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Life cycle assessment of low cost retrofit options of educational building considering renewable and non-renewable energies

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Life Cycle Assessment of Low Cost Retrofit Options of Educational Building Considering Renewable and Non-renewable Energies

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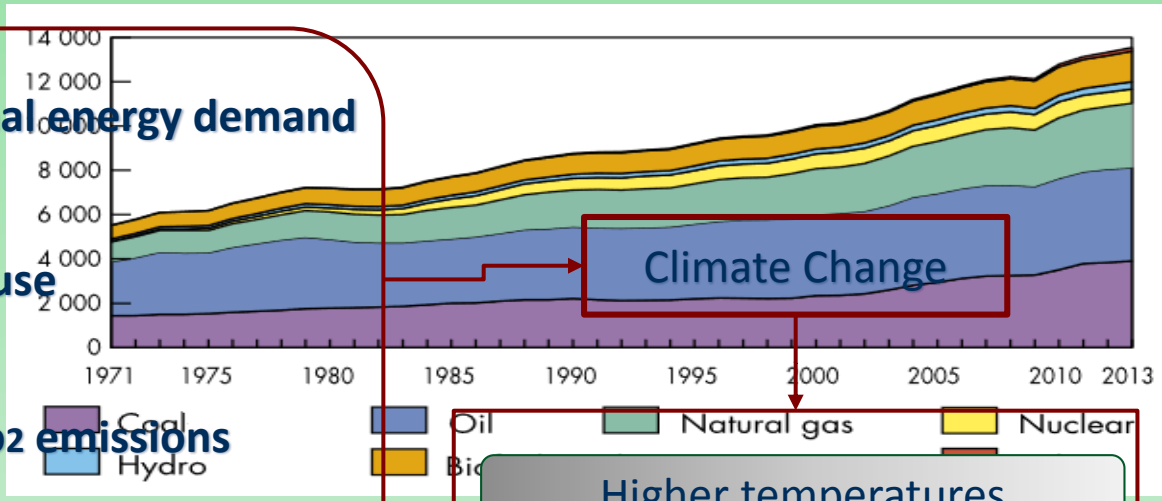
ECI
Engineering Conferences International

Buildings account for:

- ✓ More than one third global final energy demand
- ✓ 60% of the world's electricity use
- ✓ One-third of energy-related Co2 emissions (GEA, 2012)

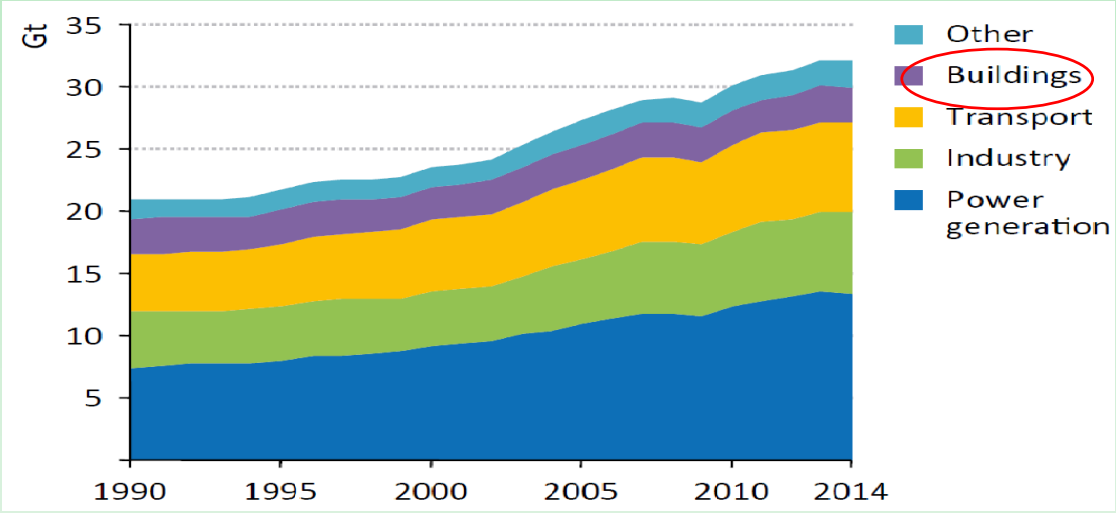
World total Primary energy supply from 1971 to2013



Climate Change

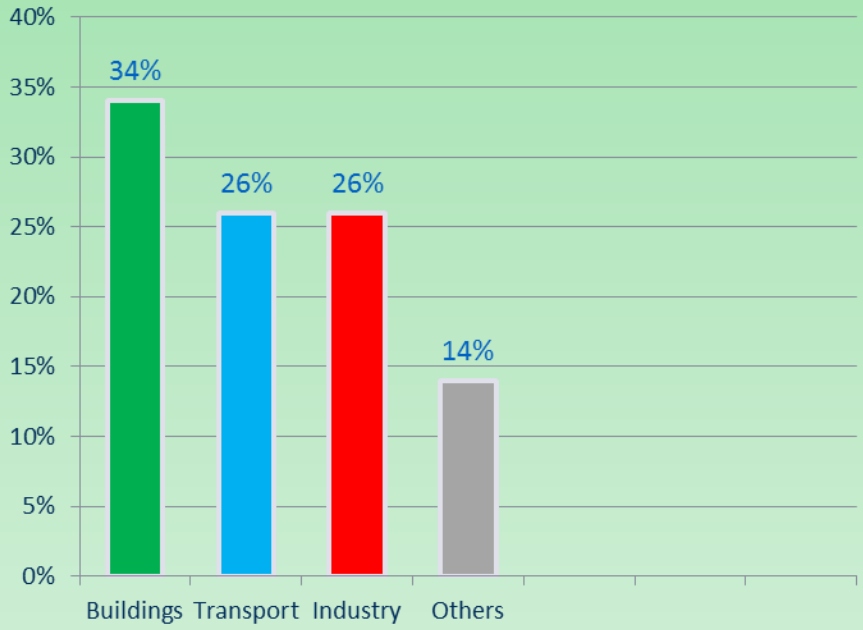
- Higher temperatures
- Extreme weather
- Water availability
- Sea level rise
- Permafrost melting

Global energy-related Co2 emission by sectors(2015)

