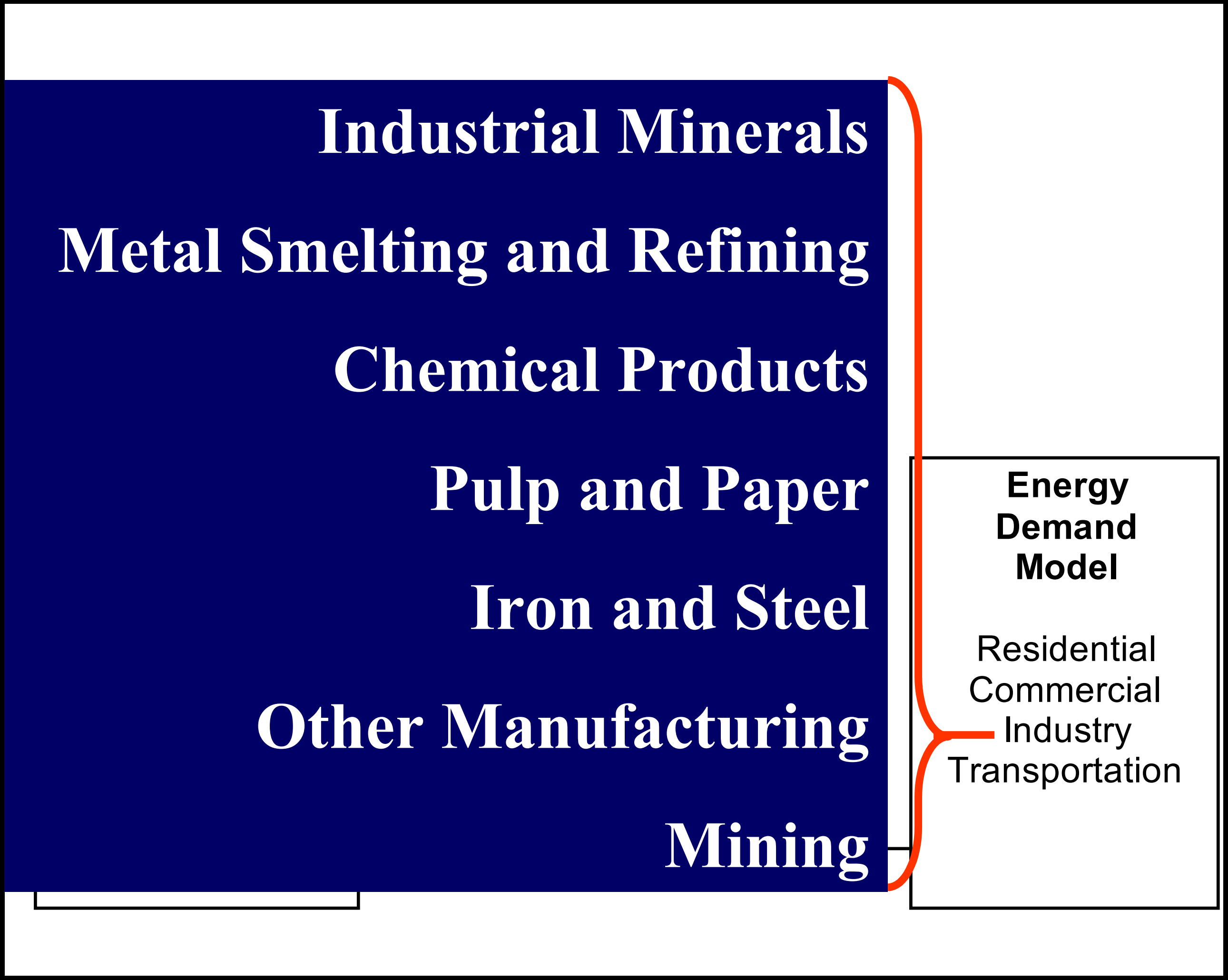
The Role of a Model

- Simplify complex systems
- Facilitate learning
- Help address conceptually complex problems
- Synergies, antagonisms
- Help evaluate and inform decisions
- A way to compare the potential ramifications of different policies

