CESAR
CANADIAN
ENERGY SYSTEMS
ANALYSIS RESEARCH

Potential Contributions to University Research and Teaching

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CESAR CANADIAN ENERGY SYSTEMS ANALYSIS RESEARCH

Canada unique position in world:

- 0.5% of population,
- 7% of land area,
- Among highest per capita energy users,
- Export 50+% energy production.

Solutions require:

- ❑ All parts of the energy systems in Canada;
- ❑ All Economic sectors;
- ❑ All Jurisdictions;
- ❑ Long term thinking;
- ❑ Behavioural and structural changes;
- ❑ Understand all costs, benefits & tradeoffs of choices.

To understand:

- Past energy systems changes;
- The costs, benefits and tradeoffs of possible future energy systems;

To inform policy and investment decisions.

Tools & Approach:

- ❑ Technology & data-rich, quantitative models;
- ❑ Enhanced visualizations tools in web interface;
- ❑ Future: Nat'l conf. series.

CanESS

www.cesarnet.ca

Proposed Mandate: *Develop the data resources, analytical tools & research community to inform policy & investment decisions on the transformation of Canada's energy systems to sustainability.*

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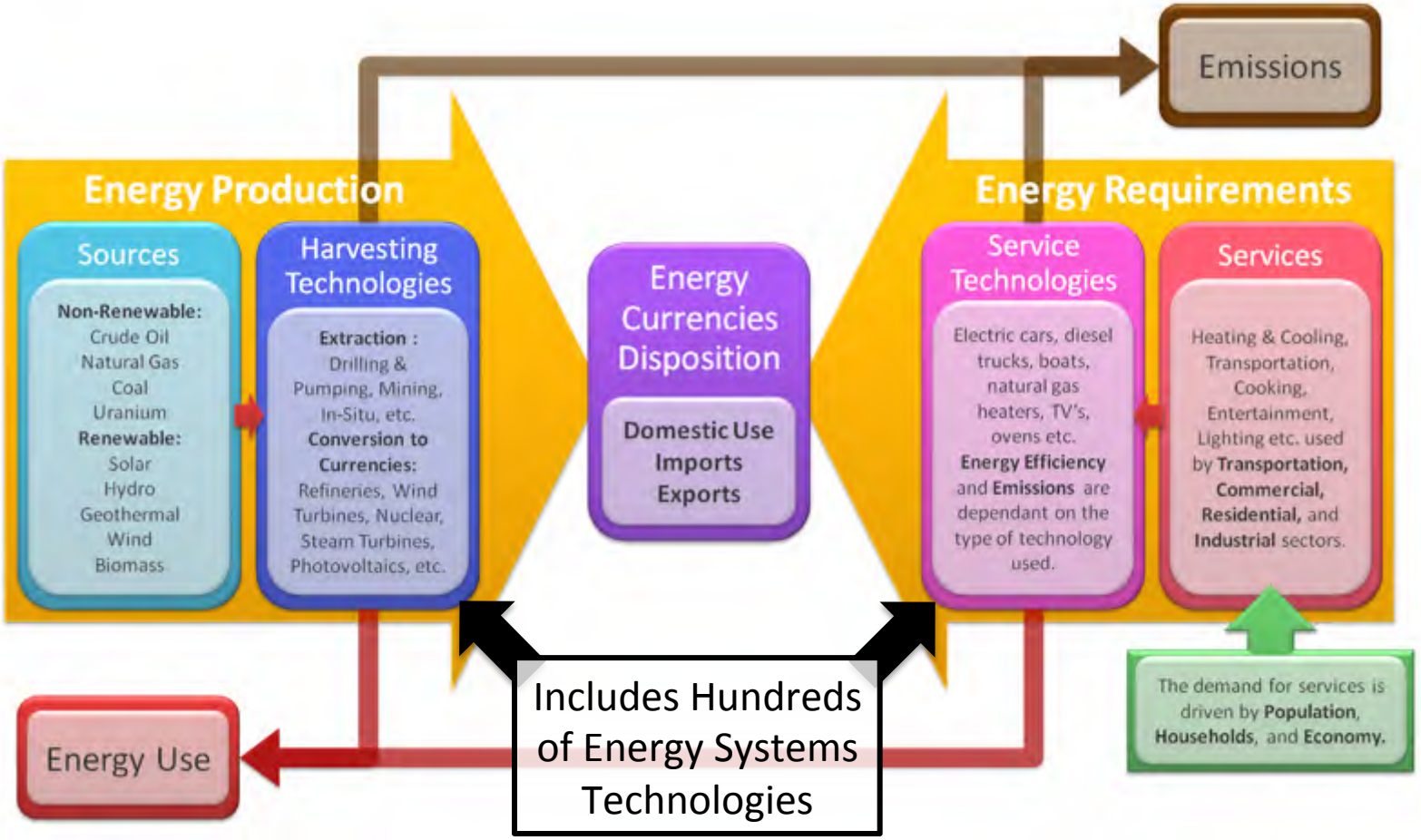
CanESS by whatIf?

CESAR CANADIAN ENERGY SYSTEMS ANALYSIS RESEARCH

- Cdn Energy Systems Simulator (CanESS) Model (from **whatIf? Technologies Inc., Ottawa**)
- Through CESAR, whatIf? has agreed to make the model available for use, validation, improvement, publication by university researchers;
- In partnership with whatIf?, the model can be used for contractual work.



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CanESS

CESAR CANADIAN ENERGY SYSTEMS ANALYSIS RESEARCH

Data Sources

- StatCan and CanSIM
- RESD
- OEE DPAD
- EC GHG inventory
- EPA Mobile 6
- NEB
- CBC
- LCA Models (GREET, GHGenius)
- Scientific Reports
- Anecdotal Data

CanESS Model

A technology rich, integrated multi-fuel, multi-sector, demand and supply model of the Canada's provincial and national energy systems.