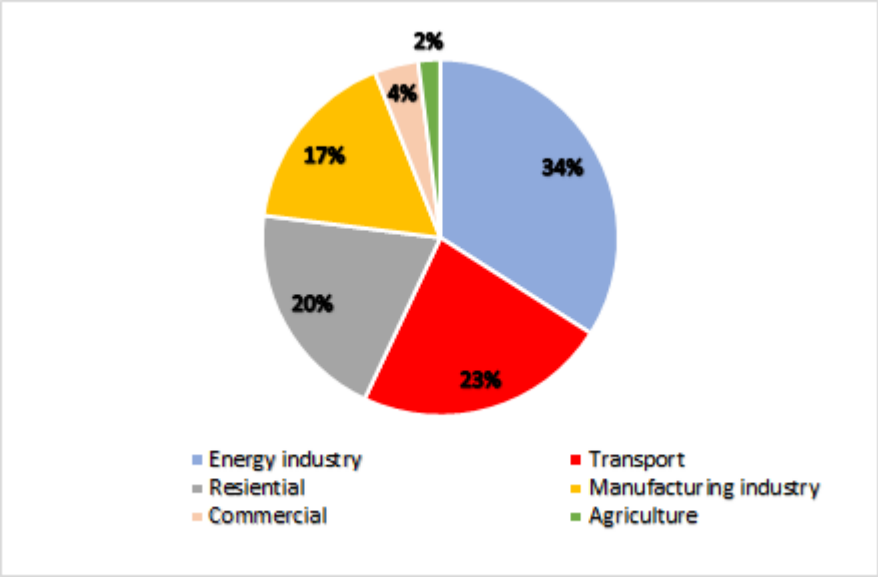


International energy agency/ Key World energy statics 2015

Final energy consumption in Iran



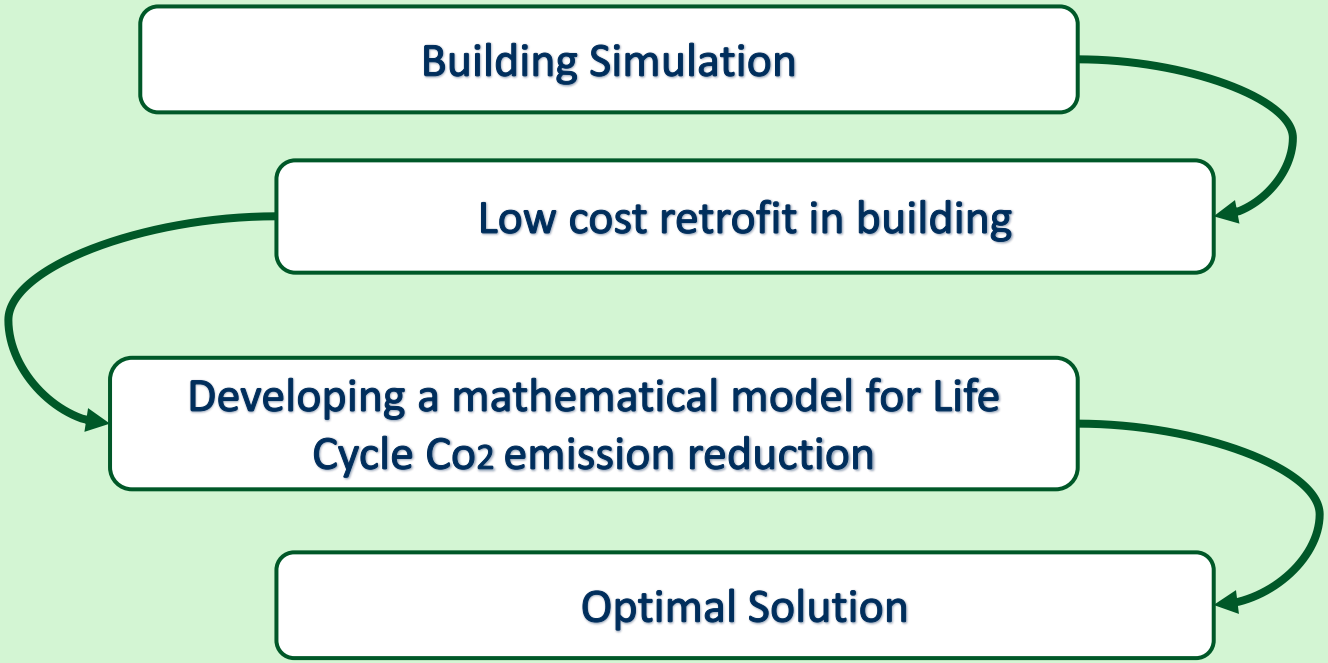
Total Co2 emission by sector in Iran.



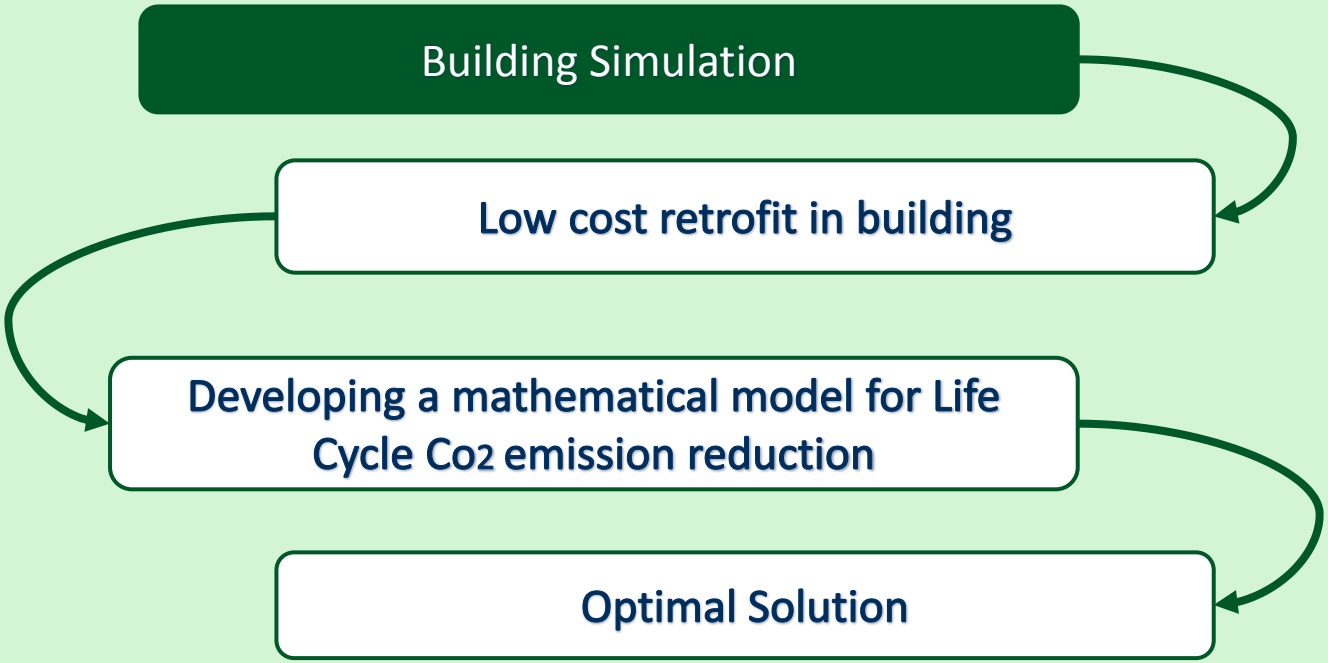
Literature review

- Life Cycle of material and Energy systems
  - ✓ Alvaro de Gracia et al, 2010.
    This study evaluates the environmental impact of including phase change materials(PCM) in a typical Mediterranean building.
  - ✓ R. Azari, 2014.
    Effects of low to medium window to wall ratio and fiberglass window frame results in the impacts on Life Cycle energy and environmental performance of building envelopes.
- Building Optimization
  - ✓ Ehsan Asadi et al., 2012.
    The practicability of the alternative materials for the external walls insulation, roof insulation, different window types and installation of a solar collector in the existing building and highlight potential problems that may arise
  - ✓ Christina Diakaki et al. 2010.
    The multi-objective decision model of this study allows the examination of a potentially infinite number of alternative measures for building retrofit.
- Building Life Cycle Optimization
  - ✓ Amir Safaei, 2014.
    This research presents a modelling framework to optimize the design and operation of Dg for Portuguese commercial building sector, while considering the Life-Cycle Impact assessment and Life Cycle Costs of meeting the building energy demand.
  - ✓ Ayat Osman, 2002.
    The research develope a framework and model to optimize a building's operation by integrating cogeneration systems and utility systems in order to meet building demand by considering the potential life cycle environmental impact that might result from meeting those demand as well as economical implications.

