CLIMATE CHANGE: ONTARIO'S PATH FORWARD

ENGINEERING THE TRANSITION OF BUILDINGS AND COMMUNITIES

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WHY CLIMATE CHANGE IS THE ENGINEER'S RESPONSIBILITY

- Professional engineers shall hold paramount the safety, health and welfare of the public and the protection of the environment.
- Engineers created the problem and should know how to fix it.
- The profession is capable of understanding the science, finding the most economic solutions, and informing public and corporate policy.
- Precaution precedes profit.

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ENVIRONMENT, ECONOMY, AND SOCIETY

- GHG mitigation and adaptation are universal priorities
- Mobilizing the transition entails full employment
- All infrastructure investment should be directed to a zero carbon outcome
- Security, sufficiency, and prosperity for all is the goal

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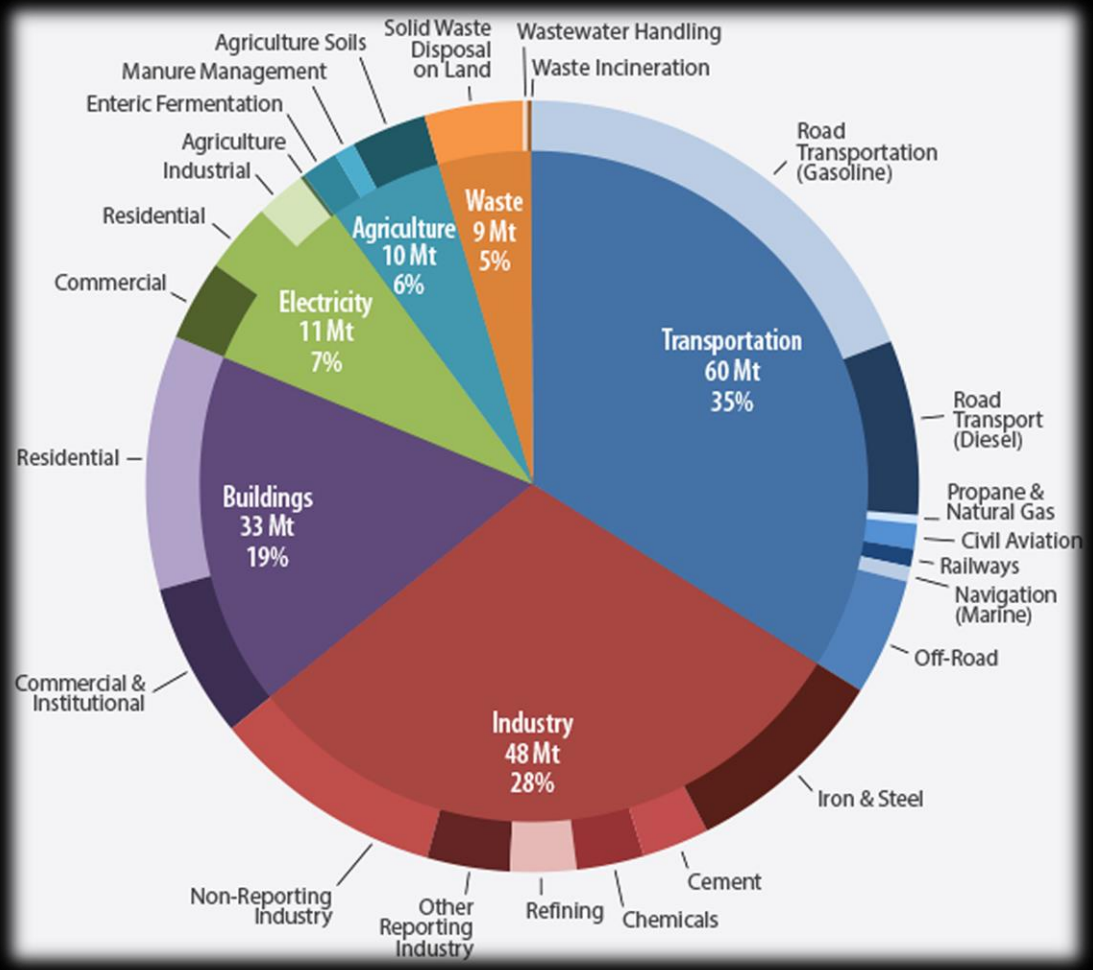
SHARE OF GHG PIE

