Net Zero 2050

June 2021

Ontario Energy Association

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- Represents the breadth of Ontario's energy sector
- Electricity Distribution (>75% of customers)
- Natural Gas Distribution (>99% of customers)
- Electricity Generation & Capacity
  - Nuclear
  - Hydro
  - Wind
  - Solar
  - Natural gas
  - Storage
  - Demand Response
  - Micro-grids
  - Energy Efficiency
  - Etc…
- Various energy sector service providers

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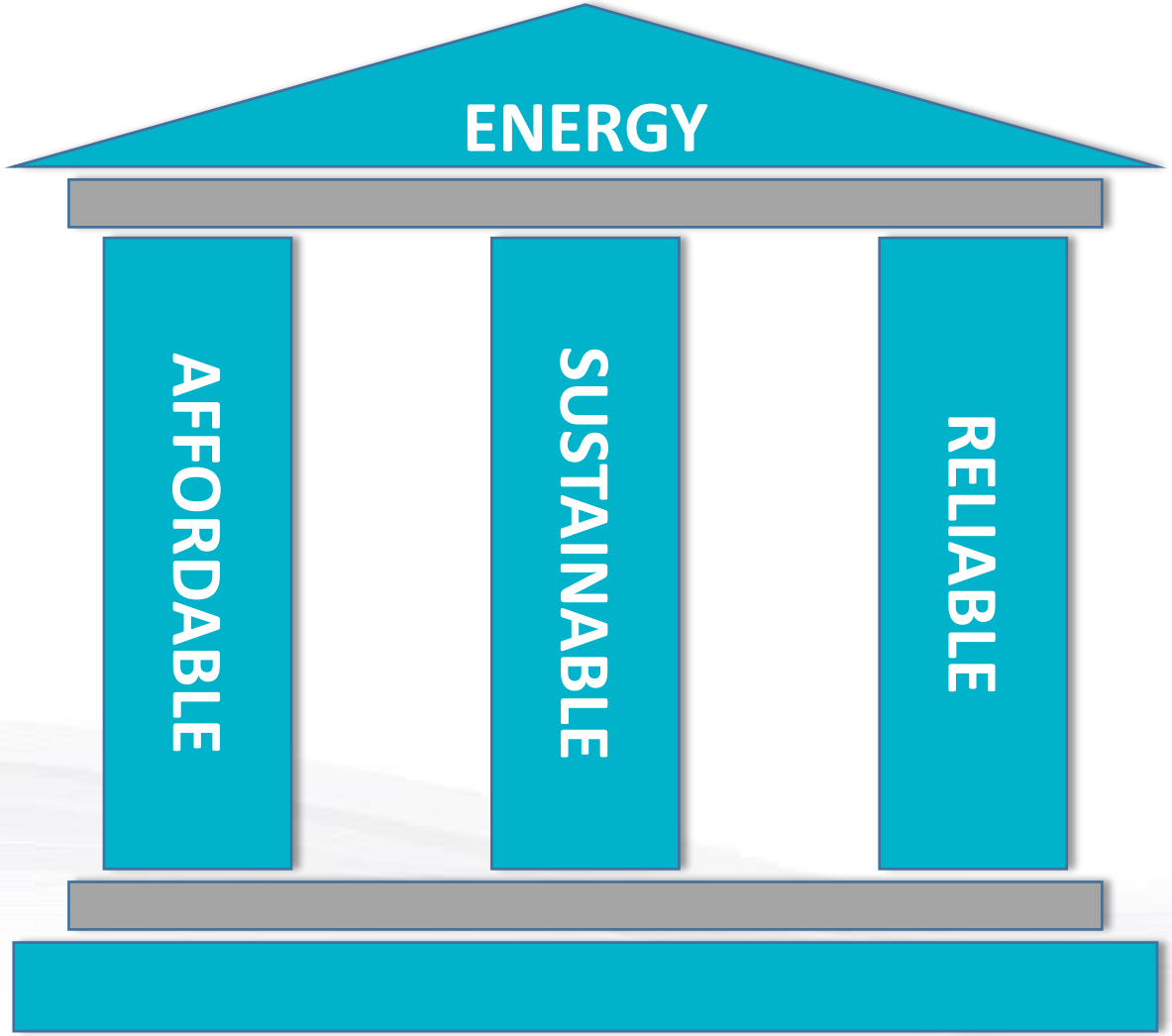
CANADA *NET-ZERO EMISSIONS ACCOUNTABILITY ACT*

- Introduced in Parliament November 19, 2020 (Bill C12)
  - Royal Assent June 29, 2021
- Establishes goal to achieve net-zero emissions by 2050
- Establishes "milestone years" for interim targets
  - 2030, 2035, 2040 and 2045
- Requires process for planning and assessing federal government progress towards these targets
- In April 2021 Canada committed to reducing emissions 40-45% below 2005 by 2030 (was previously 36%)
  - Re-affirmed at COP26

THREE ENERGY PILLARS



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OUR CHALLENGE & OPPORTUNITY

ONTARIO GHG EMISSIONS 2019

Megatonnes

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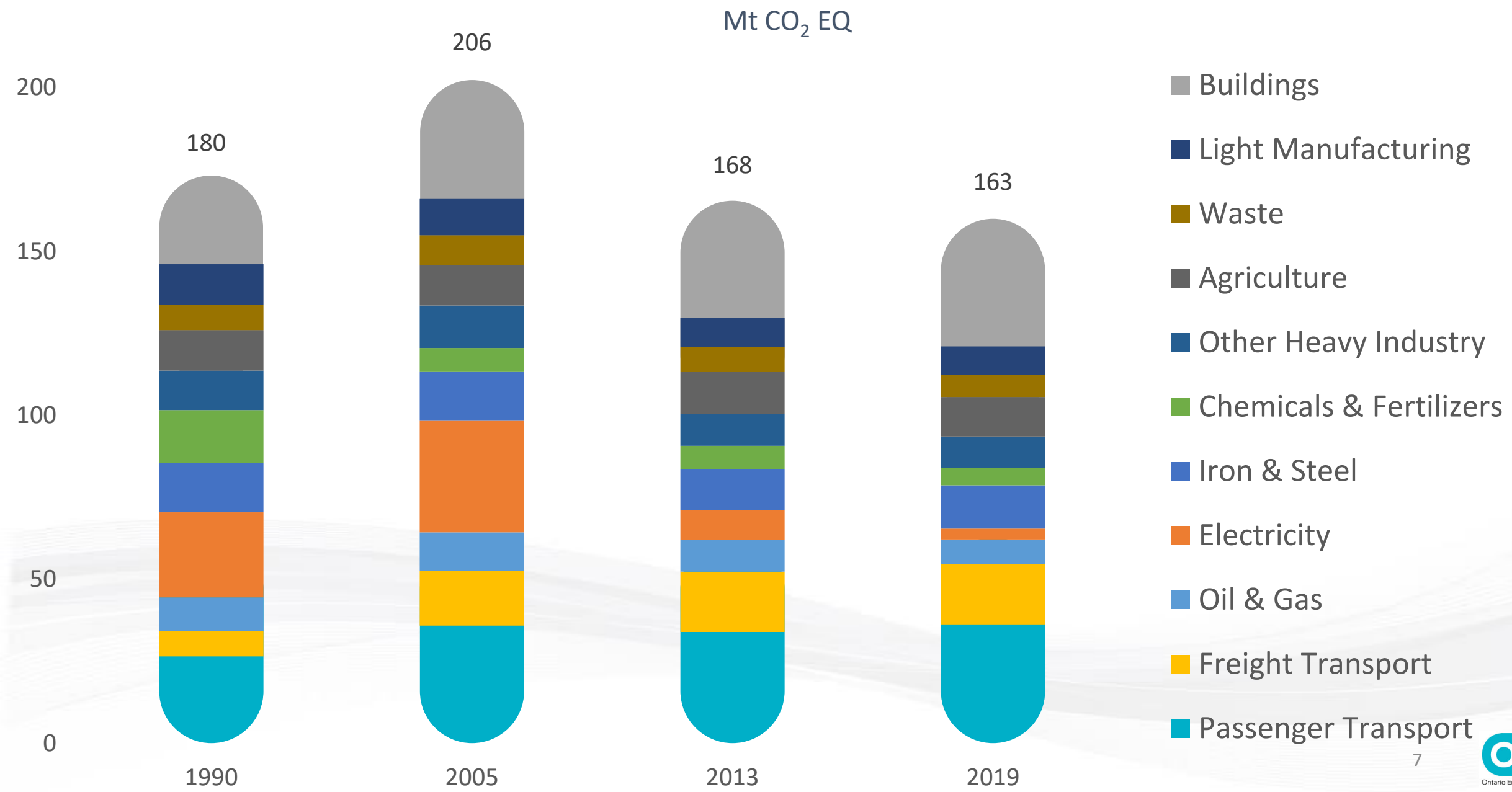
ONTARIO GHG EMISSIONS BY SECTOR, SELECTED YEARS



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EMISSIONS BY PROVINCE IN 1990, 2005 AND 2019

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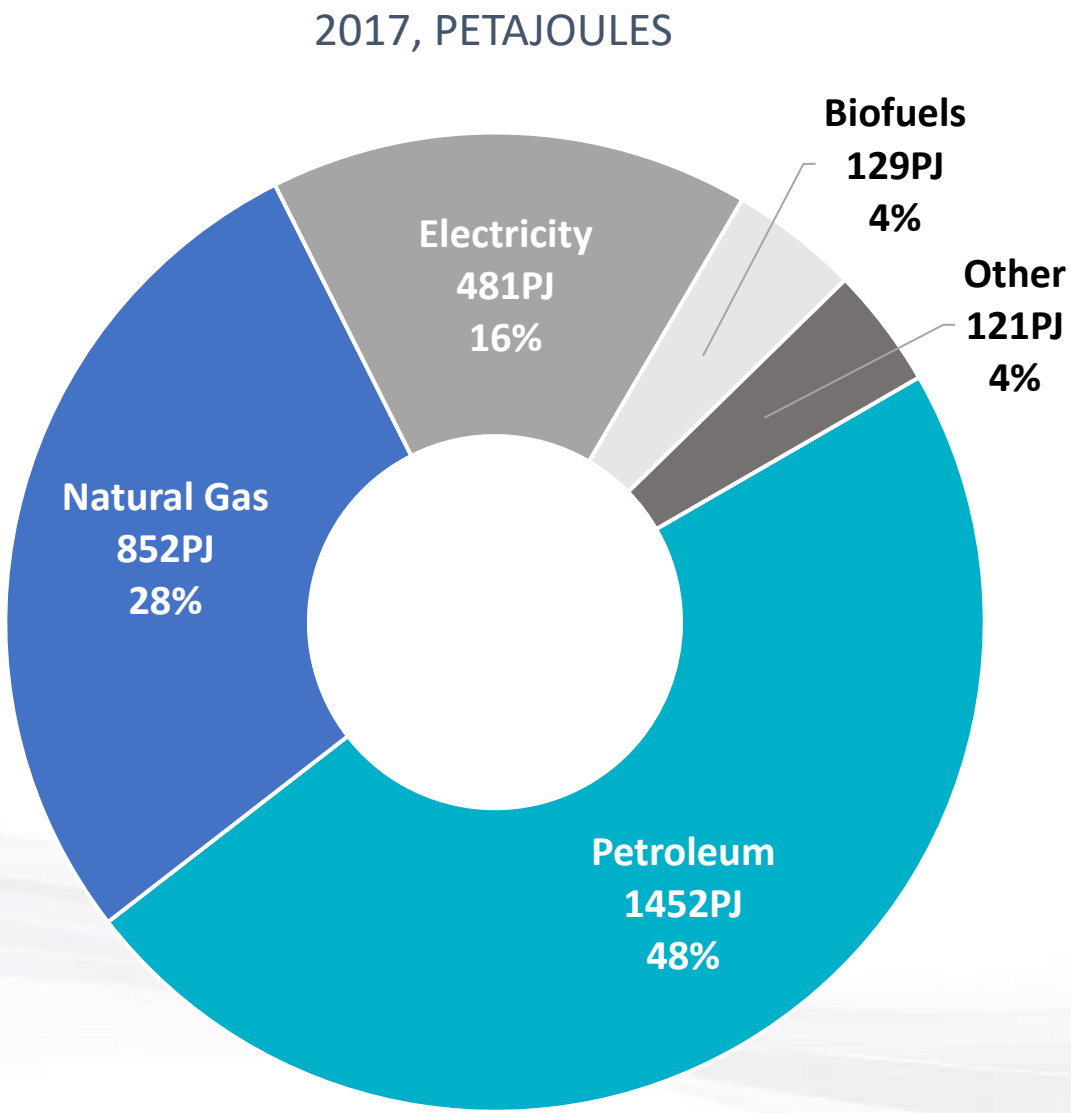
CONTEXT: OUR ENERGY SYSTEM

