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“MARLOG 13”

Towards
Smart Green Blue
Infrastructure

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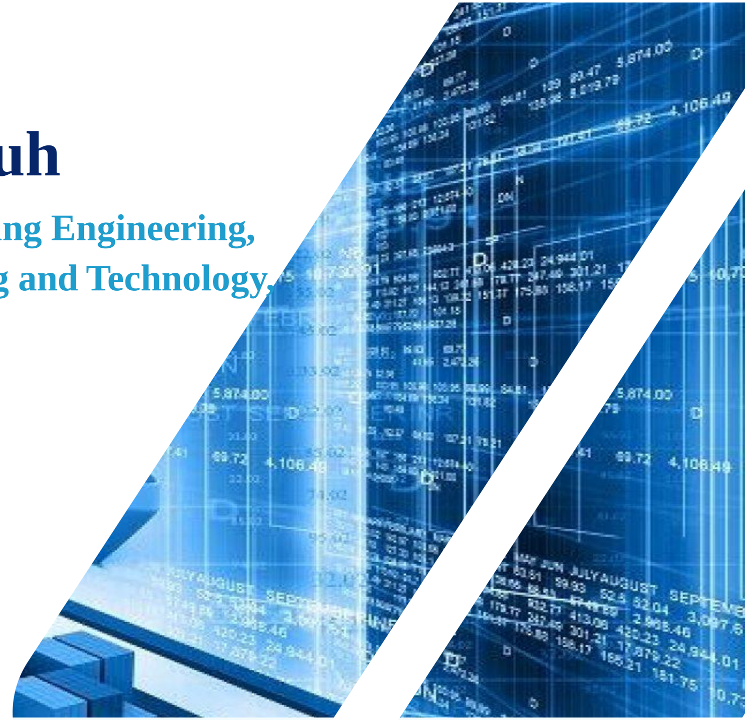

ENERGY MANAGEMENT OPTIMIZATION BASED ON FACILITIES LAYOUT PLANNING FOR PORT CONSTRUCTION: MEDITERRANEAN REGION CASE STUDY

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Content:

1.Introduction:

- Rapid growth in construction projects.
- Crucial role of ports in the global economy.
- Sustainability concept in ports.
- Facility layout management and Homer software are essential for green and sustainable ports.

Figure 1: Hamburg port on shore power supply project

Figure 2: Port of Helsinki – Carbon Neutral Port 2035

Figure 3:Port of Genoa – Onshore Power Supply

Survey

In 2016 Nain,Iran

In order to meet load demands, their research focused on optimizing storage systems and renewable energy sources. They didn't consider any aspects other than cost while selecting an optimal solution.

In 2017 Ecuador

This research worked on two scaling approaches for a hybrid generation system that are being investigated using fundamental equations, and a homer optimizer. In order to construct two systems taking in account financial and environmental aspects only

In 2018 denmark

This research worked on the ideal energy planning system for Copenhagen seaport, according to a case study the prevailing tendency was financial and environmental aspects

Gap analysis

This research revealed that the most prevalent subjects were financial and environmental issues, and no previous research had focused on how important site layout and facility management are. In this study, the port site layout and facility management take into account the least amount of area and maximum amount of energy needed.

2. Aim and objectives of the research :

- The aim of this research is to convert an existing port to a green port through energy savings using solar and wind energy using Homer software to obtain an optimal port construction facility layout with minimum cost, area, and gas emissions.

3. Methodology :

a. Describe the study area and its location.

- The study takes place in a port in the Mediterranean. The Mediterranean region has a good climate, where wind and sun are plentiful most days of the year, making it appropriate for the production of renewable energy.

