ESMIA
Energy Super Modelers and International Analysts

From economy-wide energy system optimization to energy affordability for consumers in Canada

ETSAP Fall Workshop

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Agenda

1. Introduction
2. RateVision overview and applications
3. Results: Energy rates, consumer bills, and equity impacts under economy-wide energy planning
4. Major takeaways

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Introduction

- **Least-cost energy transition pathways at the economy-wide level do not necessarily translate into least-cost outcomes for all consumer categories**, such as:
  - Residential
  - Commercial
  - Industrial
- Use a dedicated tool to **project rates impact** (as an addition post-processing of results from a strategic planning model) by considering:
  - Costs of existing and future infrastructure (generation assets, pipelines, transmission lines, utility services)
  - Current and future energy consumption levels for consumers categories
  - Regulatory frameworks and cost-allocation rules governing how utility costs are distributed

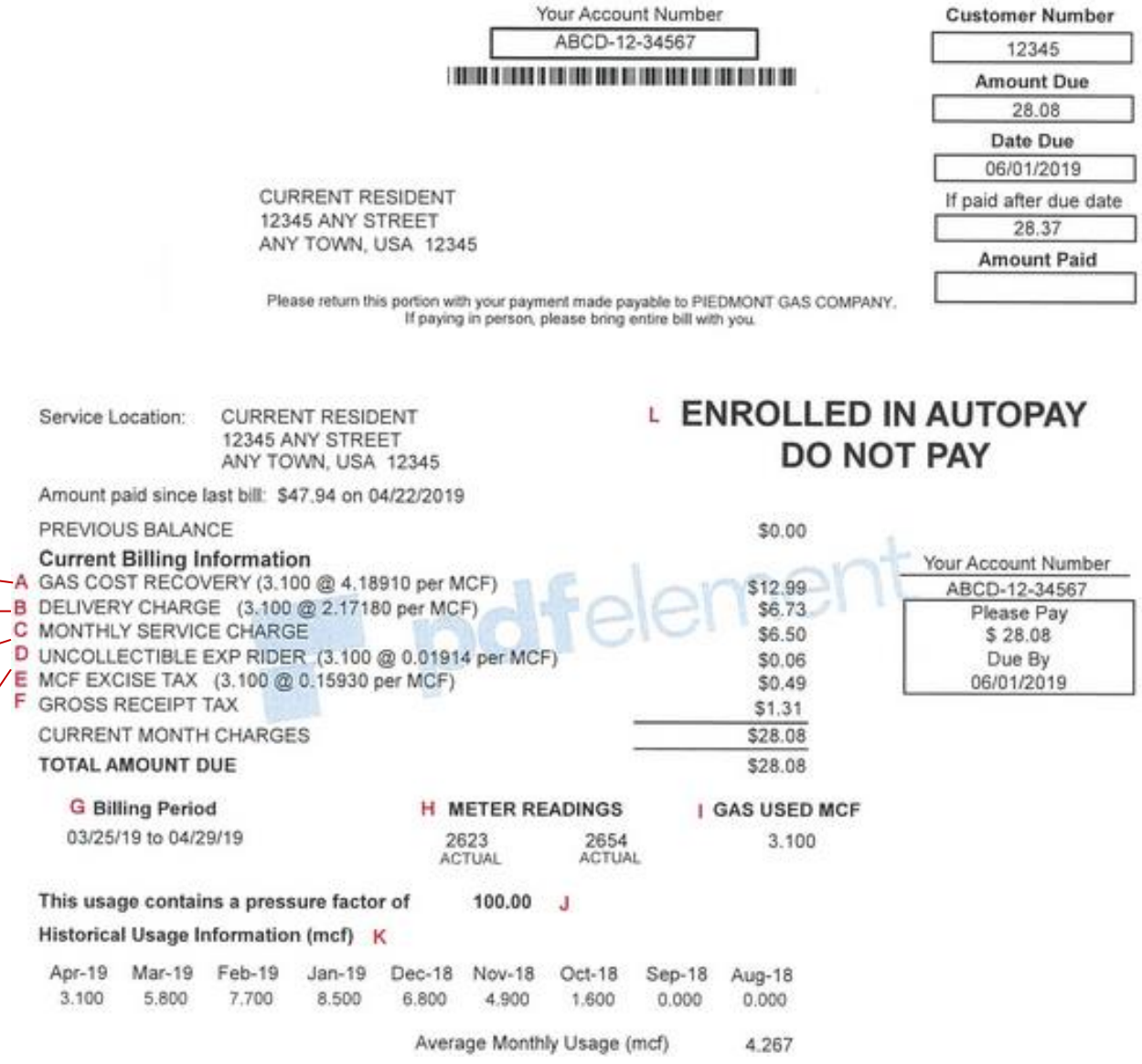
What is inside your energy bill?

