Decarbonizing the Built Environment in Saskatchewan

ASHRAE Regina & Saskatoon

November 9th, 2022

Format

- Housekeeping
  - In person
  - Online
- Acknowledgements
  - Treaty 4
  - Special thanks
- Format
  - Each presenter has been asked for a 5-7 minute presentation
  - Questions to be saved for the end of the presentations

Presenters

- Christie Gamble, CarbonCure Technologies
- Murdoch MacPherson, MacPherson Engineering
- Dave Samayoa, MacPherson Engineering
- Emmet Boyle, University of Regina
- Greg Kuntz, City of Regina
- Aaron Wirth, Government of Saskatchewan
- Megan Bunney, SaskEnergy
- Nathan Hoffart, SaskPower

Embodied Carbon

- Christie Gamble
- Senior Director of Sustainability
- CarbonCure Technologies

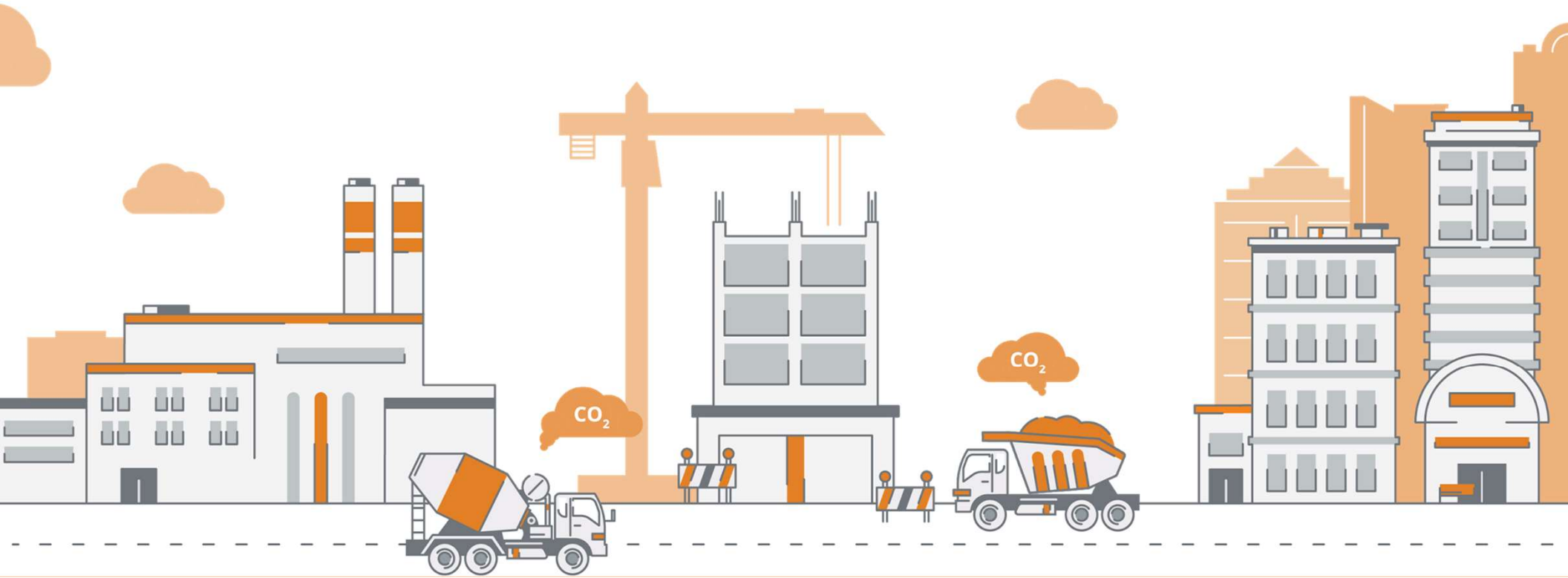

Did You Know?
The world's building stock is expected to double by 2060. This means we're building an entire New York City every month for the next 40 years.

Did you know?

Of that new construction, embodied carbon is expected to account for nearly 50% of the buildings' total carbon emissions.

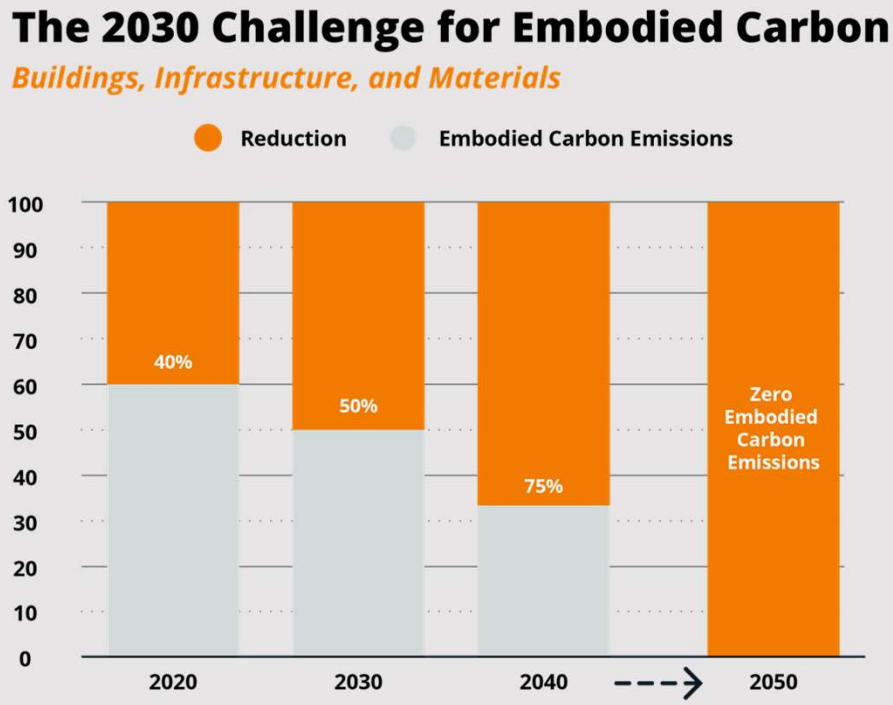
What is Embodied Carbon?

Embodied carbon is the emissions from manufacturing, transportation, and installation of building materials through to the construction of the building.



The Embodied Carbon Challenge

A multi-disciplinary challenge to achieve net zero embodied carbon by 2050.



Mission alignment with:

Carbon Leadership Forum

SEI ASCE

architecture 2030

WORLD GREEN BUILDING COUNCIL

C40 CITIES

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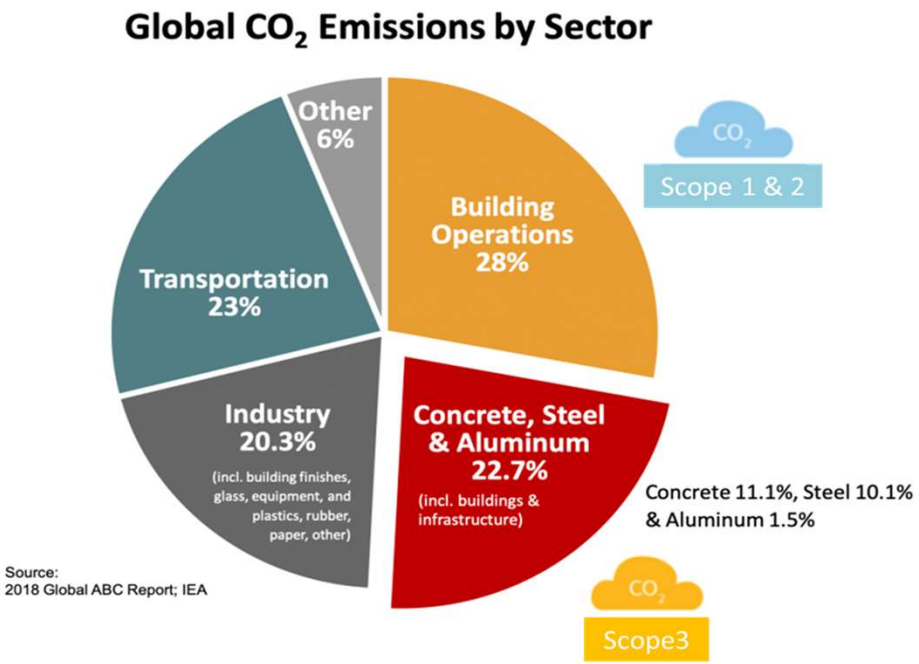
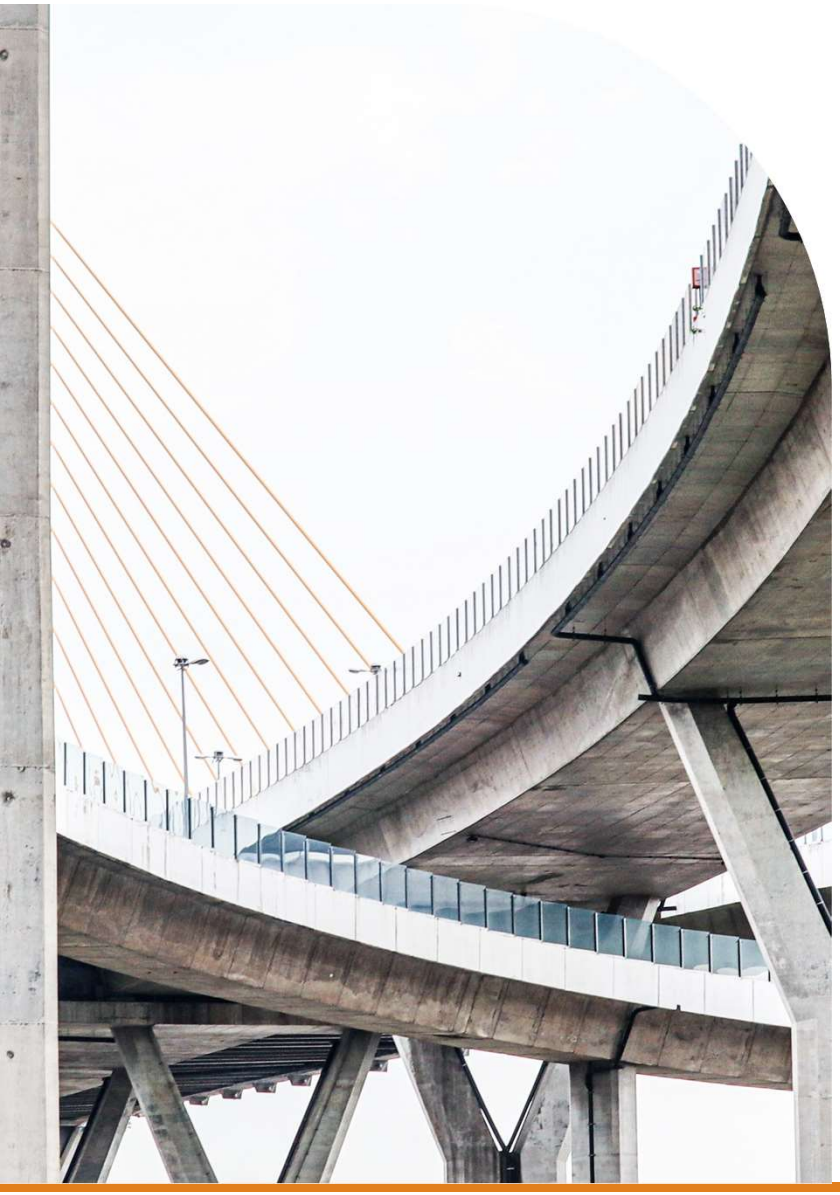
Where is Embodied Carbon Coming From?





