



Rethinking the Canadian Energy System

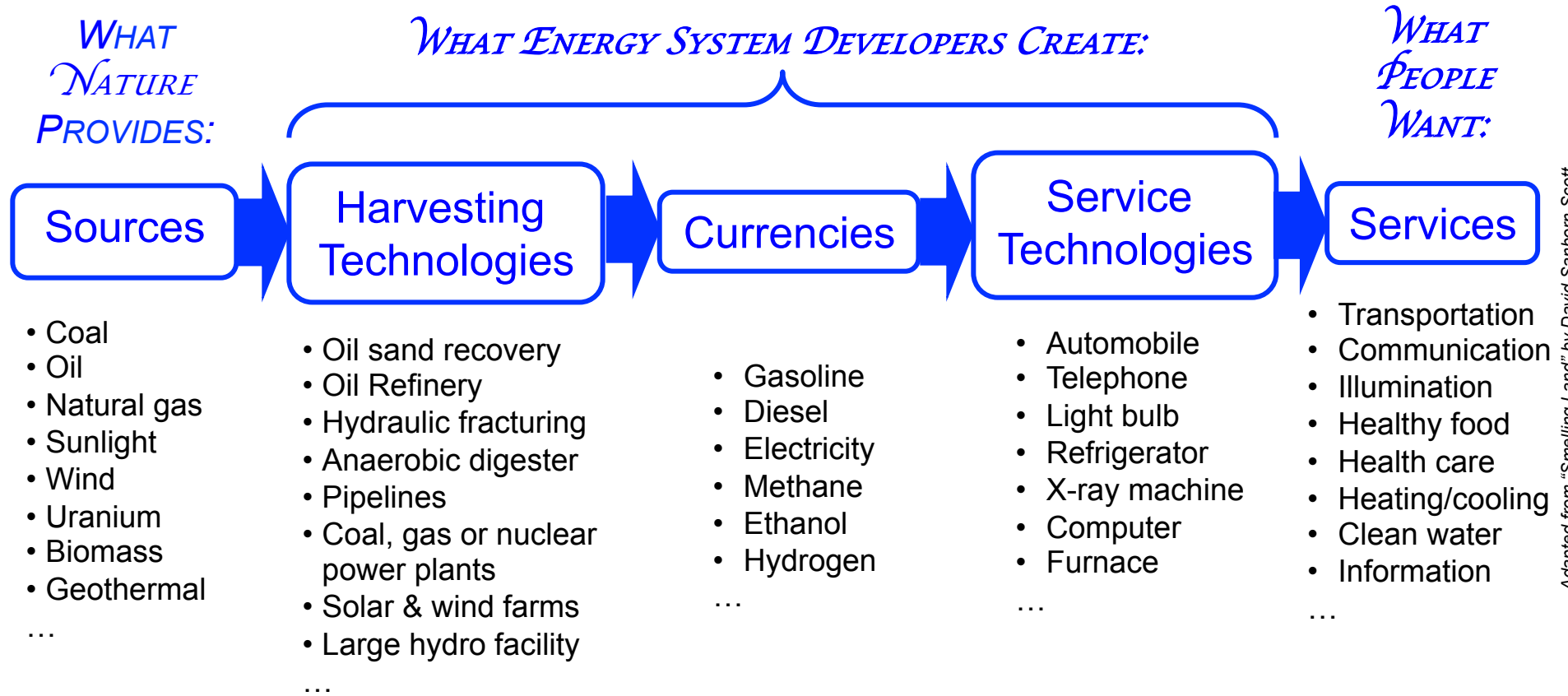
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Canadian Nuclear Association 2014, Fall Energy Seminar.
Ontario's Clean Electricity Future - Oct 7 & 8, 2014

What is an Energy System?



Adapted from "Smelling Land" by David Sanborn Scott

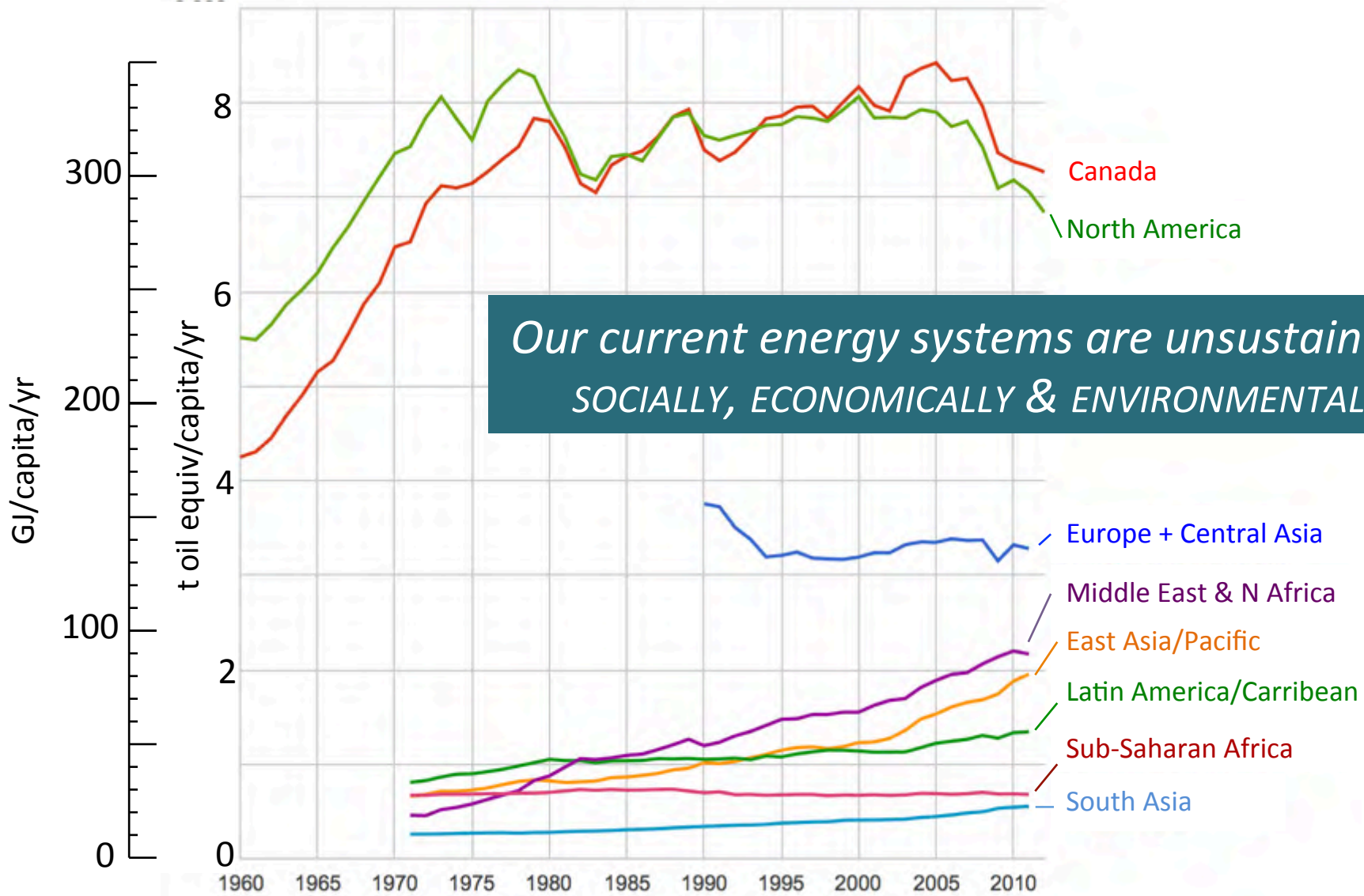
What's Good?