Energy bills accounts for various cost components

- Cost of energy 'molecule' **(A)**
- Cost of delivery for this 'molecule' **(B)**
- Other operation and administration costs **(C)**
- Cost of power (for electricity)
- Other: carbon cost, and other fees and taxes **(D, E, F)**

These components may be affected differently by the energy transition

Example of a gas bill



Your Account Number
ABCD-12-34567

Customer Number
12345
Amount Due
28.08
Date Due
06/01/2019
If paid after due date
28.37
Amount Paid

CURRENT RESIDENT
12345 ANY STREET
ANY TOWN, USA 12345

Please return this portion with your payment made payable to PIEDMONT GAS COMPANY.
If paying in person, please bring entire bill with you.

Service Location: CURRENT RESIDENT
12345 ANY STREET
ANY TOWN, USA 12345

L ENROLLED IN AUTOPAY
DO NOT PAY

Amount paid since last bill: $47.94 on 04/22/2019

	PREVIOUS BALANCE	$0.00
	Current Billing Information	
A	GAS COST RECOVERY (3.100 @ 4.18910 per MCF)	$12.99
B	DELIVERY CHARGE (3.100 @ 2.17180 per MCF)	$6.73
C	MONTHLY SERVICE CHARGE	$6.50
D	UNCOLLECTIBLE EXP RIDER (3.100 @ 0.01914 per MCF)	$0.06
E	MCF EXCISE TAX (3.100 @ 0.15930 per MCF)	$0.49
F	GROSS RECEIPT TAX	$1.31
	CURRENT MONTH CHARGES	$28.08
	TOTAL AMOUNT DUE	$28.08

Your Account Number
ABCD-12-34567
Please Pay
$ 28.08
Due By
06/01/2019

G Billing Period	H METER READINGS		I GAS USED MCF
03/25/19 to 04/29/19	2623 ACTUAL	2654 ACTUAL	3.100

This usage contains a pressure factor of 100.00 J

Historical Usage Information (mcf) K

Apr-19	Mar-19	Feb-19	Jan-19	Dec-18	Nov-18	Oct-18	Sep-18	Aug-18
3.100	5.800	7.700	8.500	6.800	4.900	1.600	0.000	0.000

