Transitioning Canada towards a net-zero electricity grid

21st APEC workshop on energy statistics

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About your presenter:

- Chris Doleman
- Senior Researcher, APERC, Tokyo (2018 to present)
- Volunteer Platform Committee Member, Energy Modelling Hub (EMH), Canada (November 2022 to present)
- Work experience (10 years in energy)
    - Market Analyst, Canadian Energy Regulator (2014-2018)
    - Two years in the Alberta oil sands

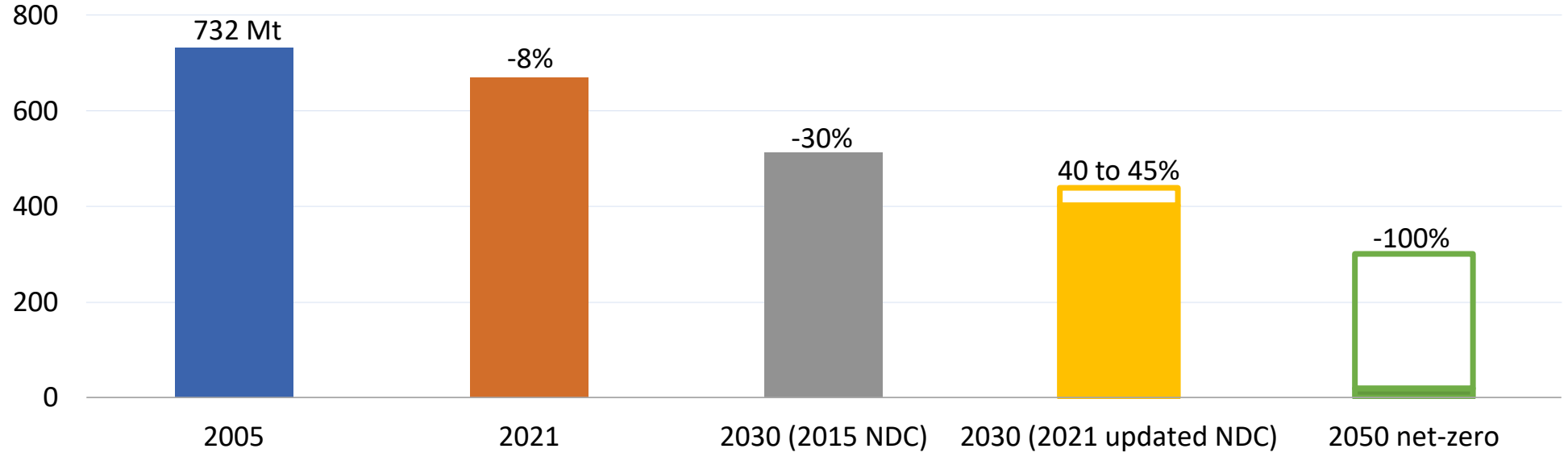
Outline

- Canada's climate ambitions
- Canada's electricity sector
- Clean electricity regulations (CER)
- Canadian energy modelling landscape
- Overcoming the obstacles
- Conclusion

Canada’s climate ambitions

Canada's climate ambitions

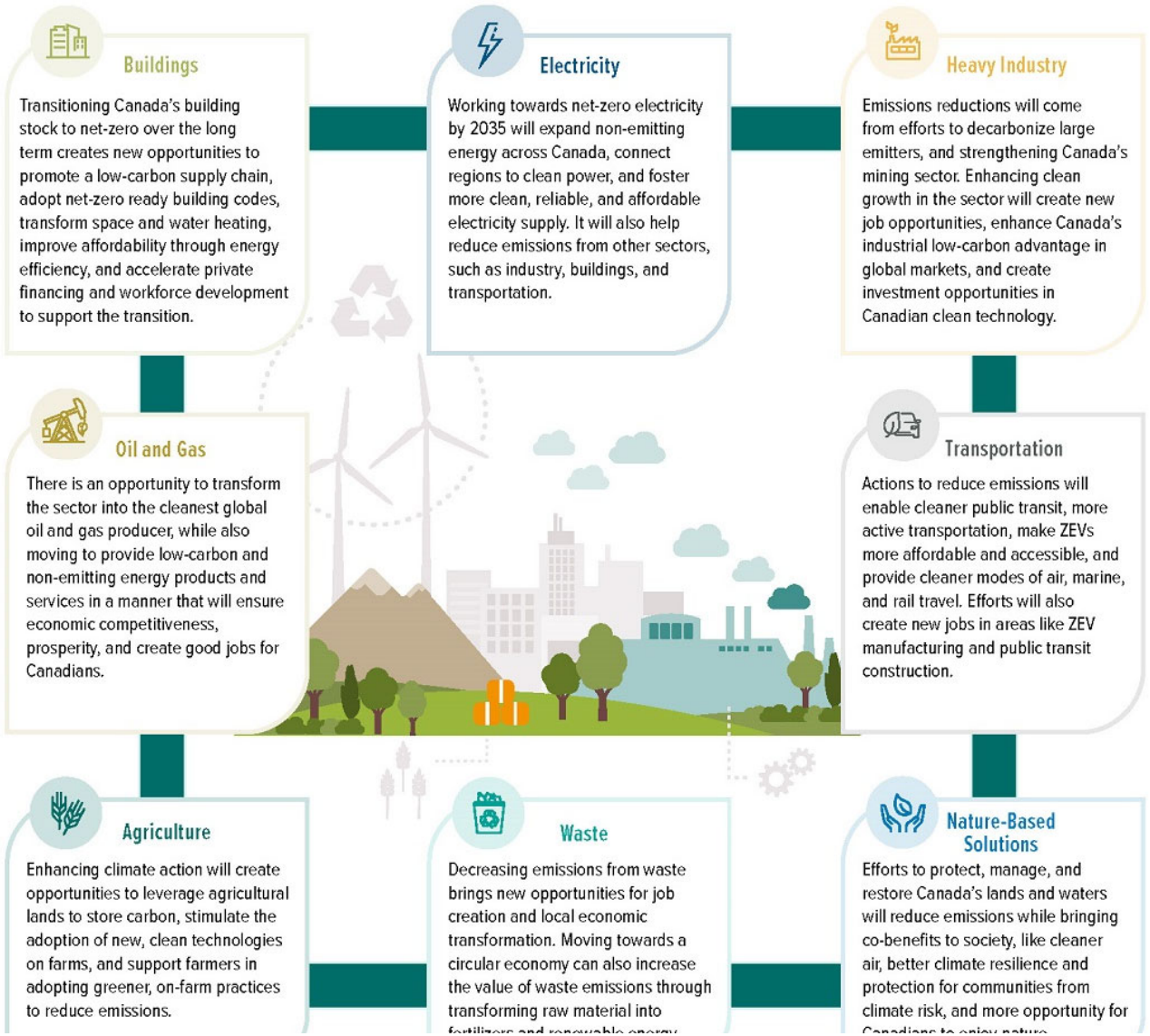
Canada's historical GHG emissions inventory and climate targets (Mt CO_2eq)