- ✓ High quality of life for most Canadians

What's not so Good?

- ✓ Unintended Environmental Impacts:
 - Climate change
 - Biodiversity loss
 - Air pollution
 - Water contamination
- ✓ Economic costs / energy security concerns
- ✓ 2 Billion Un-served; another 4B want more

Per Capita Energy Use



How can we
transform our energy systems
to maintain (& share) the benefits
but avoid
the unintended consequences?

CEESAR

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:

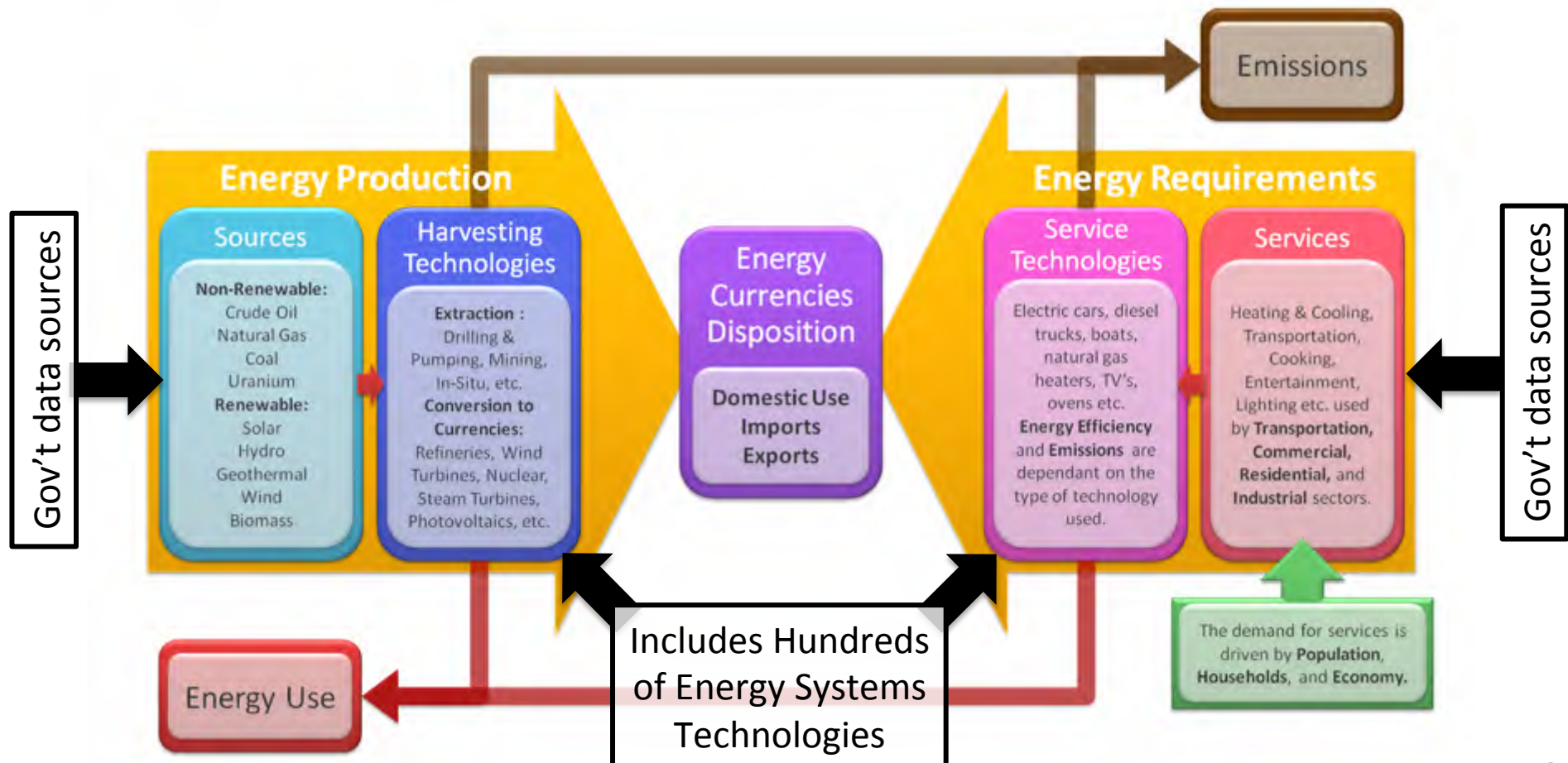
- Technology & data-rich, quantitative models;
- Enhanced visualizations tools in web interface;
- Critical, balanced research



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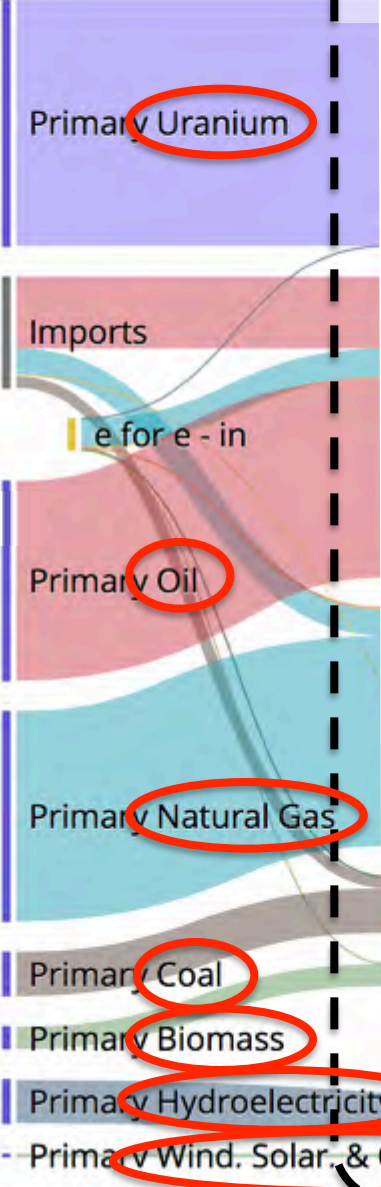
Develop the data resources, analytical tools & research community to inform policy & investment decisions on transforming Canada's energy systems to sustainability.

- ❑ 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 students and researchers;
- ❑ In partnership with whatIf?, the model can be used for contractual work.