Concrete is the most abundant man-made material in the world.

As a result, cement production creates **~7%** of the world's CO_2 emissions and is one of the **largest contributors** to embodied carbon in the built environment.

How can you help reduce concrete's carbon impact?

- ✓ **Communicate** your commitment to embodied carbon reduction throughout the supply chain *early* and *often*
- ✓ **Remove the barriers:** remove unnecessary prescriptive concrete specs and consider **performance-**based concrete specs
- ✓ **Demand Transparency:** Require Environmental Product Declarations

You can't manage what you can't measure!

What is Life Cycle Assessment (LCA)?

	Building Life Cycle Information													
Stage	Product			Construction		Use					End-of-life				Beyond
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D
Embodied	Raw material supply	Transport	Manufacturing	Transport	Construction and installation	Use	Maintenance	Repair	Replacement	Refurbishment	Demolition and deconstruction	Transport	Waste processing	Disposal	Credit for Reuse, Recycling and Recovery Potential
Operational						B6	Energy use								
						B7	Water use								

What is an Environmental Product Declaration?

- States the environmental impacts of a product based on Life Cycle Assessment
- Includes product's performance characteristics, explanation of manufacturing processes, and impact calculations.
- Must adhere to standardized rules and be verified by third party.

ENVIRONMENTAL PRODUCT DECLARATION

FABRICATED HOT-ROLLED STRUCTURAL SECTIONS

AMERICAN INSTITUTE OF STEEL CONSTRUCTION

Hot rolled structural steel sections complying with the definition of structural steel in AISC 303-10 produced in the United States and fabricated by an AISC member fabricator.

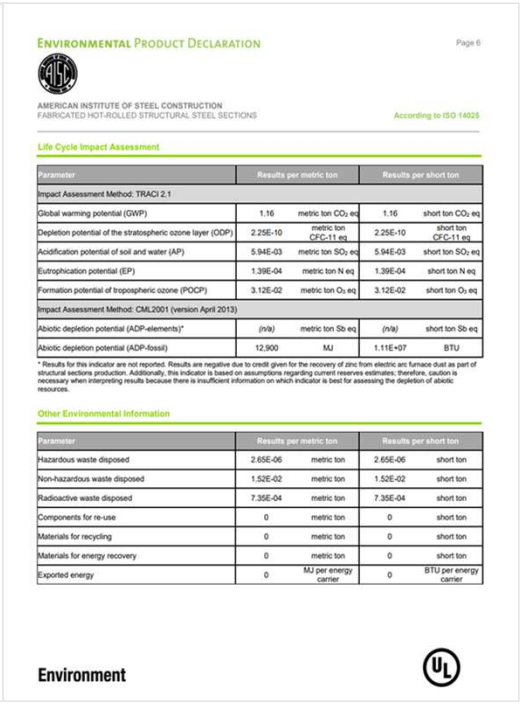
Use of this EPD is limited to AISC members. Member names are available on-line at www.aisc.org/epd

The United States structural steel industry annually supplies, fabricates and erects structural steel framing for more than 10,000 buildings, bridges and industrial projects through a network of producers, service centers, steel fabricators and erectors.

Long committed to the principles of sustainable manufacturing, the industry remains the world leader in the use of recycled materials and end-of-life recycling, with the recycled content of hot-rolled structural steel beams and columns produced at US mills averaging in excess of 95% and an end-of-life recovery rate of 98%.

The American Institute of Steel Construction is a not-for-profit technical institute and trade association established in 1921 to serve the structural steel design community and construction industry. AISC currently represents 3 producers of hot-rolled structural steel sections and over 920 structural steel fabricators in the US.

CERTIFIED ENVIRONMENTAL PRODUCT DECLARATION



ENVIRONMENTAL PRODUCT DECLARATION

Page 6

AMERICAN INSTITUTE OF STEEL CONSTRUCTION
FABRICATED HOT-ROLLED STRUCTURAL STEEL SECTIONS

According to ISO 14025

Life Cycle Impact Assessment

Parameter	Results per metric ton		Results per short ton	
Impact Assessment Method: TRACI 2.1				
Global warming potential (GWP)	1.16	metric ton CO_2 eq	1.16	short ton CO_2 eq
Depletion potential of the stratospheric ozone layer (ODP)	2.25E-10	metric ton CFC-11 eq	2.25E-10	short ton CFC-11 eq
Acidification potential of soil and water (AP)	5.94E-03	metric ton SO_2 eq	5.94E-03	short ton SO_2 eq
Eutrophication potential (EP)	1.39E-04	metric ton N eq	1.39E-04	short ton N eq
Formation potential of tropospheric ozone (POCP)	3.12E-02	metric ton O_3 eq	3.12E-02	short ton O_3 eq
Impact Assessment Method: CML2001 (version April 2013)				
Abiotic depletion potential (ADP-elements)*	(n/a)	metric ton Sb eq	(n/a)	short ton Sb eq
Abiotic depletion potential (ADP-fossil)	12,900	MJ	1.11E+07	BTU

* Results for this indicator are not reported. Results are negative due to credit given for the recovery of zinc from electric arc furnace dust as part of structural sections production. Additionally, this indicator is based on assumptions regarding current reserves estimates; therefore, caution is necessary when interpreting results because there is insufficient information on which indicator is best for assessing the depletion of abiotic resources.

Other Environmental Information

Parameter	Results per metric ton		Results per short ton	
Hazardous waste disposed	2.65E-06	metric ton	2.65E-06	short ton
Non-hazardous waste disposed	1.52E-02	metric ton	1.52E-02	short ton
Radioactive waste disposed	7.35E-04	metric ton	7.35E-04	short ton
Components for re-use	0	metric ton	0	short ton
Materials for recycling	0	metric ton	0	short ton
Materials for energy recovery	0	metric ton	0	short ton
Exported energy	0	MJ per energy carrier	0	BTU per energy carrier