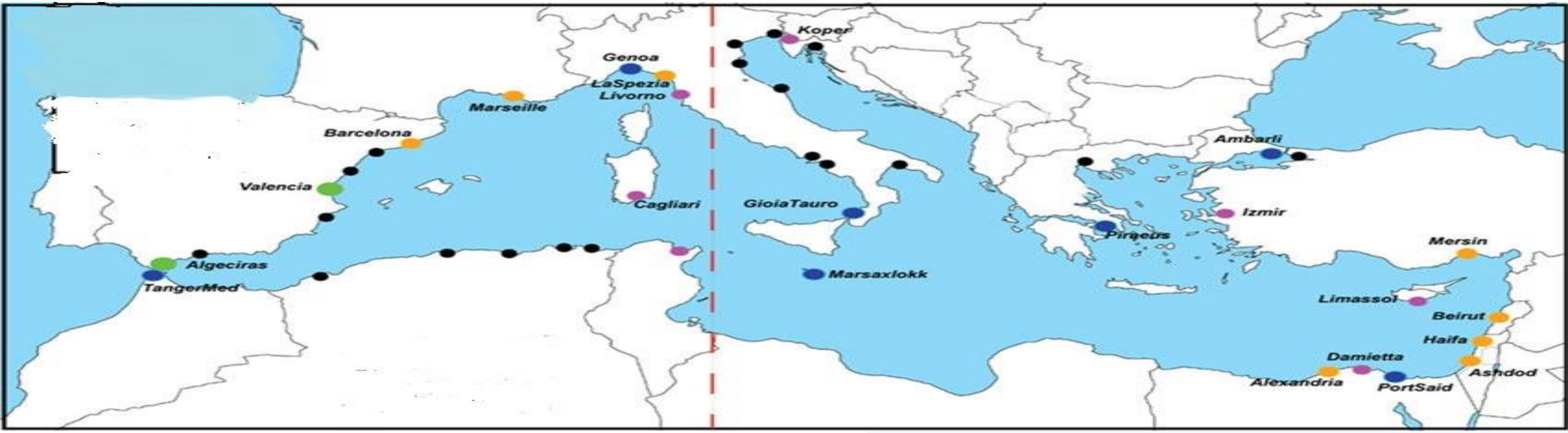

Figure 4:the main Mediterranean Ports

b. overview of study models.

