Canadian Energy Outlook 3rd edition

REPORT #2: Pathways for a net-zero Canada

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In this presentation

- **The model and main scenarios considered**
- **Main results and highlights**
- **Key takeaways from the report**

Interventions

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Questions

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About the Institut de l’énergie Trottier

POLYTECHNIQUE MONTRÉAL
UNIVERSITÉ D’INGÉNIERIE

FONDATION FAMILIALE TROTTIER FAMILY FOUNDATION

Created in 2013 with funding for the Trottier Family Foundation, support renewed in 2023

Mission

- The academic training of a new generation of engineers, scientists and innovators with a systemic and trans-disciplinary understanding of energy issue
- The research for sustainable solutions for our energy future, while supporting knowledge generation and innovation in the energy sector to help face the coming decades challenges
- The dissemination of knowledge on energy related topics, contributing to the societal dialogue on energy issues.

Some of our current projects

- Development of an evaluation grid for biomass project in the context of a next-zero Canada
- Reducing electricity peak demand and improving resiliency in a world ever more electrified
- Co-leading, with IESVic and U. Calgary, the **Energy Modelling Hub**, a pan-Canadian boundary organization that ensures the development of, maintains and makes accessible energy models and brings together public policymakers and energy modelling communities.

Who are we ?

- A modelling & consulting firm **founded in Canada in 2013**.
- Provide **3E (energy-economy-environment) integrated system modelling** for strategic decision-making.
- In North America and **globally**.
- With a team of **modellers** with strong engineering, mathematics, economics, climate change science background (M.Sc., M.Eng., M.B.A & Ph.D.).
- Professional experts with **+20 years of experience.**

Our services

- Development of **turnkey energy system models** for public or private organizations worldwide.
- **Trainings and support** to clients wishing to develop their own energy system model or to use an existing large model.
- Application of energy-economy models for **the analysis of complex problems**, including energy security and climate change mitigation.

NATEM

Long term planning- Energy system

NATEM Power

Short term planning – Electricity system

RateVision

Impact on rates and energy bills

NAGEM

Macro-economic impacts

e3cHub
HEC MONTRÉAL
Environment, energy and circular economy

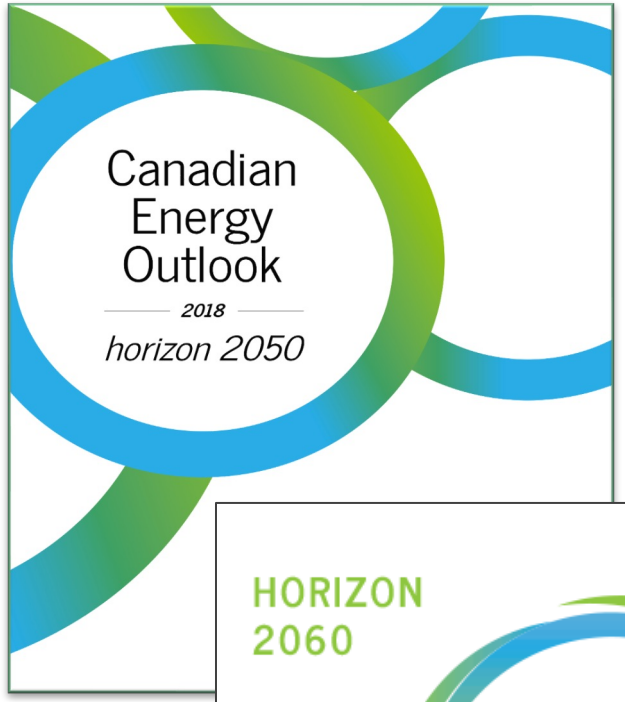
Who are we?

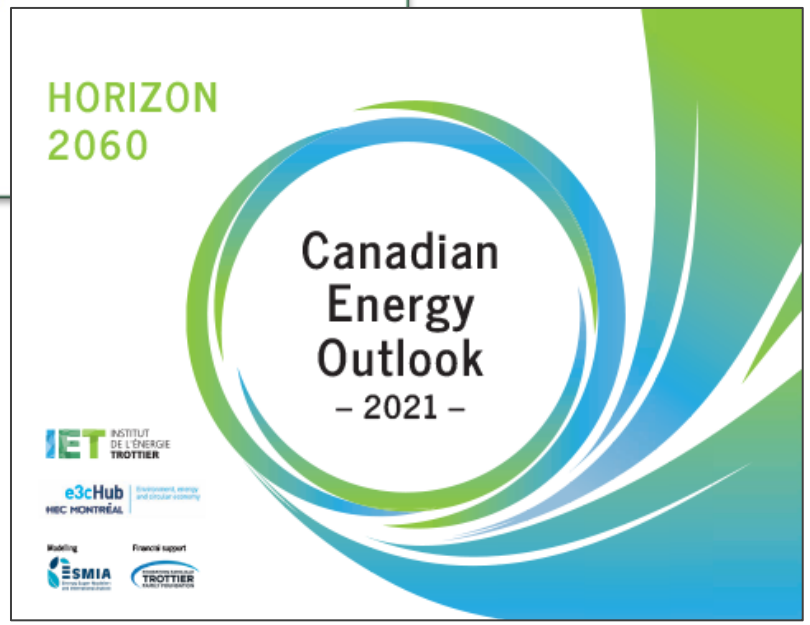
- The e3c Hub is a **multidisciplinary hub** at **HEC Montréal.**
- It comprises 13 professors, a research professional and a coordinator.

Our mission

- The e3c Hub's mission is to **advance the transition towards a sustainable society and economy**, in close collaboration with public and private organizations, knowledge transfer centers and local authorities.
- To this end, it **develops 3E models**, and more specifically the AD-MERGE model, a global integrated assessment model.
- Additionally, the e3c Hub **designs and organizes research and knowledge transfer activities** to educate and train diverse audiences in the pursuit of this transition.

Situating this report among other contributions





Canada's Energy Future 2023

Canada

Canadian Energy Outlook 3rd edition

Objectives of the project: explore and analyze challenges linked to net-zero scenarios, with the help of techno-economic optimization (NATEM)

New structure compared with past editions

- Broken down into a series of reports
- Report #1: The State of Energy and GHG Sources in Canada (January 2024)
- Report #2: Pathways to net-zero (main modelling results, June 2024)
  - Results available with summary of analyses on a dedicated platform (upcoming)

