Shortcomings and Gaps With Energy Systems Models and their Use in Canada

David B. Layzell, PhD, FRSC.
Professor and Director,
Canadian Energy Systems Analysis Research (CESAR) Initiative,
Univ. of Calgary. Web: www.cesarnet.ca Email: dlayzell@ucalgary.ca

With input from CESAR Senior Associates:
Robert Hoffman, President, whatIf? Technologies
Ralph Torrie, President, Torrie-Smith Associates

GENERATION ENERGY
Moving Canada Forward

WORKSHOP ON PATHWAYS, FORECASTING AND ENERGY DATA
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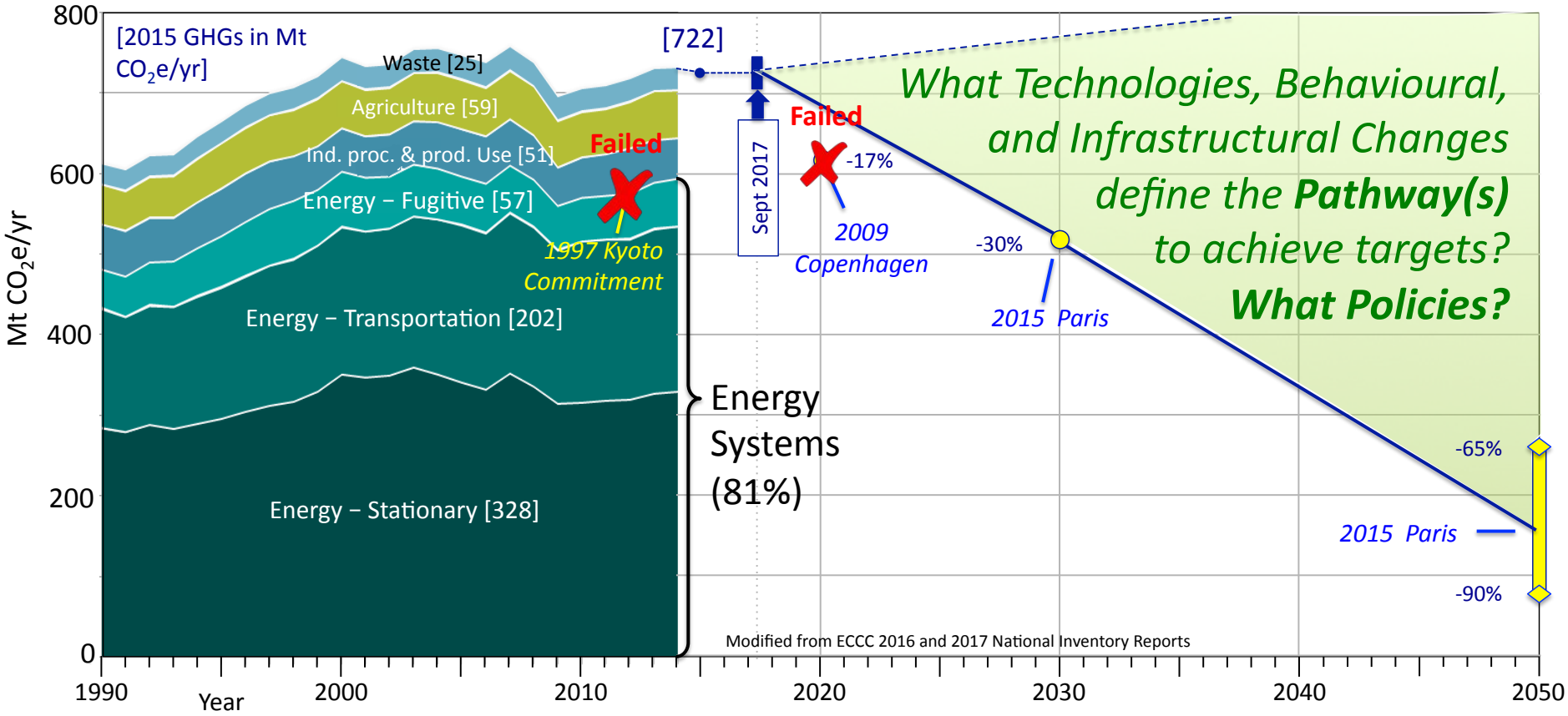
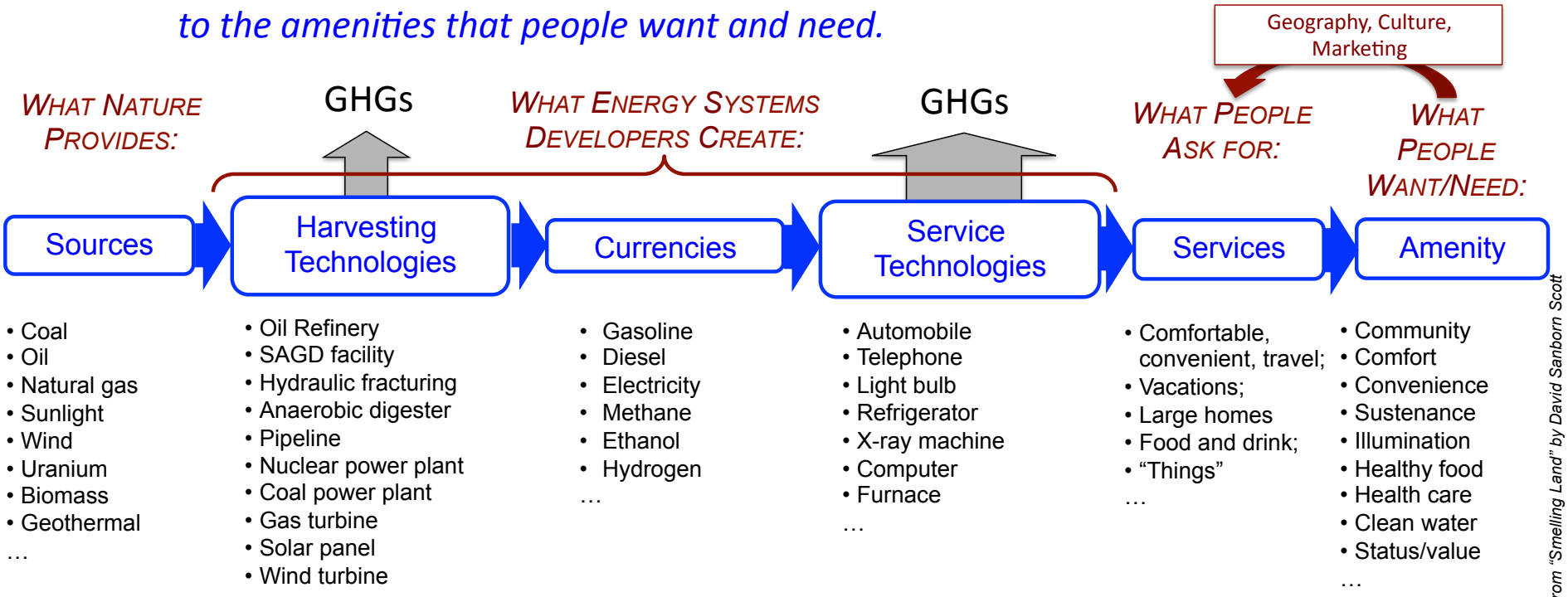
Canada's Greenhouse Gas (GHG) Emissions & Targets



