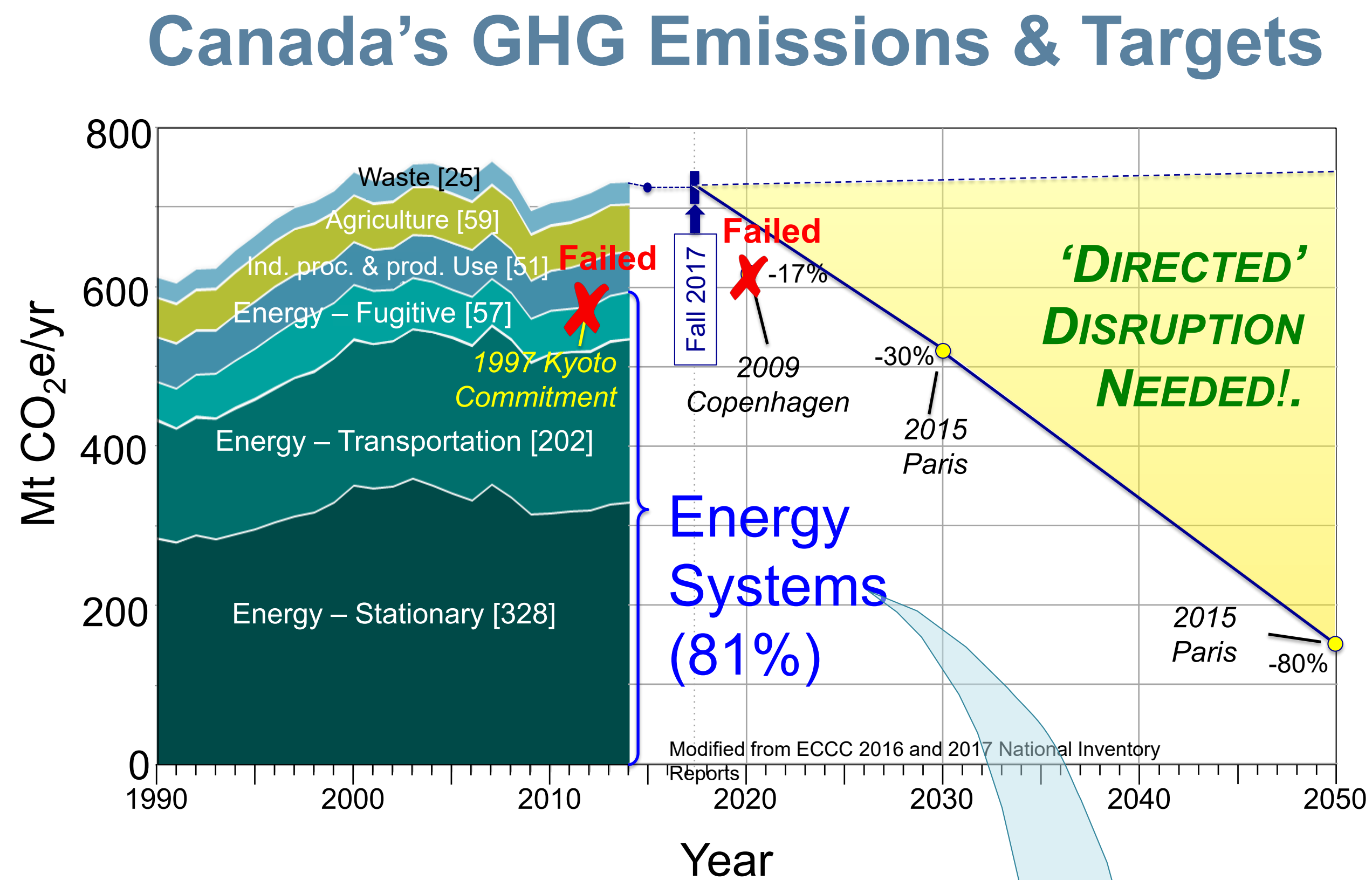


Why?

