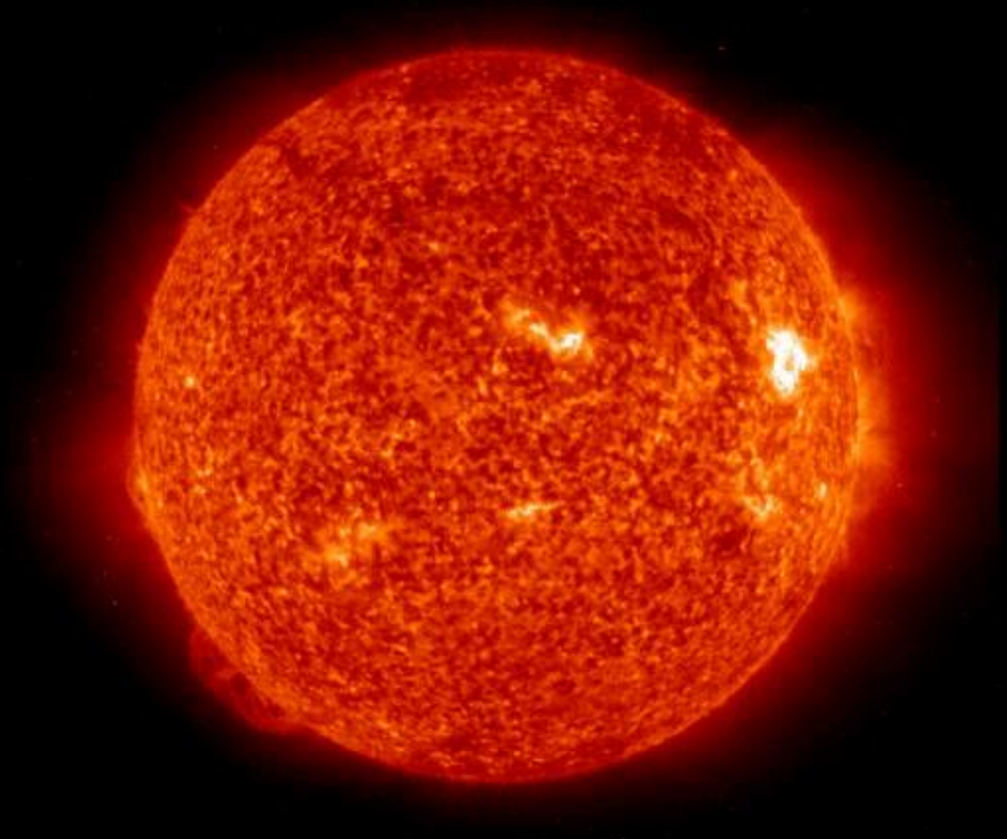
PV Systems - Applications and Design

Stand-Alone PV Systems

Week 8.1

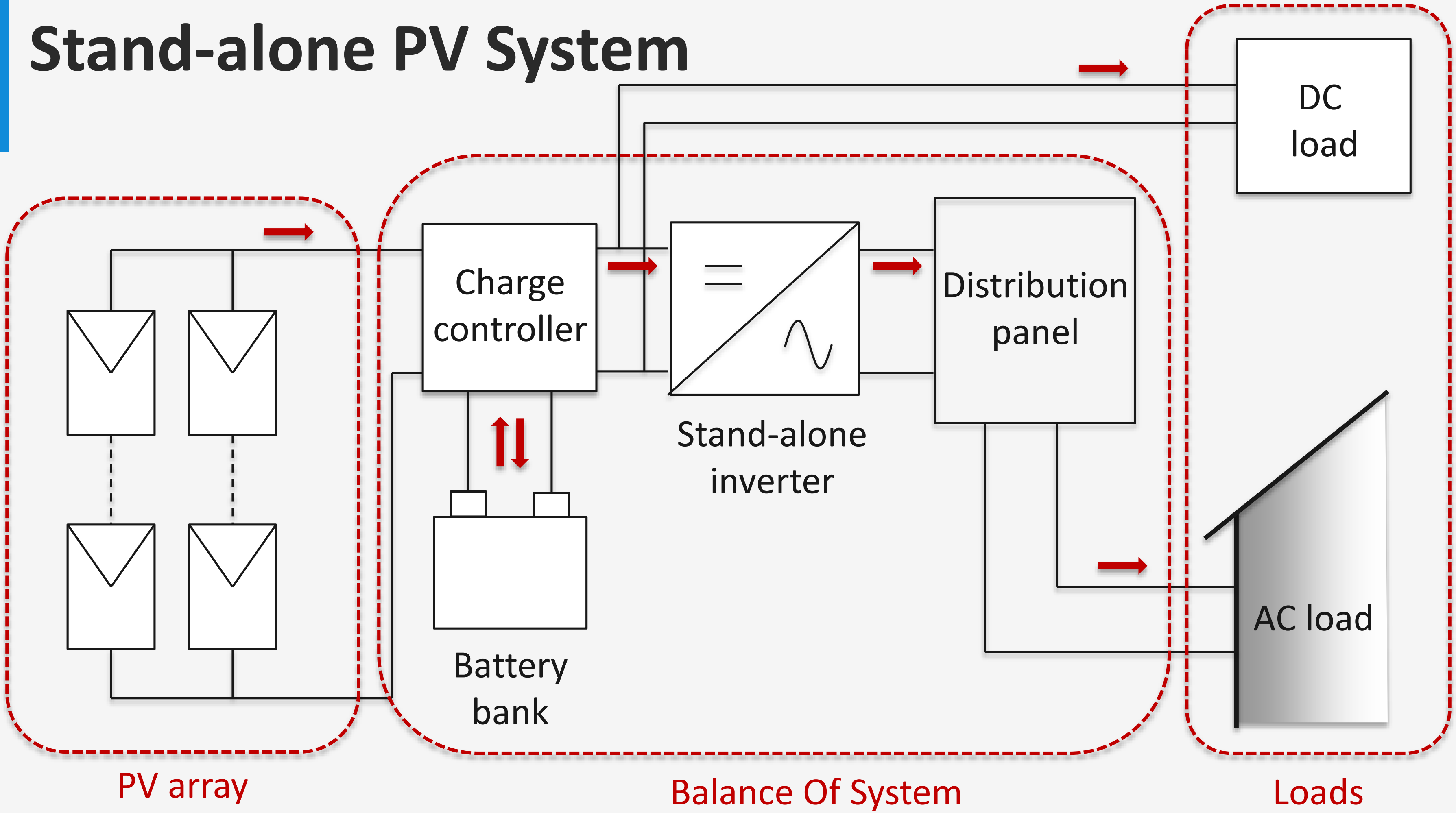