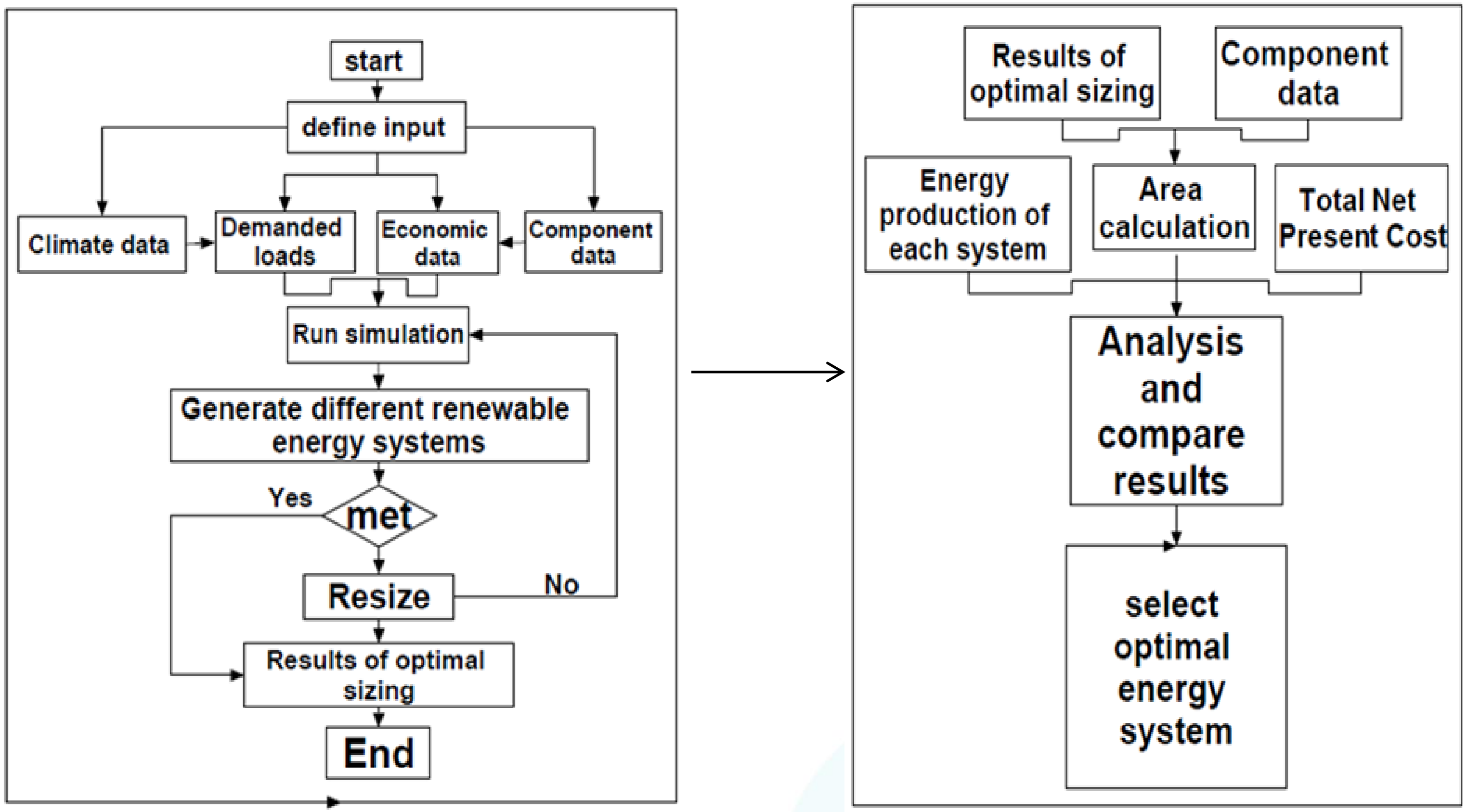

Figure 5: Flowchart showing the steps of the suggested study model.

c. Resources evaluation and load profile.