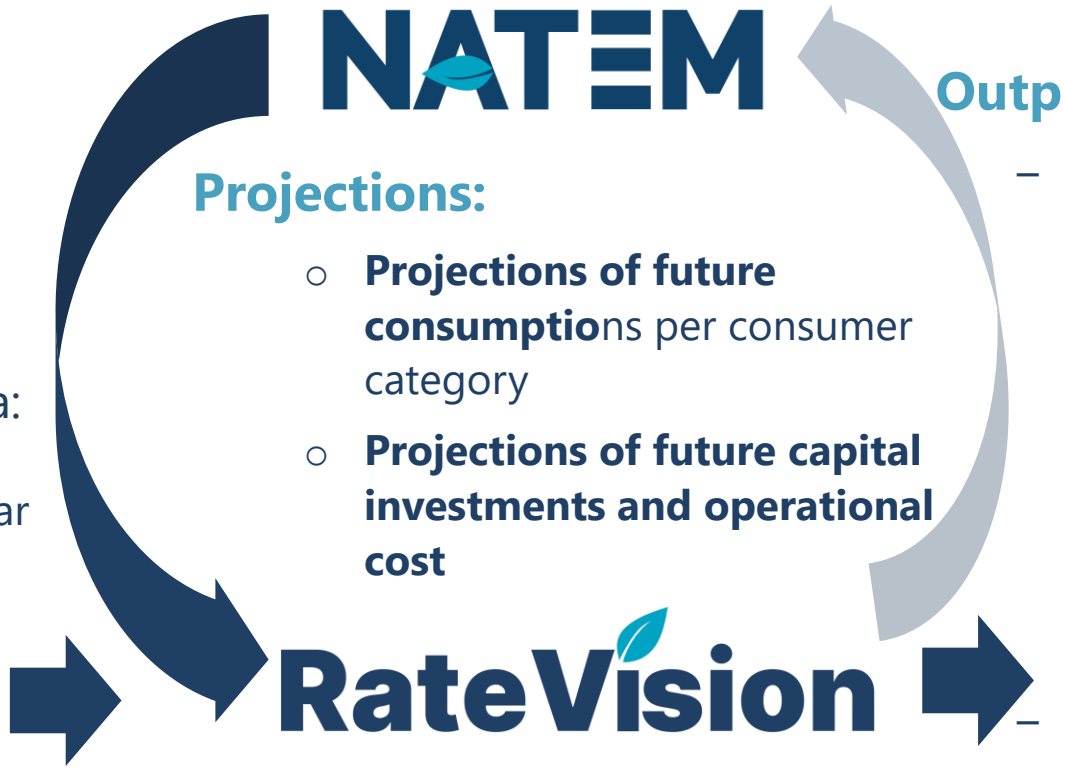
Average Monthly Usage (mcf) 4.267

Models' coupling

Potential for a retroactive loop to adjust the energy-transition trajectory in different sectors

Base year:

- Revenue requirements for **Utilities** and associated data:
  - Variable rates and fixed charges for the base year
  - Number of connected consumers in different categories for the base year
- Regulation (e.g., costs allocation per category) based on **Regulator** data



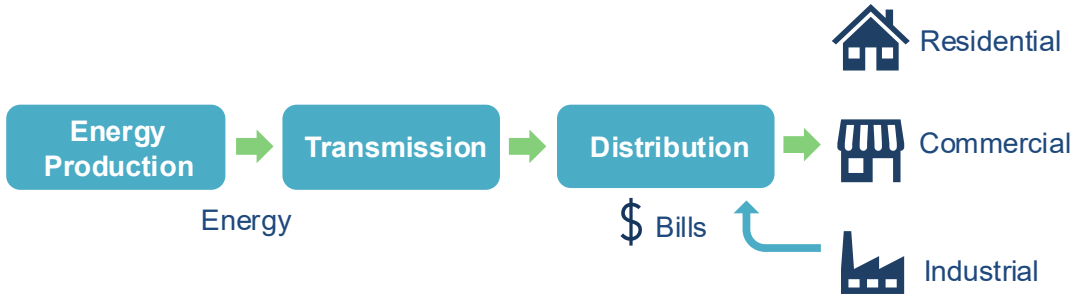
Projections:

- **Projections of future consumptions** per consumer category
- **Projections of future capital investments and operational cost**

Outputs (annual):

- **Rates and charges:**
  - **Variable commodity rate** (cost of energy 'molecule' for consumers)
  - **Variable demand charge** (for electricity)
  - **Variable distribution rate** (cost of service for energy supply)
  - **Carbon price** for an energy 'molecule'
  - **Fixed administration charges**
- **Bills:**
  - **Average bill** for a consumer category in a jurisdiction
  - **Bills for specific household archetypes**

Costs reallocation



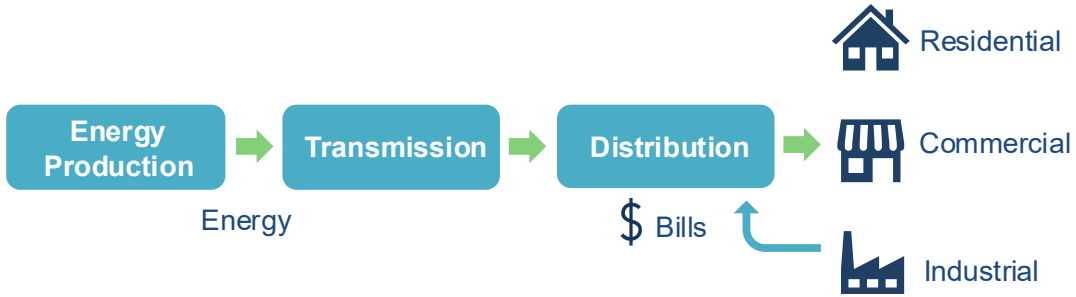
Utility Revenue Requirement (URR): The total operation and maintenance, capital and administration costs necessary to provide safe and reliable utility service.