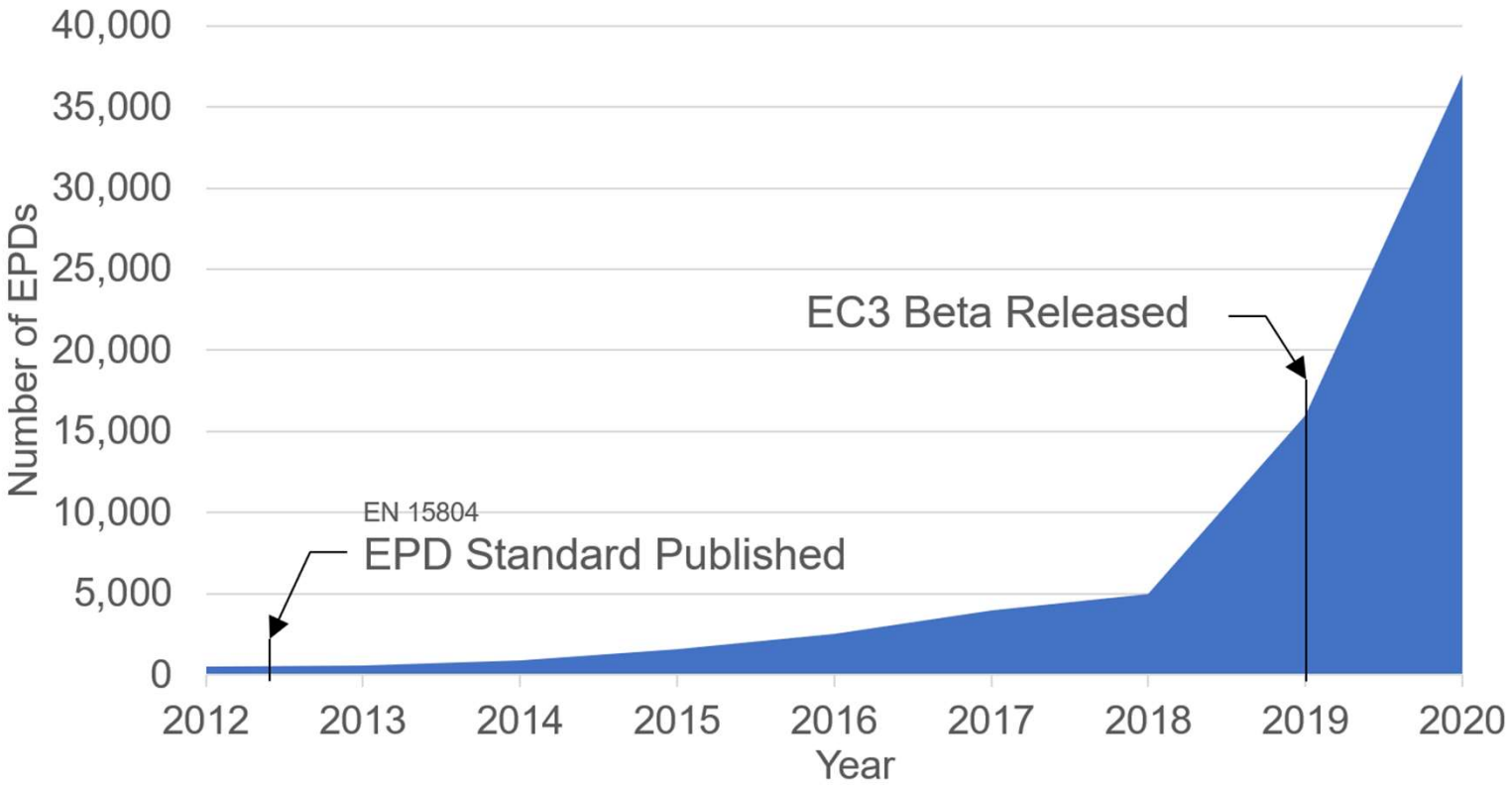
Environment

Product Impacts

Declared Unit: 1 m^3 of 10,000 psi concrete at 28 days

Amount Per Declared Unit	
Global Warming Potential	445 $kgCO_2eq$
Emitted	460 $kgCO_2eq$
Sequestered	-15 $kgCO_2eq$
Ozone Depletion	0.000 kgCFC11eq
Acidification	2.96 $kgSO_2eq$
Eutrophication	0.09 kgNeq
Smog Formation	0.61 kgO_3eq
Primary Energy Demand	3017 MJ
Non-renewable	3000 MJ
Renewable	17 MJ

Number of EPDs Over Time



Data from 2012 – 2018 was adapted from Andersen et al. (2019). Data for 2020 represents number of EPDs in EC3.

Start Tackling Embodied Carbon Today

Visit carbonleadershipforum.org

1 – Getting Started: Corporate Policies

READ MORE

2 – Embodied Carbon Procurement Policies

READ MORE

3 – Targeting Net-Zero Embodied Carbon

READ MORE

TAKEAWAYS FROM THE INTERNATIONAL BUILDING DECARBONIZATION 2022 CONFERENCE

Murdoch MacPherson, P.Eng.

8 Nov 2022

MACPHERSON ENGINEERING INC | MECHANICAL CONSULTING ENGINEERS

Biography

EDUCATION

- Bachelor of Science, Mechanical Engineering, University of Saskatchewan, 1981

ASSOCIATIONS

- Association of Professional Engineers & Geoscientists of Saskatchewan, Alberta & Manitoba
- ASHRAE (American Society of Heating, Refrigeration and Air-Conditioning Engineers)

CURRENT POSITION

- Principal Mechanical Engineer at MacPherson Engineering Inc, Regina, SK, Canada, responsible for the design, analysis, project management & construction contract administration of heating, ventilation, automatic controls, air conditioning, plumbing, site services, and fire protection systems for cultural, recreational, commercial, institutional, healthcare, industrial, warehouse, retail, transportation and research facilities.

EXPERIENCE SUMMARY

- Murdoch MacPherson is the President and one of several principal Mechanical Engineers at MacPherson Engineering Inc. with over forty years of experience in the design and evaluation of mechanical systems for buildings.

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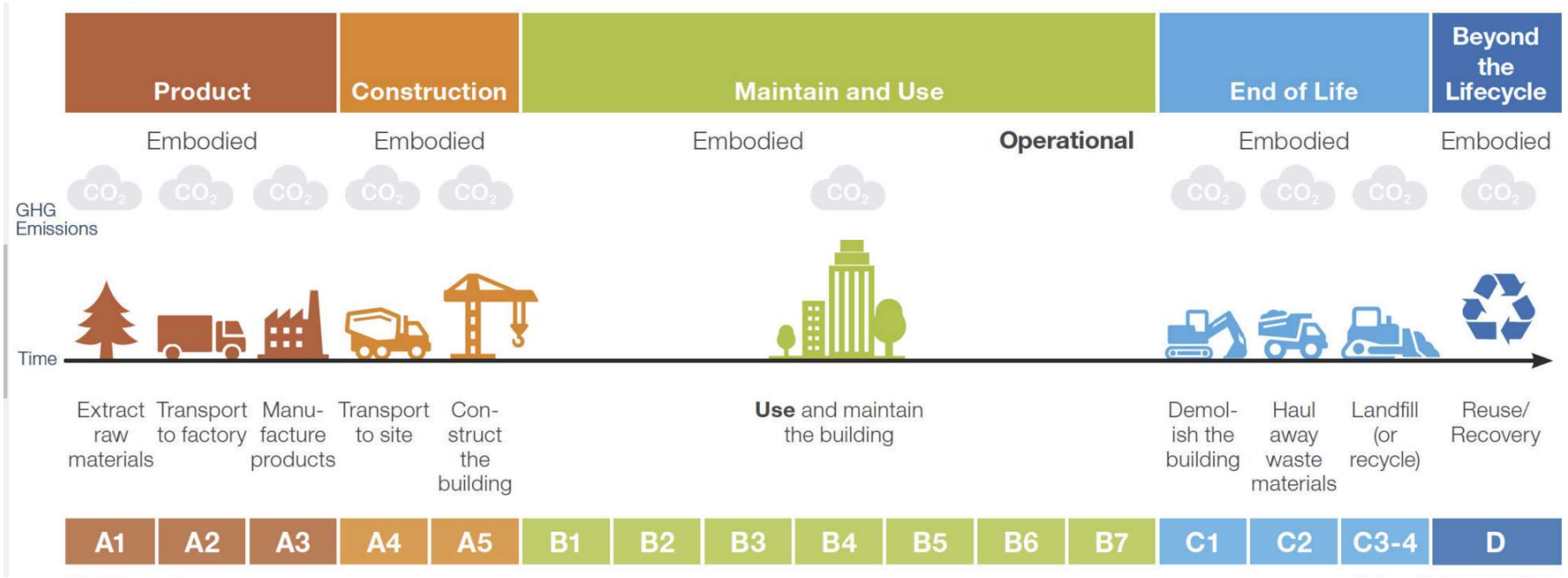
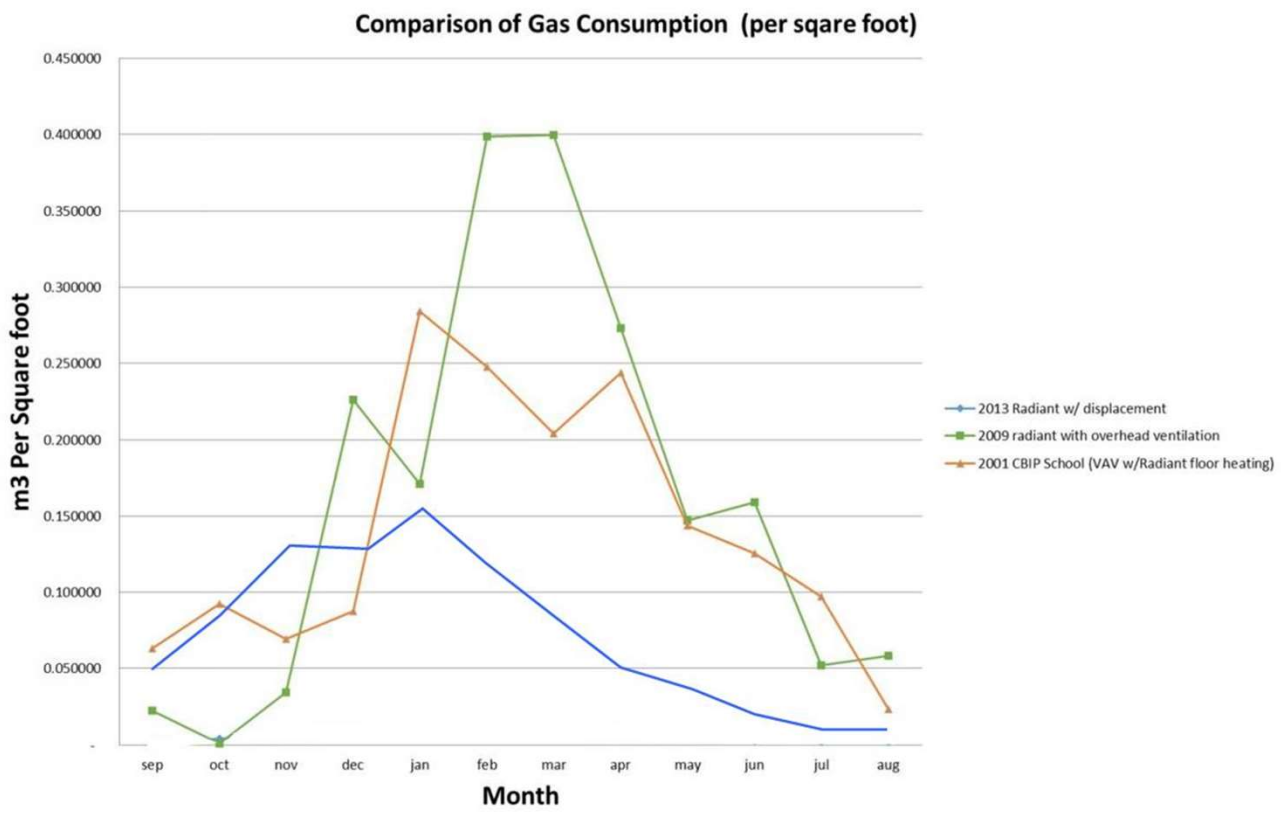
ASHRAE Position Document on Building Decarbonization

The ultimate goal is to minimize whole-life-cycle GHG emissions



What to do first?



