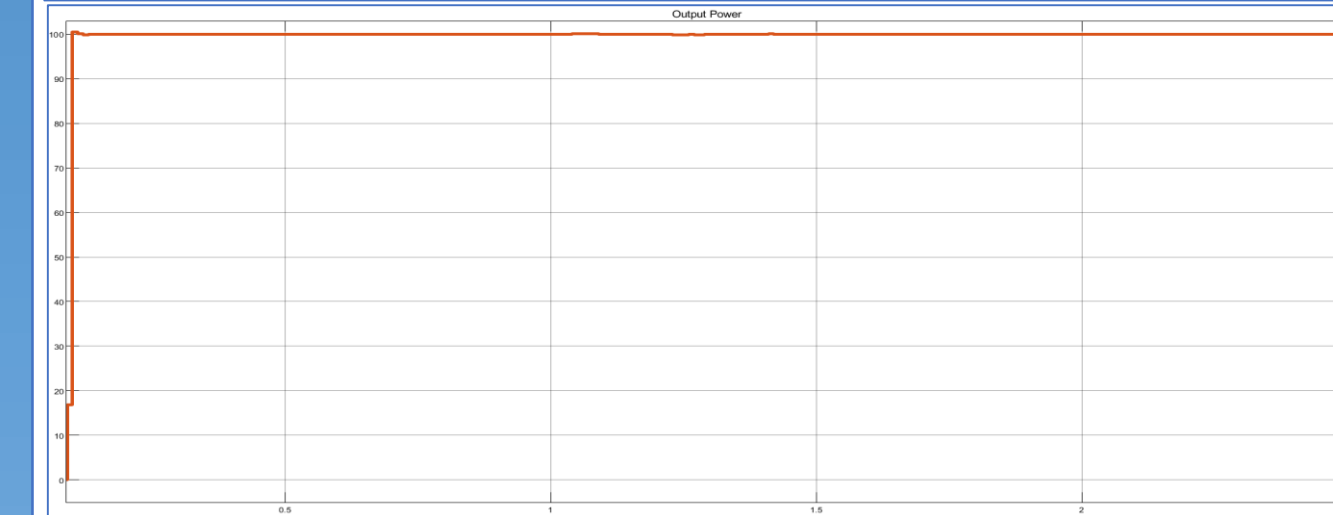
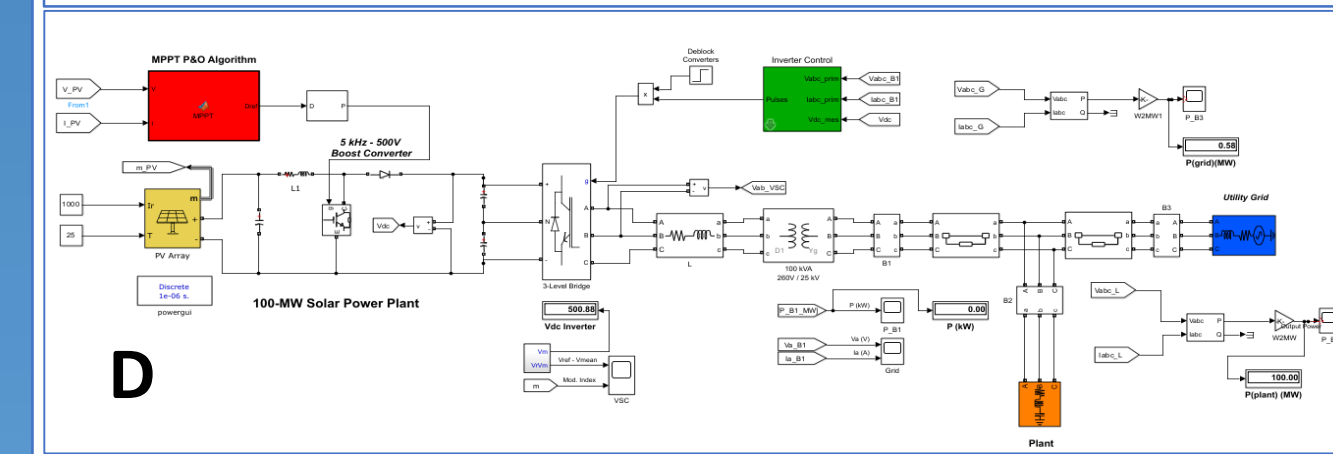
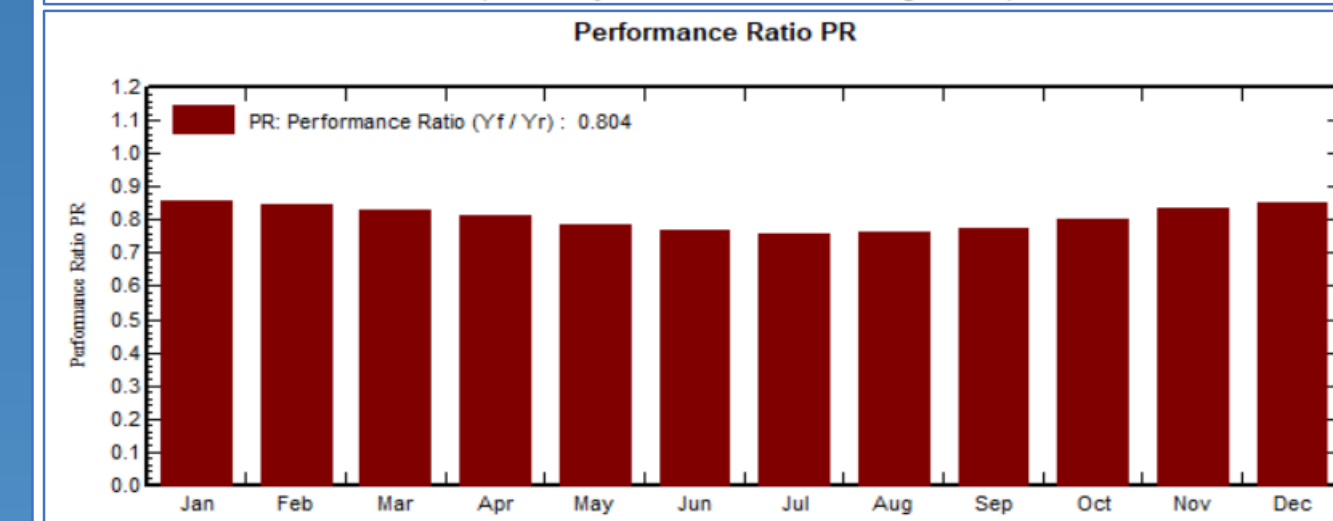
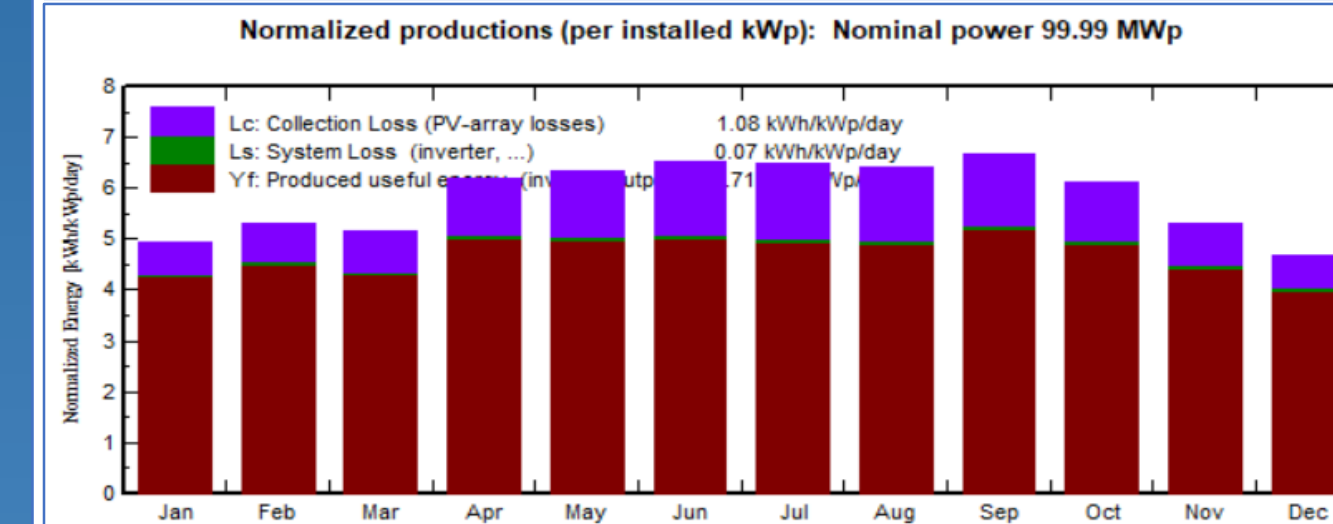


# Sustainable Ethylene Production

## Electrifying The Steam Cracking Process Reduces Carbon Emissions By 95% Or More!

- Power Plant Results:**
  - 100MW PV Power Plant.
  - The Solar Power Plant (Pv Arrays) Area 0.458221 Km<sup>2</sup>.
  - Energy Production Of 171.808 GWH/Year.
  - Performance Ratio (Pr) 80.39%.
  - Pv Modules Connection Of 6557 And 25 In Parallel And In Series Respectively.