For Canada to meet its 2030 and 2050 climate change commitments, **transformative / disruptive changes** are needed in the human systems that give rise to greenhouse gas (GHG) emissions.

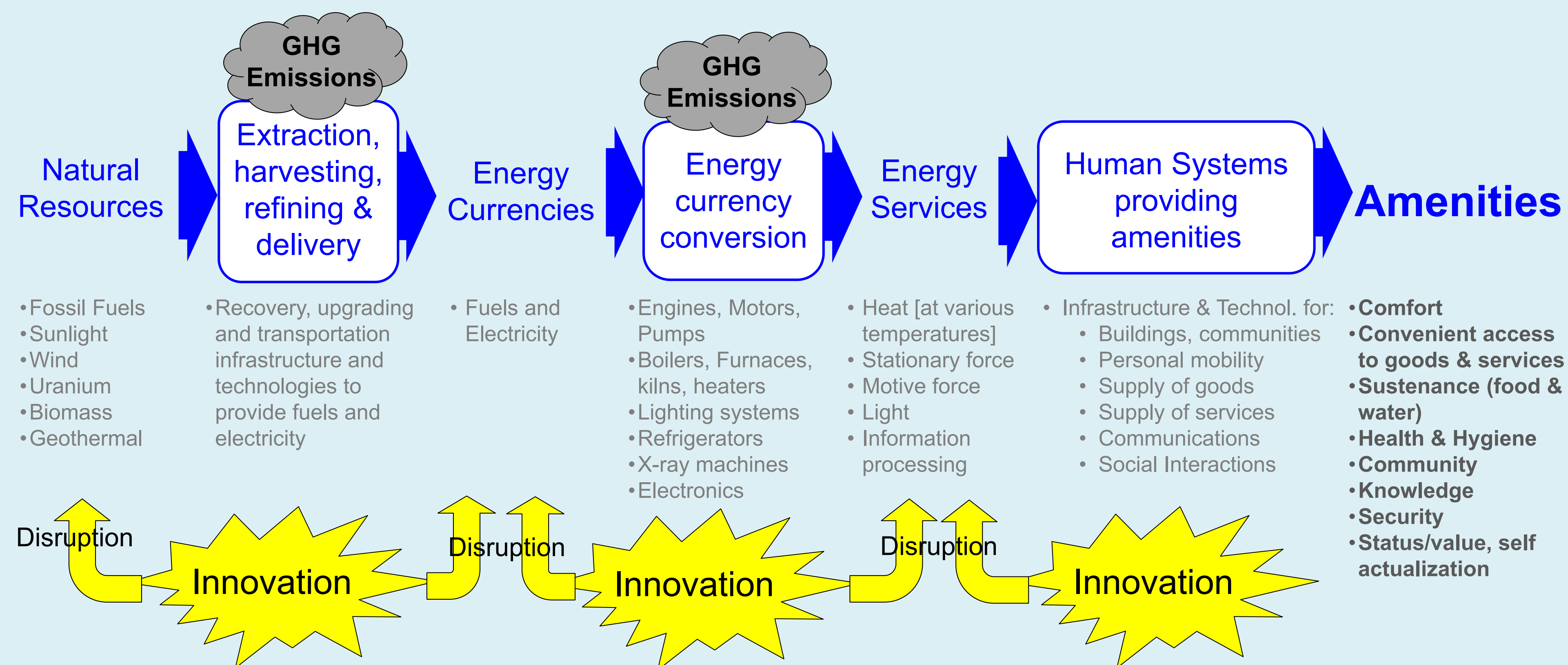


Decision makers would benefit from projections detailing the nature and timing of the **technological, infrastructure, and behavioural changes** (called 'Pathways') capable of achieving the stated commitments.

To identify & characterize such pathways, a new approach is needed for **technology-rich energy systems modeling**.

What are Energy Systems?