The Output

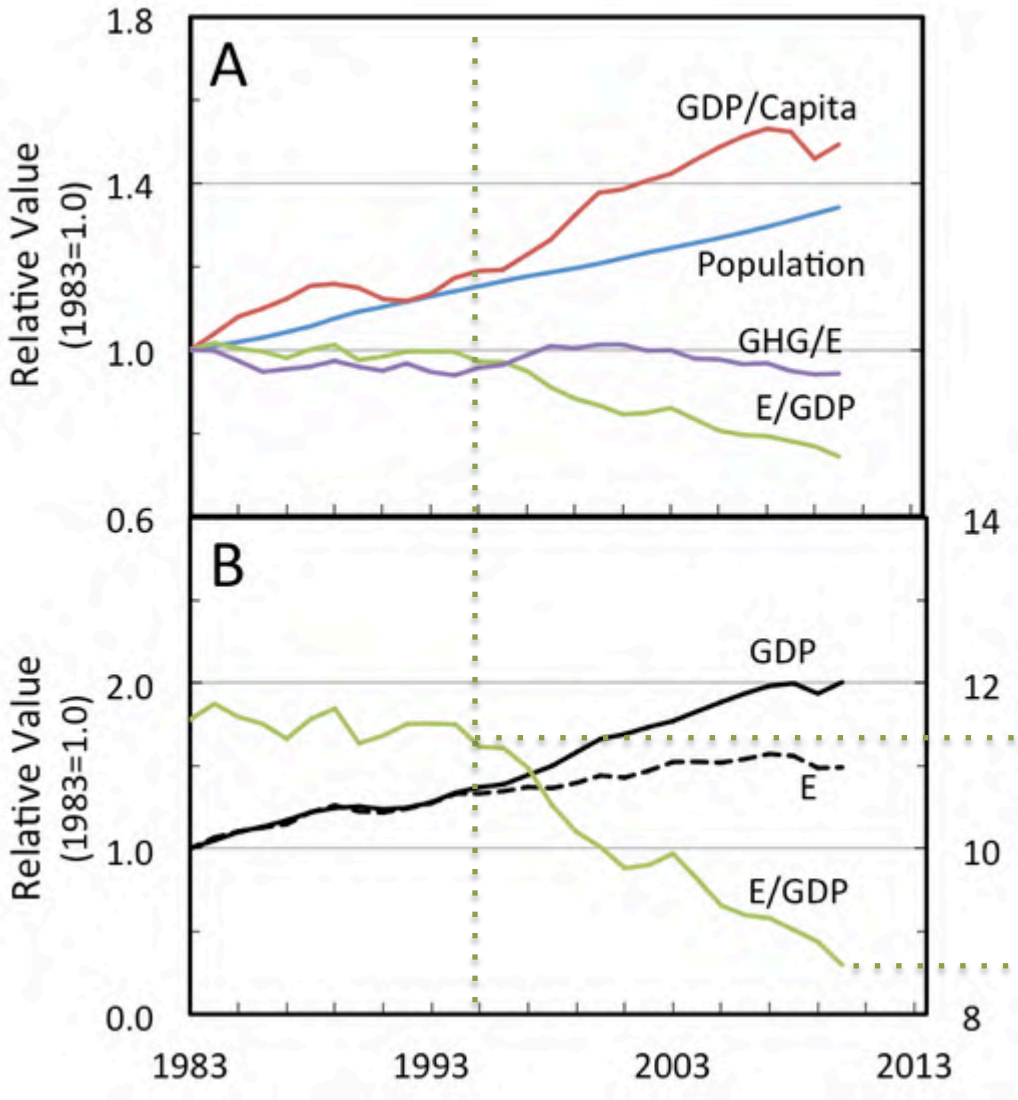
- Historical data on energy flows & GHG emissions by province, sector & technology from 1978-2010.

whatIf?

WhatIf? Technologies Inc.
338 Somerset St. W, Suite 3
Ottawa, ON K2P 0J9
www.whatiftechnologies.com

Decomposing Energy Systems

Ralph Torrie, Chris Stone & David Layzell



The 'Kaya' Identity

$$GHG = Pop \times \frac{GDP}{capita} \times \frac{E}{GDP} \times \frac{GHG}{E}$$

Why the uncoupling of energy demand from GDP after 1995?

-2.63 MJ/2002$

(~23% reduction)

Decomposing Energy Systems

Ralph Torrie, Chris Stone & David Layzell

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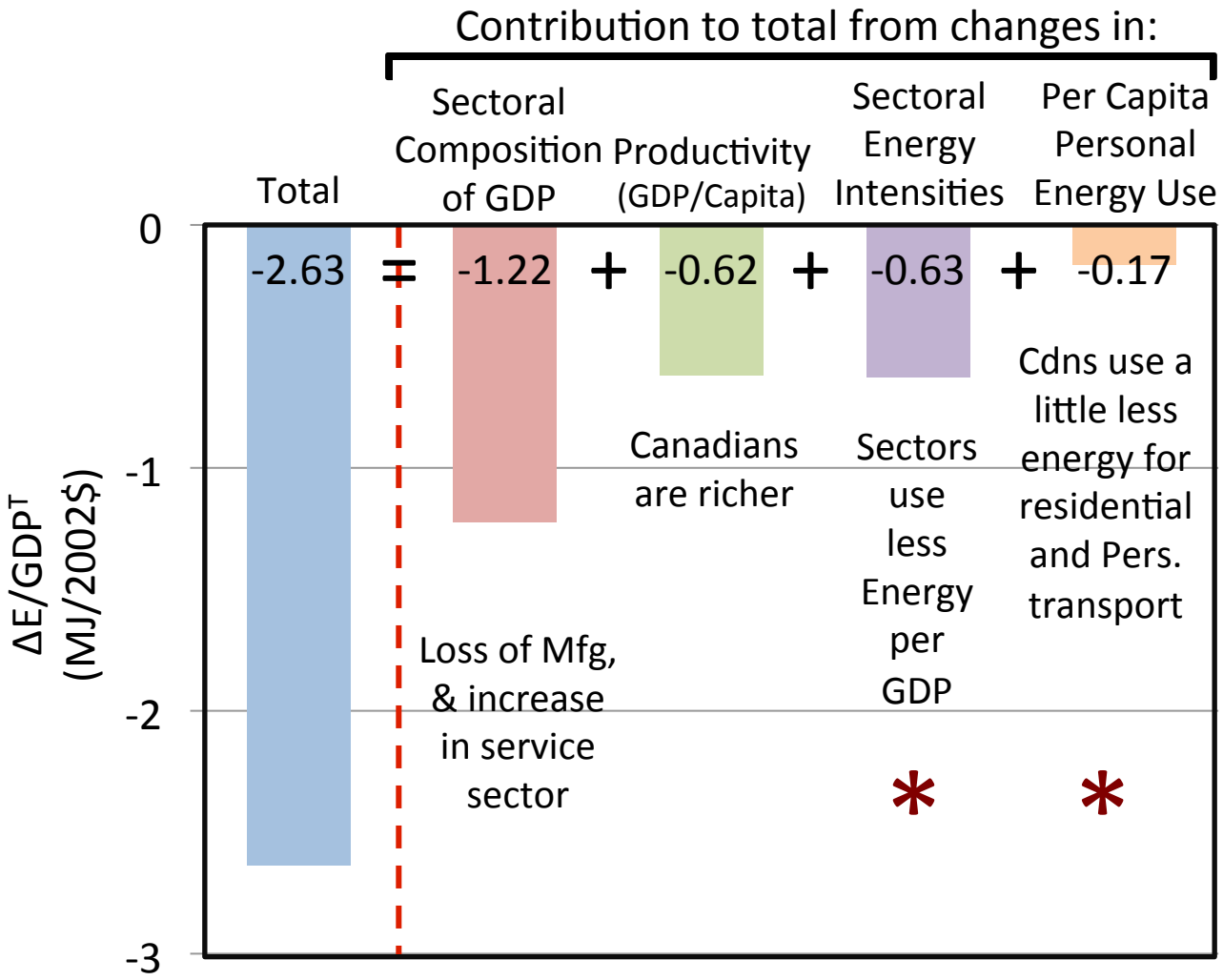
CANADIAN ENERGY SYSTEMS ANALYSIS RESEARCH



