The CESAR Pathways Project

The **CESAR Pathways Project** is defining **credible, compelling and cost-effective pathways** to future energy systems that will make it possible for Canada to meet its 2030 and 2050 climate change commitments.

Why?

For Canada to meet its 2030 and 2050 climate change commitments, substantial changes are required in the energy, agricultural and industrial systems underpinning the Canadian economy and way of life.

Previous agreements on greenhouse gas (GHG) emissions targets (Kyoto for 2010-12 and Copenhagen for 2020) were not successful. In large part, they lacked a strategic plan for deployment, one that included the nature and timing of the technological, infrastructure, and behavioural changes (called 'pathways') capable of achieving the stated objectives.

The CESAR Pathways Project applies new and powerful scenario modelling tools to explore **compelling visions** and **credible strategies** for systems change with the goal of identifying **transformative pathways to sustainability**.

CESAR's visioning and modelling tools are built around detailed narratives that describe desirable, achievable changes in human-managed systems that include, but are not limited to, GHG management. From the narratives, pathways are defined to inform decision makers in government and industry.

"We cannot predict the future, but we can invent it."
Dennis Gabor. Nobel Prize in Physics (1971)

A Unique, Value-added Approach

The CESAR's Pathways Project differs from other efforts to define transformative pathways in the following ways:

Founded on narratives that align climate objectives with other societal goals for systems change

In thinking about and planning for energy futures, CESAR believes that Canadians first need to define *'where we want to go and why'* before deciding on the policies needed to achieve systems change.

Unlike models driven by the price of carbon and/or simulations of how people make decisions, the CESAR Pathways Project begins with a deep understanding of the idiosyncrasies, inefficiencies, and unintended consequences of human-managed systems that define our demands for energy.

CESAR then draws on recent societal and technological trends to envisage and describe a future that meets societal needs and aspirations for a robust economy, improved health outcomes and high quality of life, while also reducing greenhouse gas (GHG) emissions. Currently, five interacting narratives are being written *(See box)* to define the pathways toward meeting Canada's 2030 and 2050 climate change commitments.

CESAR will consult with governments and industry groups across Canada to understand the narratives or plans they are considering for reducing GHG emissions. This consultative process will help modify and inform the CESAR narratives.

Of course, there may be many narratives for a better future, and the pros and cons of each are likely to vary by province/region and be impacted by what is happening in other provinces or internationally.

The power of the CESAR modelling approach is that each narrative can be rigorously explored and assessed to stimulate discussion, inform decision makers and move society towards a collective vision for a promising future.

Five narratives are being written to shape and define the CESAR Pathways:

1. **Personal Transport and Urban Form.** Disruption from electric, shared, autonomous vehicles;
2. **Supply Chain.** Mode share changes, electrification and biofuels;
3. **Industry.** Shifting demand, transformative technologies, and carbon capture and storage;
4. **Smart Grids and Efficient Spaces.** Disruption of utility model, urban redesign and electrification; and
5. **Biological Solutions.** Optimizing land/resource use for food, fibre, energy and enhanced carbon stocks.

Narratives include all human-managed flows of energy and carbon

The production and use of fuels and electricity (i.e. 'energy systems') represent the dominant – but not the only – way in which humans have altered the flows of energy and carbon in Canada.

In developing narratives for the future, CESAR will also consider changes in how we manage the annual flows of energy and carbon through our agricultural systems and managed forests. Adding flows through Canada's food and fibre systems to the fuel and electricity systems increases human-managed energy flows by about 21% and carbon flows by more than 40%.

These flows need to be integrated into system-level strategies to address environmental and societal challenges.

Narratives are converted to technology and behaviour-rich scenarios

CESAR narratives are converted into detailed, technology- and behaviour-rich scenarios that consider several factors. These include infrastructure in-place and rate of turnover, technology-readiness level, public acceptability of new innovations, and rates of change in market share.

Drawing on the scientific literature describing techno-economic and environmental assessments for each technology innovation, CESAR identifies key metrics or parameters (**levers**) that characterize and drive the five narratives.

At the core of the CESAR Pathways Project is the Canadian Energy Systems Simulator (CanESS) model by whatIf? Technologies Inc. (Ottawa, ON). CanESS is an integrated, multi-fuel, multi-sector stocks and flows model with detailed accounting of the sources and uses of energy and the resulting GHG emissions across Canada. Built on historical data from 1990 to the present, CanESS was designed to explore biophysically and technologically coherent pathways to low carbon energy systems for Canada and the provinces.

CESAR will begin by using the CanESS model to generate a business-as-usual or **reference scenario** to 2060. Then, drawing on the levers that characterize the five narratives, the reference scenario will be modified to create at least two additional scenarios. The **Transformation Lite Scenario** will involve a conservative adjustment of the levers, while the **Deep Decarbonization Scenario** will adjust the levers to the point needed for Canada to meet its 2030 and 2050 targets.

Assessment of costs and benefits of pathways to inform policy options

In defining the narratives, CESAR considers the economic or policy instruments that could be used to incentivize the scenario pathways. Once pathways are defined, societal costs, system-level transformative costs and benefits are estimated.

Results are used to inform policy and investment decisions by industry and governments.

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Supporting CESAR

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To carry out this major initiative, and to enable CESAR to embark on other projects, we seek additional partners to help us identify new narratives, enhance the scenario modelling process, make the modelling tools widely available to others, and communicate the insights.

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