Overview of CIMS

- Energy-economy simulation model
- Models technology evolution over time
- All sectors and regions of Canadian economy
- Technologically detailed*
- Behaviorally realistic*

Basic Structure of CIMS



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Technological Detail

- Technologies determine resource efficiency and ultimately control pollution generation
- Energy using and producing technologies are included
- Overtime old techs abandoned, adapted ▸ evolution!
- Each technology described by its:
  - Current characteristics (efficiencies, costs, market shares, lifespan, link to other technologies)
  - Future characteristics (cost and efficiency changes, new technologies, date of availability)
  - Emissions

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Behavioural Realism

- Realistic representation of technology choice
  - not based on financial costs alone
- Preference includes financial and non-financial parameters
  - capital and o/m costs, risk, time value of money, and ‘intangibles’
- Market share approach
  - more than one technology can be used to perform a given service

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Examples of Policies

Market instrument: fuel tax, emission tax, carbon tax, permit trading with cap, …

Financial (dis)incentive: subsidy for emission reduction investments, "green" electricity, feebates

Education: EnerGuide, information packages

Regulation / Infrastructure: building codes, energy efficiency standards, best available technology requirements, …

Let's take a look at a policy

Federal GHG policy → CAC emission changes ?

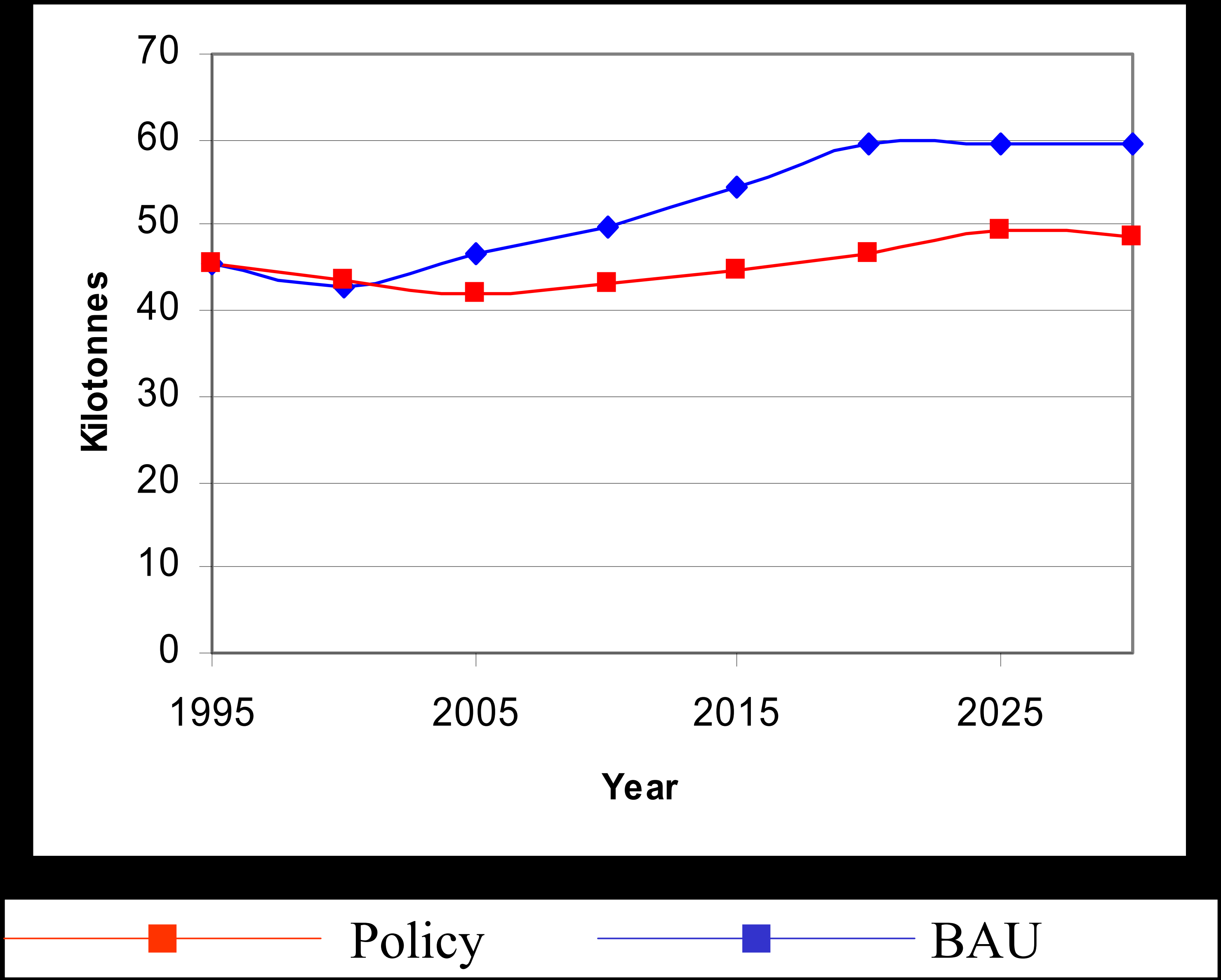
GHG emission changes ?