Source: ECCC, UNFCCC

- 2015: 2030 NDC to reduce emissions 30% below 2005 levels by 2030
- 2021: Updated NDC to reduce emissions to 40 to 45% below 2005 levels by 2030
- 2022: Submitted a net-zero emission by 2050 target as part of LT-LEDS UNFCCC submission

CANADA'S EMISSIONS REDUCTION PLAN FOR 2030 AND PATHWAY TO 2050

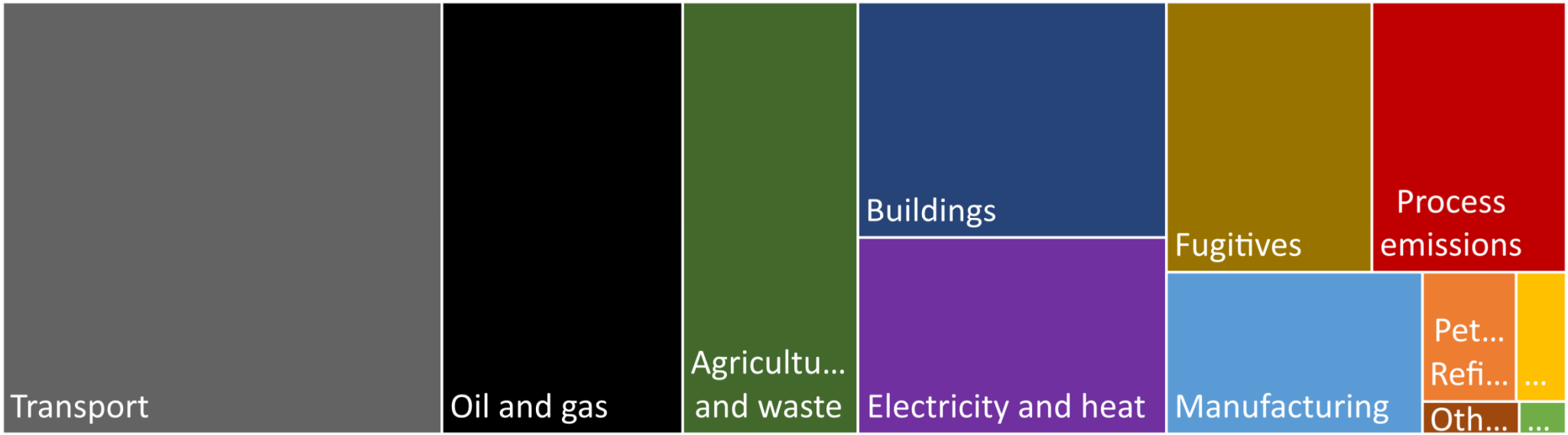


- Works towards net-zero electricity by 2035
- Enable electrification to achieve higher emission reductions
- Ensure that energy remains affordable and reliable

