DESIGN OF A HOT-WATER SUPPLY SYSTEM FOR PRIMARY HEALTH CENTER IN LEKKI, LAGOS, NIGERIA

Sustainable Renewable Energy Technologies

Supervisor –
Dr. Herena Torio

Presented By:

- **Kayode Awonugba**
- **Dinesh Papal**
- **Rajasekar Reddy**

https://www.sonnewindwaerme.de/solarthermie/freeware-berechnung-solaren-luftkollektorfeldern

OUTLINE

- Motivation
- Project Demographic details
- System Layout
- Environmental Conditions
- Project Descriptions
- Solar Collector Model Selection
- Sensitivity Analysis

MOTIVATION

- Harnessing of potential solar energy at the project location.
- Going green by switching from conventional to renewable energy sources.
- Potentiality to meet hot water demand from available natural resources.
- Negligible operational and minimum maintenance.
- Economically viable option for primary health care centres.

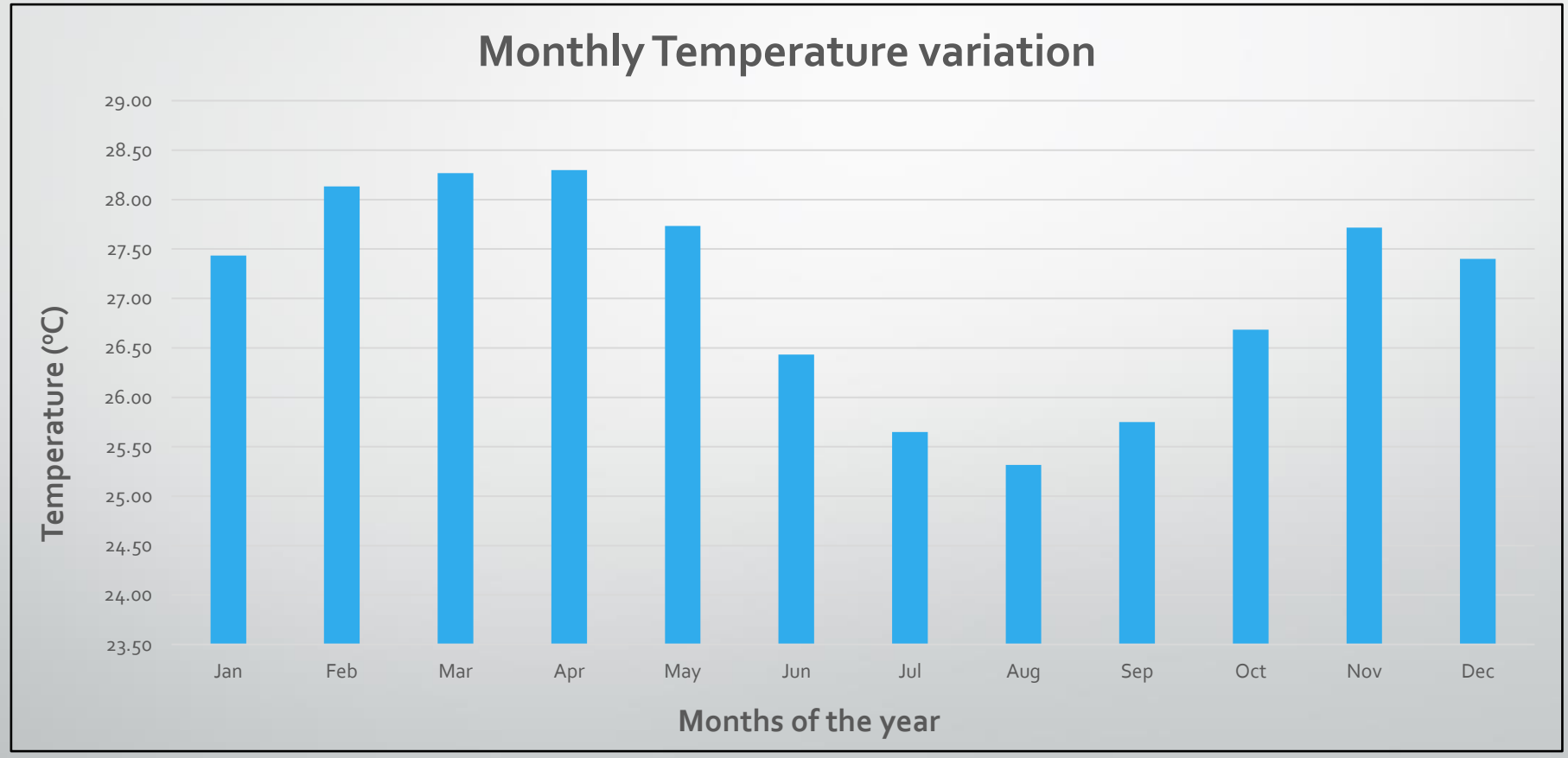
PROJECT DEMOGRAPHICS DETAILS

- Location: Lekki, Lagos, Nigeria (Latitude: 6.452 , Longitude: 3.494)
- Source of irradiance database - PVGIS-SARAH 2

Primary Health Care Centre

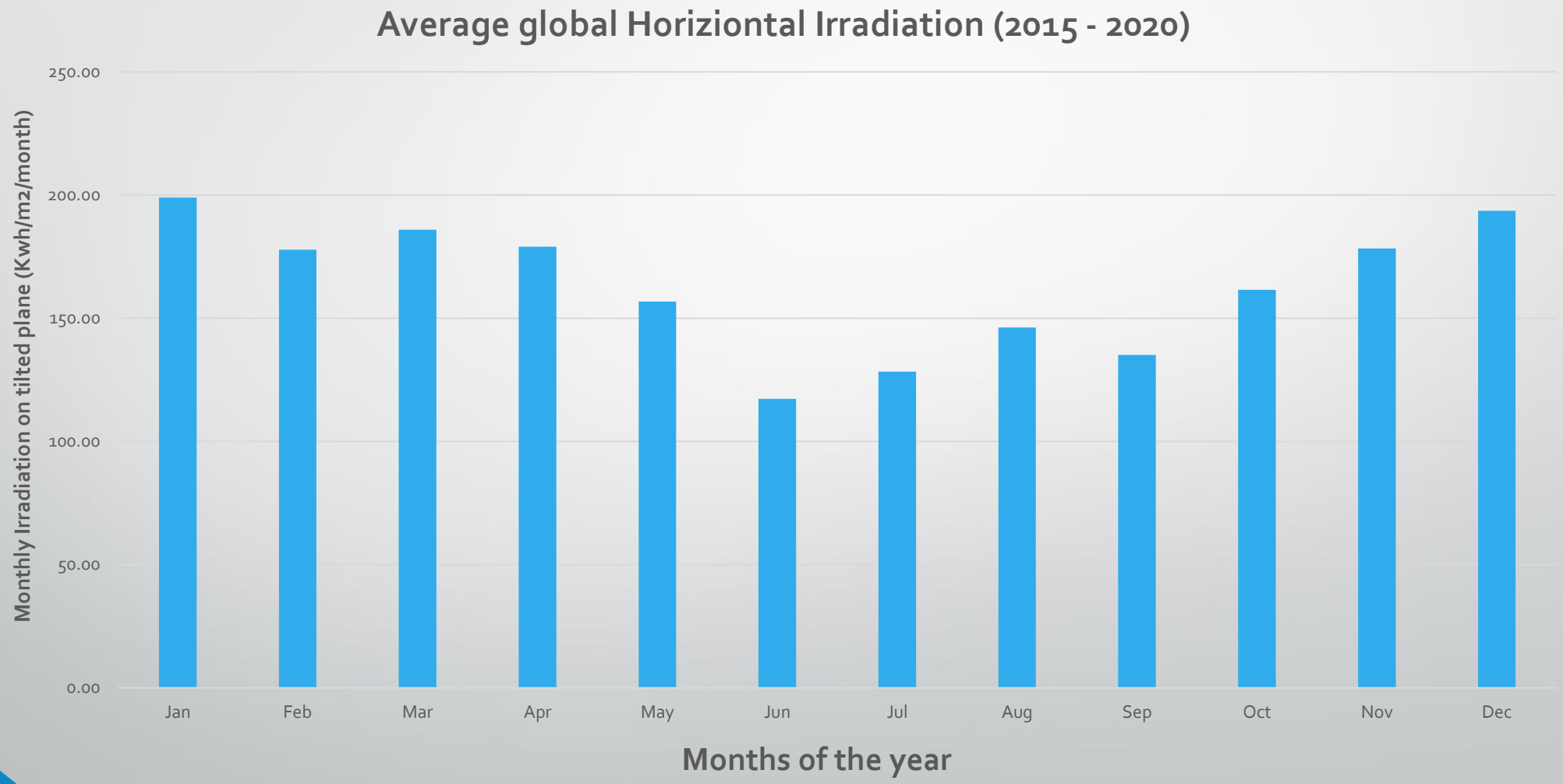
ENVIRONMENTAL CONDITIONS IN LEKKI

- Monthly average ambient temperature (2015 – 2020)



