# BC Nexus Model

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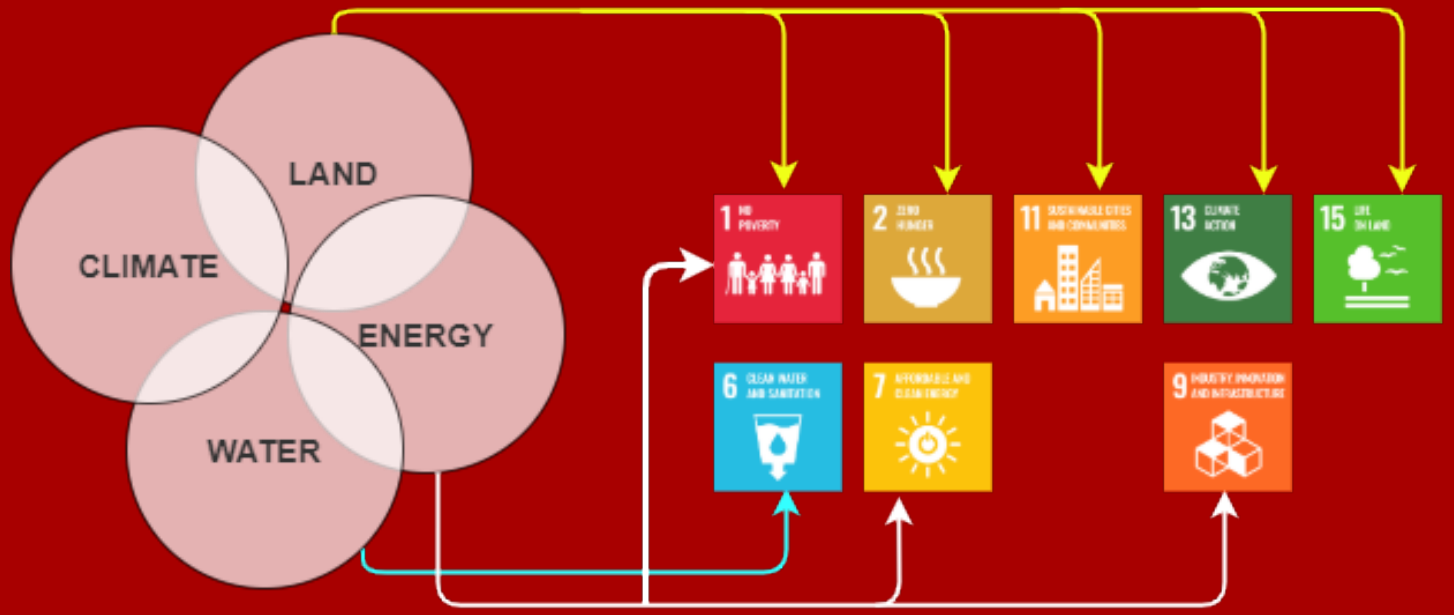
31 March 2021

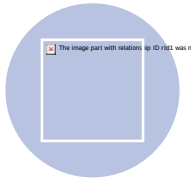
# Motivation



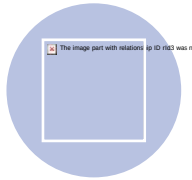
# What is the “Nexus”?

- The term “NEXUS” refers to the interactions among interdependent systems.
- The GOAL OF MODELLING NEXUS systems is to safeguard the resiliency of the whole system by creating feedback mechanism between its components

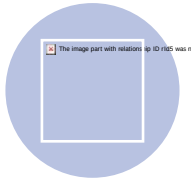
# Climate, Land, Energy, Water systems (CLEWS) Modelling Tool



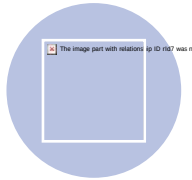
An extended linear program capacity expansion model