Decomposition Method:

Logarithmic Mean Divisia Method I (LDMI-I) by Ang (2005)

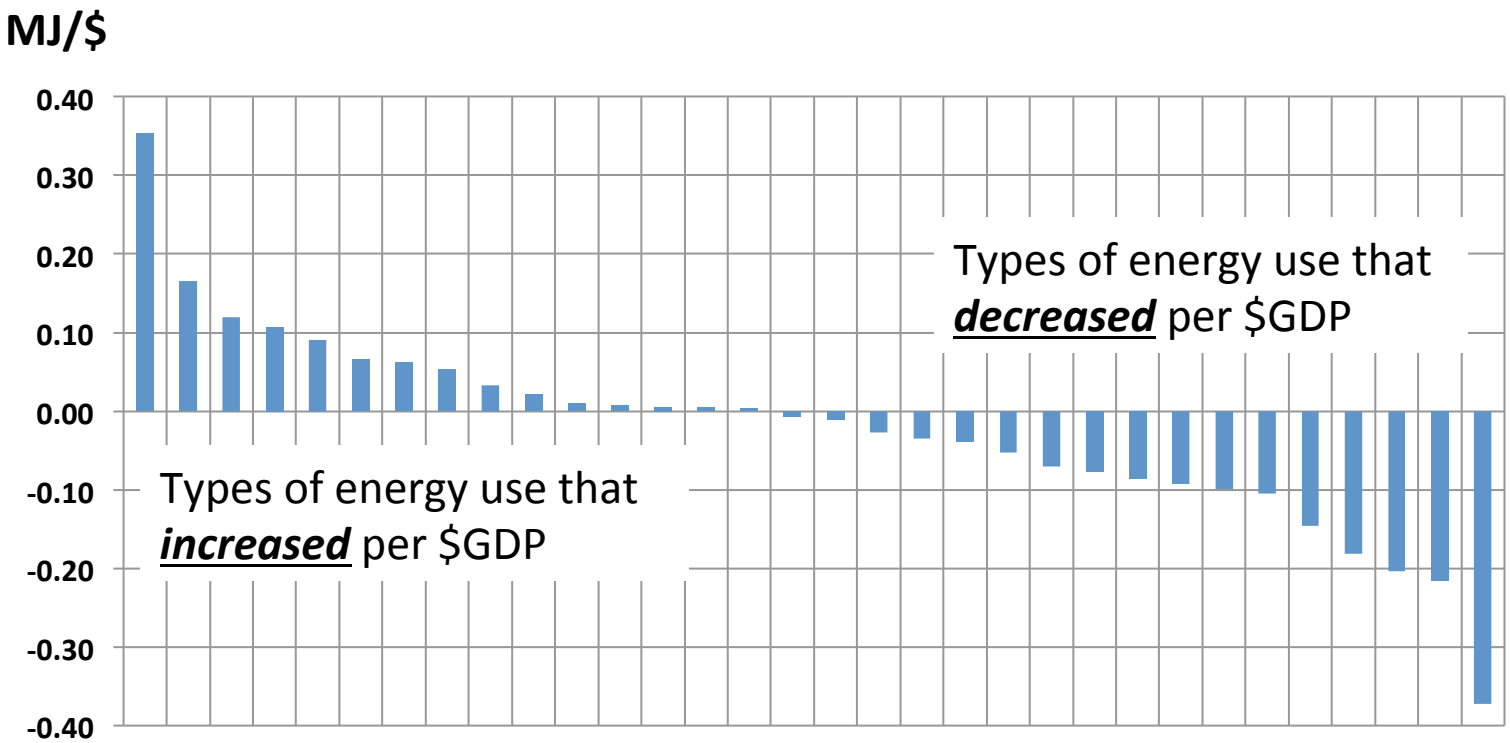
* Further Decomposition

Decomposing Energy Systems

Ralph Torrie, Chris Stone & David Layzell

Full decomposition of energy systems change in Canada between 1995 and 2010

Labels Removed – not final results



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CanESS Model

A technology rich, integrated multi-fuel, multi-sector, demand and supply model of the Canada's provincial and national energy systems.

The Output

- ❑ Historical data on energy flows & GHG emissions by province, sector & technology from 1978-2010.
- ❑ Simulates future energy systems (esp. energy flows & GHG emissions) associated with technology & policy choices (2011 – 2060+).

Assumptions

- Population growth
- GDP growth
- Existing or new technologies
- Policy instruments

whatIf?

