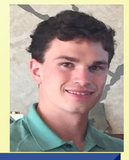
# Rooftop Solar Energy:

## A Study on Technical Potential in Alberta

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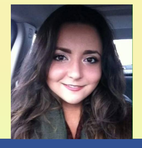

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## Introduction

Alberta's public electricity grid has a carbon intensity more than 5 times the national average[1], with current emissions of 49Mt$CO_2$eq/year[2]. Photovoltaics on rooftops and parking structures would reduce these emissions while providing electricity directly where it is needed. We have created three scenarios projecting market adoption to 2060 based on payback periods (PBP) and the technical potential of rooftop solar in Alberta.

**Figure 1:** The Town of Canmore, 64.6kW Civic Center Rooftop Solar Array

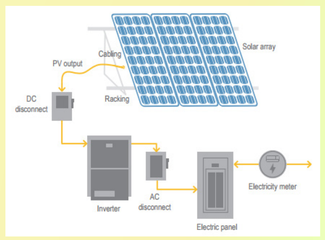


**Figure 2:** Schematic of a typical solar array, including residential system components[3]

## Methods

Due to the absence of data, a method[6] was developed (Fig.3) to estimate solar potential based on building area[7,8].

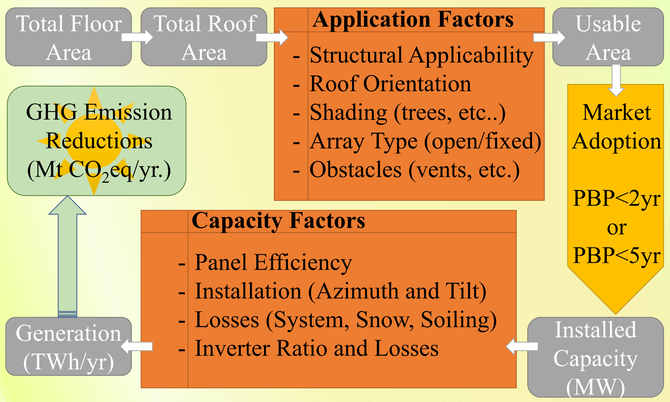


**Figure 3:** Flow chart representation of methodology. Assumptions are initially made to convert floor area to roof area, then Application Factors are applied according to the chart above to get a roof area suitable for PV installation. After economics are considered, Capacity Factors are input in PVWatts[4] to take the rated output of an array and reduce it to a realistic annual value for a location. An example of population-weighted factors are presented in the table below; not all factors are listed as they vary in each scenario for new and existing buildings.

Table 1 - Example Application and Capacity Factors

| | Residential | Commercial | Carports | |
|---|---|---|---|---|
| Application Factor (Existing Buildings) | 26% | 40% | 20% | As a percent of total roof area |
| Population Weighted Avg. Capacity Factor | 14% | 13.5% | 13.5% | As a percent of rated output |

## Results & Discussion

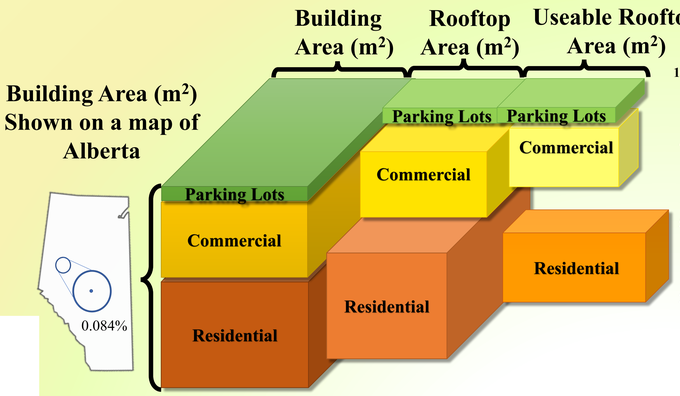


**Figure 4**: Diagram depicting process of turning total land area into useable roof area

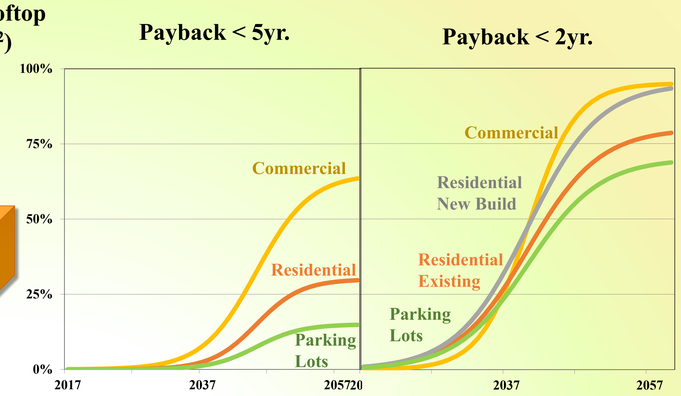


**Figure 5**: Market Adoption Scenarios, derived from Table 2 and Figure 6

Table 2 – Solar Economics for each Scenario

| | Business As Usual | Payback <5yr. | Payback <2yr. |
|---|---|---|---|
| Electricity Cost ($/MWh) | $65 | $200 | $200 |
| Installation Costs ($/Watt) | $3 Res. $2.3 Com. | $1 | $0.5 |
| Payback Period (Years) | 19.6 Res 15.6 Com. | 3.3 | 1.6 |

