Solar Energy

Sizing of solar electrification systems

Emmanuel M Biririza, Energy Specialist, UN-HABITAT

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In this video you will learn:

- What solar system sizing is
  - Understanding the steps to size basic solar home system
    - Come up with appropriate system size

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Introduction

- Sizing is an art of determining solar PV systems components needed to run a certain load requirements
- Appropriate size (avoiding oversizing and undersizing)
- Solar PV system size is specific from one user to another – not general!

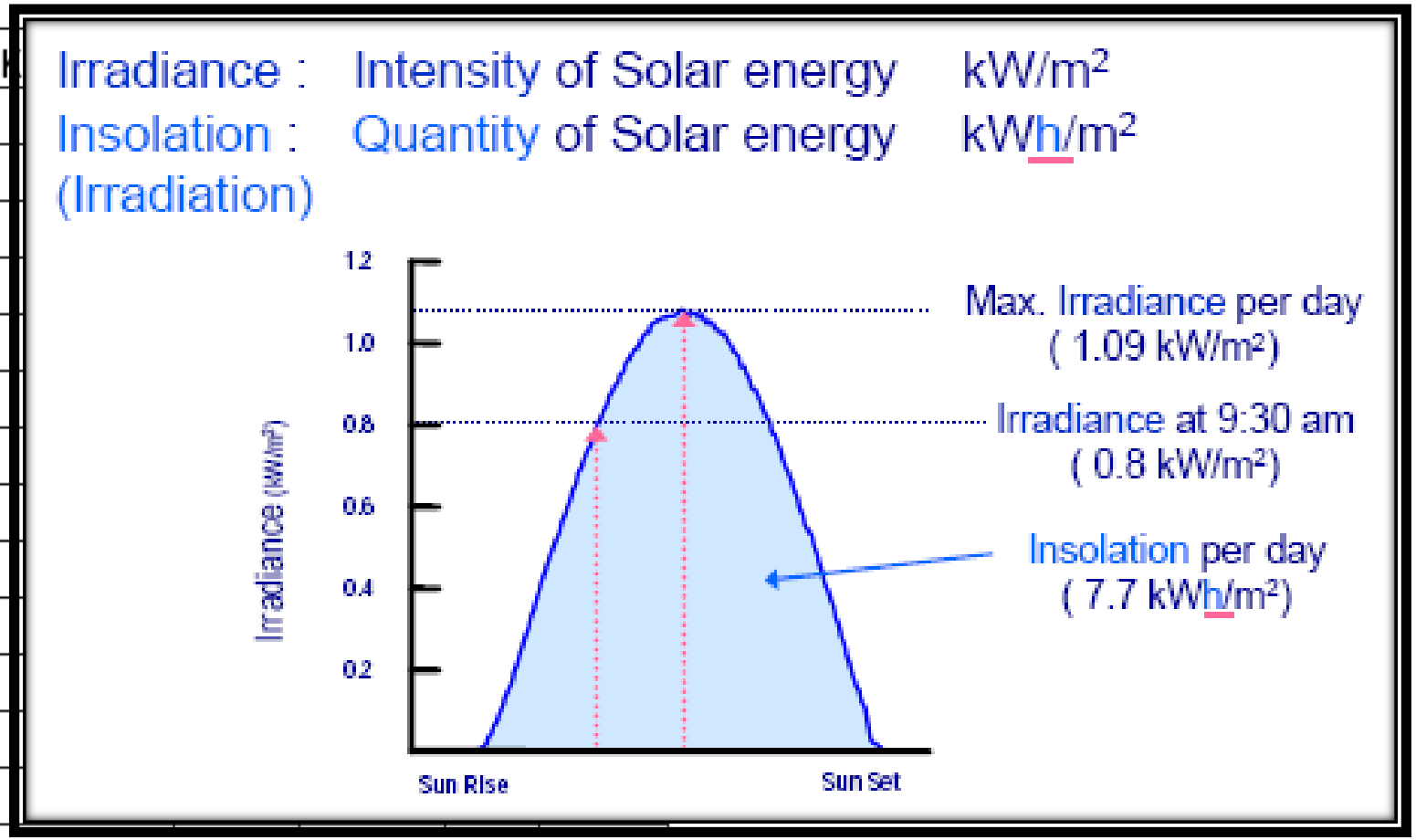
Steps for Sizing a Solar PV system

- Determine system energy requirements (load assessment)
- Select the battery size
- Select the module/panel size
- Select the charge controller size
- Select inverter size, for AC powered appliances/equipment
- *Important: one needs to know the location at which the system will be installed, take into considerations the efficiency of the equipment*