ENVIRONMENTAL CONDITIONS IN LEKKI

- Monthly average horizontal irradiation



PROJECT DESCRIPTION

❑ Application Type:

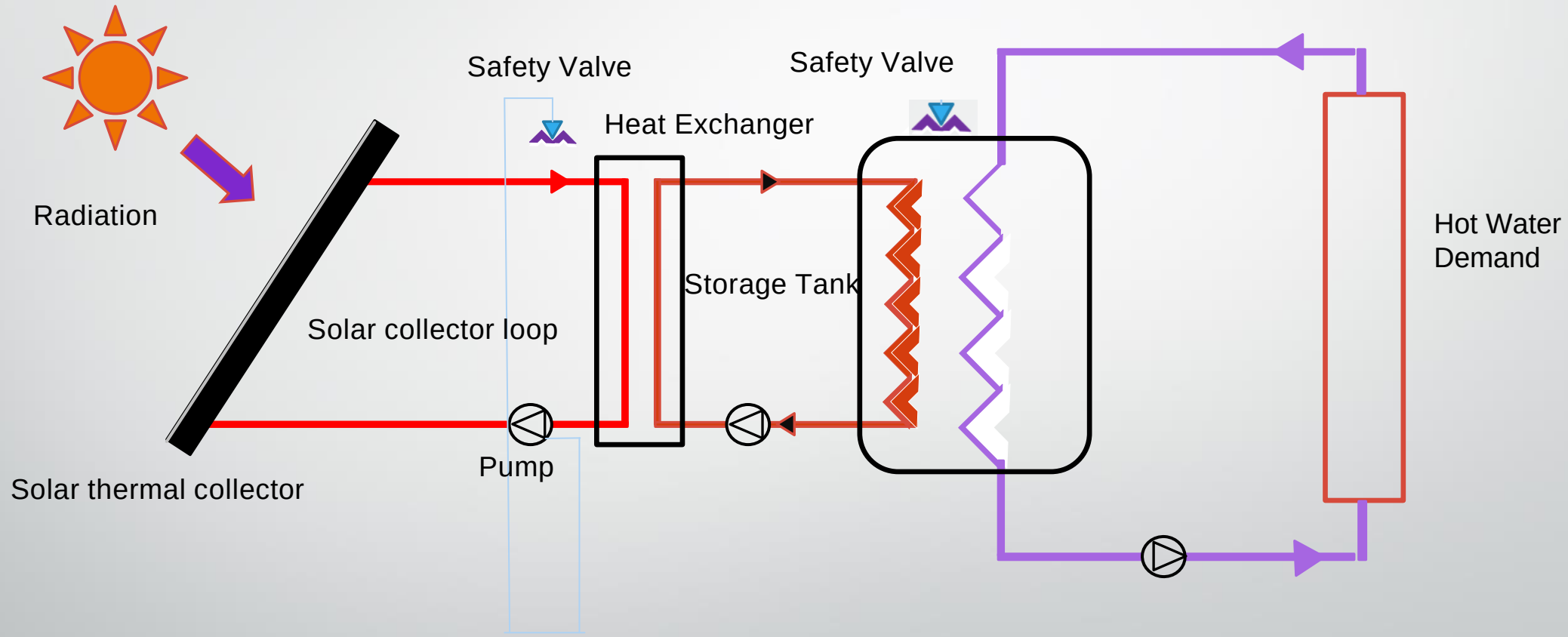
❑ Hot water supply system

- Outlet Temperature for DHW system = 50°C,
- Inlet Temperature = 22°C (Winter) and 27°C (Summer)

❑ Building Characteristic:

- primary health care centre
- 4 person max at any given time

System Layout



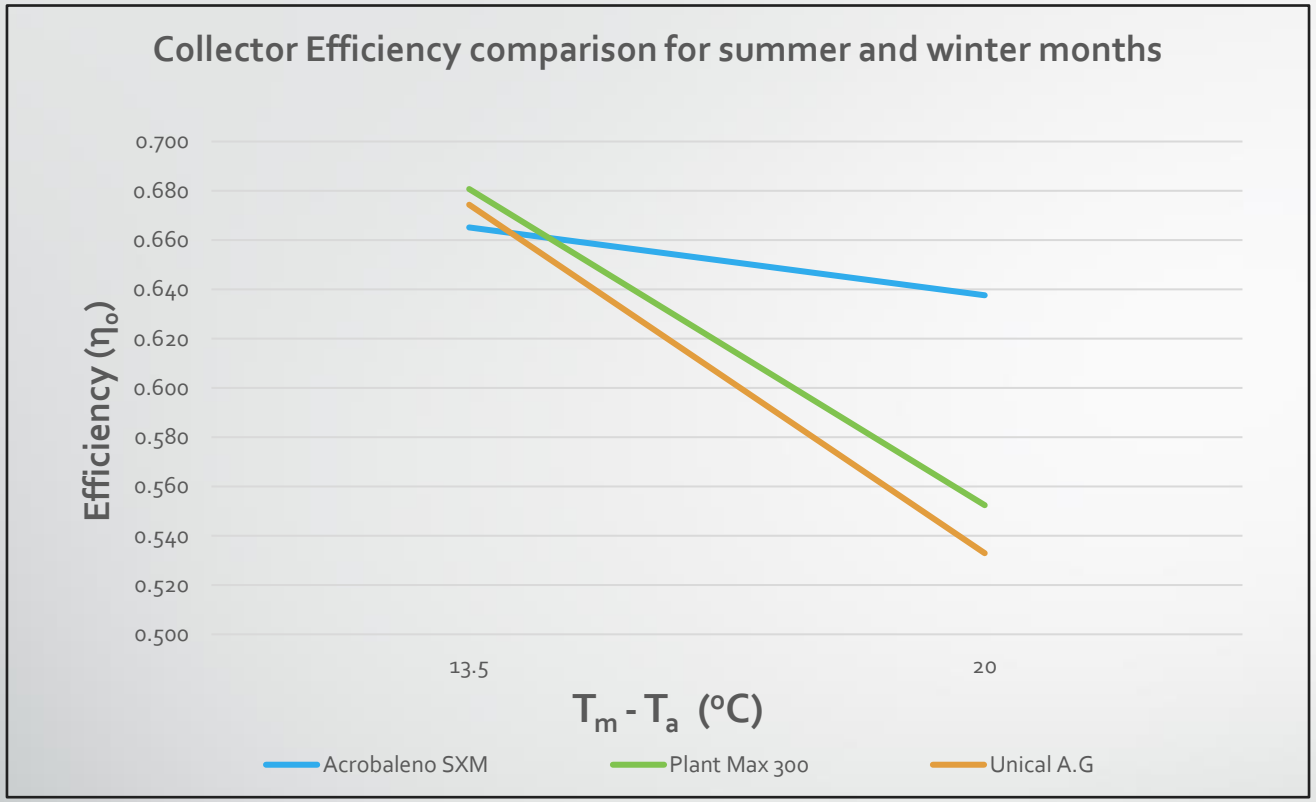
Energy Demand

Application	Consumption per day per person (Litre)	Number of People	Total consumption per day (Litre)
Shower	25	4	100
Sterilization	15	4	60
Laundry and Cleaning	20	-	20

- Required outlet temperature for DHW system = **50°C**
- Average monthly energy demand = **948,832 KJ**
- Constant demand

https://weatherspark.com/y/91632/Average-Weather-in-Helsinki-Finland-Year-Round

SOLAR COLLECTOR MODEL SELECTION



Solar Collector	Parameters
Unical AG S.p.a	$\eta_0 = 0.726$ a1= 3.74 a2= 0.006
Planet-Max 300	$\eta_0 = 0.727$ a1= 3.29 a2= 0.010
Acrobaleno SXM	$\eta_0 = 0.719$ a1= 3.81 a2= 0.013

Efficiency of Collector [%]:

$$\eta_{coll} = \eta_0 - c_1\left(\frac{T_m - T_a}{G_T}\right) - c_2\left(\frac{T_m - T_a}{G_T}\right)^2$$