For each consumer category (simplified): Energy

$$URR_{year}^{Energy} = Variable\ rate_{Base\ year}^{Energy} \cdot Consumption_{Base\ year} + Total\ annualized\ costs_{year}^{Energy\ generation}$$

$$Variable\ rate_{year}^{Energy} = \frac{URR_{year}^{Energy}}{Consumption_{year}^{Energy}}$$ $/kWh

Costs reallocation



Utility Revenue Requirement (URR): The total operation and maintenance, capital and administration costs necessary to provide safe and reliable utility service.

For each consumer category (simplified): Service

$$URR_{year}^{Service}$$
$$= Variable\ rate_{Base\ year}^{Service} \cdot Consumption_{Base\ year}$$
$$+ Fixed\ charges_{Base\ year}^{Service} \cdot Number\ of\ consumers_{Base\ year} + Total\ annualized\ costs_{year}^{Energy\ delivery}$$

$$Variable\ rate_{year}^{Service} = \gamma_{Variable} \cdot \frac{URR_{year}^{Service}}{Consumption_{year}^{Energy}}$$ $/kWh

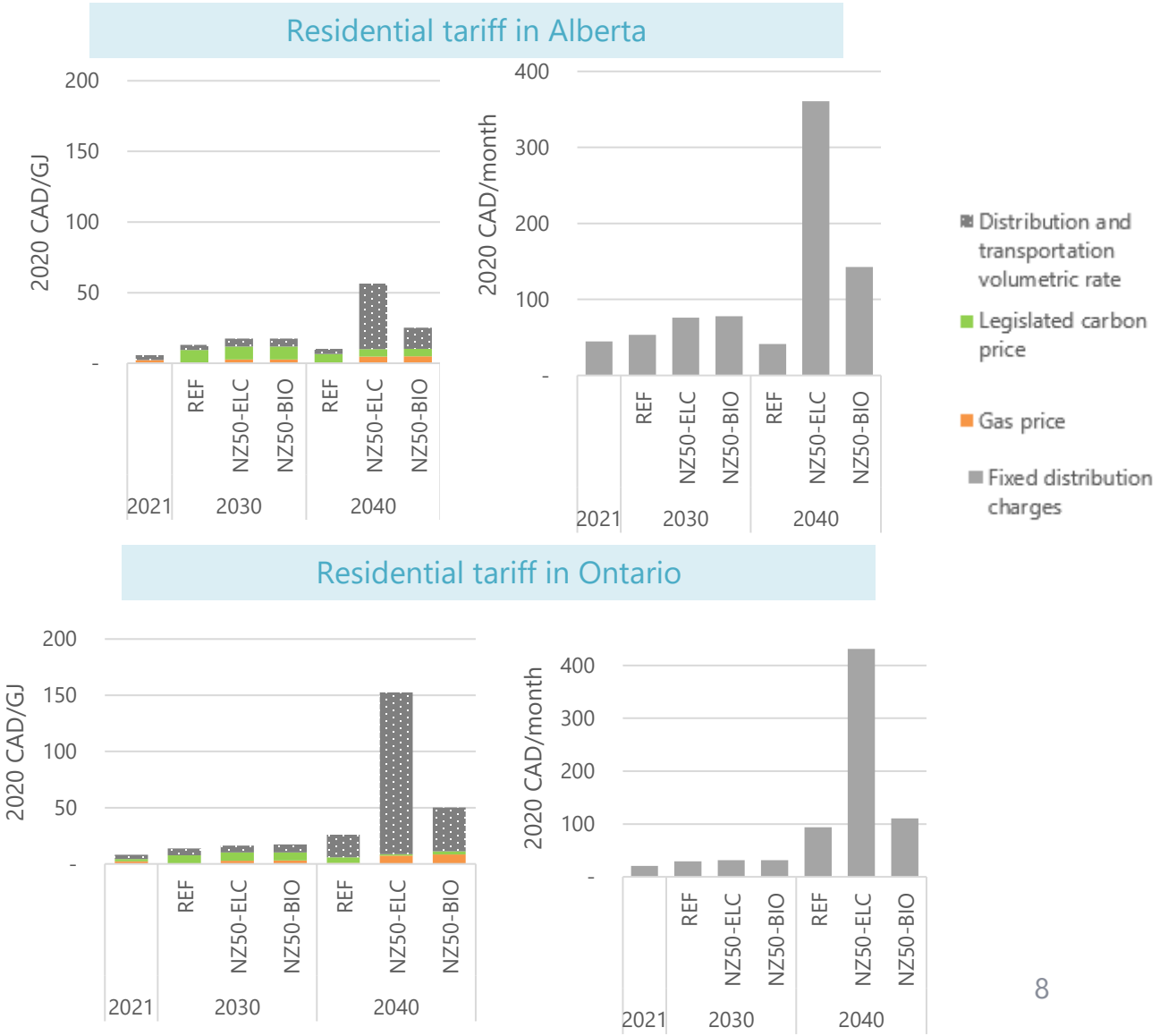
$$Fixed\ charges_{year}^{Service} = \gamma_{Fixed} \cdot \frac{URR_{year}^{Service}}{Number\ of\ consumers_{year}^{Energy}}$$ $/month