$10/tonne CO_{2e}

- Electricity sector
- Ontario, Alberta, Quebec

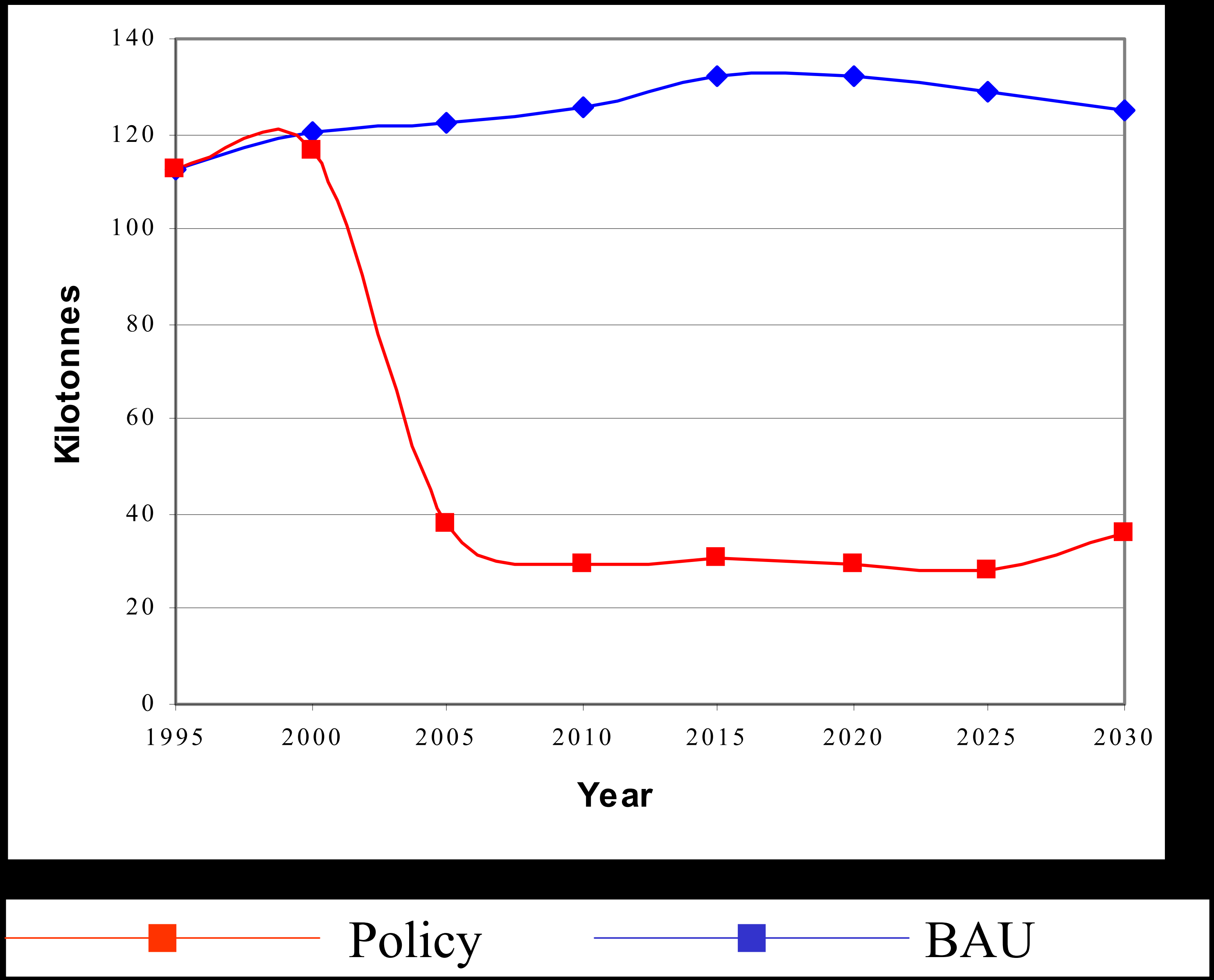