Source: ECCC,

Canada's sectoral emissions

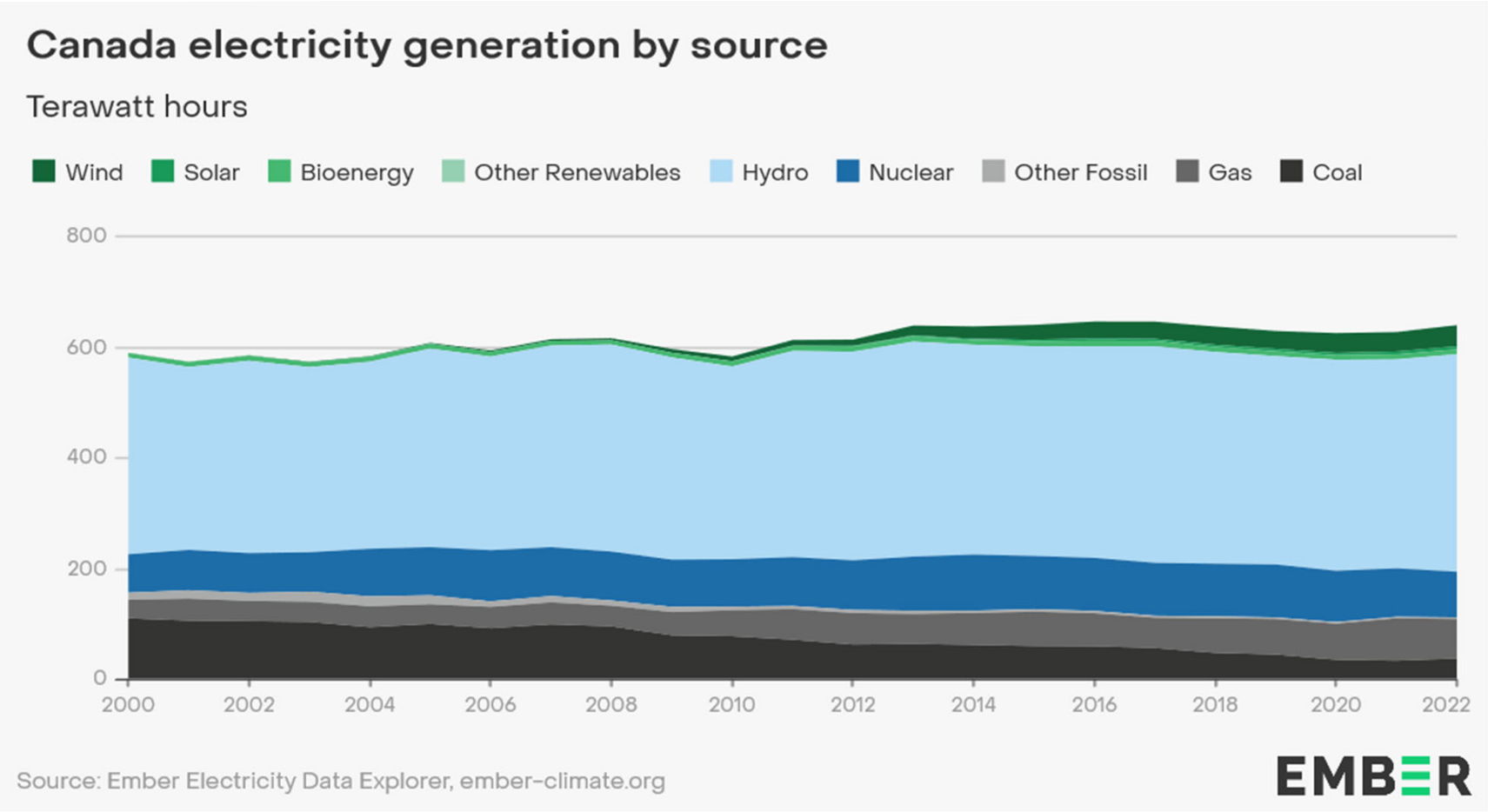
Canada's GHG emissions inventory breakdown by IPCC sector, 2021



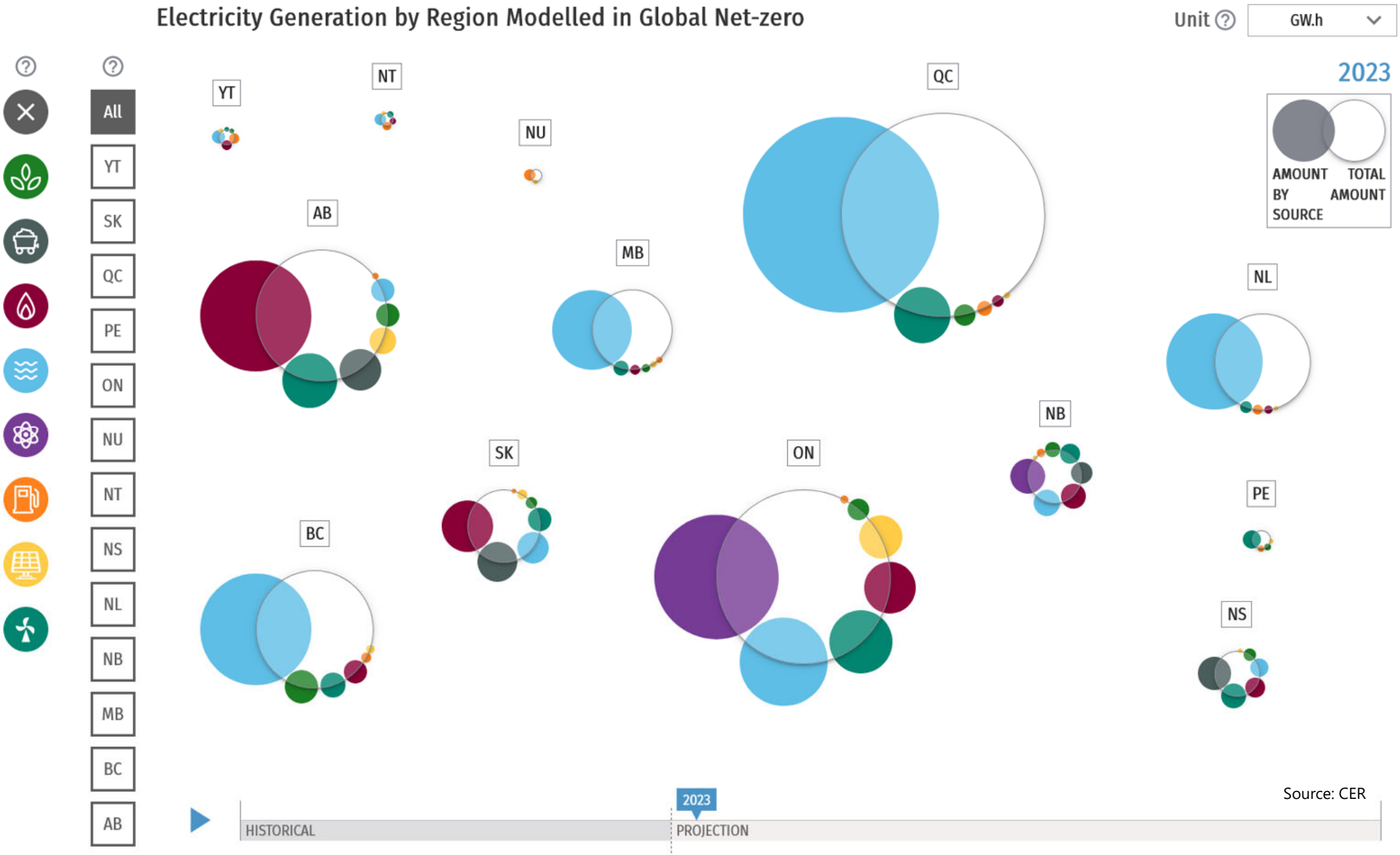
Source: ECCC

- Electricity is Canada's fifth-highest emitting sector…
- … but is only responsible for 9.0% of emissions (60 $MtCO_2eq$ of 670 $MtCO_2eq$)
- Non-emitting electricity will be the backbone for deep emissions reductions

