NextGrid model in development of the Clean Electricity Regulations

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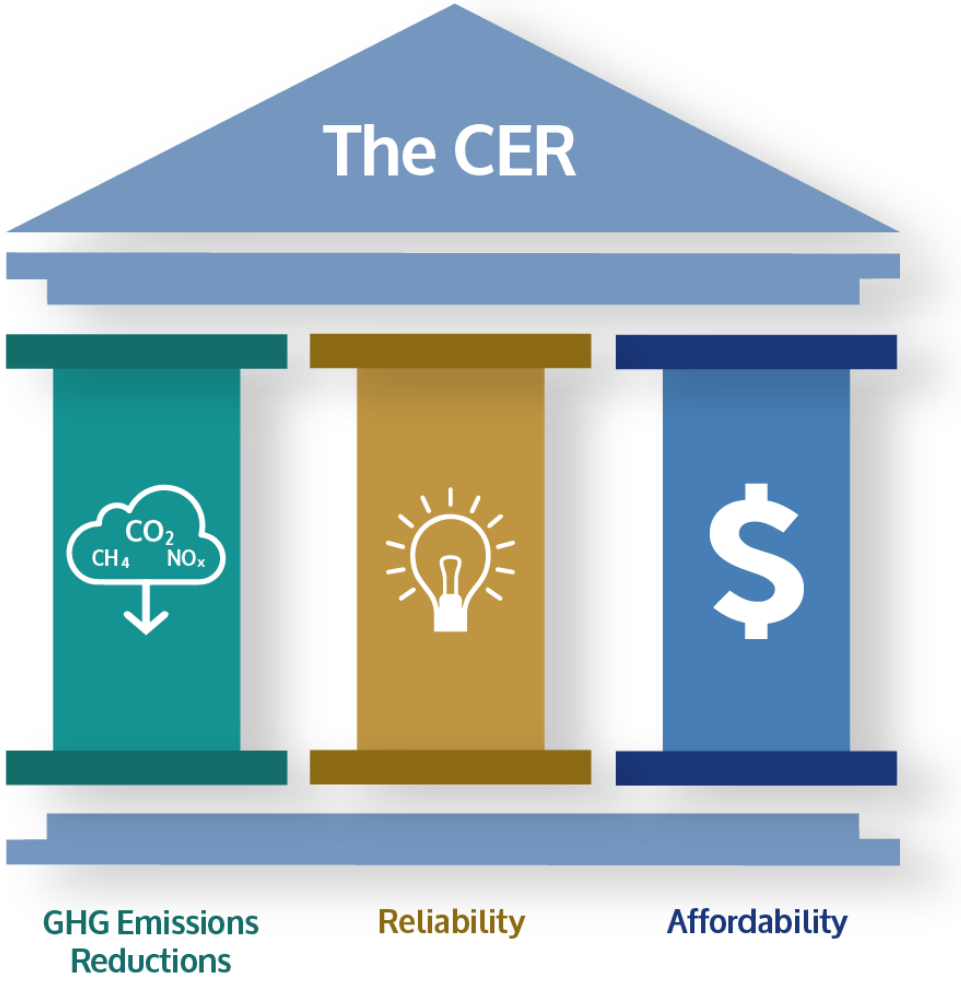
Canada

Clean Electricity Regulations

The CER, together with a suite of complementary measures, will accelerate Canada on the path to a net-zero electricity sector:

- The CER will do the heavy lifting in reducing emission while mitigating impacts on affordability and supporting reliability, but given the monumental scale of the clean energy transition, a full suite of measures are essential to maintaining the affordability and reliability of electricity.

The CER's design is balanced upon three pillars:
Emissions Reductions, Reliability, and Affordability



The Federal Clean Electricity Regulations set a technology-neutral, achievable emissions standard