Statement of research:



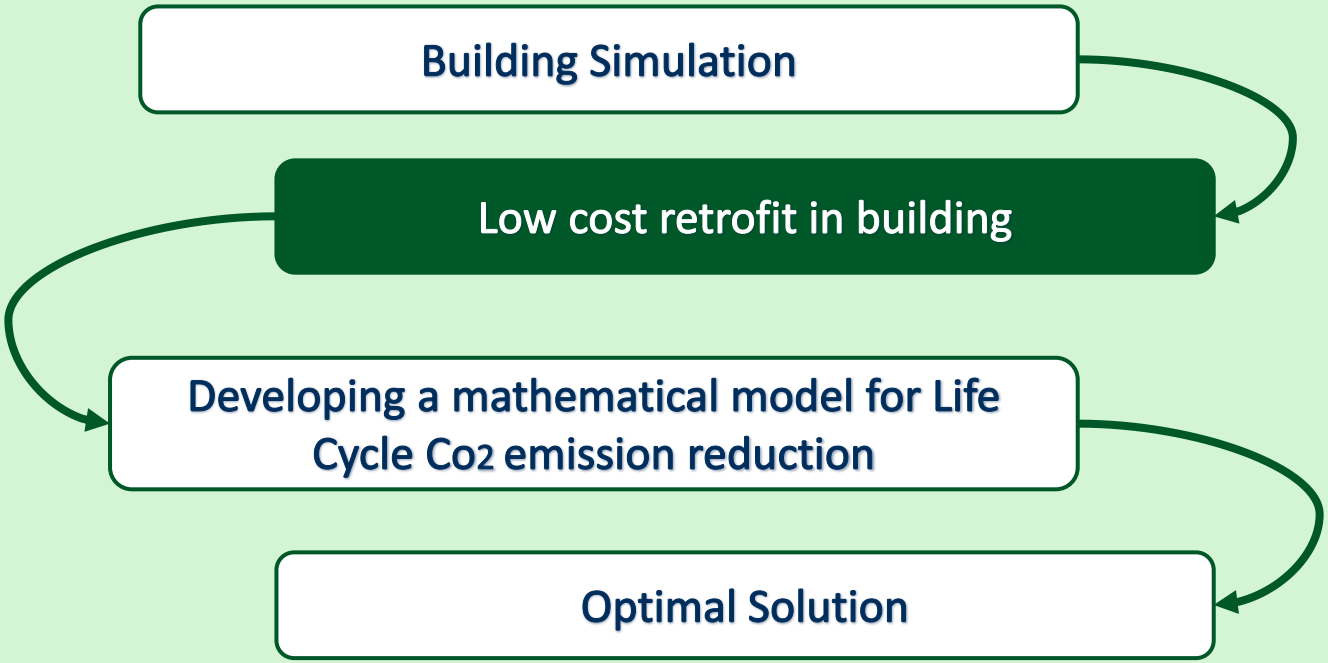
Statement of research:

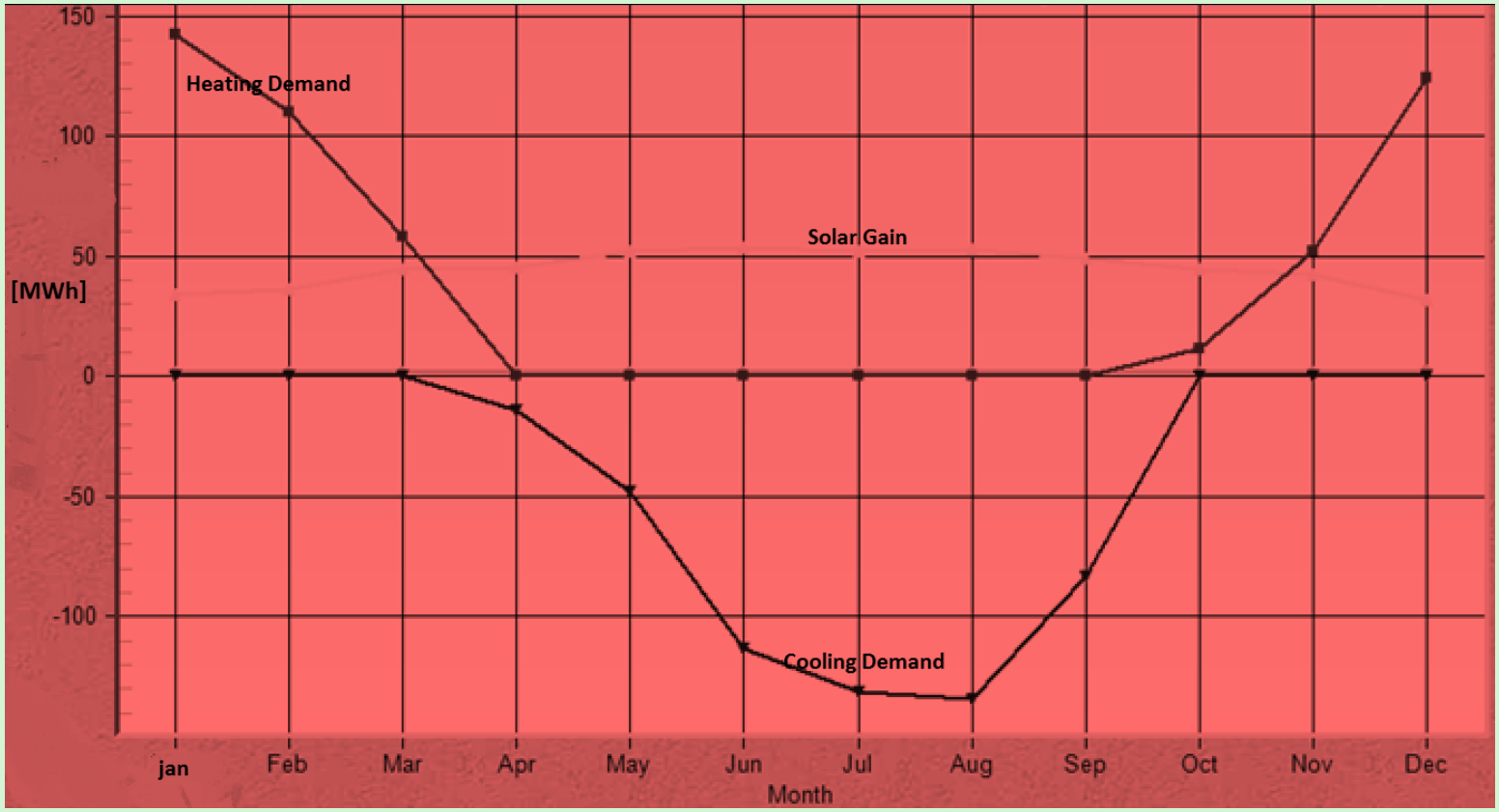


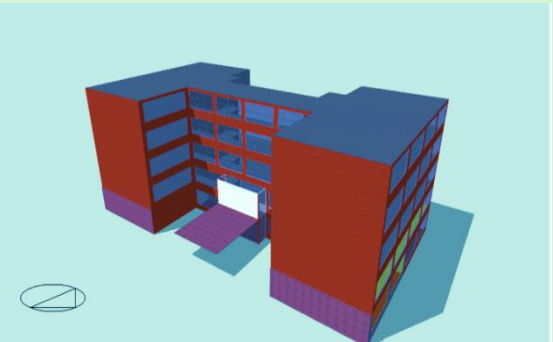
Department Of Energy Engineering	Property
Occupied Floor Area	4760
Unoccupied Floor Area	1122
Window to Wall Ratio	70%
External Wall U-Value [W/m2K]	1.01
External Floor [W/m2K]	0.6
Semi-exposed Wall	0.69
Flat Roof	0.63

Existing Heating-cooling Systems	Capacity[KW]	Cop
Absorption Chiller	700	0.9
Boiler	600	0.7

Statement of research:

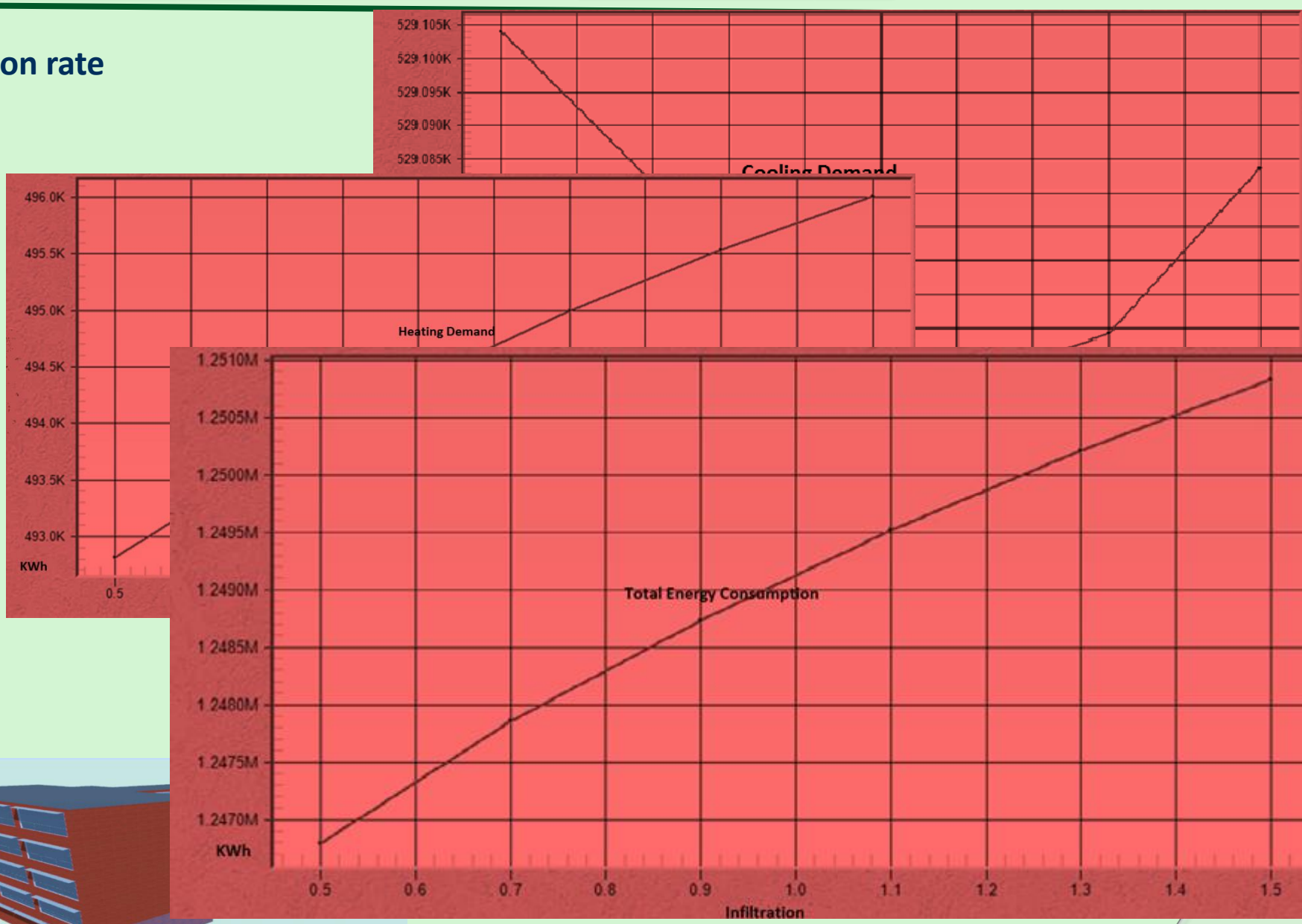






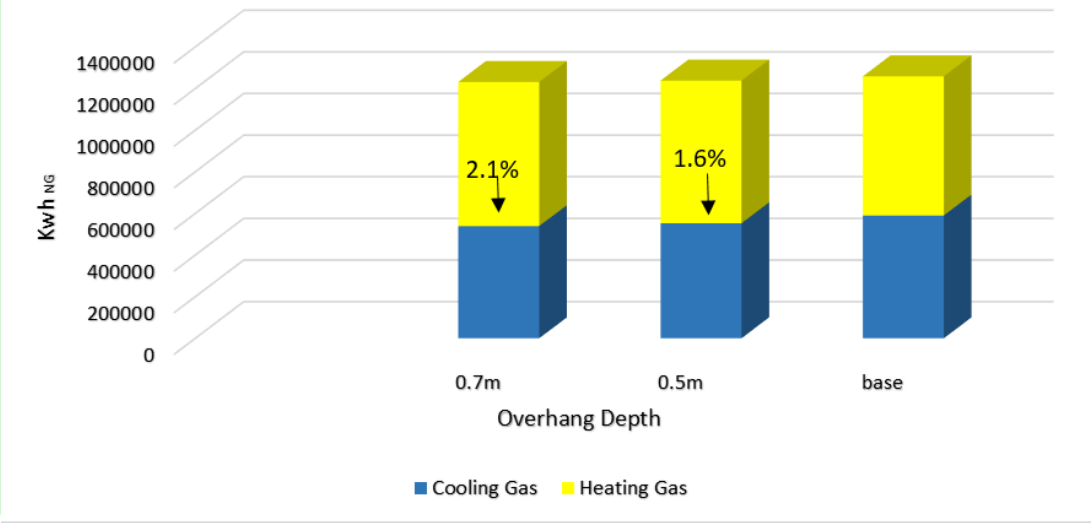
Monthly Heating and Cooling energy demand