ONTARIO ENERGY USE BY FUEL TYPE, 2017



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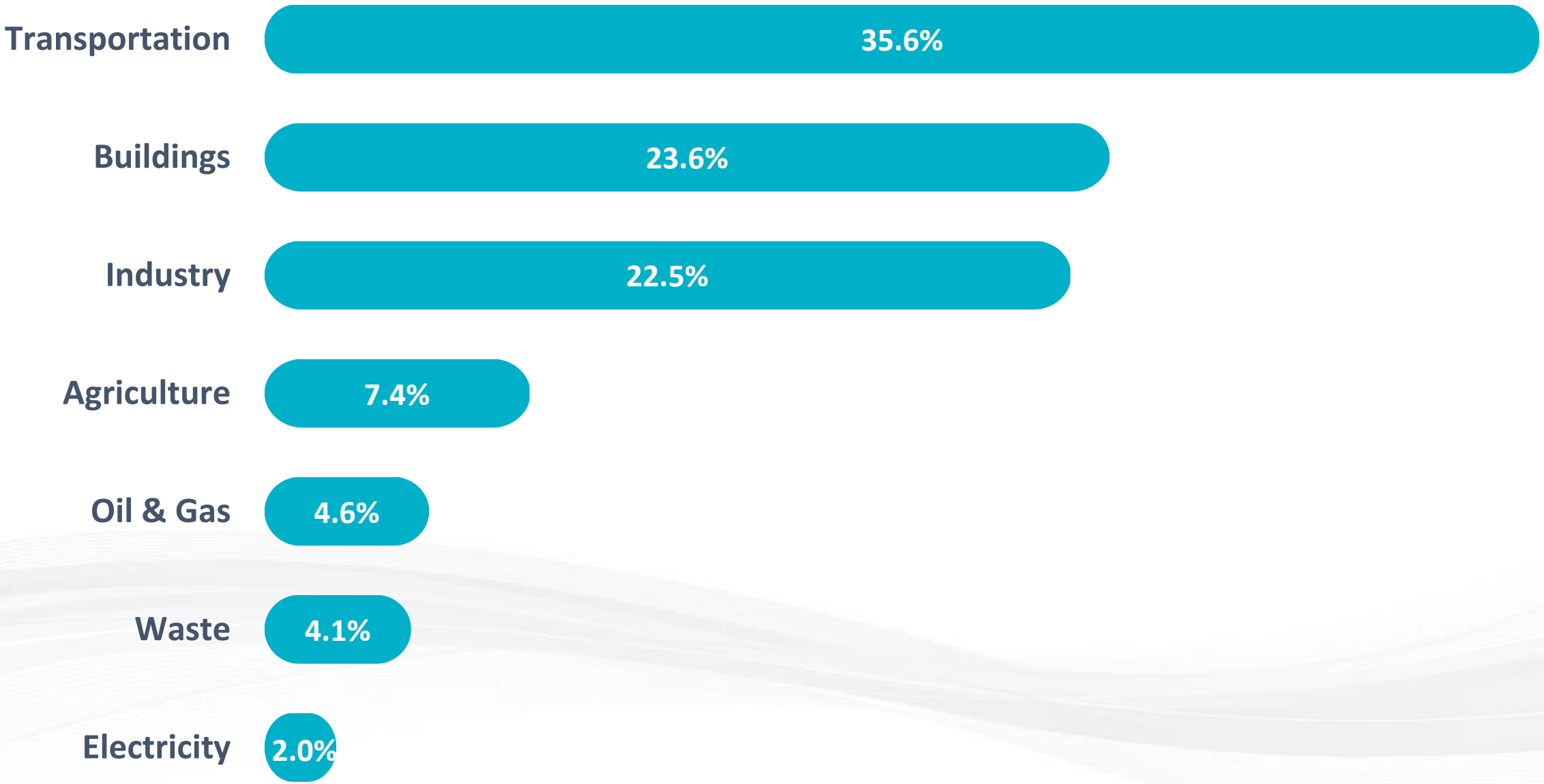
ONTARIO GHG EMISSIONS BY SECTOR, 2019



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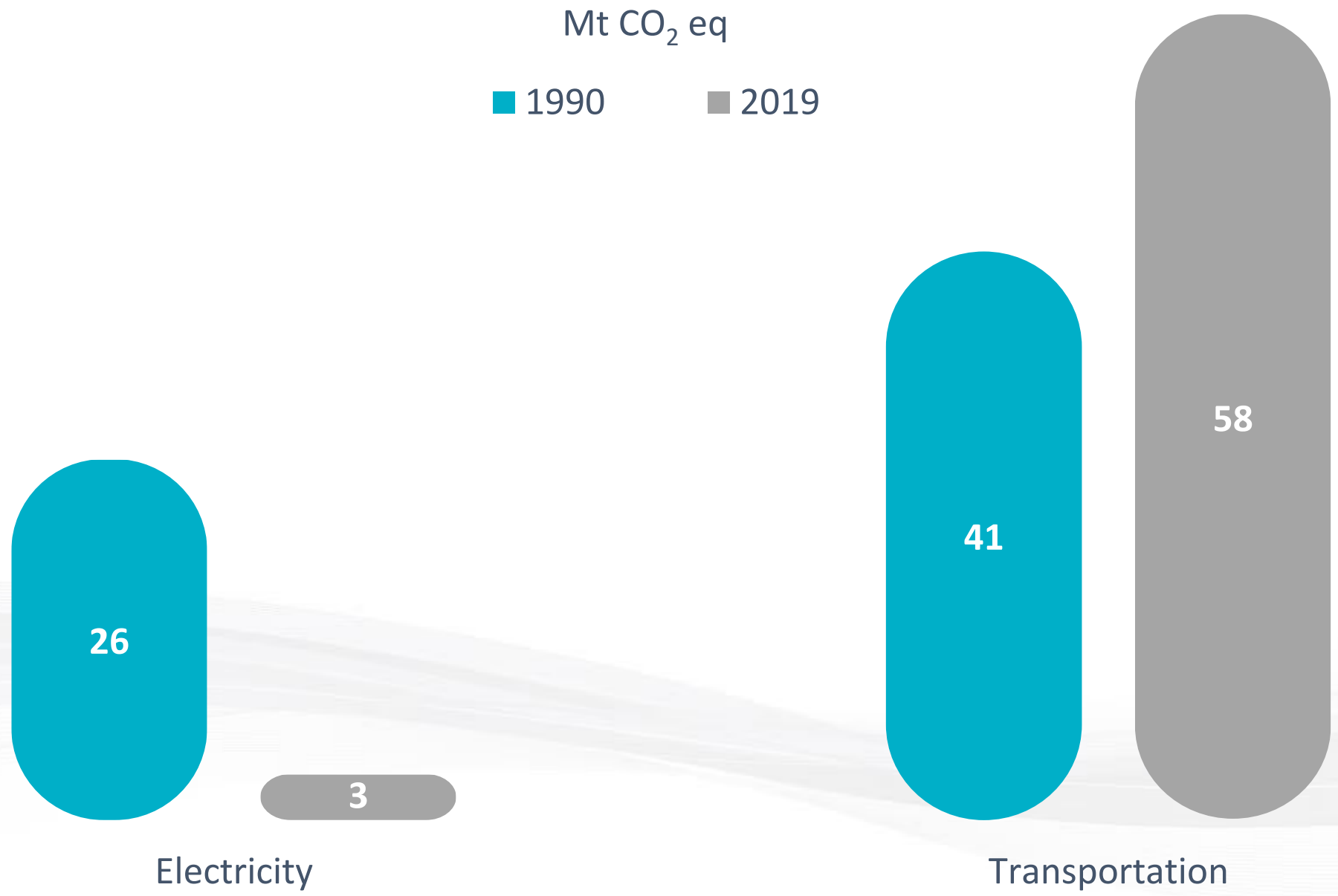
ONTARIO ELECTRICITY VERSUS TRANSPORTATION EMISSIONS



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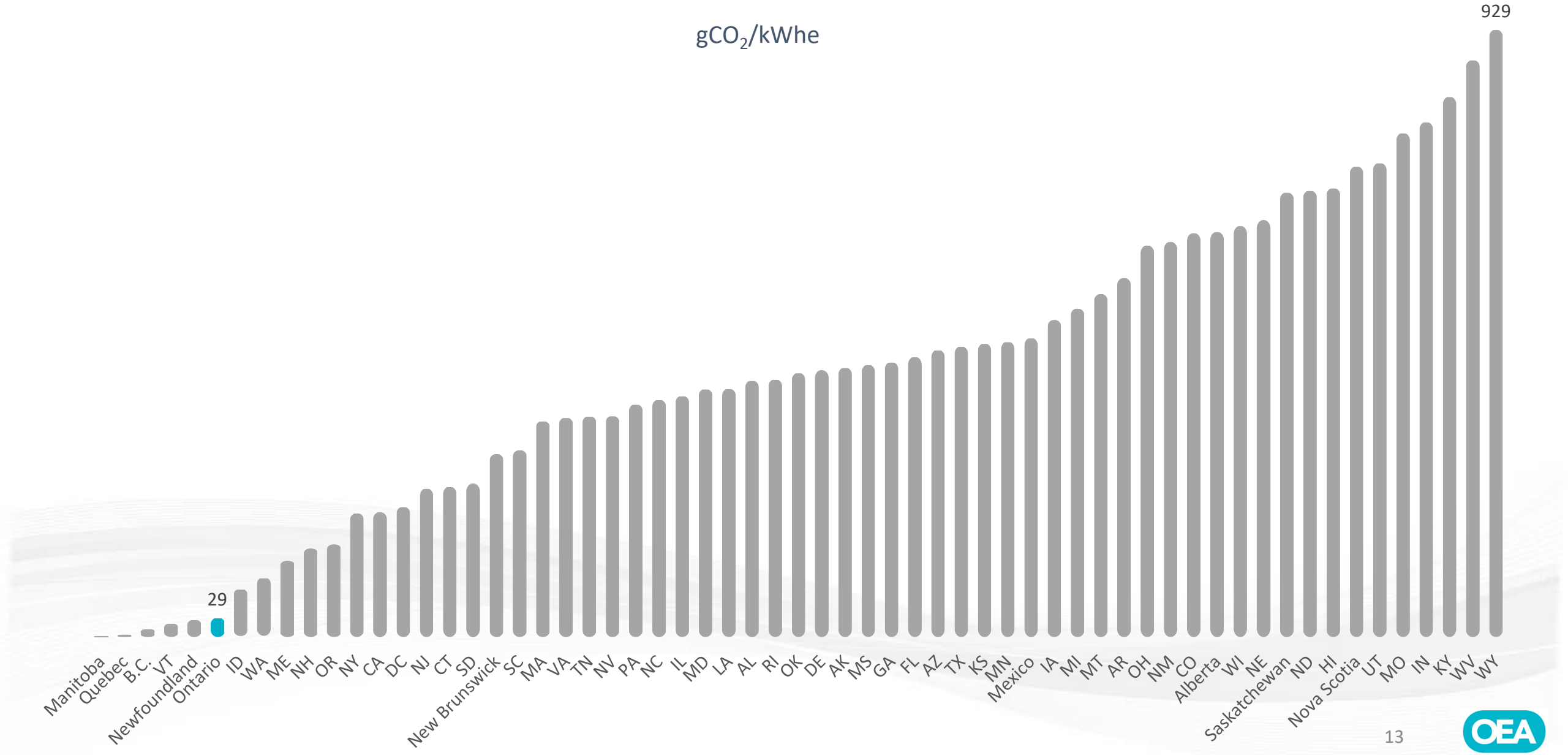
CARBON INTENSITY OF ELECTRICITY SYSTEM, NORTH AMERICA, 2018



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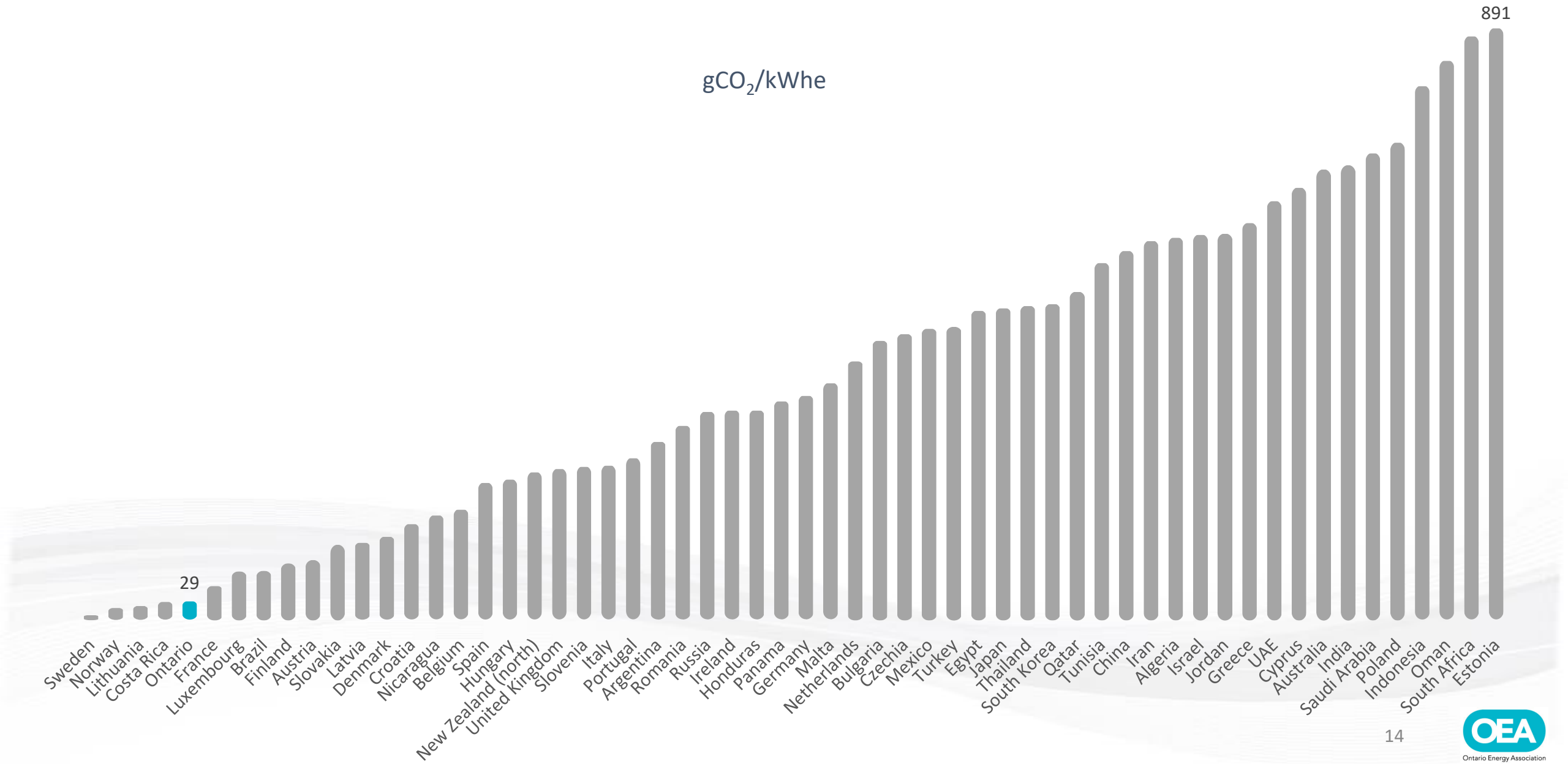
CARBON INTENSITY OF ELECTRICITY SYSTEM, INTERNATIONAL, 2018-20



