

Optimal sizing of solar photovoltaic and lithium battery storage to reduce grid electricity reliance in buildings

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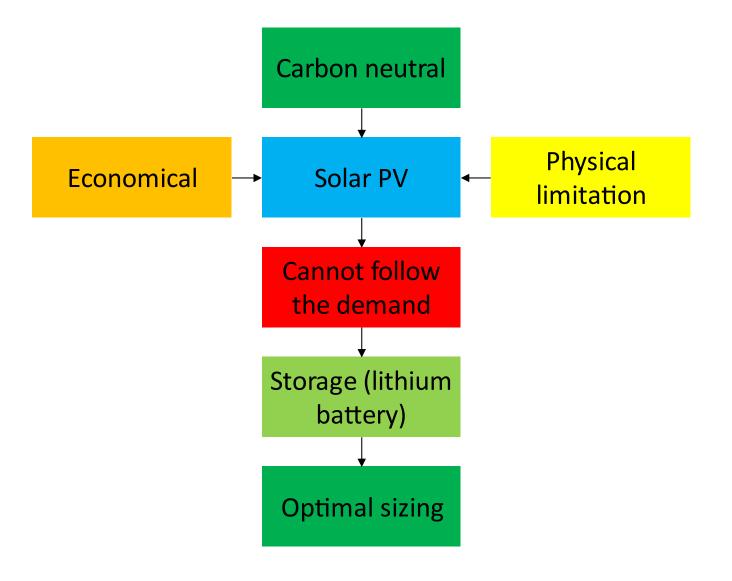