Arno Smets, Nishant Narayan

TU Delft Delft University of Technology

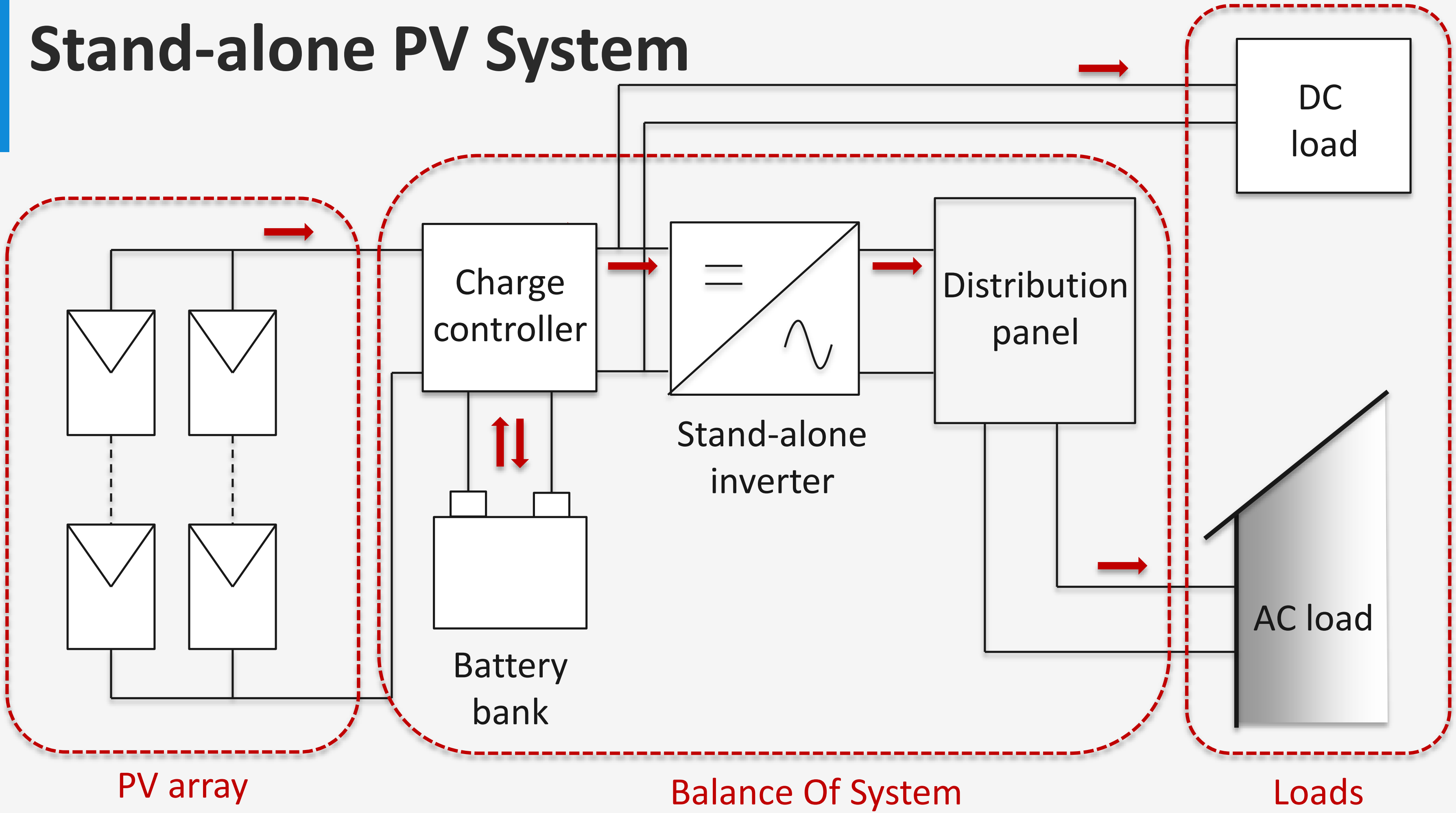


(Source: NASA)