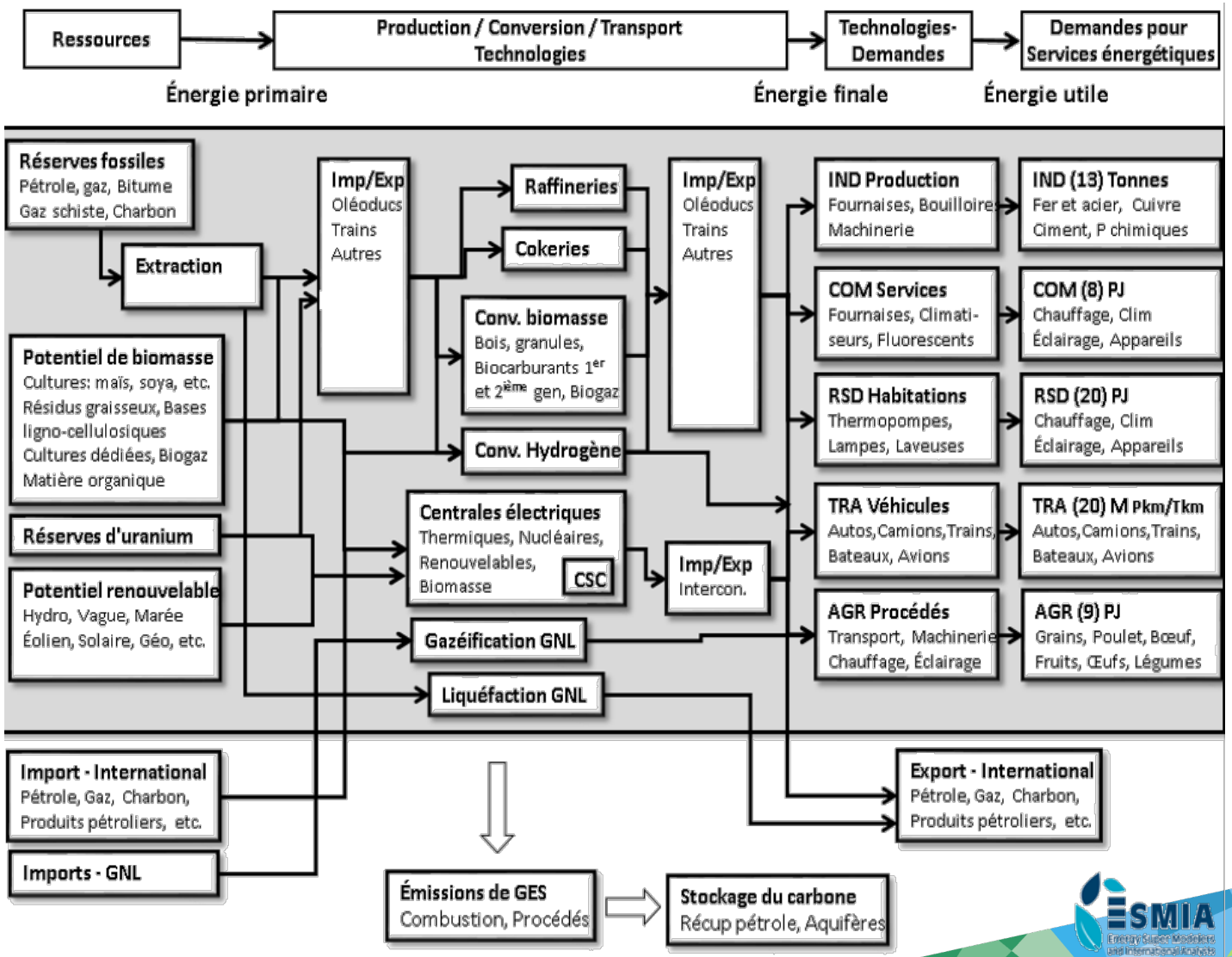
After which:

- Series of reports on strategic challenges or themes identified from the modelling results

NATEM – A TIMES family model

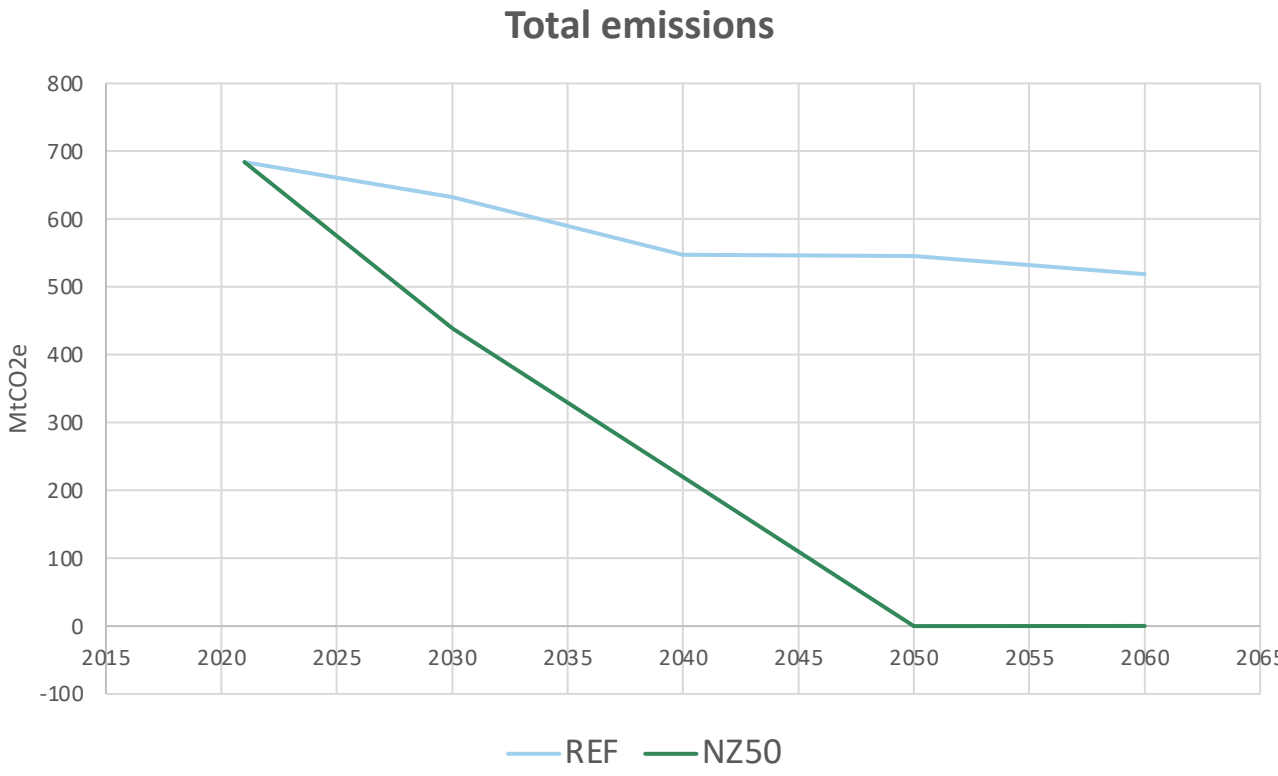
Strengths

- System representation
- Technology explicit: capital stock turnover, effect of techno regulation, >4500 technologies
- Results at the provincial level
- Full coverage of emissions outside of LULUCF (partial coverage)