Electrification and the use of heat pumps is the perceived ultimate goal to heat buildings. Interim strategies to decarbonize should minimize energy use first, until the utility replaces dirty energy sources with low carbon energy sources and expands the grid capacity.

Examples of energy efficient strategies include the use of code-mandated exhaust air heat recovery systems, displacement ventilation systems and delivering heating and cooling using low temperature radiant systems that store energy in the thermal mass of buildings. These systems can easily be adapted to utilize electric water to water heat pumps in the future.

When to Electrify?

Proposed GSA Federal Building Decarbonization Prioritization Approach

Grid Emissions Intensity	Low	Medium	High
High	Deep Retrofit + On-site RE	EE Retrofit + On-site RE	RCx + On-site RE
Medium	Deep Retrofit	EE Retrofit	RCx
Low	Deep Retrofit + Electrification (Low Electricity Score)	EE Retrofit + Electrification (Low Electricity Score)	RCx + Electrification (Low Electricity Score)

Energy Efficiency Score

Energy Efficiency Score - The ENERGY STAR Score from ENERGY STAR Portfolio Manager is used as the energy efficiency indicator when available. This indicator provides a percentile ranking of building energy performance normalized for building type, building size, building occupancy, plug-loads, and climate zone. If this data is not available, then the percentile ranking of building site energy use intensity may be used.

Grid Emissions Intensity – The data used for this factor is the most recent eGRID Scope 2 emissions factor (MT CO2e/kWh) from the appropriate subregion.

Electricity Score – The electricity score is the ratio of electricity use (BTUs) to the building total energy use from all sources (electricity, gas, oil, district heat and chilled water.

* Note: In addition to a low grid emissions factor, electrification should be prioritized for buildings with low electricity scores and significant fossil fuel usage. Also, electrification will be most economical if the ratio of electricity to fossil fuel cost per BTU is low.

Note: This represents a draft product of the U.S. General Services Administration, Green Building Advisory Committee, Federal Building Decarbonization Task Group gsa.gov/gbac

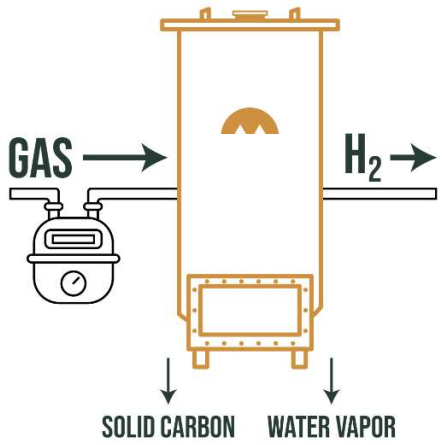
What's Next?

Keep a close eye on emerging technologies:

- Heat pumps that perform in our winter climate.
- Hydrogen created onsite from natural gas

For those of us on the outside looking in, there's uncertainty in the timelines and proposed technologies associated with decarbonizing our electrical grid. Our best guess, primarily based on new natural gas fueled electrical generation stations still in construction, is that we're 20 years away from not generating power from natural gas.

When the utilities are able to provide that certainty, we'll follow with appropriate mechanical systems designs. In the meantime, we'll concentrate on designing energy-efficient systems that can be adapted in the future to low carbon electricity.



Onsite Hydrogen Production

- Decarbonize Gas Use with Today's Infrastructure.
- Reduced CO_2 Emissions.
- No H_2 Transmission & Distribution Costs.

ASHRAE®

Regina Residential Home Energy Modelling Project

David Samayoa, EIT

November 09, 2022

MACPHERSON ENGINEERING INC | MECHANICAL CONSULTING ENGINEERS

Biography

Education:

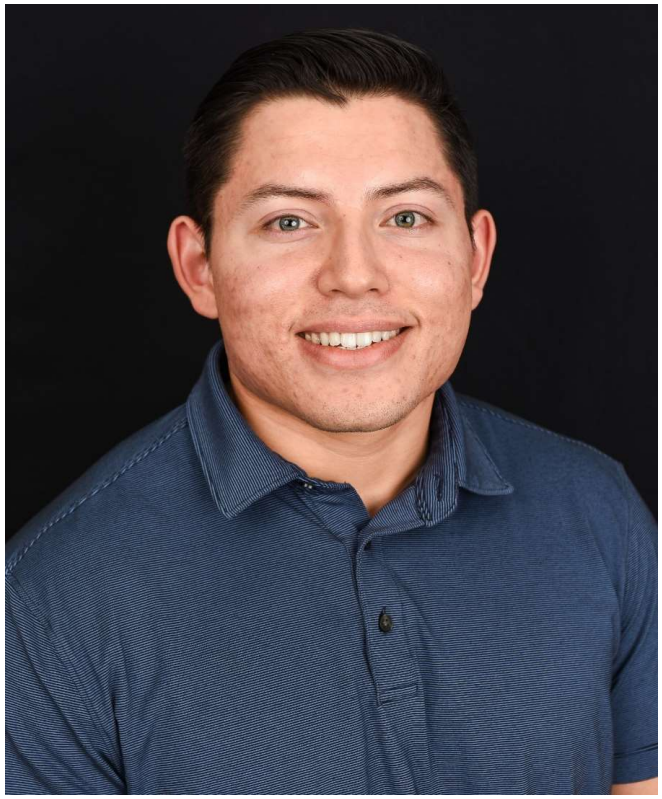
- Red Seal Journeyman Plumber Certification, Saskatchewan Apprenticeship and Trade Certification Commission, 2016
- Bachelor of Applied Science, Industrial Systems Engineering, University of Regina, 2022

Associations:

- APEGS (Association of Professional Engineers & Geoscientists of Saskatchewan)
- ASHRAE (American Society of Heating, Refrigeration and Air-Conditioning Engineers)

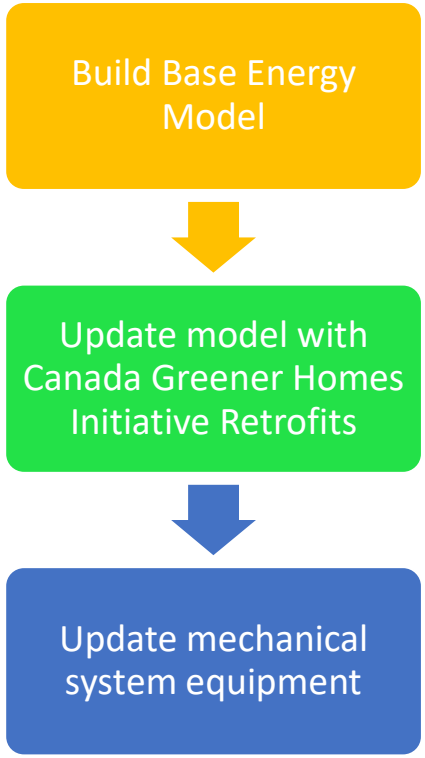
Current Position:

- Junior Mechanical Engineer-in-training at MacPherson Engineering Inc., Regina, Sk. Responsibilities include design and analysis of heating, ventilation, and air conditioning (HVAC) in commercial, and institutional buildings.



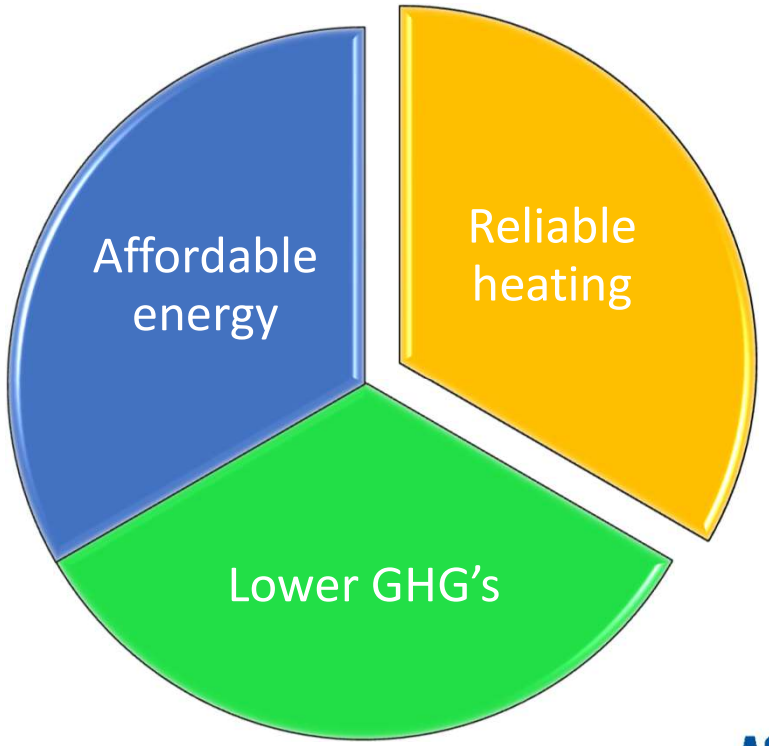
Regina Residential Home Energy Modelling Project

The residential home energy modelling project will analyse three existing homes in Regina, to determine the annual energy usage. Next, we will build the models to reflect retrofits that are supported under Canadas Greener Homes Initiative to find the most effective retrofits. Last, we will model the homes to reflect various mechanical systems to understand the impact that higher efficient systems and heat pumps will have on energy consumption, utility costs, and greenhouse gas emissions.