Canada’s electricity sector



- Generation is 84% non-emitting (APEC is about a third)
- Unabated coal is set to be phased out by 2030
- Tempting to look at this and think that Canada has an easy net-zero pathway
- However, there is significant variation across the economy …


Electricity Generation by Region Modelled in Global Net-zero
Unit
GW.h
2023
AMOUNT BY SOURCE
TOTAL AMOUNT
All
YT
SK
QC
PE
ON
NU
NT
NS
NL
NB
MB
BC
AB
YT
NT
NU
QC
AB
MB
NL
NB
SK
ON
PE
BC
NS
2023
HISTORICAL
PROJECTION
Source: CER

Regulatory structure of electricity in Canada

- Municipal governments: role in permitting, ownership of local distribution companies
- Provincial and territorial governments: regulate generation, transmission, and distribution within their regions; responsible for market and regulatory structures
- Federal governments: federal government regulates interprovincial power lines, nuclear power, electricity exports, and environmental regulations

Implications:

- Variability in market structure, resource endowments and fuel mix across Canada
- Regional governments worry about ensuring resource adequacy and reliability at affordable rates
- Federal government is unable to mandate resource mixes explicitly
- Guiding regional energy supply requires crafting environmental policy
  - Example: Canada's 2030 Coal phase-out sets an emission standard per unit of electricity generated
- Variability across Canada necessitates an approach that allows for provincial autonomy and flexibility

Clean electricity regulations (CER)

CER – core principles of regulation

- **Maximize greenhouse gas reductions** to achieve net-zero emissions from the electricity grid by 2035
- Maintain electricity **affordability** for Canadians and businesses
- Maintain grid **reliability** to support a strong economy and meet Canada's growing energy needs

CER – the draft regulations (simplification)

- Regulation: emission performance standard of 30 tCO_2e per GWh
  - Gas-fired units emit between 350 to 420 tCO_2e per GWh
- Applies starting in 2035 for:
  - All petroleum coke- and coal-fired units
  - All other fossil fuel (oil products or natural gas) units commissioned in 2025 or later
  - Units that increase generation capacity by 10% since commissioning
- Applies starting in 2035 or 20 years after commissioning for all other units
- Delayed application for any coal-to-gas conversion units

CER – flexibility provisions

Exemptions:

- Emergency circumstances
- Units smaller than 25 MW
- Remote, and off-grid systems (not connected to a North American Electric Reliability Corporation (NERC) standards ('NERC-regulated electricity system')
- Peaker provisions: unabated units can operate under 450 hours a year, emit

CCS operational allowances:

- During the first seven years that CCS equipment is in use, and before 2040, the standard is 40 tCO_2e per GWh

CER – summary

- Exemptions provide a clear, flexible guidepost for the provinces to develop their own solutions
- Fossil fuels are allowed, if CCS can rise to meet the challenge
- Consultation period open now; final regulations available in 2024
- How can policymakers and modellers work together to inform the regulations?

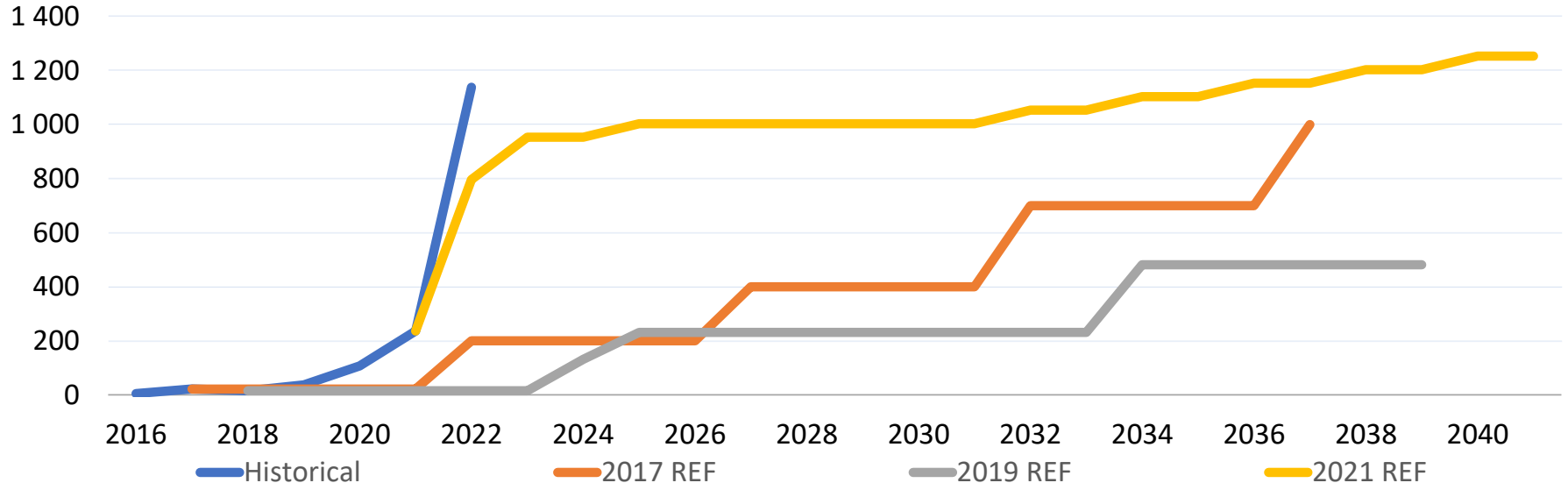
Canadian energy modelling landscape

Energy Modelling Initiative (EMI): forensic audit of Canada's modelling network

- Canada has no shortage of models, but the network is fractured into silos
- Silos do good work
- There is a general lack of accessibility and transparency
  - 10% of the models are open-source, free
  - **Data often not adhering to FAIR principles (findability, accessibility, interoperability, and reusability)**
  - **Assumptions and data retrieval methods are not transparent, leading to questionable results, data quality issues**
- Some models are trying to answer questions they are not suited to answering
- The needs of policymakers, model users is evolving rapidly, which is challenging the effectiveness and suitability of models, assumptions or their approaches
- Some models are unable to deliver timely results
- **Problem: If policymakers do not have access to evidenced-based analysis that can quickly deliver solutions to their questions, they will likely turn to interest groups to inform their decisions**