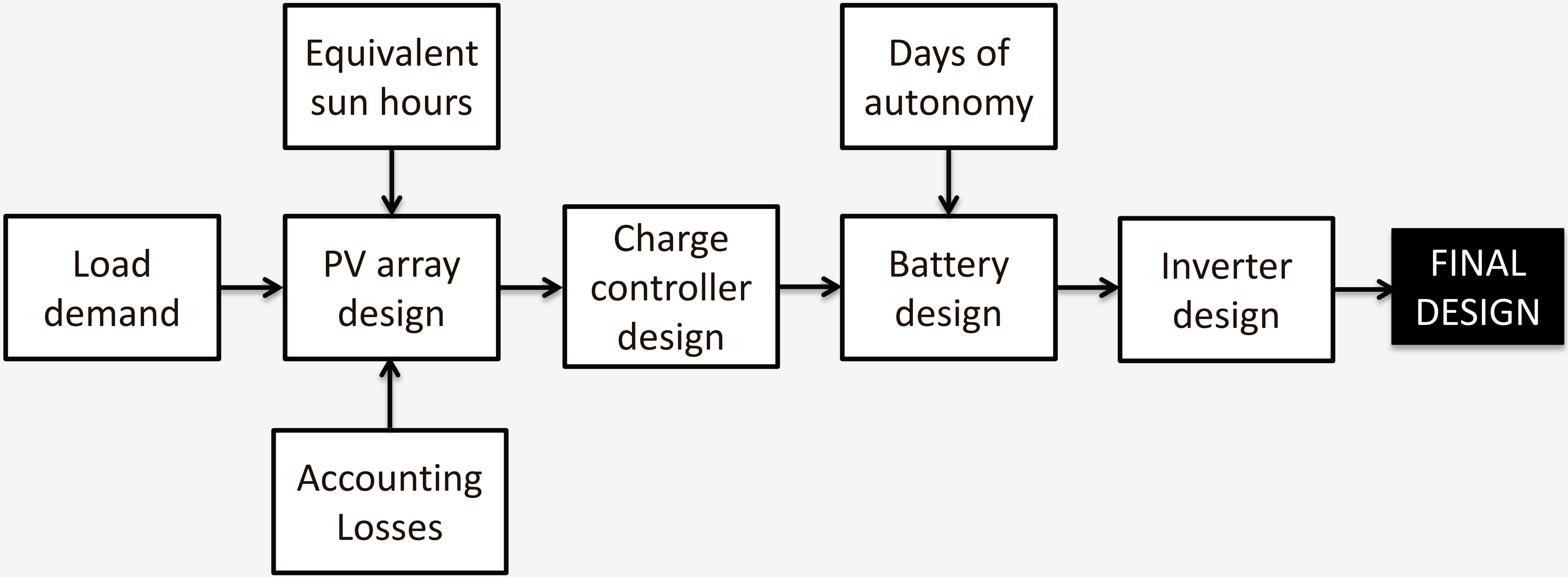
Stand-alone PV System



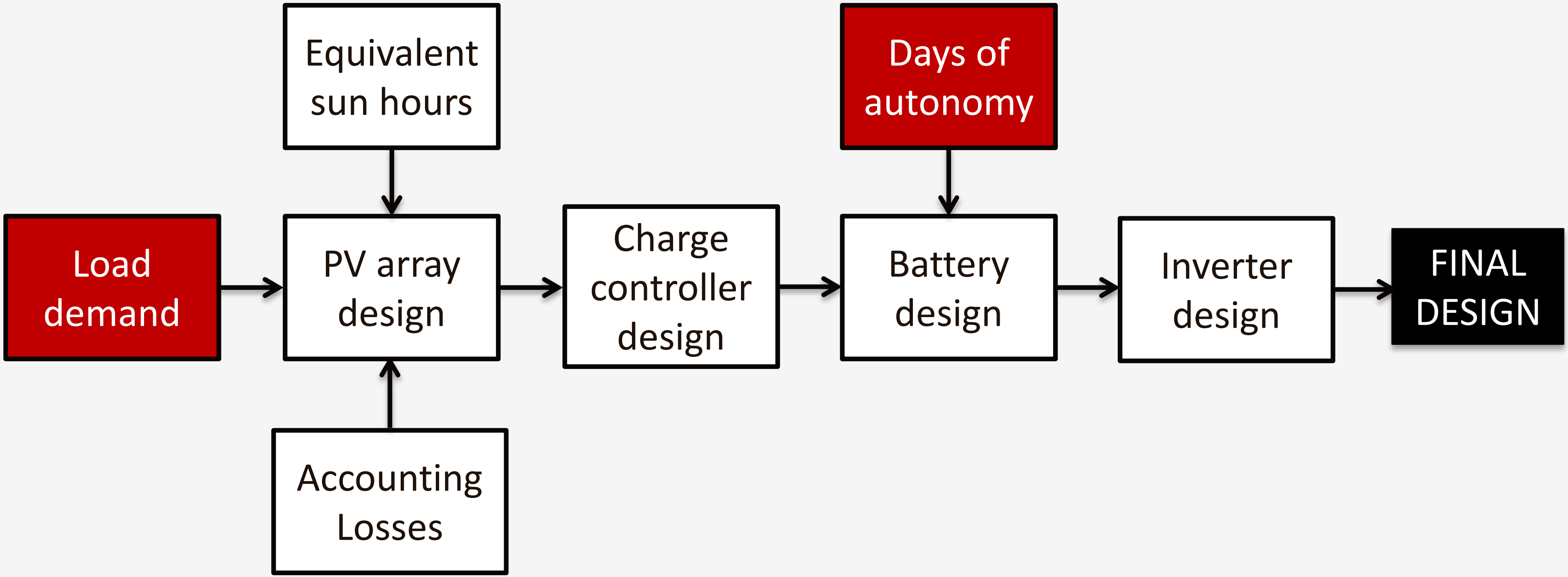
Stand-alone PV System



Design example - Flowchart



Design example



Design Example – Load