- The technologies, infrastructure and behaviours that connect the flows of materials and energy from natural resources to meet societal wants and needs (**Amenities**).
- Although energy flows from natural resources, the primary control in energy systems is the demand for energy services
- Technology, infrastructure and behavioural Innovation can have incremental or disruptive impacts on energy systems

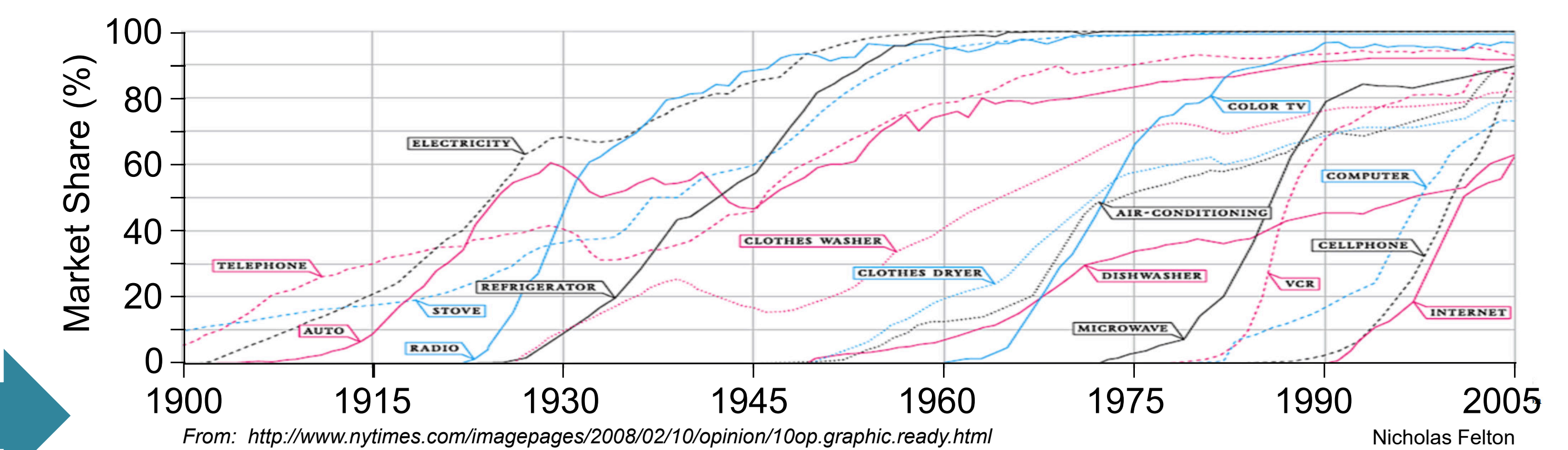


How?