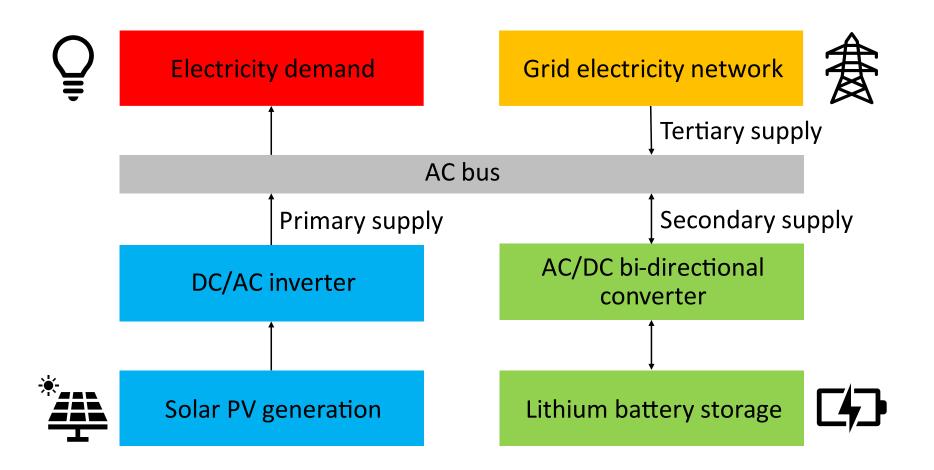




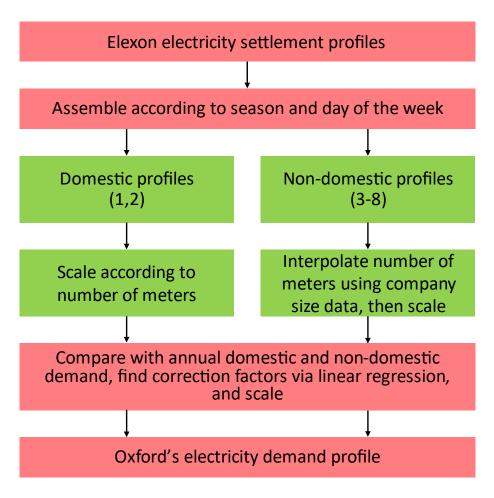
Motivation

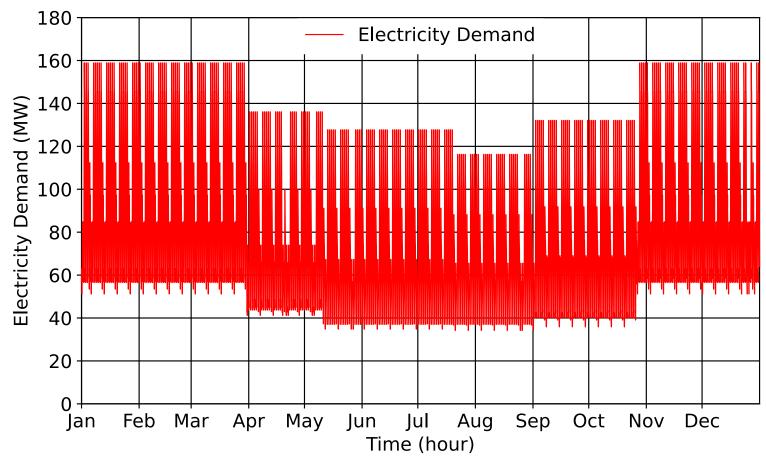


System Setup and Operation Strategy

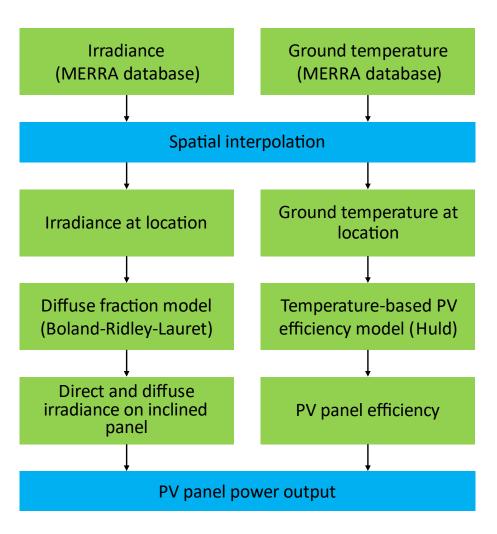


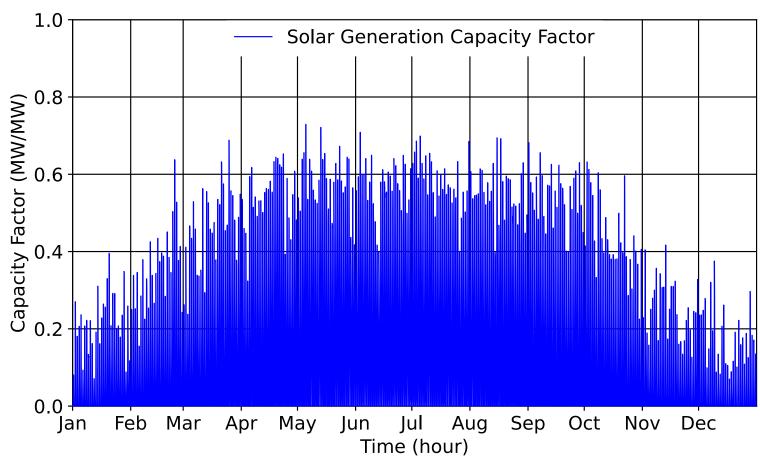
Demand Model