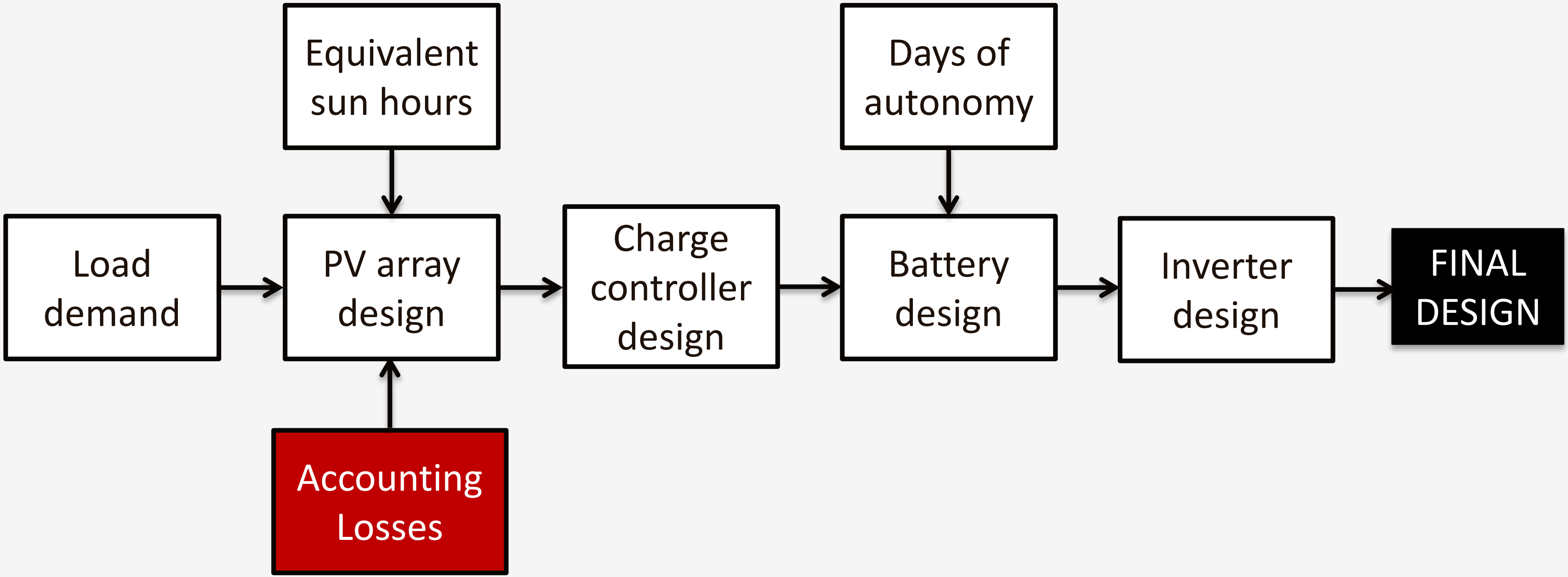
Design Example – Load

Item	Quantity	Power per item (W_{DC})	Total power (W_{DC})	Time of use (h/day)	Total energy (Wh)
Light	4	25	100	3	300
TOTAL			**100**		**300**