SOLAR COLLECTOR SPECIFICATION AND JUSTIFICATION

❑ Acrobaleno SXM Specifications:

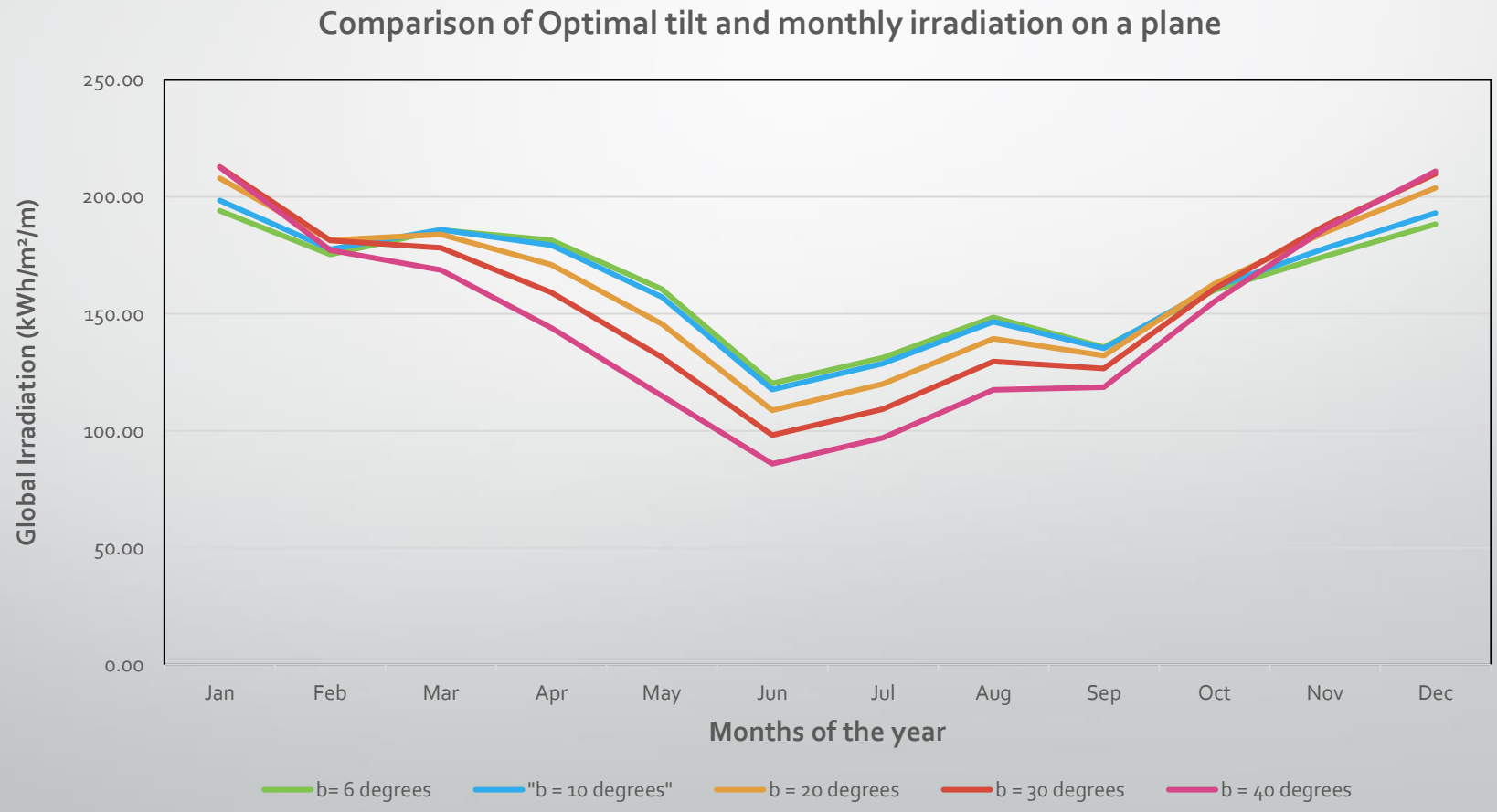
- Efficiency: Winter (63.8 %) Summer (66.5 %)
- Solar plate collector area: 2.34 m^2
- Flow rate per gross area: 0.02 Kg/(m^2Sec)

❑ Justification:

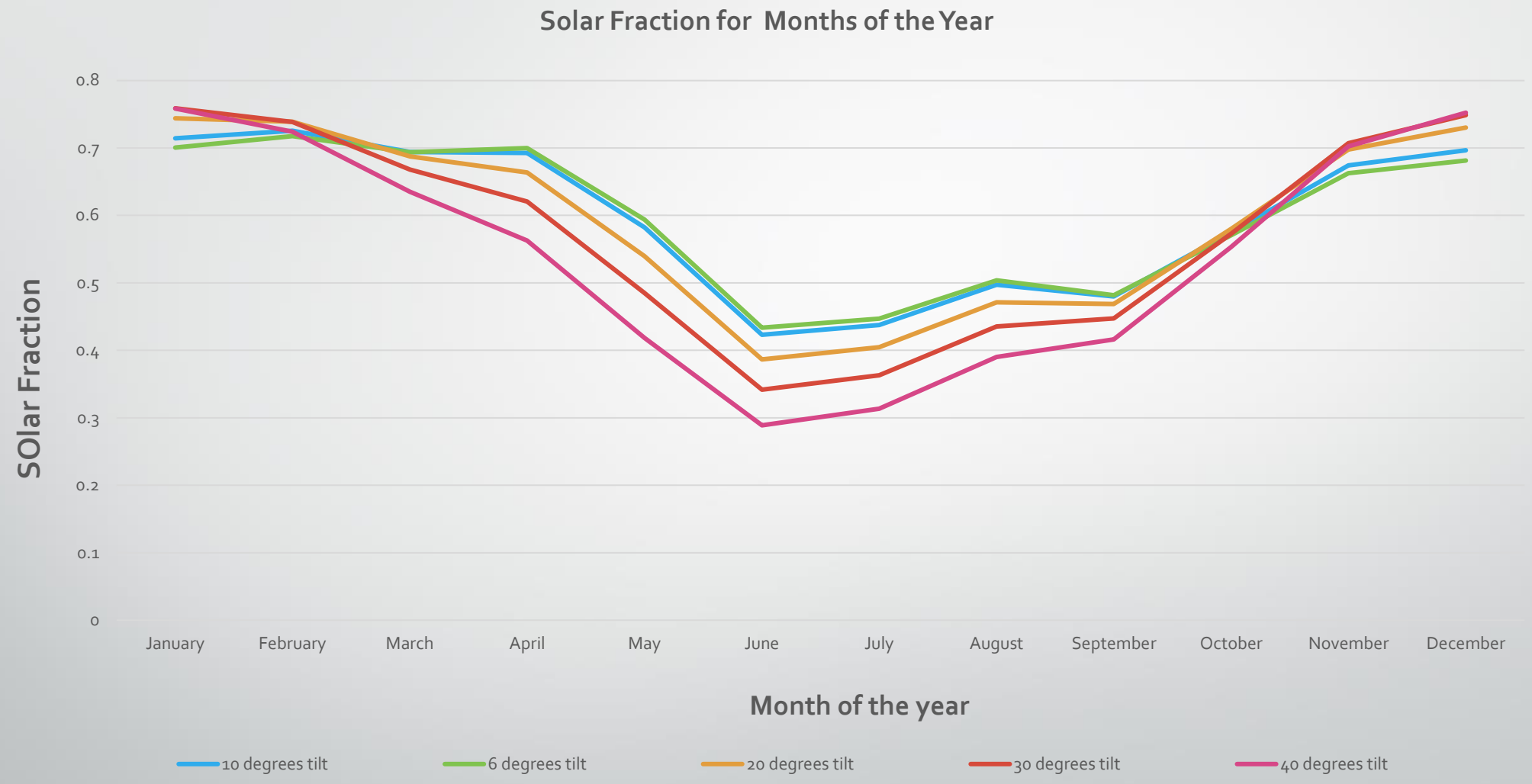
- Flat plate collector fits well in tropical weather.
- Cost effective.
- Application is for primary health care center.
- Less maintenance over their lifespan.
- Ease to integrate into the existing structure on rooftop.