Ontario: $10 tax

SO_x Emissions Forecast



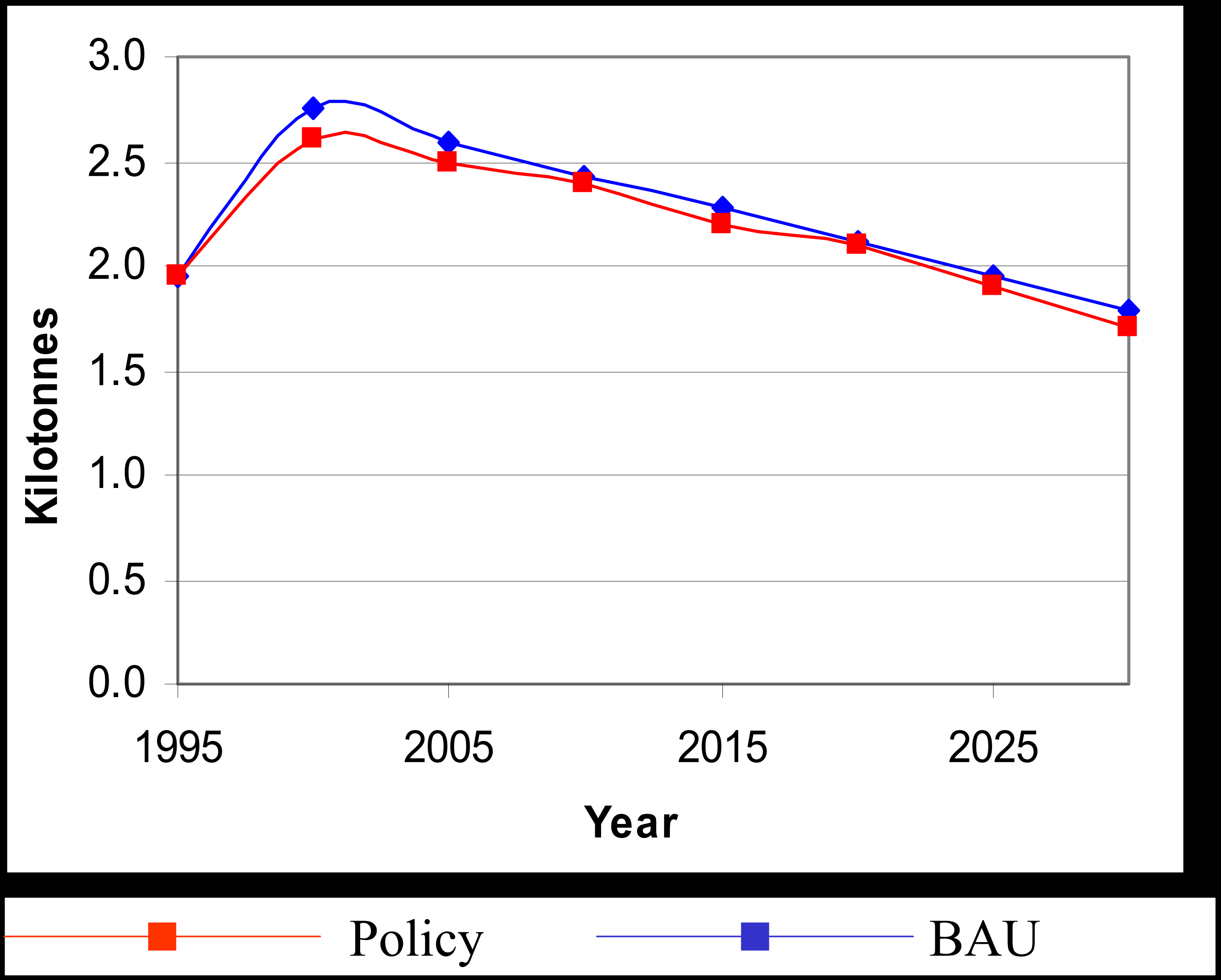
Alberta: $10 tax

SO_x Emissions Forecast