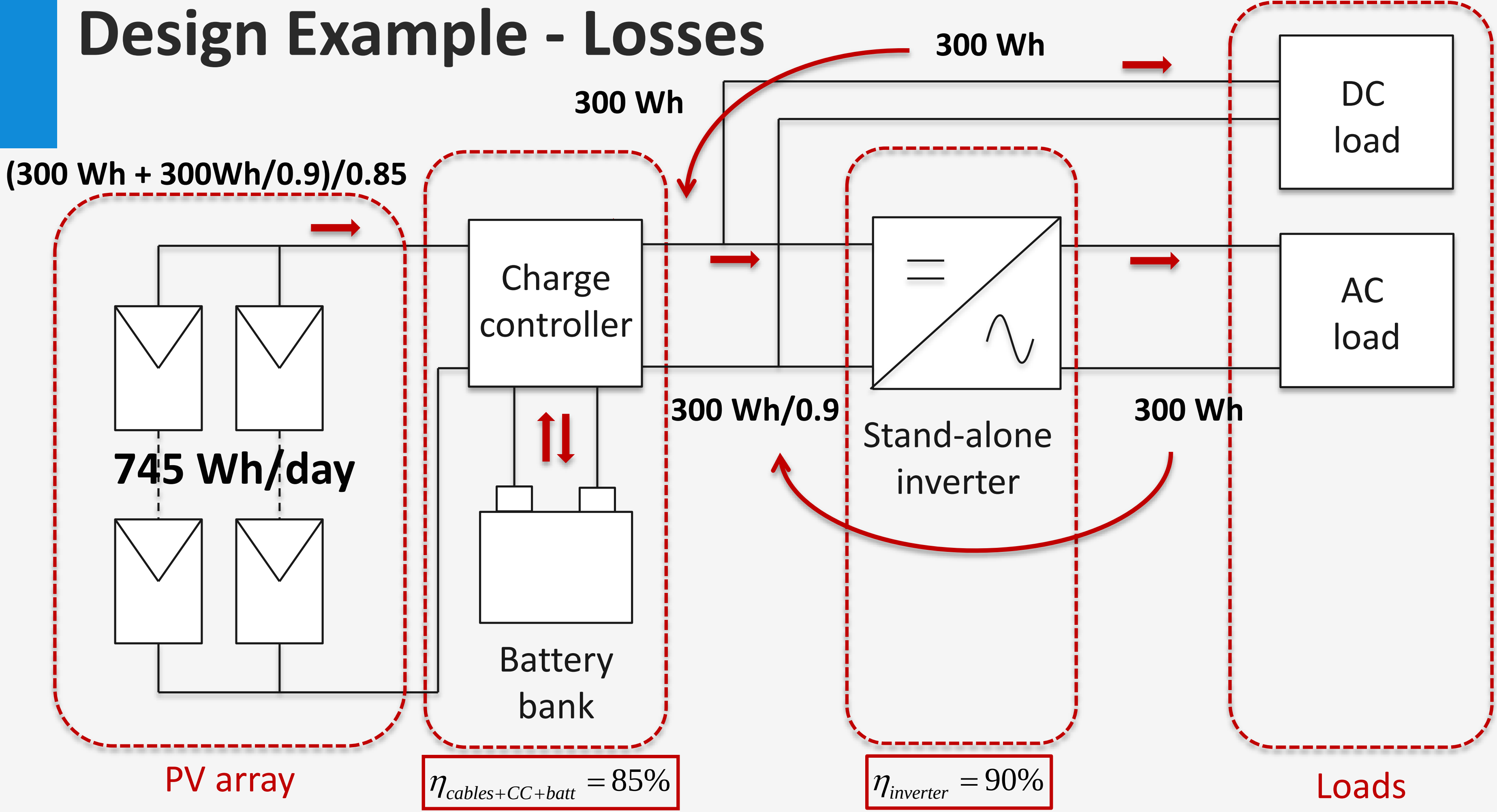
Item	Quantity	Power per item (W_{AC})	Total power (W_{AC})	Time of use (h/day)	Total energy (Wh)
TV	1	100	100	2	200
Desktop	1	100	100	1	100
TOTAL			**200**		**300**