TILT ANGLE COMPARISON

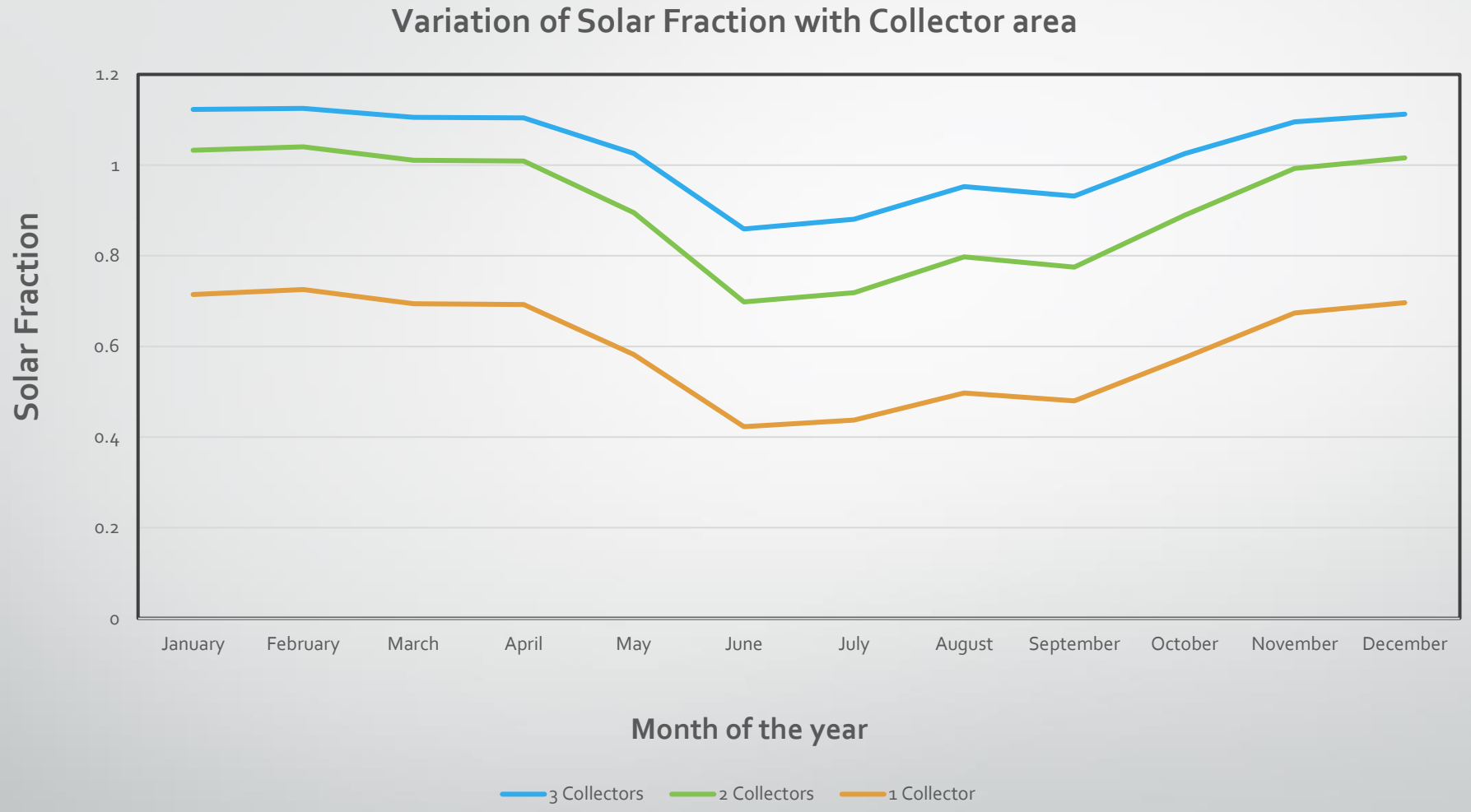
- Optimum tilt angle = 10 degrees
- Orientation: South - latitude of Lekki 6.452 °N