Choosing Appropriate Insolation

- Insolation (PSH) for selected regions in Tanzania

	Arusha	Bukoba	Dsm	Dodoma	Iringa	Kigoma	K
Jan	6.22	4.75	5.29	5.82	5.92	4.44	
Feb	6.2	4.61	5.37	5.7	5.79	4.7	
Mar	5.83	4.72	4.82	5.84	5.86	4.76	
April	5.44	4.44	3.88	5.49	5.85	4.36	
May	5.09	4.27	4.24	5.38	6.1	4.51	
Jun	4.51	4.73	4.26	5.49	6.27	4.82	
Jul	4.53	4.66	4.26	5.44	6.14	4.45	
Aug	5.31	4.74	4.59	5.77	6.49	4.88	
Sept	5.98	4.83	4.94	6.06	6.78	4.68	
Oct	6.58	4.5	5.09	6.2	7	4.68	
Nov	6.01	4.31	5.71	6.25	6.61	4.13	
Dec	6.03	4.3	5.48	6.01	5.89	4.46	
AVERAGE	*5.64*	*4.57*	*4.83*	*5.79*	*6.22*	*4.57*	



Determination of Load and Energy Requirements

- Example: Kiosk has the following energy needs

Appliance	Power Rating (Watts)	Quantity	Total Load (Watts)	Operating hours per day (hours)	Energy Requirements per day (Watt-hours)
32” TV set	120	1	120	5	600
Decoder	15	1	15	5	75
Lights, LED	5	2	10	4	40
Phone charging	3	5	15	2	30
			160		745

- Total Load: 160 W
- Total Energy Daily Energy Requirements: 745 Wh

Solar Module/Array Sizing

- *Important: Know the location, in this case, Dodoma, Tanzania. Get sun-peak hours (insolation)*

$$Module\ Size\ (Watts) = \frac{Total\ Daily\ Energy\ Requirements\ (Watt - hours)}{Average\ insolation\ (hrs)}$$

- Taking the peak sun-hours of Dodoma, Tanzania, 5.38 hrs (from the least sunny month – May)

$$Module\ Size\ (Watts) = \frac{745\ Wh}{5.38\ h} = 138.48\ W$$

- Take loses into account, say 25% losses, then

$$Module\ Size\ (Watts) = \frac{138.48\ W}{0.75} = 184.64\ W$$

- Choose the nearest standard number/size, this case, <u>200W</u>

Battery Bank Sizing

- *Important: Battery efficiency 85%; Allowable Depth of Discharge (DOD) 80%; Choose days of autonomy, say 2; System voltage, say 12V.*

$$Battery\ Capacity\ (Ah) = \frac{Daily\ Energy\ Requirements\ (Wh) * Days\ of\ autonomy}{Depth\ of\ Discharge * System\ Voltage\ (V)}$$

$$Battery\ Capacity\ (Ah) = \frac{745\ Wh * 2}{0.80 * 12\ V} = 116.86\ Ah$$

- Choose the nearest highest standard size, this case <u>120Ah</u>.

Charge Controller Sizing

- Charge controller should be able to withstand the total current flowing from the solar panel/arrays.
- From our example, 200W module has a shot circuit current of around 12A, this is available in the data sheet and labelled at the back of the module.
- Choose the nearest standard number, this case choose 15A