- Buildings and infrastructure 25%
- Including industrial buildings 40 %
- Main primary source - natural gas
- Upstream emissions not included



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Flared and fugitive gas

Bakken play

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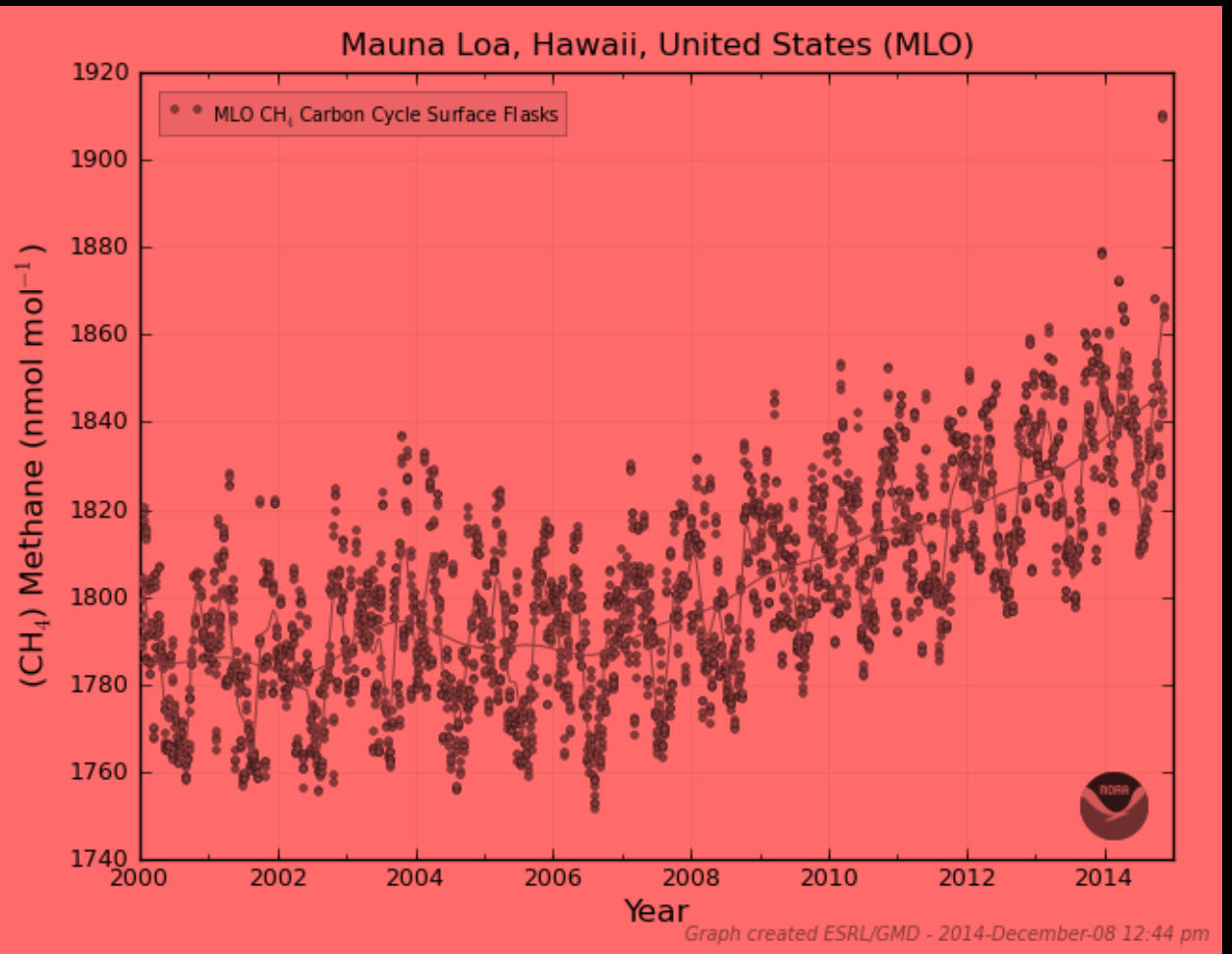