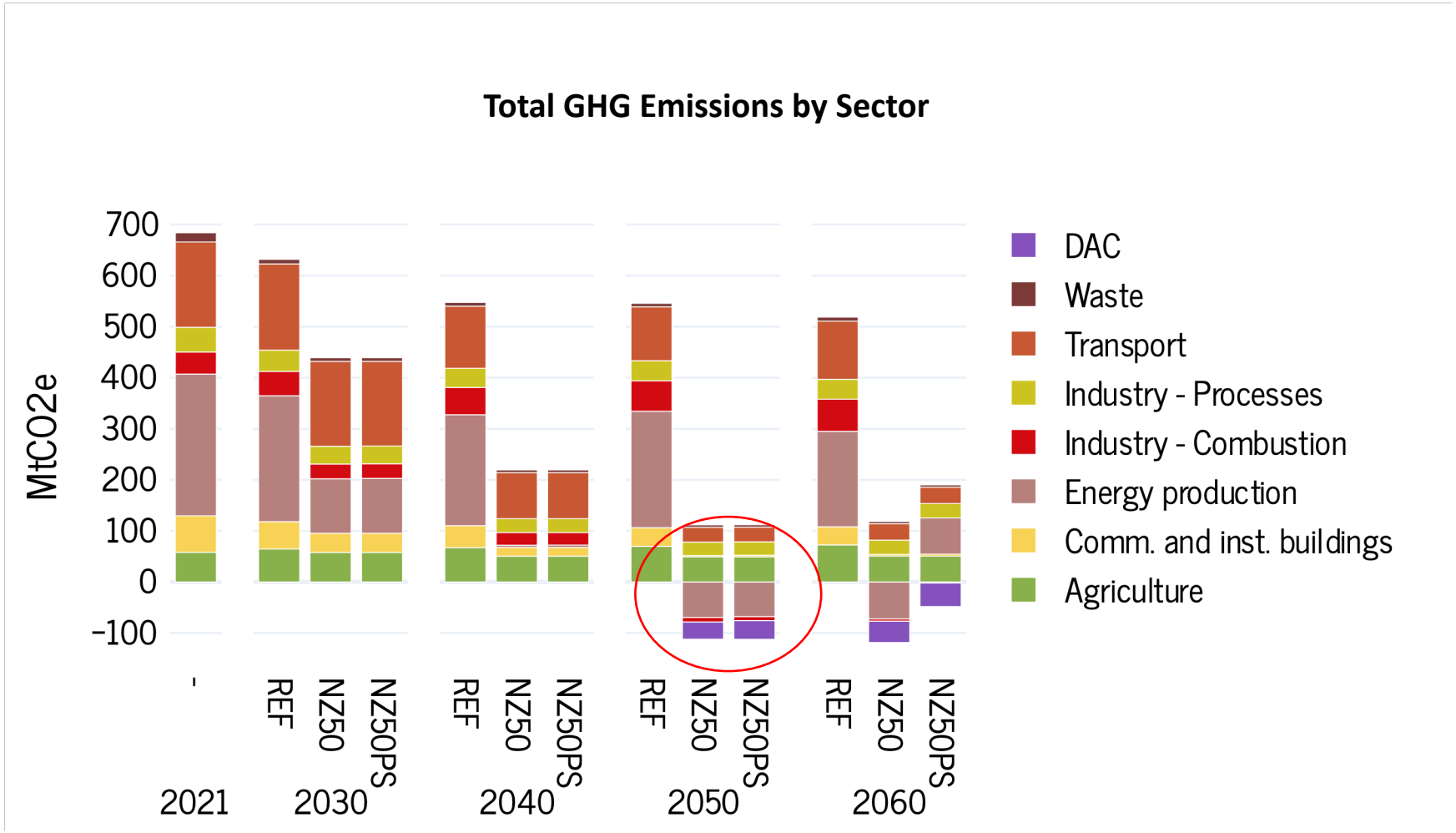
The scenarios

REF	No constraining GHG reduction targets. Macroeconomic assumptions (GDP, population, oil and gas export prices) are aligned with the Canada Energy Regulator's projections, imposing no additional constraints in terms of GHG emissions. Includes all GHG reduction and energy policies already in place in addition to the Clean Electricity Regulations and Zero-Emissions Vehicle sales mandate
NZ50	This scenario imposes a net-zero emissions target on total CO2-eq by 2050, and a 40% reduction target by 2030, with respect to 2005.
NZ50PS	Same as NZ50 except for cost projections for nuclear SMRs, which are higher (Pessimistic SMR cost projections)



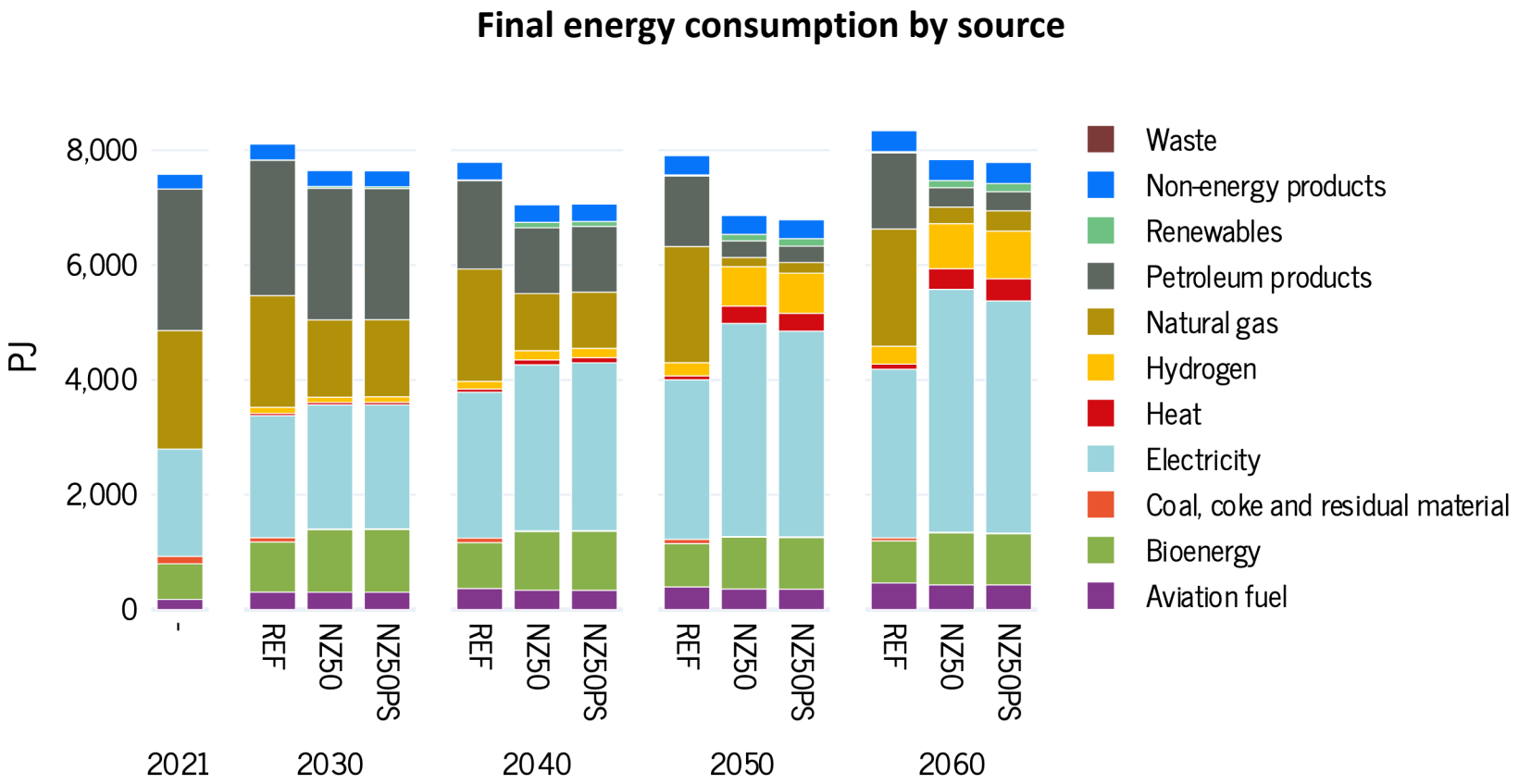
Reaching net-zero emissions

- REF shows downward emissions trend, although short of the 2030 target
- Rapidly expanding gap between NZs and REF
- NZs require a significant amount of emission removal, mainly in the energy production sector