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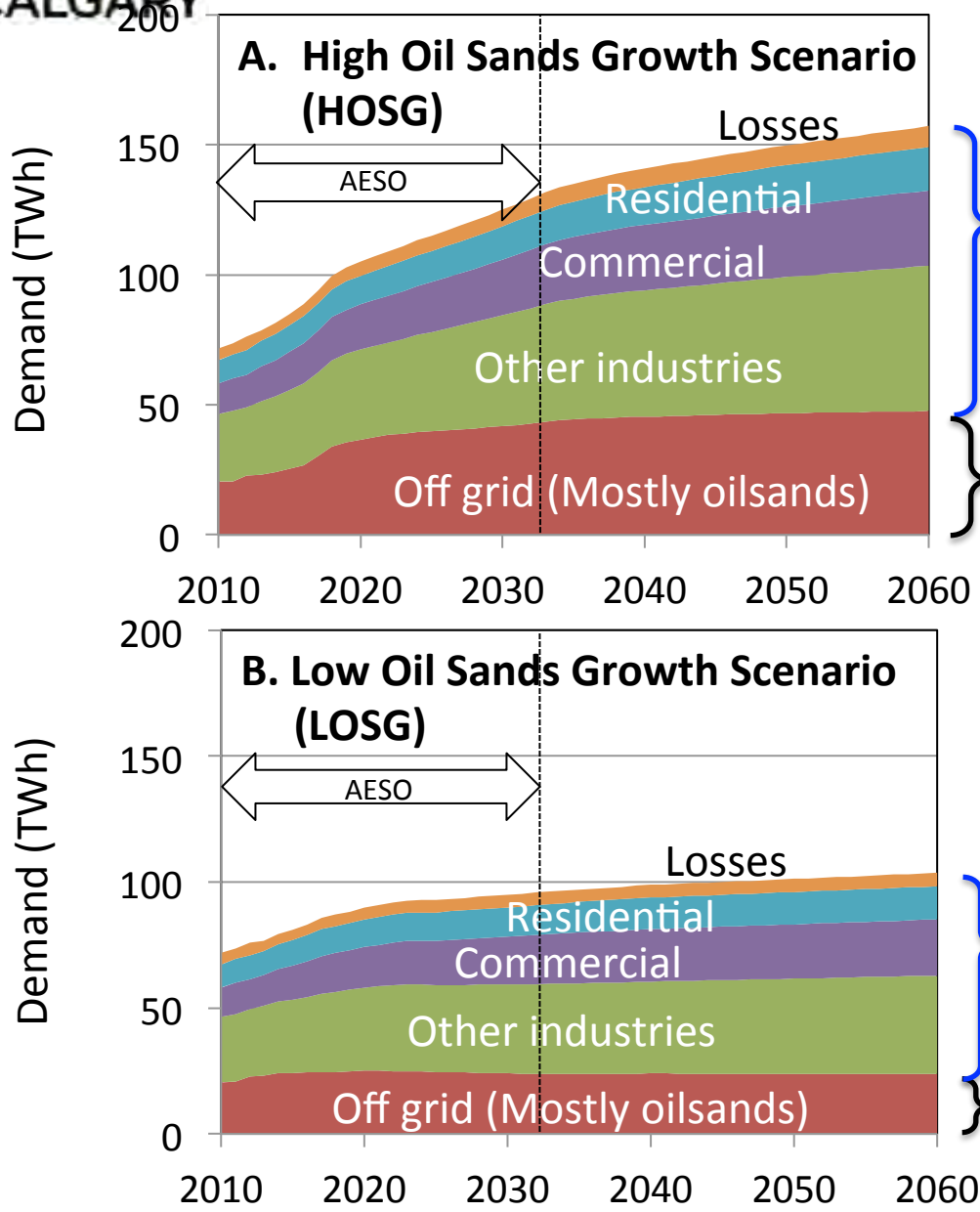
Two Examples of Scenario Analyses

1. **Transforming the AB Electrical Grid (2011-2060)**

2. **Energy Efficiency and Sustainability Scenarios (2010-2050)**

AB's Electricity Demand Future -

Raied Hasan, Anis Haque & David Layzell



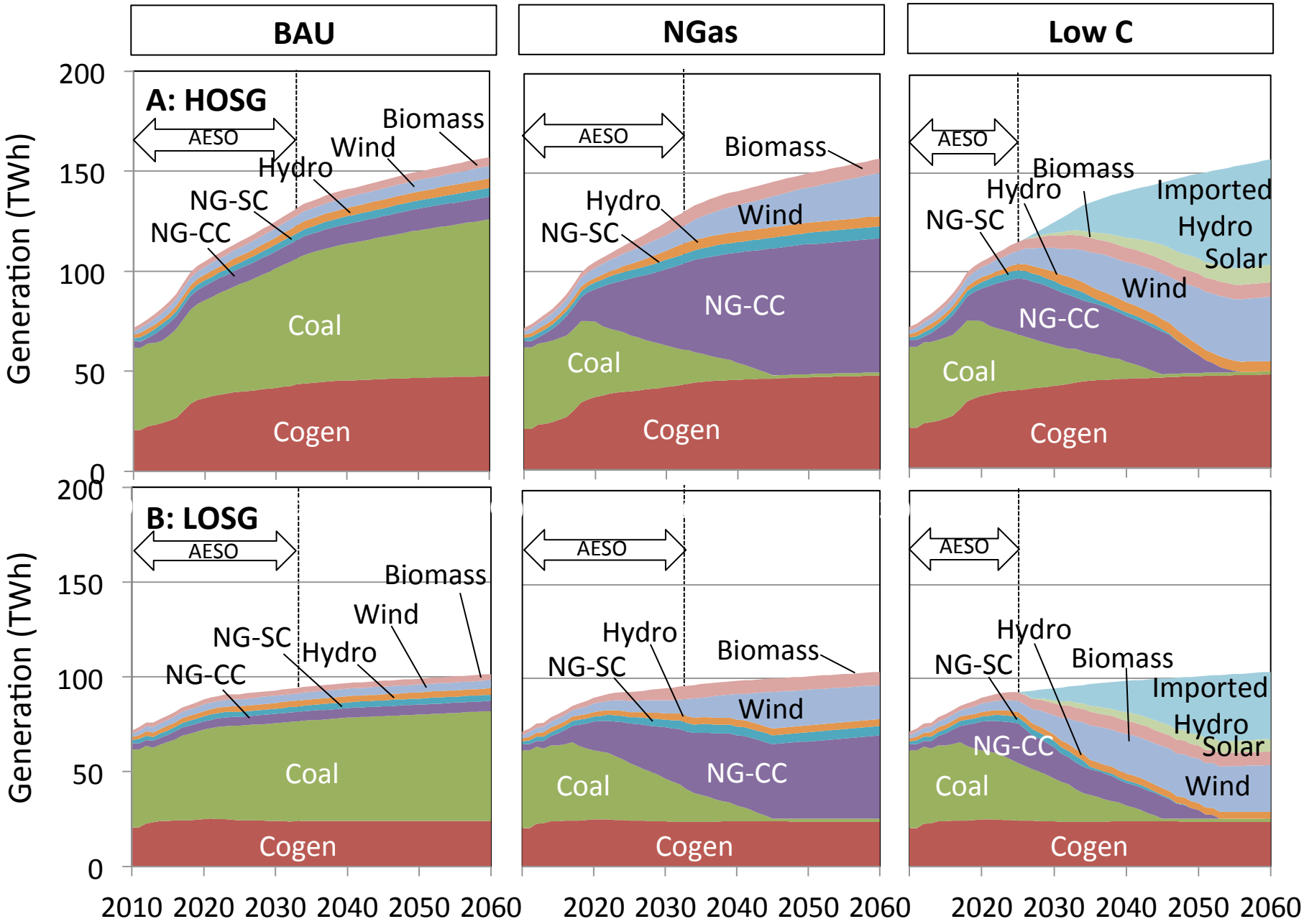
Modeled 3 Supply Scenarios for Grid Demand:

1. BAU (Coal dominated)
2. NGas (NG dominated)
3. Low C (renewables dominated)

Oil Sands power demand assumed to be met by NG-Cogen

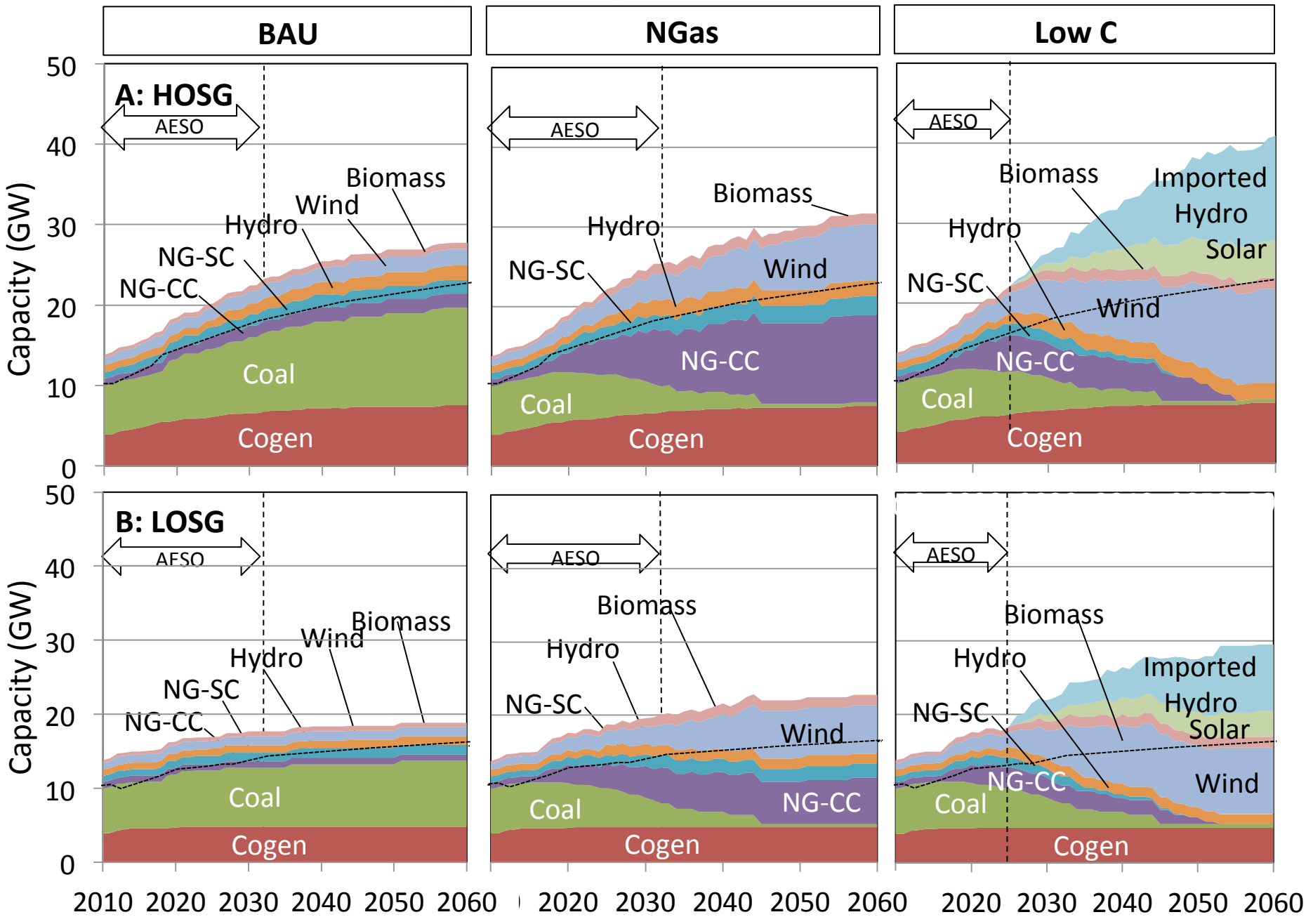
AESO = AB Electricity System Operator

Generation Scenarios