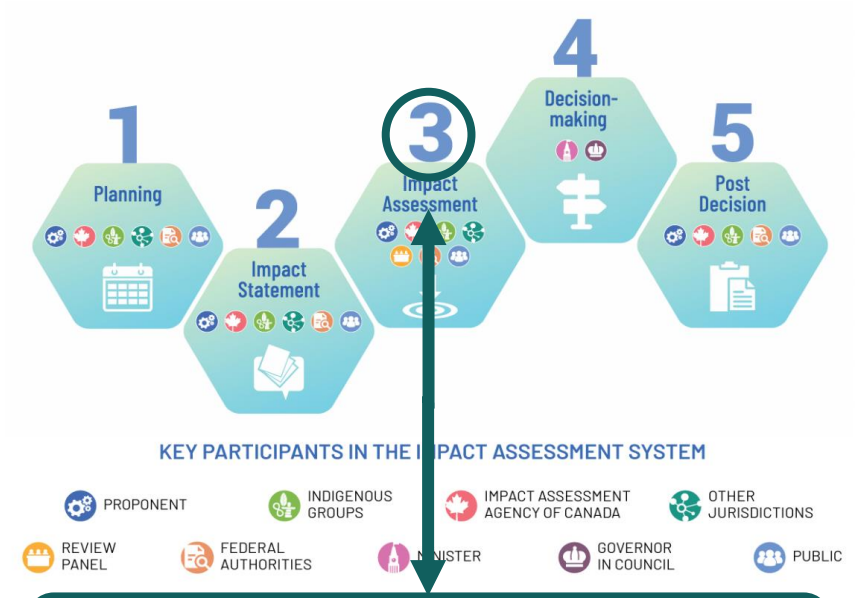
- CER comes into force **January 1, 2025,** **and, starting in 2035, the requirements will apply to new units while gradually phasing in the performance requirements to existing units.**

Current Status

- **Canada Gazette, Part I**, released in August 2023.
- After considering extensive feedback during CGI consultations, ECCC responded with a **Public Update** in February 2024, proposing changes to the draft regulations for comment
- After the release of the Update, ECCC received **134 written submissions** and held over **55 meetings** with interested parties
- Currently finalizing the key design parameters - targeting a **CGII publication** in the fall/winter of 2024

Modelling the CER: two models

E3MC



Used for regulatory impact assessment

Macroeconomic model

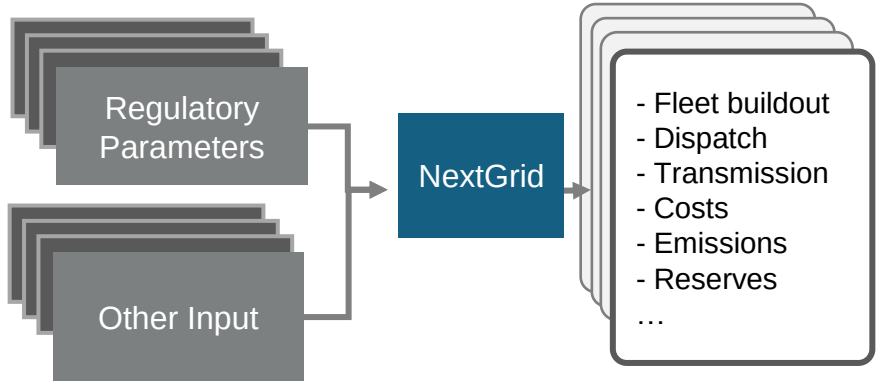
ENERGY 2020

Alignment

Changes have been made to both models so that they align via:

- Assumptions
- Data input

NextGrid



Used for the development of the regulation

Uses a vast amount of simulations to assess the impacts of different regulatory designs and parameter values

NextGrid

NextGrid is based on the GridPath model developed by Blue Marble Analytics – open source modelling platform

NextGrid is a capacity expansion model that includes all existing electricity generation units in Canadian provinces and that captures the investments in and operation of electricity generation, storage and transmission assets out to 2050 under different regulatory constraints

Optimization is done at a federal level (but can be taken down to the province level in provincial and 8760 models)

Model identifies least-cost solution

NextGrid is nimble – enabling the flexibility to explore policy questions

- Can easily modify the code of the NextGrid model as needed to explore policy questions
- Allows ECCC the flexibility to implement *almost* any policy variation
  - If the policy team requests a policy variation (e.g. allow units to pool their allowable emissions limits), the modellers are able to transform those ideas into code and assess the impact.
- MARS has contributed and worked with the main developer to include some functionalities to the underlying framework, i.e., GridPath, for example, fuel constraints and endogenous capacity trade

NextGrid is informed and vetted by experts

- NextGrid has -had significant improvements in the last 18-months in response to input received from provinces and utilities during development of the regulations
  - Implemented changes to inputs and assumptions as a result of provincial feedback
  - Feedback on the policy has led to ECCC testing out some alternative regulatory scenarios
  - Over 50 meetings in total, including more than 15 since publication of CGI, plus modelling feedback in written submissions
- Model results/assumptions reviewed by prominent academics
- Results and inputs challenged internally by a staff of 30+ engineers with decades of experience.
- Three external organizations (one academic, one OGD, one consultant) are running their own models to verify NextGrid findings