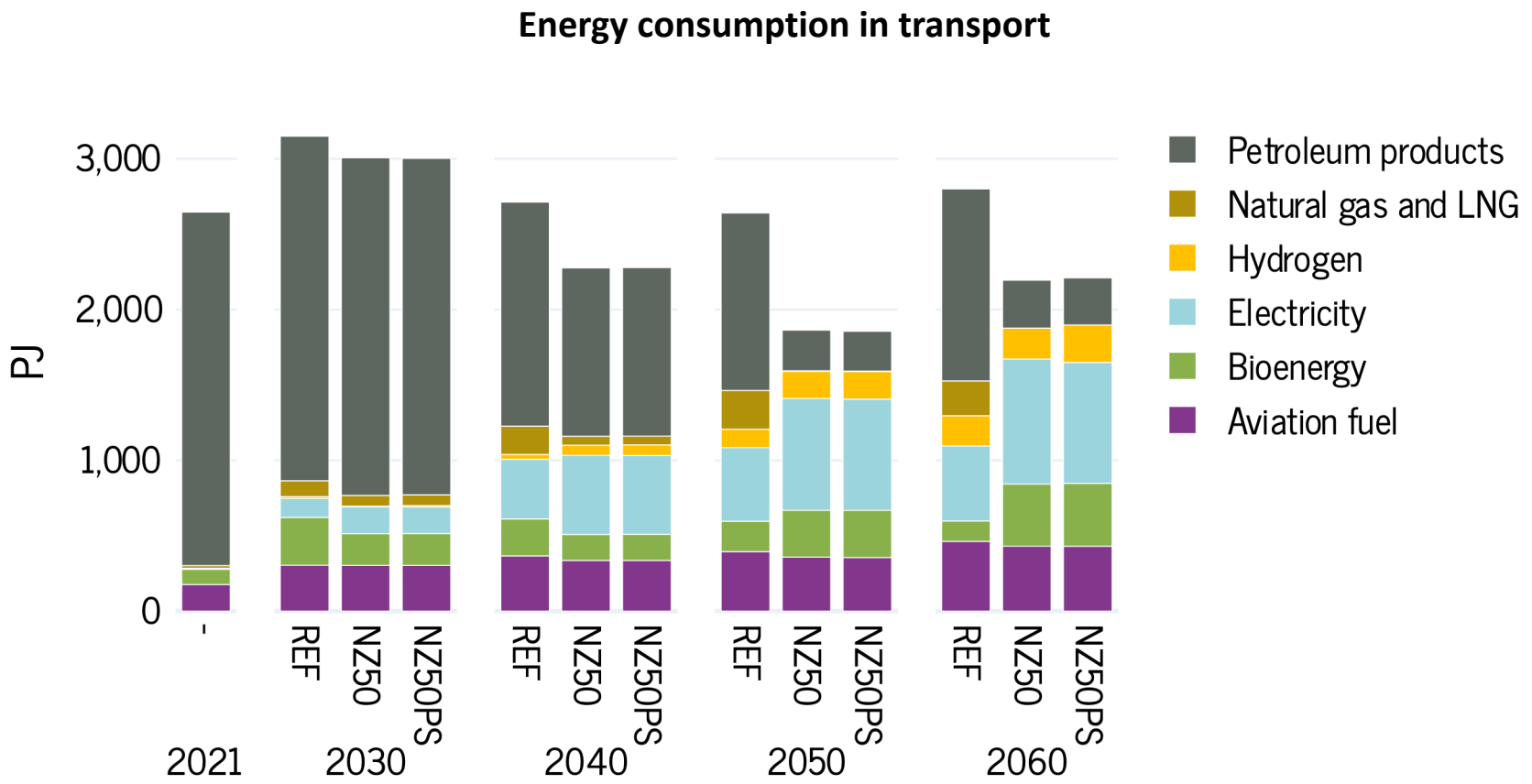
Transformation of energy consumption profiles

- Demand goes down over time in NZs, despite population growth and even without loss in energy services
- Productivity gains in the delivery of services, including from electrification
- Rebound after 2050 due to population growth and almost completed electrification



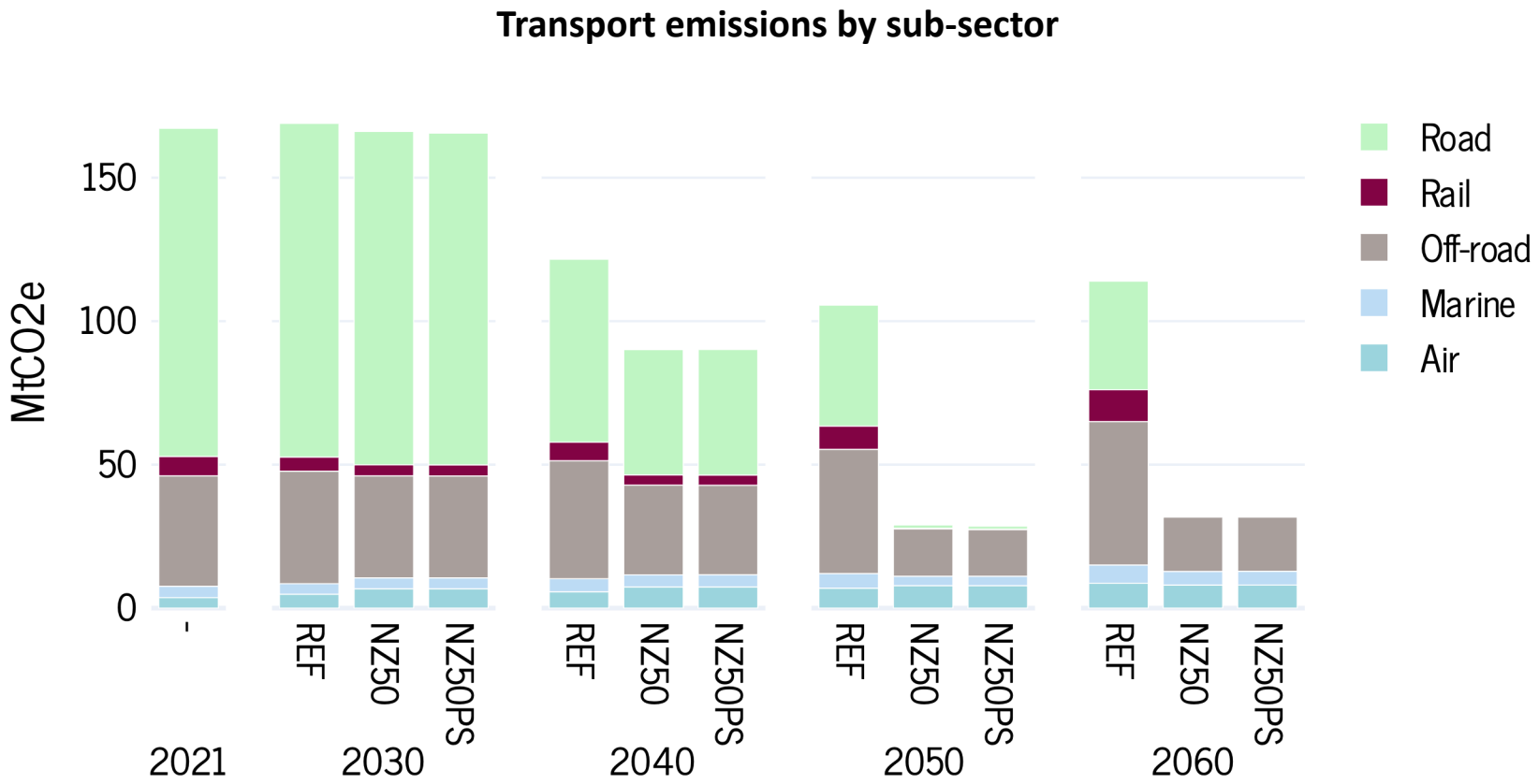
Transport

- ZEV leads to the electrification of light duty vehicles
- Limited decarbonization in REF outside of this segment
- Choices ahead: many technologies compete in some sub-sectors, several of which require significant new infrastructure