What are 'Energy Systems'?

…the technologies, infrastructure and behaviours that connect the fuels and electricity (i.e. "energy") provided by nature to the amenities that people want and need.



To change, we must understand. To understand, we must Model.

Adapted from "Smelling Land" by David Sanborn Scott

Canadian Energy Systems Models

		Canadian Government			Consulting Companies / Universities				
	Type	NEB	ECCC	NRCan	Navius/SFU	EnviroEcon	ESMIA/UM	WhatIf?	SEI/UA
Top Down (defined in Macro-economic Space)	Macro-econometric	----- TIM% -----							
	Computable Gen. Equil.		EC-pro		---- GEEM ----				
Bottom Up (defined in bio-physical Space)	Optimization						NATEM		
	Consumer Choice	--------- Energy 2020* ----------							
	Exploratory Simulation							CanESS	LEAP
	Hybrid		E3MC		----- CIMS ------		MERGE		

ABBREVIATIONS: CanESS, Canadian Energy Systems Simulator**; CIMS,** Canadian Integrated Modelling System*;* **ECCC**, Environment and Climate Change Canada; **ESMIA**, Energy Super Modelers and International Analysts; **GEEM**, General Equilibrium Energy Model; **LEAP**, Long Range Energy Alternative Planning System; MERGE, Model for Evaluating the Regional and Global Effects of GHG reduction policies; **NEB**, National Energy Board; **NATEM**, North American Times Energy Model; **NRCan**, Natural Resources Canada; **SEI**, Stockholm Environmental Institute; **SFU**, Simon Fraser University; **UA**, Univ of Alberta; **UM**, Univ of Montreal

% Infometrica model currently being updated by Policymodels Corp * Owned by Systematic Solutions Inc. (USA)

Adapted from IET 2017 "For a Sustained Energy Systems Modeling Init." Institut de l'énergie Trottier (IET), Canada

How Does Canada Compare Internationally?

Other nations:

- Have stronger, more coordinated ES data and modeling efforts;
  - CCC (UK); SEA (Sweden); EIA (USA)
  - Coordinated energy Data collection and validation since 1970
- Use their universities to build ES modeling expertise
  - Core of CCC work (UK), SEA (Sweden) supports 70 PhD theses; EMF (USA)
- Maintain both 'Top Down' and 'Bottom Up' models to do their analyses;
- *Actually* use their models to make recommendations on targets (e.g. UK C budgets) and mitigation strategies (Sweden and UK even meet targets!);
- Use models to enhance energy literacy and engage the public

For details, see IET (2017), "For a Sustained Canadian Energy Systems Modelling Initiative", Institut de l'énergie Trottier (IET), Canada, http://iet.polymtl.ca/en/publications/for-a-sustained-canadian-energy-systems-modelling-program/

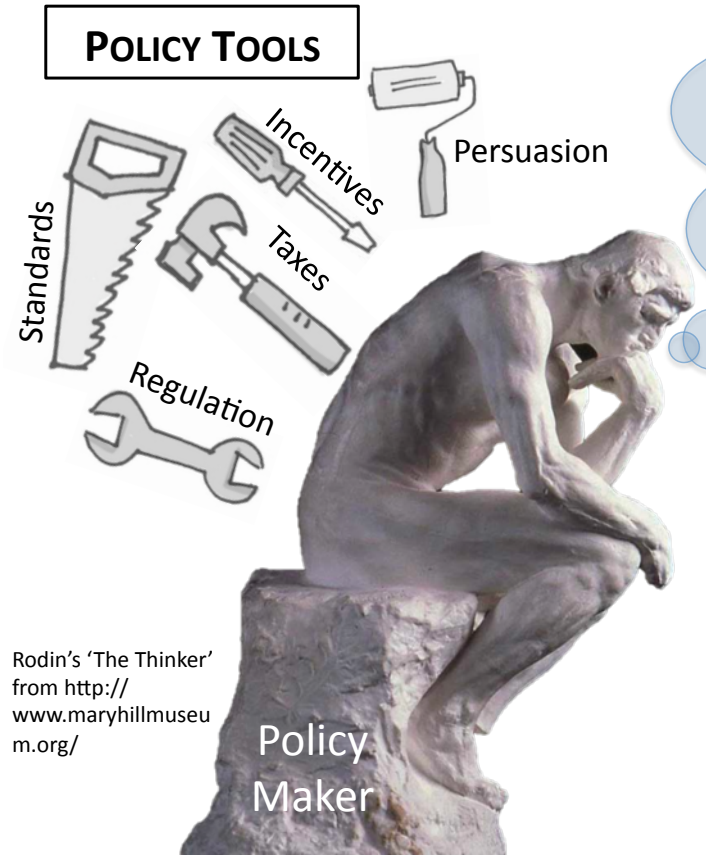
Energy Systems Models are Essential for Canada…

…but to deliver their full potential, four issues must be addressed:

1. Framing the Problem;
2. Transparency and Access;
3. Modeling Capacity;
4. Data Challenges

1. Framing the Problem:

Questions Asked of ES Models?