  - Total Of 163925 PV Modules With The Following Characteristics: (Jinkosolar, Jkm-610n-78h14-bdv, 610wp, 38V).
  - Total Of 17 Solar Inverters With The Following Characteristics: (Sma, Sunny Central 4600 Up, 4600kw, 1003-1325v).
  - Total TCO<sub>2</sub> Emission Balance Of 3,144,614.3 Over A Period of 30 Years.

### Matlab/Simulink and PVsyst Simulations:



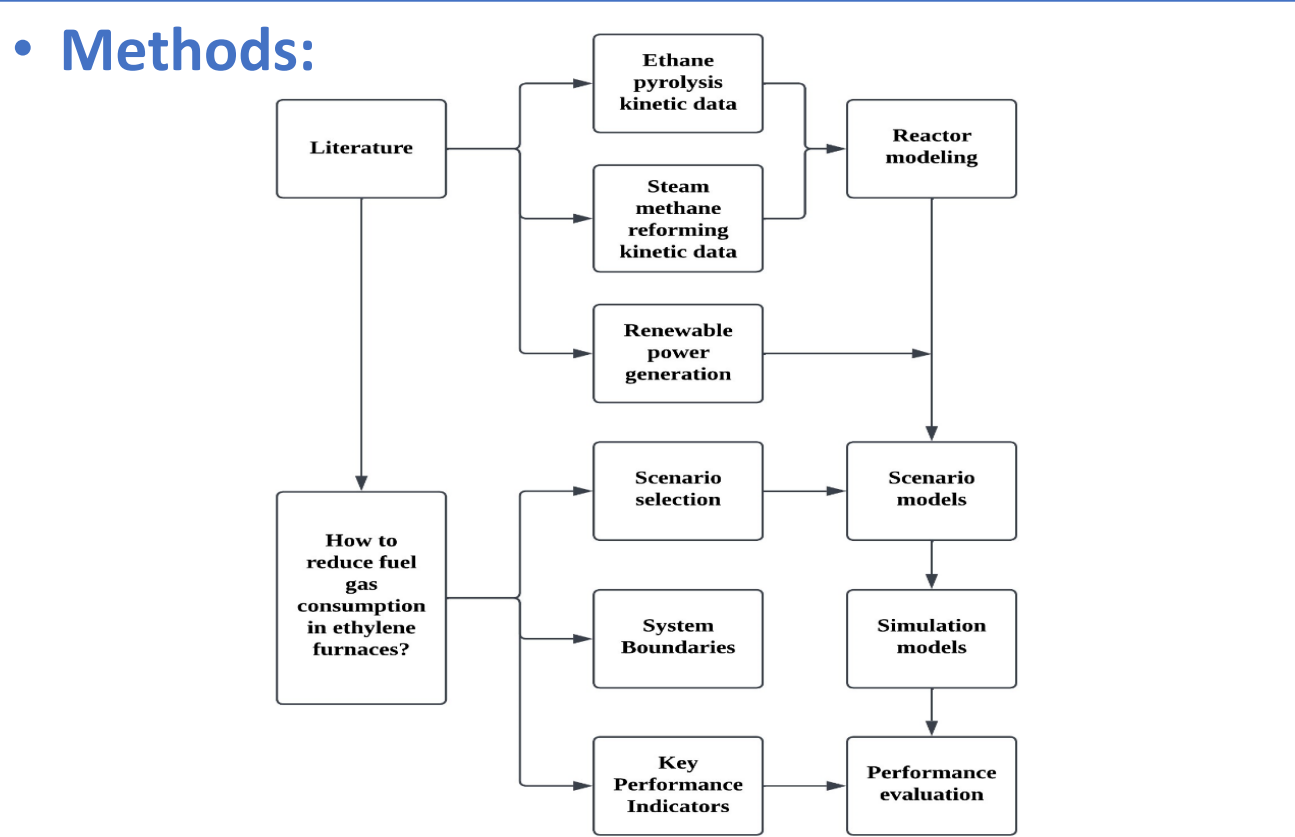
Nawaf Al-Harhi - ChE  
 Khalid Al-Baiz – ChE  
 Mohammed Al-Jali - EE  
 Abdulaziz Al-Tamimi - ChE  
 Omar Al-Harbi - ISE

**KFUPM**

- Project Statement:** To Meet The Global Sustainability Targets By Comparing Two Electrification Alternatives To Fuel Gas Firing In Ethylene Cracking Furnaces.