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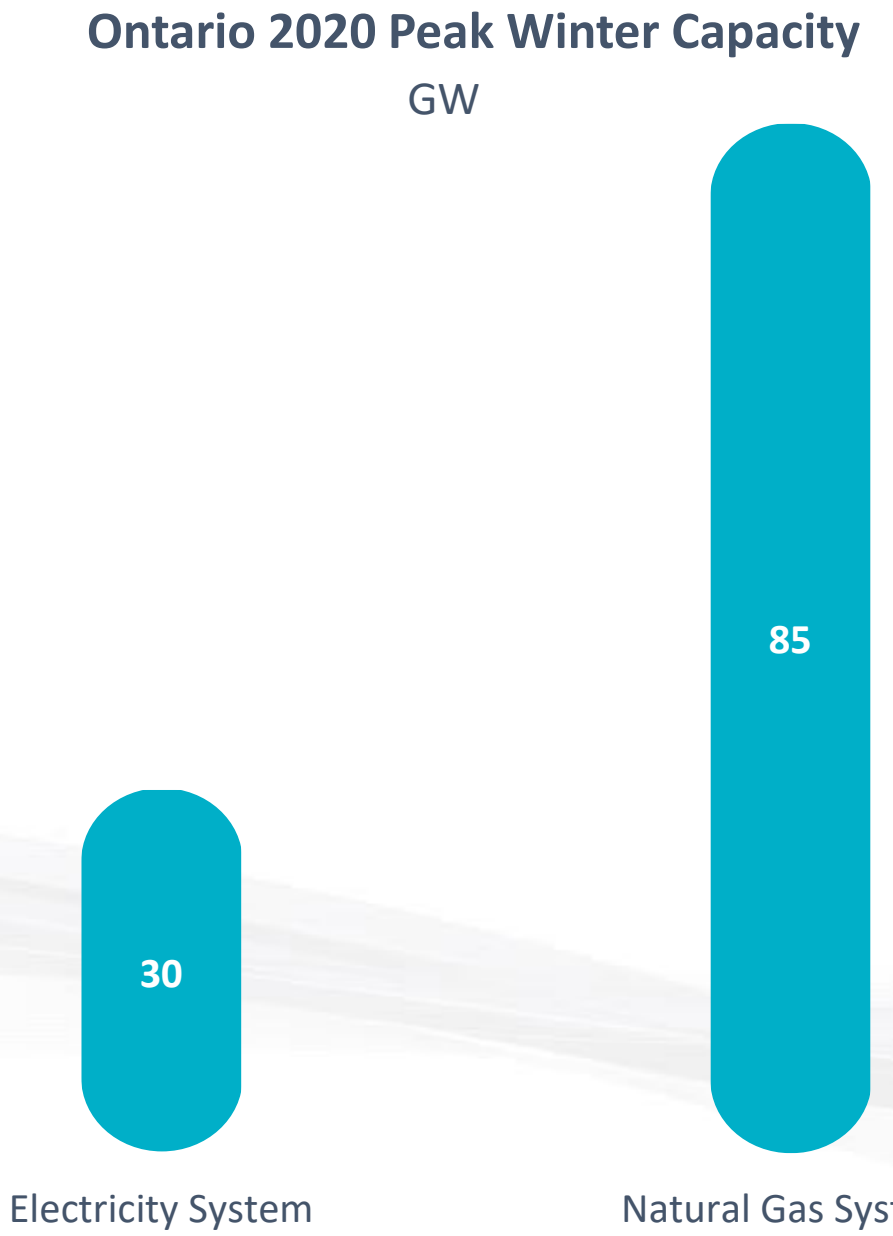
SIZE OF ONTARIO'S NATURAL GAS SYSTEM IN PERSPECTIVE



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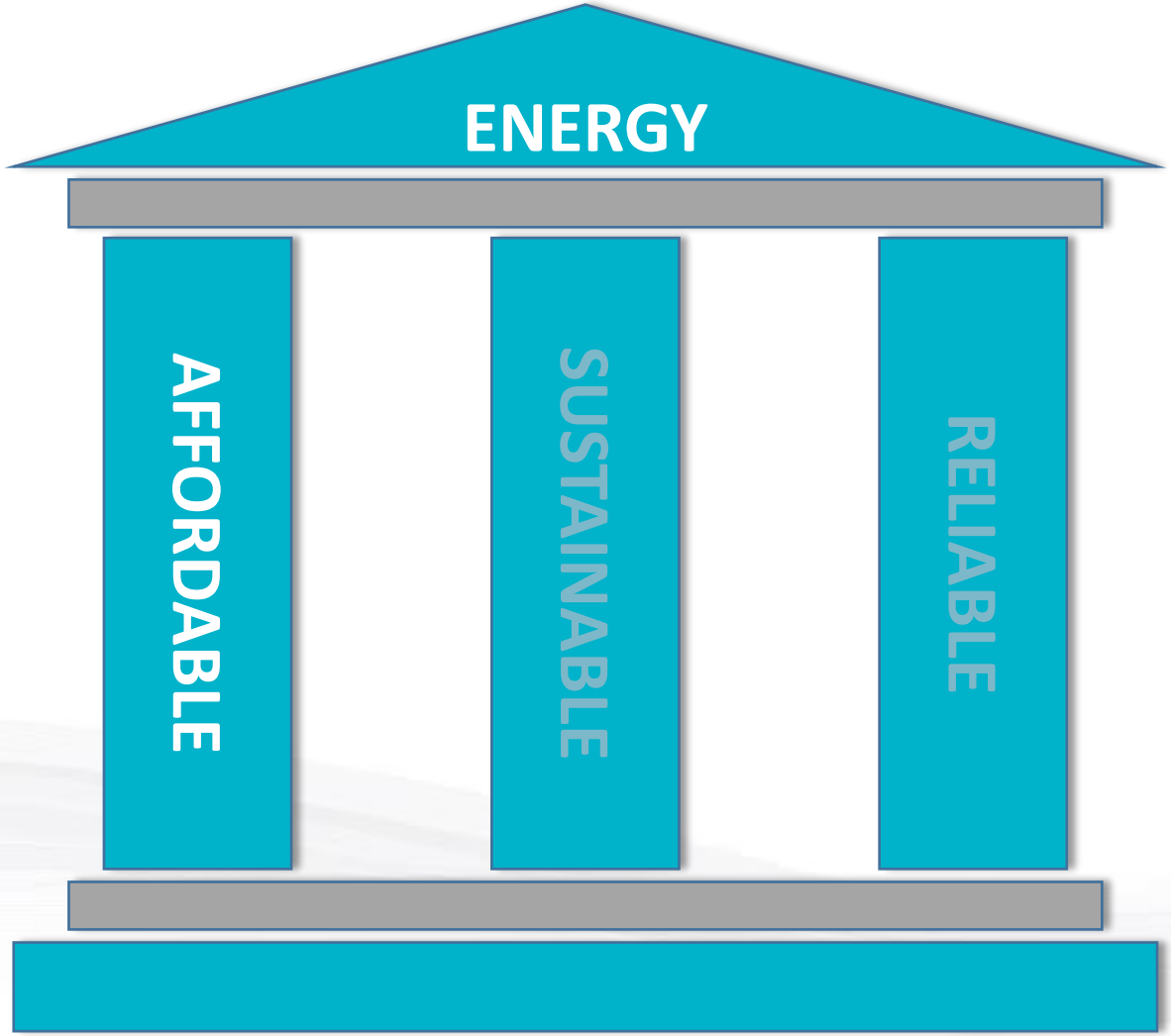
AFFORDABILITY



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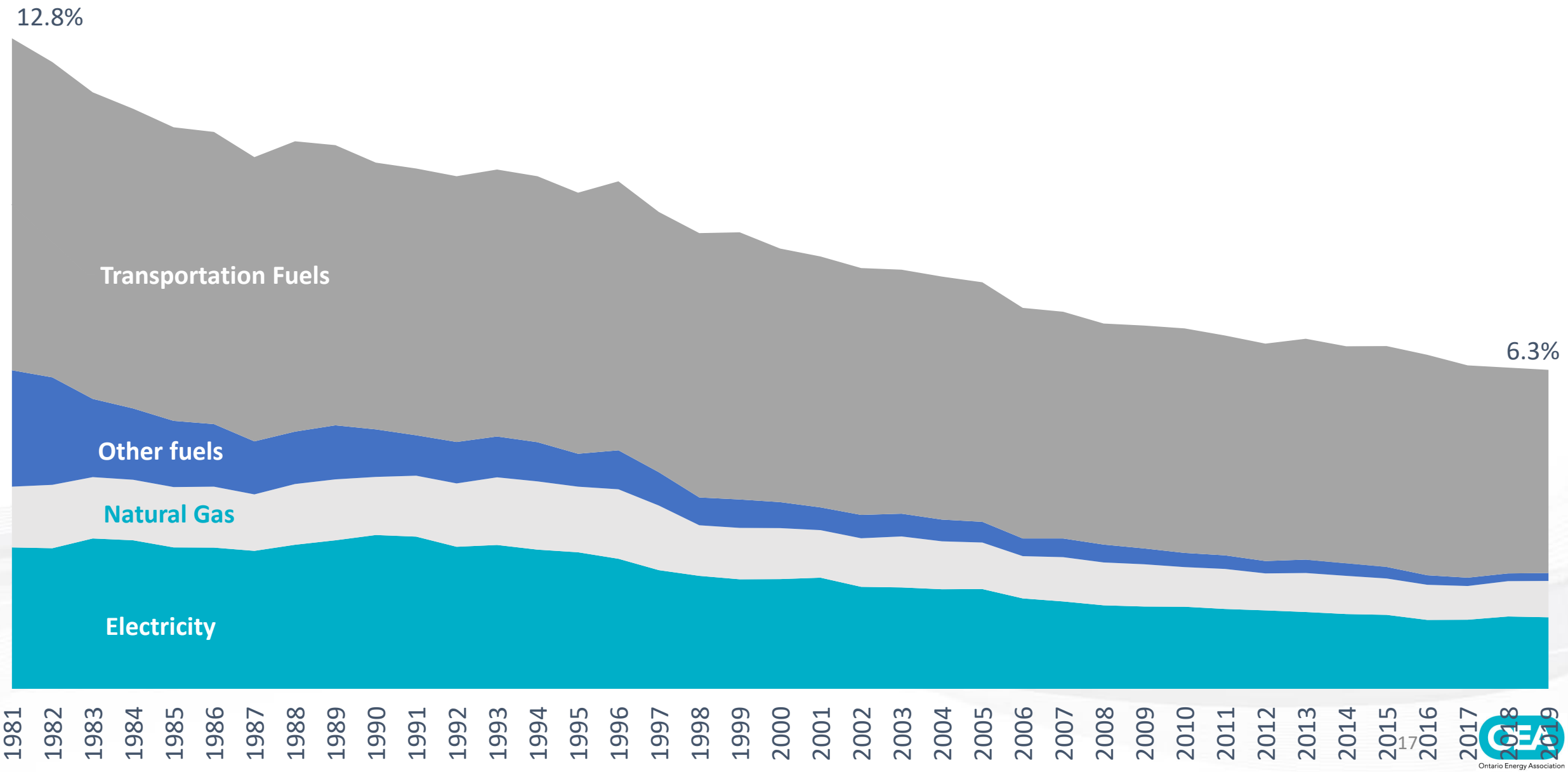
ENERGY % OF TOTAL HOUSEHOLD SPENDING, ONTARIO



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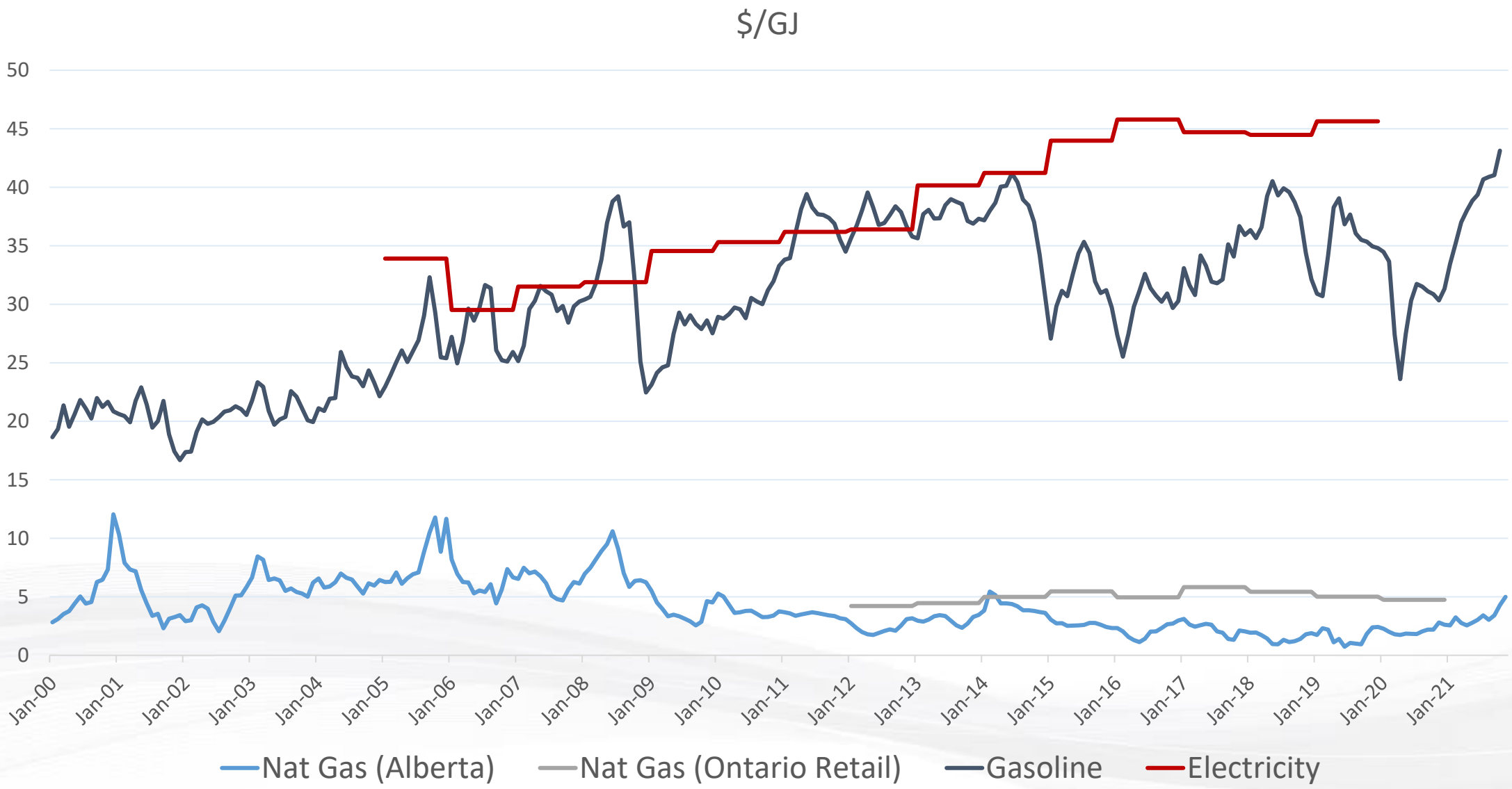
ONTARIO ENERGY COST BY FUEL TYPE



Source: OEA based on: OEB Utility Yearbooks; IESO custom table; Statistics Canada Table 18-10-0001-01; NGX