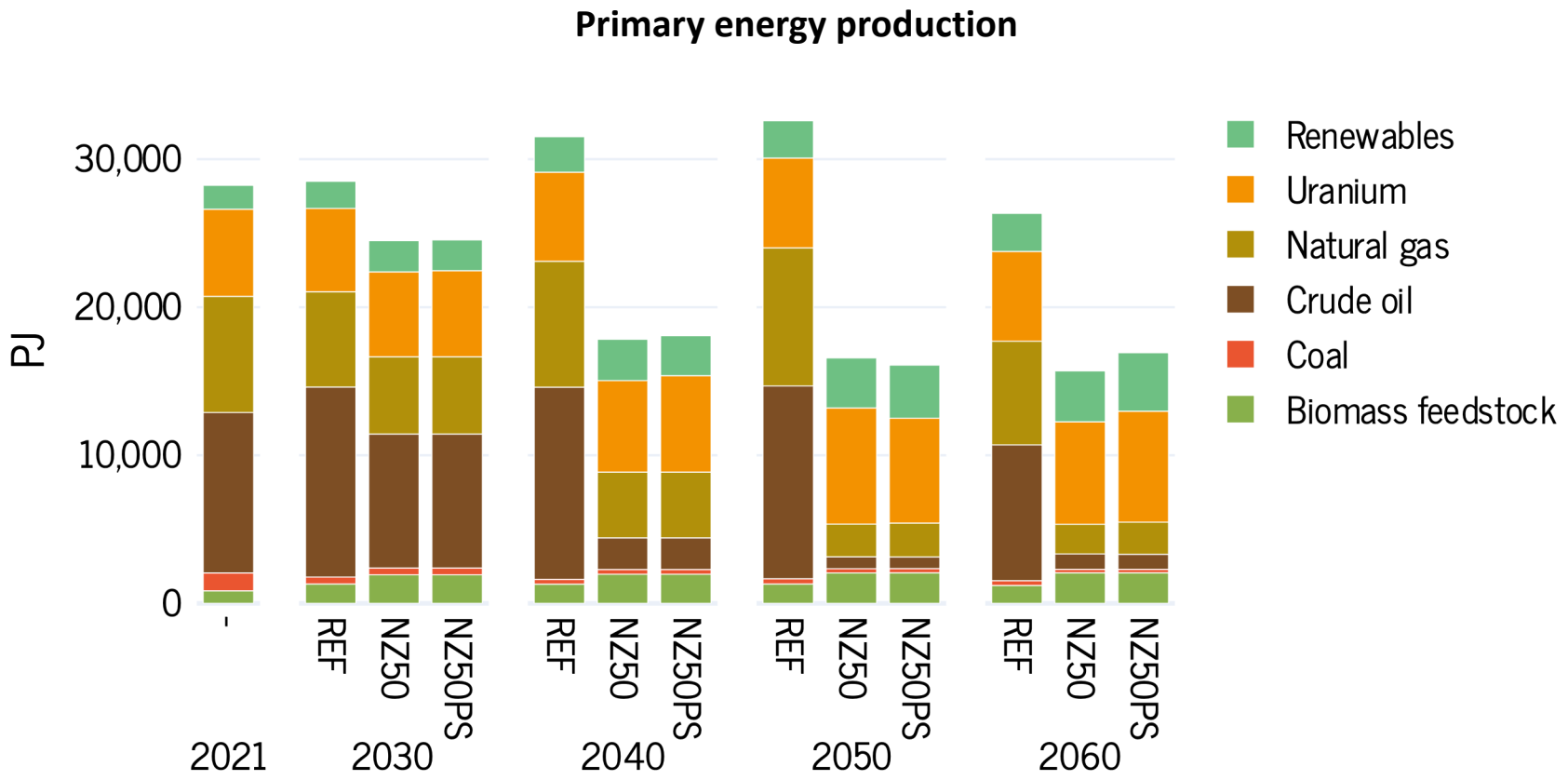
Transport (continued)

- Evolution of scenarios (including REF) shows growing importance of some segments
- High cost of decarbonization options for marine and air, and neglect of off-road



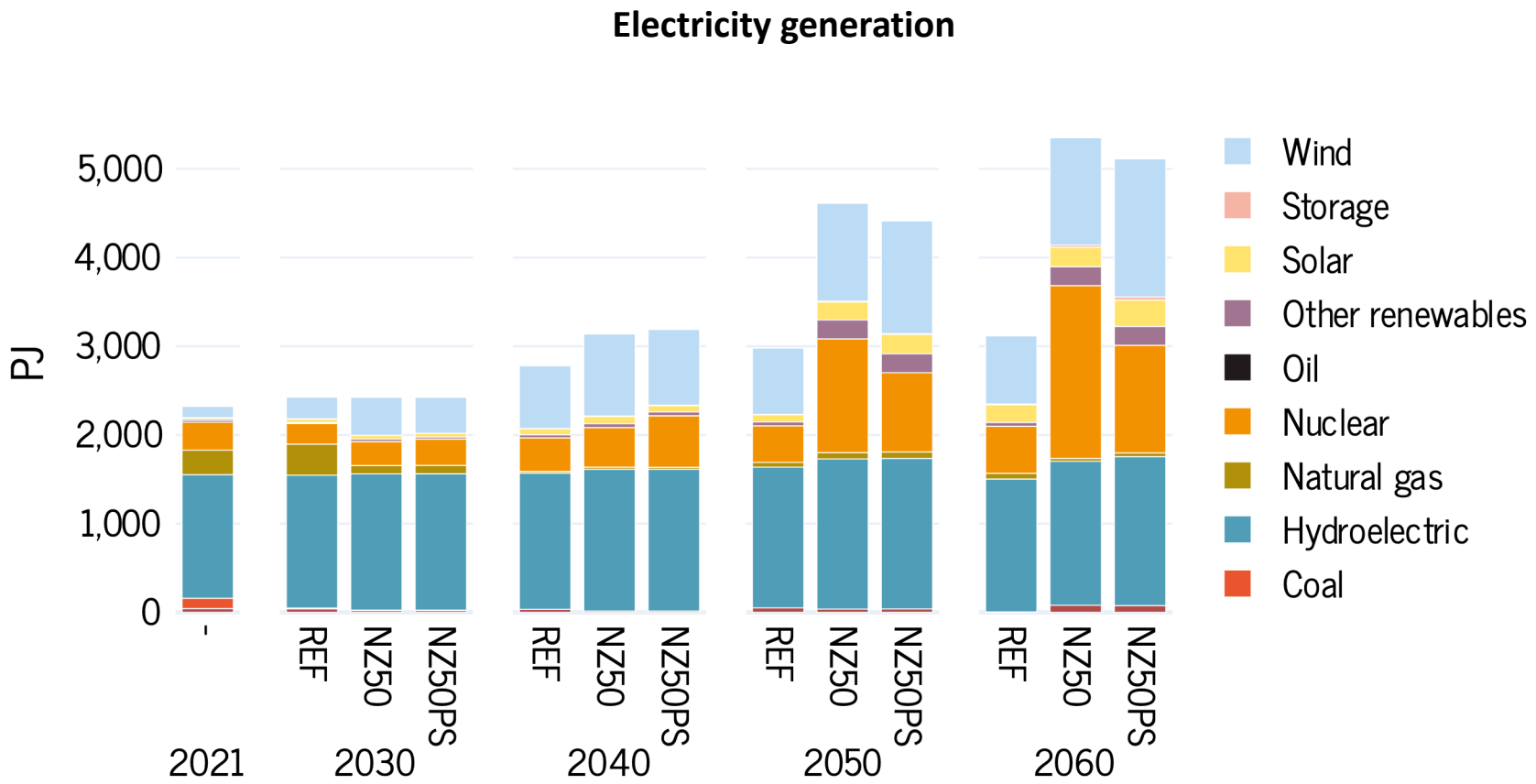
Energy production

- Floor imposed on oil and gas production
- Not reducing O&G production as extensively as in NZ means reducing elsewhere at much higher cost
- Natural gas and uranium driven by domestic demand (export markets projections are given)