Derived by policies

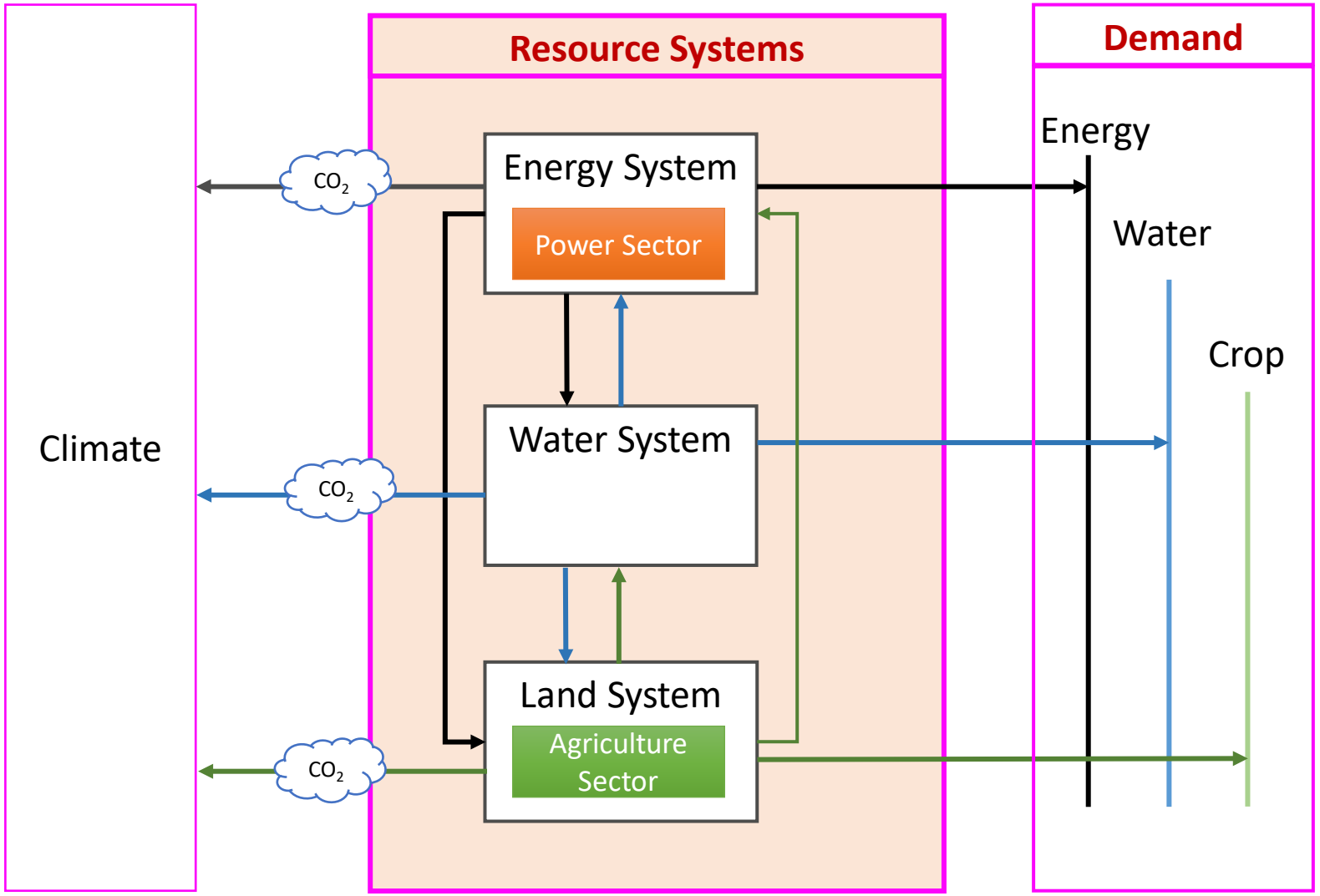


Optimization cost analysis



Outputs technology mix and cost, synergies and tradeoffs between all nexus systems, $CO_2$ emissions