Regina Residential Home Energy Modelling Project

The intent of this project is to determine the most responsible residential home retrofits for Saskatchewan residents that will reduce our greenhouse gas emissions while providing reliable heating/cooling and ensuring that utility costs for the average homeowner remain affordable.



City of Regina Residential Home Energy Modelling Project

Key Metrics:

- Site Energy Usage Index (EUI_{site}) – Considers all energy consumed at the building on an annual basis in kBtu/ft^2 (kWh/m^2).
- Source Energy Usage Index (EUI_{source}) – Considers total amount of energy required to produce and transport the energy to the site in kBtu/ft^2 (kWh/m^2).
- Greenhouse gas intensity (GHGI) – Considers the carbon emissions generated from energy sources consumed by the building in tons of CO_2e/ft^2/year.

City of Regina Residential Home Energy Modelling Project

Resources:

- ASHRAE Standard 90.2 – Energy-Efficient Design of Low-Rise Residential Buildings
- City of Regina Energy & Sustainability Framework
- Canada Greener Homes Grant Initiative
- National Energy Code of Canada: 2020

Energy Efficiency Resources

City of Regina Residential Home Energy Modelling Project

Design options:

Walls/Floors/Roofs

- Increase quality of insulation
- Reduce air leakage (infiltration)
- Activate thermal mass*

Windows & Doors

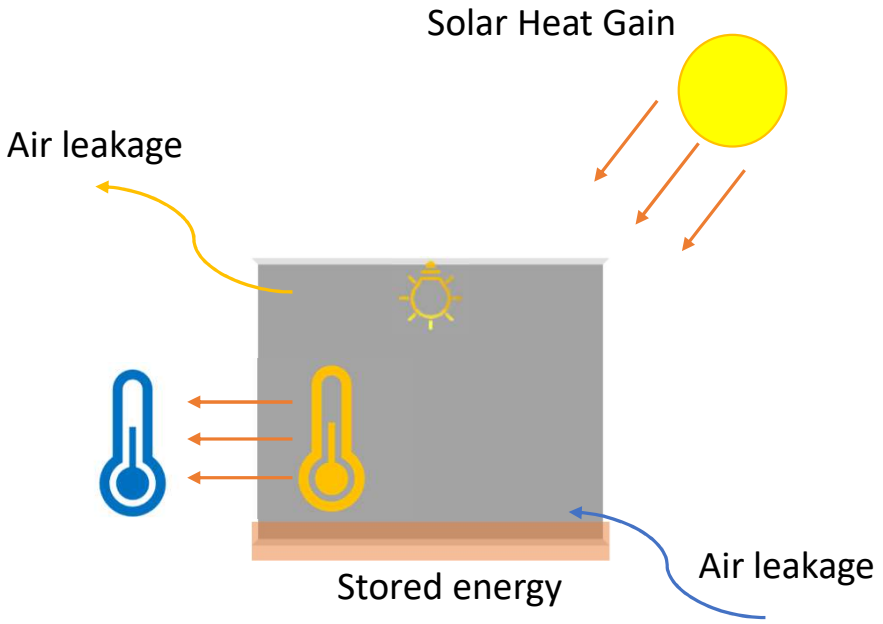
- High performance windows and doors

Lighting & Plug Loads

- LED Lights

Mechanical Equipment

- High-efficient furnace and boilers
- Heat pumps
- Exhaust air heat recovery
- Radiant heat retrofit*

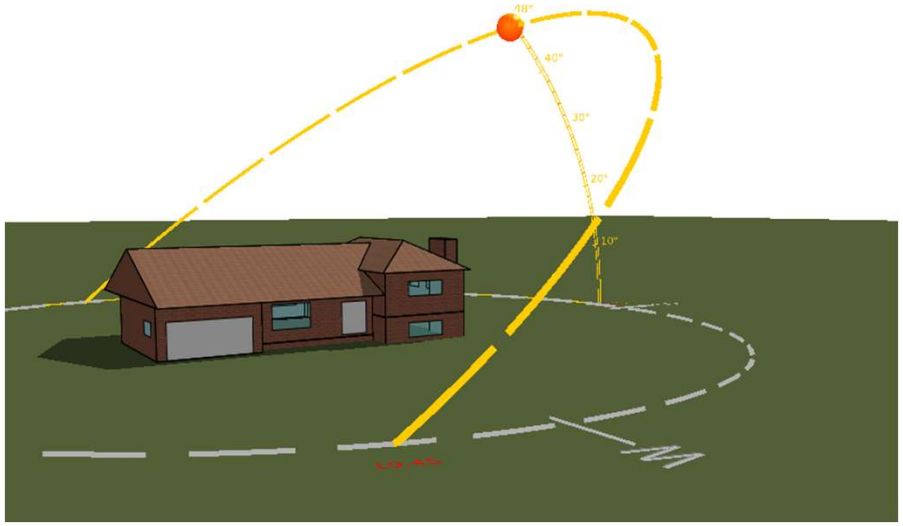


City of Regina Residential Home Energy Modelling Project

Saskatchewan pathway to decarbonize

The expected outcome is to determine the most effective residential home retrofits for Saskatchewan residents, available for grants through the Canada Greener Homes Grant Initiative.

It is also expected to provide direction for electrifying residential home heating while considering electricity prices and greenhouse gases generated through electricity generation.



City of Regina Residential Home Energy Modelling Project

Thanks for listening

•U of R Pathways to Decarbonization

•Emmet Boyle – Director of Maintenance & Utilities

•November 9, 2022

University of Regina

•About the U of R

•Mid-size comprehensive university with about 16,000 students.

•2.8 million square feet of building area; range from 1964 to 2016. Includes teaching, sports, residence, library and laboratory space. Diverse and complex portfolio.

•All significant buildings are served by the Central Heating and Cooling Plant; 165 psi steam and chilled water. Also supply Innovation Place, Luther & Campion Colleges

•The Annual Numbers

- •250,000 GJ natural gas
- •45,000,000 kWh Electricity; ~ 10 MVA peak demand
- •17,000 te CO2e from electricity
- •12,000 te CO2e from natural gas
- •~$1,000,000 carbon tax in FY 22/23

•What's Driving Us

•University's Strategic Plan calls for a 25% reduction in our carbon footprint by 2025 and carbon neutrality by 2040.

•Central plant steam boilers are beyond natural life cycle.

•Chillers are capacity constrained and the R123 & R134a refrigerants will be phased out by 2030.

• It's the right thing to do!

•Success to Date

•Long history of proactive energy management

•Investment in Energy Management Information System (EMIS)

•Innovative designs: In floor heating and cooling in Kisik Towers. Chilled water free cooling in RIC (laboratory) make up air system.

•Hired an Energy Manager

•Pathways Forward - Electricity

•To reduce carbon emissions from purchased electricity we are looking at a 13MW solar farm on our Wascana East Lands. This project was submitted for funding to the Federal Low Carbon Economy Challenge. We should hear if it was successful for funding later this month.

•Pathways forward - Thermal

•Working on a Carbon Reduction Technical Pathways Study

•Study is focused on the district heating and cooling systems

•Possible options:

➢Waste to energy steam service with absorption chillers

➢Waste to energy hot water with absorption chillers

➢Low temp hot water with baseload from geothermal ground source heat pump with peaking from renewable fuels; electric chillers

•What's Next?

•Need to consider the options and select one pathway to pursue.

•Need to consider complexity of solid fuels, land needs for fuel delivery & storage, changing distribution system.

•Buildings would also need significant investment to operate with lower temperature options.

•Broader aspects of sustainability and embodied carbon.

•All options will require significant investments over a long period of time.

•Conclusion

•We have some once in a generation decisions to make and we need to get them right. Will take some time and lots of collaboration.

•Stay tuned!