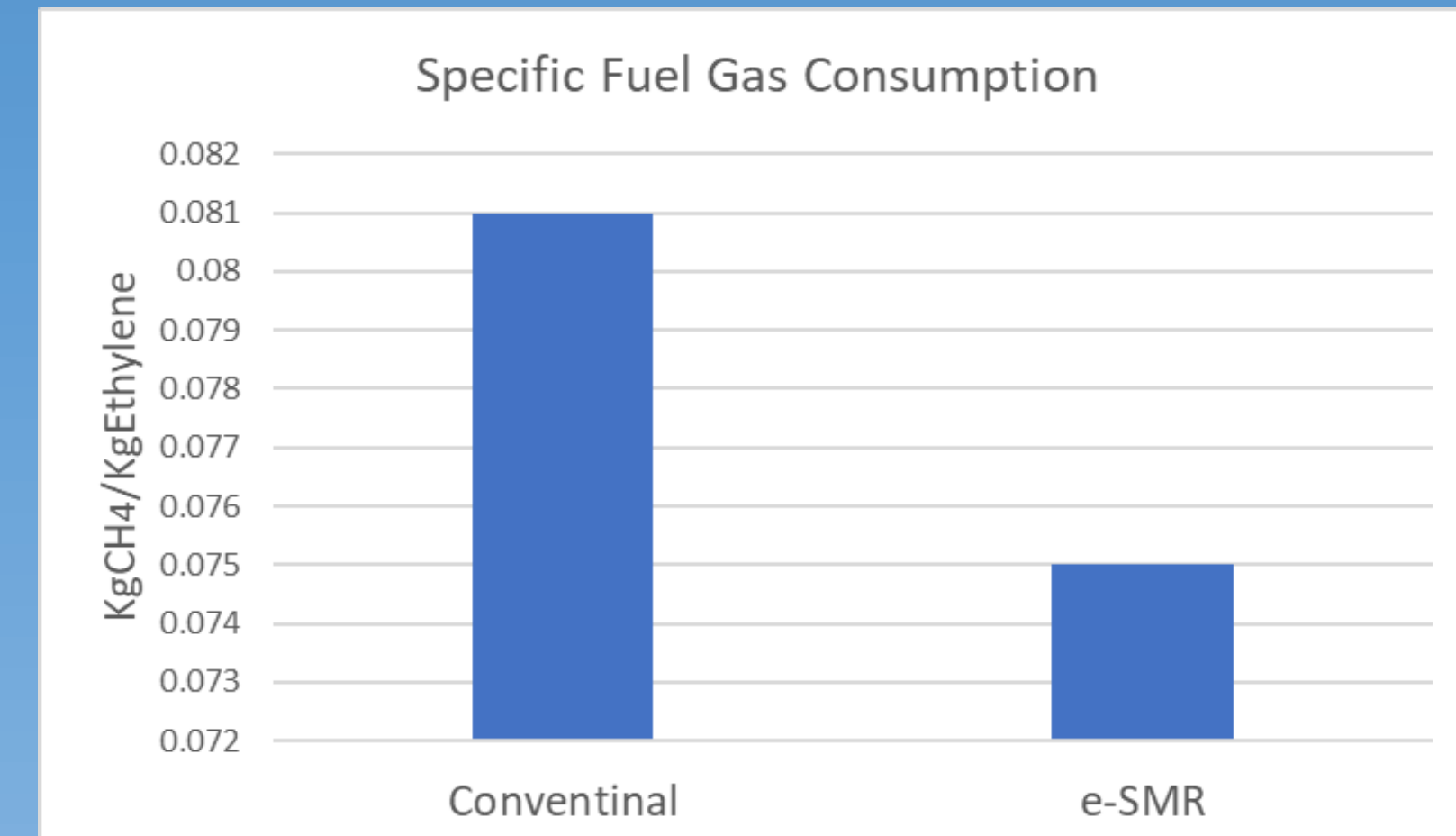
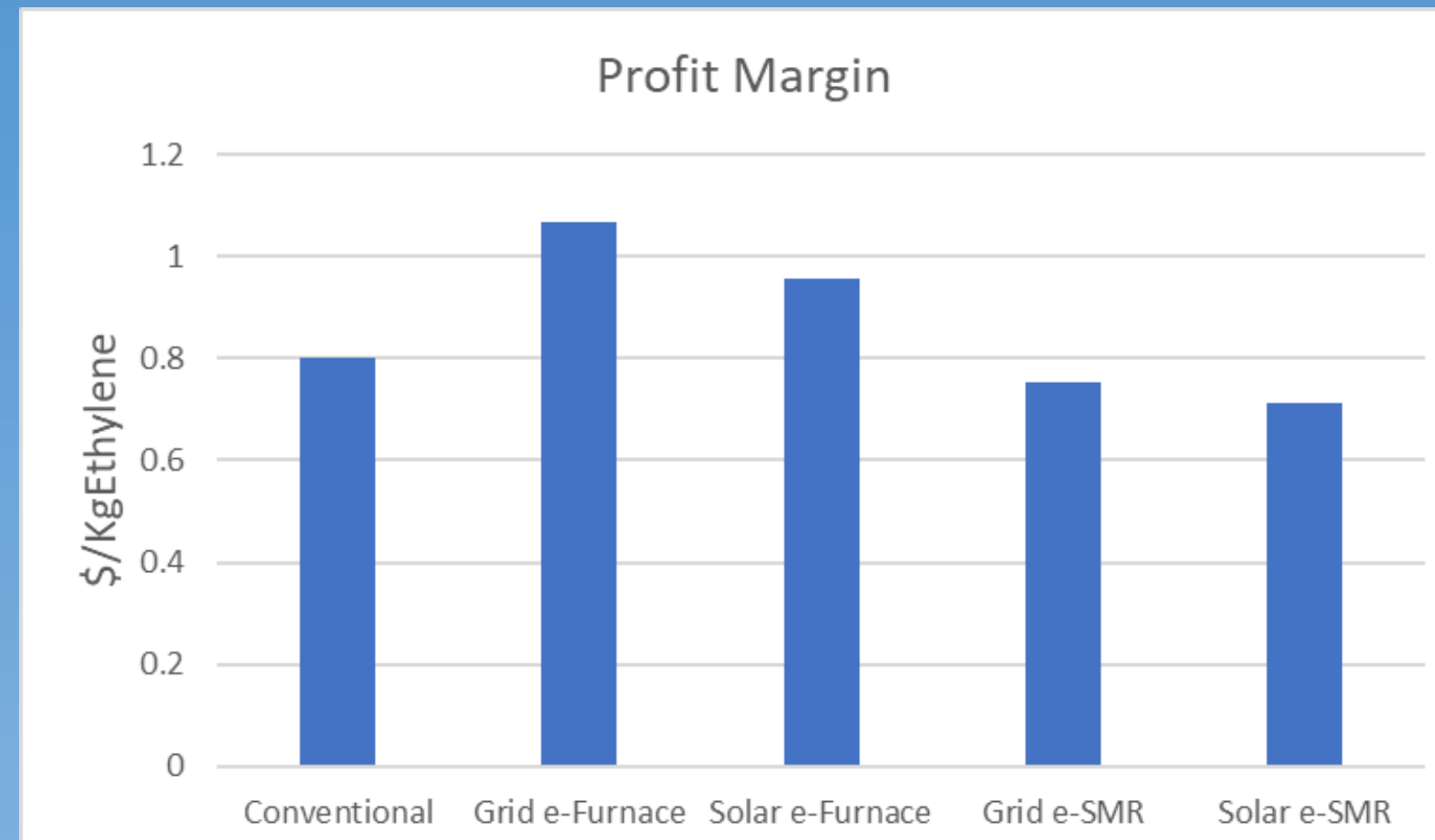
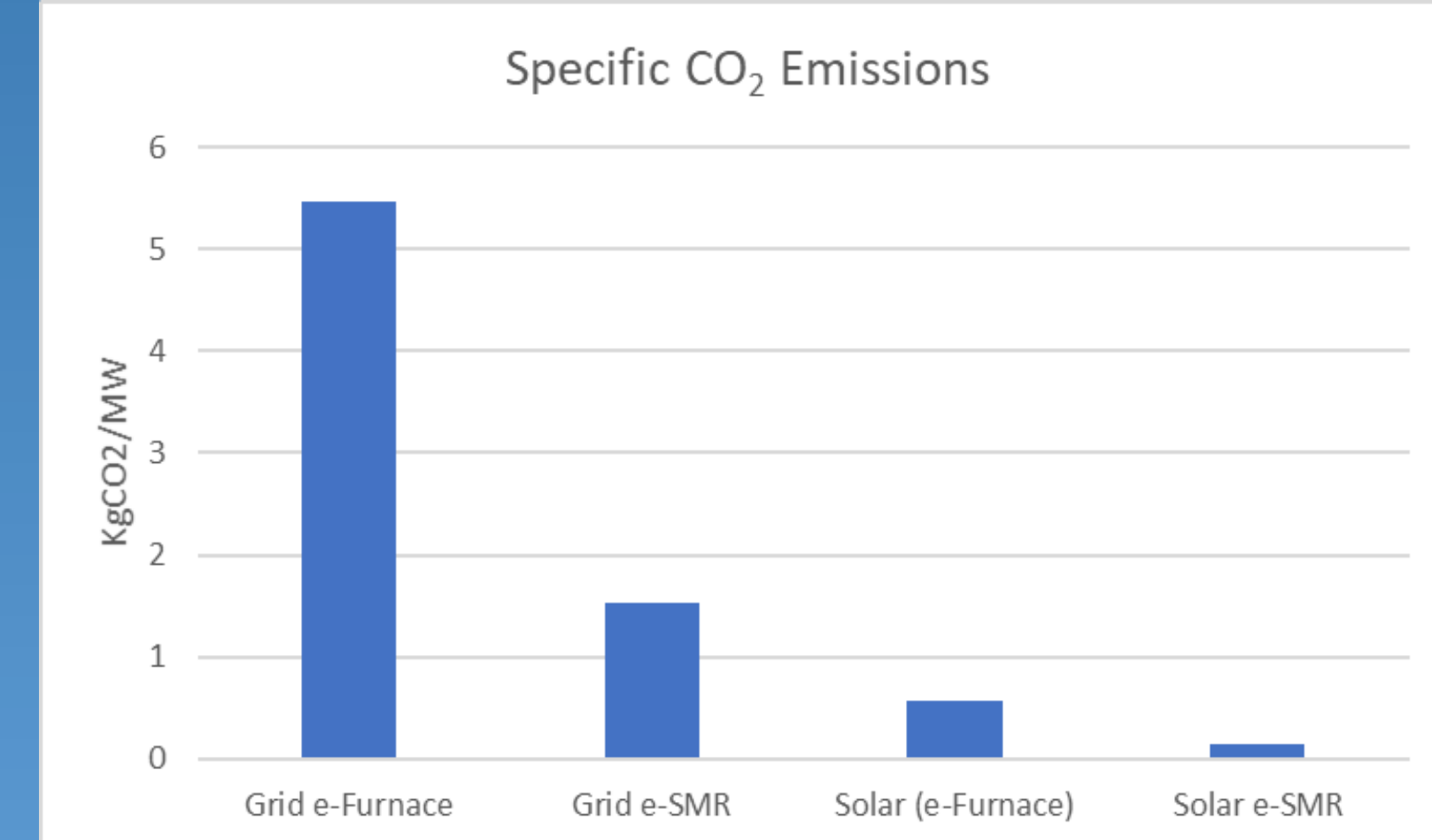
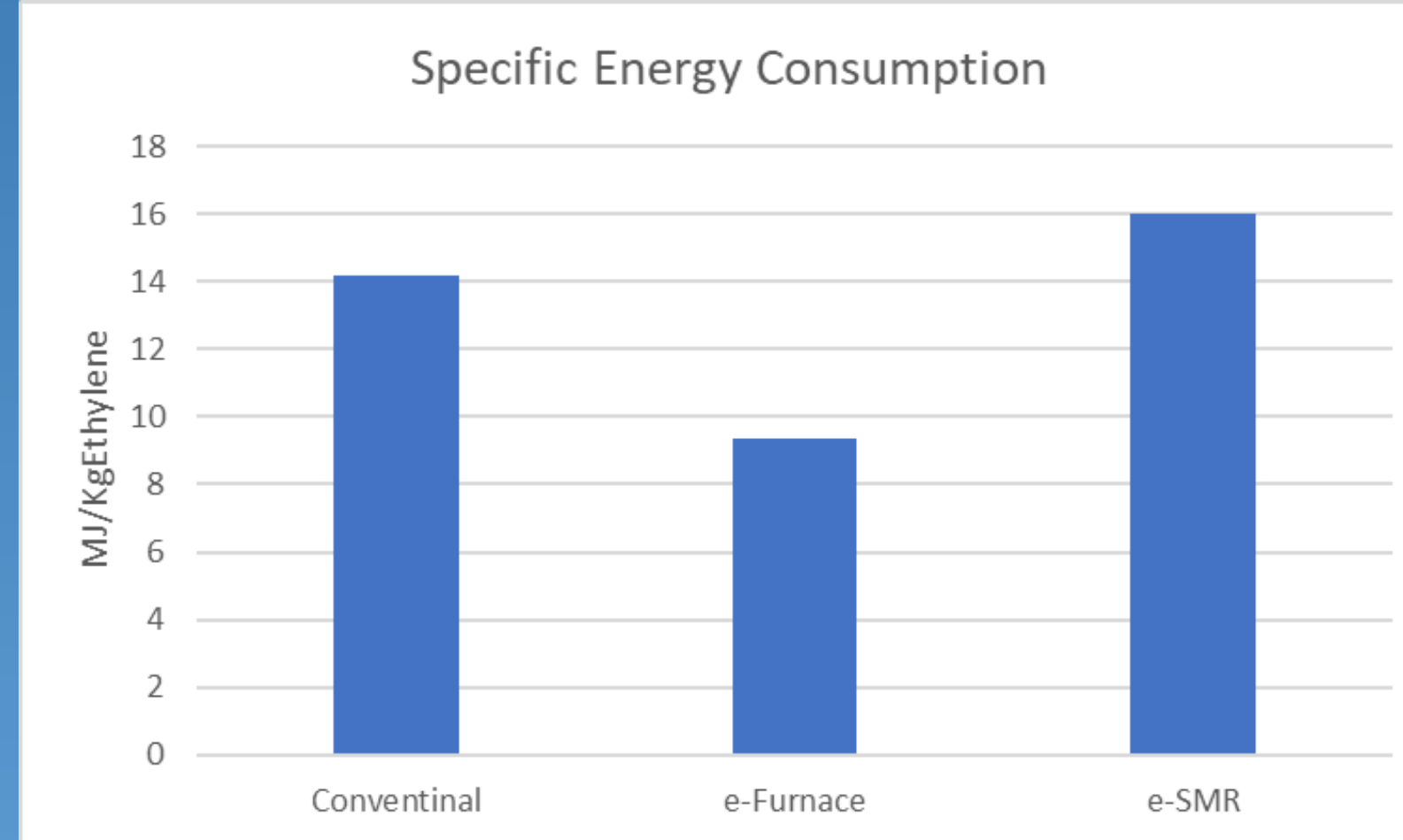
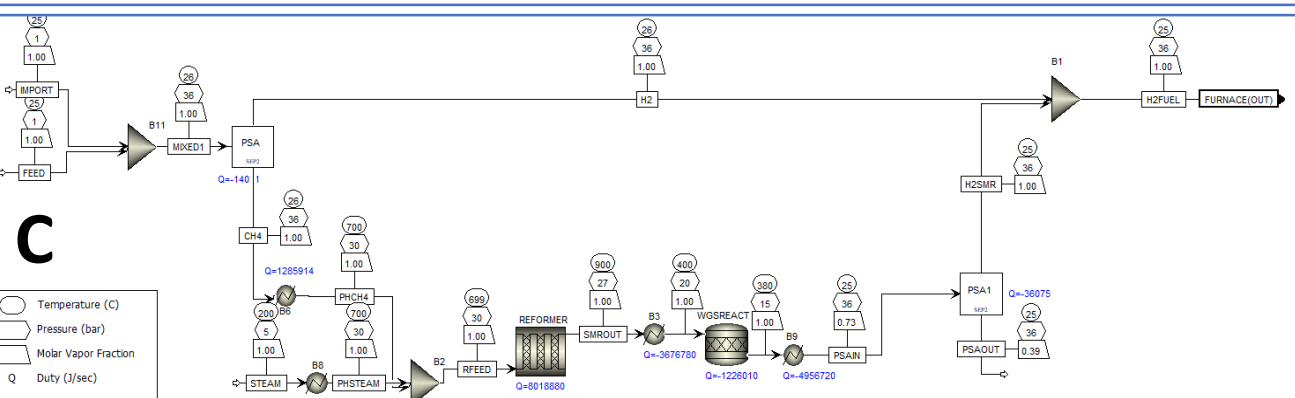
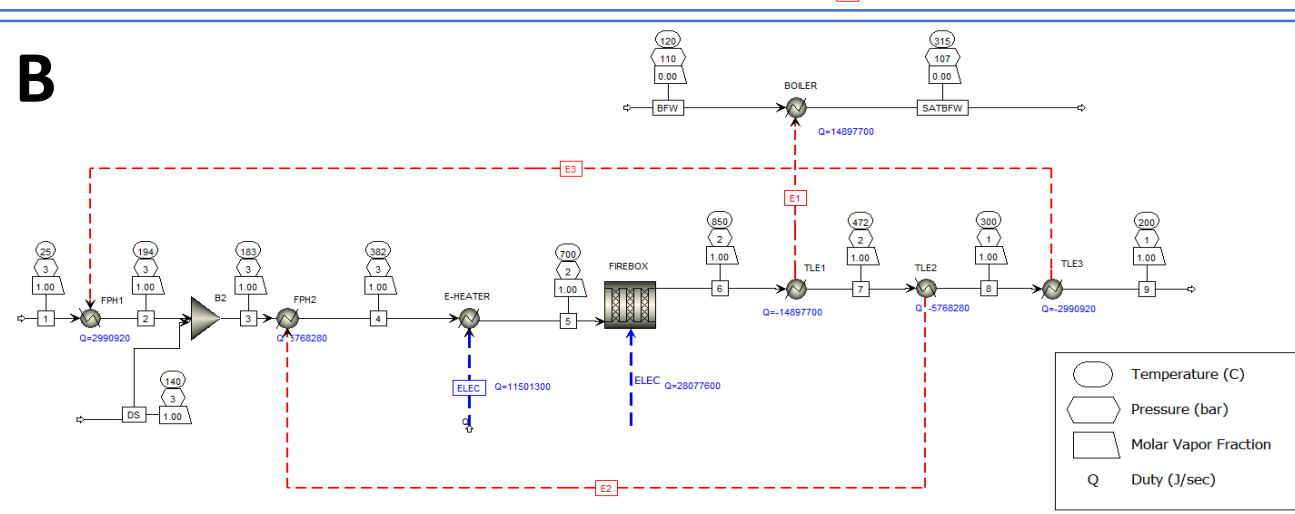
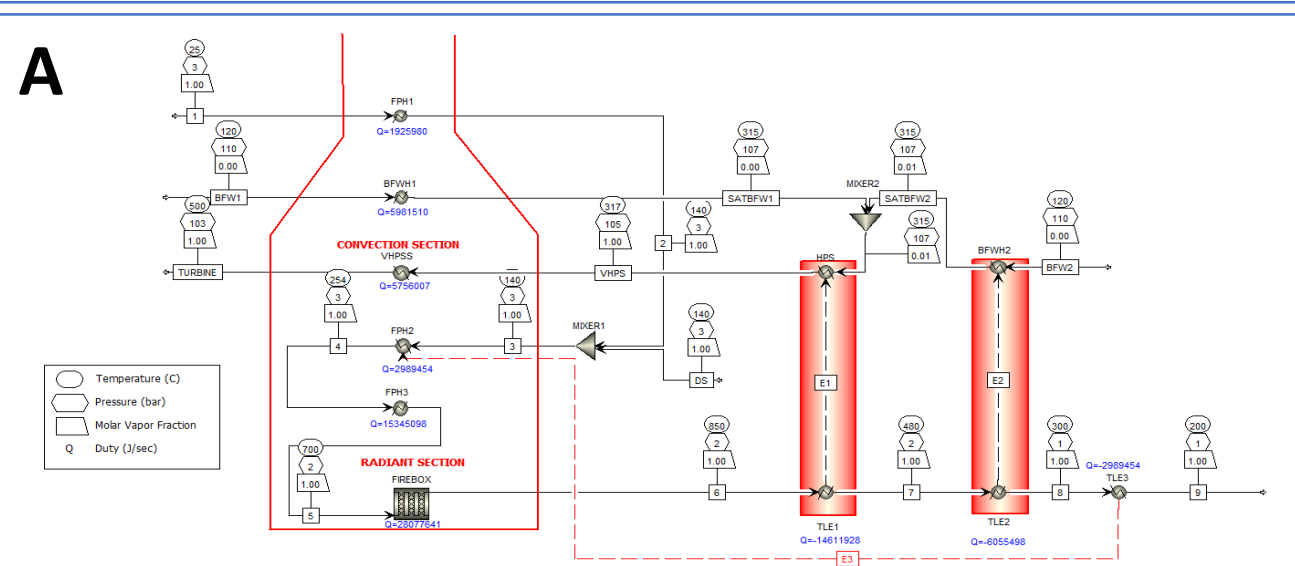
- Specifications**
  - 850°C ≤ Reactor Outlet Temperature ≤ 900°C