Days of Autonomy: 2

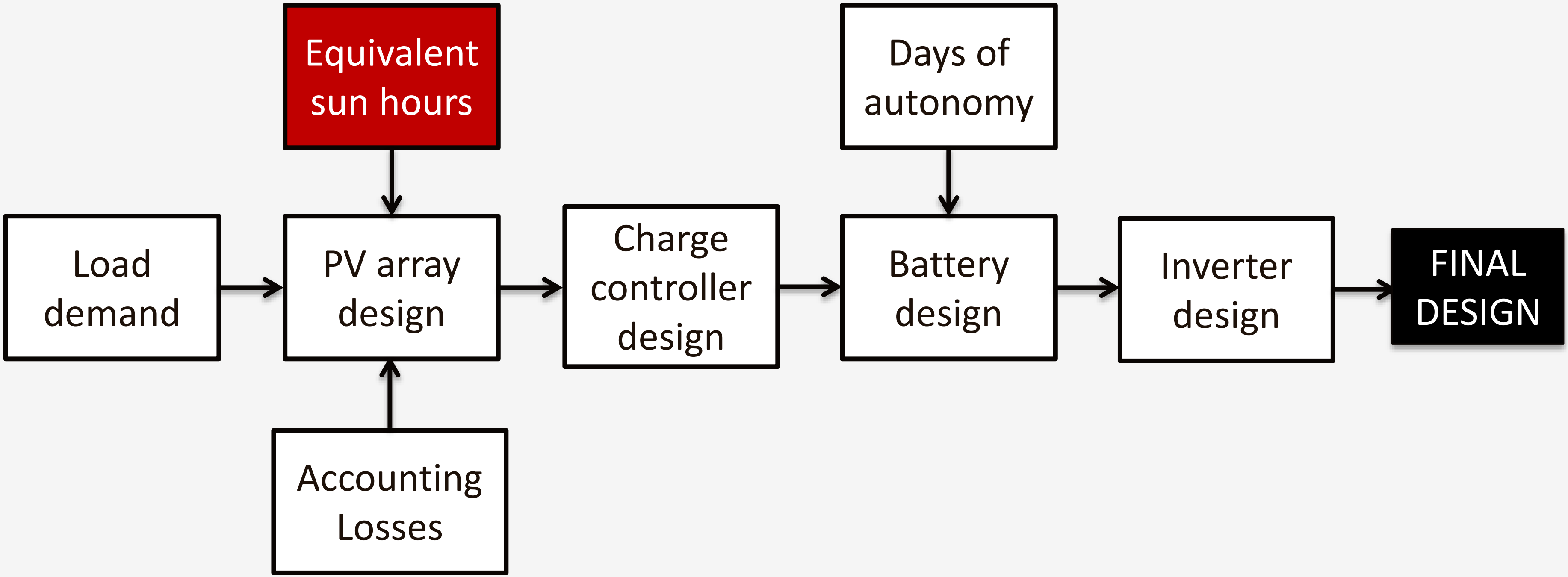
Design example



Design Example - Losses



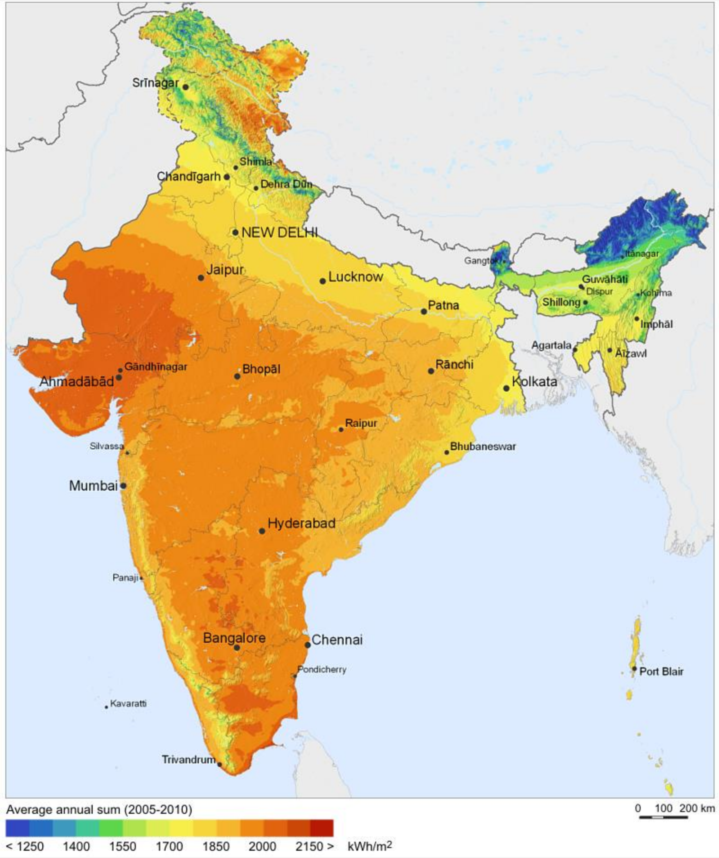
Design example



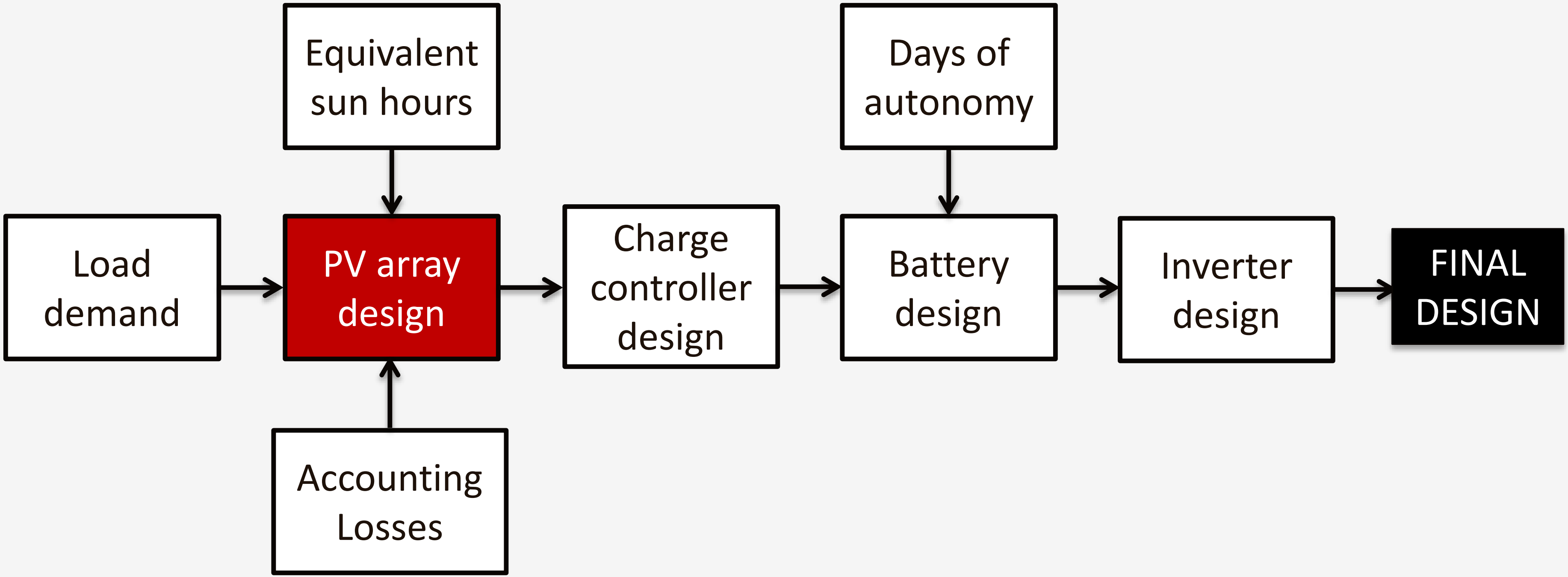
Design example – Insolation

Equivalent sun hours

~4.5 h/day



Design example



Design example – PV array

Panel specifications(example)	
Power output (Wp)	100
V_{MPP} (V)	16
I_{MPP} (A)	6.25
V_{OC} (V)	20
I_{SC} (A)	7

?