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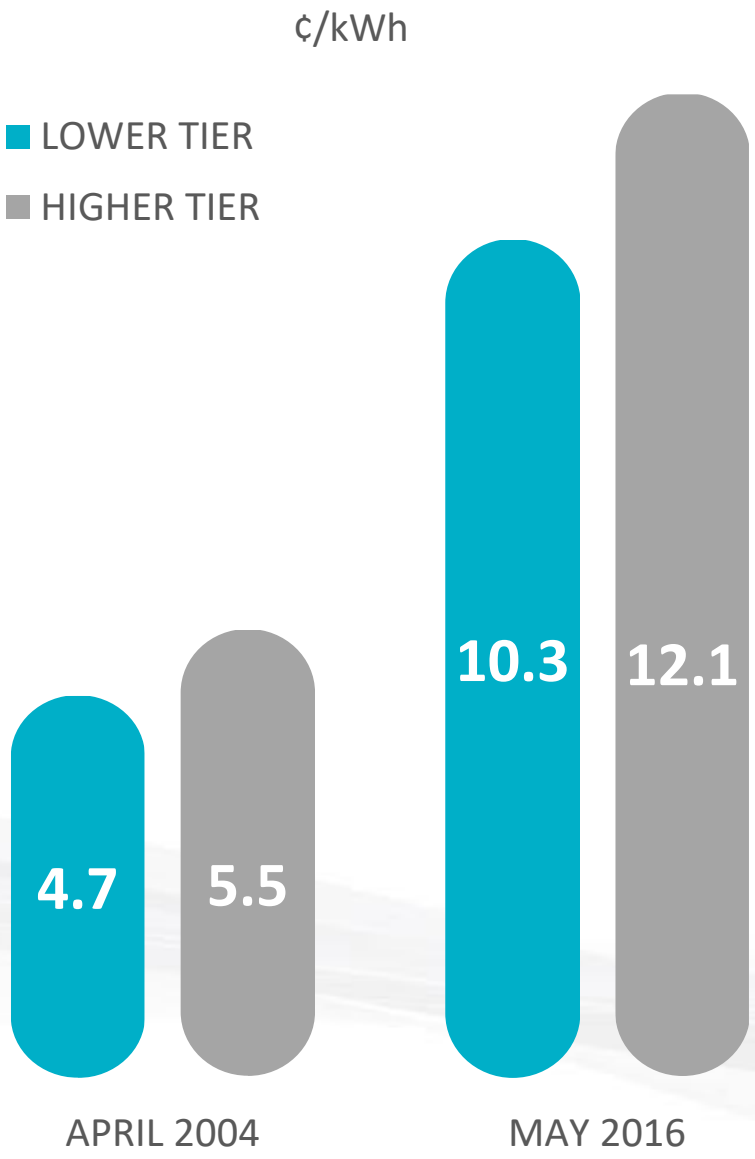
ONTARIO RESIDENTIAL TIERED ELECTRICITY RATES



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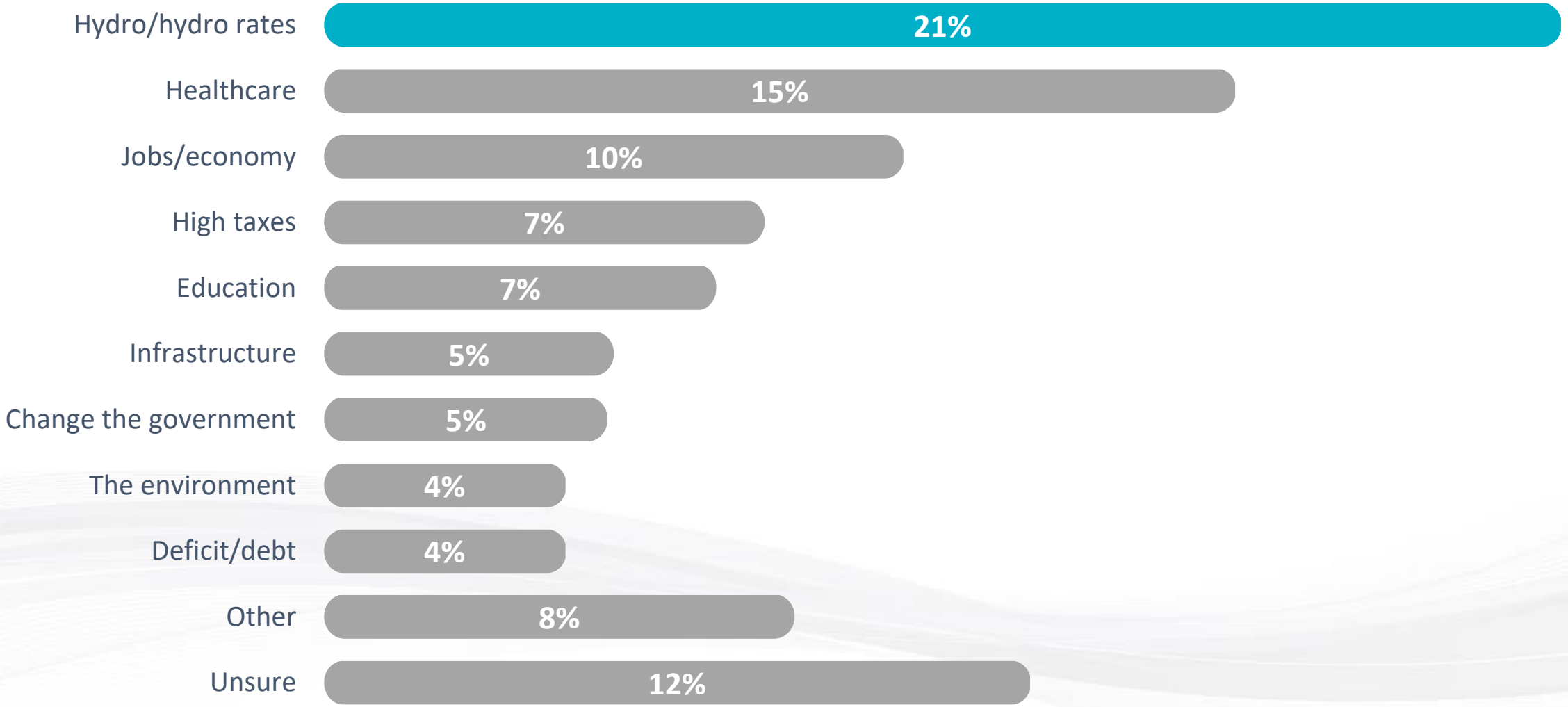
"WHAT IS YOUR MOST IMPORTANT PROVINCIAL ISSUE OF CONCERN?"

NANOS RESEARCH POLL, NOVEMBER 2016



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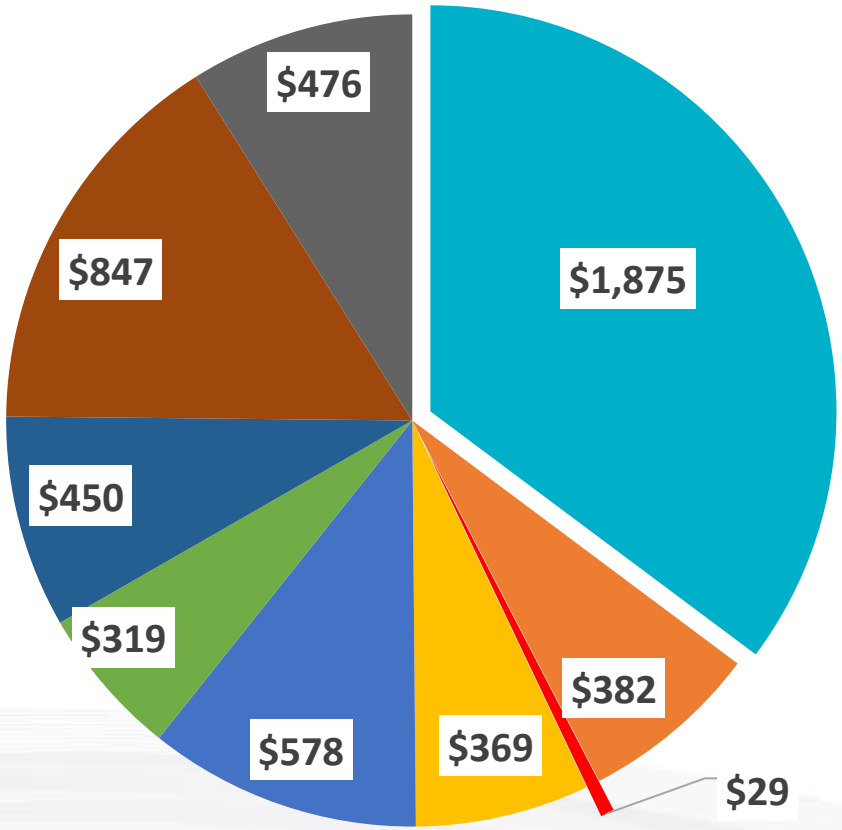
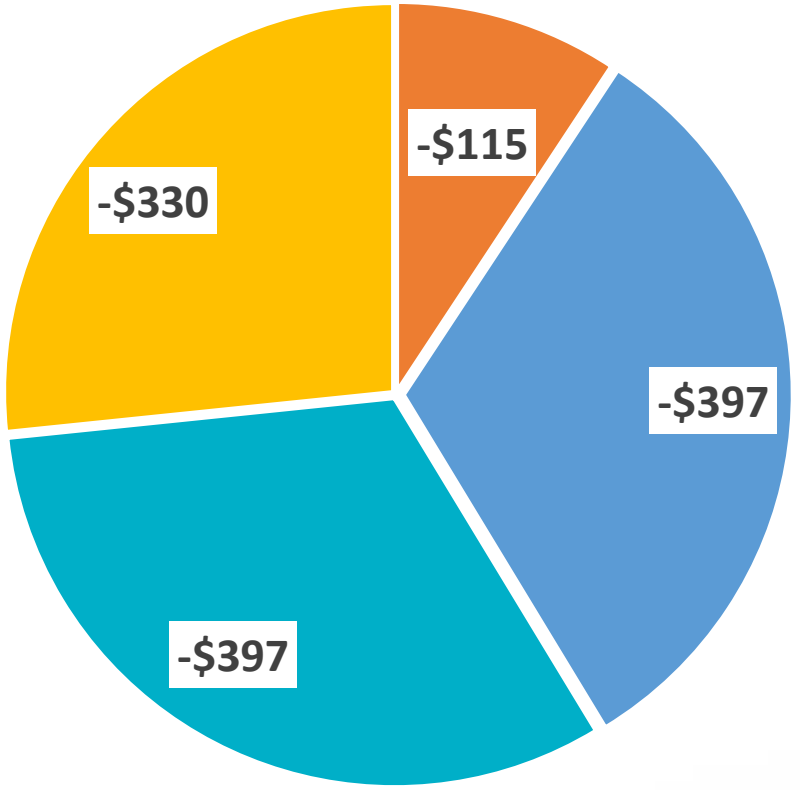
HOUSEHOLD EXPENDITURES BY MAJOR CHANGE, 2010-2017 , CONSTANT $2017

Larger Expenditure Increases



- Housing
- Electricity
- University Tuition
- Pension/Retirement
- Other
- Communications
- Recreation
- Financial Services
- Gifts, Support Payments & Charity

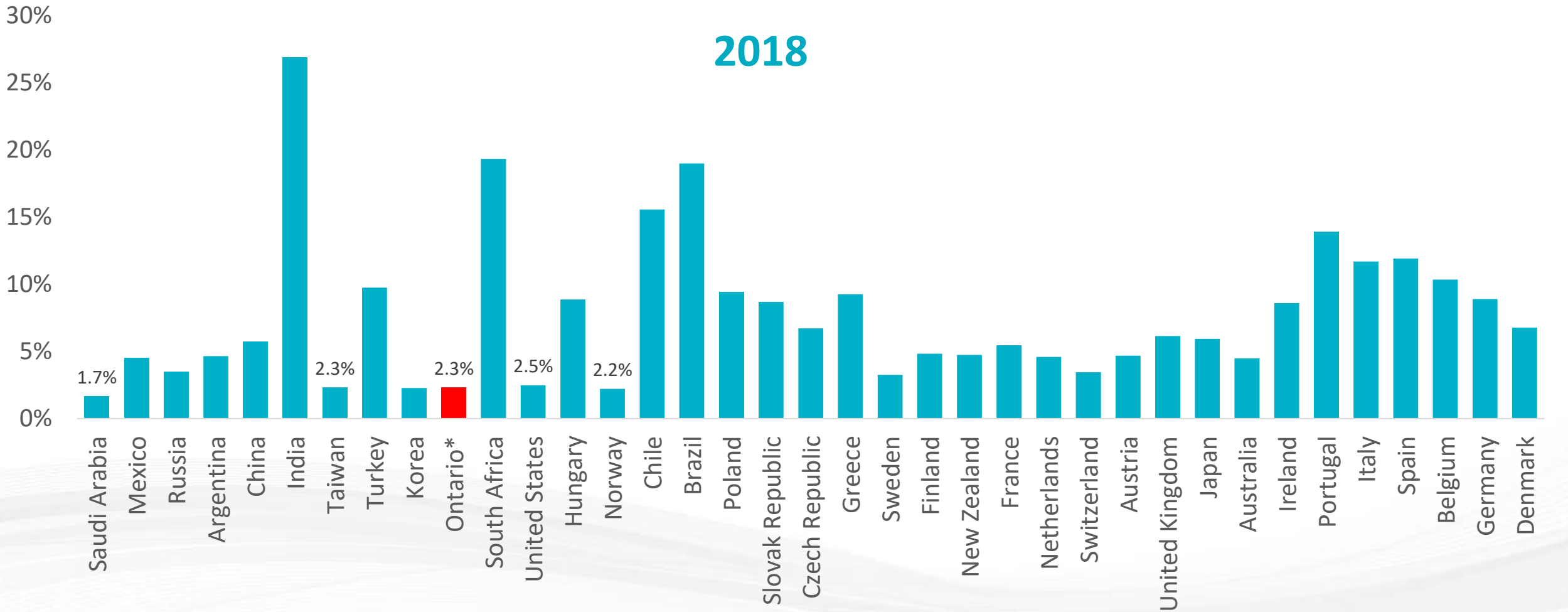
Larger Expenditure Decreases



- Natural Gas
- Clothing
- Transportation
- Home entertainment equipment

Source: OEA based on Statistics Canada. Table 11-10-0222-01 Household spending, Canada, regions and provinces

