# Impacts of Climate Change on Solar PV in Southern Alberta

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## Background

Accurate modelling of solar resource is essential for generating reliable energy yield forecasts, specially to facilitate the financing of solar PV projects. The increased incidence of climate change related phenomena like forest fires, heat waves, floods, droughts, and hailstorms, coupled with the increase in cases of PV production being lower than forecasts, calls for a deeper look into the effects of climate change and specifically wildfire smoke on production which is covered in the study below.

## Emission Scenarios

### How Bad Can It Get?

- Two emission scenarios considered:
  - SSP2-4.5 (+1.7°C mid-term)
  - SSP5-8.5 (+2.4°C mid-term)
- Two time horizons considered:
  - Short Term (2020-2039)
  - Mid Term (2040-2059)
- The operational life of a solar project has within a wide band of potential impacts.

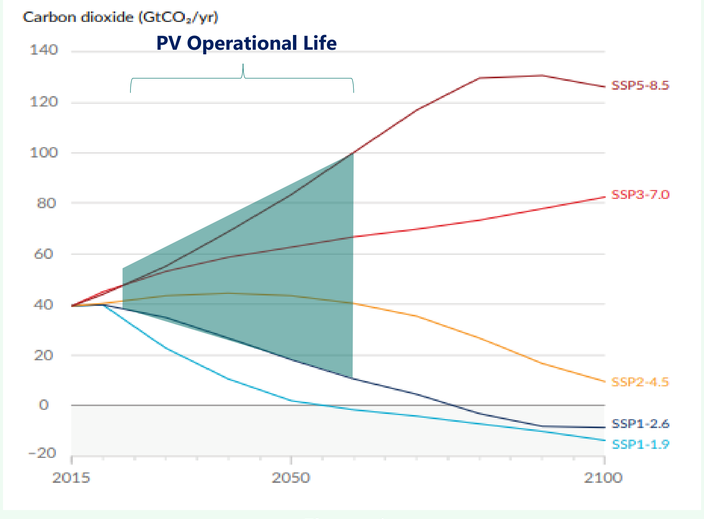



Figure 1

## Climate Change Risk Analysis

### Effect on PV Yield Forecast

- Examined a typical 50 MW plant in southern Alberta.
- Used data from Climate Scale to adjust Typical Meteorological Year (TMY).
- Predicted Short Term Change (SSP5-8.5): GHI -0.2%, DHI +0.1%, Temperature +1°C, Wind Speed -0.8%, Precipitation +7%.
- Outcome: A production shortfall of 0.2-0.4% and 0.5-1% predicted for short and medium term, respectively.

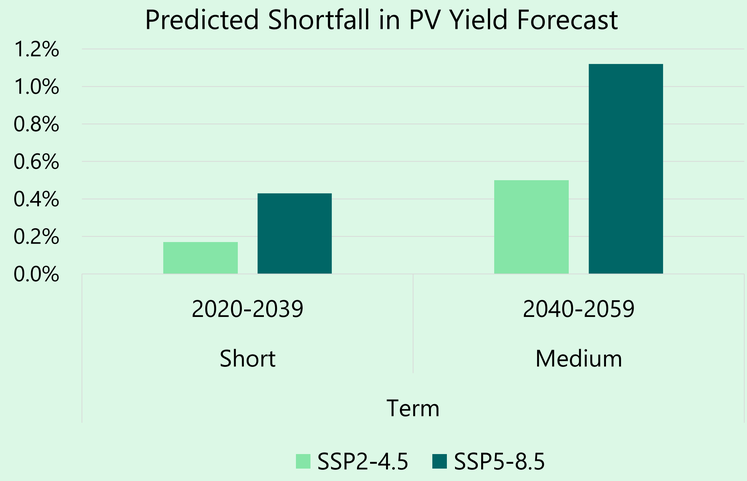



Figure 2

## Aerosol / Forest Fire Smoke

### Forest Fire Smoke Analysis

- Air quality stations are in urban centers and not close to projects where wildfire smoke is having an impact.
- Looking at nearby air quality data is helpful BUT looking at clear sky irradiance (which includes aerosols and excludes clouds) in particular DNI_clear and DHI_clear as shown in Figure 3 for your project site is better.
- Wood used daily DNI_clear values which were more than one standard deviation lower than the long-term average (1998-2022) as an indicator (flag) for days influenced by forest fire smoke.

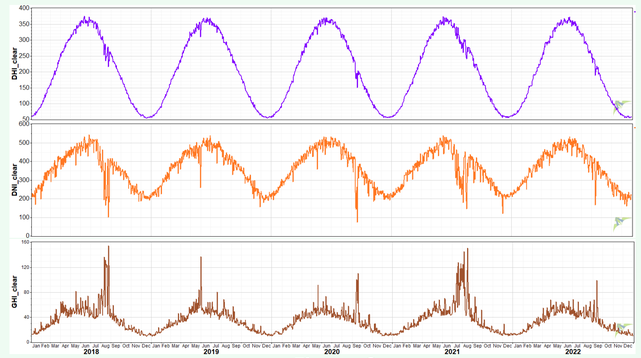



Figure 3

### Lost Production

- Using NREL NSRDB data for all 36 utility scale solar sites across Alberta, Wood created an hourly reference dataset by replacing GHI/DNI/DHI values with long term averages for when the DNI_clear flag indicated forest fire smoke at each site.
- Wood averaged the hourly GHI/DNI/DHI reference and actual datasets for 1998-2022 across all sites in Alberta, and batch simulated each year in PVSyst for a typical fixed tilt and tracker system as shown in Figure 4.

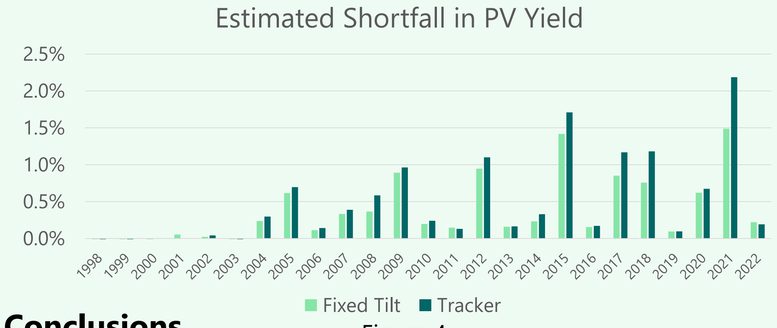



Figure 4

## Conclusions

- Aerosols / forest fire smoke have a growing impact (>2%) on a PV plant performance.
- Climate change risk analysis performed with climate scale data is based on annual average changes and does not capture increase in extreme events.
- Using long term historical data (20-year TMY) to predict future performance will not capture recent uptick in climate change effects (i.e., forest fire smoke).