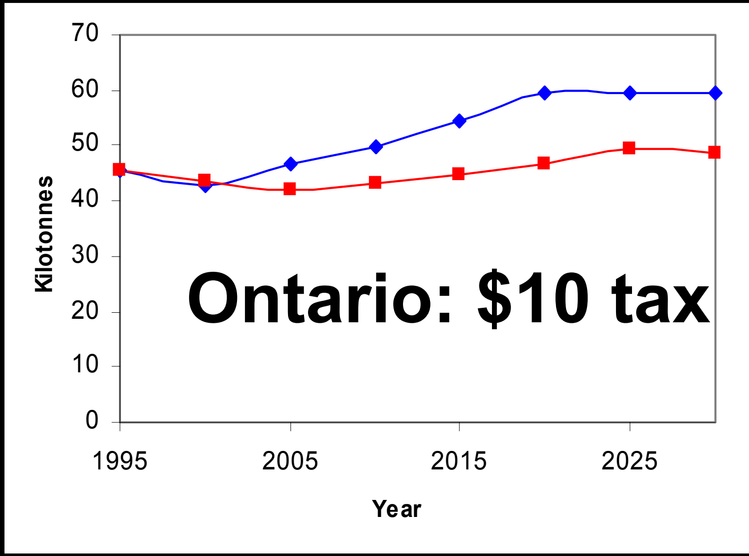


Quebec: $10 tax

SO_x Emissions Forecast



What happened?