ELECTRICITY COSTS* % OF MEDIAN HOUSEHOLD INCOME



*assumes monthly consumption of 700 kWh for comparison purposes

Sources: OEA based on International Energy Agency (IEA) data and GlobalPetrolPrices.com for electricity costs.
Gallup survey for median household income. https://news.gallup.com/poll/166211/worldwide-median-household-income-000.aspx

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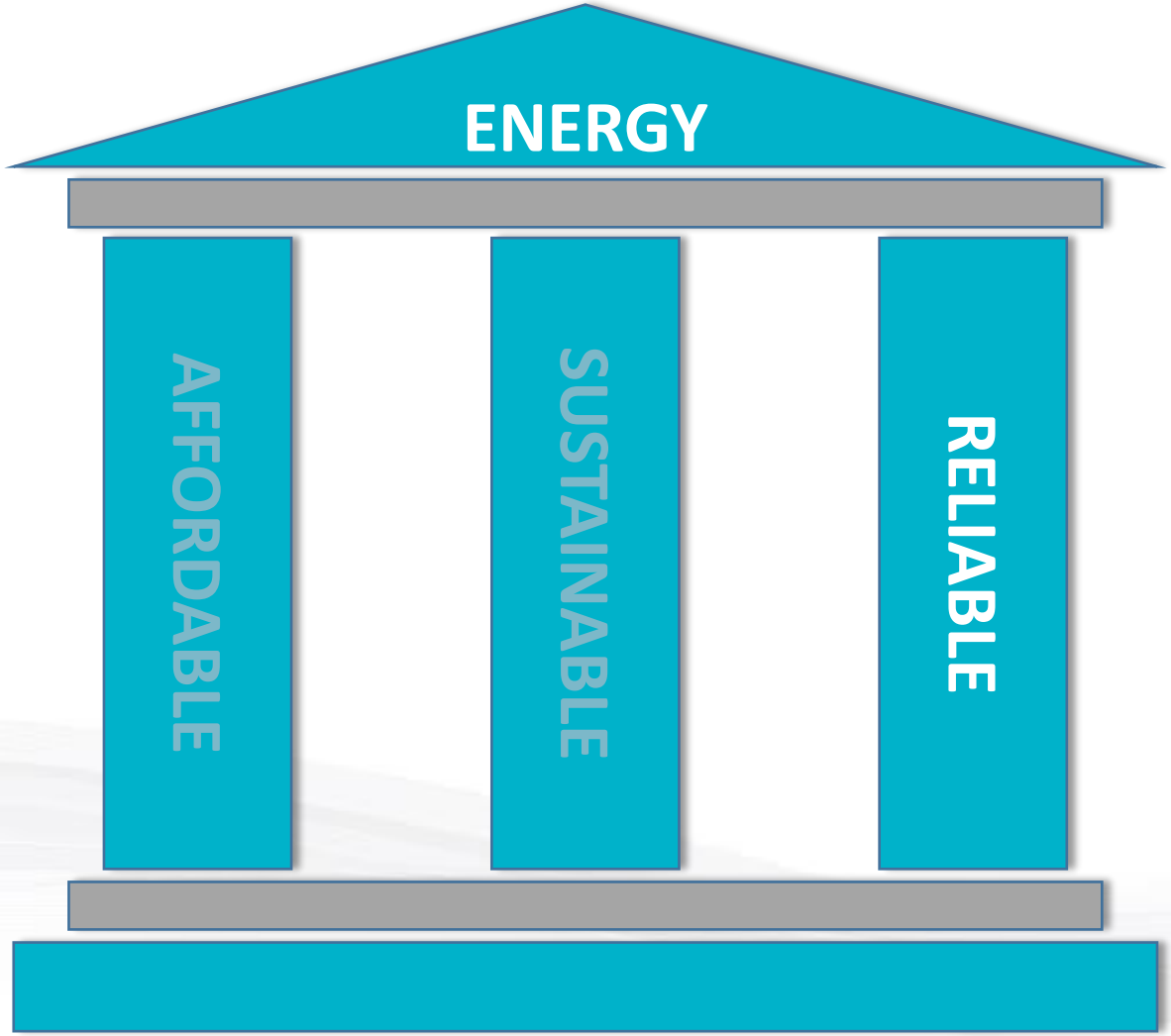
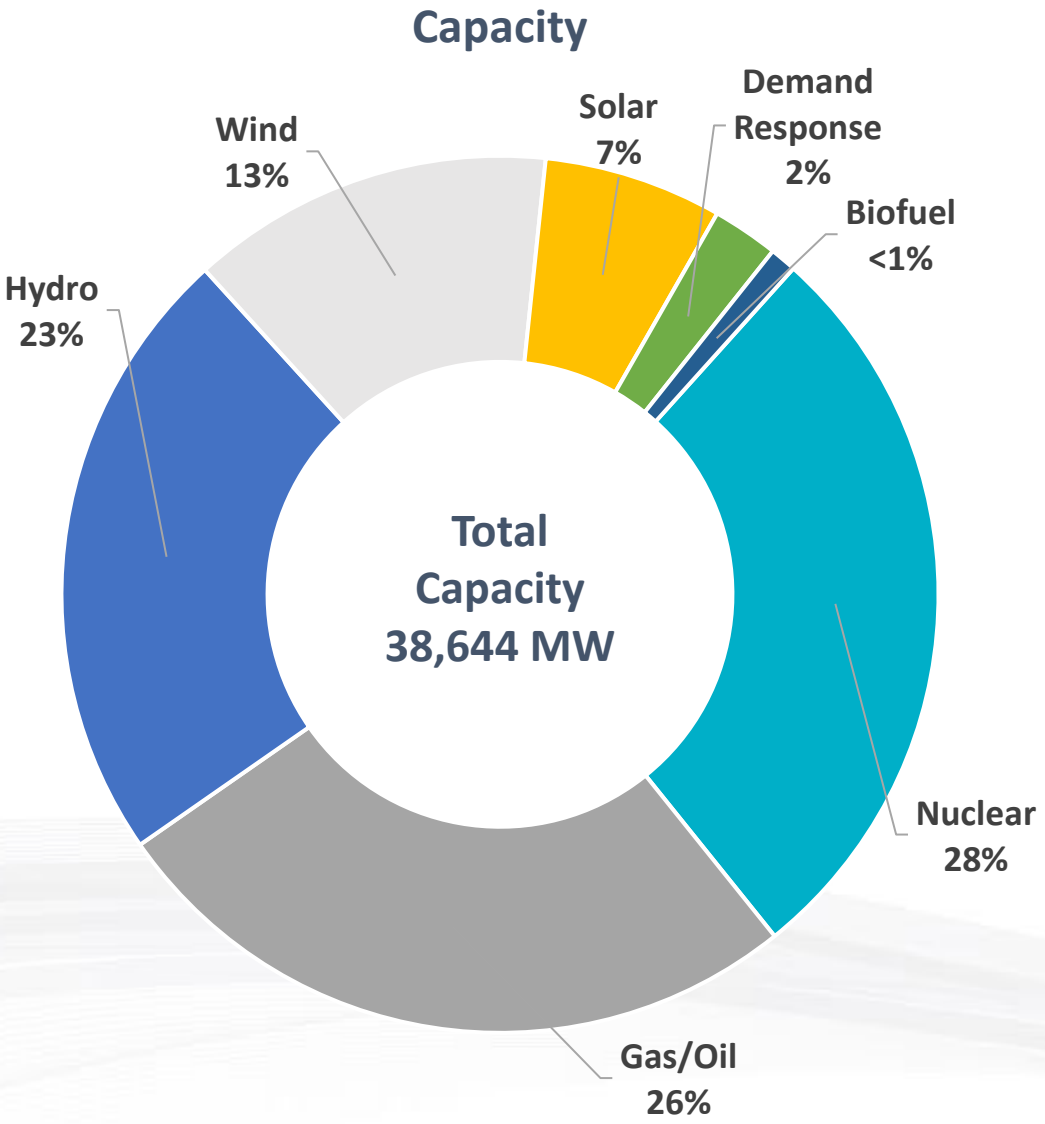
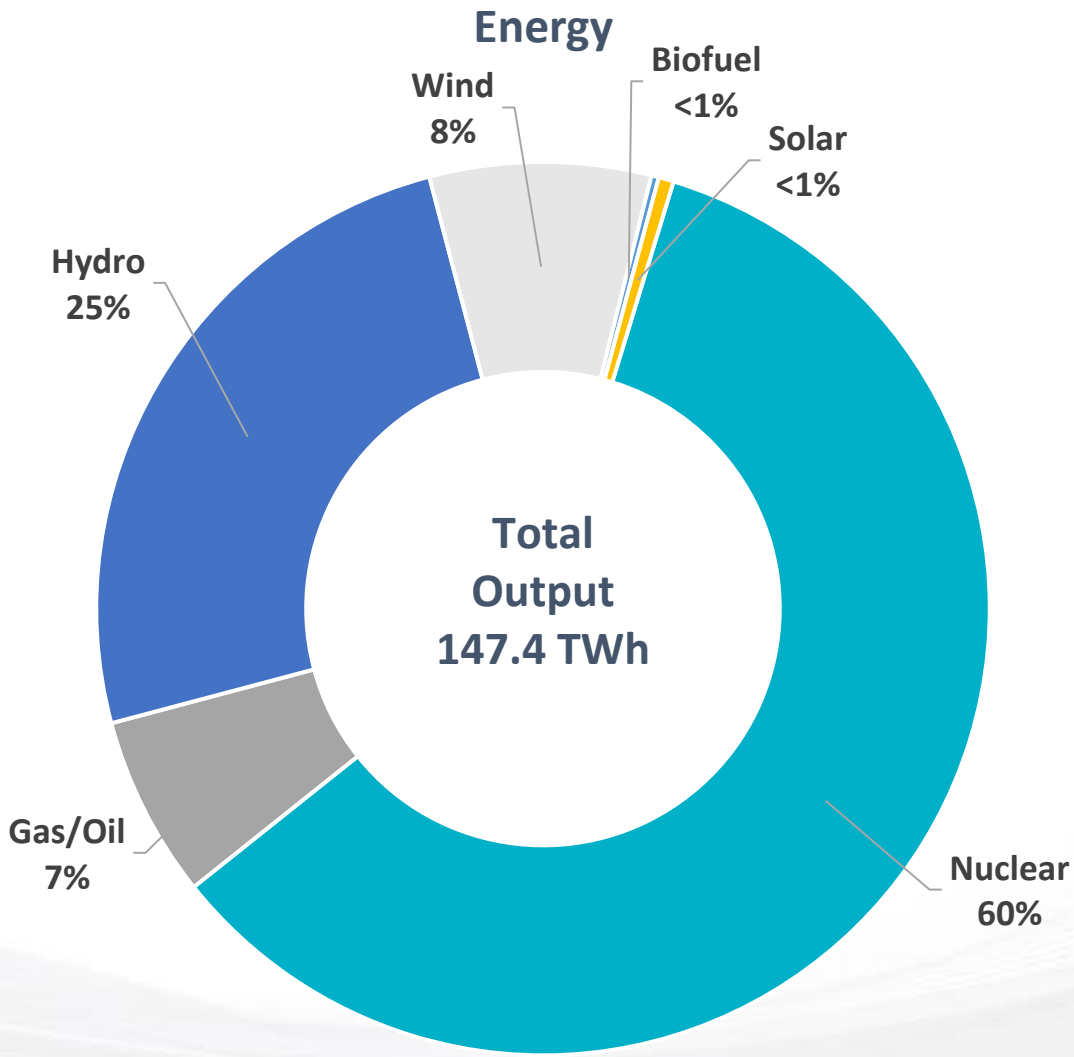
RELIABILITY

