PANDIT DEENDAYAL ENERGY UNIVERSITY

Raisan, Gandhinagar – 382 426, Gujarat, India

B. TECH- Mechanical

Laboratory Manual

Name- Kush Patel

Roll no.- 20BME081

Subject- Industry 4.0 Laboratory

Semester- 5

Submitted to

Department of Chemical Engineering

School of Energy Technology, Pandit Deendayal Energy University

PANDIT DEENDAYAL ENERGY UNIVERSITY

Raisan, Gandhinagar – 380 007, Gujarat, India

Chemical Engineering Department

Certificate

This is to certify that

Mr./Ms. Kush Patel Roll no. 20BME081

Exam No. Lab Submission 4 of 3rd Year B. TECH Degree in

Industry 4.0 has satisfactorily completed his/her term work in Industry 4.0 Laboratory subject during the semester from to at School of Technology, PDEU.

Date of Submission:

Signature:

Faculty In-charge Head of Department

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Name: Kush Patel

Roll No: 20BME081

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Experiment No.: 1

Title:

Design and analysis of solar water heating system using System Advisor Model (SAM)software.

Aim:

Design a SWH system and assess the annual energy saved for a varying water demand of 50 l/day to 300 l/day (interval of 50 l) for a single collector costing Rs. 160000 (2000$) for location as discussed during the session. Calculate the LCOE and Capacity factor for varying water demand and plot the results (w.r.t. varying water demand). Working fluid is water.

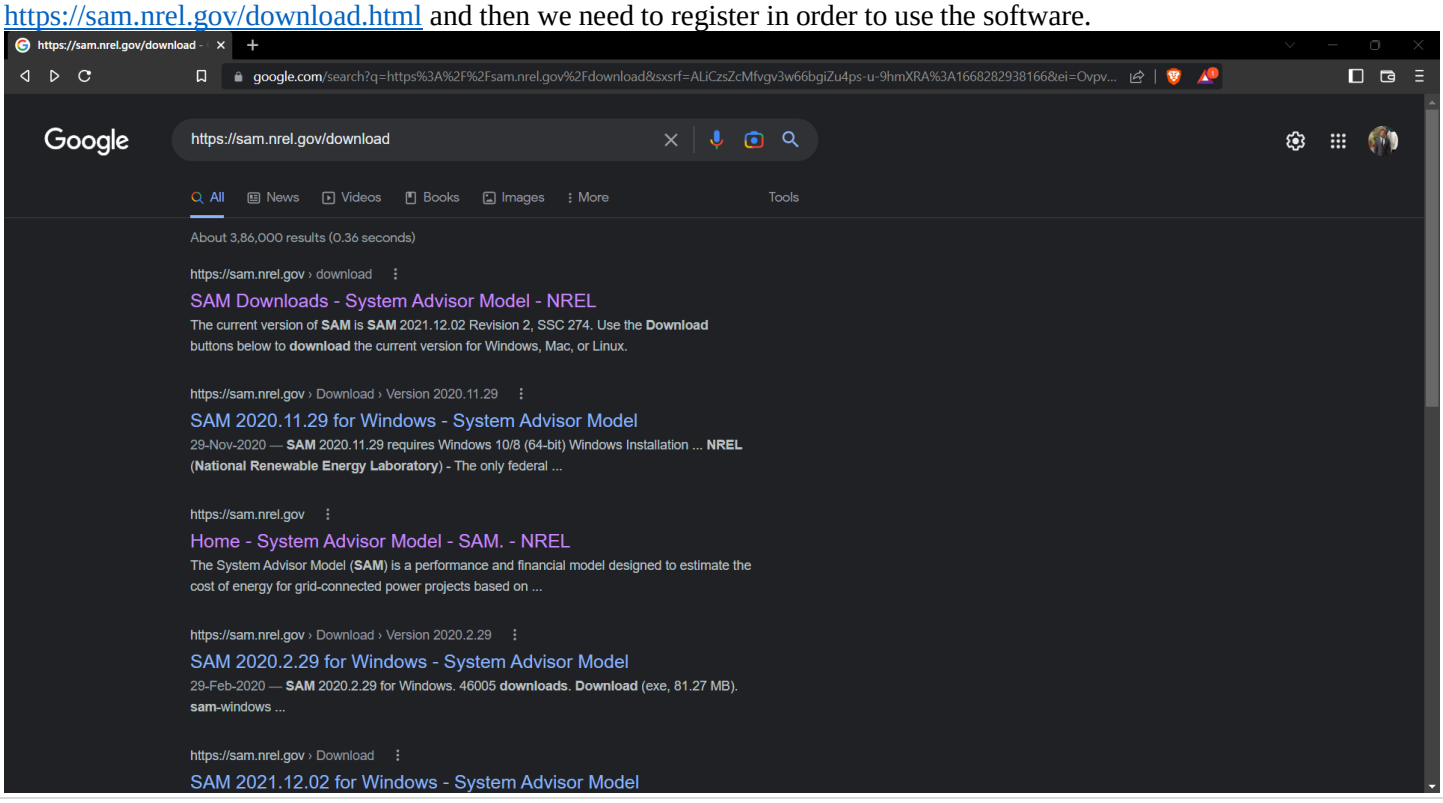
Software Details:

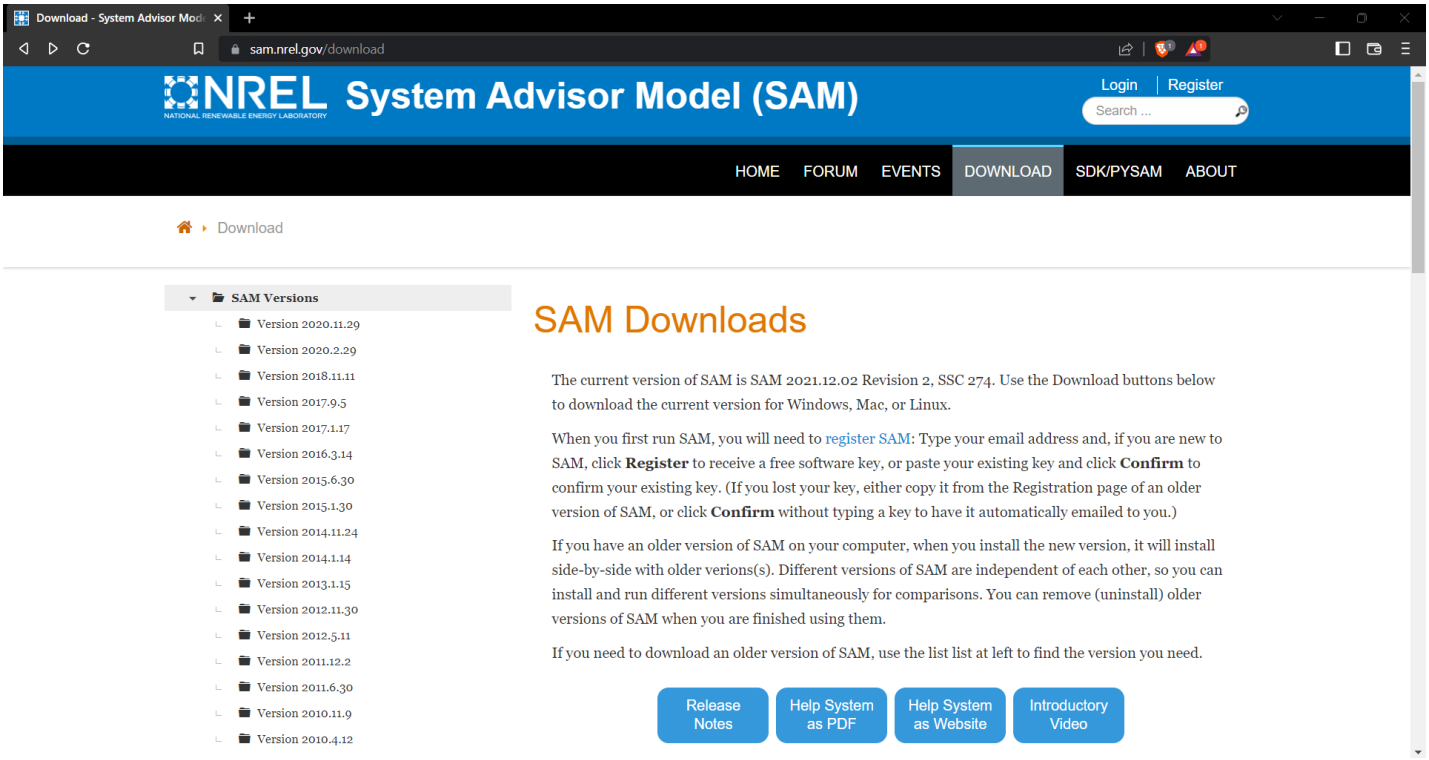
System Advisory Model (SAM) is a free software that enables detailed performance and financial analysis for renewable energy systems.
It is a software used by Lawmakers, Utilities, Developers, Engineers, Researchers and Students to study and analyze renewable energy sources.