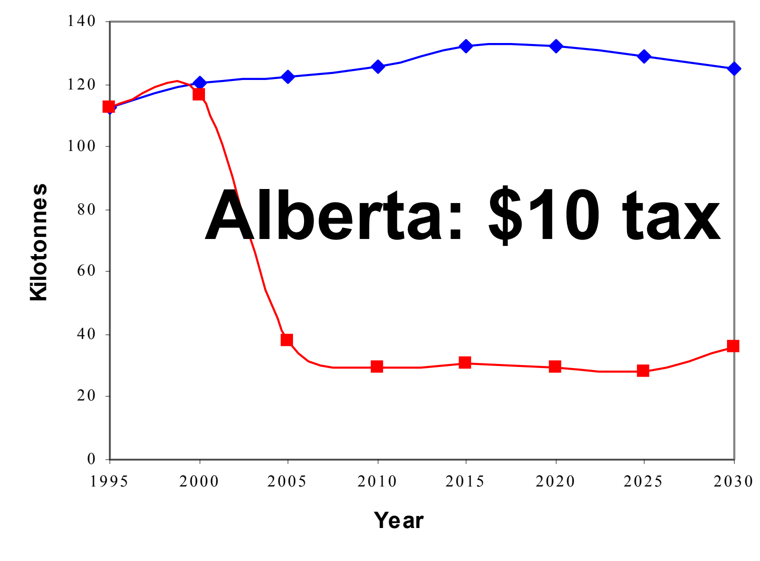
Diversified electricity sector

- Natural gas, coal, nuclear, hydro

Electricity demand reductions	22 %
Efficiency improvements	22 %
Fuel switching (Coal ‣ Ngas)	20 %
More renewable sources	20 %
More large hydro	16 %

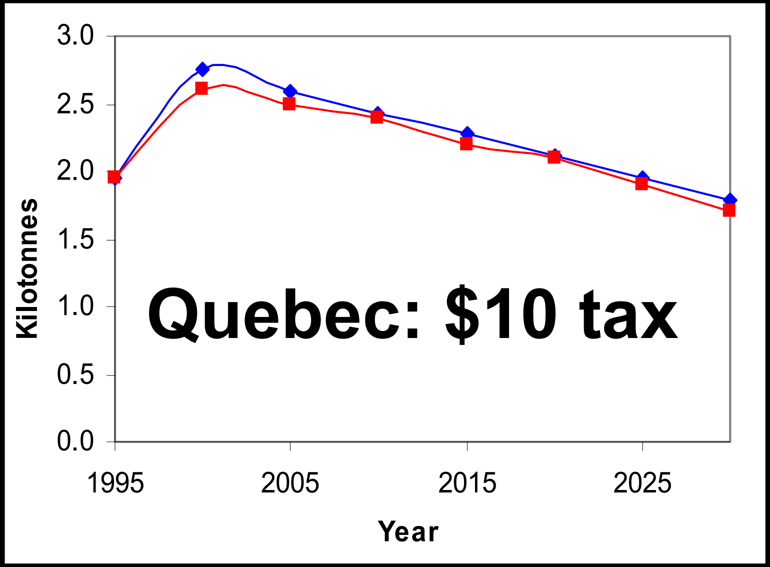
What happened?

Fossil fuel based – mainly coal



Electricity demand reductions	16 %
Efficiency improvements	56 %
Fuel switching (Coal ‣ Ngas)	28 %

What happened?



Hydro dominated

Less room for CAC reductions from electricity sector

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Summary

- Analysis – just a sample
- One step in a larger analysis chain
- Yes, CAC reductions can be realized with GHG policies
- Potentially large differences between regions
- Models are useful

Questions?

Lots of useful information regarding our research:

www.emrg.sfu.ca

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This research sponsored by Environment Canada

Characterization of Air Pollutants

Local

CAC*s*

- Nitrogen Oxides
- Volatile Organic Compounds
- Sulphur Oxides
- Particulate Matter
- Carbon Monoxide