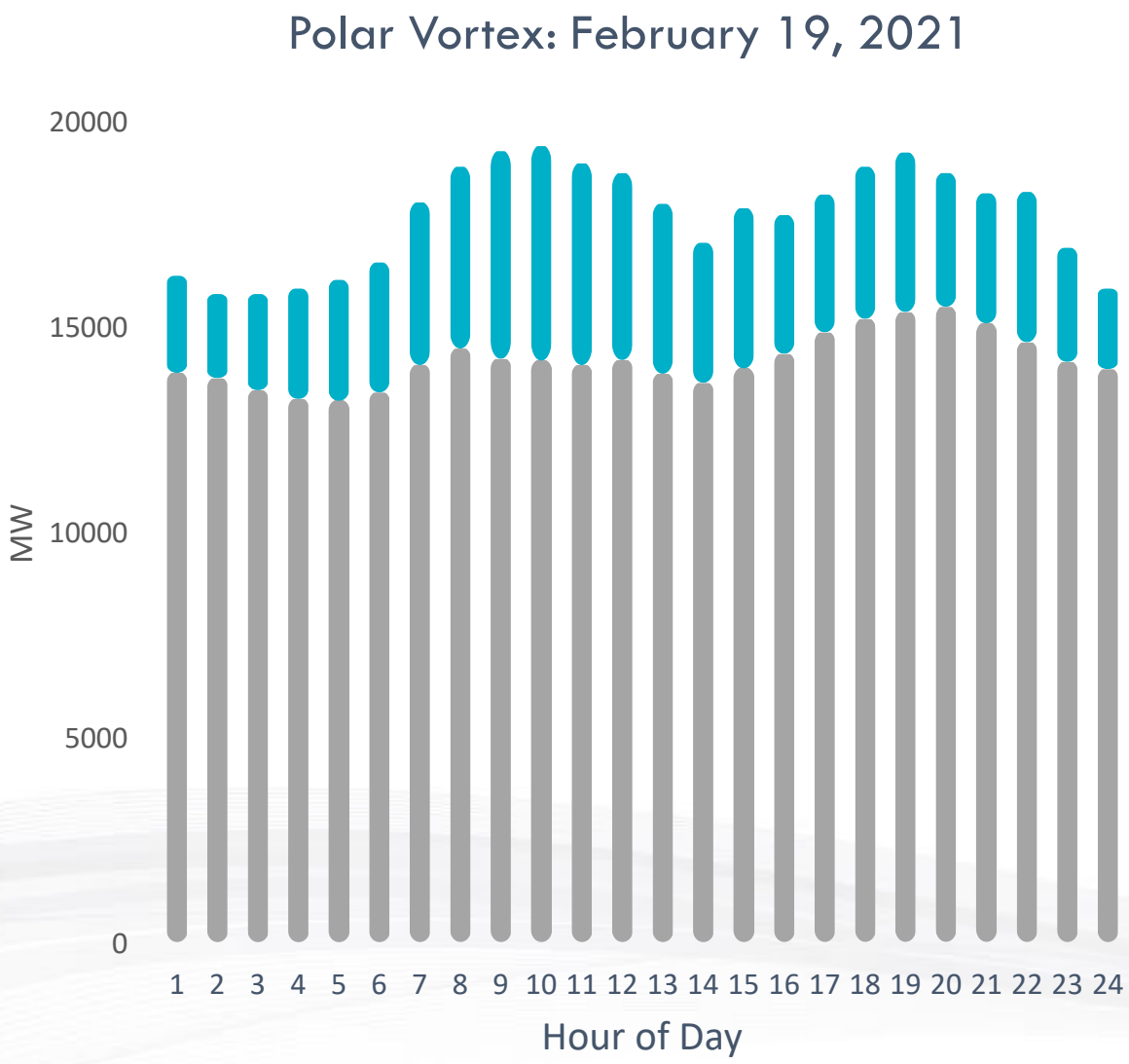


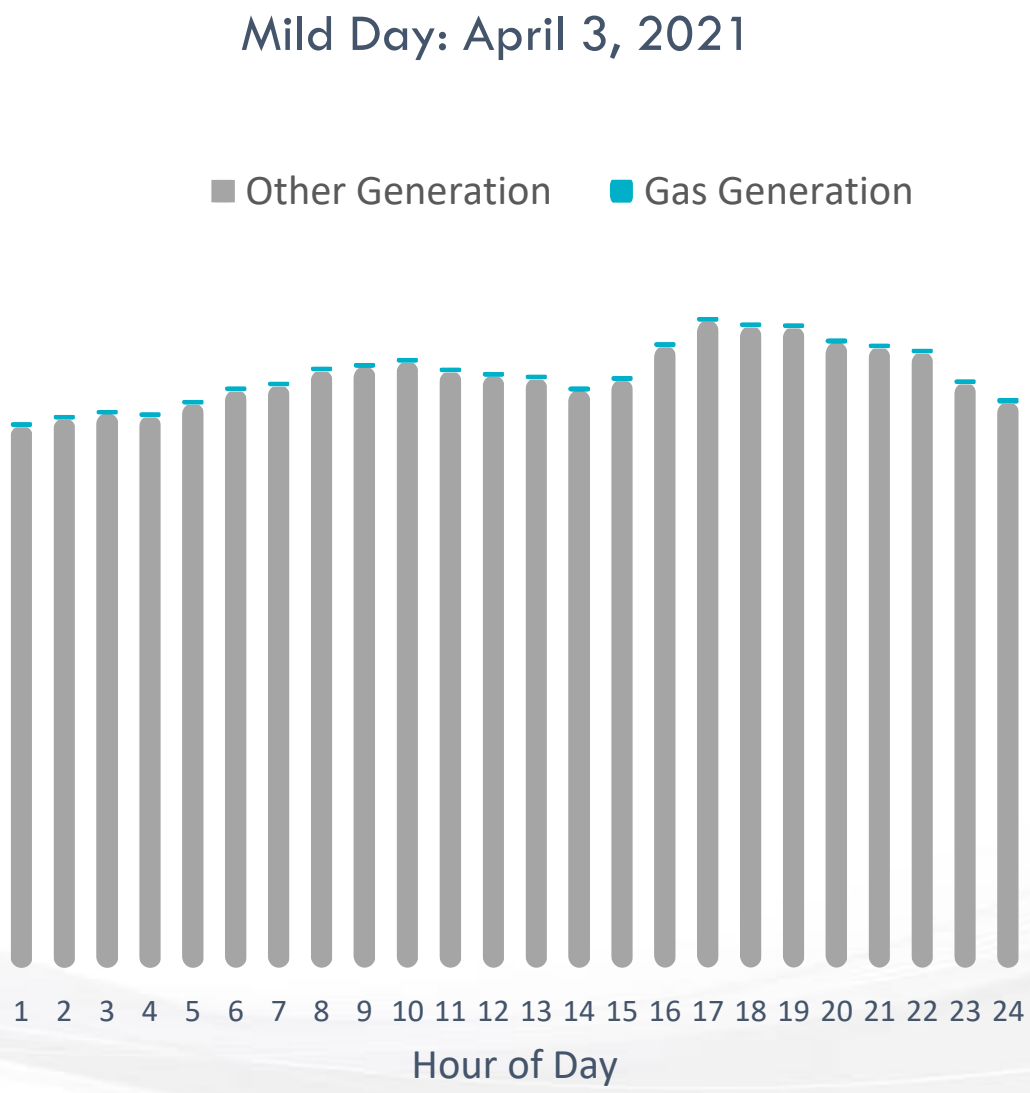
ONTARIO ELECTRIICTY SYSTEM CAPACITY VS. ENERGY 2020





GAS GENERATION SYSTEM RELIABILITY EXAMPLE





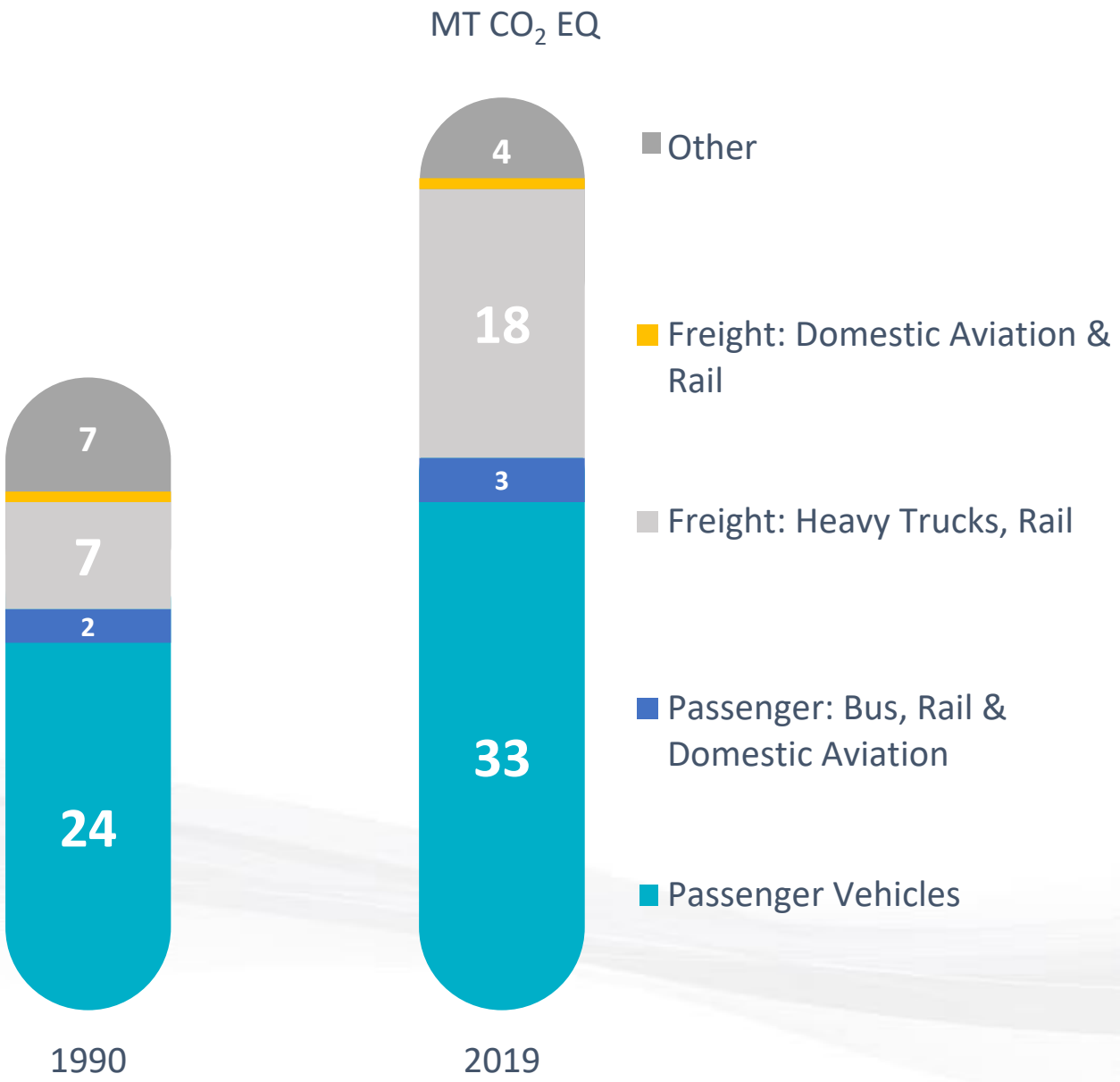
NATURAL GAS SYSTEM RELIABILITY

- Ontario's Dawn Hub can store 280 billion cubic feet of natural gas
- We rely on this system to heat our homes and buildings for an extended period

KEY SECTOR EMISSIONS

TRANSPORTATION SECTOR

ONTARIO TRANSPORTATION EMISSIONS



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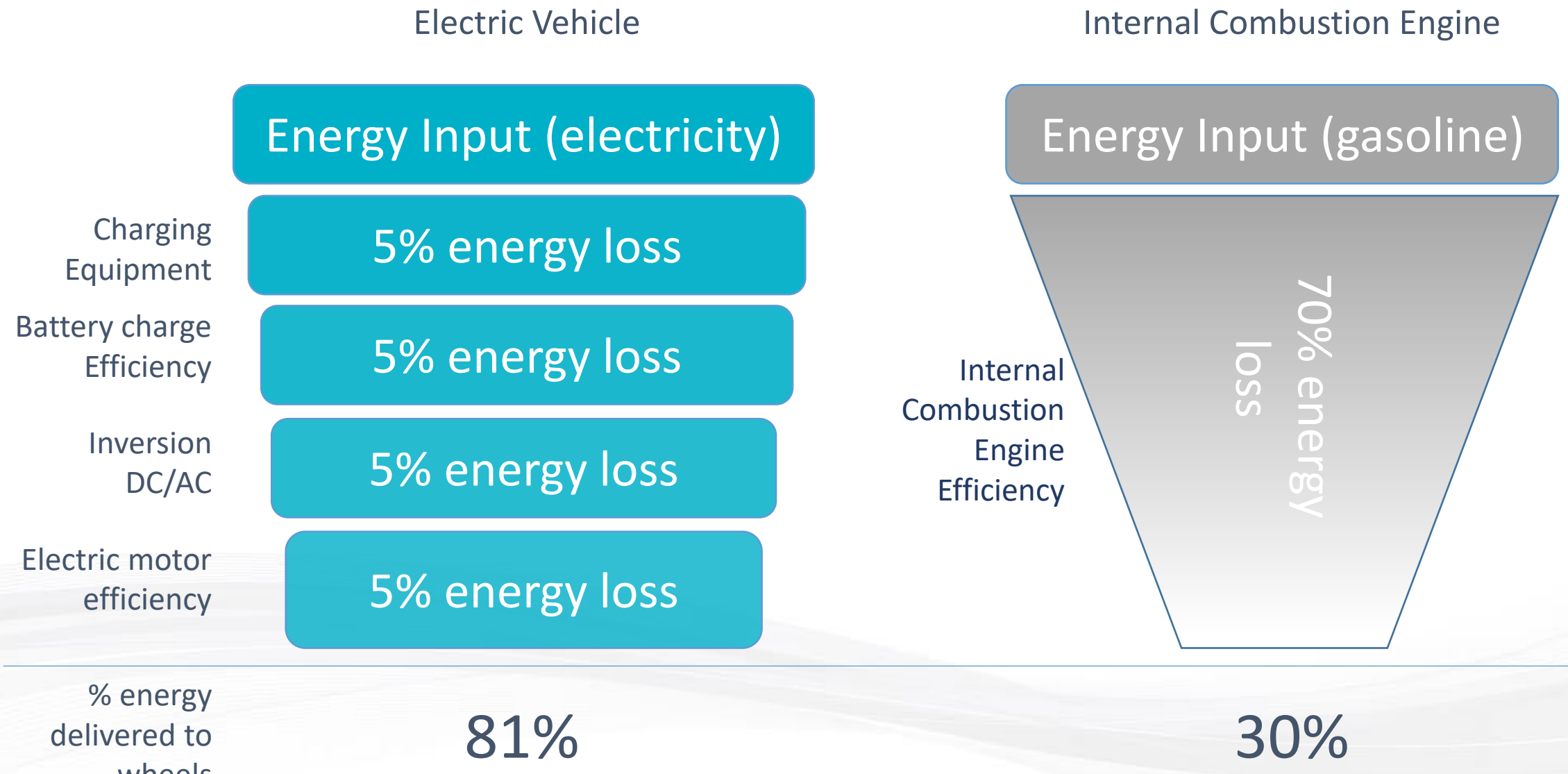
EVs VERSUS INTERNAL COMBUSION ENGINGE EFFICIENCY



PASSENGER VEHICLE ELECTRIFICATION

- 8.5M light duty vehicles in Ontario
- By 2050, almost all can be electrified
- 50-60 TWh/year of electricity
  - Implies a peak of 12-13 GW
- However, with modern technology and proper pricing incentives
  - e.g. managed charging, management software, rate structure
  - Peak load can be controlled
  - 5-7 GWs peak demand increase
- Still requires a significant investment in the grid
  - Generation, transmission, distribution

HYDROGEN FUEL CELL ELECTRIC VEHICLES (FCEVs)

- Heavy duty and long-haul transportation uses more difficult to decarbonize
- IEA predicts hydrogen will be largest fuel source for these types of uses
- FCEVs proven around the world using Canadian technologies
- Match diesel range, with higher efficiency and zero emissions