# BC Nexus Model's Components & Linkages




Reference: After [1]

## Energy System

- Power plants location, capacity, nominal generation, actual generation, operational life span, residual capacity, capacity and availability factor
- Capital, fixed, and variable costs
- Transmission loss
- Energy demand in each sectors
- Import/export

## Land-use

- Land use types and sizes
- Collecting crop suitability estimation data for BC land
  - Clustering crop suitability data (yield, water demand, etc.) using the GAEZ (Global Agro-Ecological Zoning) model
- Demand projection

## Water and Climate Systems

- Tracking only
  - Water demand in various sectors, availability
  - Climate: $CO_2$ emission form every activity within and between systems
- Forest Carbon Uptake

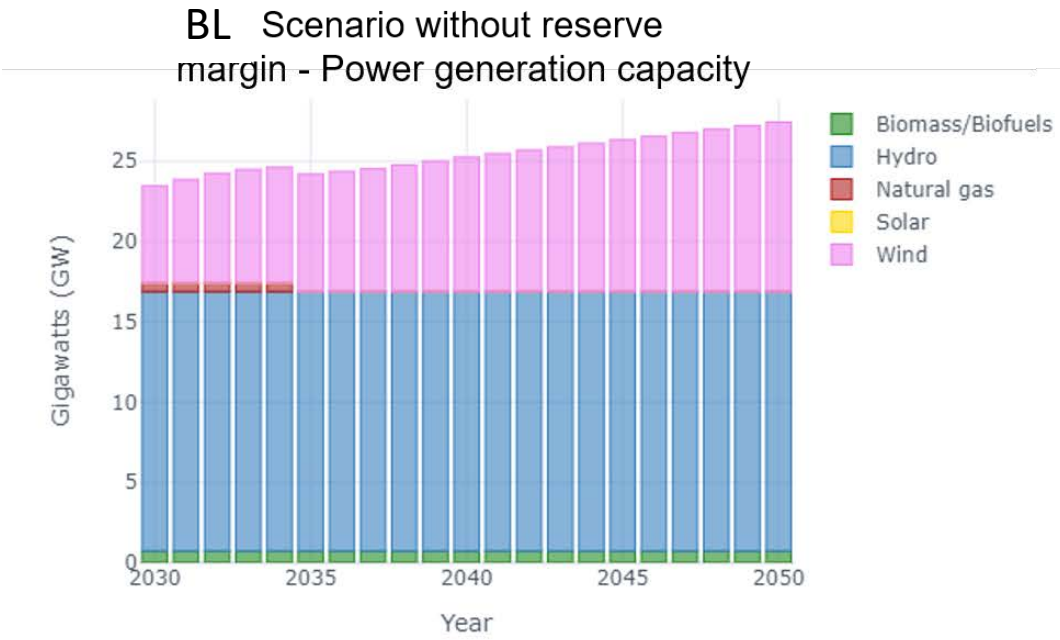
# Scenarios

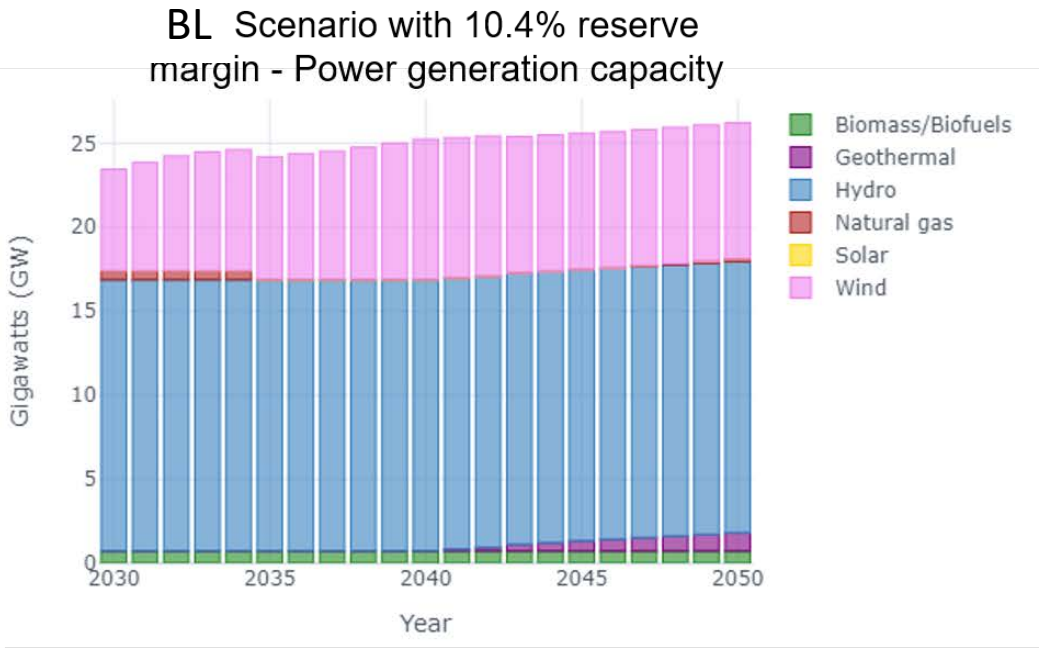
**Baseline (BL) scenario: Canada's Energy Future report of 2019**

- Scenario 1 (S1): BAU scenario+ More aggressive electrification without carbon tax
- Scenario 2 (S2): BAU scenario+ More aggressive electrification with carbon tax

# Baseline (BL) Simulation- Reserve Margin

Power generation capacity to meet the demand between 2030-2050 with and without reserve margin



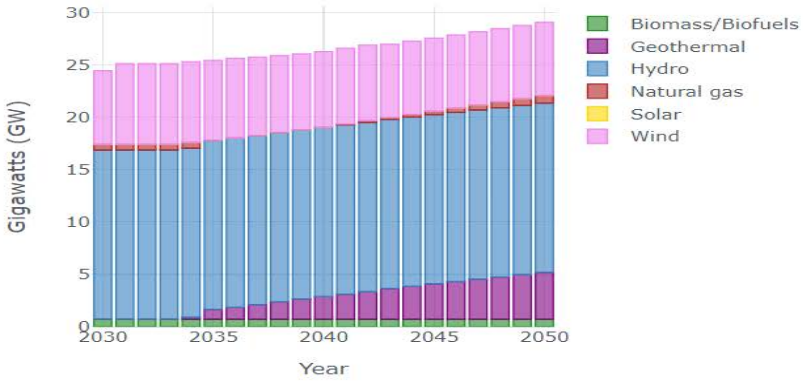



# BL vs. S1 –Energy System

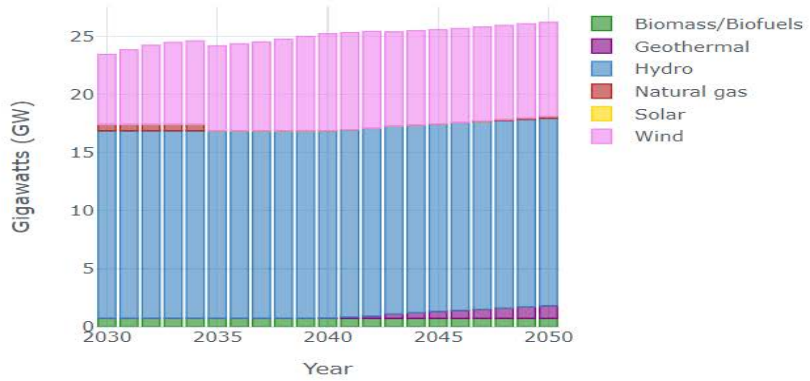
**BL**

Power Generation Capacity (Detail)