•Thank-you

City of Regina

Energy & Sustainability Framework Implementation

Greg Kuntz

November 9, 2021

Biography

- Greg Kuntz, P.Eng.
- Director, Sustainable Energy & Adaptation
- City of Regina

Energy & Sustainability Framework Implementation

- This is a community plan that requires participation from all
  - City of Regina will lead by example
  - We don’t have agency over several sectors
- There is no single perfect solution
  - We can’t rely on one technology
  - New ideas and technologies are needed
- Engagement and facilitation is one of the most important roles the City of Regina can play
  - Events like this play a huge part
  - Increased engagement and participation has resulted in better understanding

Prairie Resilience

A Made-in-Saskatchewan Climate Strategy

Aaron Wirth

November 9, 2022

Biography

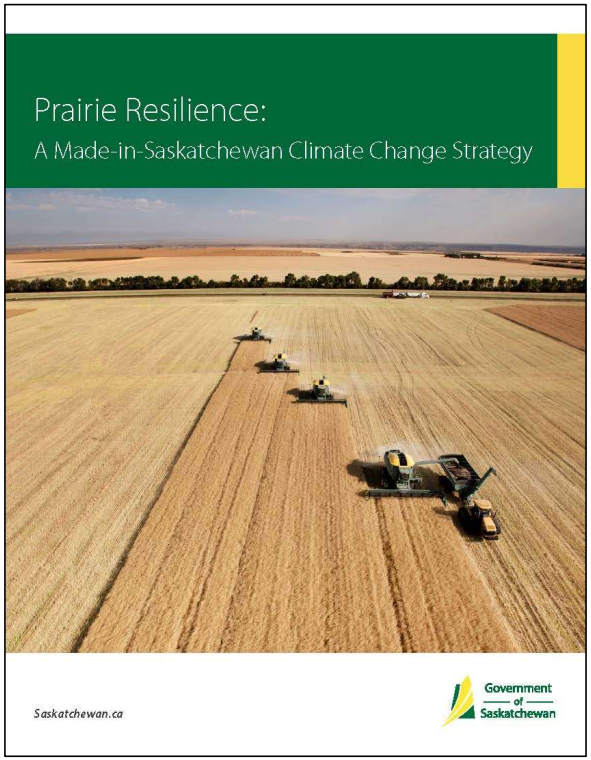
Aaron Wirth

Executive Director, Climate Resilience Branch

Saskatchewan Ministry of Environment

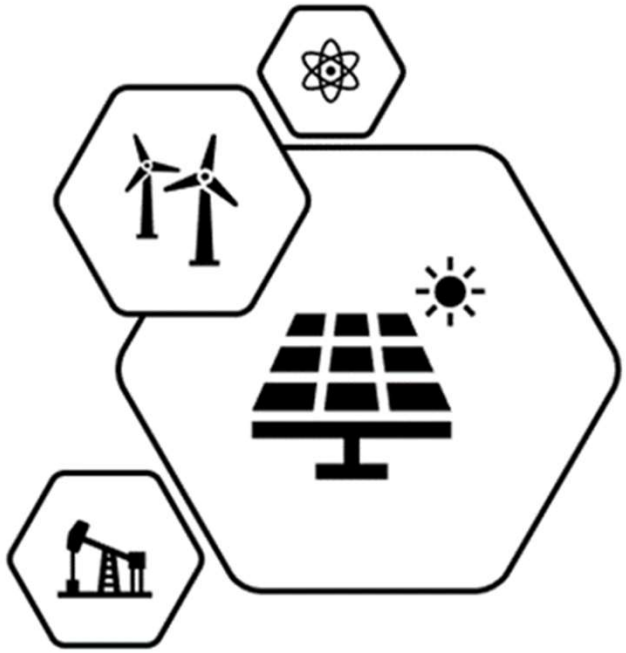
Saskatchewan's Approach to Climate Change

- Saskatchewan's climate change strategy is *Prairie Resilience: A Made-in-Saskatchewan Climate Change Strategy*
- The strategy makes more than 40 commitments in five key areas:
  - Natural Systems
  - Physical Infrastructure
  - Economic Sustainability
  - Community Preparedness
  - Monitoring and Reporting



Key Climate Change Initiatives in Saskatchewan

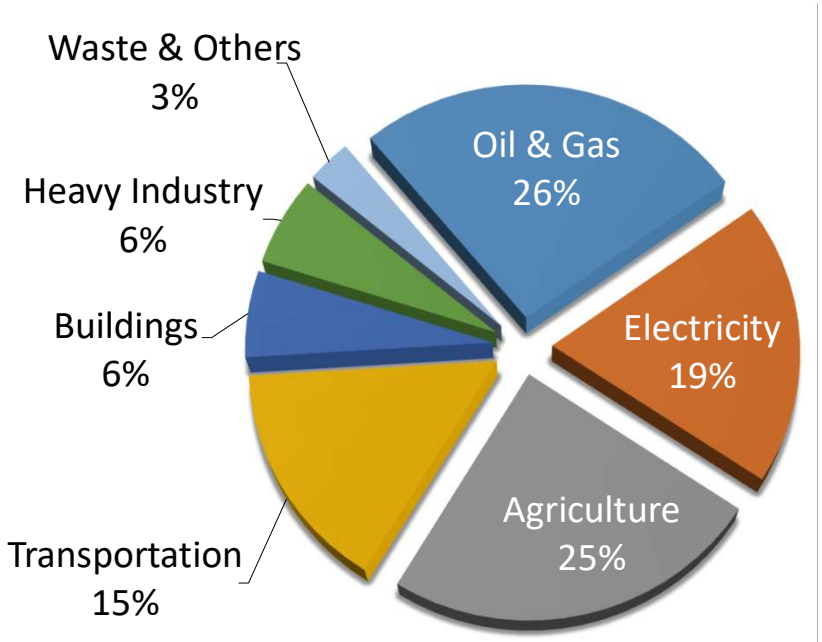
- Output-Based Performance Standards (OBPS) Program
- Saskatchewan Technology Fund
- Carbon Capture Utilization and Storage (CCUS) Strategy
- Methane Action Plan
- Climate Resilience Measurement Framework
- SaskPower's 50% renewable generation target



GHG Emissions in Saskatchewan

- The oil and gas sector is the largest source of GHG emissions in Saskatchewan, but has been trending downwards.
- This is in contrast to the agricultural sector, which is the second largest source of emissions but is trending upwards.
- Emissions from the electricity sector, the third largest, have been declining rapidly.
- Emissions from buildings and heavy industry have both been increasing as the number of buildings and heavy industrial sites increases.

2020 SK Emissions-Economic Sector (MtCO2e)



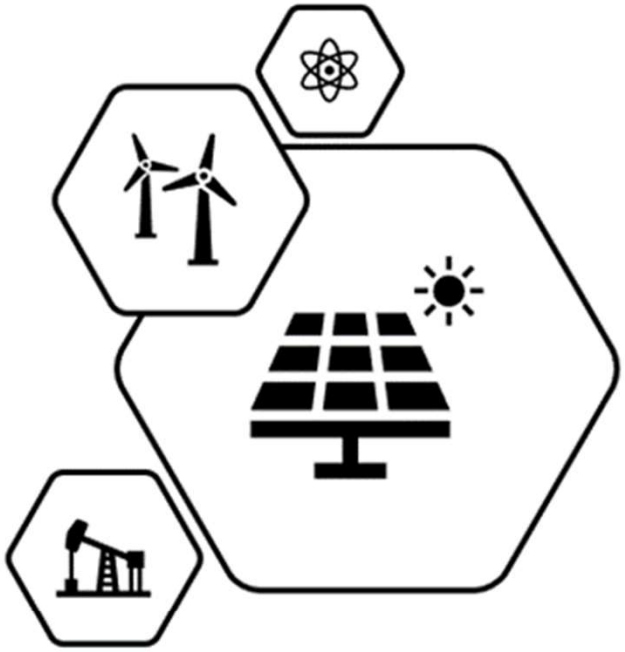
Sask Total (2020) = 65.9 Mt CO2e

Source: ECCC NIR 1990-2020, 2022

Climate Change
Ministry of Environment

Looking Forward: Saskatchewan's Priorities

- Explore low- or non-emitting power generation options to achieve net-zero electricity by 2050.
- Implementation of the expanded OBPS 2023 program. The OBPS 2023 program will save Saskatchewan businesses $3.7B relative to the federal backstop.
- CCUS strategy, hydrogen strategy, critical minerals strategy, and further development of the methane action plan.



Natural Gas in a Low Carbon Future

Megan Bunney

SaskEnergy

November 9, 2022

Biography – Megan Bunney

Manager of Market Sustainability
Customer Solutions group
SaskEnergy

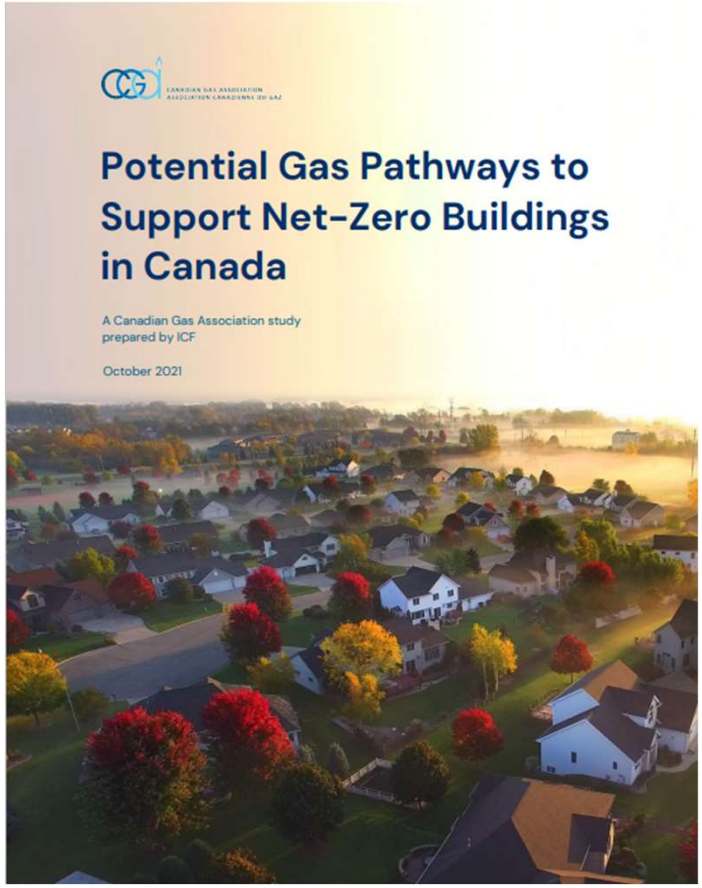
- energy efficient and low carbon customer solutions
- advancing innovative technology
- the role of gas in a low carbon environment
- focus on helping customers achieve emissions reductions.