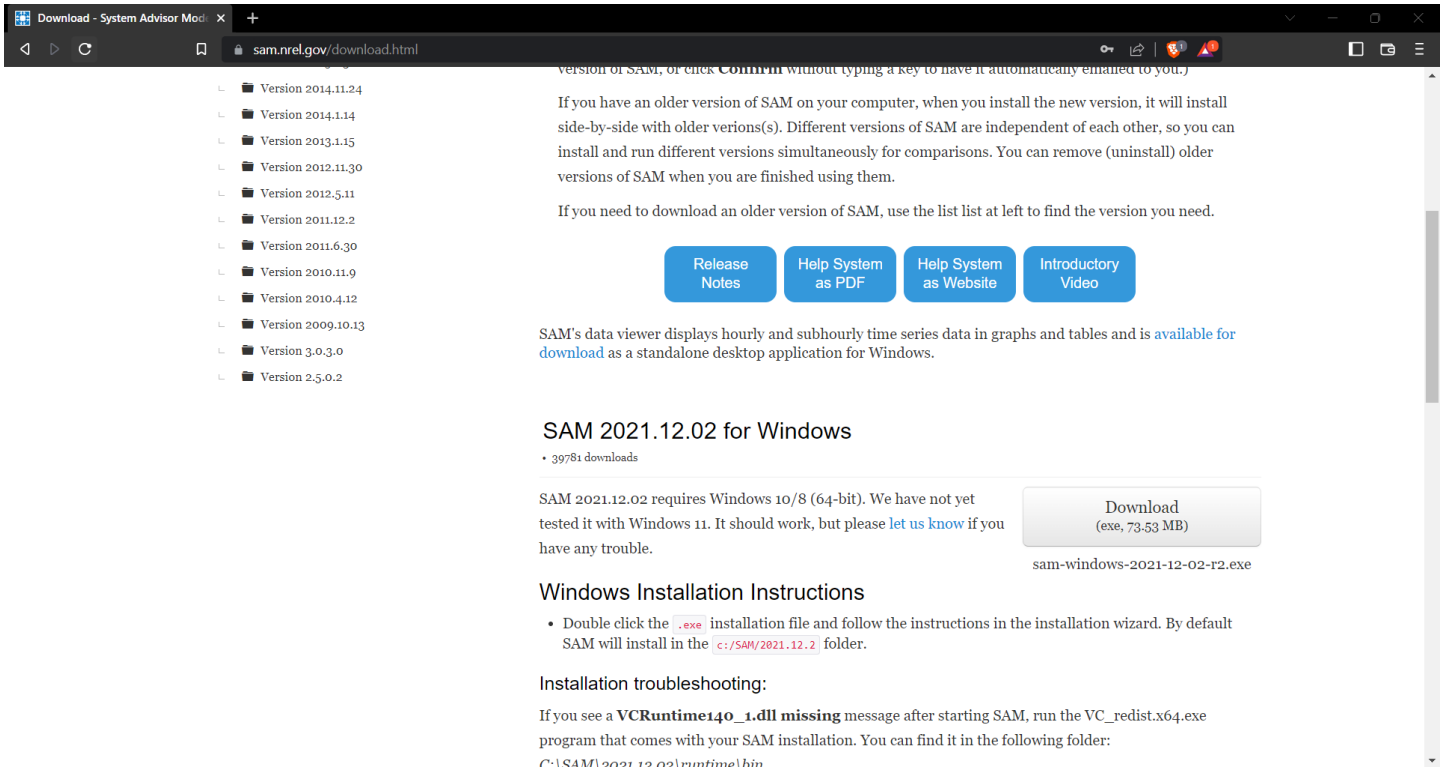
Some important features of SAM are -

- It provides detailed, time-based financial modeling across multiple market sectors,including complex utility rates, combined with detailed performance modeling.
- It is the only publicly available tool with detailed battery model that accounts forvoltage characteristics, calendar and cycle degradation, etc.
- It has built-in parametric, stochastic, probability of exceedance and scripting featuresenable complex questions to be answered quickly and easily.

In order to install SAM software, we have to download and install the software from https://sam.nrel.gov/download.html and then we need to register in order to use the software.