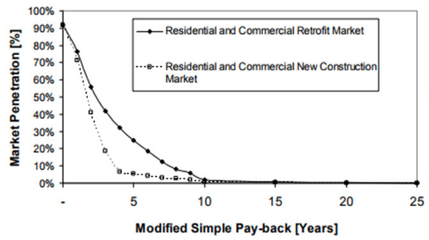


**Figure 6:** Payback period and market adoption[5]

Table 3 –Percentage of Electricity Demand Offset by Rooftop Solar Generation in 2060

| | Commercial Demand Offset | Residential Demand Offset |
|---|---|---|
| Payback <5yr. | 21% | 19% |
| Payback <2yr. | 34% | 65% |

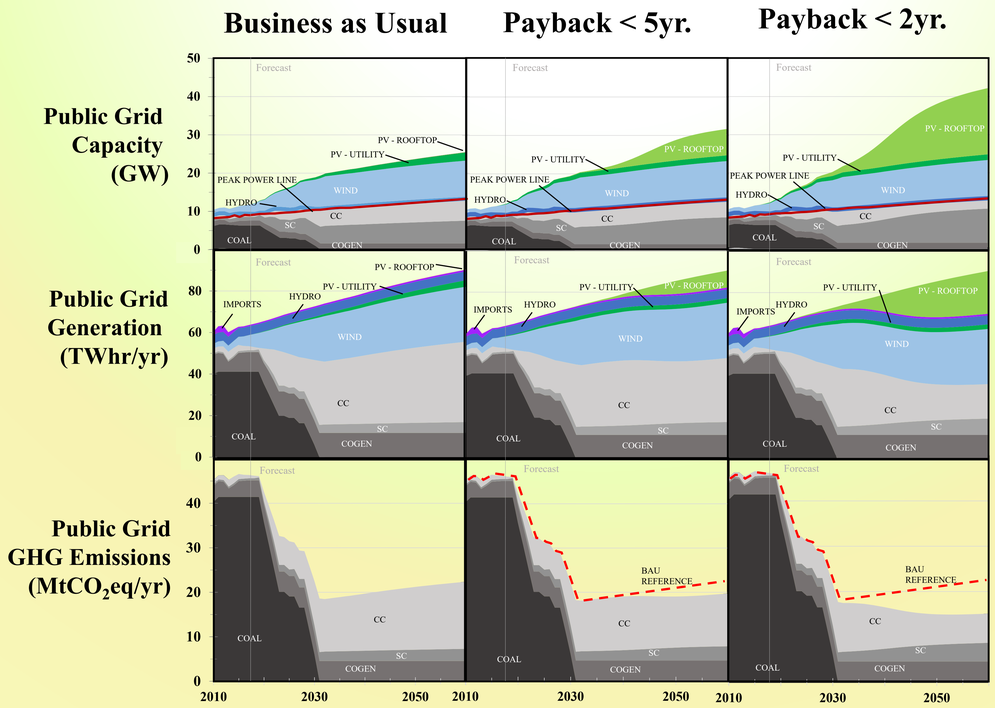


**Figure 7**: Graphical results of the technical rooftop solar potential model[6] depicting three projected scenarios from 2010 to 2060

### Notes:

Increase in Capacity over Business as Usual:
- ❑ 65% in Payback <2yr.
- ❑ 24% in Payback <5yr.

- ❑ All scenarios meet Peak Power demand (black baseline)
- ❑ PV offsets CC generation but requires increased SC for backup

Rooftop Solar accounts for:
- ❑ 23% of generation in Payback <2yr.
- ❑ 9% of generation in Payback <5yr.
- ❑ 0.1% of generation in Business as Usual

GHG Reduction compared to Business as Usual:
- ❑ 32% in Payback <2yr.
- ❑ 12% in Payback <5yr.

## Conclusion

In our most optimistic scenario with less than 2 year payback period and building optimization, rooftop solar has the potential to generate 21TWh/yr and offset annual greenhouse gas emissions by 32% (7Mt CO2e/yr) in 2060. However, due to the low capacity factor of solar a 65% increase in capacity compared to our Business as Usual scenario is required. With 17GW of additional solar capacity installed, a 3GW increase of single cycle capacity is necessary to offset intermittency of solar generation.

Despite recent improvements, rooftop solar is still not economically viable when compared to current generation technologies. For rooftop solar to have a significant impact on Alberta's public grid, payback periods need to be reduced to less than 5 years. To reduce payback period, options include:

- Technological improvements (increased system efficiency, decreased costs, solar paints, solar tiles, solar windows)
- Government incentives (carbon tax, installation rebates, Feed In Tariffs)
- Creative payment/financing options (PACE, rooftop leasing)

## Acknowledgments


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## References


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