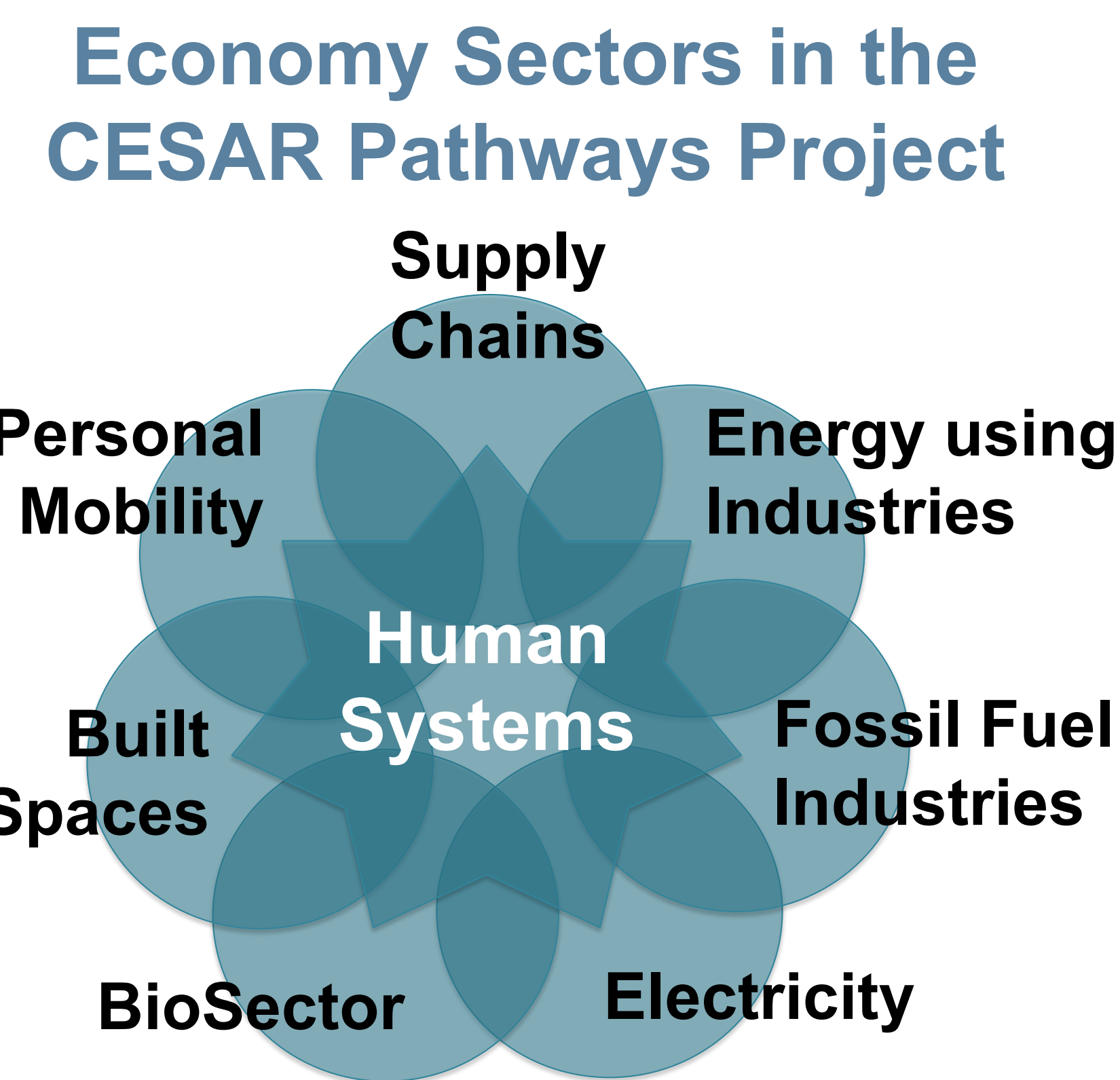
CESAR [1] has been working whatIf? Technologies Inc. [2] to use their **Canadian Energy Systems Simulator (CanESS)** as an Exploratory Model.

Exploratory Models are able to project the deployment of disruptive technologies, especially those that are not being deployed to address GHGs.