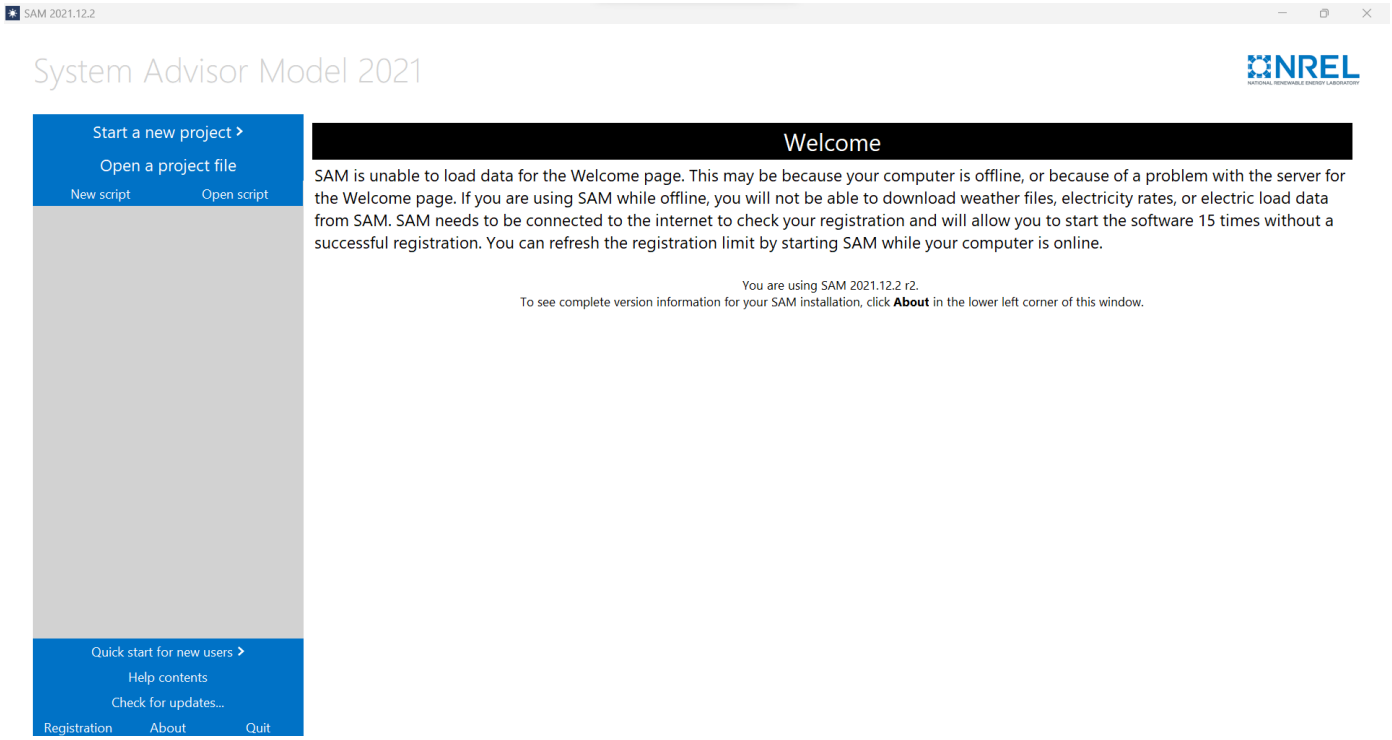


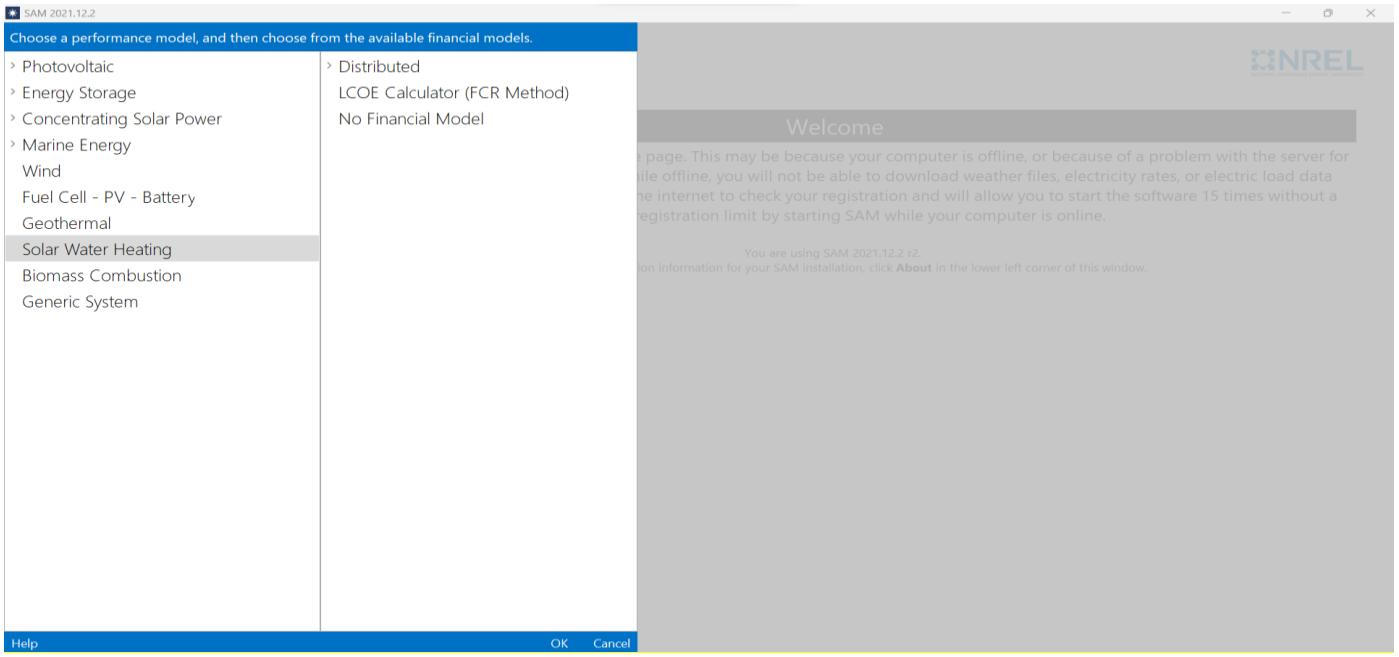