Infiltration rate

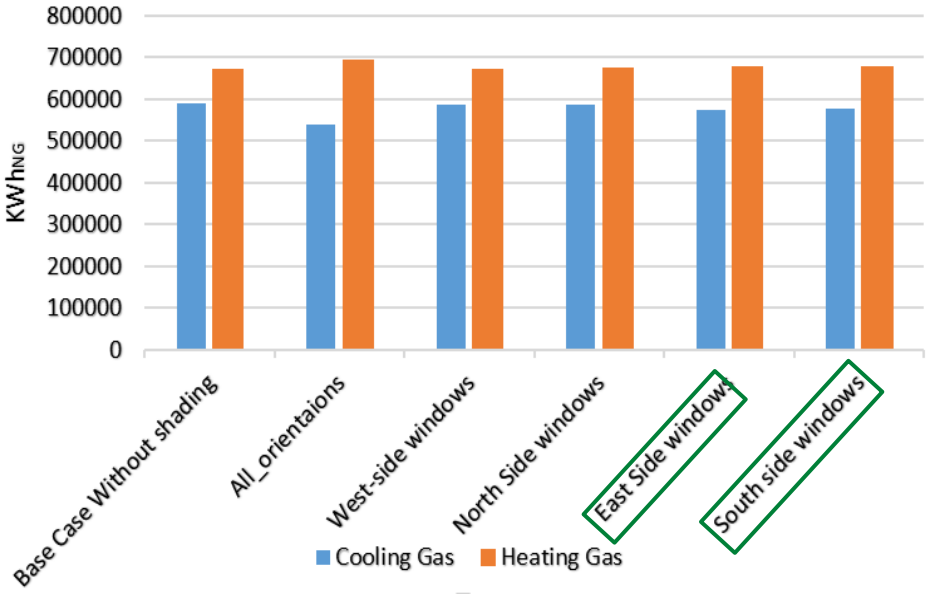


Shading

Annual Gas consumption For Meeting Cooling and Heating Demand

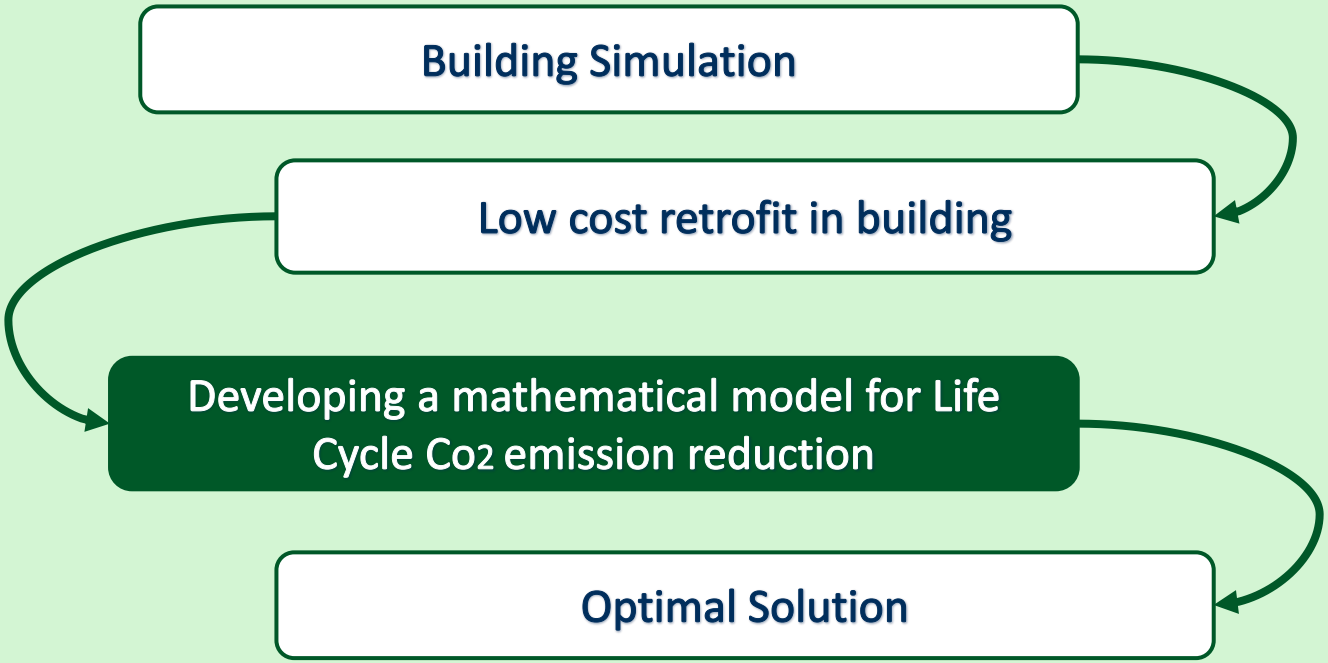


Comparison of various shading orientations in Cooling Demand



East and South sides are the most effective orientations in the building for shading installation

Statement of research:



Distributed Generation Systems (DG)

The employment of DGs is considered as a relevant mean to enhance the energy use in buildings.

Technologies For DG

- Cogeneration Combined Heat and power (CHP) And Combined Cooling heating and power (CCHP)
- Photovoltaic
- Solar Thermal
- Wind Turbine
- …

Life Cycle Optimization Model

Objective Functions:

- **Minimizing Life Cycle Emission:**

$$Emission_{grid} + Emission_{boiler} + Emission_{PV} + Emission_{WT} + LCA_{Internal\ engine} + LCA_{MicroTurbine}$$

- **Minimizing Total Cost:**

$$Electricity_{cost} + Boiler_{operation\_cost} + Photovoltaic\ Pannel_{investmentcost} + Wind\ Turbine_{investmentcost} + CCHP_{Internal\ combustion\ engine\_total\ cost} + CCHP_{MicroTurbine\_total\ cost}$$

Constrains:

- **Meeting Heating demand:**

$$Heating_{Boiler} + Heating_{CCHP} = Heating_{demand}$$

- **Meeting Cooling demand:**

$$Cooling_{Absorptionchillerchiller} + Cooling_{CCHP} = Cooling_{demand}$$

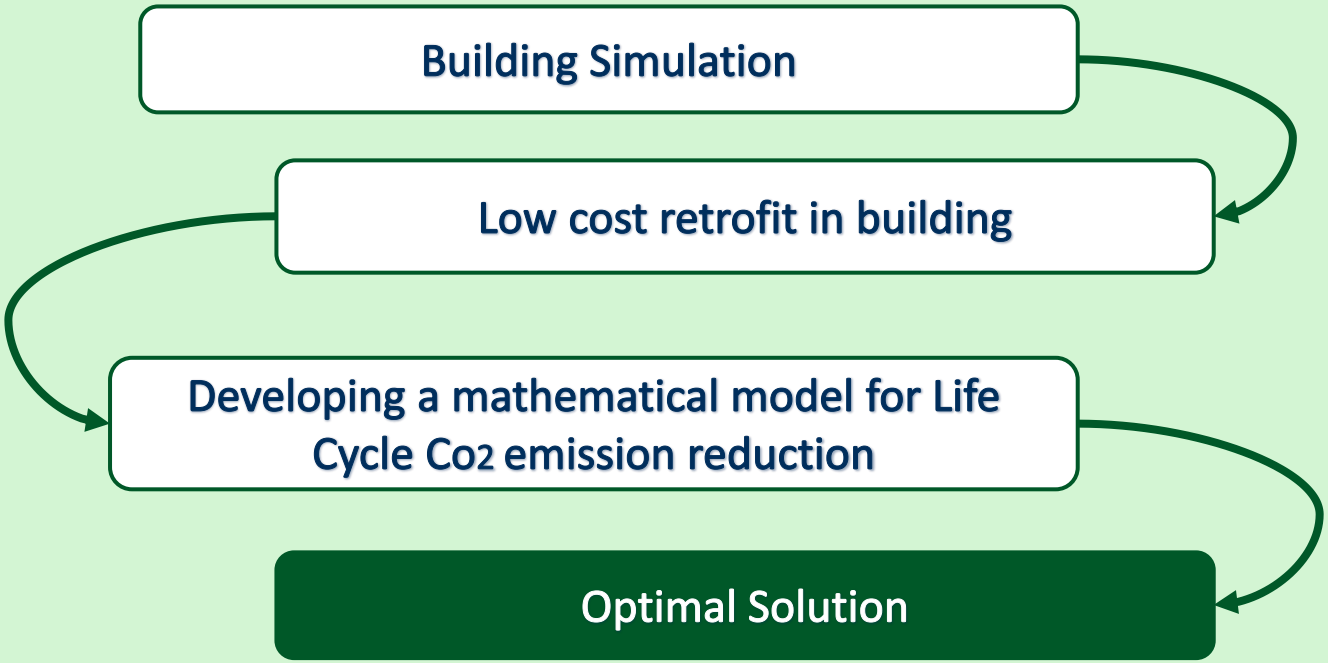
- **Meeting electricity demand:**

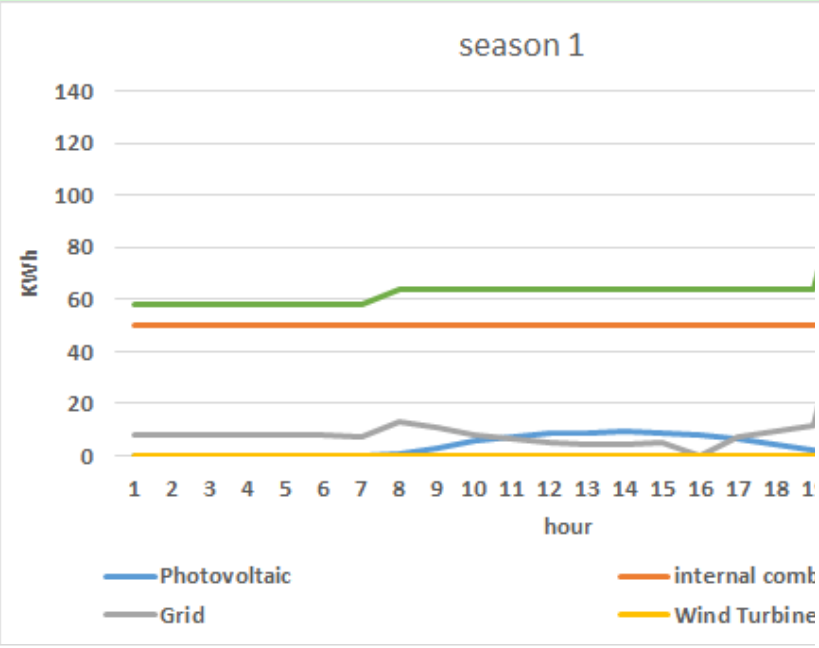
$$Grid_{elec} + Windturbine_{elec} + Photovoltaic_{elec} + InternalCombustionEngine_{elec} + MicroTurbine_{elec} = Electricity_{demand}$$