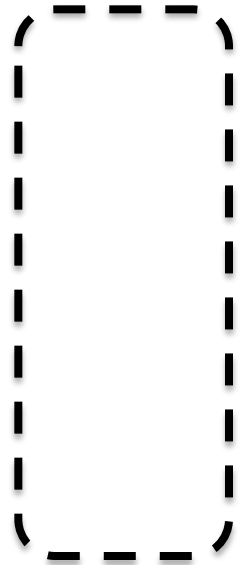
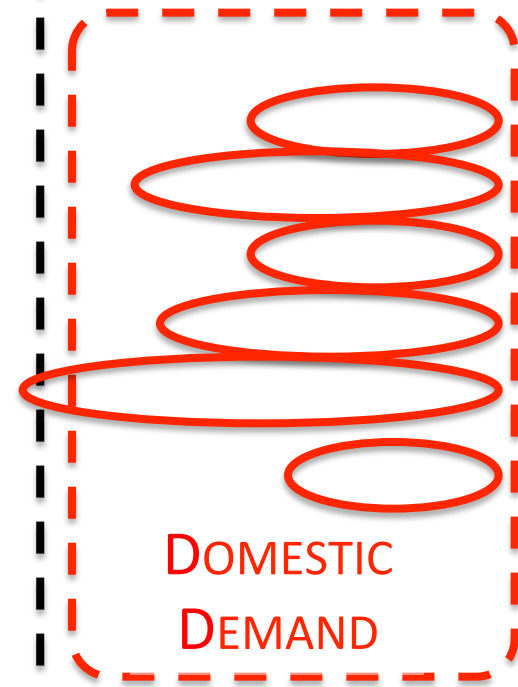
ENERGY SOURCES

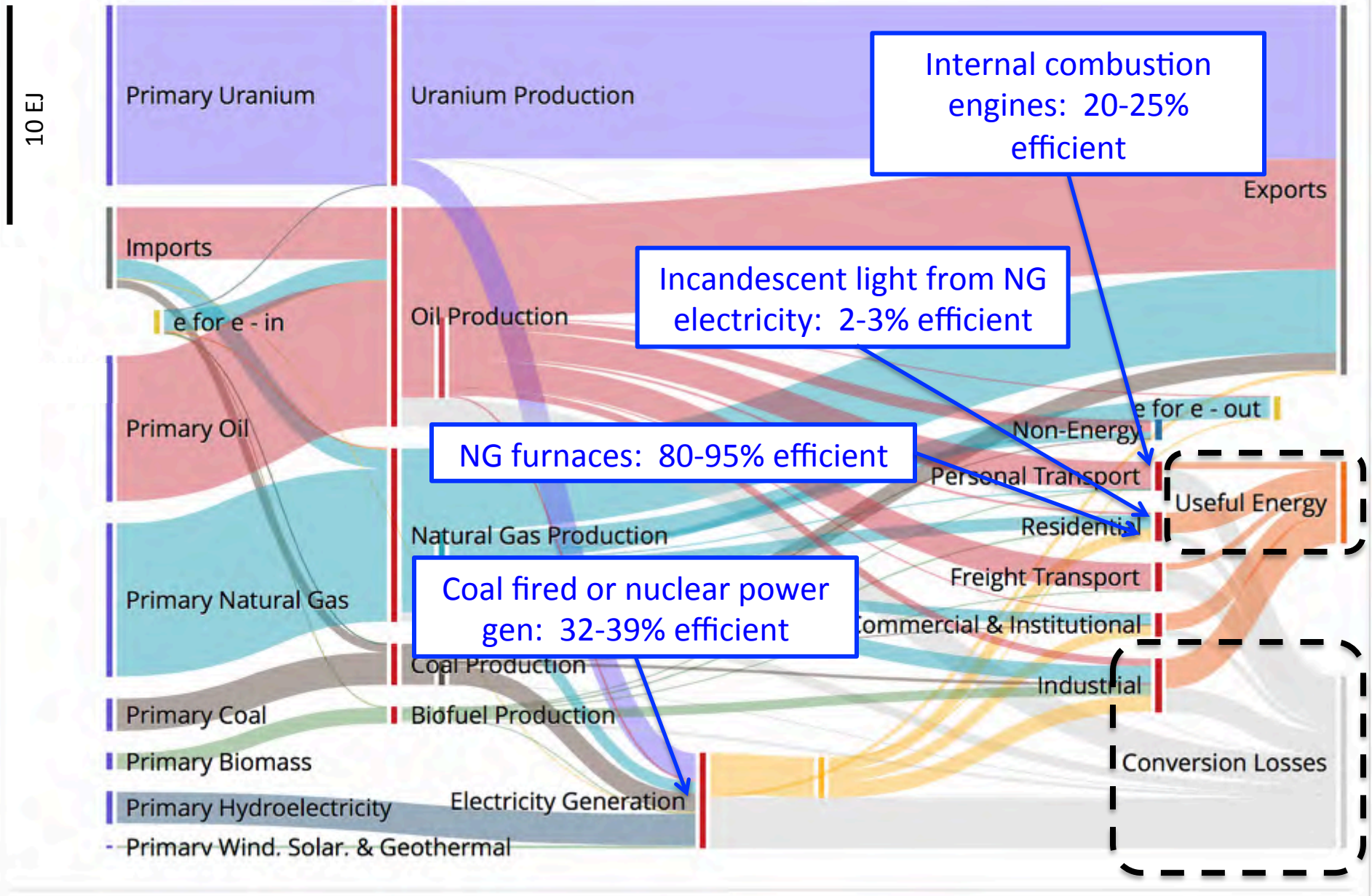
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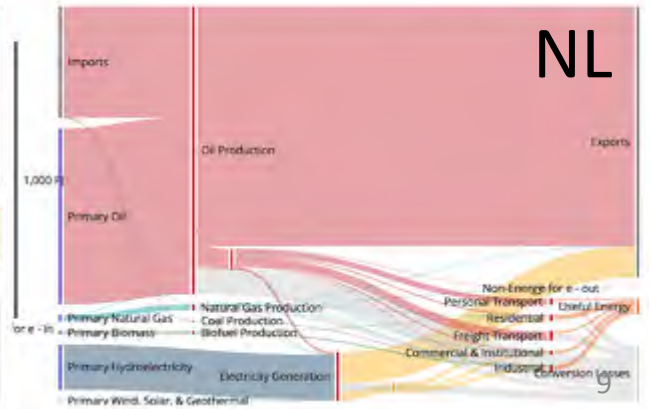
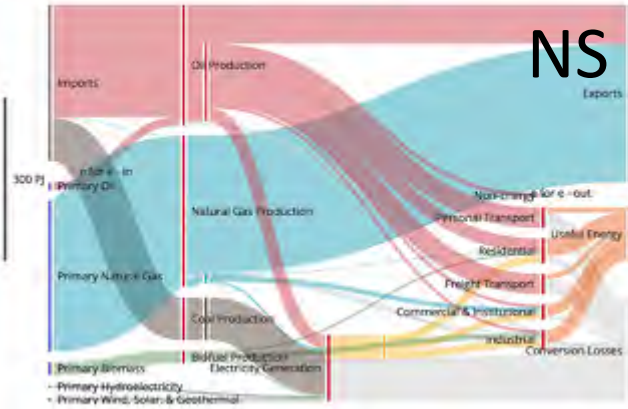
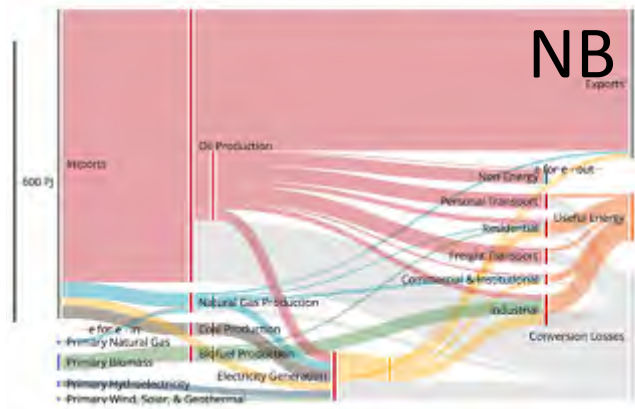
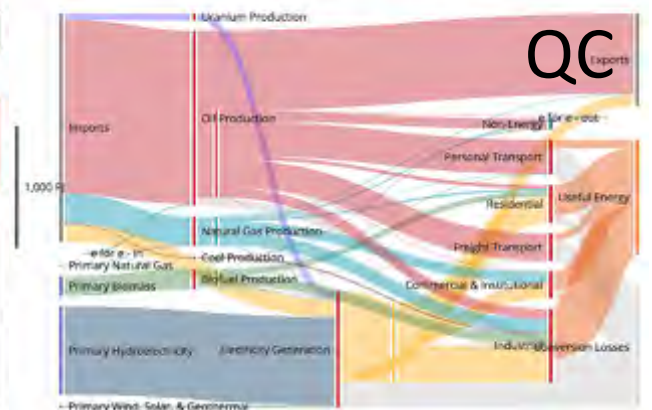
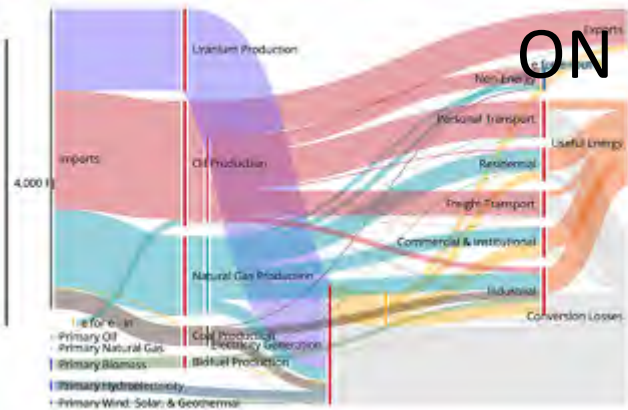
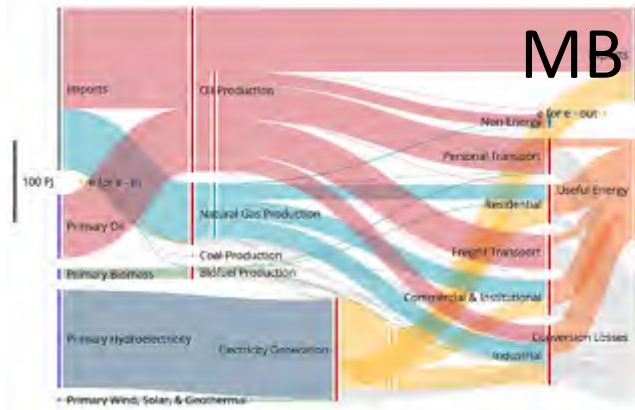
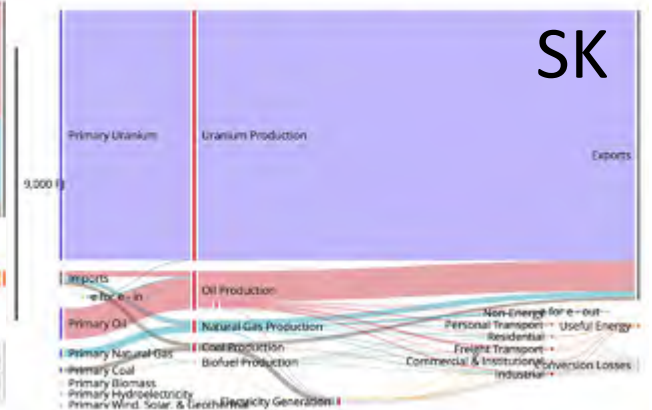
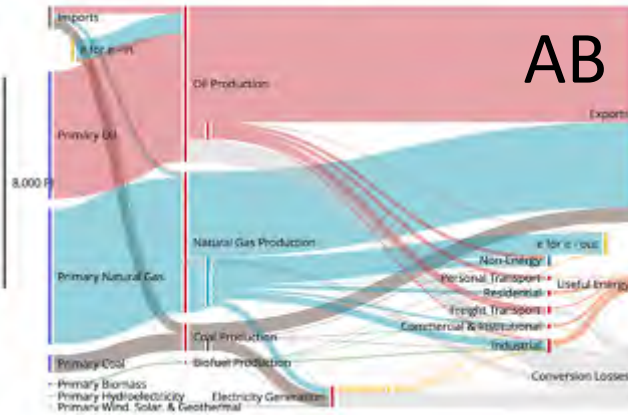
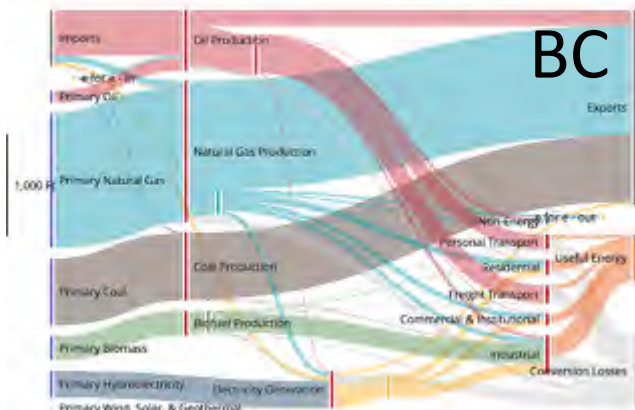
THE ENERGY INDUSTRIES