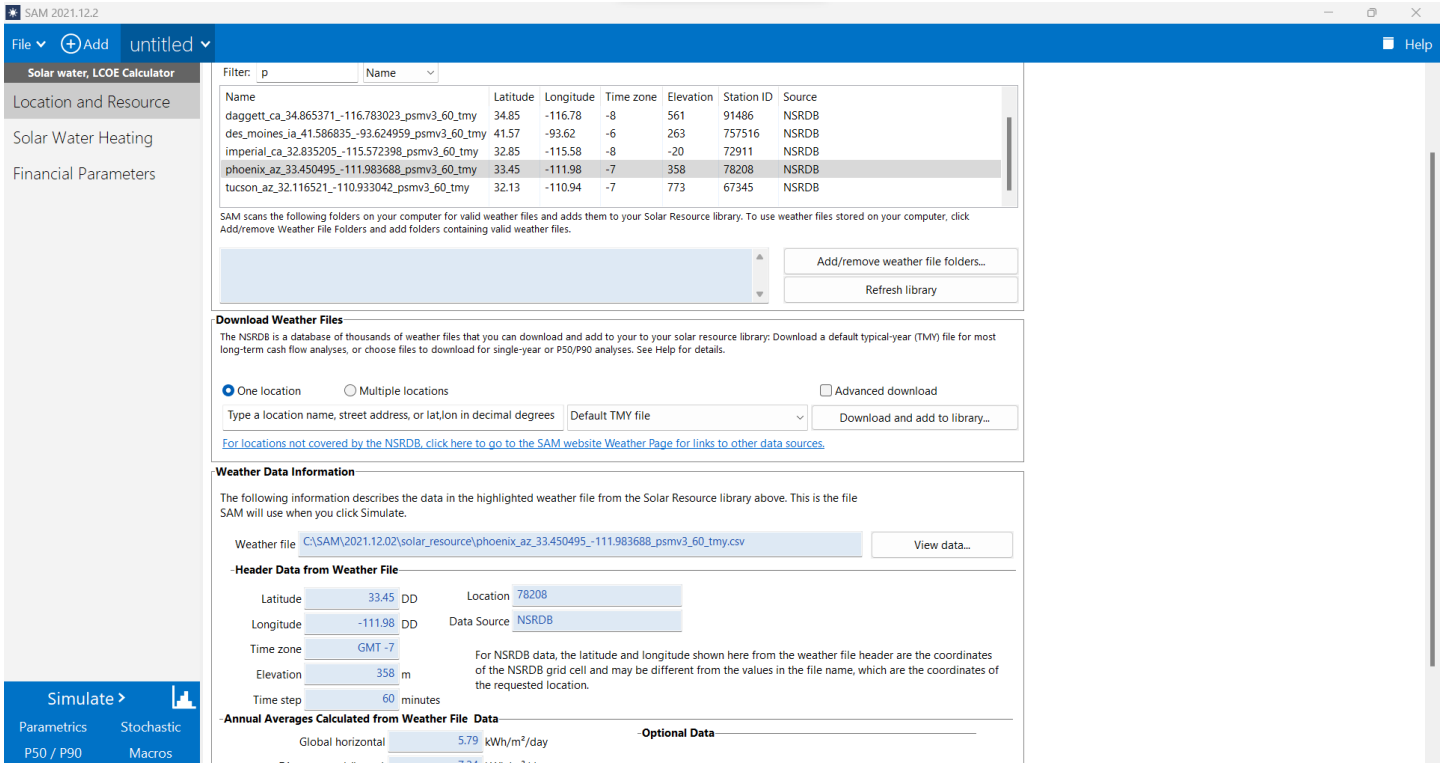
Procedure:

1. Open the software and create new project. Select Solar Water heating system and LCOE calculator.

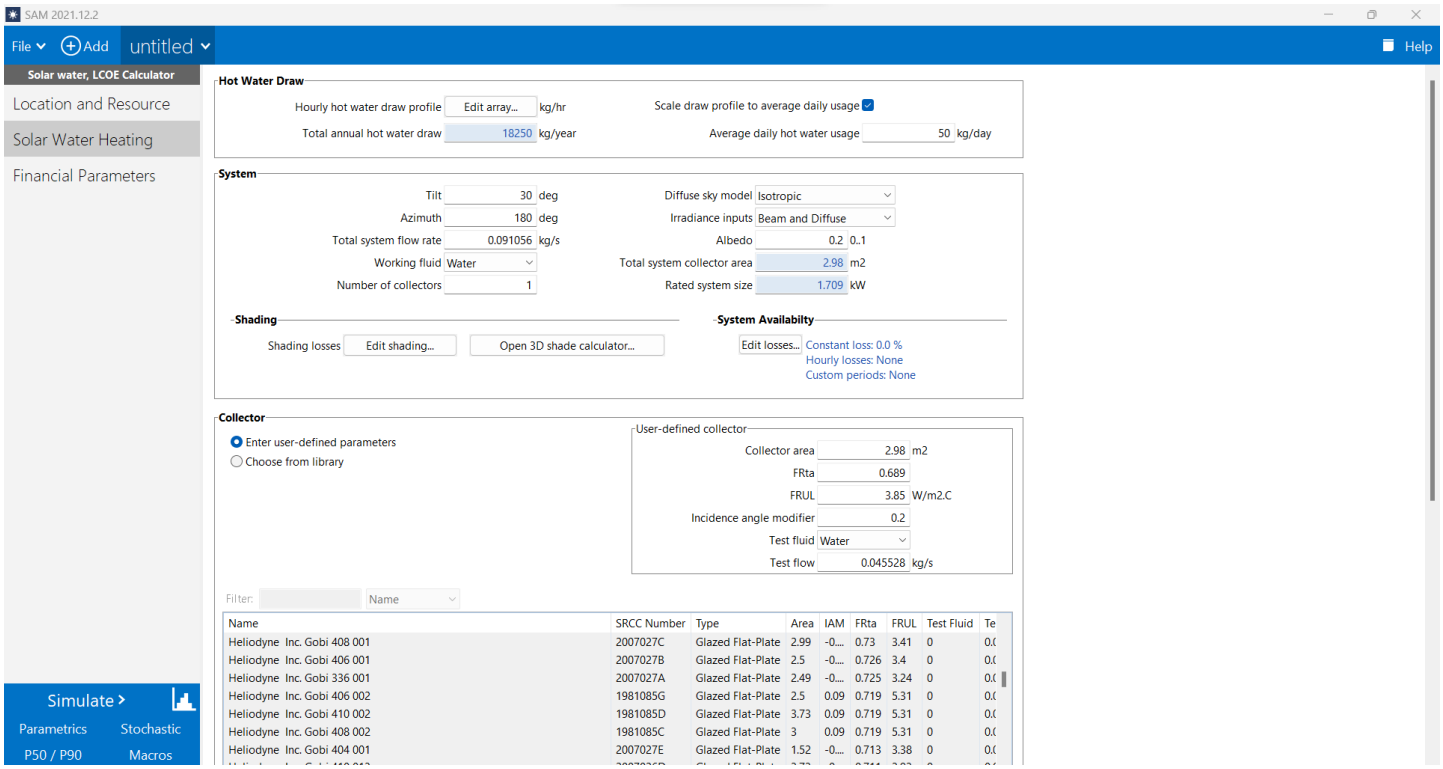




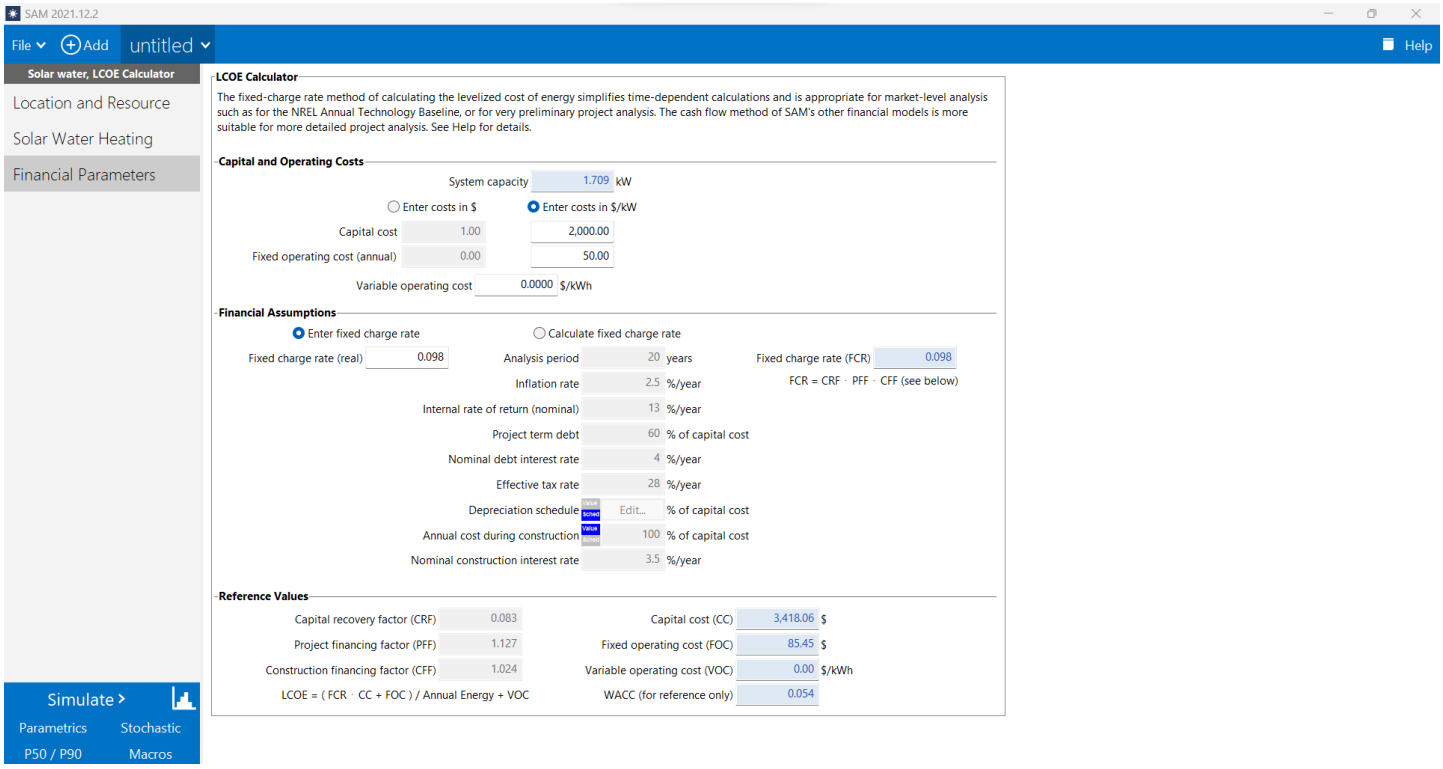
2. **Select location – phoenix**
   Longitude- -111.98
   Latitude- 33.45



3. **Now select Solar Water Heating. Set Working fluid and test fluid as water and no ofcollectors as 1. Set the average daily hot water usage as 50kg/Day.**



4. Go to Financial Parameters. Set the Cost to 2000 $ (1,60,000 ₹).



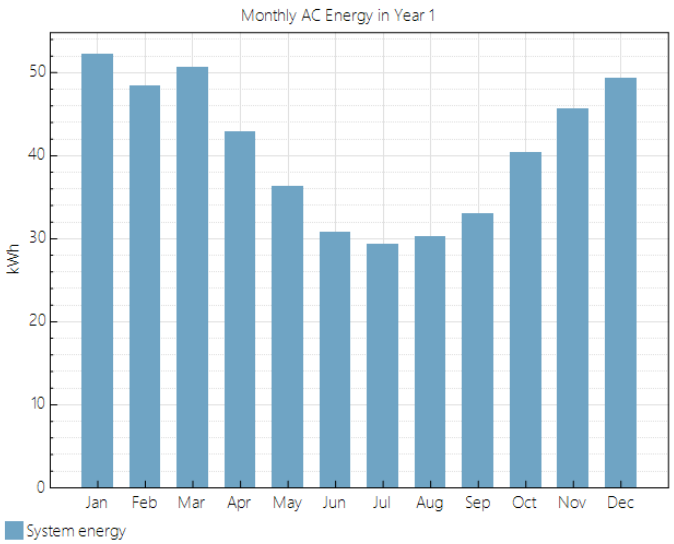
5. **Stimulate and save results.**

6. **Repeat steps 3,4 and 5 for different values of average daily hot water usage (values to betaken as 100,150,200,250 and 300 kg/Day).**