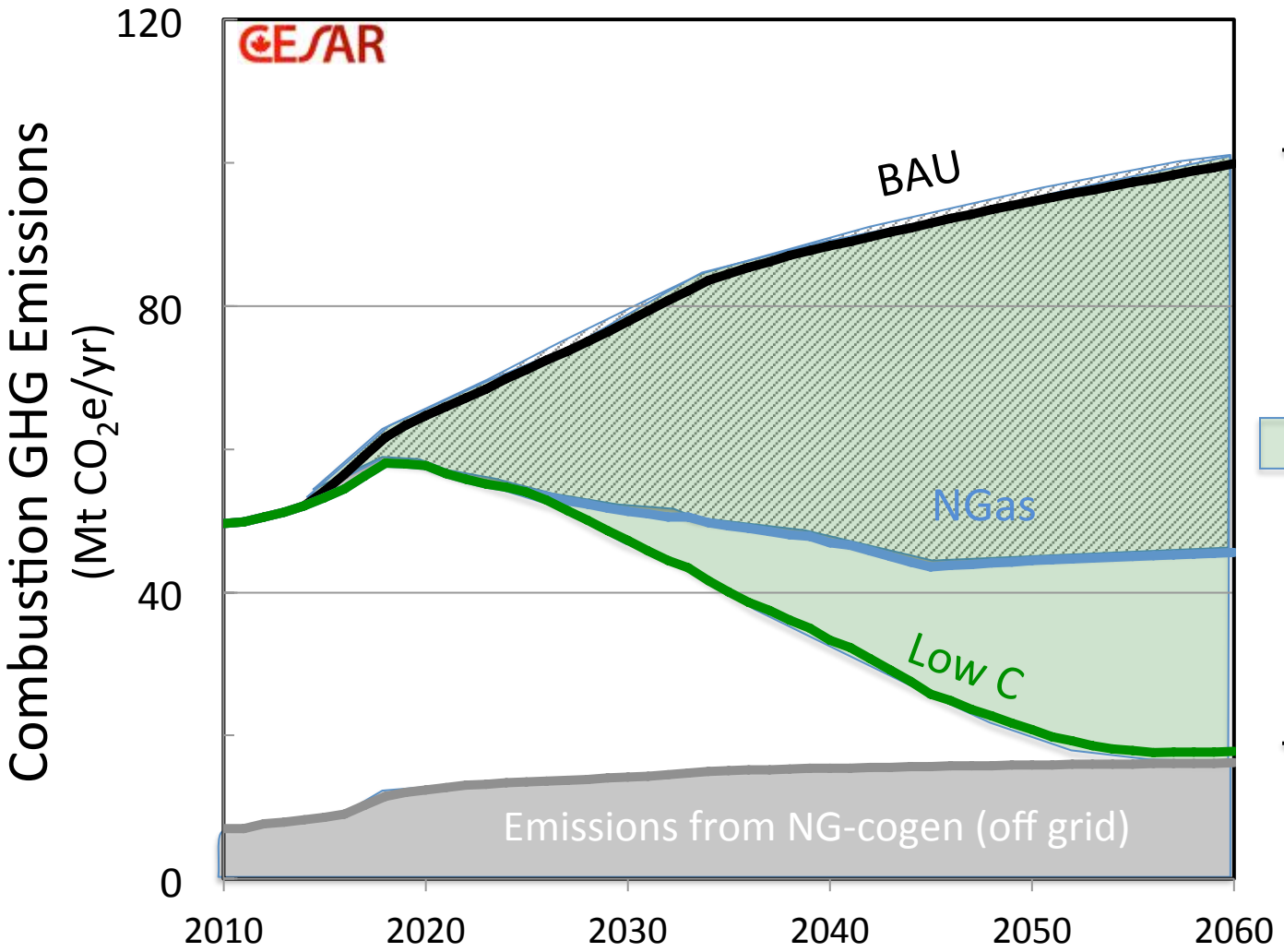


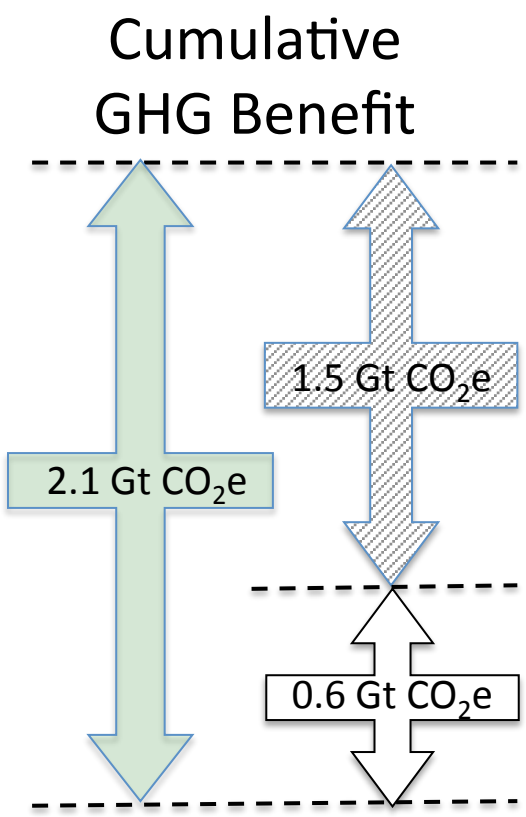
Location: HOSG_Model_140611\Figure 3)

Capacity Scenarios



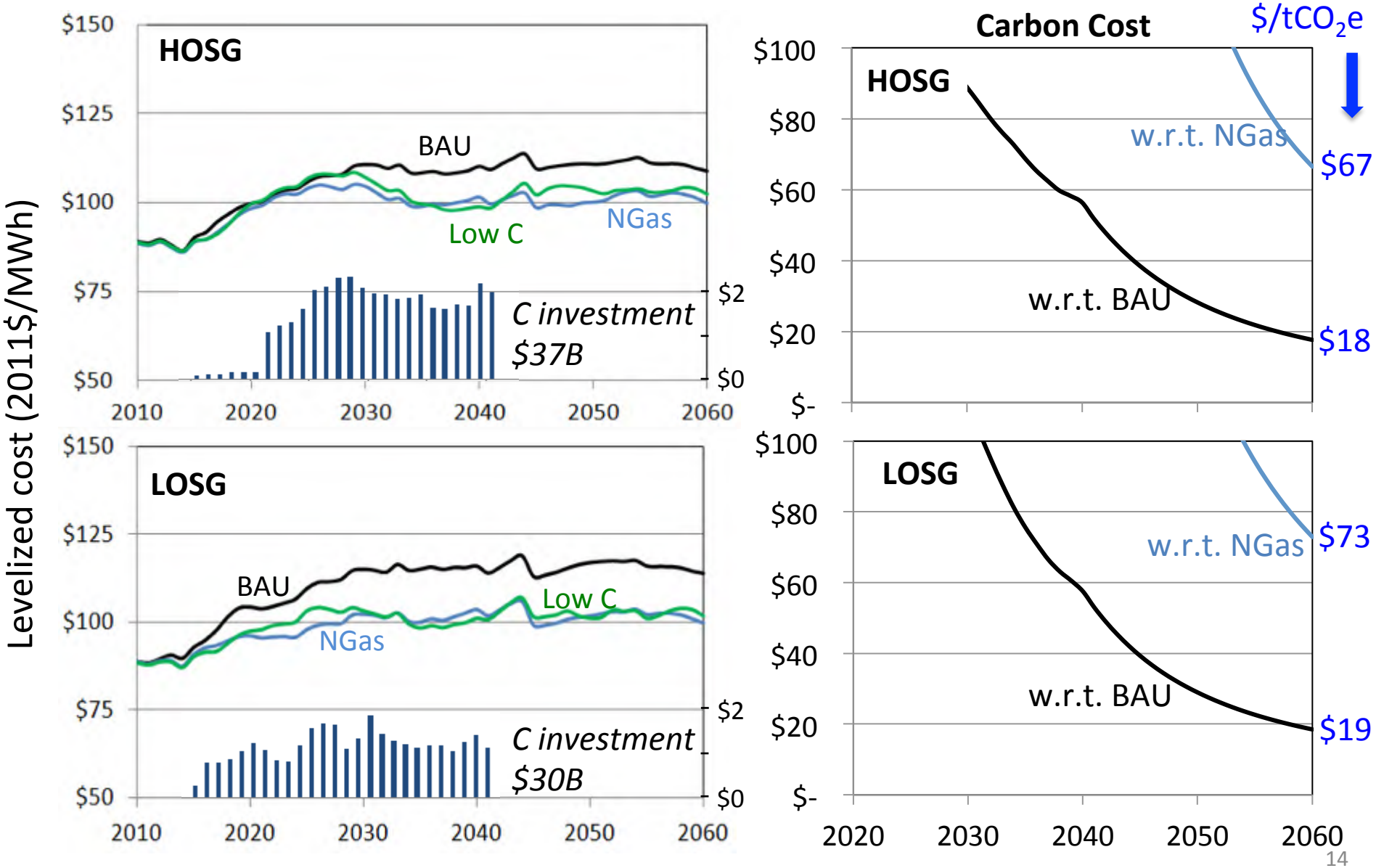
GHGs from Power Generation in Alberta (HOSG)