**S1**



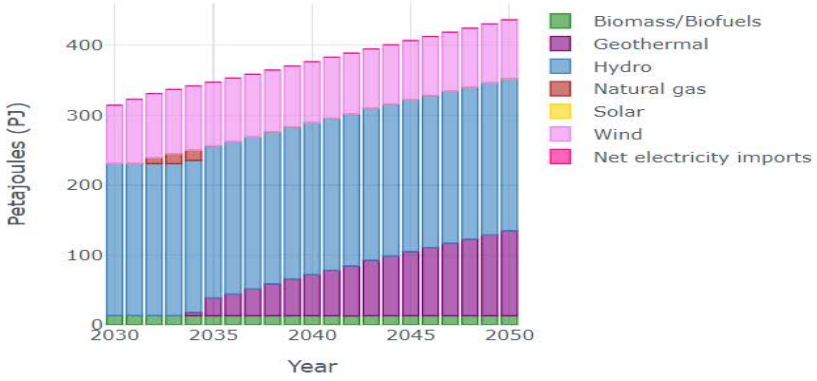

BL



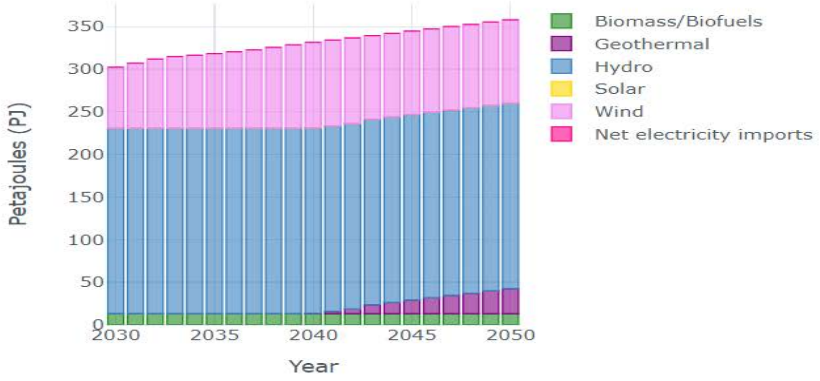

# BL vs. S1 – Energy System

Power Generation (Detail)

**S1**



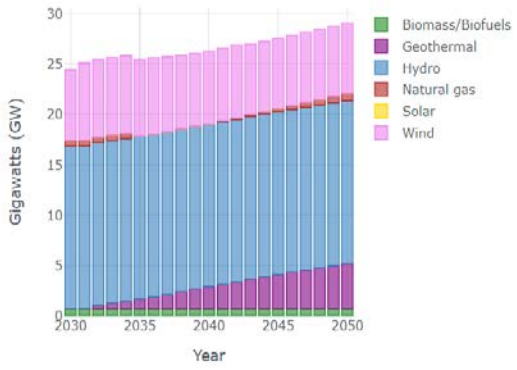

BL



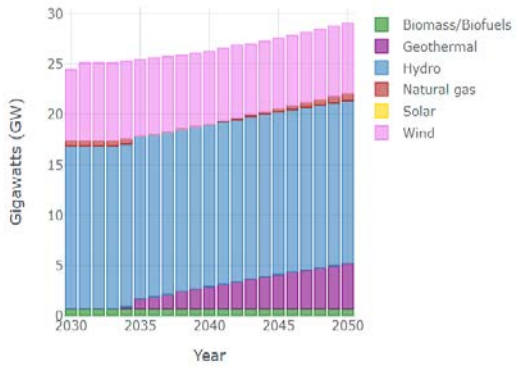
# BAU, S1, S2 – Power Generation

Power Generation Capacity (Detail)