NextGrid is evergreen – undergoing continuous evolutionary improvement

- Ever since the model was established, have been refining inputs:
  - Up to date unit list: new projects/retirements incorporated on a regular basis
  - Updated cost assumptions for technologies and fuels
  - Operating characteristics: based on input from utilities
  - Intertie capacity: based on existing and planned projects
  - Energy and capacity contracts
  - Build out constraints and technology limitations

- Adding new functionalities:
  - CER policy functions (CER emissions limit, unit operations decisions for fuel blending, pooling, offsets, etc.)
  - Modelling of US trade
  - Sustaining capital costs for natural retirements
  - Variable heat rate curves
  - Fuel blending approaches

- Provincial specific modelling:
  - Provincial carbon pricing systems: e.g. TIER, provincial OBPS

Able to provide perspective on the CER policy from ALL angles: over 400 policy variations modelled to date

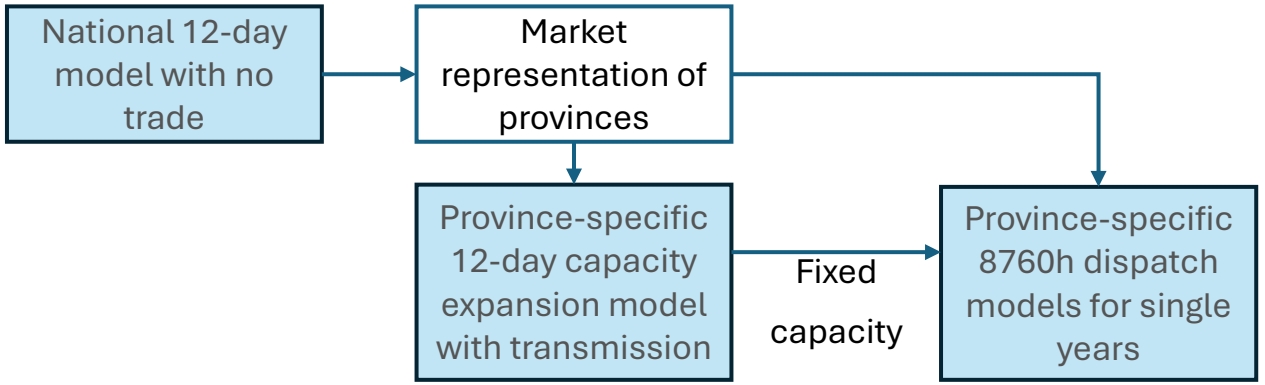
CER Policy toggles	Tech/Assumption toggles
Performance standard (intensity vs absolute)	Demand profiles (low vs high electrification)
End of Prescribed Life	Carbon price (no change vs full exposure in future)
Offsets	Interprovincial transmission expansion (planned, constrained, unconstrained)
Pooling variations	Interprovincial capacity trade
Cogen treatment variations	Technology availability (CCS, SMR)
Cut off date for new	Clean fuel cost/availability (RNG, H2)
Etc.	Etc.

NextGrid capacity mixes will be tested using additional detailed models: Provincial, 8760 models

To be able to run hundreds of permutations with different assumptions, functionalities and regulatory designs, NextGrid usually runs for *representative days*

The optimisation is based on least cost for ALL provinces

(1) provincial models that optimise on the costs of single provinces and (2) 8760h models



Informing policy

Assessment of **model outputs**:

- Observe incremental costs and emissions reductions
- Which policy levers have the largest impact on emissions reductions and incremental costs?
- What types of capacity are built?
- Are energy needs met in the 8760 model?

- Development of **other indicators** from model outputs:
  - Affordability

Key Indicators of Success

	Scenario
Reliability	
Capacity and energy needs are met in the 8760 model	✓
Gas units have adequate room to operate as load-following to backup variable renewables	✓
Emission reductions	
Grid relies less on natural gas, and more on non-emitting	✓
Maximize emissions reductions	✓
Affordability	
Minimal rate increases attributed to the CER	✓
Household energy budget: most Canadians are expected to pay less overall for energy when considering the CER and electrification	✓
Other	
Technology neutral	✓
Technically achievable (does not rely too much on novel tech)	✓

Closing

NextGrid is a robust, nimble model that is using the best available data to represent the Canadian electricity sector.

These attributes make it ideal for providing timely information on the CER policy, ensuring that the final policy will have considered key pillars (reliability, costs, emissions) as well as myriad options for policy design.

NextGrid results inform policy design but do not present a prediction of what Canada's future electricity supply will look like. The actual outcome will depend on factors such as:

- Provincial and utility actions
- Future availability and cost of technologies
- Future uptake of electrification and adoption of energy efficiency, demand side management