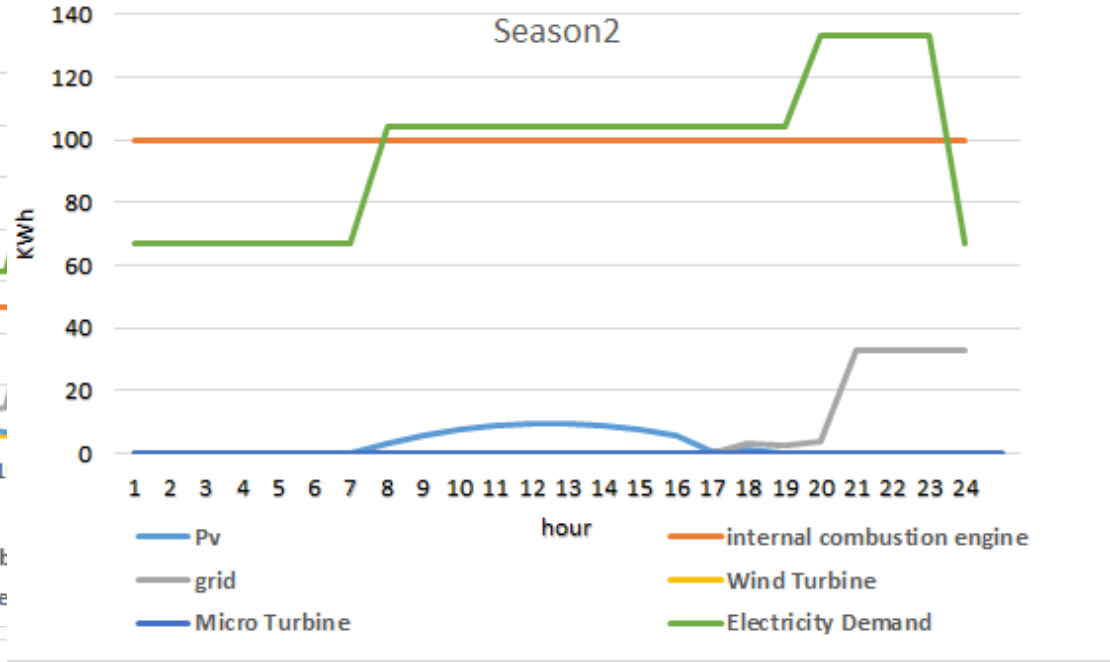
Assumptions:

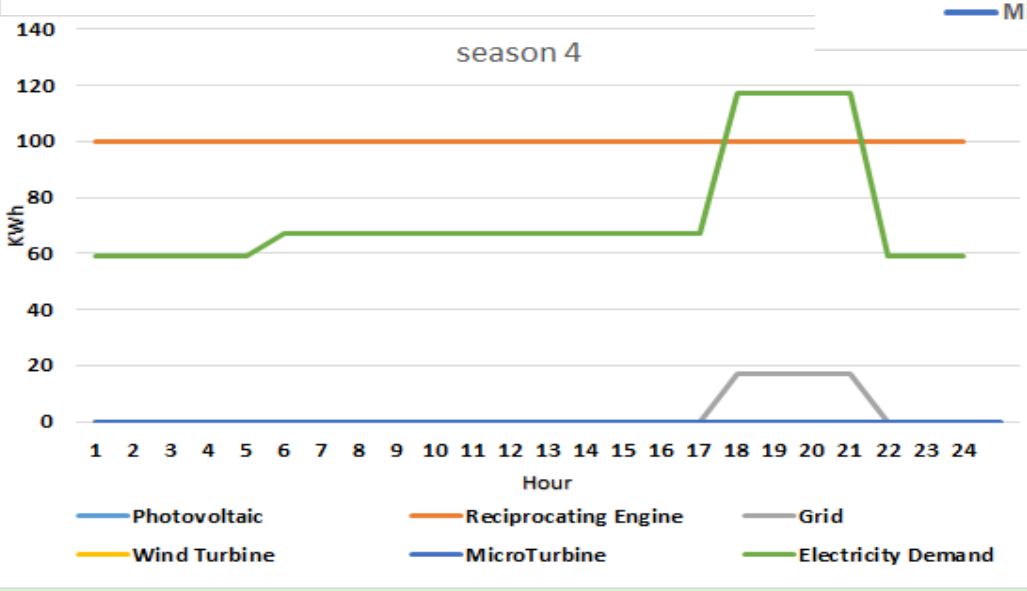
- **Distributed Generation Systems are not Grid-Connected.**
- **Storage Unit is not assumed.**
- **4 Peak days in Each Season are Selected for Design Capacity of DG.**

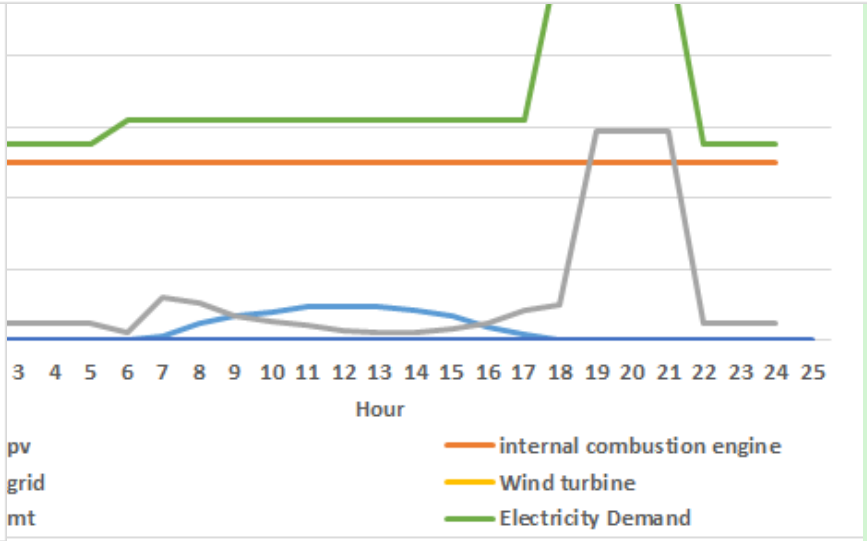
Statement of research:



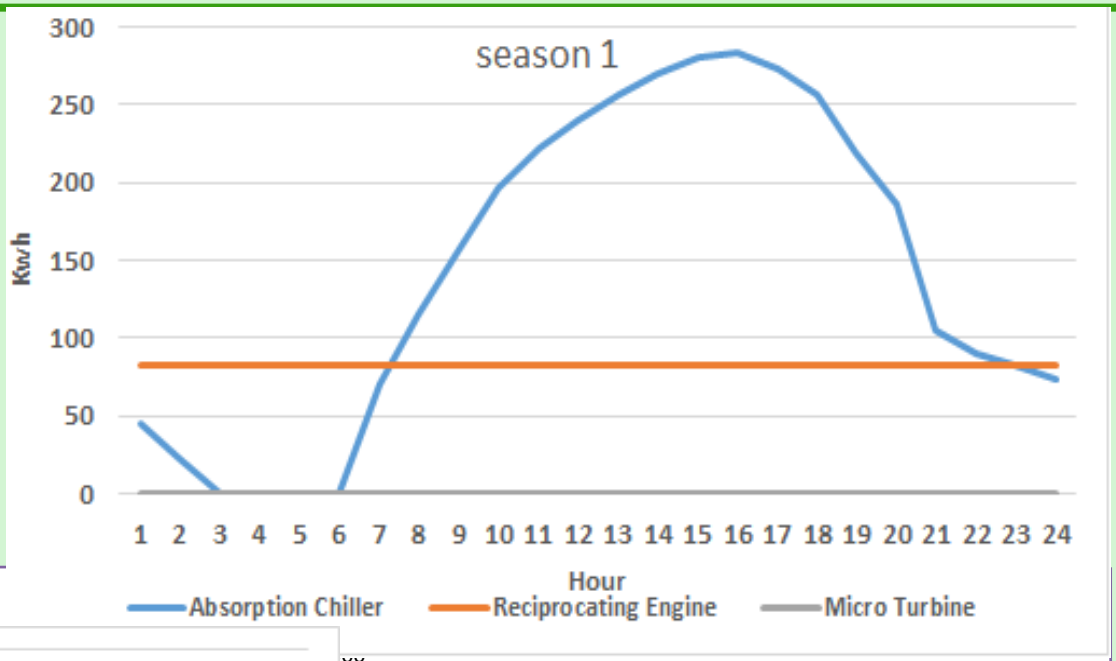

season 1
KWh
hour
Photovoltaic
internal comb
Grid
Wind Turbine


Season2
KWh
hour
Pv
internal combustion engine
grid
Wind Turbine
Micro Turbine
Electricity Demand