Disruptive Technology Deployment in US Household Sector



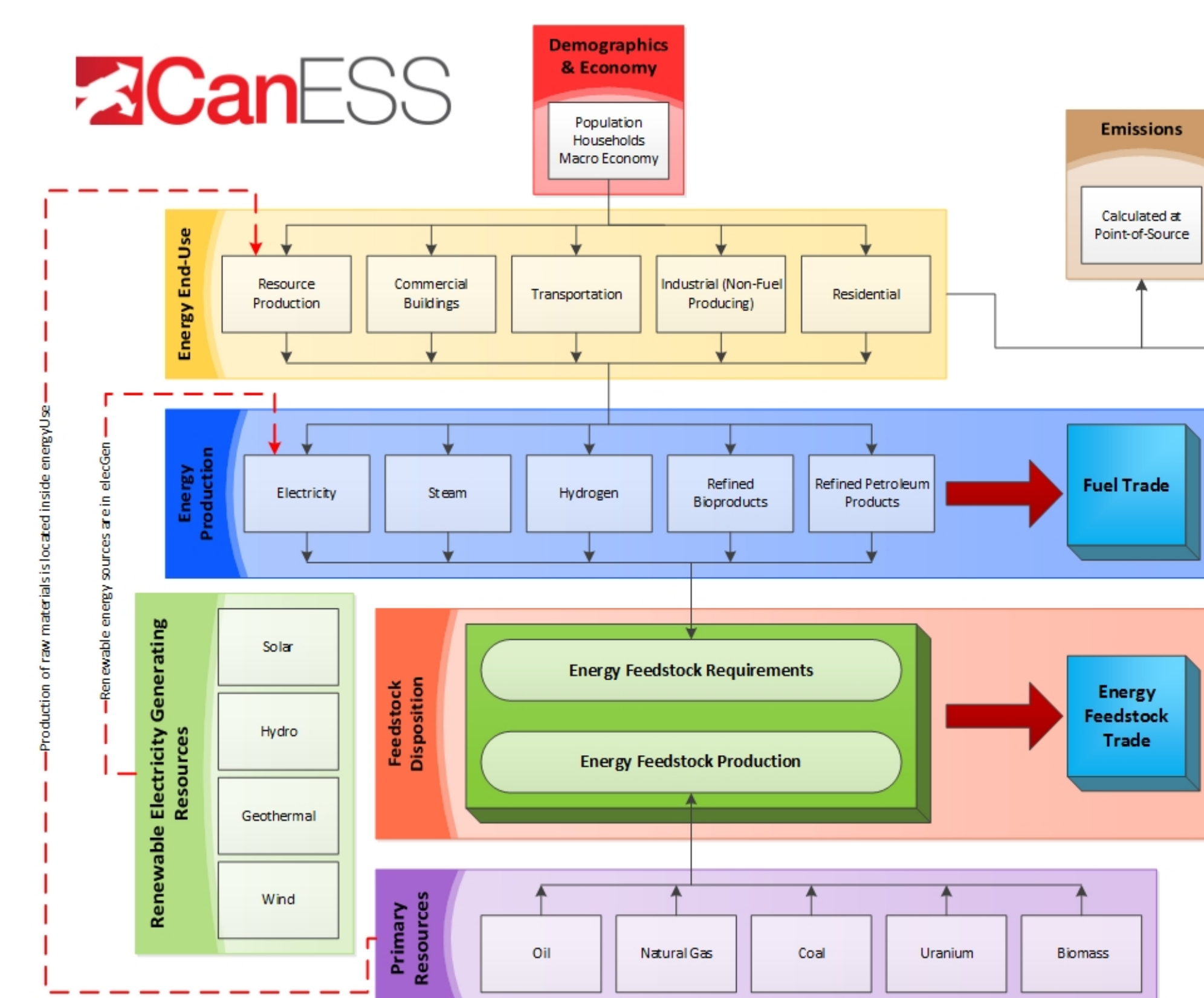
Past disruptive technologies...



The **CESAR Pathway Project** uses the following exploratory modeling approach:

1. **Understand** strengths, weaknesses and unintended consequences of existing human systems incl. GHGs)
2. **Identify** possible disruptive technologies
3. **Build technology-rich 'Narratives'** that describe a compelling vision for an improved future for human systems.
4. **Extract 'levers'** (metrics) for an energy system that would need to change (how far and when) to realize the alternative energy future;
5. **Model impacts** on energy flows and GHG emissions
6. **Assess costs, benefits & trade-offs**; readjust 'levers' as needed'
7. **Identify policy and investment options** for deployment

The CanESS Model



- An integrated, multi-fuel, multi-sector model with detailed accounting for the sources and uses of energy and the GHG emissions across Canada;
- A dynamic tool for scenario analysis with a long-term horizon, and therefore a platform for exploring energy system futures;
- Disaggregated by province and accounts for energy production, use and trade for all fuels and feedstocks;
- Calibrated with observed historical data from 1978 to the present, and enables projection of scenarios forward in one-year time steps to 2050 and beyond;
- Present-day and future harvest, conversion and service technologies are explicitly represented
- As such, the impact of any technological change deemed suitable can be explored through scenarios.