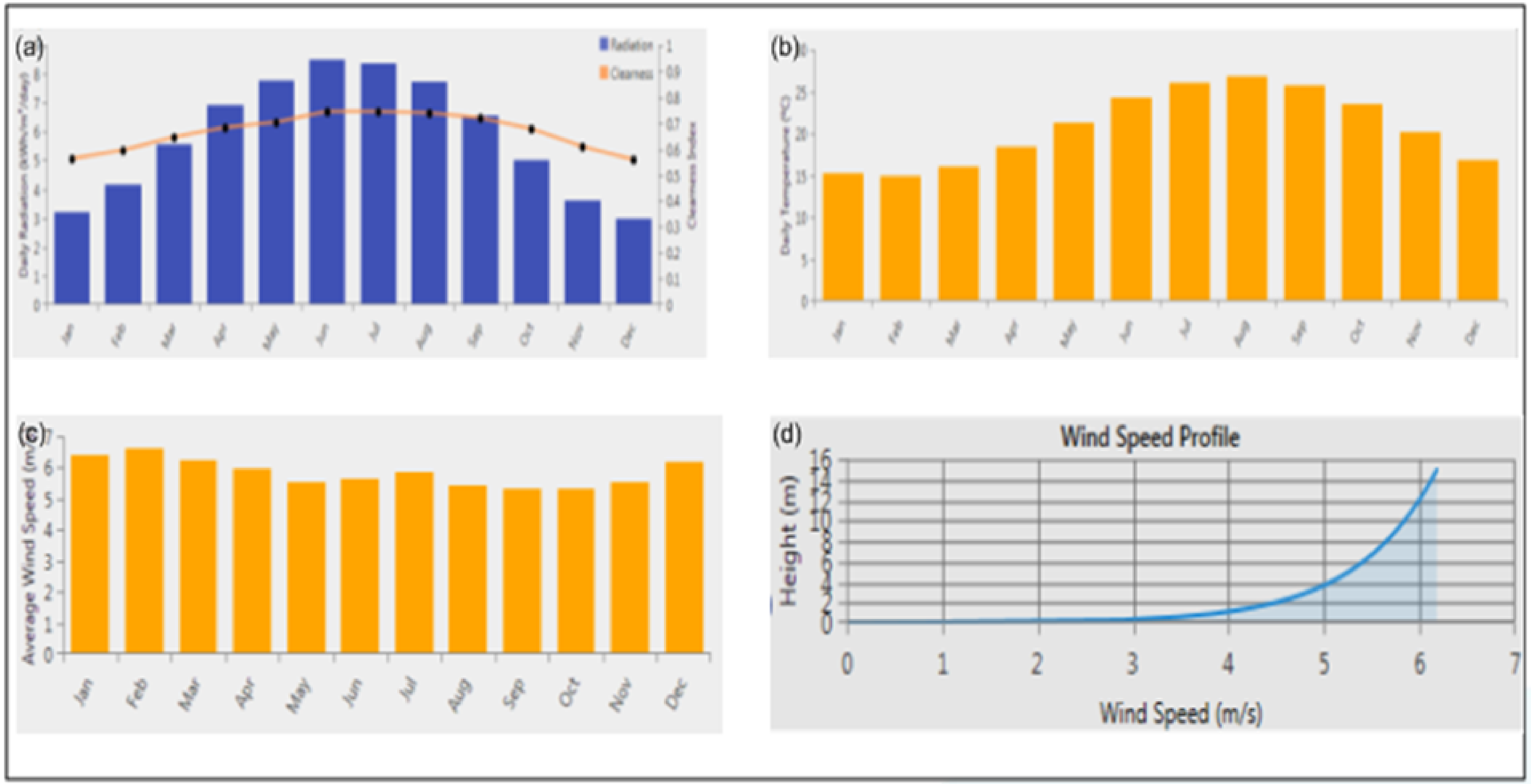

Figure 6: a) Average monthly daily clearance index and radiation, b) Average monthly daily temperature, c) Average monthly wind speed, d) wind speed profile

d. HOMER optimization and simulation.

$$P_{PV} = Y_{PV} f_{PV} \left(\frac{\overline{G}_T}{\overline{G}_{T,STC}} \right) \left[1 + \alpha_P \left(T_c - T_{c,STC} \right) \right] \quad (1)$$

PV array's output power.

$$U_{hub} = U_{anem} \cdot \left(\frac{Z_{hub}}{Z_{anem}} \right)^{\alpha} \quad (2)$$

The wind speed at the wind turbine hub height.

$$P_{WTG} = \left(\frac{\rho}{\rho_0} \right) \cdot P_{WTG,STP} \quad (3)$$

The amount of electricity the wind turbine generates

$$P_{batt,dmax,kbm} = \frac{-kcQ_{max} + kQ_1 e^{-k\Delta t} + Qkc\left(1 - e^{-k\Delta t}\right)}{1 - e^{-k\Delta t} + c\left(k\Delta t - 1 + e^{-k\Delta t}\right)} \quad (4)$$

The maximum power that the storage bank can discharge.

$$P_{batt,cmax,kbm} = \frac{kQ_1 e^{-k\Delta t} + Qkc\left(1 - e^{-k\Delta t}\right)}{1 - e^{-k\Delta t} + c\left(k\Delta t - 1 + e^{-k\Delta t}\right)} \quad (5)$$

The maximum amount of power that the storage bank is capable of storing.

d. HOMER optimization and simulation.

scenario (s)	**hybrid renewable energy system**
s1	PV/converter/grid
s2	PV/converter/battery
s3	wind/converter/battery
s4	wind/grid
s5	50 % PV/50 % wind/battery/converter
s6	50 % PV/50 % wind/grid/converter
s7	25 % PV/ 75 % wind/battery/converter
s8	25 % PV/ 75 % wind/grid/converter
s9	75 % PV/ 25 % wind/battery/converter
s10	75 % PV/ 25 % wind/grid/converter

Table 1. Hybrid renewable energy scenarios

e. area calculations.

I. PV

The research utilizes PV units from the same manufacturer to produce 1 kwh, measuring the footprint in m^2, indicating the area needed for each scenario.