Cost?

Levelized Cost of Electricity (LCOE)
- with C investment -



AB Energy Efficiency Scenarios

(J Rowe, M Hoffman & D Layzell)

	Nature of efficiency (levers)	Example of change
1. RESIDENTIAL	1.1a Envelope Efficiency – new homes	- new building standard
	b Envelope efficiency – existing homes	- retrofit required with change in ownership
	1.2 Heating equipment efficiency	- increased furnace efficiency
	1.3 Lighting efficiency	- movement to LED
	1.4 Appliance & Electronics Efficiency	- energy star + regs on phantom power use
	1.5 Water heating efficiency	- energy star + low water use machines
	1.6 Building Size	- cap average dwelling size
	1.7 Dwelling type	- more multi-unit, less single family
	1.8 Occupant behaviour	- real time feedback on energy use
2. COMM'L/ INSTIT'L	2.1a Heating/cooling effic. – New bldgs	- new building standard
	b Heating/cooling effic. – Exist. Bldgs	- higher standards on upgrades
	2.2 Auxillary motors	- high efficiency pumps and motors
	2.3 Lighting efficiency	- movement to LED, indoor and outdoor
	2.4 Water heating efficiency	- High efficiency + lower water use
	2.5 Auxillary Equipment (Plug load)	- enhig effic. + regs on phantom power use

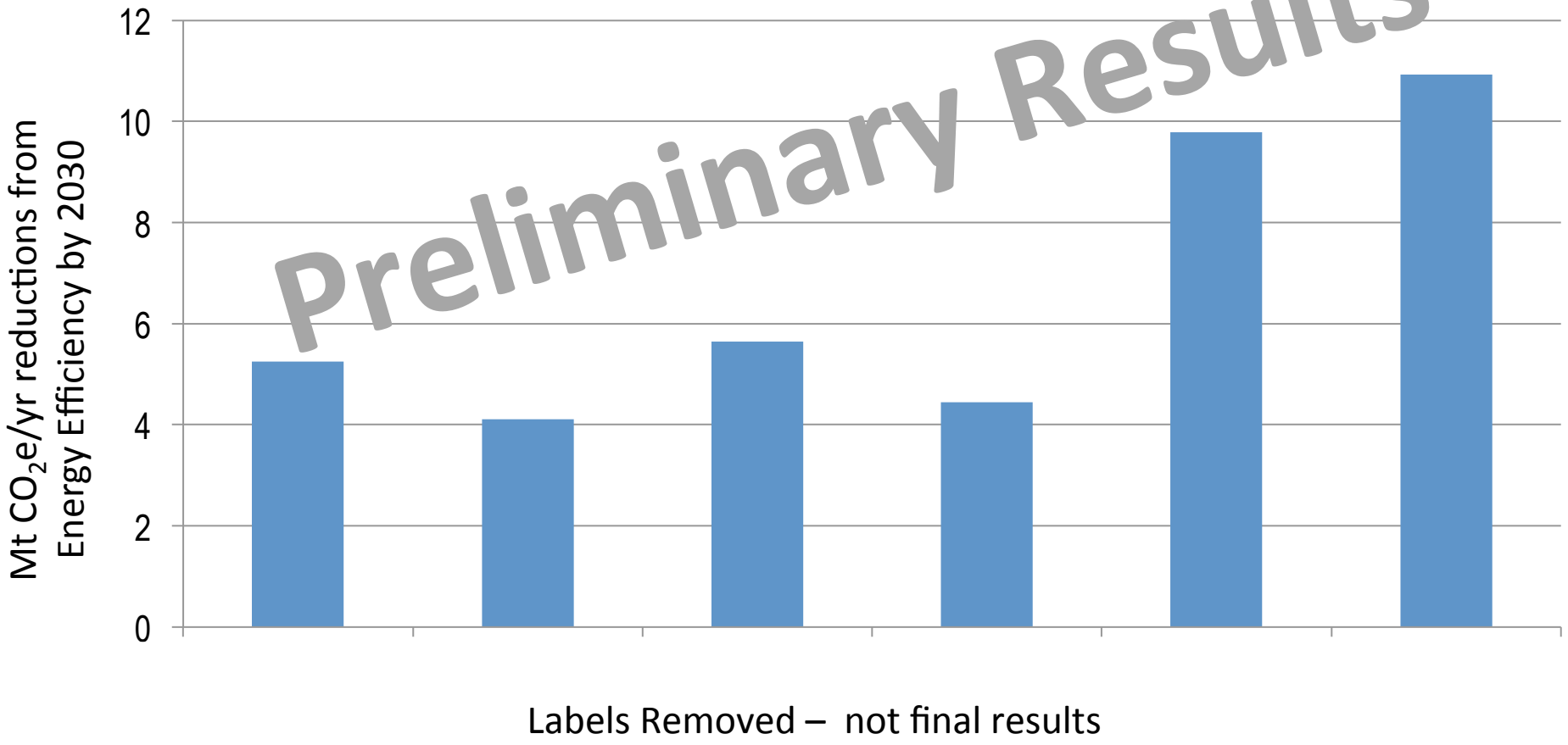
AB Energy Efficiency Scenarios

(J Rowe, M Hoffman & D Layzell)