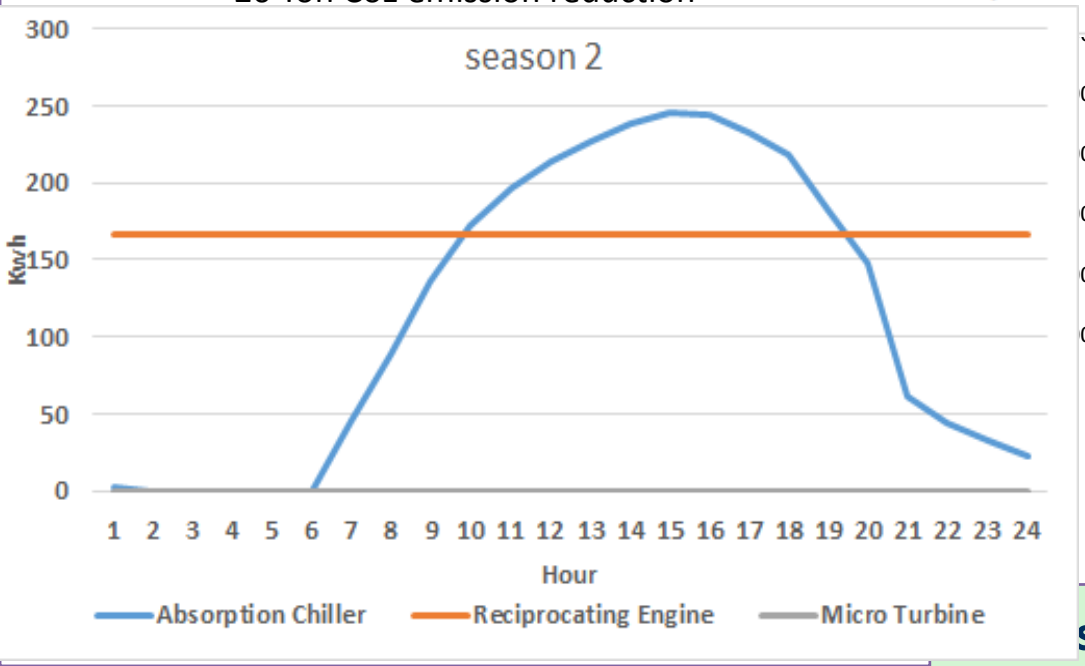

season 4
KWh
Hour
Photovoltaic
Reciprocating Engine
Grid
Wind Turbine
MicroTurbine
Electricity Demand