II. Wind turbines.

The research employs different units of wind turbines from the same manufacturer, using rotor diameter to calculate area. The distance between turbines is 10 times the diameter along the wind direction and 3 times the diameter perpendicular.

4. RESULTS AND DISCUSSIONS.

a. Economic results from Homer

The HOMER modelling program was utilized to calculate hybrid renewable energy systems using 10 scenarios. The minimum total net present cost (NPC) results showed that scenario number 4 (S4), which contains a grid, has a lower NPC than scenario number 2 (S2), which contains batteries.

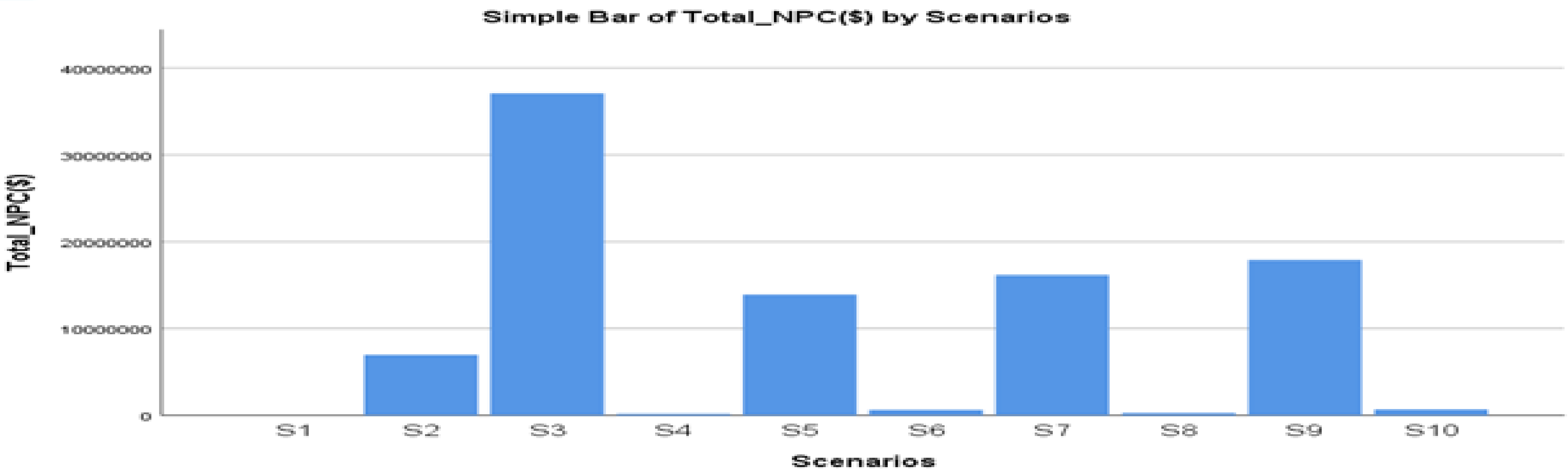

Figure 7 : chart of the total net present cost in the 10 scenarios

- This research finds that the cost of energy refers to the same result as the previous figure, which refers to scenario number 4 (S4), and scenario number 2 (S2) has the lowest energy cost ($/kwh).