CNG AND RNG GAS BLEND FOR HEAVY TRANSPORTATION

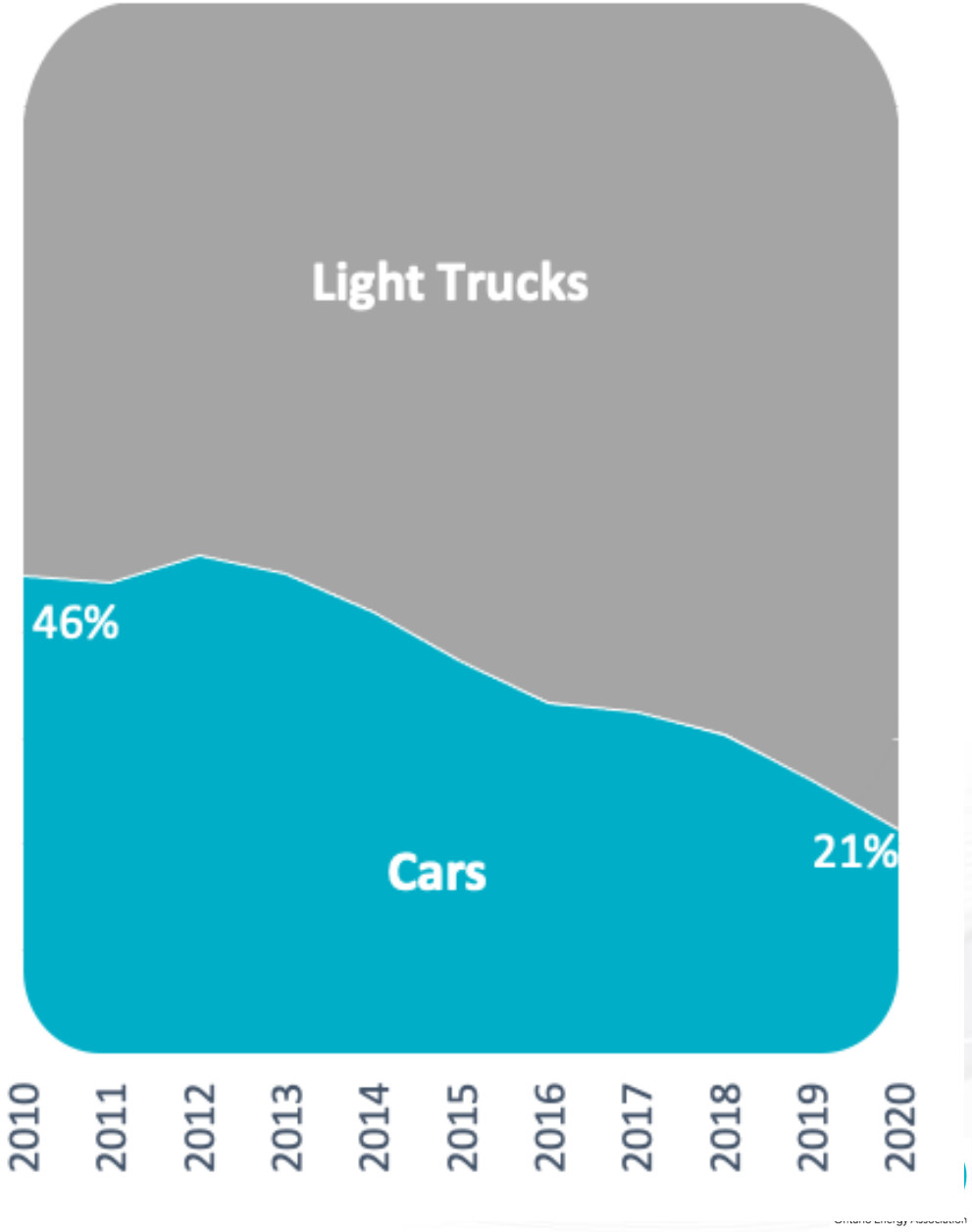
- Compressed natural gas (CNG) and renewable natural gas (RNG)
- Same range as diesel engines; lower emissions
- Low cost
- Option to be carbon-neutral or carbon-negative with RNG

BIOFUELS

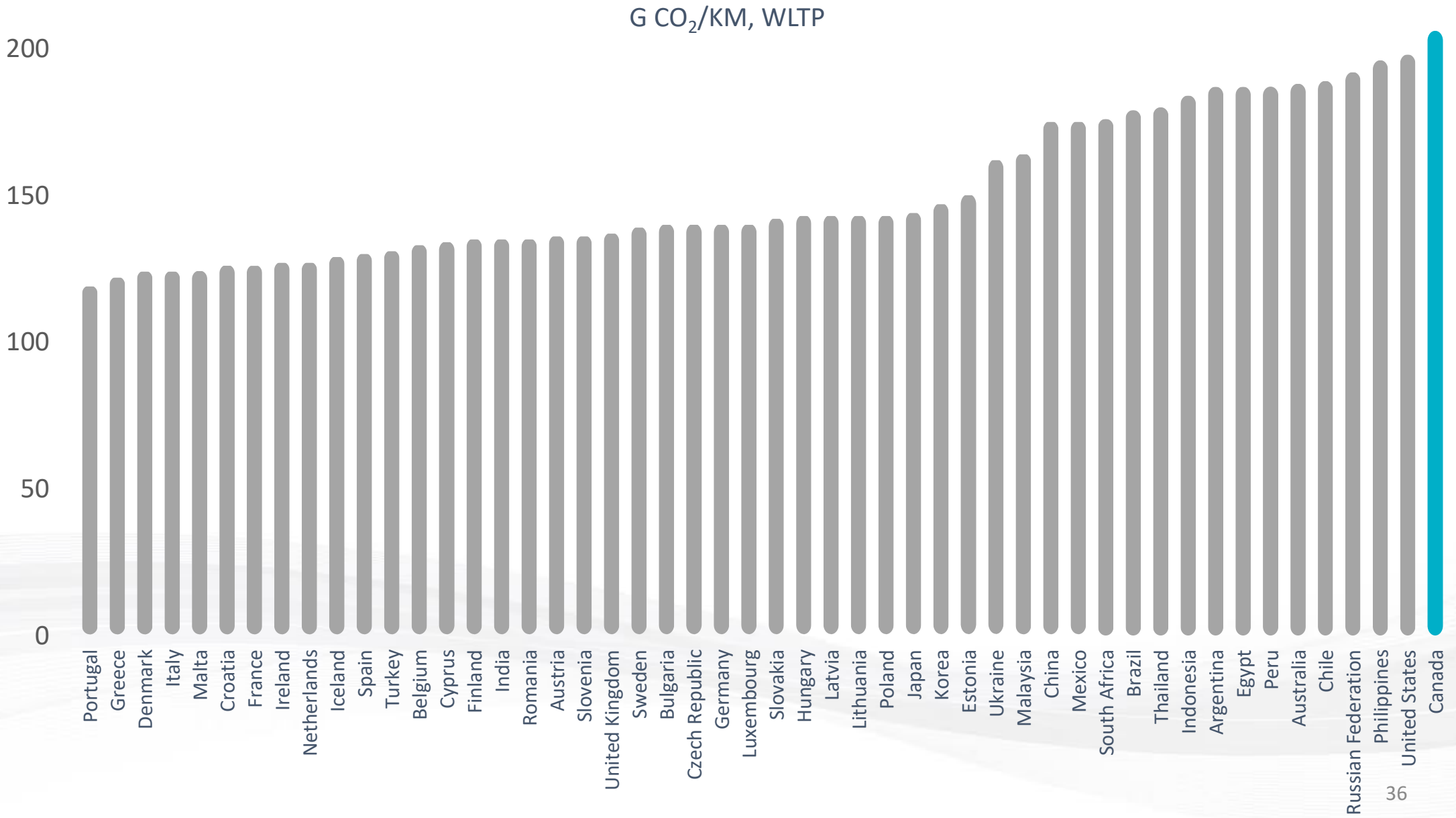
- Currently blended with petroleum in Ontario
- They include
  - Ethanol
  - Biomass-based diesel fuel (biodiesel)
- Cleaner burning than gasoline and diesel
- Ethanol made from:
  - Sugars in grains (corn, barley, …)
  - Agricultural products (beets, potato skins, rice, yard clippings, …)
- Ontario government increasing biofuel from 10% to 15% by 2030
  - Equivalent to taking 300,000 cars of the road every year
- Feedstock limitations and possible agricultural implications sometimes raised

CONSUMER BEHAVIOR AND ENERGY EFFICIENCY

- Energy efficiency of cars has been improving steadily since 1975
- However, emissions from cars has not improved
- Our cars have been getting bigger, and more powerful
- Sales of cars declined from 46 percent of sales in 2010 to 21% in 2020
  - Replaced by light trucks (SUVs)



AVERAGE CO_2 EMISSIONS PER KILOMETER BY COUNTRY 2017



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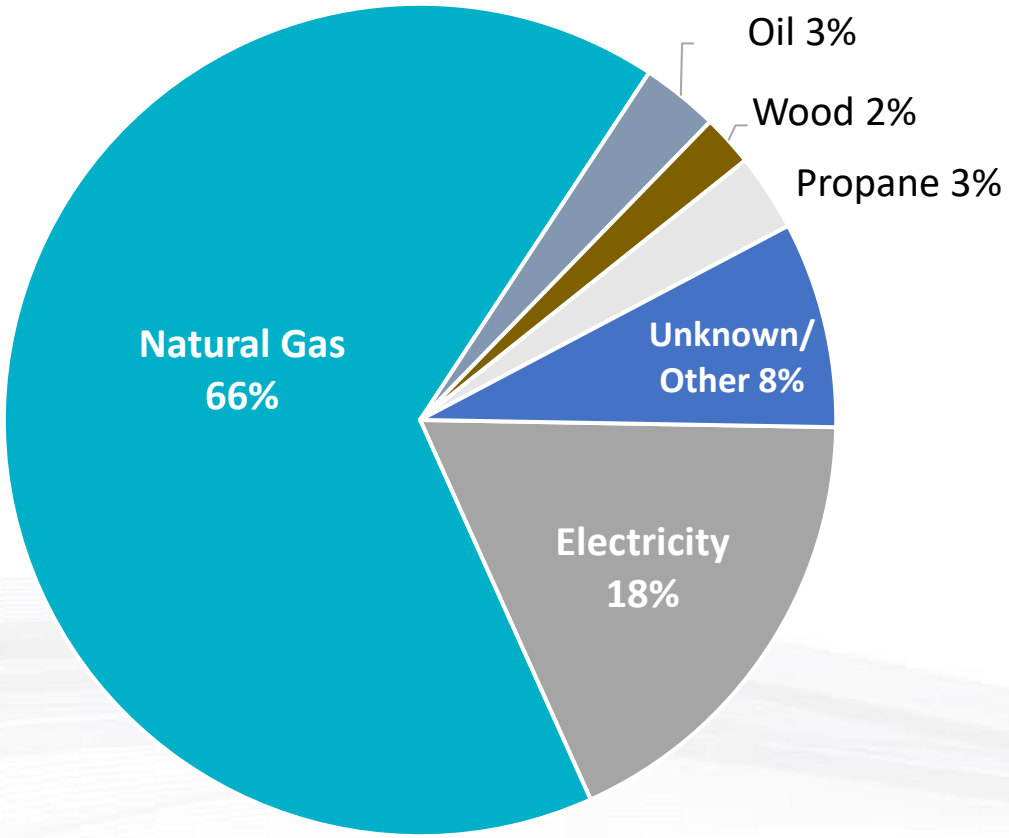
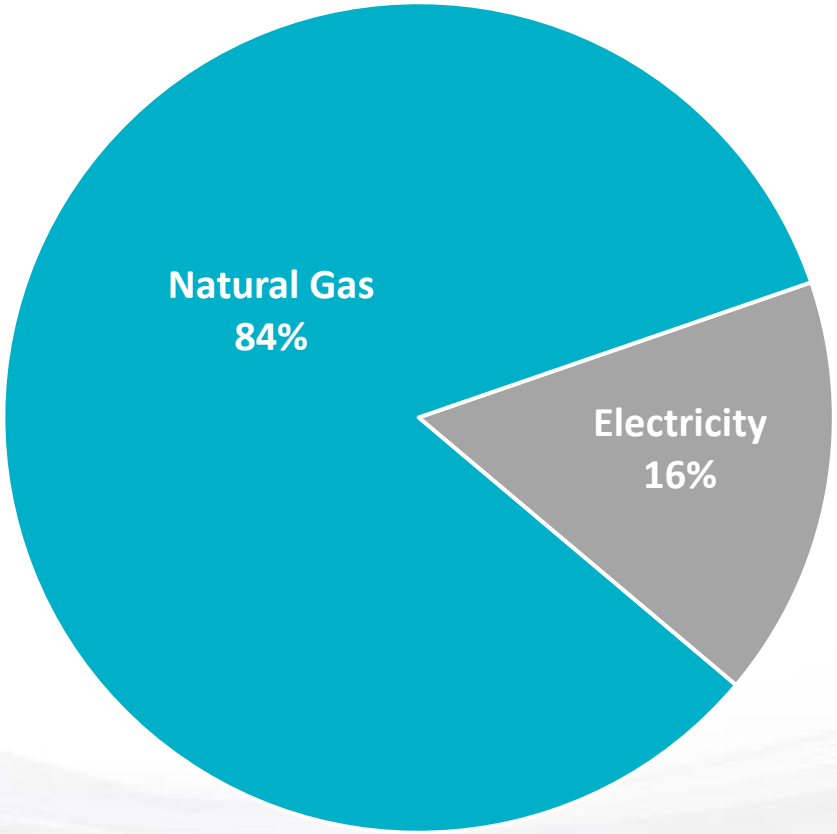
BUILDINGS SECTOR

ONTARIO SPACE HEATING BY FUEL TYPE

RESIDENTIAL BY HOME



COMMERCIAL & INSTITUTIONAL BY ESTABLISHMENT



RENEWABLE NATURAL GAS

- Currently being injected into Ontario's natural gas system
- Made-in-Ontario clean energy
- Can be carbon negative – eliminates methane emissions

Stormfisher London Biogas Facility

BLENDING HYDROGEN

- Ontario already has one project demonstrating blending
  - First of its kind in North America
- Can leverage existing natural gas infrastructure
- Can be combined with RNG
- Blending 1% by volume
  - 100,000 tonnes GHG reduction
  - 22,000 cars from the road/year
- Government direction needed
  - Allow blending of H_2 at different cost than NG

Markham P2G Facility

ENERGY EFFICIENCY

- Proven cost effectiveness
- Utility led-DSM programs under OEB framework
- 2019 Achievable Potential Study
  - Can reduce gas consumption by 5,485 million cubic metres
  - 10,672 KT CO_2
  - 3 to 1 benefit/cost ratio using “Total Resource Cost” test
- Federal government and IESO also leading programs
  - Coordination necessary
  - Leverage utilities customer-facing relationship

HYBRID HEATING AND HEAT PUMPS

- Existing technology
- For many months of year, can provide home heating
- However, for coldest months, provide insufficient heat
  - Pair with natural gas system to provide heat in coldest months
  - Can significantly reduce GHG emissions
- Air source heat pumps
- Natural gas heat pumps
  - Could reduce gas consumption 20-40% by replacing furnace and hot water heater