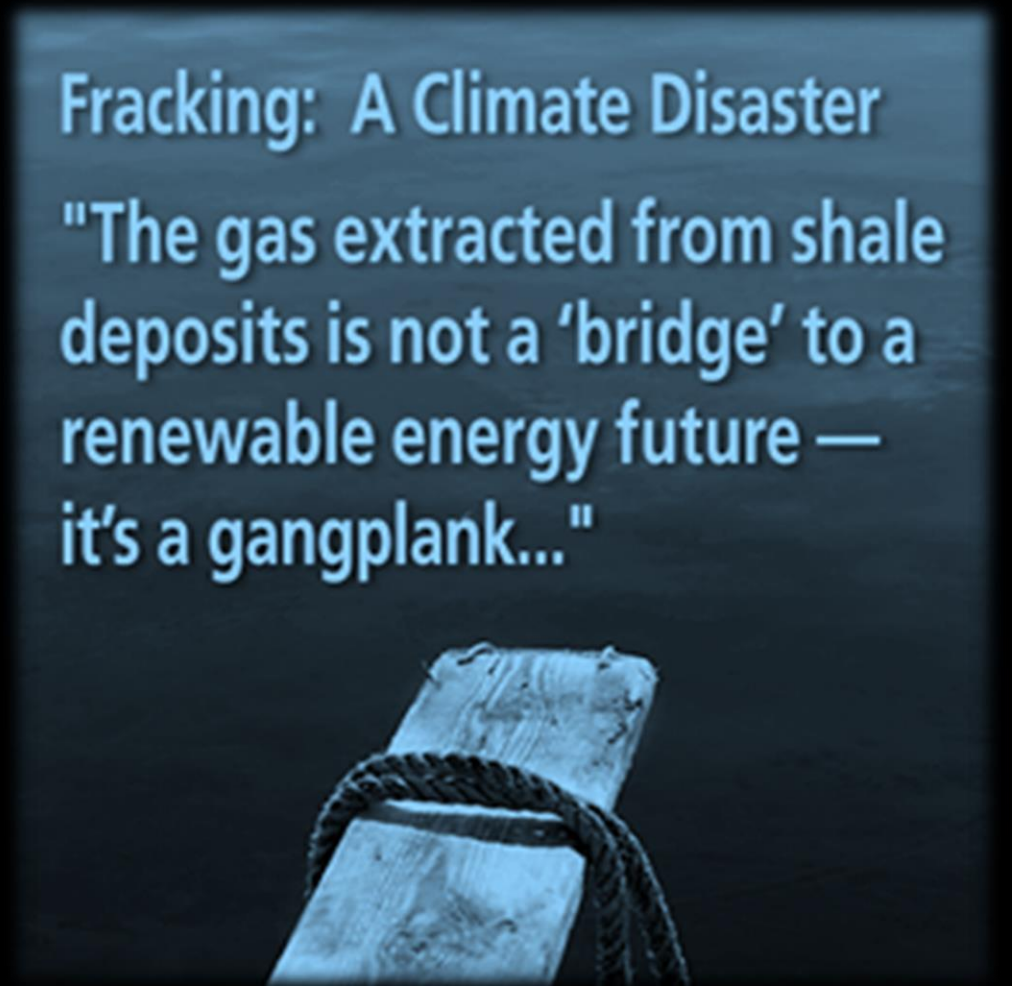

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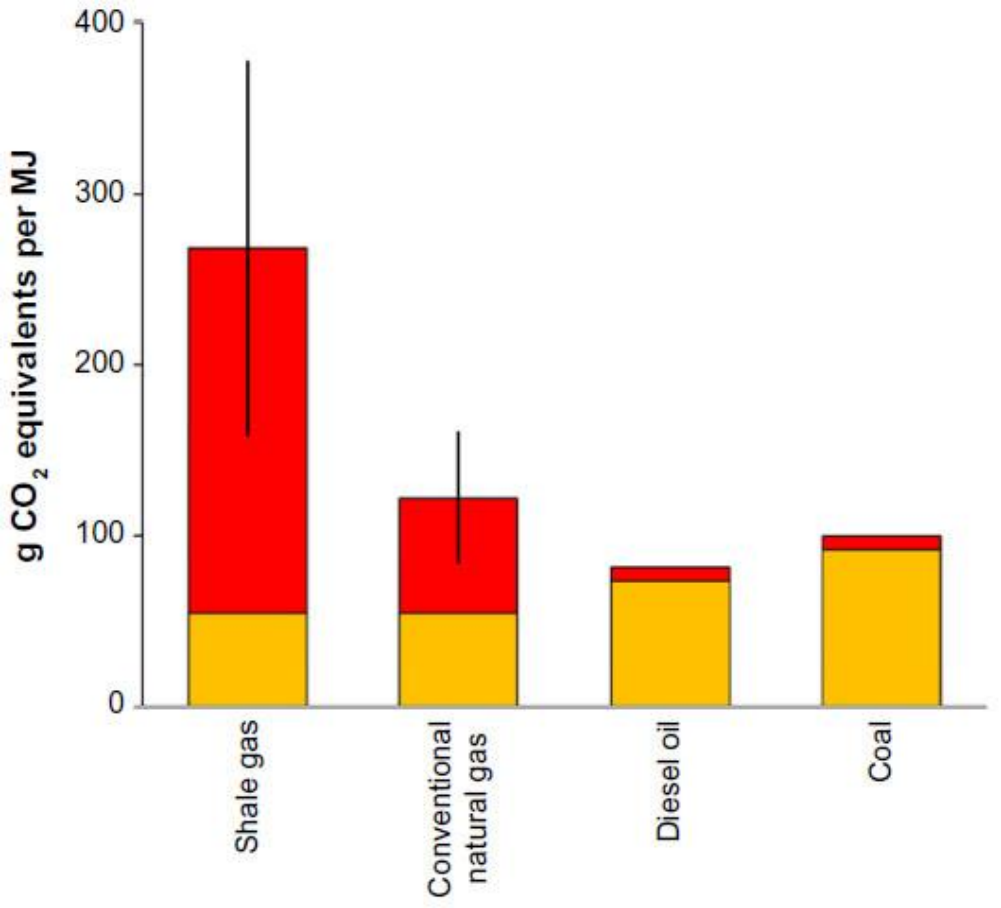
LIFECYCLE EMISSIONS

- Fugitive gas GWP (20 years) 84 x CO_2
- Shale gas leakage 2 to 12 %