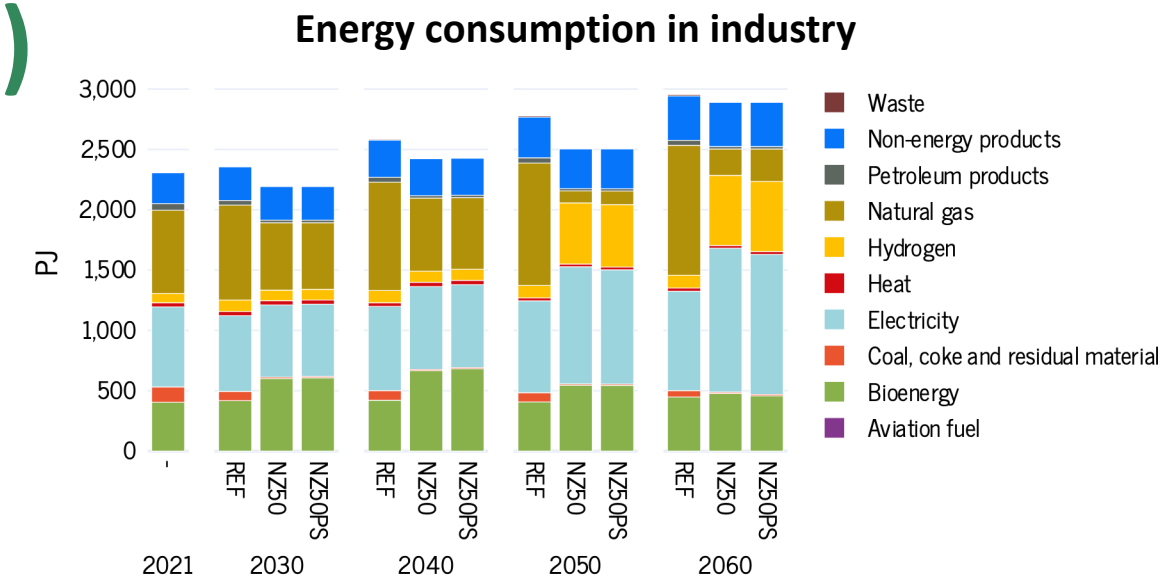
Electricity generation

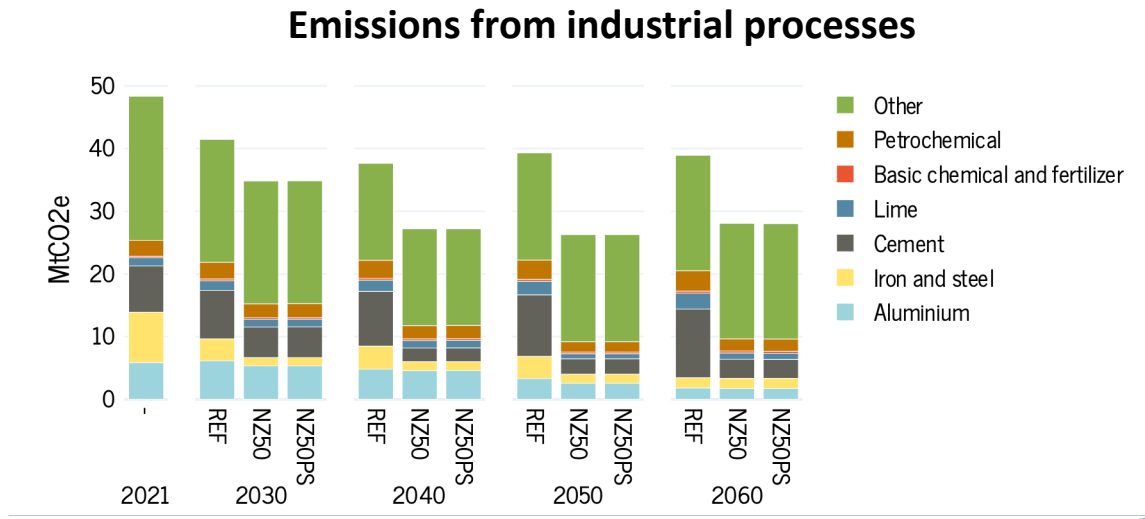
- Electricity demand expands dramatically in all NZs
- Uncertainty beyond cost for deployment of some sources
- NZ50PS scenario used as a proxy for baseload deployment choices (social acceptability for instance)



Industry (outside oil & gas)

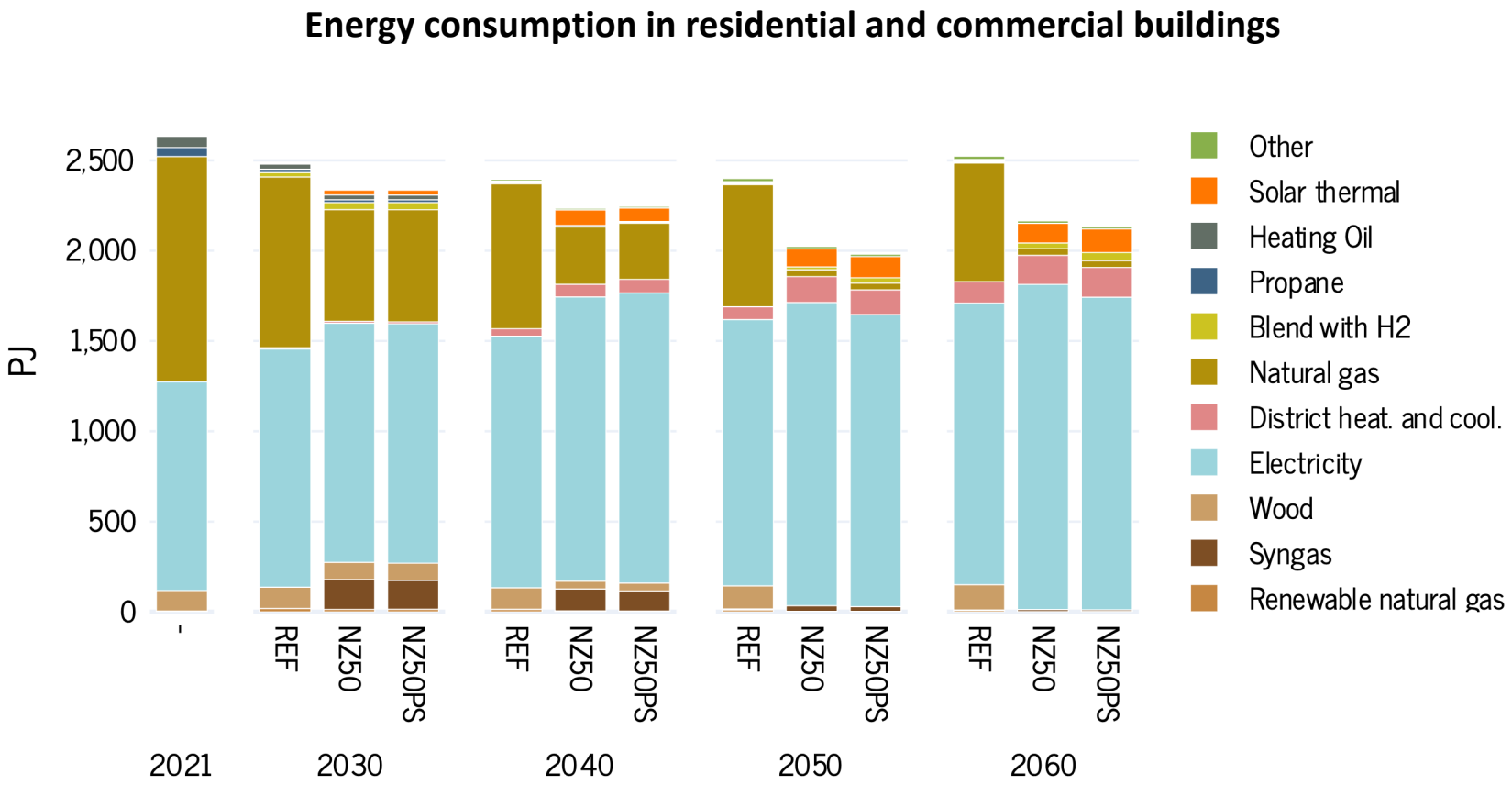
- An already diversified energy mix in industry evolves slowly in NZs, highlighting barriers
- Important challenges result from the varied needs across sub-sectors and the importance of process emissions