Observation:

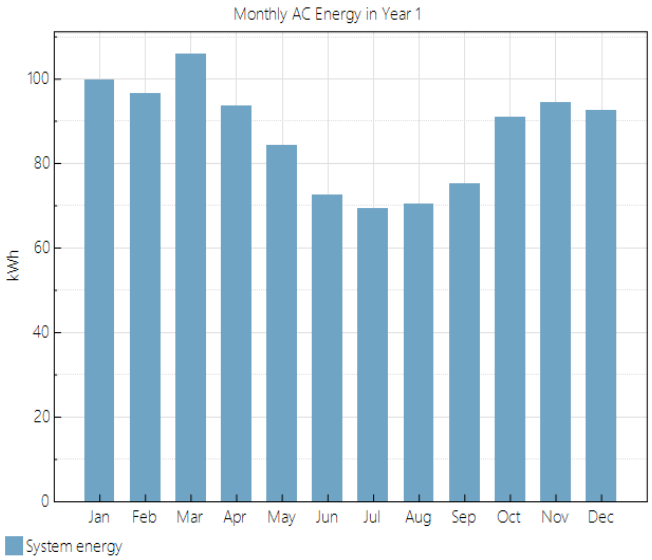
- For 50 Kg/Day

Metric	Value
Annual AC energy saved (year 1)	489 kWh
Solar fraction (year 1)	0.78
Aux with solar (year 1)	12.5 kWh
Aux without solar (year 1)	630.2 kWh
Capacity factor (year 1)	3.3%
LCOE Levelized cost of energy	85.98 ¢/kWh



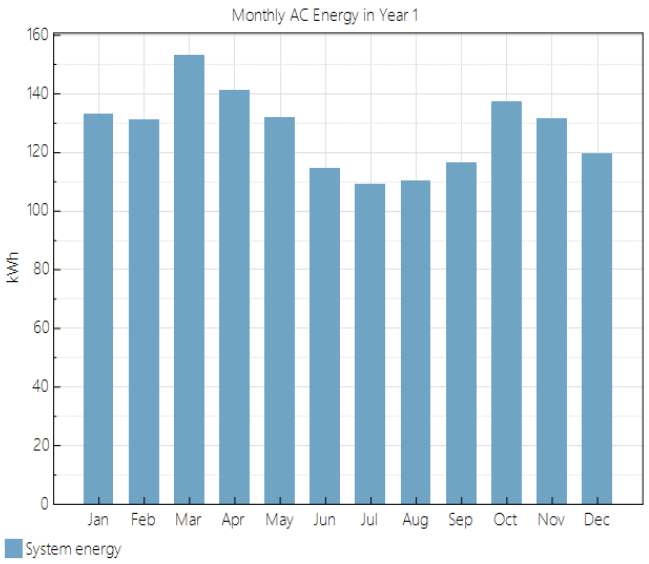
- For 100 Kg/Day

Metric	Value
Annual AC energy saved (year 1)	1,046 kWh
Solar fraction (year 1)	0.83
Aux with solar (year 1)	77.1 kWh
Aux without solar (year 1)	1,260.4 kWh
Capacity factor (year 1)	7.0%
LCOE Levelized cost of energy	40.21 ¢/kWh



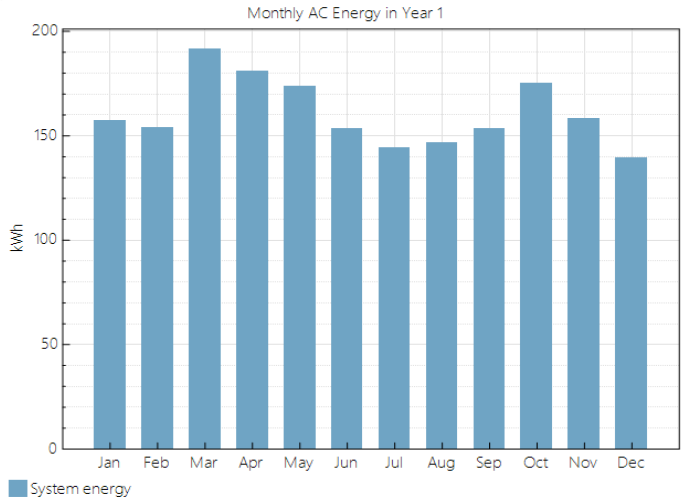
- For 150 Kg/Day

Metric	Value
Annual AC energy saved (year 1)	1,528 kWh
Solar fraction (year 1)	0.81
Aux with solar (year 1)	220.5 kWh
Aux without solar (year 1)	1,890.6 kWh
Capacity factor (year 1)	10.2%
LCOE Levelized cost of energy	27.51 ¢/kWh