ELC – Focus on electrification
BIO – Focus on low-carbon fuels

How may gas rates evolve in the future?

Grid-related component of gas tariff is highly sensitive to to the context and electrification strategy

- **Major impact on residential rates** driven mostly by increasing distribution component due to the decrease of consumers connected to the grid that must support the remaining costs
- **While the increase of industrial rates is typically, moderate**



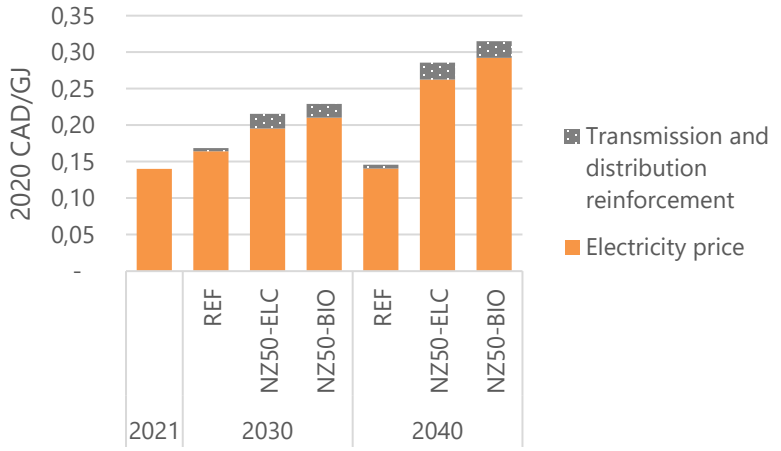
ELC – Focus on electrification
BIO – Focus on low-carbon fuels

How may electricity rates evolve in the future?

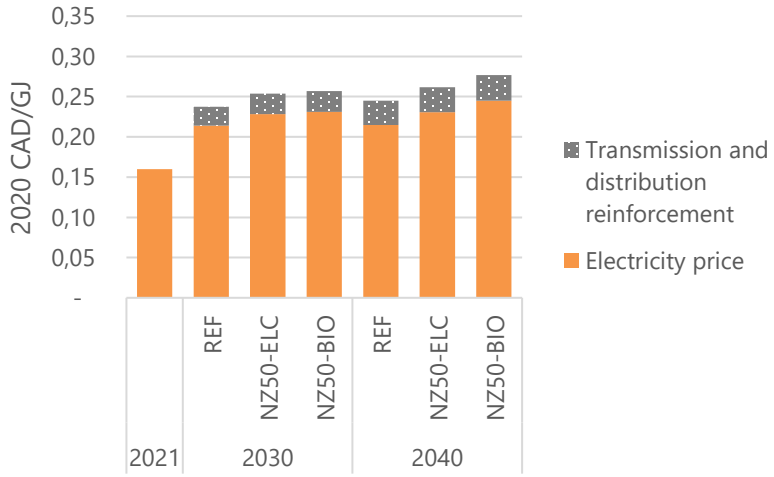
Electricity tariffs increases more moderately compared to gas, but may double in some provinces between 2021 and 2050

- Provinces with **strong reliance on fossil-fuels** (including gas) see higher increase in electricity commodity rates
- Additional cost for **grid reinforcement** may represent more than 10% of the variable rate