Ex: a “surprise” solar boom in Alberta

Alberta’s solar capacity additions, actual and forecasted by AESO in Reference case of last three long-term Outlooks (MW)

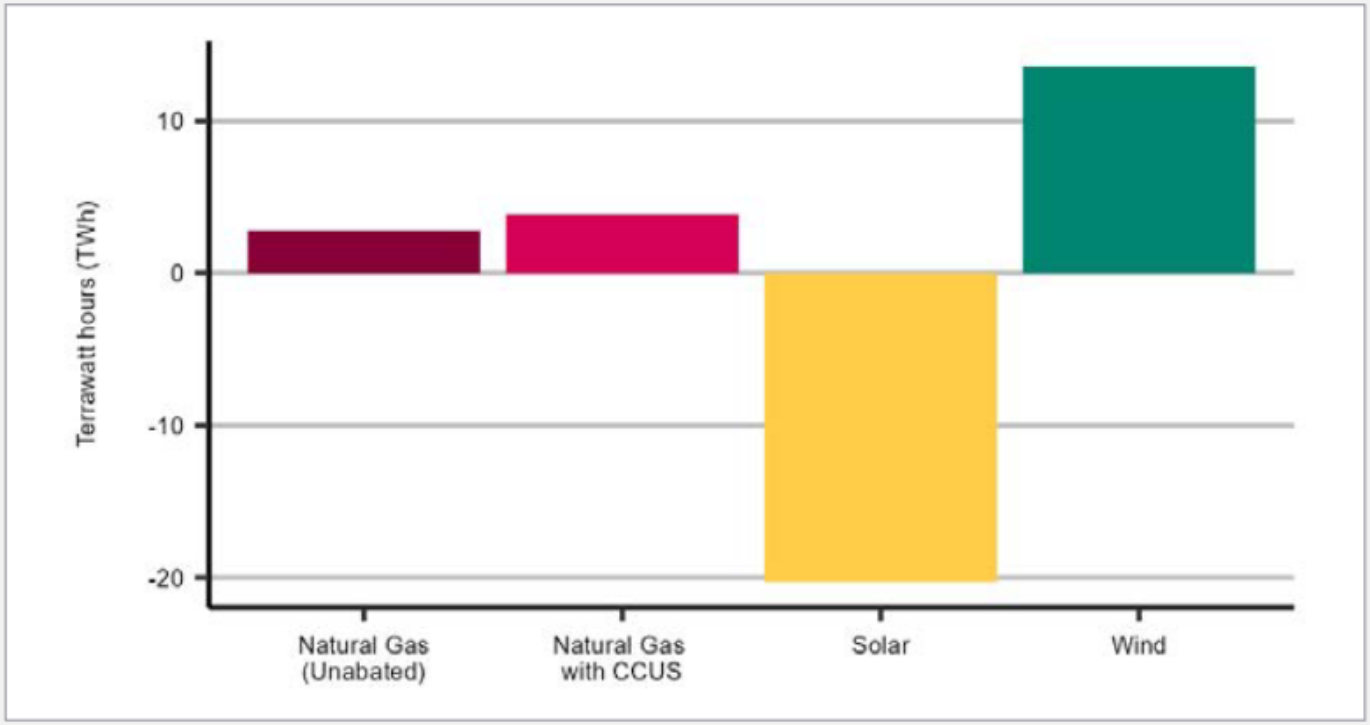


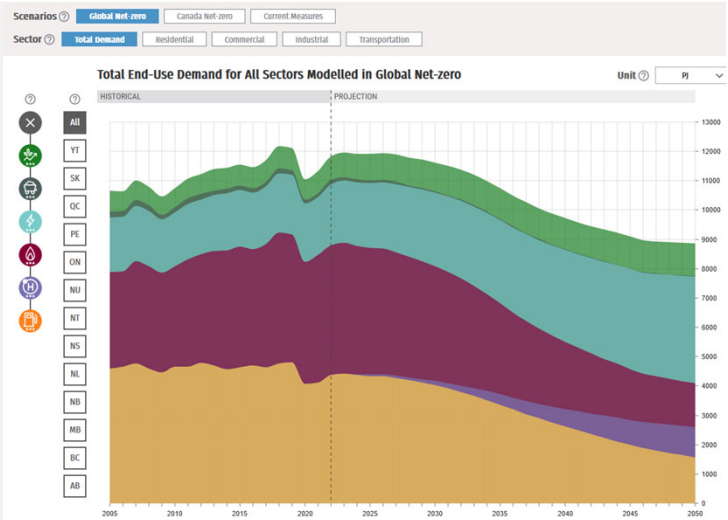
Source: AESO, CER, analyst judgement

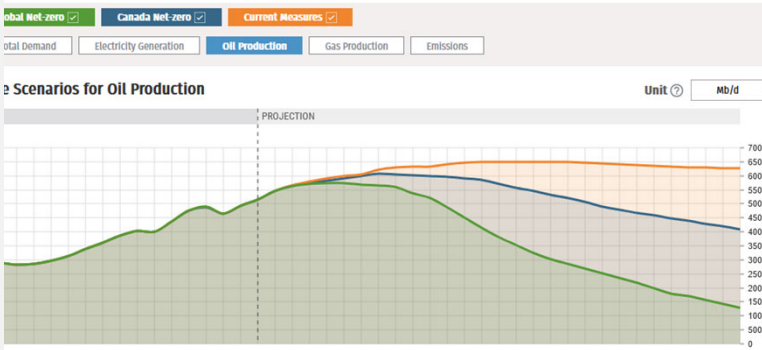
- Renewable cost assumptions were multiples above actual levels
- AESO is reconsidering its market design, deeming the energy-only market adequate in 2019
- Suboptimal planning, policy decisions can result stemming from these poor assumptions
- How to change modelling framework to avoid such surprises during an energy transformation?