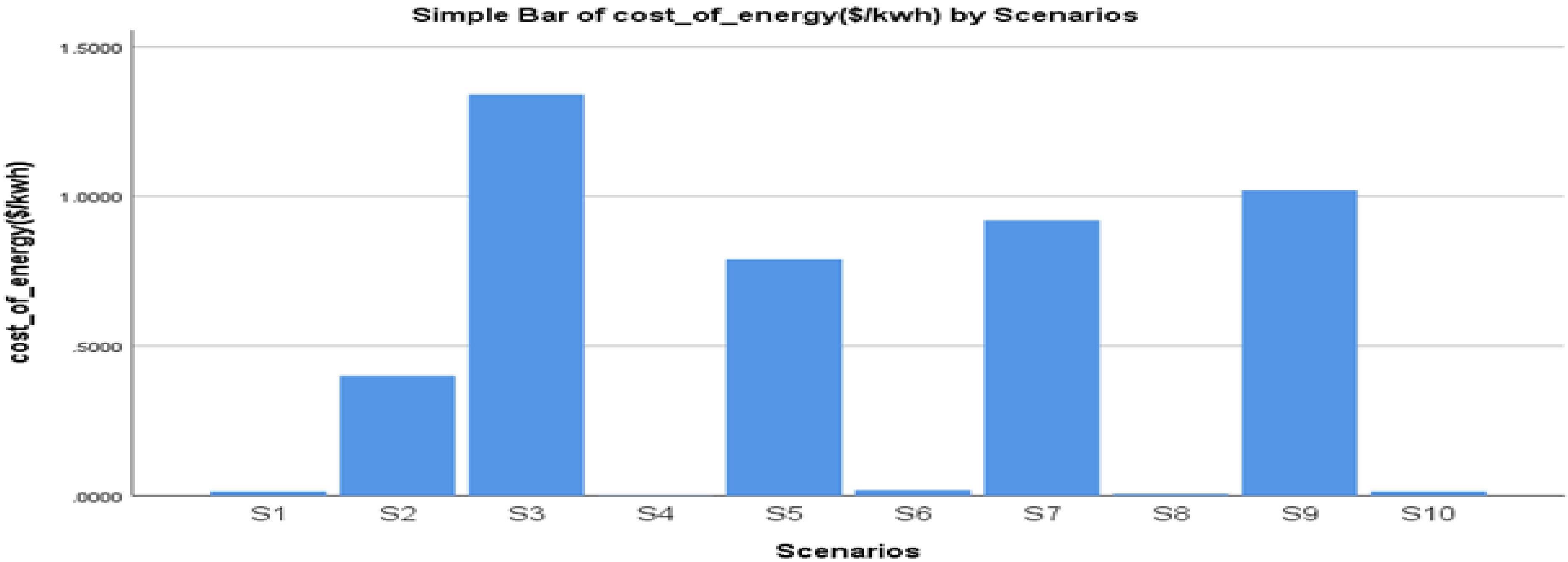

Figure 8 : chart of the cost of energy in the 10 scenarios

b. Environmental results from Homer

In this research, all scenarios use renewable energy sources as the region of the study has good weather most of the year, which gives the chance to use PV and wind turbines. Renewable energy scenarios that use batteries record zero emissions, but scenarios that use grids cause carbon dioxide emissions.