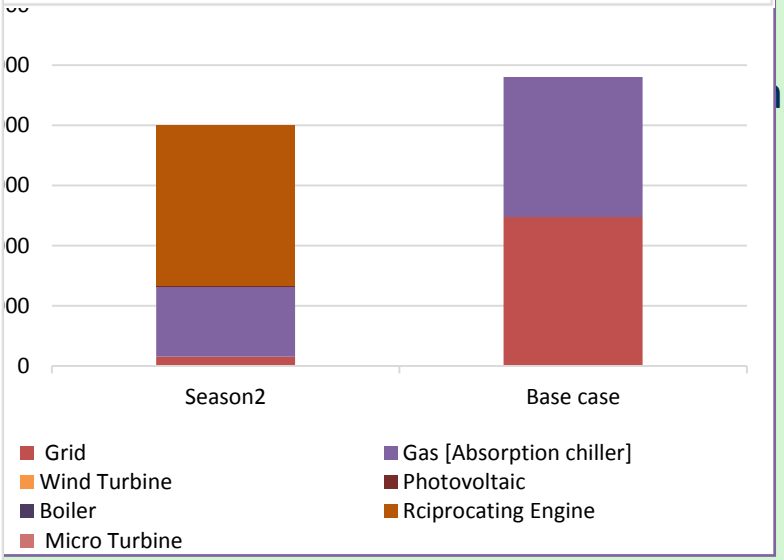

Hour
pv
internal combustion engine
grid
Wind turbine
mt
Electricity Demand

Meeting Cooling Demand by DGs



20 Ton Co_2 emission reduction





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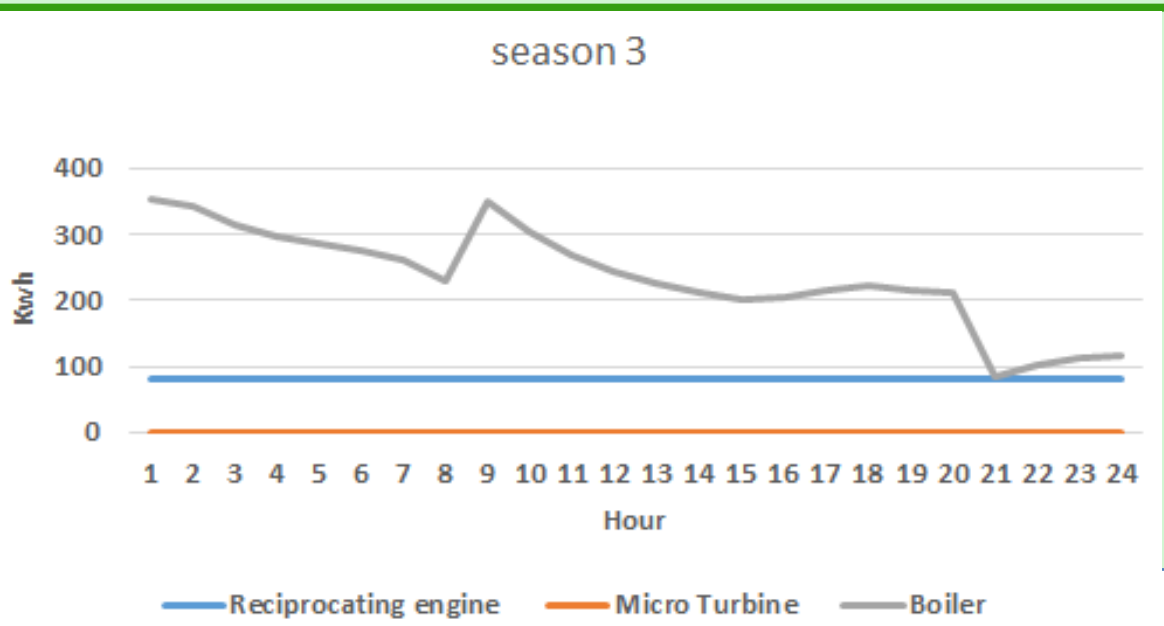
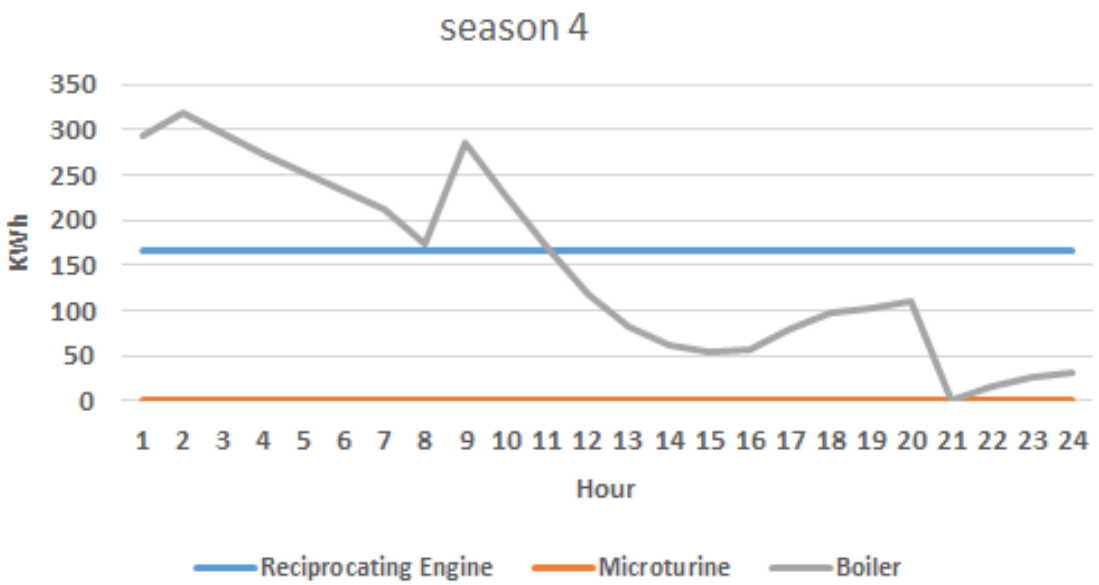
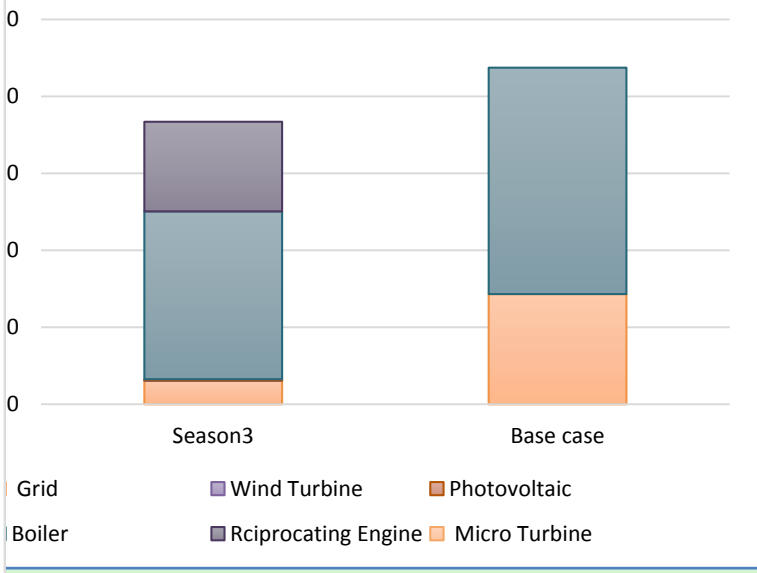
Meeting Heating Demand by DGs

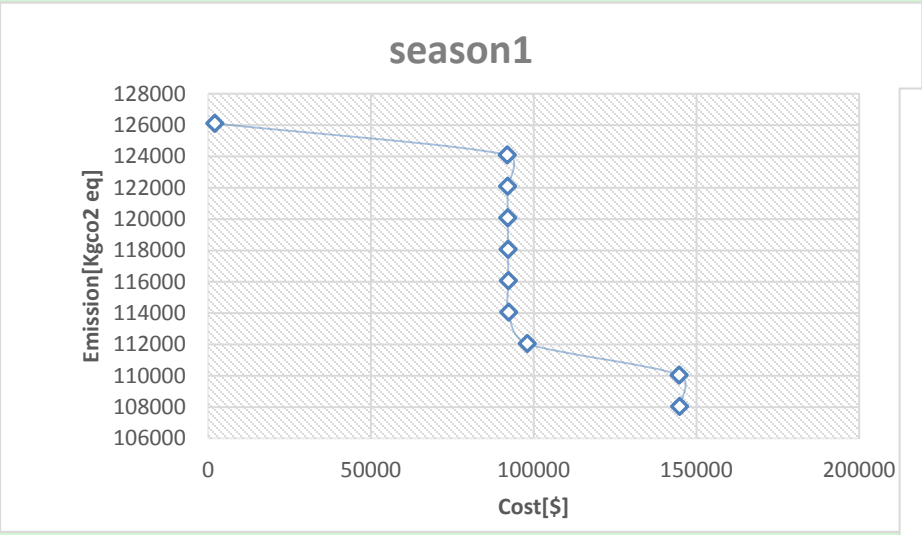


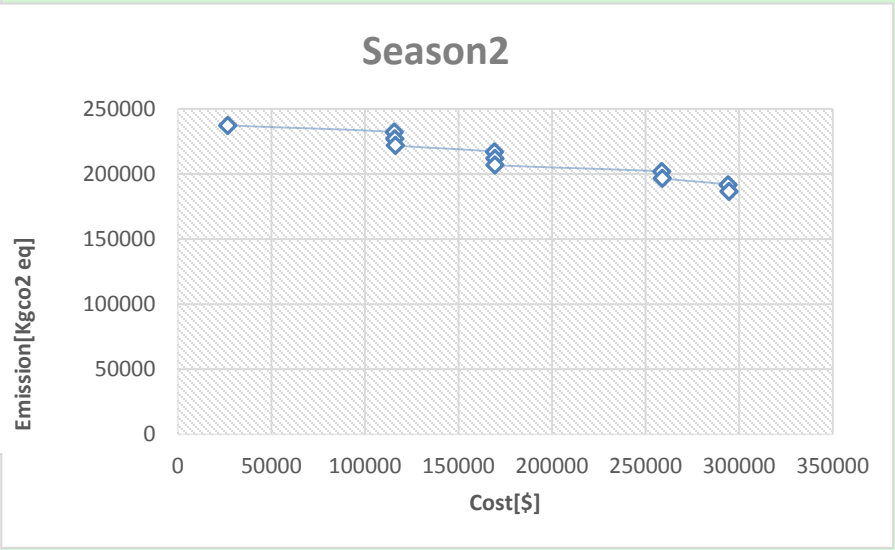
42 Ton Co2 emission reduction

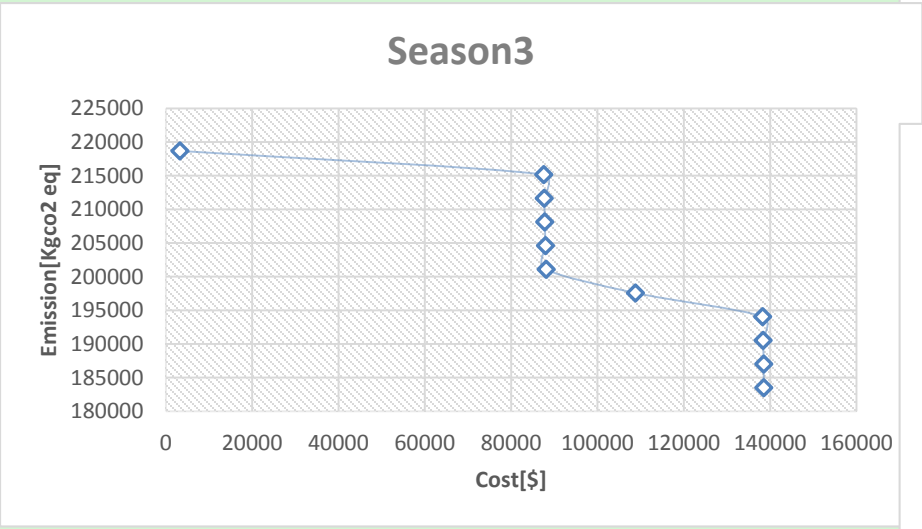




Pareto optimal solutions







Thank you so much for your kind attention

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