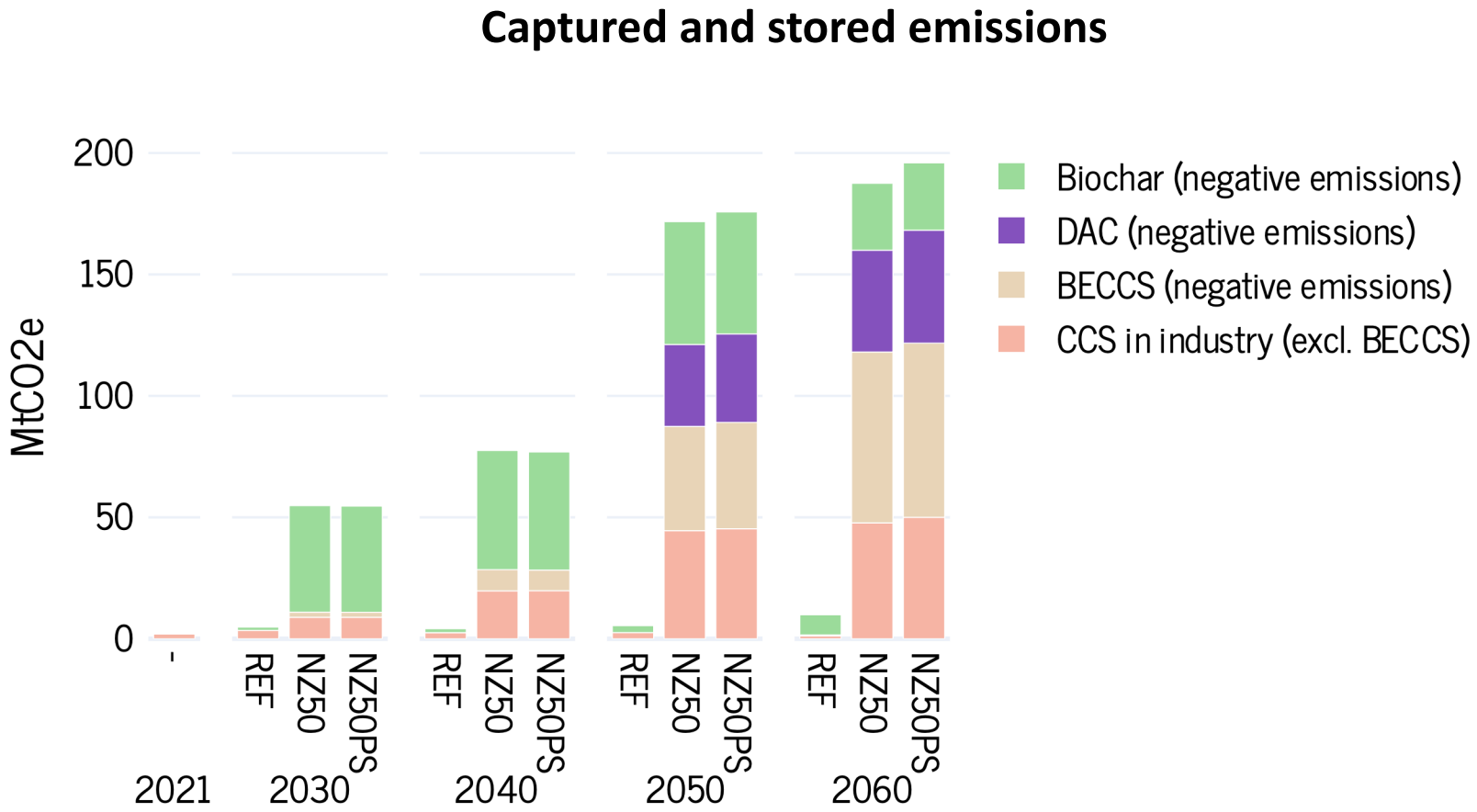
Buildings

- Decarbonizing buildings through electrification represents a low-hanging fruit, but barriers remain
- Convergence of winter peak demand requires adapted solutions to avoid overbuilding electricity capacity (not fully captured by the model)



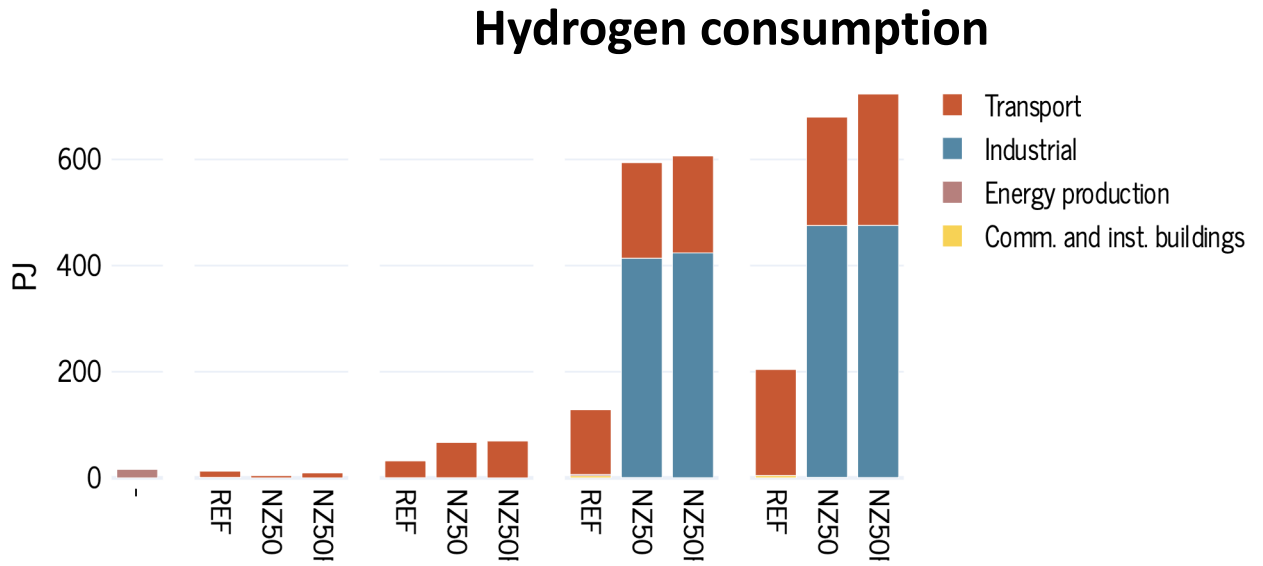
Capturing emissions

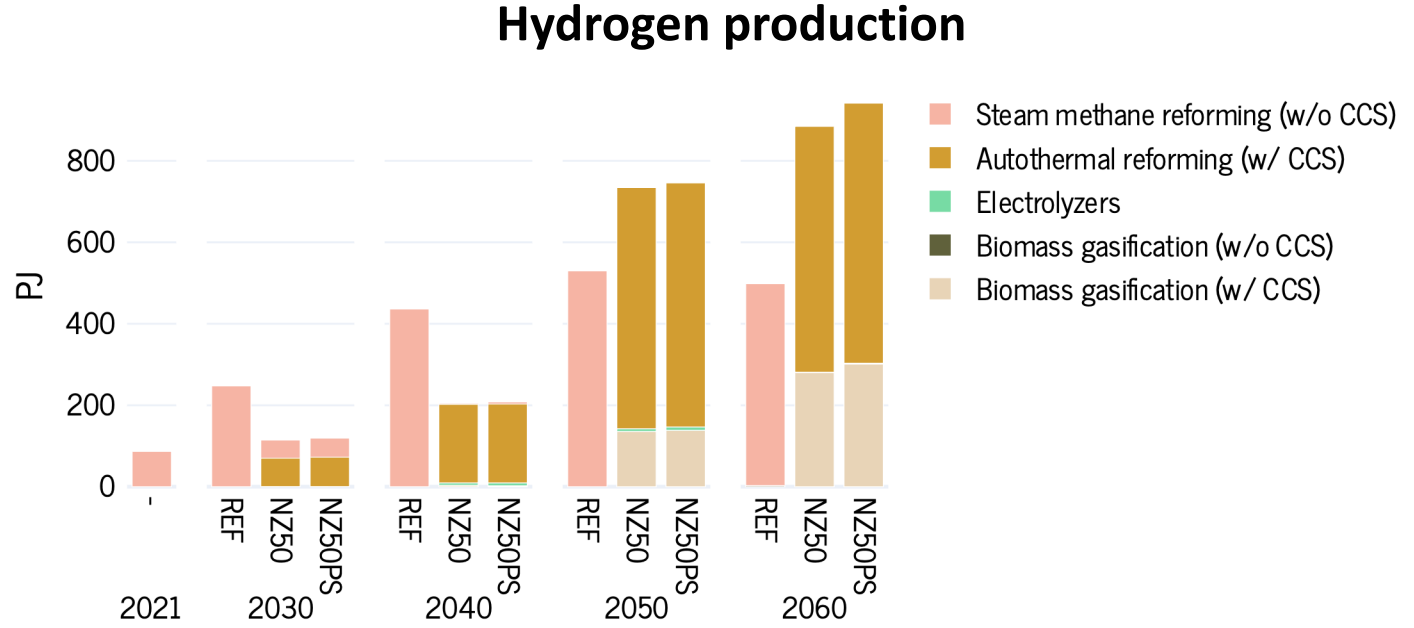
- Around 172 MtCO2e of emissions (25% of today's) must be captured annually to reach net-zero, growing to 196 by 2060
- Negative-emission technologies are essential, with very important uncertainties