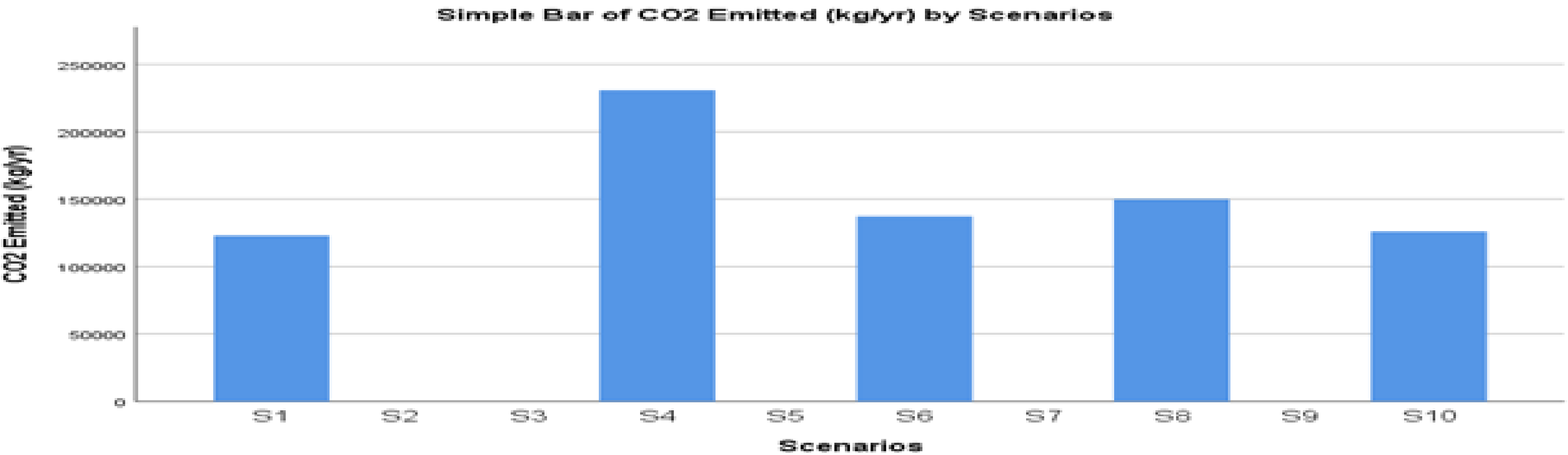

Figure 9 : chart of CO2 emitted in the 10 scenarios

c. Area results

One of the aims of this study is to obtain the optimum facility layout taking into consideration the area of each scenario as one of the criteria for identifying the optimal renewable energy system. the minimum area S1 and S2.

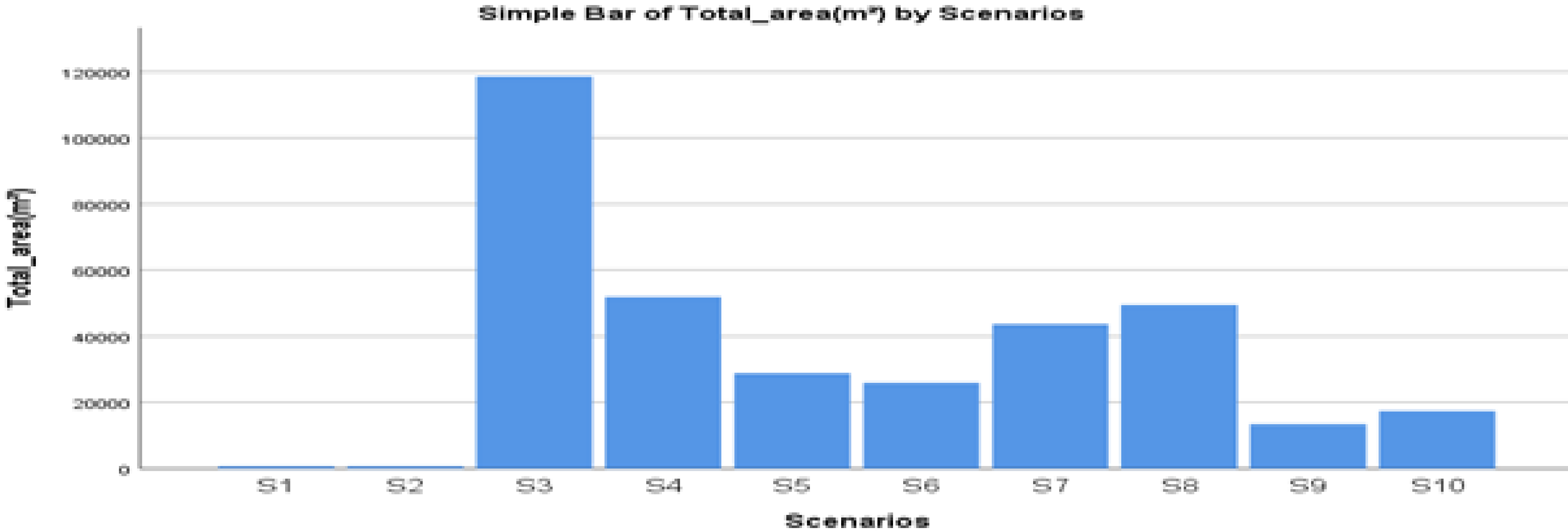

Figure 10 : chart of area in the 10 scenarios

5. Conclusion :

- The study uses three stages: cost analysis, area calculation, and comparison of outputs.
- cost analysis resulted S2 and S4 offer the most economical net present costs and energy costs.
- area calculation shows the minimum area S1 and S2.
- Renewable energy scenarios that use batteries record zero emissions.
- The research demonstrates the inverse relationship between area and energy production in optimal construction facility layout management.

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