Design example – PV array

MPPT

Total energy demand

$$Minimum W_p = \frac{745Wh/day}{4.5h/day} = 165.6W$$

Equivalent sun hours

$$Number\ of\ panels = \frac{165.6W}{100W_p} = 1.7 \approx 2\ panels$$

Design example – PV configuration

Short circuit current

Parallel

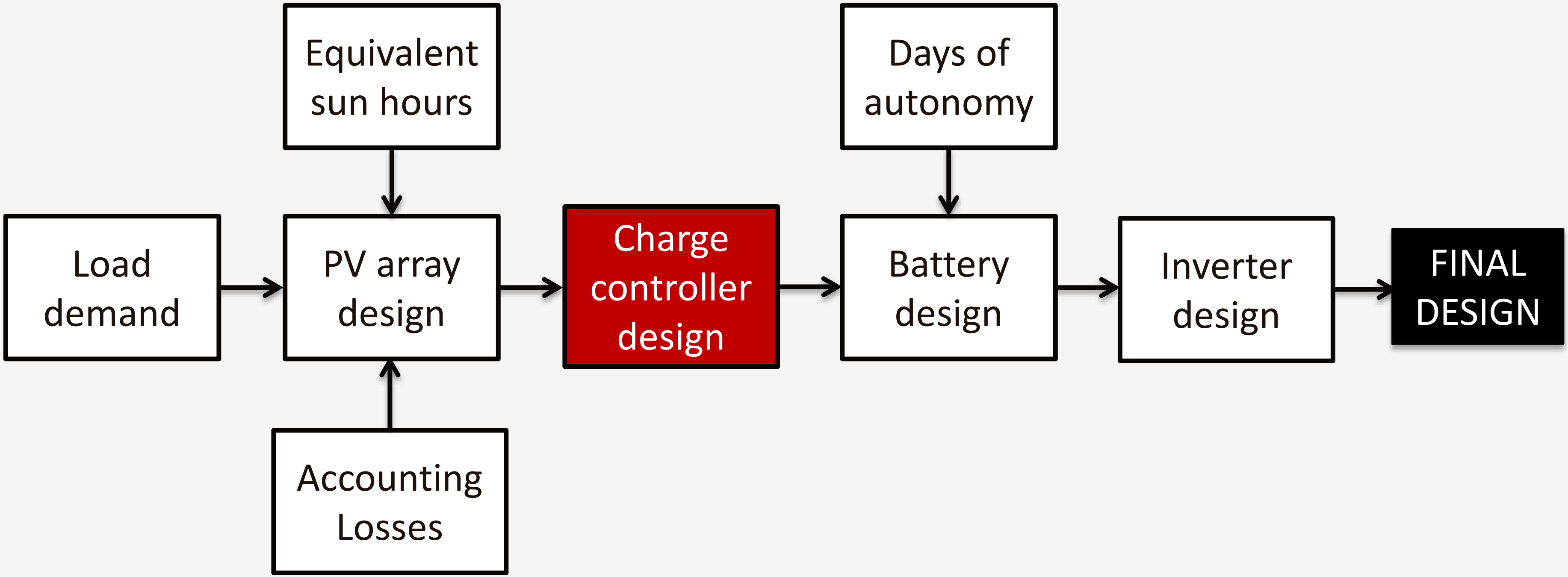
$$Maximum\,current\;\; I_{\max} = 7A \times 2 = 14A$$

Series

$$Maximum\,voltage\;\; V_{\max} = 20V \times 2 = 40V$$

Open circuit voltage

Design example



Design example – Charge controller

Charge controller specifications(example)	
Maximum voltage (V)	60
Maximum current (A)	10
Operational voltage	12V/24V
MPPT	Yes