Ex: federal net-zero pathways

Figure R.16:
Difference in generation between the Global Net-zero Scenario and the Uncoordinated Charging Case in 2050, by select fuel







Source: Canada Energy Regulator

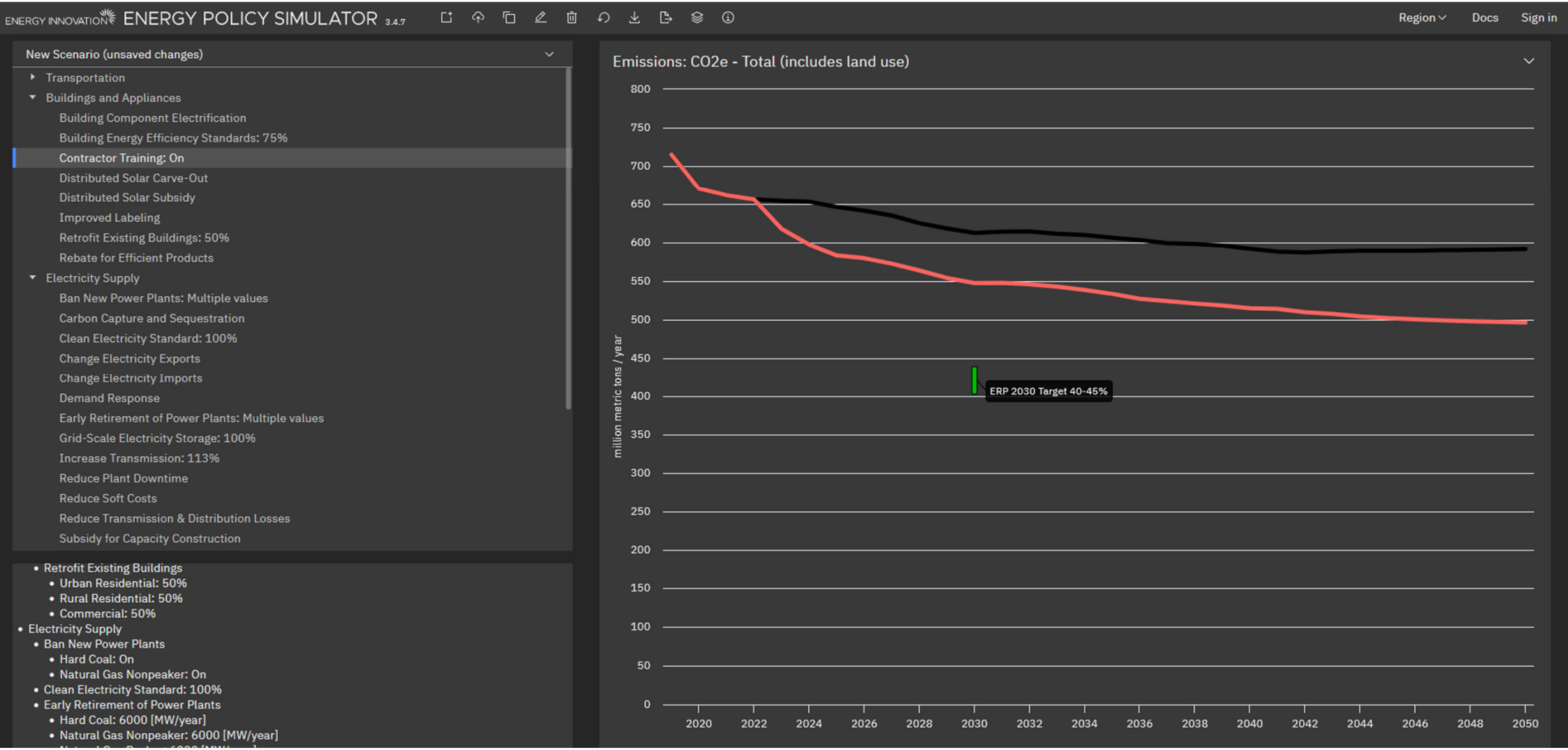
Overcoming the obstacles

Energy Modelling Hub (EMH)

- EMH launched national network of energy modellers created to guide the transformation of Canada's complex energy systems
- Mission: support evidenced-based policymaking towards net-zero and facilitate access to energy modelling expertise and modelling tools
- Strategic priorities:
  - **Convene and communicate** knowledge transfer across the modelling community
  - **Train and connect** modellers and policymakers
  - **Facilitate access to models and data:** develop and maintain open-source modelling and data sources (using FAIR principles: findability, accessibility, interoperability, and reusability)
- EMH is trying to illustrate how to convene its activities by using attempting to model a net-zero economy, starting with the electricity sector
- **EMH Annual Forum identified the availability and open licensing of data as the topic challenge for policymakers to make effective policy decisions**