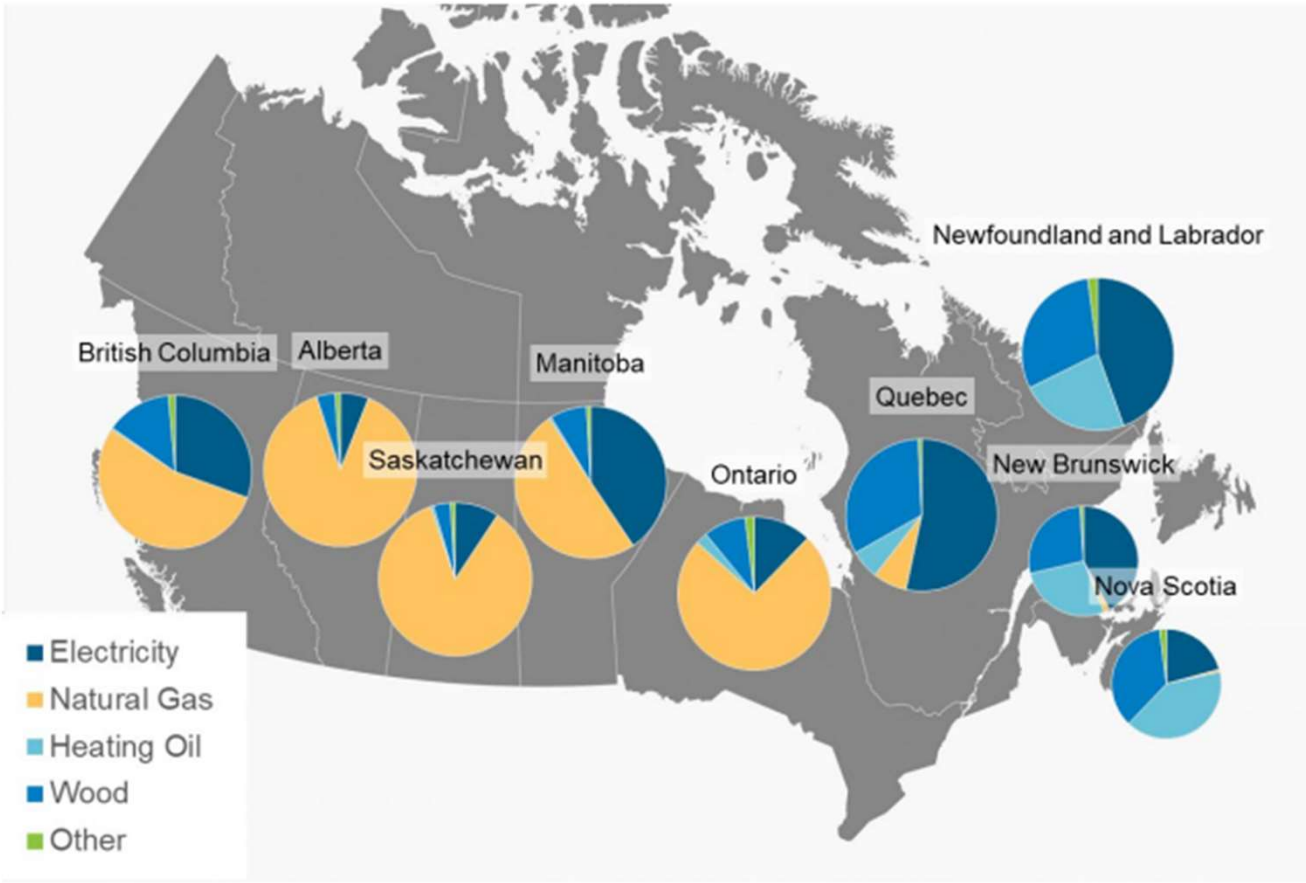
Customer Solutions manages the Network and customer energy efficiency portfolio

SaskEnergy's Commitment

- Provide critical energy for a greener Saskatchewan
- Reduce emissions from operations by 35% by 2030
- Expanded customer program portfolio

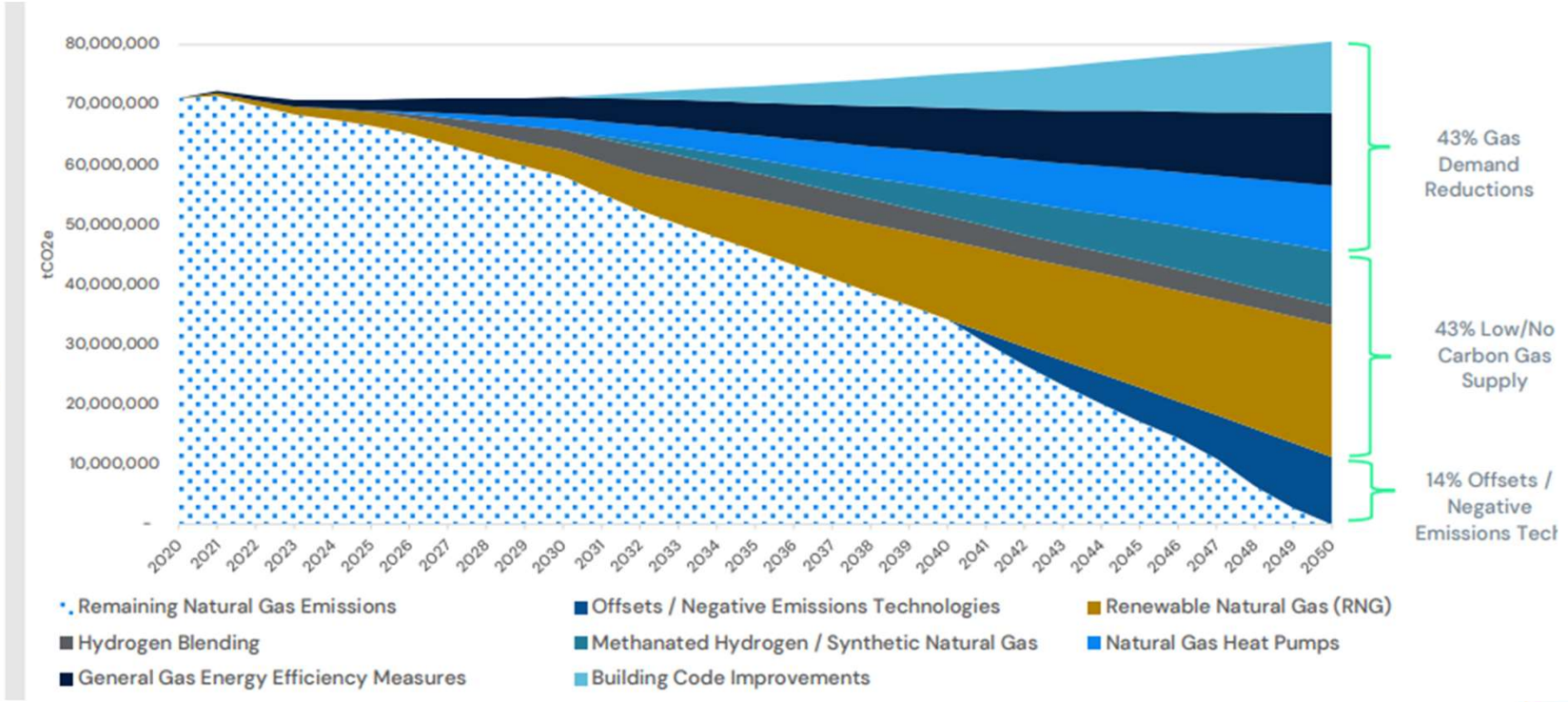
Natural Gas in a Low Carbon Future





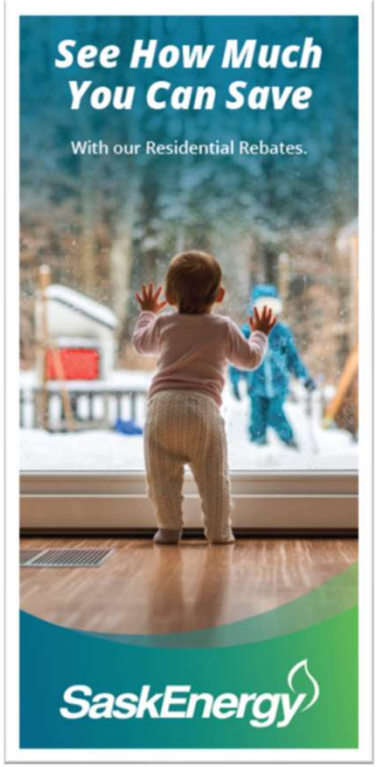
Natural Gas in a Low Carbon Future

Pathway 1: Gas Energy Efficiency Focus



Source: Canadian Gas Association www.cga.ca

Energy Efficiency



- Residential Equipment Replacement Rebate
  - Rebates for furnaces, boilers, combi-boilers, water heaters and HRVs
  - Offered by Network Members
  - Currently no end date

- Commercial Rebates
  - Rebates for furnaces, boilers, high efficiency water heaters, HRVs, infrared heaters and hydronic additives

ASHRAE®

Hybrid Heating

- Willowview Heights Net Zero MURB in Saskatoon
- CHBA affordable, comfortable Net-Zero
- ASHP, right-sized high efficient gas furnaces, smart thermostats
- LEEP design process

Low carbon gases & carbon capture

- Renewable Natural Gas
  - Able to move RNG today
  - 20% of customers know what RNG is
  - RNG customer purchase programs in other provinces
- Hydrogen
  - Joint Industry Project – Customer Appliance Testing
  - Hydrogen blending in Fort Saskatchewan, AB and Markham, ON
- Small Scale Carbon Capture
  - Pilot currently being installed

Technology Innovation

- NGIF Industry Grants
  - Industry granting accelerator
  - Provides a **non-dilutive grants** to **cleantech startups** to develop and demonstrate a **pre-commercial clean technology solution** through a field trial or pilot
  - Aim to improve environmental and economic performance of natural gas end-use

Gas Heat Pump

Technology

- Natural gas air-source heat pump
- Provides heat, cooling and domestic hot water
- Being installed at SaskEnergy's training centre in Saskatoon

Small Scale Carbon Capture

Jaeson Cardiff, left, CEO of Clean02, explains his CARBiN-X technology that uses a chemical process to convert CO2 captured from heating system exhaust into a stable carbonate used in soaps and detergents, at the company's facility in Calgary, Alta., Thursday, July 22, 2021.