	Nature of efficiency (levers)	Example of change
3. PERSONAL TRANSPORT	3.1 Person Vehicle km Traveled	- city densification, public transit
	3.2 Vehicle Fuel Efficiency	- smaller engines, hybrids, etc
4. FREIGHT TRANSPORT	4.1 Tonne-km Transported by mode	- truck to rail/ship; move to 1990 modal shift
	4.2 Energy Efficiency	- improved vehicle efficiencies
5. INDUSTRIAL	5.1 Petroleum, Coal & Chemical mfg	- more efficient equip + heat recovery
	5.2 Pulp and Paper	- more efficient equip + heat recovery
	5.3 Non-metallic minerals	- more efficient equip + heat recovery
	5.4 Primary & Fabricated metal mfg	- more efficient equip + heat recovery
	5.5 Food, Beverage & Tobacco mfg	- more efficient equip + heat recovery
	5.6 Transport equip / machinery mfg	- more efficient equip + heat recovery
	5.7 Plastic, rubber & other mfg	- more efficient equip + heat recovery
	5.8 Agriculture	- more efficient equip + heat recovery

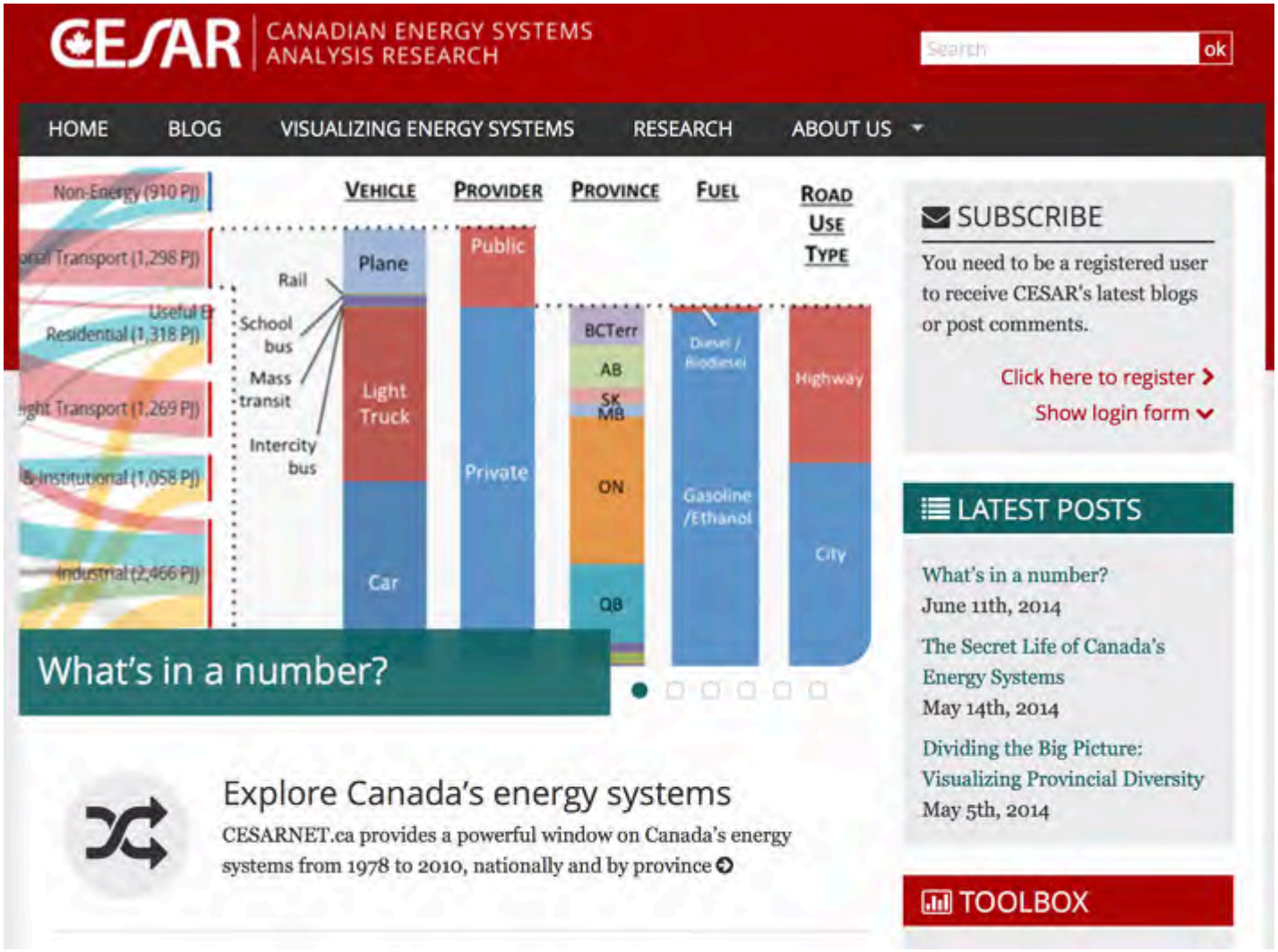
AB Energy Efficiency Scenarios

(J Rowe, M Hoffman & D Layzell)



CESARnet.ca

…to encourage & communicate research and critical analysis around the transformation of Canada's energy systems.



- ✓ Interactive access to historical data on Canada's energy systems by province & sector;
- ✓ Powerful visualizations;
- ✓ A blog for 'Nerds' of energy systems analysis and systems change;
- ✓ A portal to latest research results;
- ✓ Access to talented researchers, analysts & modelers.

A short tour of

http://www.CESARnet.ca

How to get involved?

- Use cesarnet.ca visualizations in your lectures / notes;
- Identify cesarnet.ca as student resource material;
- Register with cesarnet.ca and participate in discussions;
- Send me ideas for scenario analysis around which you would like to author a blog;
- Help CESAR fund technical assistance (esp. for CanESS) and use that to launch your own energy system analysis project;
- Help CESAR attract broad-based support, so it can incorporate and help create research community and support research / teaching projects ;
- ???

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