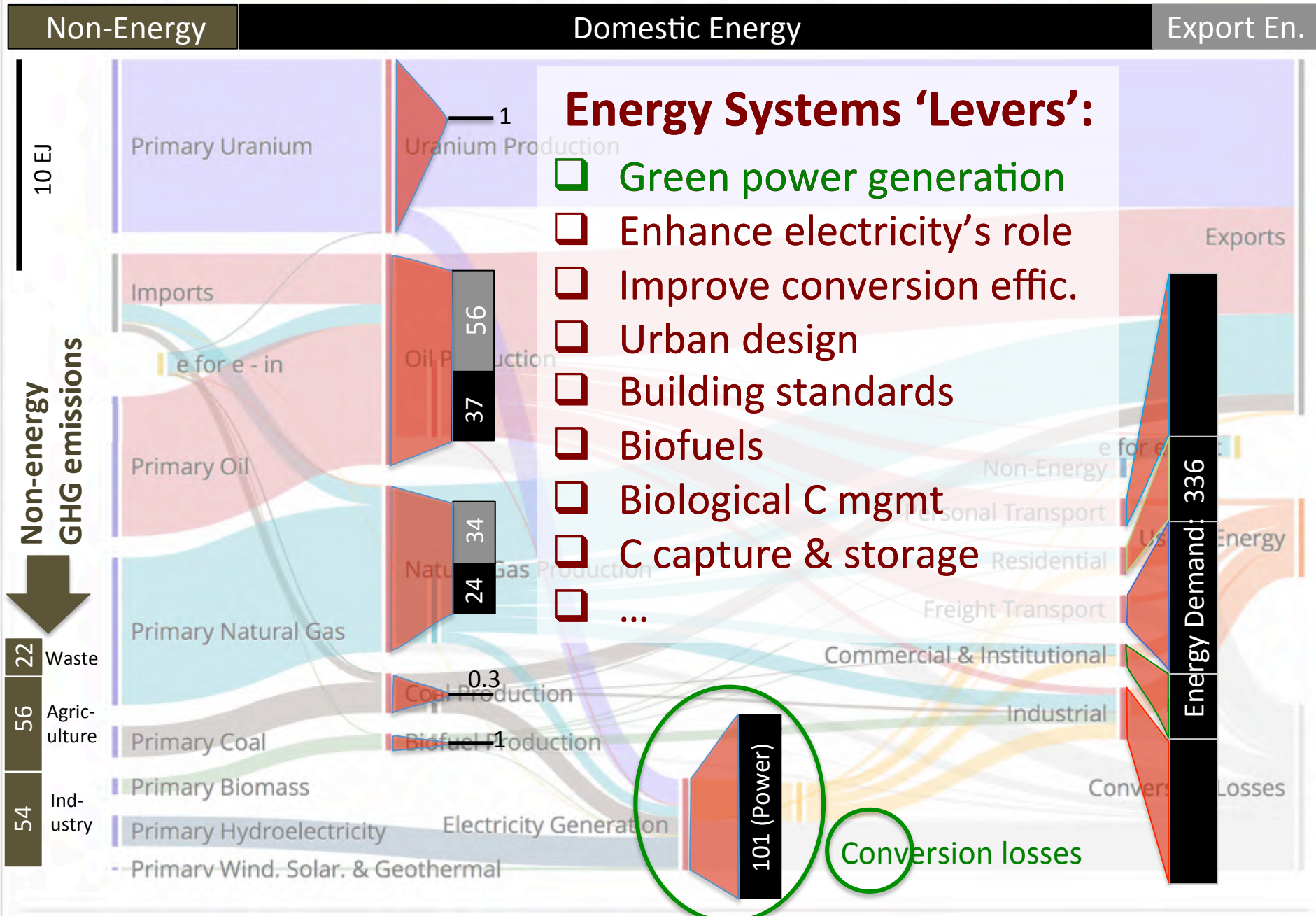
SANKEY DIAGRAM:
Width of lines
 \propto
Energy flow