S2




S1

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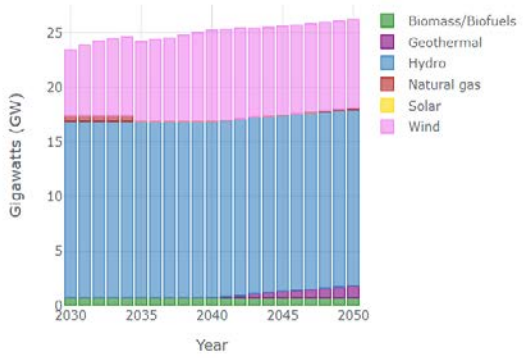
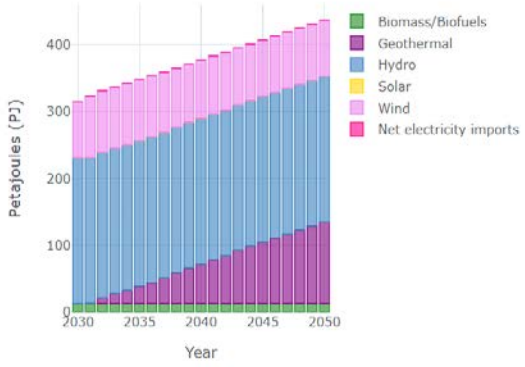
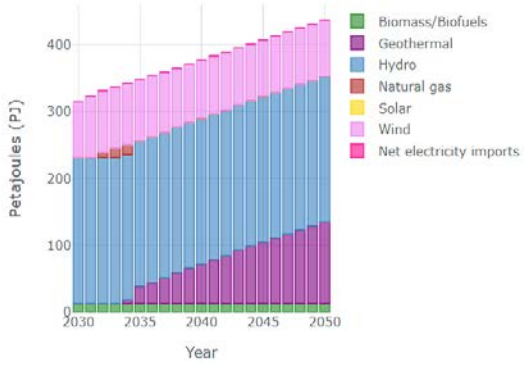



Power Generation (Detail)

S2




S1

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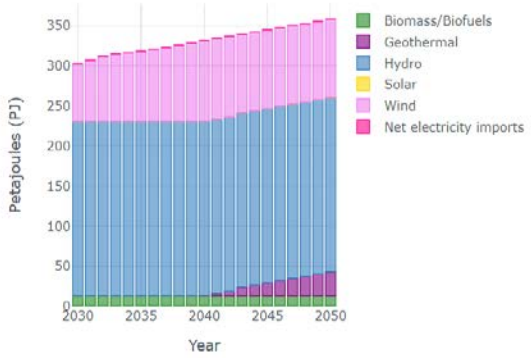


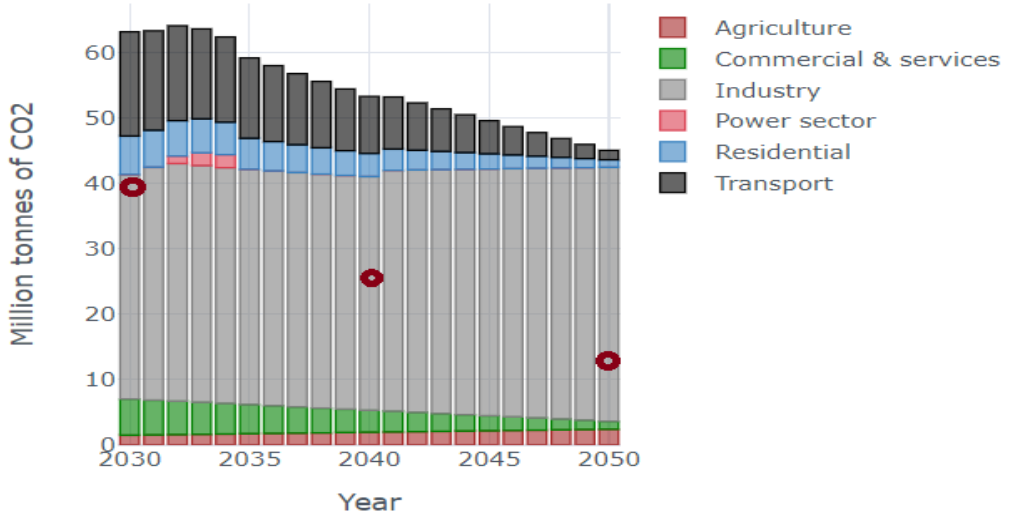
# Land and Water Use

- Low impact reported due to selected technology mix
  - No further solar development
  - Low biofuel demand form agriculture sector
  - Moving from fossil fuels