Electricity rate components in Alberta



Electricity rates components in Ontario

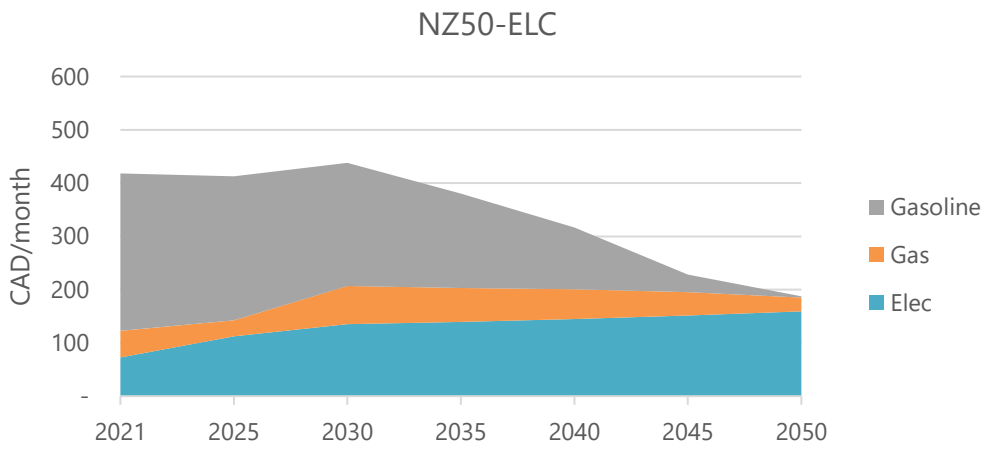


Impact on an average household energy expenses

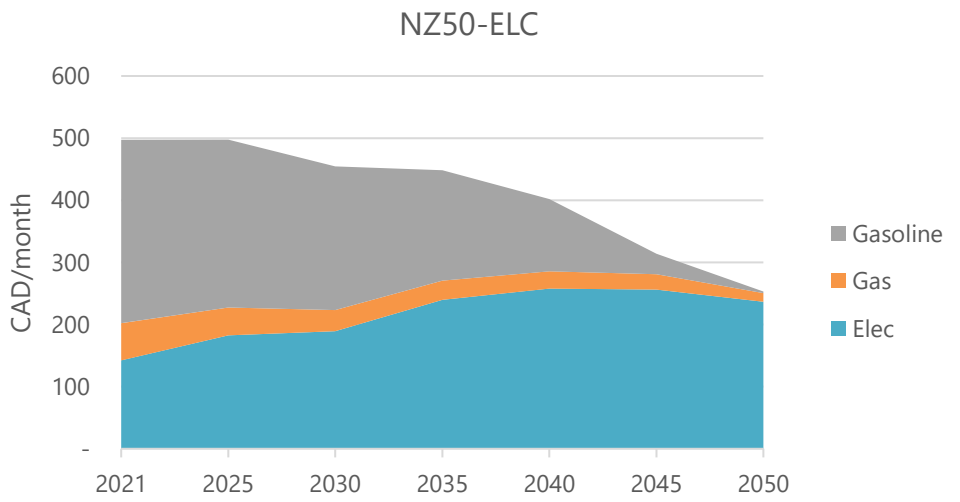
Average household energy expenses will decrease in the future

- Despite the increase in energy rates and charges, **average household expenses across different jurisdictions tend to decrease**
- Decrease in consumption and **increase in energy efficiency**:
  - Switch to electric technologies
  - Retrofit and control measures
  - Distributed generation