- NG reductions in Ontario provide GHG reductions in jurisdictions producing gas
- Supply share of gas from shale approaching 50%



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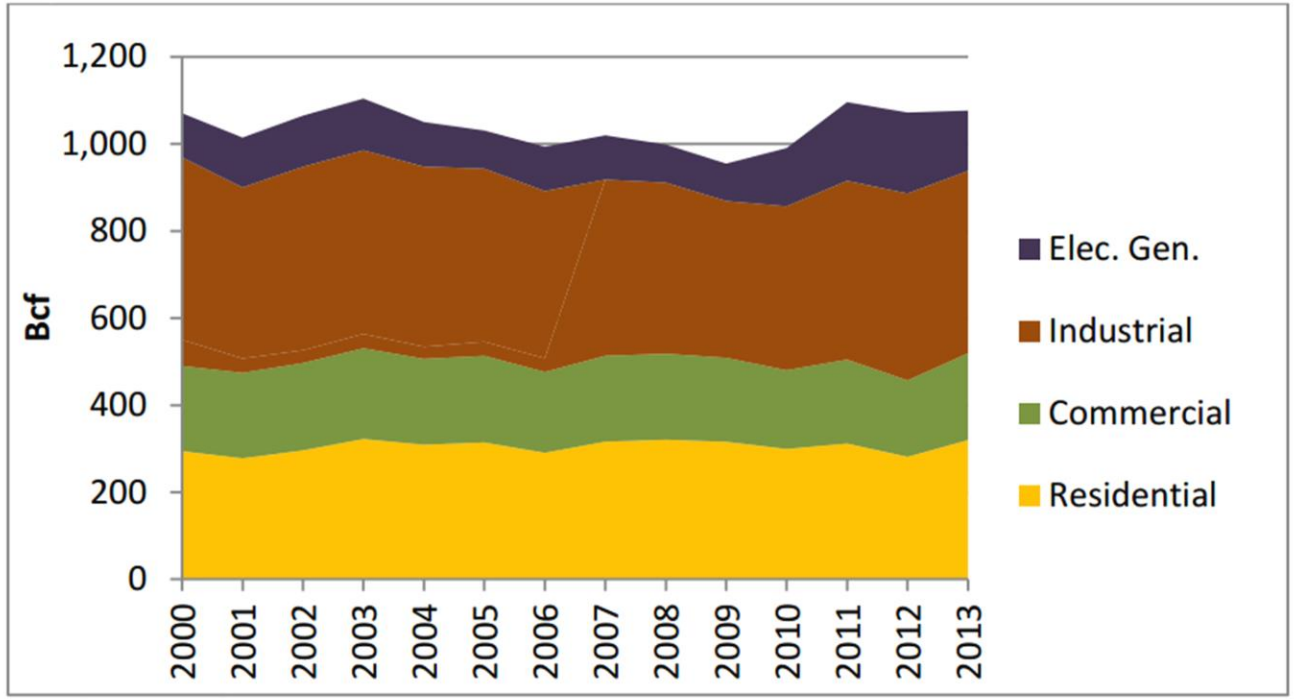
NATURAL GAS BUILDING USAGE