JEFF MCINTOSH/THE GLOBE AND MAIL

Technology

- Integrates with boiler system
- Proprietary chemical process sequesters carbon from exhaust
- Process is exothermic and preheats boiler water
- ~20% GHG reduction

Circular Economy

Additional value

- Clean O2 provides maintenance of the carbon capture unit
- They retrieve the potassium carbonate and pay the customer for it in cash or soap

What we learn

- Measurement and verification of energy savings and carbon capture

SaskPower

Nathan Hoffart

SaskPower

November 9, 2022

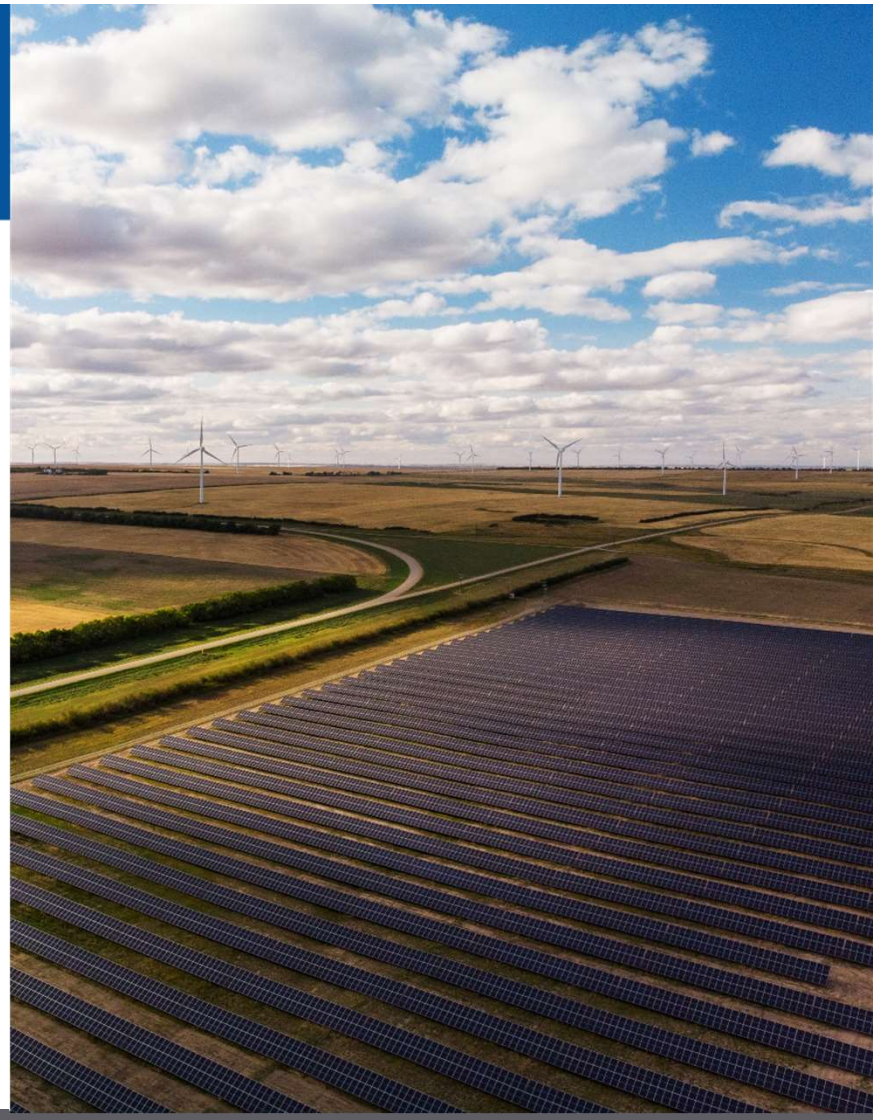
NATHAN HOFFART

Manager, Customer Solutions

Nathan leads Customer Solutions which develops strategy and builds and implements customer-facing products, programs, and services. Customer Solutions is a team of engineers and program managers focused on EVs and electrification, distributed generation and storage, demand side management, and smart technologies. Nathan has worked in various roles at SaskPower since 2011 and is a graduate of the College of Commerce at the University of Saskatchewan.

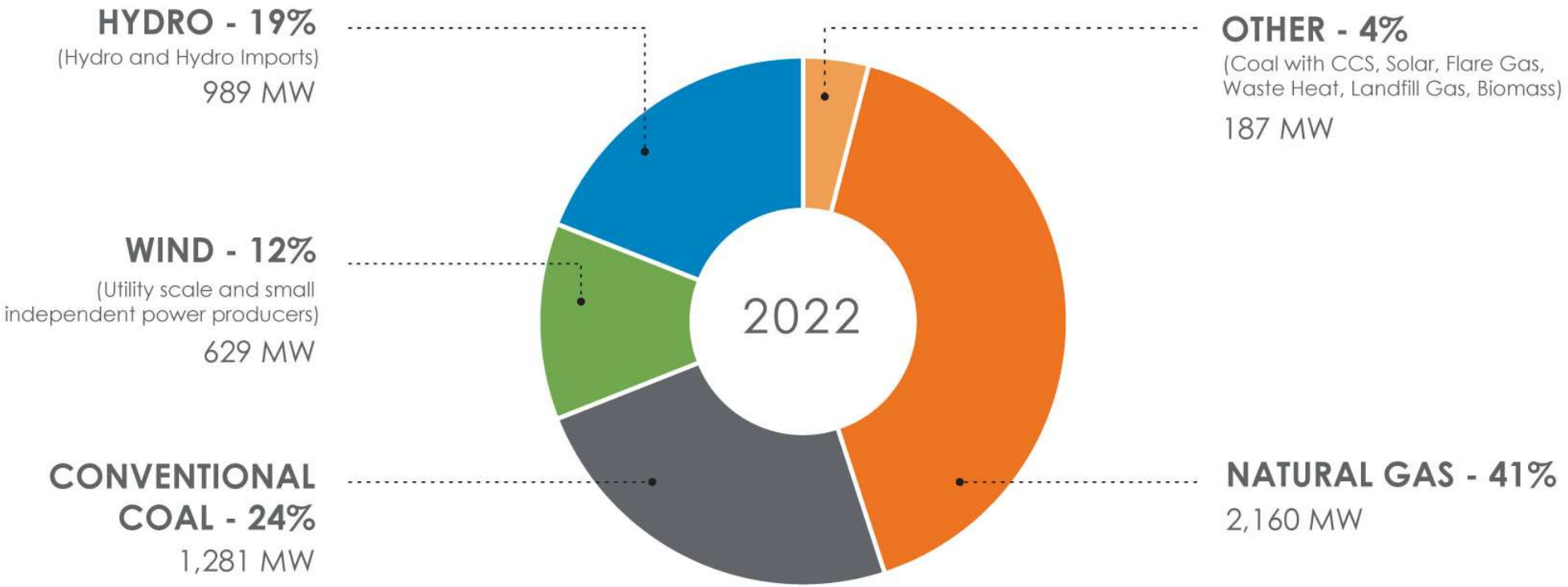
SASKPOWER'S MISSION

Ensuring reliable, sustainable and cost-effective power for our customers and the communities we serve.



SASKATCHEWAN'S POWER MIX

Generating Capacity: 5,246 MW (as of May 31, 2022)



OUR CONTINUED PATH TO NET-ZERO EMISSIONS

SaskPower has already been working to decarbonize Saskatchewan's electricity system:

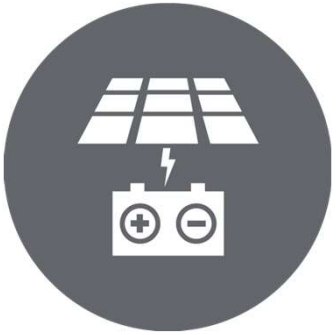
- Retire conventional coal by 2030
- Up to 50% renewables by 2030
- Reducing GHG emissions by 50% below 2005 levels by 2030
- Planning our system for a net-zero GHG future

INVESTING IN INNOVATION

- Carbon capture and storage
- Nuclear small modular reactors (SMRs)
- More transmission interconnections
- Renewables
- Modernizing our power grid
- Utility-scale energy storage
- Customer programs

DISTRIBUTED ENERGY RESOURCES

EVs &
Electrification



Distributed
Generation & Storage

Demand Side
Management

DISTRIBUTION SYSTEM TRANSFORMATION

Demand Side Management

- Energy Efficiency & Demand Response
- Energy Education & Engagement
- New Construction & Retrofits
- Lower Income and First Nations

Question Time!

When asking your question include

Your name

Your company

Your job title

Who you are directing your question to