Expenses of an average household in Alberta



Expenses of an average household in Ontario



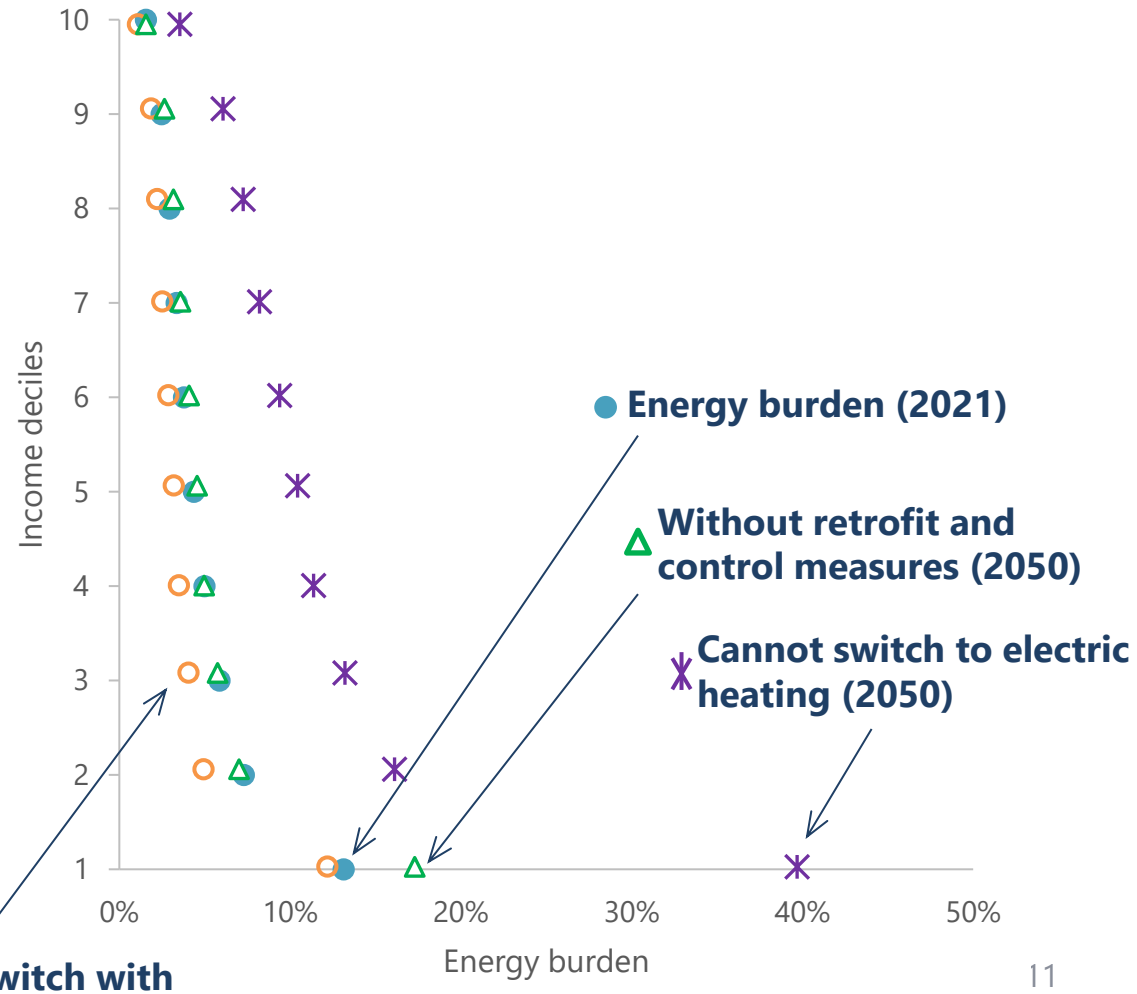
Impact on vertical and horizontal equity in 2050

Energy transition tends to increase horizontal and vertical inequities

- Increase of vertical inequity due to:
  - **High costs** (retrofit, distributed generation, dual systems, EV)
- Increase of horizon inequity:
  - Difference **in starting conditions** for households (e.g., already electrified vs. relying on natural gas)
  - **Structural differences between consumer categories such as landlords versus tenants**

Energy burden = Dwelling energy bill/After-tax income
Vertical inequity = Consumers in different income deciles have different energy burden
Horizontal inequity = Consumers in the same income decile have different energy burden

Energy burden by decile in Ontario, 2021 versus 2050



Major takeaways

- **Energy transition tends to increase energy inequity:** both vertical inequity (between households of different income deciles) and horizontal inequity (among consumers within the same decile).
- **Economy-wide strategic energy models is completed with post-processing tools** to assess differentiated impacts across consumer categories and other stakeholders.
- **These insights enable decision-makers to design tailored support measures** adapted to each jurisdiction's energy use, income distribution, and structural characteristics.
- **A retroactive feedback loop can inform the strategic planning model**, allowing it to adjust sectoral transition pathways to reduce emerging inequities.

Questions?

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