  - 200 KTA Furnace Production Capacity.
  - At Least 90% CO<sub>2</sub> Reduction Compared To Conventional Steam Cracking.
  - 0.3/1 ≤ Steam/Ethane Ratio ≤ 0.6/1 for Ethane Pyrolysis.
  - Methane/Steam Ratio = 0.3/1 for SMR.
  - 80mol% H<sub>2</sub>, 20mol% Ch<sub>4</sub> Fuel Gas Composition.
  - 100 MW Solar Power (PV) Plant Capacity.

- Constraints:**
  - No Current Industrial Scale Electric Furnace For Reference.
  - Radical Reactions Modeling Are Tedious, A Molecular Reaction Scheme Was Implemented From Literature Instead.
  - 15-Week Time Limitation.
  - Solar Panels Reliability.
- Deliverables:**
  - Aspen Plus Simulations of 3 Scenarios .
  - Simulink & PVsyst simulation of a Solar PV Power Plant.



- Modeled Scenarios**
  - Conventional gas-fired furnace (for comparison).
  - Electrified furnace (e-Furnace).
  - H<sub>2</sub>-fired furnace using electrified reformer (e-SMR).
  - Electric Solar PV Plant.

### Aspen Plus Simulations:



### Conclusions:

- e-Furnace Powered By Electricity From The Grid Showed The Highest Profit Margin.
- Hydrogen Generated From E-furnace Process Can Be Sold (Price = 5 \$/KgH<sub>2</sub>).
- e-SMR Demonstrates High Potential For Current Steam Cracker Plants Because Its Easy To Retrofit To Existing Steam Crackers, And Requires Less Electricity Per Kg Ethylene.
- Indirect Emissions Are Lower From Solar PV, But Costs More Than The Grid Electricity.