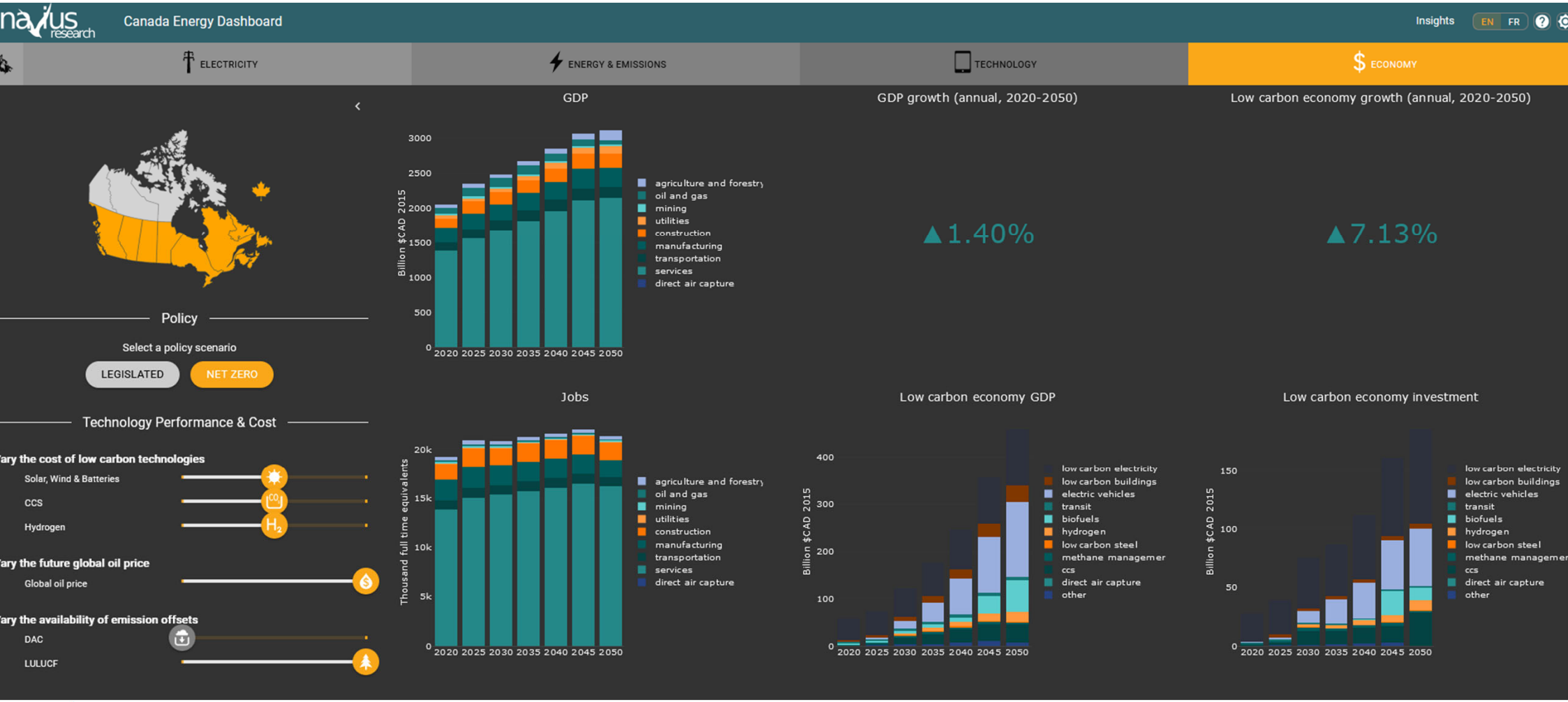
Open-source energy modelling tools are emerging