Rodin's 'The Thinker' from http://www.maryhillmuseum.org/

- *What will be future demands for fuels and electricity (domestic and int'l)? What is our capacity to deliver? GHG implications?*
- *What impact would policy tool 'x' have on energy use and GHG emissions in area 'Y'?*
- *What policy tool(s) would work best to achieve significant GHG reductions in area 'Y', and what would that cost?*

Energy Systems Models

- ❑ Macro-econometric
- ❑ Computable General Equilibrium
- ❑ Optimization
- ❑ Consumer Choice
- ❑ Hybrid

1. Framing the Problem:

Great Questions…

…but will they Provide the Insights Needed to Achieve the Targets? … ***No!***

- Models tend to project incremental, not disruptive change
  - **DISRUPTIVE** change may be necessary
- There are other **Disruptive** forces impacting 'human systems' that are more powerful than GHG policies – they need to be understood & in some cases 'directed'.

Example: Personal Mobility System
- Kills / seriously injures over 10,000/year;
- Congestion reduces productivity;
- Expensive vehicles used only 3-4% time;
- Parking needs use valuable land;
- Cities car centric, not people centric;
- Air pollution;
- GHG emissions (tailpipe and upstream).

- Systems changes may be needed in sectors / behaviours that are little affected by energy costs.

Example:
- Architects
- Engineers
- Urban Designers
- Researchers, innovators
- Telecommuting
- Diet
- Where we live
- How we vacation

1. Framing the Problem:

Expanding the Insights Demanded from ES Models

What are the challenges and unintended consequences of our existing 'systems' and how could they be addressed in ways that align with our GHG objectives?

*How could **DISRUPTIVE** technologies and business models be directed to address societal goals (including GHGs)?*

How rapidly could these changes be implemented, and what would be the costs, benefits and tradeoffs?

Rodin's 'The Thinker' from http://www.maryhillmuseum.org/

Decide where you want to go, before focusing on how best to get there.

Energy Systems Models

- ❑ Exploratory

2. Transparency & Access:

Cdn Science & Policy Would Benefit by Increasing Both

- Most, if not all, Cdn Energy Systems models are either privately or government owned:
  - Restricted access;
  - Not transparent;
  - Few understand how they work (assumptions, strengths, weaknesses).
- Ideally ownership of key models would be in a 'Not-for-Profit' with the funding and mandate to:
  - **Support** model improvements, improved access, manage source code;
  - **Create** excellent documentation;
  - **Co-fund** model use to address research or policy questions;
  - **Improve** energy literacy.

3. Modelling Capacity

Universities Need to Train Students for Careers in Industry & Gov't.

- Models constantly need R&D:
  - ❑ **Understand and communicate** complex systems;
  - ❑ **Incorporate** better data, or new features;
  - ❑ **Include new** technology, infrastructure, behavioural options;
  - ❑ **Explore** new disruptive forces;
  - ❑ **Testing** policy options, new pathways
- Open source, open access, transparent models are essential
- Multi-disciplinary perspectives needed
- Need for workshops & conferences to present ideas, challenge / argue, set standards / protocols, recognize contributions.

4. Data Challenges:

This is such a major issue,
it needs a another presentation…

Conclusions:

Energy Systems Models are Essential for Canada…

…but to deliver their full potential, four issues must be addressed:

1. (Re)Framing the Problem
   - ❑ *Include "Directing Disruption"*
2. Transparency and Access;
   - ❑ *Need for a NFP with budget & mandate*
3. Modeling Capacity;
   - ❑ Build multi-disciplinary expertise
4. Data Challenges