CODES AND STANDARDS

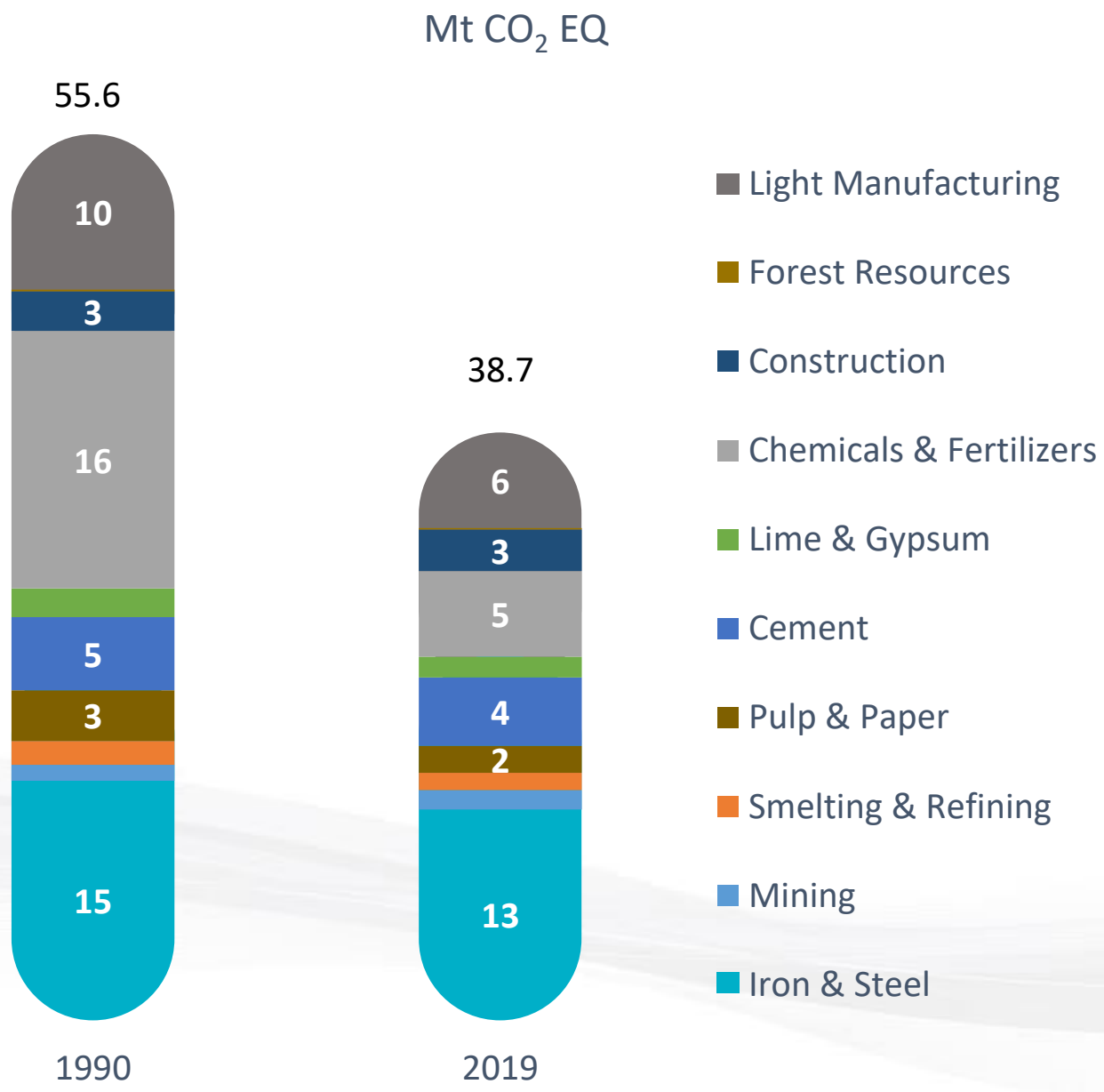
- Building codes and standards for new construction and renovation set by provincial government
- Under Municipal Act, municipalities can add additional standards
- Construction adds 1-2% to building stock annually
- 2009 survey found 46% of commercial and industrial buildings
  - 46% were renovated 2005-2009
- Codes and standards could have a significant impact on building energy efficiency

STRANDED ASSETS

- Impacts of government policy (federal, provincial, municipal) must be kept in mind
- Policies that strand assets will drive up costs for remaining customers
  - Will impact affordability of energy
  - Will impact trade-risked industry

INDUSTRIAL SECTOR

ONTARIO INDUSTRIAL EMISSIONS



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PRIVATE/CONSUMER ACTION TO ACCELERATE

- World Business Council on Sustainable Development
  - 200 of world's largest companies, $18 trillion revenue, 19M employees
  - NZ2050 goal for members
- Glasgow Financial Alliance for Net Zero (GFANZ)
  - 450 financial firms; 45 countries; $130 trillion in assets
  - Pledged action to ensure portfolios align with climate objectives
- Climate Action 100+
  - 617 global investors
  - $60 trillion in assets in 33 markets
  - Established a common agenda for emissions reductions and climate-related disclosure
- Canada's steel producers have committed to net zero 2050
- Just a few examples demonstrate private initiatives, independent of government action, will be driving transition

TECHNOLOGIES AND PATHWAYS

INTERNATIONAL & CANADIAN STUDIES

IEA ***Technology Perspectives 2020***

Princeton University ***Net-Zero America*** (Dec. 2020)

Canadian Institute for Climate Choices ***Canada's Net Zero Future*** (Feb. 2021)

CMC Low Carbon Pathways Group ***Pathways to Deep Decarbonization Canada*** (2015)

SNC Lavalin Engineering ***Net Zero: Canadian Technical Report*** (Mar. 2021)

Government of Ontario ***Made-in-Ontario Environment Plan*** (Nov. 2018)

"Almost half the emissions cuts required to move us on a path to net zero by 2050 may need to come from technologies that are not on the market yet."

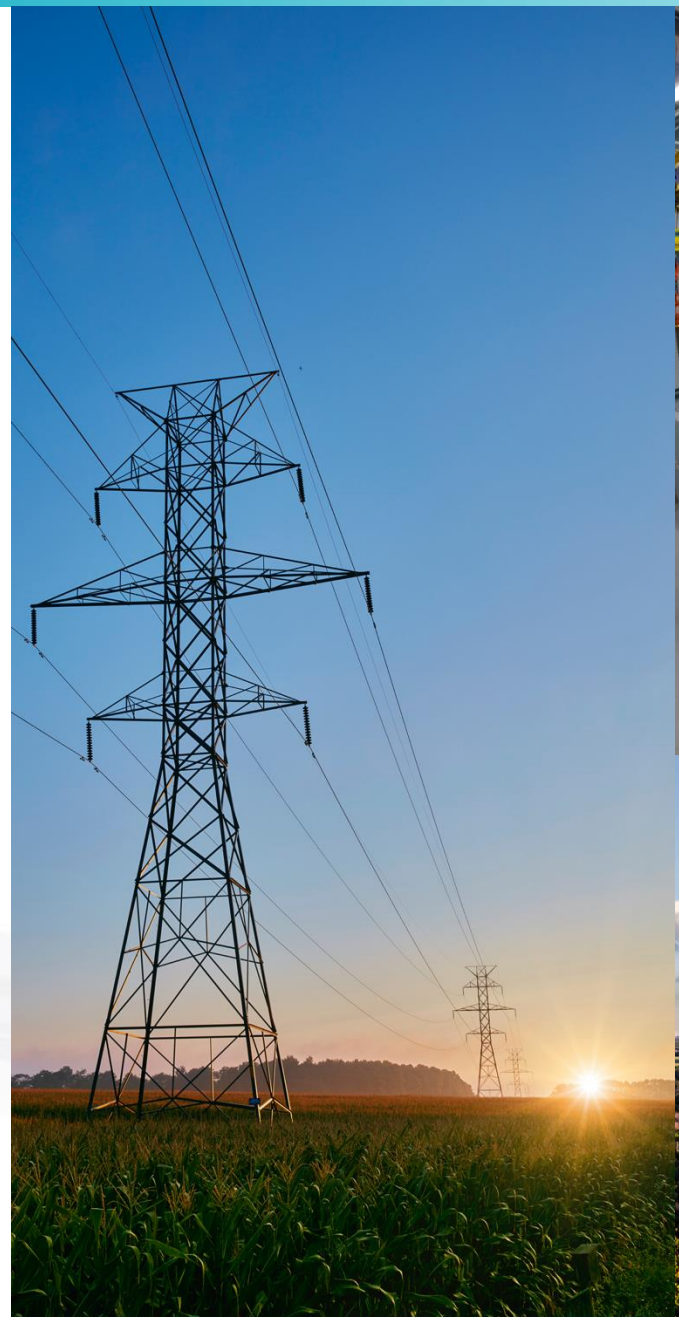
Dr. Faith Birol, Executive Director, IEA

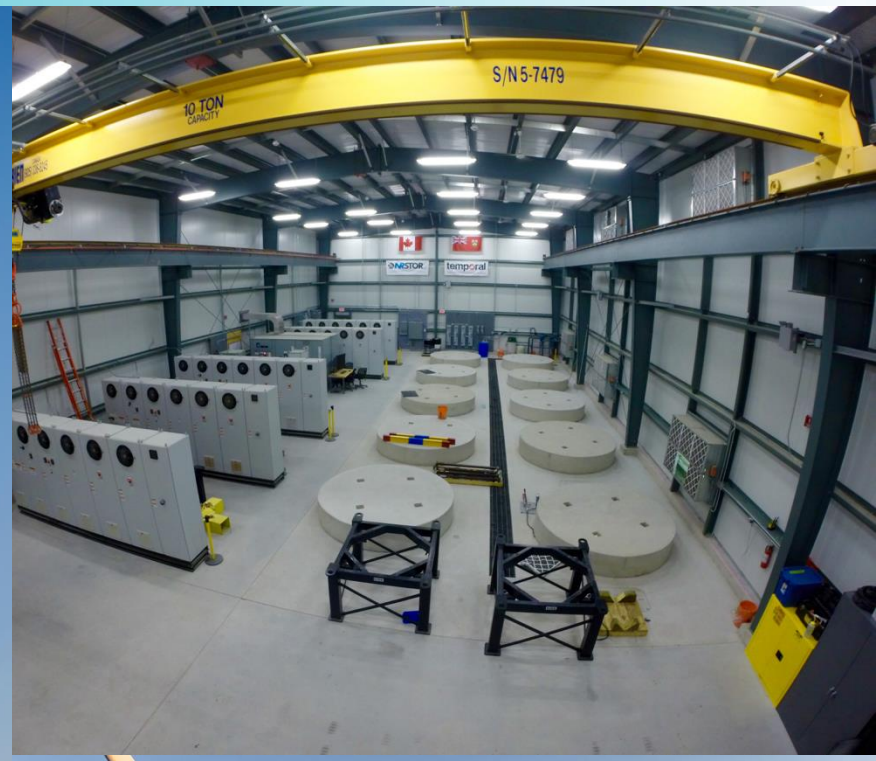
RESEARCH TAKEAWAYS

- Electricity system expansion
- Hydrogen expansion
- Carbon capture utilization and storage (CCUS)
- Alternative clean fuels
- Behavioral change
- Energy efficiency
- Fostering technological innovation

ELECTRICITY SYSTEM EXPANSION

- Overnight EV charging
- Energy storage
- Demand response
- Energy efficiency
- DERs
- Imports
- Transmission and distribution system expansion
- New generation
  - Wind
  - Solar
  - Energy storage
  - Wind or solar paired with storage
  - Traditional nuclear reactors
  - Small modular reactors (SMRs)
  - Hydro





CONSIDER ROLE OF NATURAL GAS FIRED GENERATION

- All studies suggest we need to expand our electricity system
- Natural gas fired generation currently provides 26% of our capacity
  - We will need it to support expansion
- Gas plant provide backup and flexibility
  - Enable renewables
- Could hamper our Net Zero progress to contract our electricity system, and its capability, at the time we need to expand

Napanee Generating Station

HYDROGEN

- Zero carbon hydrogen a critical element of NZ2050
- The most promising option to decarbonize “hard to abate” sectors
  - Heavy transportation
  - Iron and steel production
  - Chemicals
- Countries around the world adopting hydrogen strategies
- Canada is a leader in hydrogen technology
  - Enbridge, Cummins/Hydrogenics, New Flyer, Svante, Planetary Hydrogen, Hydra Energy, etc.
  - Canadian technology powers half the 2,000 FCEV buses on the road around the world
- Canada released hydrogen strategy in December 2020
  - Up to 30% of energy use by 2050
- Government support needed to help build capacity
  - Pilots and initial developments

CARBON CAPUTURE UTILIZATION & STORAGE (CCUS)

- Allows us to decarbonize hard-to-abate and vital sectors
- Can unlock clean energy opportunities
  - Blue hydrogen
  - Low-carbon petrochemical developments
  - Cement manufacturing
  - Steel manufacturing

"reaching net zero will be virtually impossible without CCUS"
-IEA

ALTERNATIVE CLEAN FUELS

- Alternative clean fuels will be necessary for NZ2050
- Bioenergy
- Biofuels
- Biogas
- Hydrogen-based fuels
  - Ammonia and synthetic fuels
- Higher volumetric density fuels will be required to replace current shipping and air transportation fuels

BEHAVIORAL CHANGE

- Individuals and businesses can have a huge impact on emissions based on behavior
- This impact runs through most of our daily decisions
- We need to mobilize behavior change as a society

COMPREHENSIVE PLANNING
& COORDINATION

COMPREHENSIVE ENERGY PLANNING

- Most energy consumption happens outside electricity system
- Therefore, need a comprehensive ENERGY strategy
- Eliminate energy silos
  - MENDM fuels policy and review
  - OEB oversight of natural gas and some electricity costs
  - IESO planning and operation electricity system
  - Provincial government leads electricity system procurement
- These efforts should be coordinated under a broad energy framework

GOVERNMENT COORDINATION

- Federal, provincial, regional and municipal government are all active on NZ2050
- Coordination will be necessary for success
- Governments cannot work at cross-purposes
- Provincial government needs to ensure that municipal strategies and initiatives are:
  - Coordinated;
  - fully-costed; and
  - complementary

CONCLUSION & RECOMMENDATIONS

CONCLUSION AND RECOMMENDATIONS

1. **Transportation fuel switching**
   - Should be our first priority
2. **Reduce emissions from natural gas system**
   - Given the volume of energy, not practical to fully electrify concurrently with transportation and industrial electrification
3. **Plan to expand the electricity system**
   - Leverage our clean system
4. **Comprehensive energy planning, not just electricity policy**
   - Given most energy use currently outside of electricity system
5. **Accelerate hydrogen programs and pilots**
   - Need to scale this resource quickly
6. **Federal, provincial and municipal coordination**
   - Need alignment and complimentary efforts for success

Thank you

Questions?

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THESE SLIDES ARE PART OF AN ONTARIO ENERGY ASSOCIATION PRESENTATION AND ARE INCOMPLETE WITHOUT ACCOMPANYING ORAL COMMENTARY