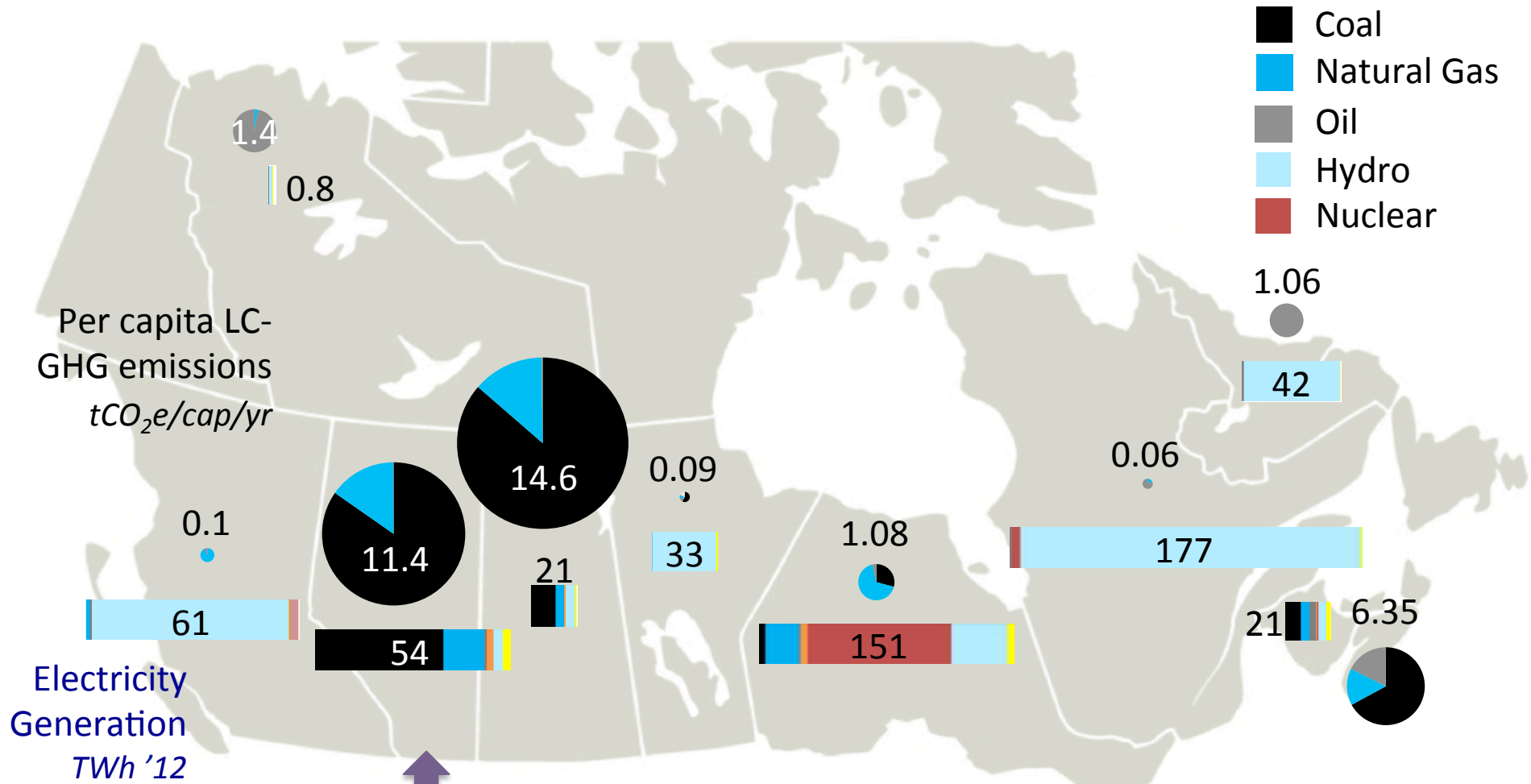


Provincial Energy Systems (2010)