- Residential 30%
- Commercial 20%
- Industrial 20%
- Electrical 10%
- Total 80%

Primarily space and water heating



Source: Navigant / StatsCan

Figure 12: Historical Ontario Natural Gas Demand by Sector

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REPLACING NATURAL GAS BUILDING LOADS

- About 200 TWh, 150 space heating, 50 DHW
- retrofit for 80 % reduction in space heat load, 50 % DHW (solar + GWHR)
- Combined heat and power/ heat pump, 2/1 load split
- Peak heat pump demand during off-peak hours – 2 GWe
- Cogeneration with dispatch and thermal storage – 2 GWe / 4 GWt

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COMMUNITY THERMAL ENERGY

Biomass cogeneration

Vancouver Olympic Village solar

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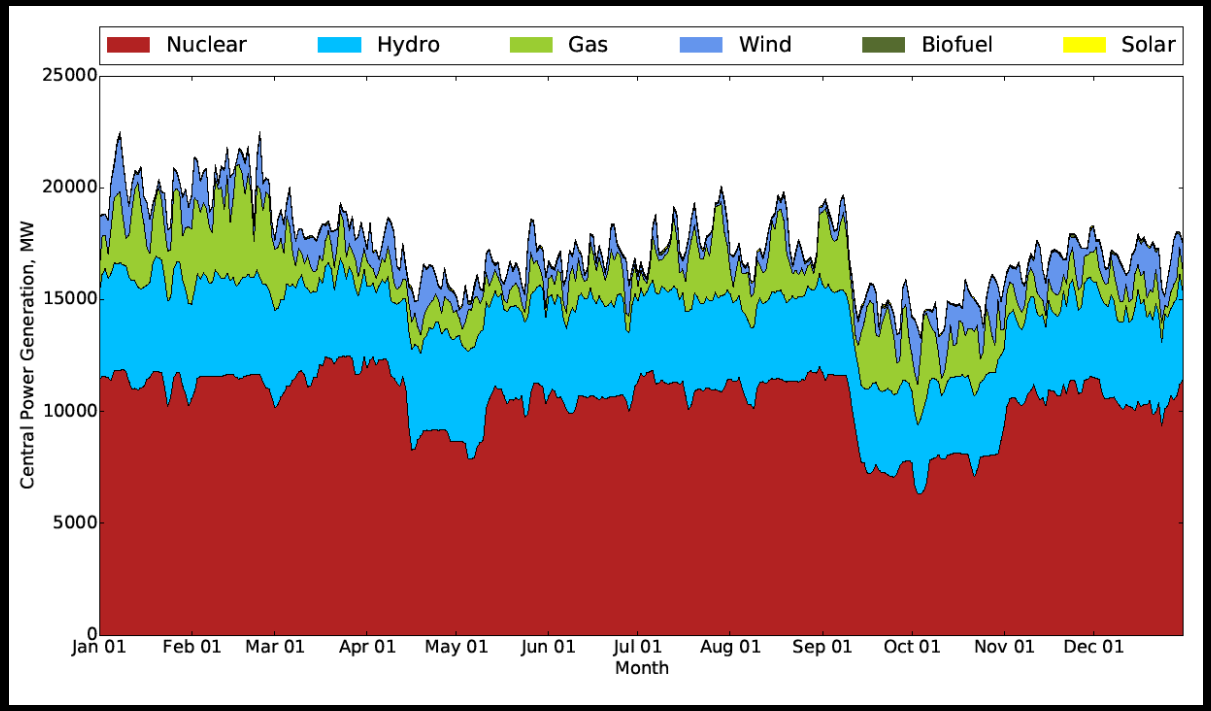
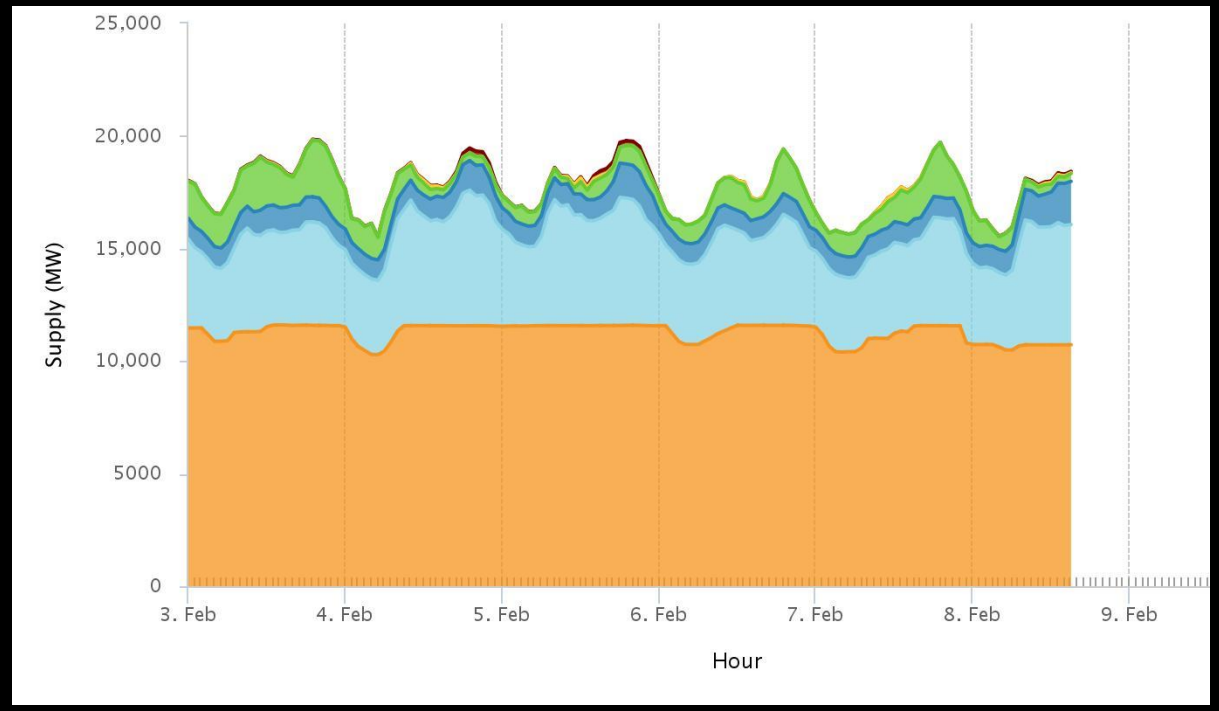
NUCLEAR CURTAILMENT