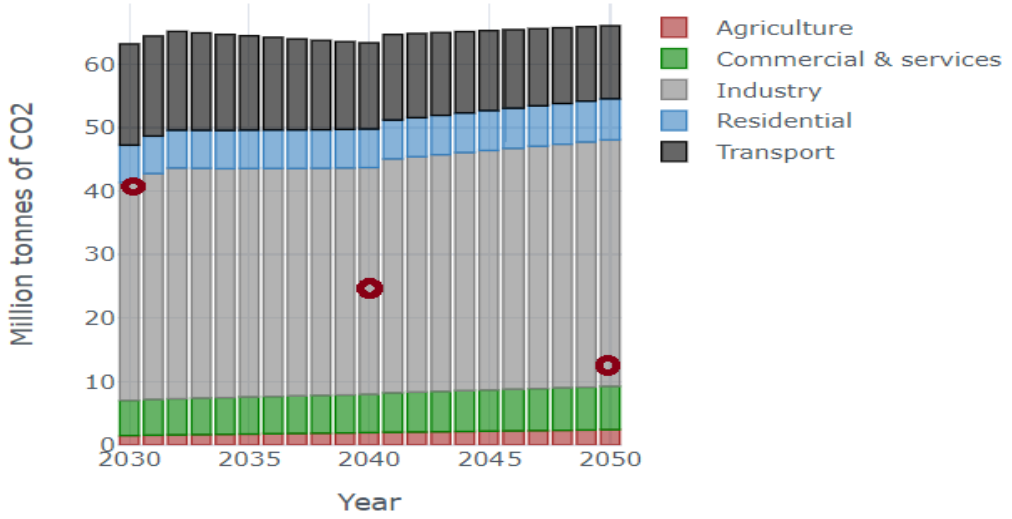
# $CO_2$ Emission and BC Targets

CO2 Emissions By Sector

**S1**




**BL**




B.C.'s legislated emission targets

- 2030 ~ 40 Million tonnes of $CO_2$ (40% below 2007)
- 2040 ~ 25 Million tonnes of $CO_2$ (60% below 2007)
- 2050 ~ 12 Million tonnes of $CO_2$ (80% below 2007)

# Key Finding from Scenarios

- The model did not choose further investment in the solar generation capacity in any of the scenarios despite the low development cost.
- Low water and land impacts
- The BL and S1 scenario highlights the significant role that the baseload energy options are playing in the power grid's stability
- To meet the provincial $CO_2$ emission reduction targets, the industry sector need to cut emissions by half by 2040 another half by 2050.
- The results of the S2 scenario did suggest that policies such as carbon tax and cap-and-trade approaches by setting a limit on pollution and creating a market can change the timeline and direction of investment in the energy technology mix.

# Next Steps

- Addressing the gaps in representing the energy transition.
  - grid flexibility and reliability
  - energy storage representation
  - operational and installed capacity limits on various technologies
- Addressing the gaps in the representation of the cross-disciplinary linkages
  - a better representation of land use related to energy system impacts
  - the impact of changes in water and land systems on climate and economy
  - a closer look at the role of forestry carbon uptake in BC
- Expanding the nexus system
  - health impacts, natural security, individual well-being and cultural values

# Reference

On slide 5: [1] Sridharan, V., Shivakumar, A., Niet, T., Ramas P. E., Howells, M. (2020). Land, energy and water resource management and its impact on GHG emissions, electricity supply and food production- Insights from a Ugandan case study. Environment Research Communication

# Discussion/Thank you!