Hydrogen

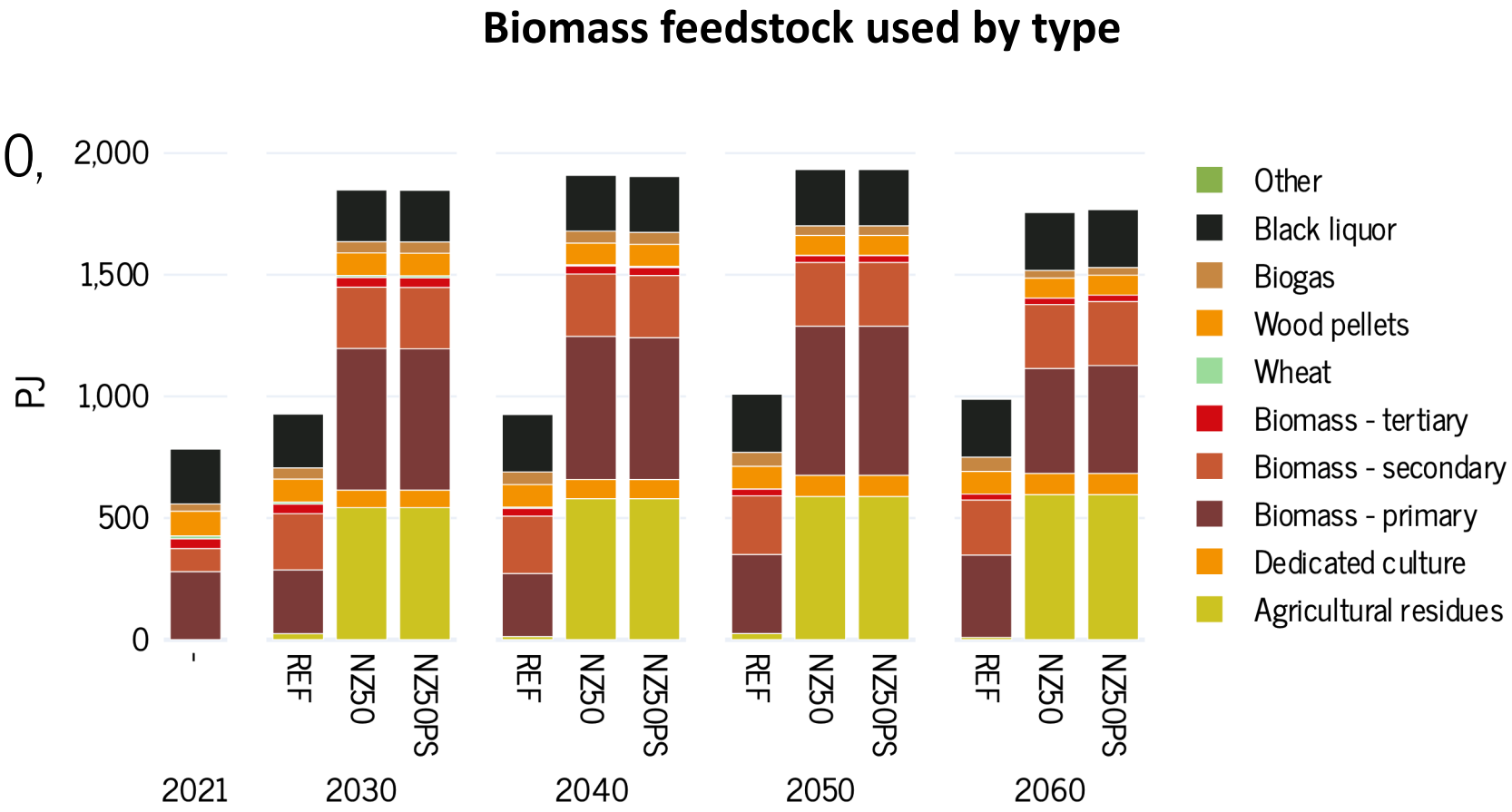
- Consumption smaller in REF despite strong growth
- REF and NZ50 differ sharply on production technology and importance of exports as a driver





Bioenergy

- Tripling of use in NZs by 2030, largely because of ability to compensate remaining emissions



Thinking about 2030

- Main emissions reductions for 2030 are expected from oil and gas production, buildings and electricity generation
- But much faster pace suggested by NZ50 to meet the 2030 target almost structurally impossible

	2021	2030		2050	
	Reference year	REF	NZ50	REF	NZ50
Reductions wrt 2005 (730 $MtCO_2e$)	-6%	-14%	-40%	-25%	-100%
Total net emissions ($MtCO_2e$)	684	632	439	546	0
Sectors					
Electricity production	77	49	13	5	-17
Oil and gas (including fugitive emissions)	185	175	131	181	10
Buildings	72	54	37	36	3
Industry (outside of oil and gas)	92	89	64	99	18
Transport	167	169	166	106	29
Agriculture	58	64	58	70	49
Waste	18	9	7	7	5

Differences between now and CEO 2021

Main differences:

- Reference scenario shows reductions, not increases, in GHGs (ZEV, CER, CFS, …)
- Costs of decarbonizing are less than projections for net-zero in 2021 (technological developments providing solutions but also reducing uncertainties)

Similarities:

- Dramatic expansion of electricity (including in REF)
- Reductions in crude oil production to mitigation costs
- Magnitude of emissions compensation (with the addition of biochar)

Main takeaways

Net-zero requires making choices compatible with the long-term goal, regardless of the short-term target

- Additional measures and road maps urgently needed to enable a net-zero pathway, including from provinces
- No time for dead-end solutions

Main takeaways

Infrastructure deployment faces numerous challenges

- The infrastructure gap is enormous and requires deployment plans rapidly (IRPs)
- The dramatic expansion of electricity's role in the mix is not simply a challenge in terms of infrastructure construction
- In some sectors, competing technologies will require political choices to avoid duplication or inefficiencies in infrastructure deployment

Main takeaways

Need for road maps to reduce uncertainties and unknowns

- Some understudied sectors could be relatively low hanging fruits
- Road maps needed for sectors where few reductions are expected
- Assessing the role of biomass in decarbonization pathways, including beyond bioenergy, is necessary
- Exploring and planning the deployment of negative emissions options is urgent

Building on the results and the questions they raise, several new projects in development for part 3 in the fall

Q & A

Thank you!

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https://iet.polymtl.ca/en/energy-outlook/