CC GAS AS BASELOAD



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REPLACING NATURAL GAS GENERATION

- 1 GW of combined cycle plants require 70% capacity for load following
- Standby accounts for about 50% of annual natural gas usage
- Contributes to curtailment of available zero-carbon generation
- Diurnal load flattening with thermal and electric storage
- Seasonal demand/supply matching such as PV for summer and biofuel cogeneration in winter

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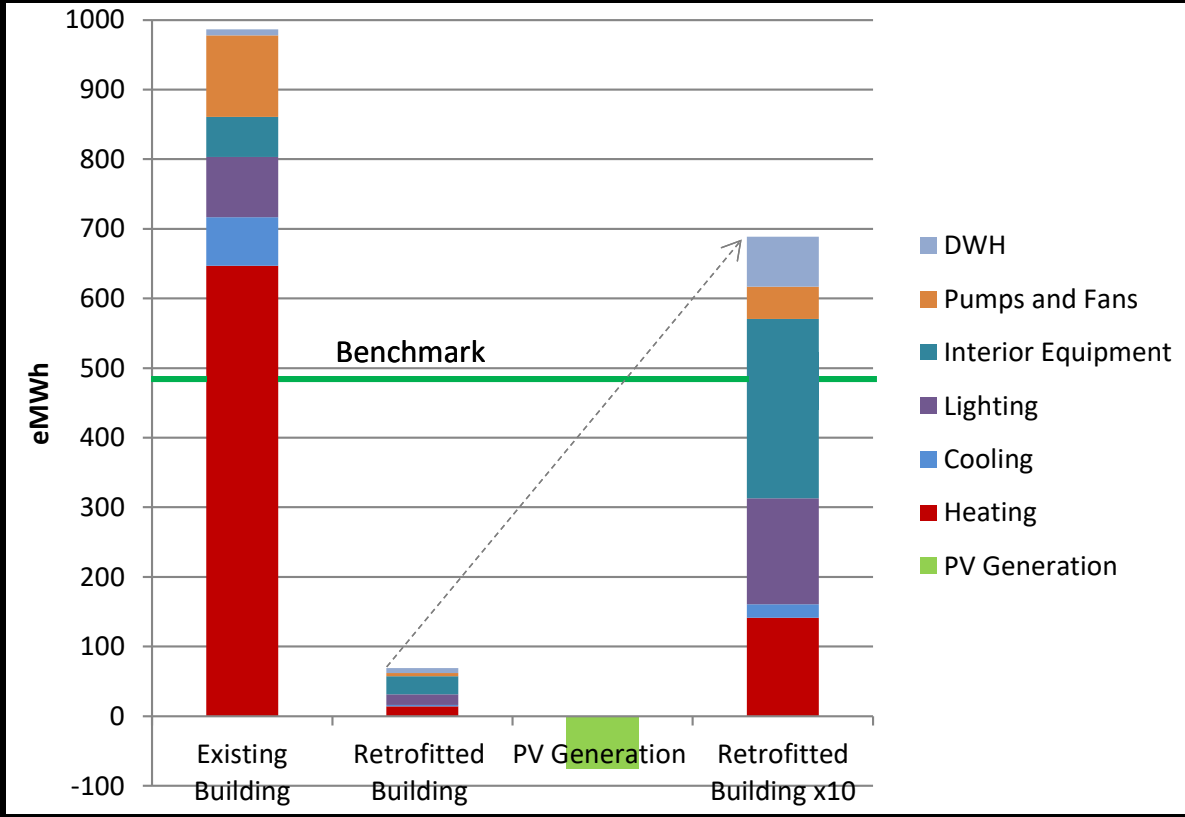
DEEP RETROFIT

OAA Building 2030 Challenge Retrofit >90% Reduction



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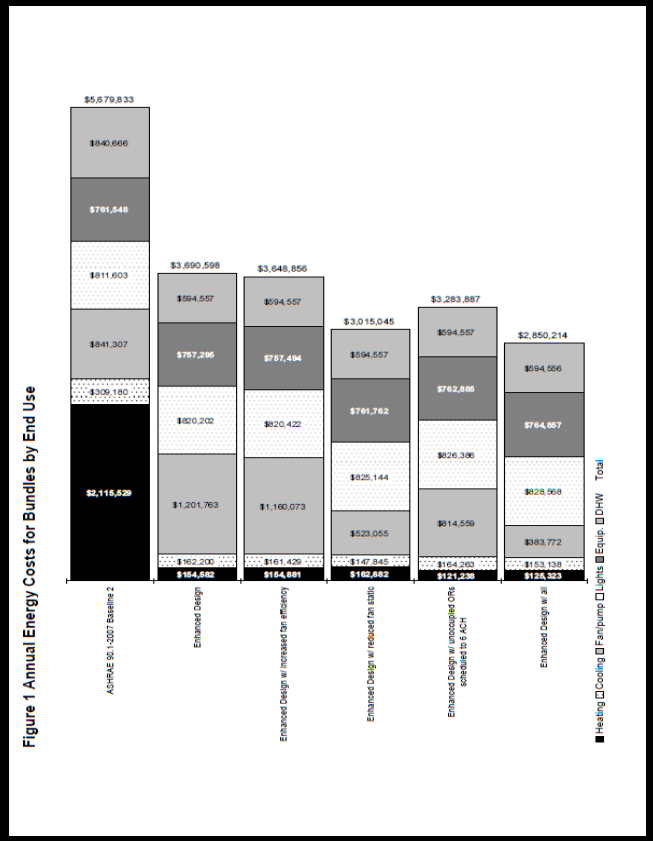