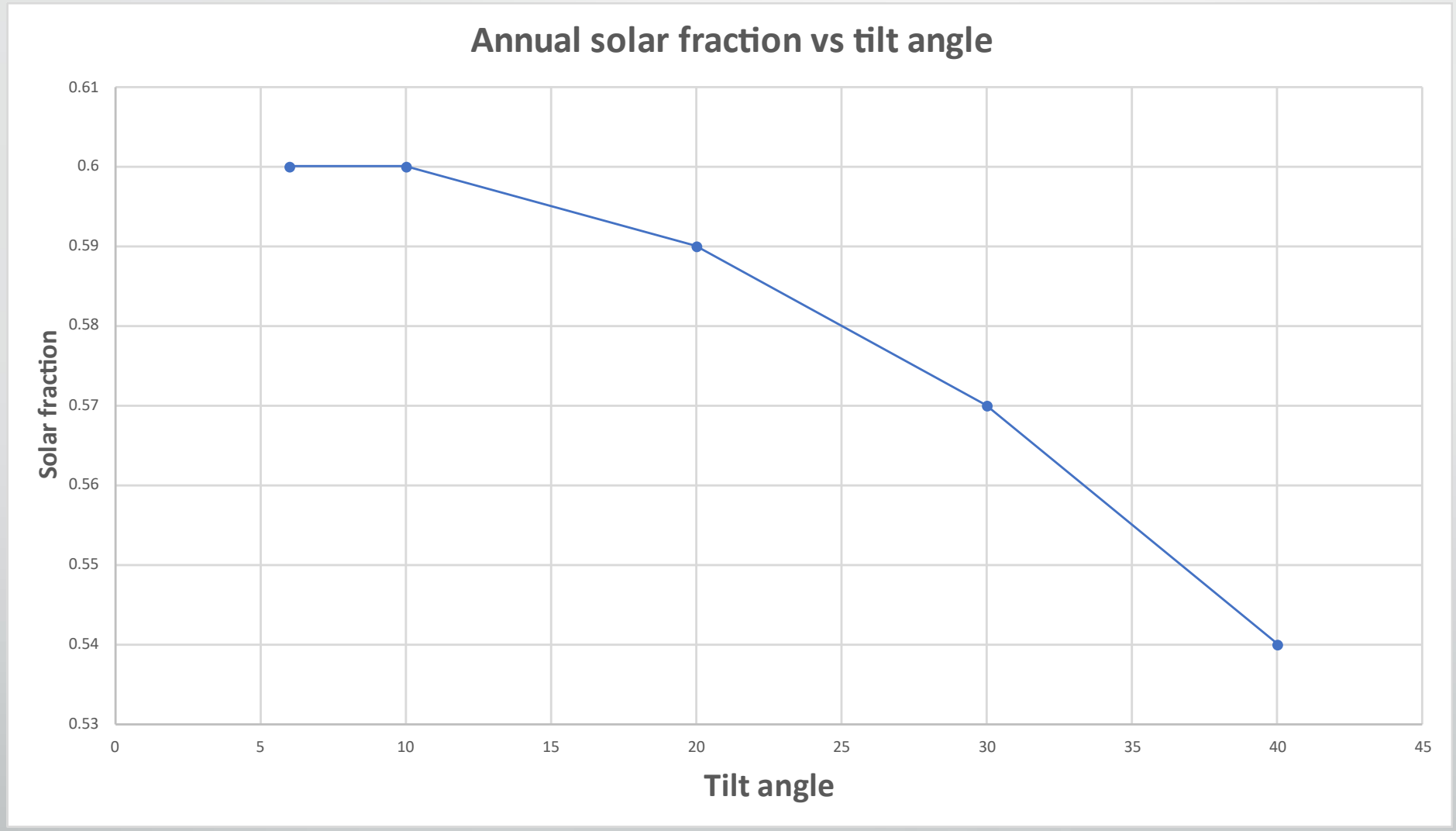
F- CHART DESIGN & ASSESSMENT METHOD



SENSITIVITY ANALYSIS



ANNUAL SOLAR FRACTION VS TILT ANGLE



STORAGE DESIGN

Application	Daily Consumption per person (Litre)	Number of People	Total consumption per day (Litre)
Shower	25	4	100
Sterilization	15	4	60
Laundry and Cleaning	20	-	20

- V_{st} = Volume of the storage
- Daily Water Requirement
  = (100+60+20) = 180 liters
- V_{st} = **360** liters (assumed 2 days of autonomy)

CONCLUSION

- Identifying the most efficient Solar collector ensures optimal performance across the year.
- Designed Collector significantly meeting most of the demand with given irradiance.
- Identified the best collector area to meet hot water demand.
- Solar collector fraction is higher for summer months and lower for winter.
- Sensitivity analysis result shows the optimal tilt angle and area that fits in the range of β= 6 to 10° tilt angle.
- Optimal storage size defined to meet the daily water storage.

THANK YOU!!