Inverter Sizing

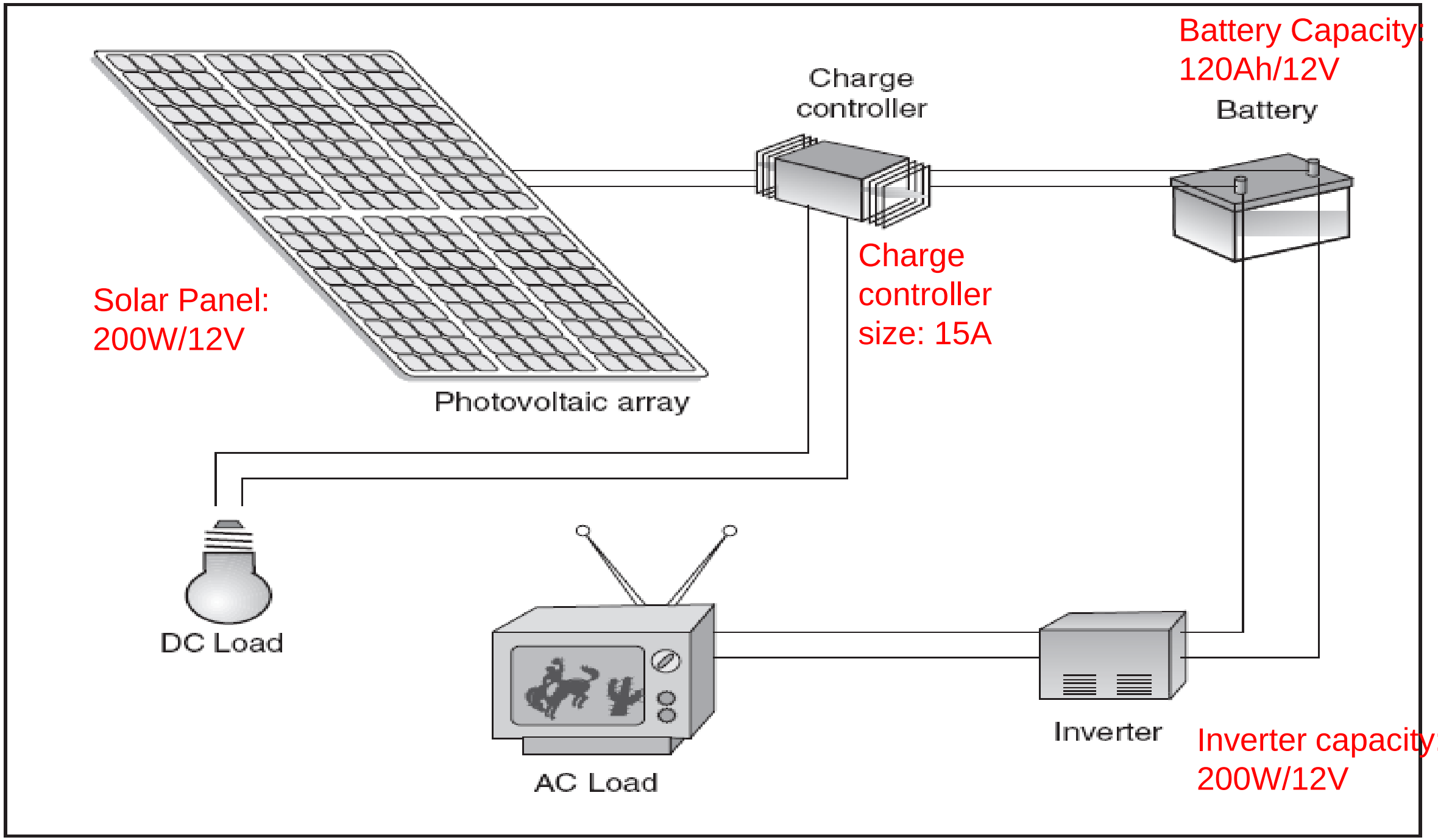
- Investor should be able to carry the total load (watts), from our table, total load is 160W.
- Take into account inverter efficiency, typically 85%
- Therefore, inverter power rating:

$$= \frac{Total\ Load\ (160\ W)}{Efficiencty\ (0.85)} = 188\ \text{W}$$

- Choose the nearest higher standard number, 200W.

Use of Appropriate Cable Sizes

- Wires should be able to limit voltage drop to around 5%. Standards are provided in a table.
- Typically,
  - cable size used to connect from Panel to Controller is $6mm^2$ (for a 12V system) and $4mm^2$ (for a 24V system).
  - For controller to battery $10mm^2$.


Battery Capacity:
120Ah/12V
Charge
controller
Battery
Solar Panel:
200W/12V
Charge
controller
size: 15A
Photovoltaic array
DC Load
AC Load
Inverter
Inverter capacity:
200W/12V

Additional References

- Solar PV Training & Referral Manual: https://docslib.org/doc/4192987/solar-pv-training-referral-manual
- Training Manual for Engineers on Solar PV Systems: https://www.researchgate.net/publication/268387350_Training_Manual_for_Engineers_on_Solar_PV_System
- Solar PV Installation Training Handbook: https://energypedia.info/images/2/2e/Solar_PV_Installation_-_Training_Handbook_2017.pdf
- Solar Training Manual (intermediate): https://www.hamk.fi/wp-content/uploads/2018/09/Training-Manual.pdf
- Solar Electric Systems for Africa: A Guide for Planning and Installing Solar Electric Systems in Rural Africa: https://books.google.co.ke/books?id=nPfp9CgTDxcC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

THANK YOU

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