Residential Space Heating & Greenhouse Gas Emissions:

The impact of insulation, retrofits, size limits, and high furnace efficiency

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INTRODUCTION

Home heating demands account for **~9%[1] of Alberta's greenhouse gas emissions** and are expected to **increase by 40% by 2060** if no action is taken.

This project investigates four mechanisms to reduce these emissions:

1. Improve the Alberta Building Code (ABC) for new builds
2. Retrofit existing buildings
3. Legislate high efficiency (HE) furnaces
4. Encourage smaller homes




METHODS

An MSExcel© model was developed to calculate greenhouse gas emissions from single-detached residential houses in Alberta.

- **"Business as Usual" (BAU)** vs. **Improved building codes** and an energy efficiency **retrofit program.**
- BAU model was run using data provided by CanESS.[2]
- Natural gas was assumed to be the primary source of home heating energy[2] for the foreseeable future
- Figure 1 shows the calculated reductions in residential space heating possible through each mechanism.
- The 2015 average load is 0.67 GJ/m^2[2]

Factor	GJ/m^2	% Change
New ABC (new builds)	0.30	50%
Retrofit (old homes)	0.40	50%
High efficiency furnace	0.10	14%
Home size(new builds)	0	45%

Fig. 1 Table of possible space heating load reductions

RESULTS

BUSINESS AS USUAL SCENARIO

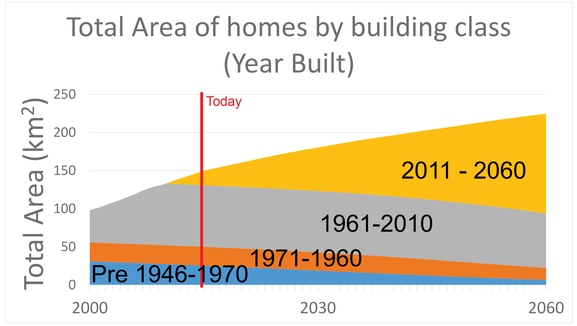

Fig. 2 Area of homes by building class

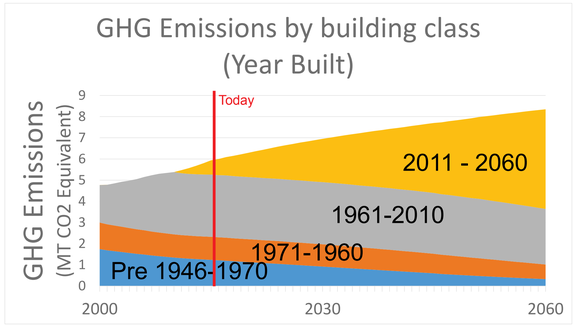

Fig. 3 GHG emissions by building class

ALTERNATIVE SCENARIO

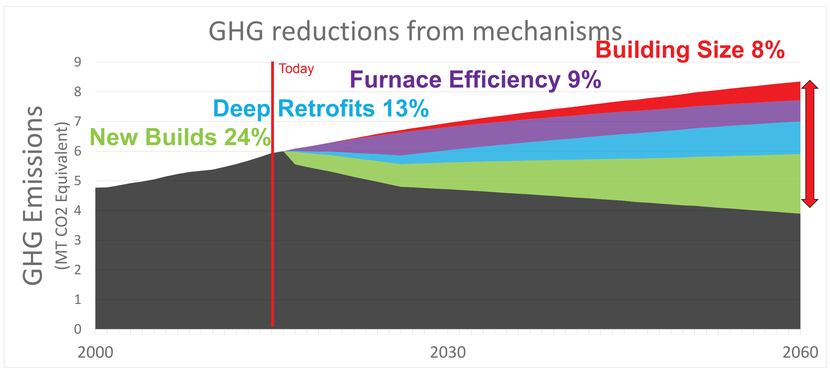

Fig. 4 GHG reductions due to mitigation measures

- Rapid reductions possible through HE furnace legislation and building code changes
- **Total reductions of 4.4 Mt per year at 2060**
- Mechanisms are ~50% more effective if taken individually
- New builds and retrofits could provide the greatest absolute reduction

Intervention Mechanism	Required Carbon Price Per Ton (For net zero cost to consumer)
Encourage smaller homes (average of 120m^2)	N/A
Legislate 95% efficient furnaces	$10
Legislate 98% efficient furnaces	$40
Reduce new build energy use by 50%	$100
Retrofit half of existing homes to use 50% less energy	$750

Fig. 5 Table of required carbon price to pay for each intervention mechanism

1. Savings on utility bills and carbon tax fees already make 95% efficient furnaces profitable
2. Changes to the building code could easily be accepted by public if carbon tax increased to $50 and incentive program were put in place to cover half of the costs
3. It is not very cost effective to use retrofit programs to reduce space heating GHG's in single detached homes

DISCUSSION

The greatest absolute GHG reductions can be achieved through an intensive deep retrofit program and a progressive building code.

The most financially feasible approach is a push to increase furnace efficiency provincially and to add smart-legislation on air barriers in the building code. **This result is similar to that found in literature.[3]**

This model could be enhanced by including study of the modal shift towards multi family dwellings like apartments (which have roughly ½ the space heating requirements of single detached homes)

CONCLUSIONS

Through a four pronged approach, depending on the level of mitigation intensity:

It is possible to reduce GHG emissions from residential space heating by at least 50% (4.4 Mt CO_2eq) by 2060 in comparison to a "business as usual" scenario.

This comes with an economic cost and potential political cost.

The key areas of focus are increasing furnace efficiency and air sealing of new builds.

REFERENCES

[1] Mohareb E., and Row J. Improving Energy Efficiency in Alberta's Building Code. Pembina Institute. Alberta Real Estate Foundation, 2014. Web. 30 Sept. 2015.

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[3] Straube, John. "BSD-011: Thermal Control in Buildings." Building Science Corporation. Building Science Corporation, 2 Nov. 2006. Web. 16 Nov. 2015.

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