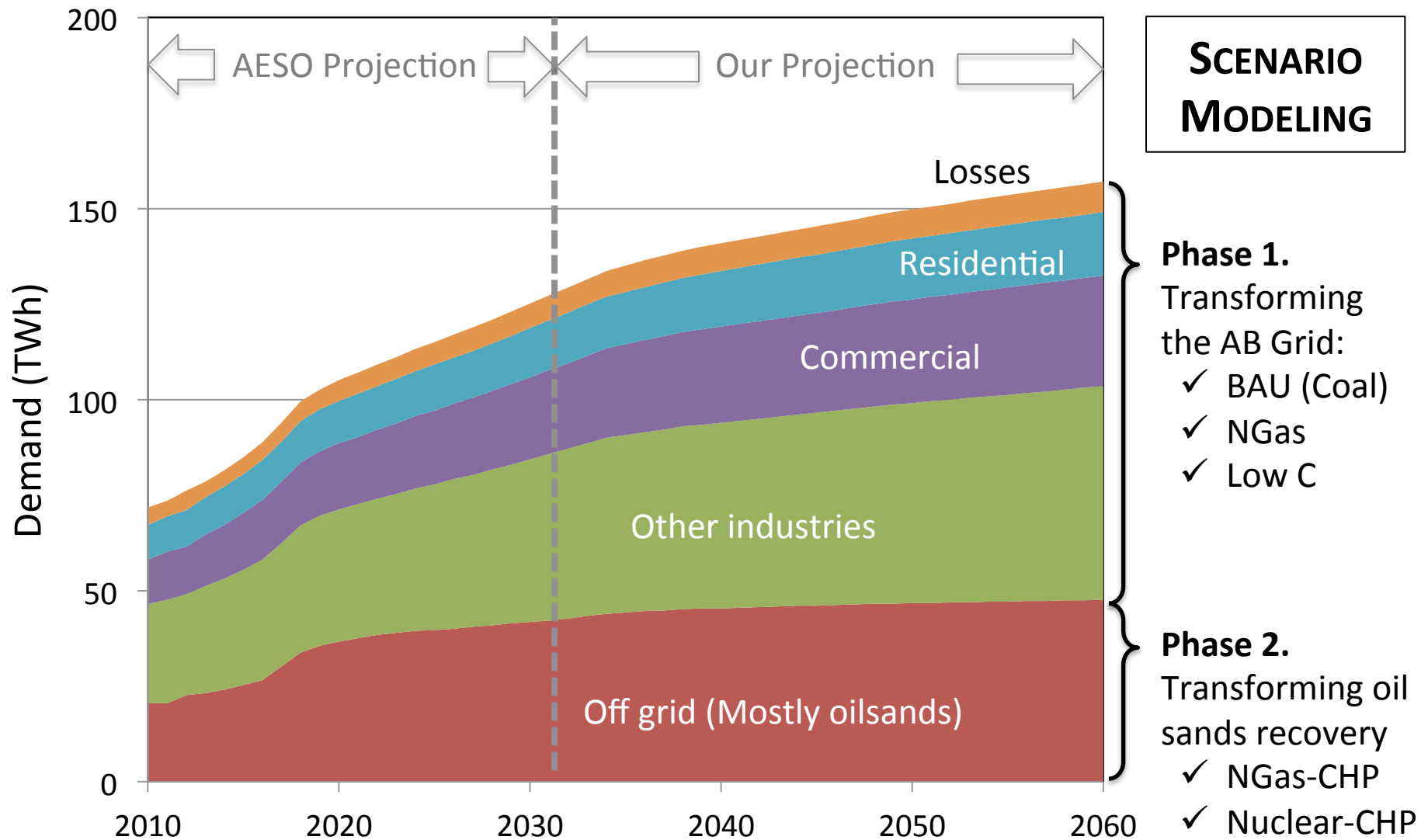


Cdn Electricity Generation (TWh) & GHG Emissions (tCO₂e/cap/yr)



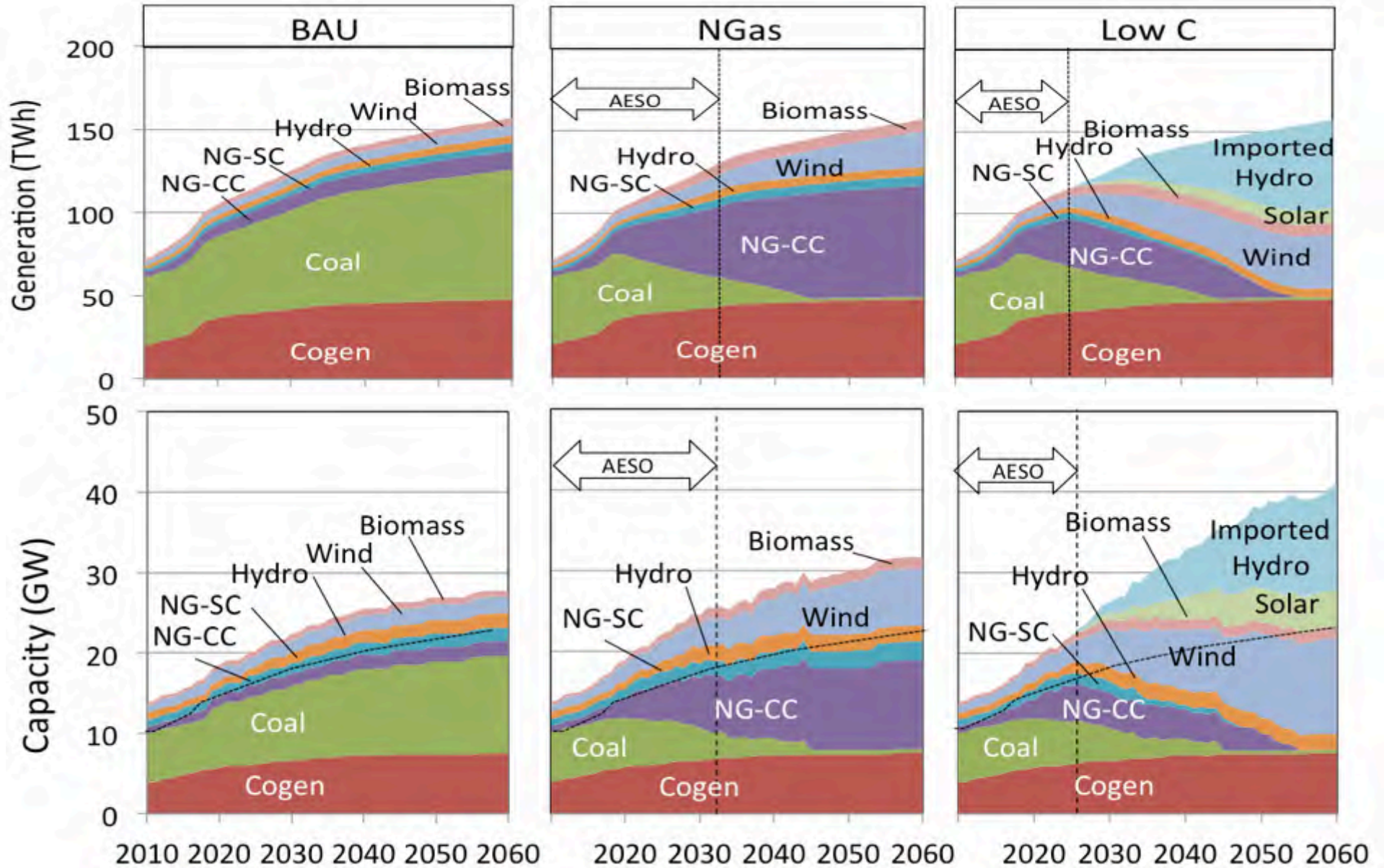
Modeling scenarios to 'green' AB power gen.