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TORONTO'S BIOGAS DIGESTERS

Disco Rd. City Organic Waste

Zoo Poo Co-op

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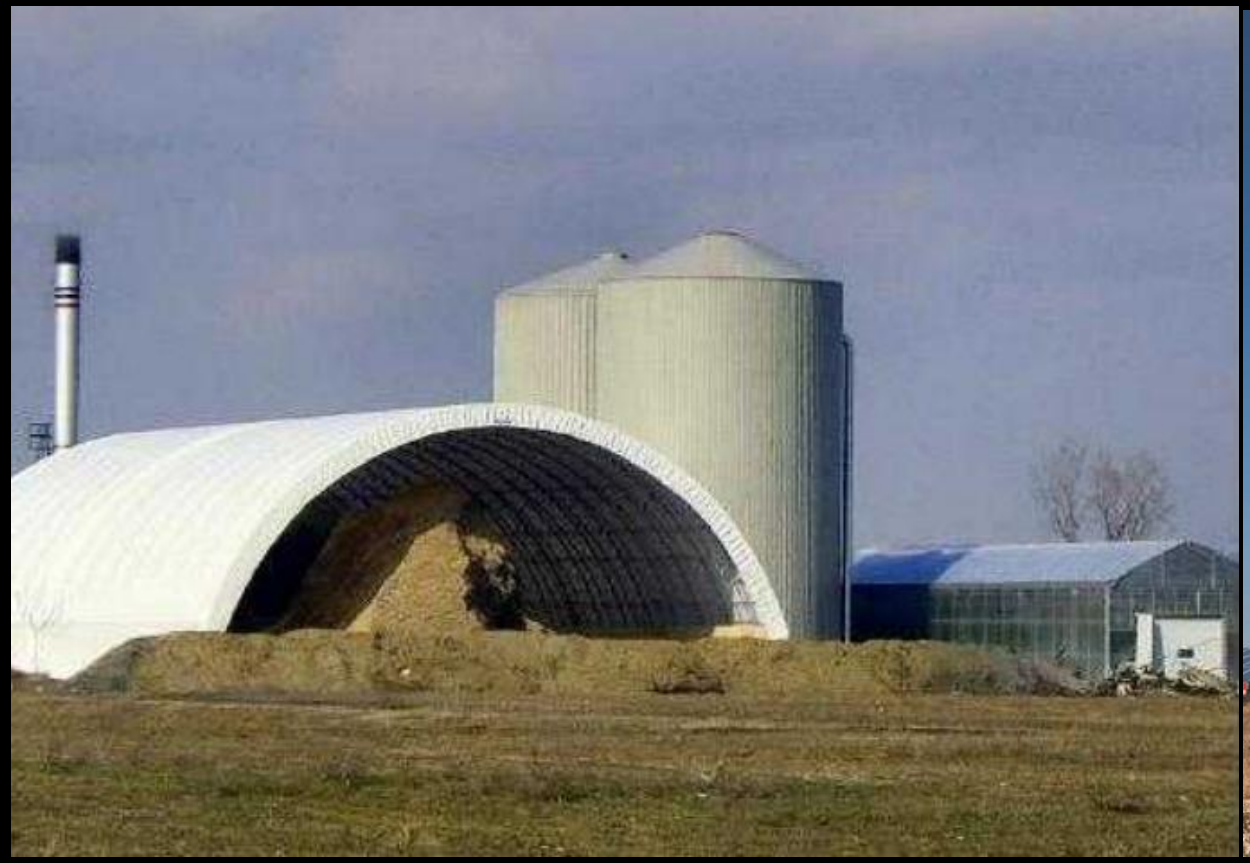
POWER TO SPARE AND SHARE

Biomass for greenhouse heating + biochar



Wind, solar, and agriculture farms

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STORAGE

Thermal

Hydraulic

Battery

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POLICY AND PLANNING

- Long term integrated energy plan for 100% renewables
- GHG metrics with 20-year impact, full lifecycle, and marginal accounting
- Assessment of technologies based on emergy, EROEI, and life cycle
- Market creation for least-cost, zero GHG outcomes
- Demand management and conservation requires financial support commensurate with system benefits and GHG abatement
- Distributed grid assets and microgrids supported to ease T&D constraints

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SPECIFIC RECOMMENDATIONS

- Cancel all new gas plants and pipeline expansions
- Set caps based on revised GHG life-cycle emissions
- Support municipal and regional carbon neutral planning
- Building Code based on zero carbon emissions
- District energy systems support, mandatory in new development
- Replace natural gas generation with demand dispatch and storage
- Incentivize and contract for deep retrofit
- First Nations and remote community financing of zero-carbon microgrids
- Educational, research, and technology development support