Source: Pembina

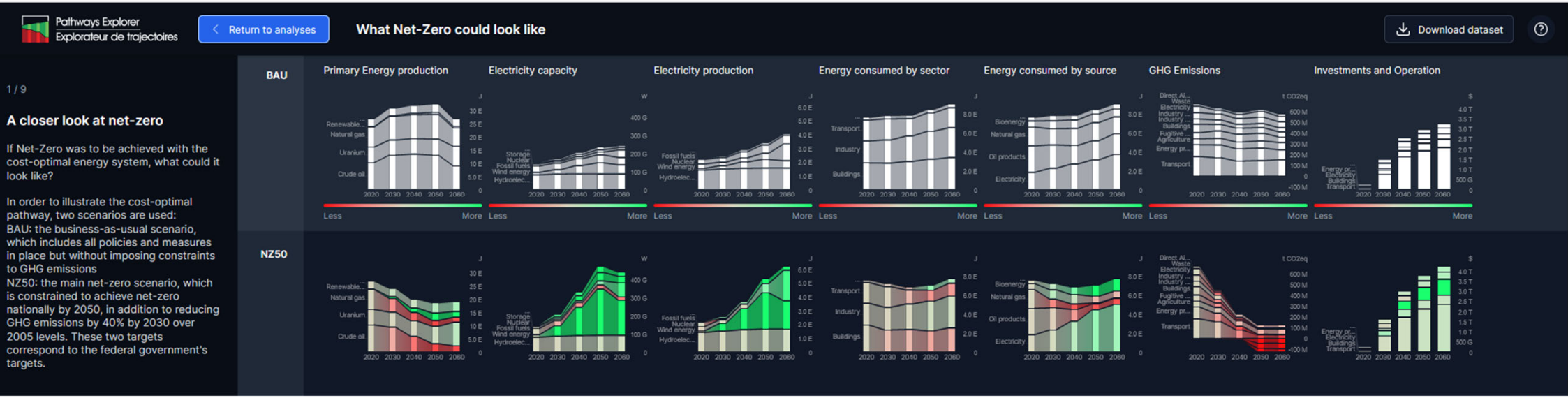


Open-source energy modelling tools are emerging

Source: Navius



Open-source energy modelling tools are emerging



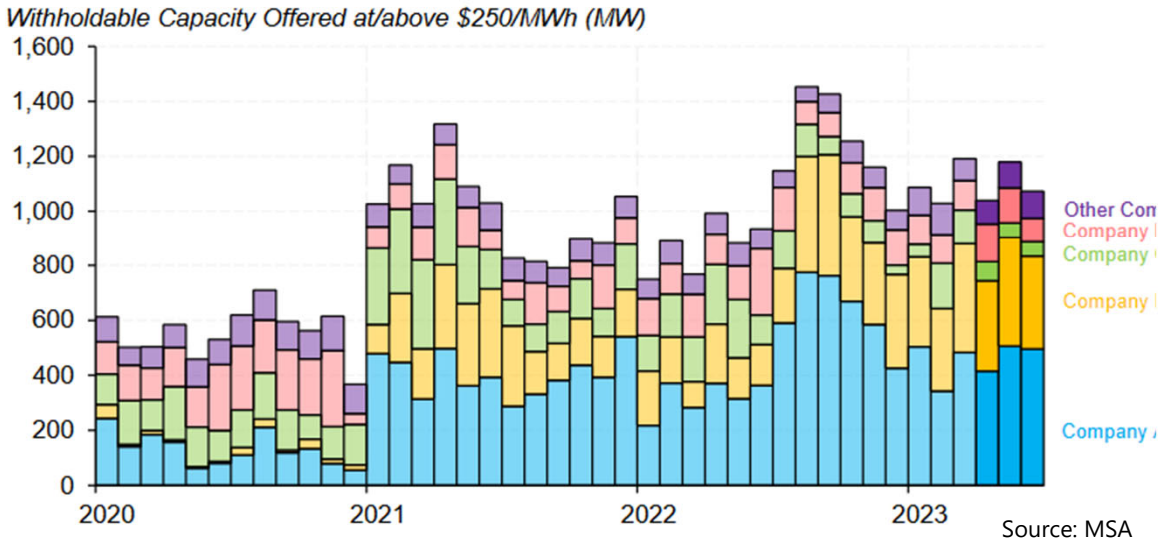
Source: IET

Addressing the data challenge

- Many data sources, many different standards, many different answers
- CODERS (Canadian Open-source Database for Energy Research and Systems-modeling)
  - EMH initiative aiming to reduce burden on gathering data, while being transparent and maintaining quality
- Gaps in data coverage
  - Detail on renewable fuels, hydrogen data
  - **Electricity:**
    - **Lack of granularity on demand side, particularly the shape of load curves**
      - **How to model demand response if you don't know end-user behavior?**
    - **Need for more accurate storage costs assumptions**
  - Significant gap in buildings, transport data necessary to model a net-zero economy
  - **Emerging, conflating issues can create new data gaps**
- EMH is partnering with AI-driven data sources to gather energy datasets

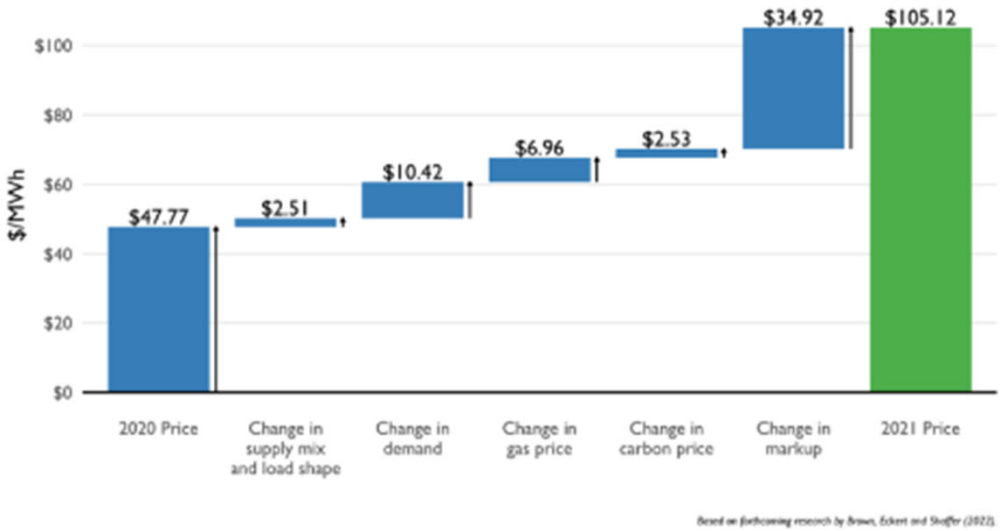
Ex: Expiry of Alberta PPAs at the end of 2020

Figure 30: Monthly average withholdable capacity offered at/above $250/MWh by company (January 2020 to June 2023)



Source: MSA

Estimated drivers of Alberta wholesale electricity price changes from 2020 to 2021 (CAD per MWh)



Source: Shaffer, Brown and Eckert

- Wholesale prices are tripling, residential rates are at record highs
- Many conflating this with rising levels of solar, wind capacity, higher carbon prices, etc.
- Shaffer, Brown & Eckert (2022) suggest that markups post-PPA expiry are driving 75% of the wholesale increase
- Affordability is also a reason why AESO is reviewing its market design

Anticipating emerging questions

- Much work put into forging and visualising net-zero pathways via variations in policy, technology
- Models will need to address emerging concerns in a timely manner
- Ignorance of emerging issues risks derailing ambitions
- Questions regarding how policy choices and mixes affect grid reliability, energy security, and affordability
- Not all models are set up to answer these questions

Conclusion

Conclusions

- A net-zero electricity sector is seen as the backbone of Canada's emission reduction plan
- Provincial autonomy and resource variability necessitate a flexible policy approach from the federal government, which the draft CER is attempting to accomplish
- Canada can model energy system transformation, but policymakers could be guided by vested interests in the absence of accessible, transparent tools that address their areas of concerns
- EMH is striving to coordinate the modelling community so that open-source modelling tools are available for stakeholders to transparently inform policy development
- Canada is beginning to collect data about emerging technologies, fuels, energy carriers
- Expansion of FAIR data principles via CODERS could help prevent analytical blunders and simplify energy data retrieval processes
- Responding to the emerging questions and concerns of stakeholders will reveal gaps in data coverage
- Failing to address emerging concerns could derail a coherent transformation of the energy system

Questions?

Sources

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Thank you.

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