Photochemical smog, acid rain

Global

GHGs

- Carbon dioxide
- Methane
- Water vapour
- Nitrous oxide
- Fluorinated compound

Global warming

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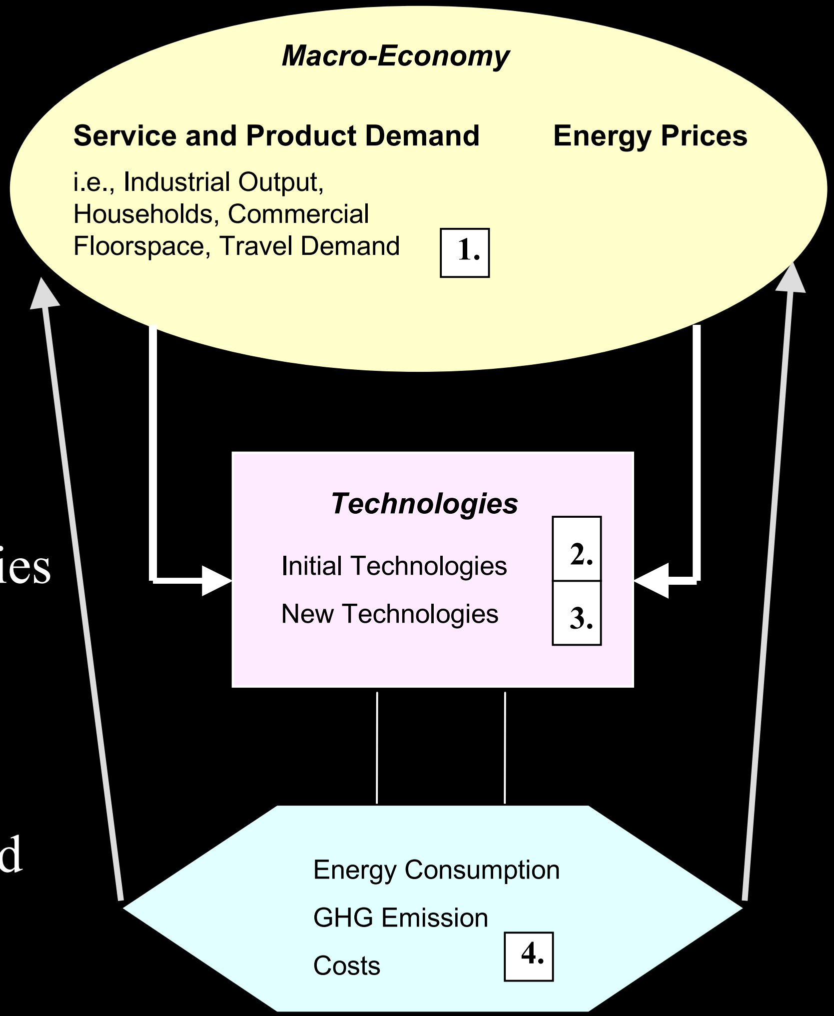
Other Pollution Prevention Applications

- What is the most cost-effective way to simultaneously reduce CAC and GHG emissions?
- Policy focus ramifications
- Avoided costs of compliance
- Head of Pipe vs. End of Pipe comparison

Steps in CIMS Simulation Algorithm

1. Growth in Demand
   - Growth forecasts used to estimate change in service demand for each sector
2 Retire and Retrofit
   - Portion of technology stock retired (by age)
3. Technology Competition
   - Competition of available technologies based on the *annualized life cycle costs* of technologies
4. Generation of Output
   - Energy consumption, emissions, and costs summed for all stocks



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Energy –Economy Model Characterization

Top Down

- Use price-consumption relationships (elasticities)
- Tend to over-estimate costs, inadequate representation of technological innovation

Bottom Up

- Systems engineering approach (technologically detailed)
- Fail to account for consumers' surplus, technologies are not always perfect substitutes

Hybrid

- Incorporate aspects of both (behavioural realism, technological detail)

The Co-benefits…

The extra benefits associated with actions to reduce GHGs

Reduce other pollutants (CACs, PAHs, etc.) → Cost savings

↓

Cleaner air → Better quality of life

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Emissions in CIMS

- Calculated after equilibrium is reached in each time period
- Use emission factors
  - Relate <u>average</u> emissions from a technology to fuel consumption or material production/consumption
  - Specific to technology and fuel
- Includes fugitive emissions, process and combustion related emissions

The Magic of the Simulation

- Business As Usual, or 'BAU' forecast is established (benchmark)
- Policy scenario simulated over 40 year time frame
- BAU – Policy = effect of the policy
- Calculate change in costs, emissions, energy demand