Projected AB Power Demand (Assumes High Oil Sands Growth)





Supply Scenarios

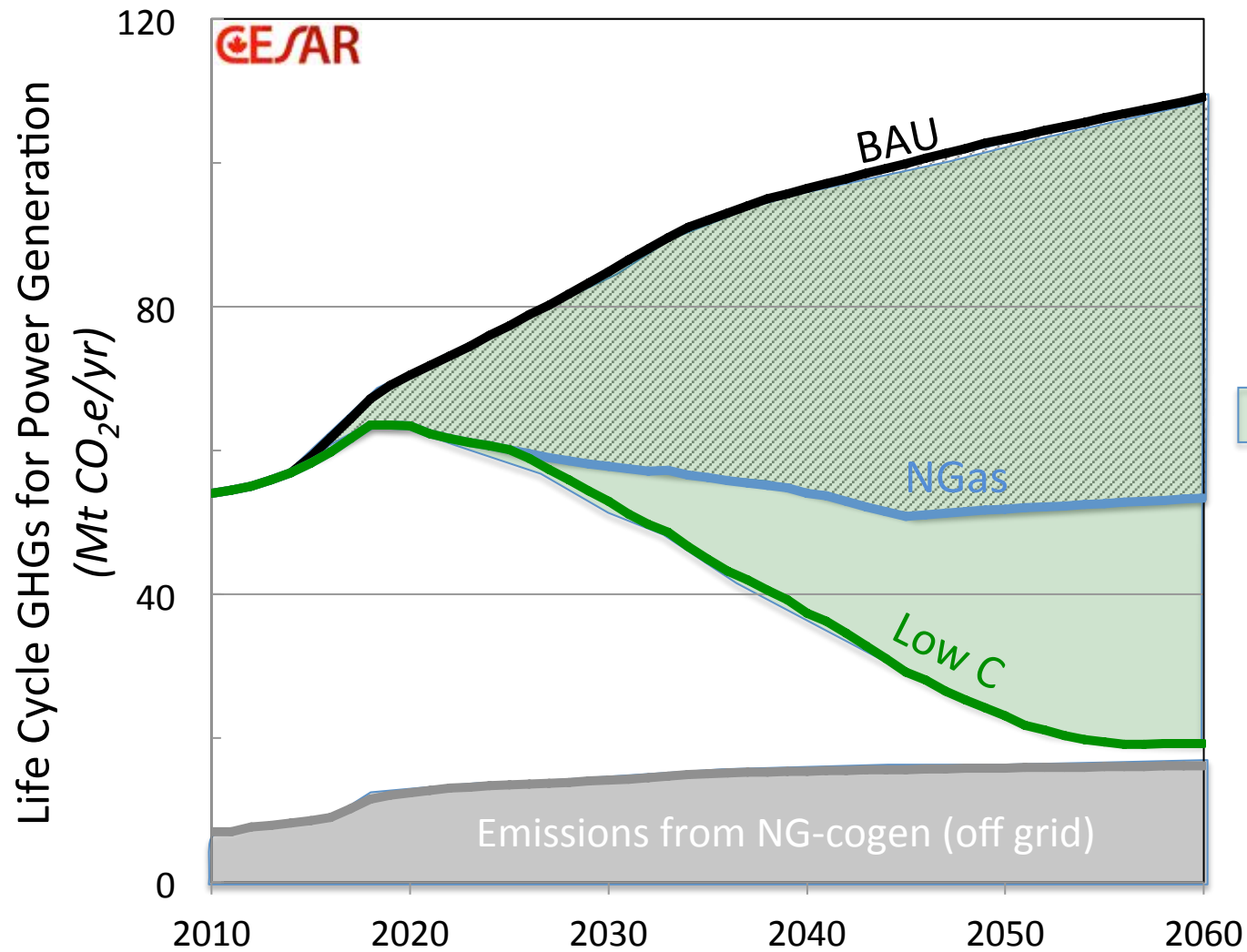


Why Imported Hydro?

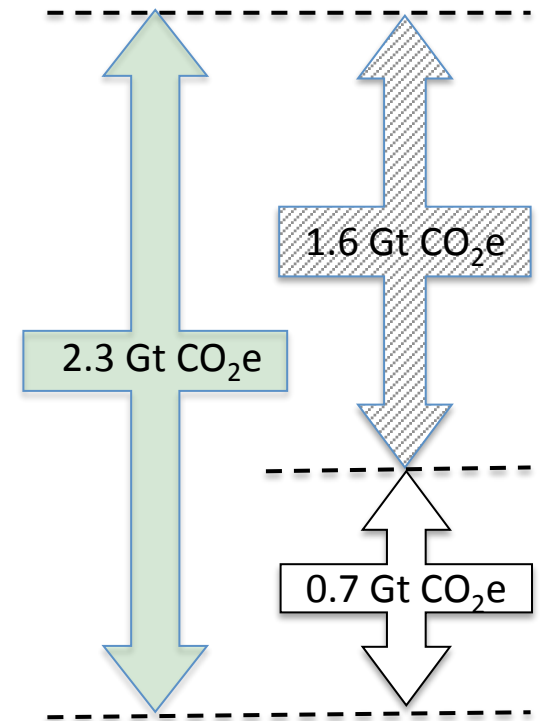
(~55 TWh by 2060)

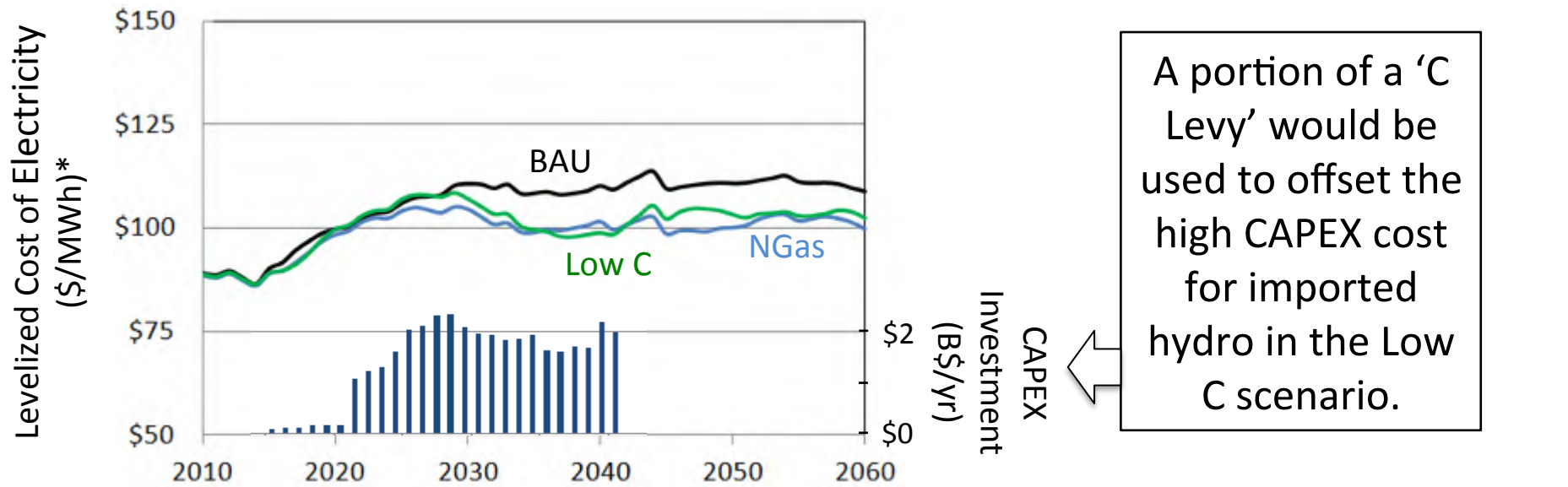
- ❑ Reliable supply with low C footprint
- ❑ Untapped potential in adjacent jurisdictions
 - BC (116 TWh); NT (102 TWh); MB (31 TWh);
- ❑ Energy storage potential (for AB wind & solar);
- ❑ Cost effective with long term investment
 - High CAPEX, but Low OPEX
- ❑ Encourages inter-prov. energy cooperation
 - Possible energy corridors (power in, oil & gas out)