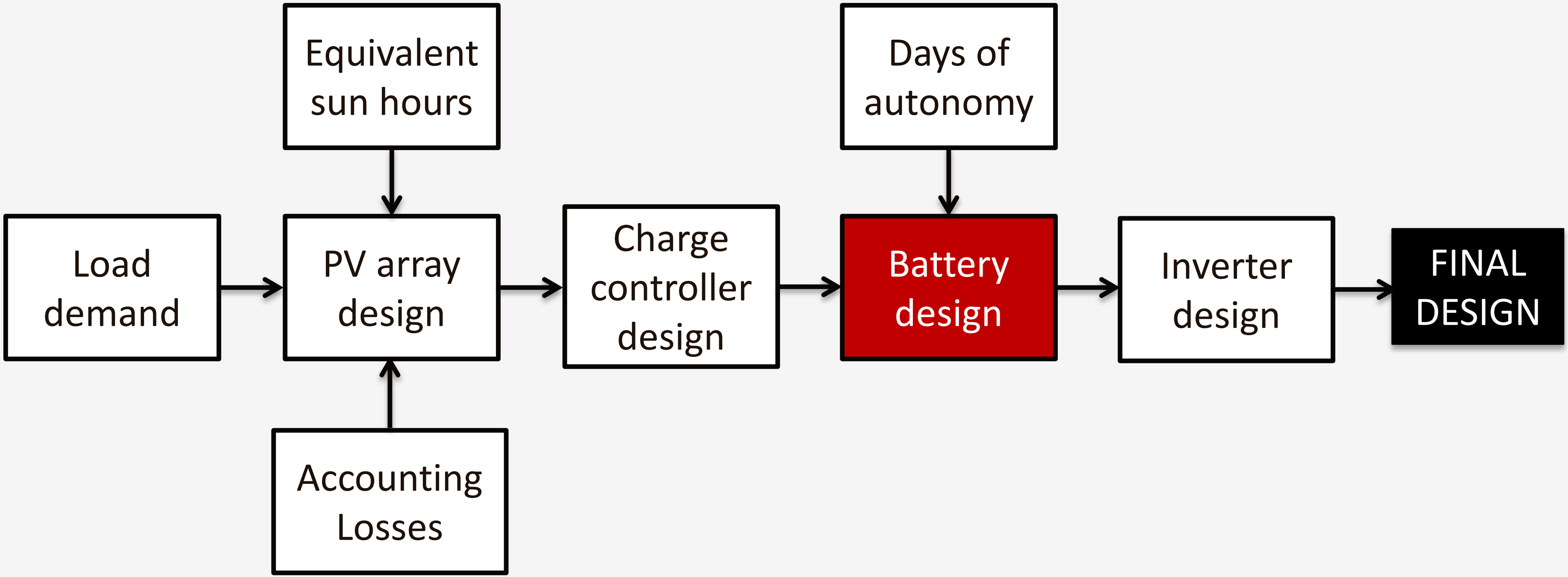
$> V_{Max}$

$< I_{Max}$

Operational Voltage

Panels in Series

Design example



Design example – Battery

Batteries : Hoppeke

Battery specifications(example)	
Depth of discharge	60%
Battery voltage (V)	12
Battery capacity (Ah)	21

?

Design example – Battery

Batteries : Hoppeke

Total energy demand

Days of autonomy

$$Minimum\ C_{batt} = \frac{745Wh}{0.6 \times 24V} \times 2 = 103.5Ah$$

Depth of discharge

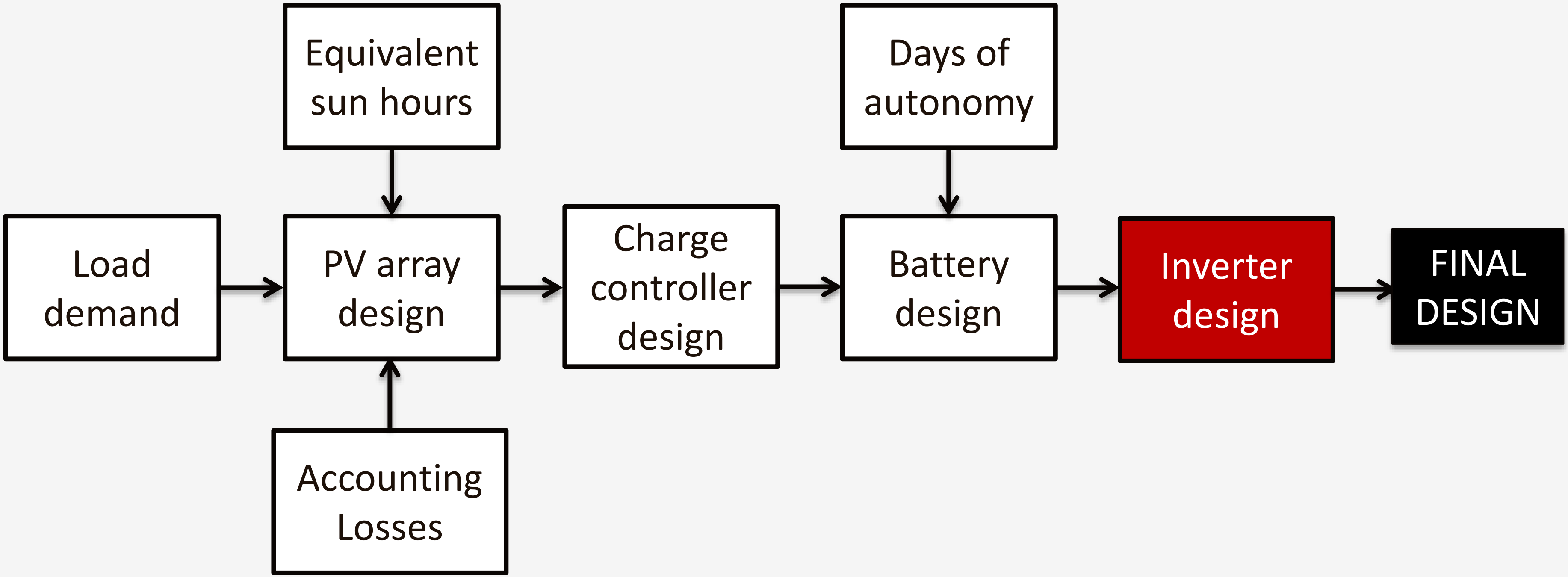
Operational voltage of the system

$$Number\ of\ batteries\ in\ series = \frac{24V}{12V} = 2\ batteries$$

$$Number\ of\ batteries\ in\ parallel = \frac{103.5Ah}{21Ah} = 4.93 \approx 5\ battery$$

$$Number\ of\ batteries = 2 \times 5 = 10\ batteries$$

Design example



Design example - Inverter

Inverter specifications(example)	
Efficiency	90%
Operational voltage	24V

?

Design example - Inverter

Inverter specifications (example)	
Efficiency	90%
Operational voltage	24V

Total power demand

$$\text{Minimum Nominal Power Rating} = \frac{200W}{0.90} = 222.2W$$

Inverter efficiency

Thank you for your attention!