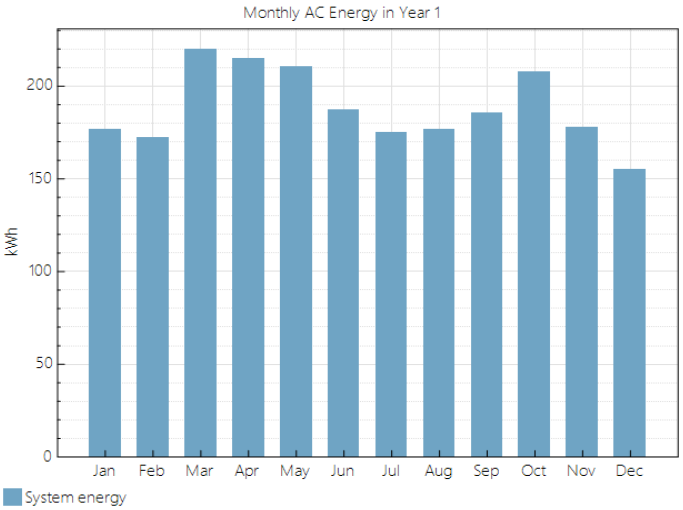
- For 200 Kg/Day

Metric	Value
Annual AC energy saved (year 1)	1,928 kWh
Solar fraction (year 1)	0.76
Aux with solar (year 1)	448.2 kWh
Aux without solar (year 1)	2,520.8 kWh
Capacity factor (year 1)	12.9%
LCOE Levelized cost of energy	21.81 ¢/kWh



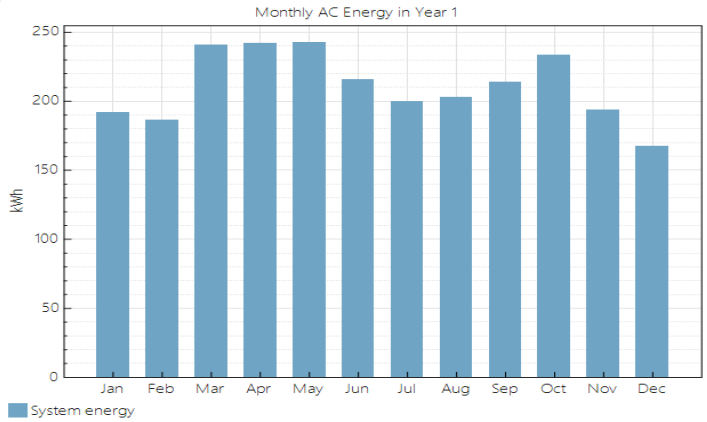
- For 250 Kg/Day

Metric	Value
Annual AC energy saved (year 1)	2,258 kWh
Solar fraction (year 1)	0.72
Aux with solar (year 1)	745.7 kWh
Aux without solar (year 1)	3,151.0 kWh
Capacity factor (year 1)	15.1%
LCOE Levelized cost of energy	18.62 ¢/kWh



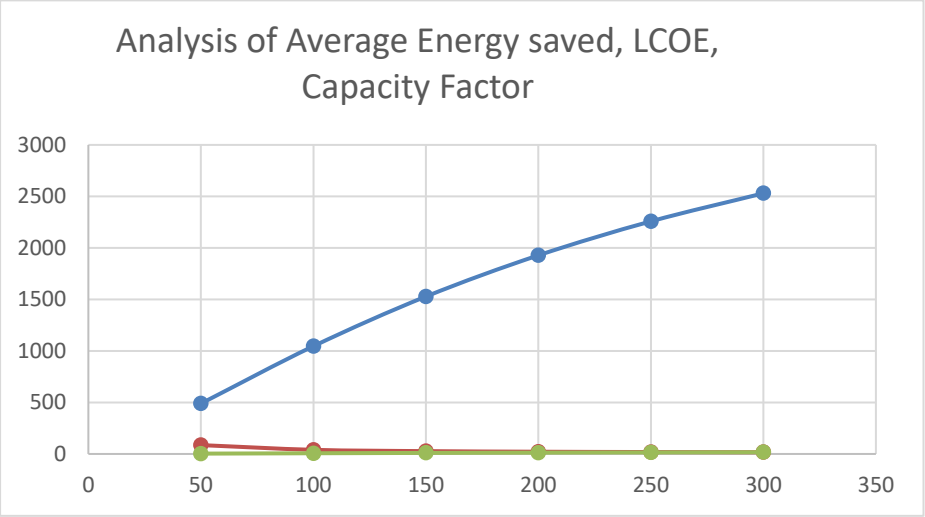
- For 300 Kg/Day

Metric	Value
Annual AC energy saved (year 1)	2,530 kWh
Solar fraction (year 1)	0.67
Aux with solar (year 1)	1,102.0 kWh
Aux without solar (year 1)	3,781.2 kWh
Capacity factor (year 1)	16.9%
LCOE Levelized cost of energy	16.62 ¢/kWh



Result:

Average Daily Hot Water usage (kg/Day)	Annual Energy Saved (kWh)	Levelized Cost of Energy (LCOE) ($/kWh)	Capacity Factor (Percentage)
50	489	85.98	3.3
100	1046	40.21	7
150	1528	27.51	10.2
200	1928	21.81	12.9
250	2258	18.62	15.1
300	2530	16.62	16.9



Discussion and Conclusions:

- When the average water usage is 50 kg/Day, the annual saved energy is 489 kWh andat average water usage of 300 kg/Day, the energy saved annually is 2530 kWh. On observing the trend, we can say that the annual energy saved increases with increase in the average daily hot water usage.
- The Levelized Cost of Energy (LCOE) at water usage of 50 and 300 kg/Day are 85.98and 16.62 $/kWh respectively. Therefore, we can say that the LCOE values decreaseswith increase in daily water usage.
- The capacity factor increases with more hot water usage. At water usage of 50 and300 kg/Day, the values of capacity factor are 3.3 and 16.9 respectively.