The GHG Footprint



Cumulative
GHG Benefit

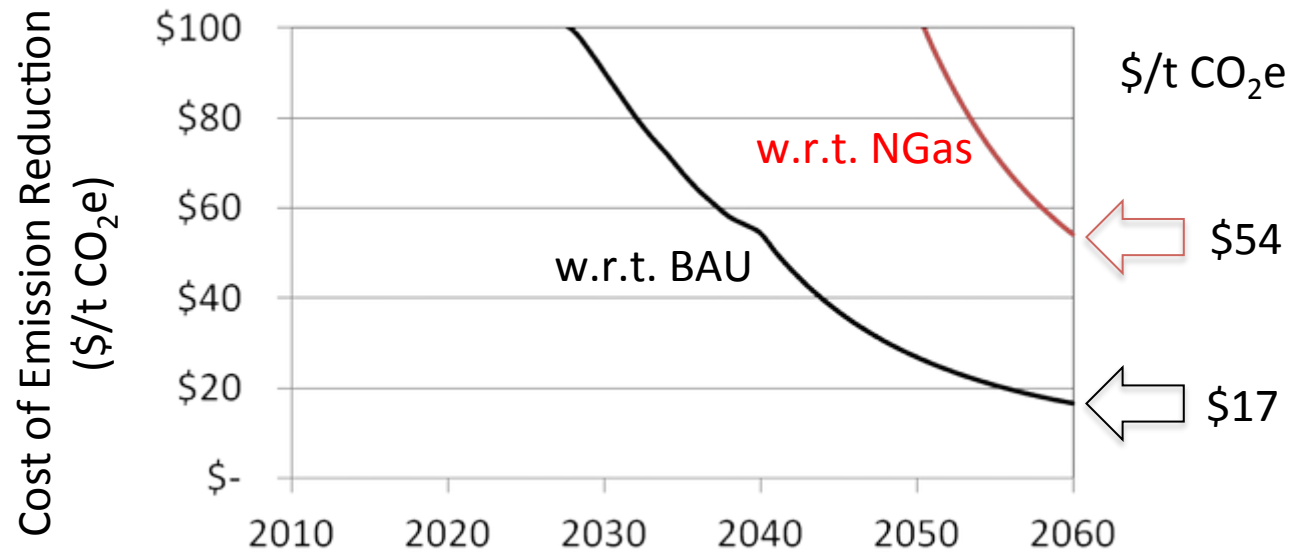




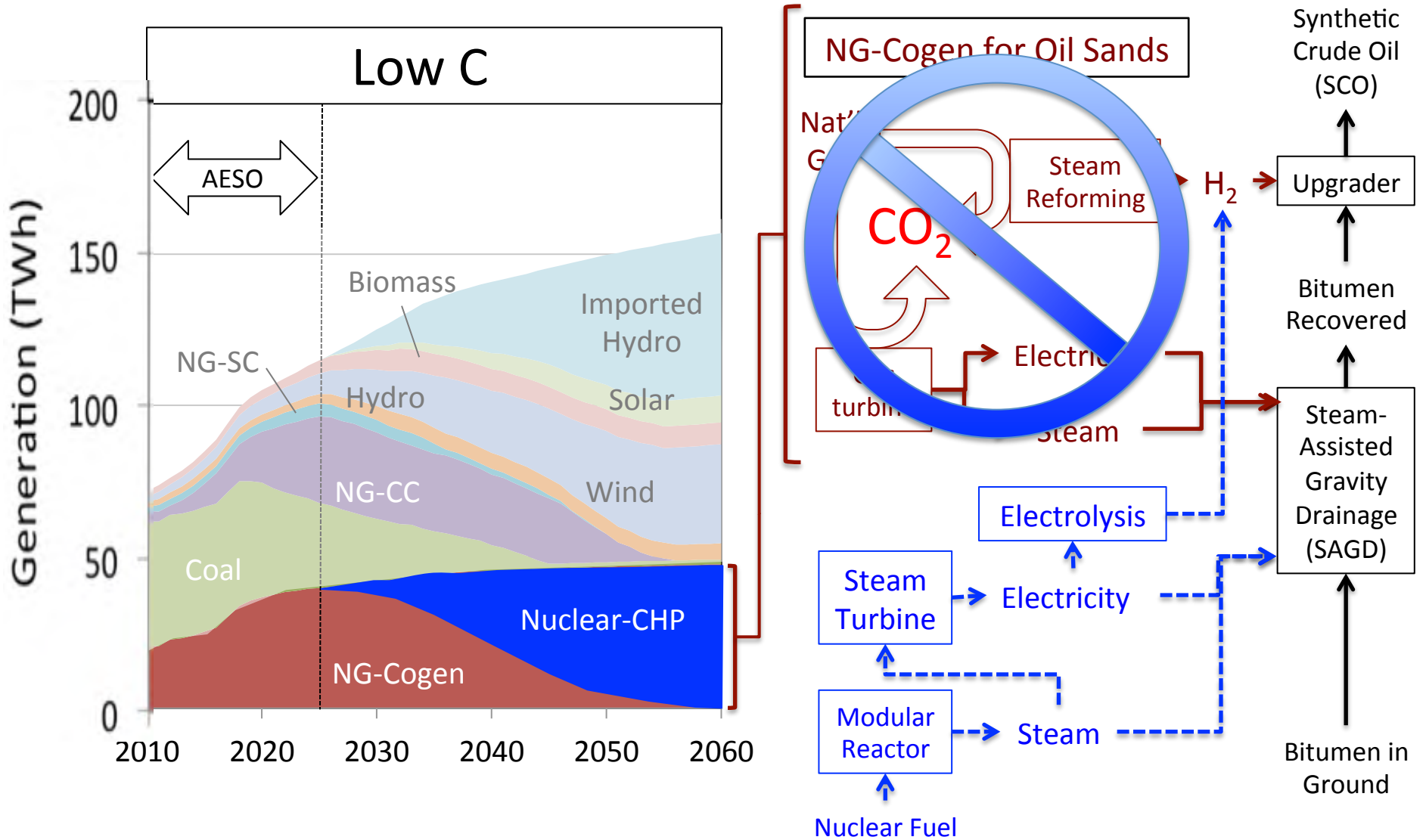
A portion of a 'C Levy' would be used to offset the high CAPEX cost for imported hydro in the Low C scenario.

*Assumes:

- C levy rising from \$5/t CO₂e in 2015 to \$28/t CO₂e in 2060
- NGas price \$3.25/GJ to \$8/GJ in 2060



Greening the Oil Sands



Closing Comments

1. Movement to sustainability requires an **ENERGY SYSTEMS** approach (*supply → demand; all sectors, jurisdictions, etc.*)
2. Modeling & visualizing past, present and possible future energy systems scenarios are valuable in:
 - ✓ *Identifying challenges and opportunities*
 - ✓ *Elevating understanding among public & decision makers*
 - ✓ *Informing policy and investment decisions*
3. *Electricity is key: C free + increased role in energy system;*
4. *There is an important, unfilled niche for **distributed, C-free combined heat and power (CHP)**. Is this an opportunity for new nuclear?*
 - ✓ *Modular, safe, mass produced reactors*