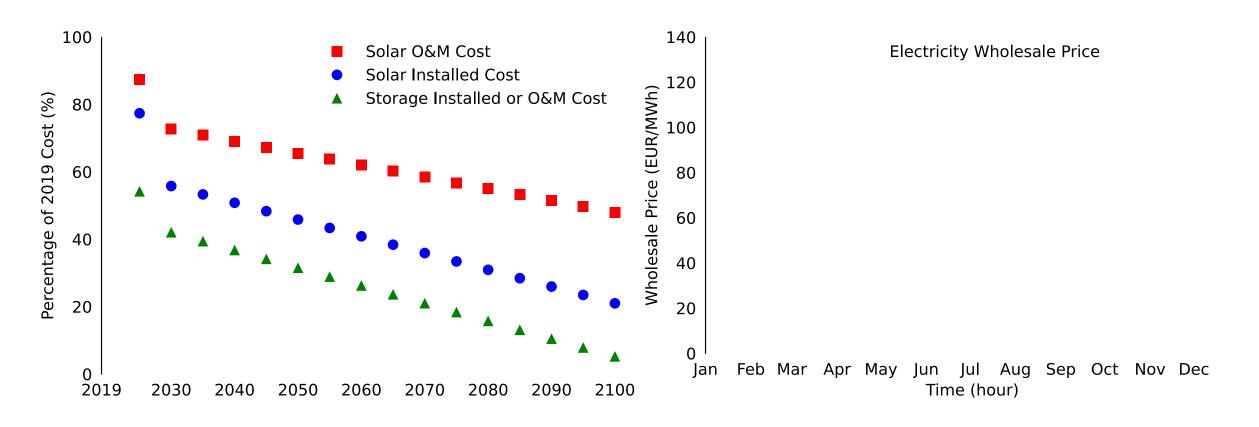


Generation Model



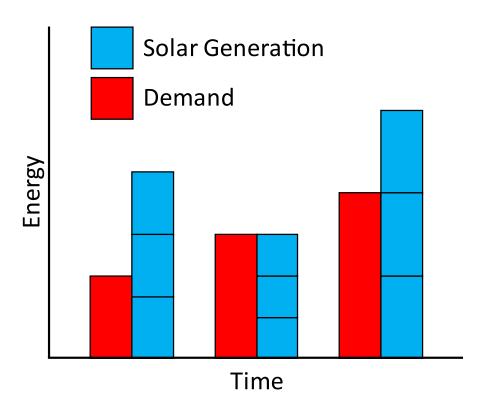


Cost Model



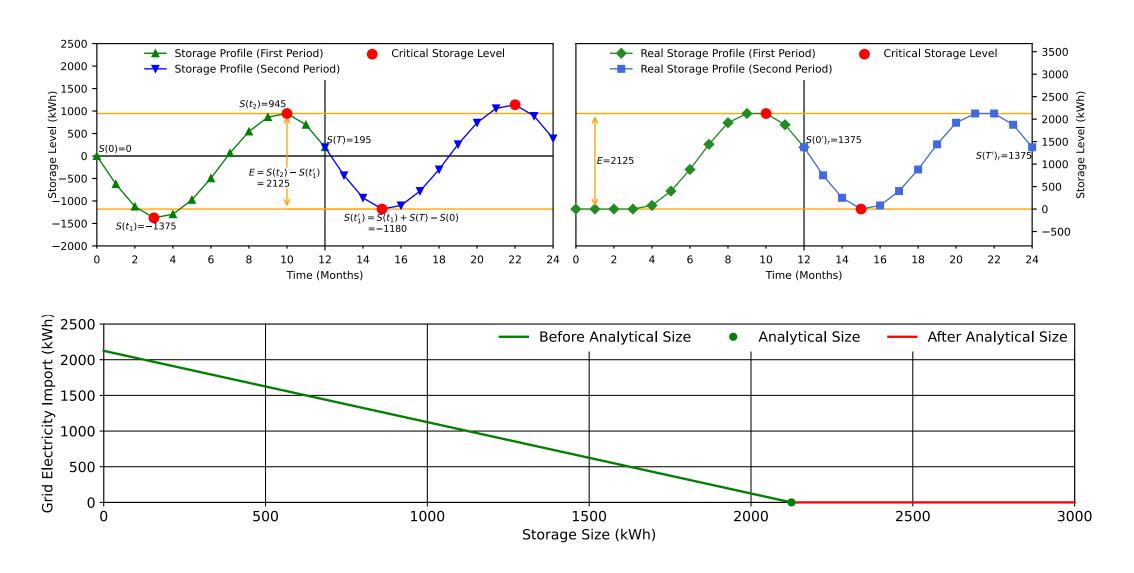
$$LCOE = \frac{Solar Cost + Storage Cost + Electricity Import Cost}{Demand}$$

Sizing Method: Solar Size Range

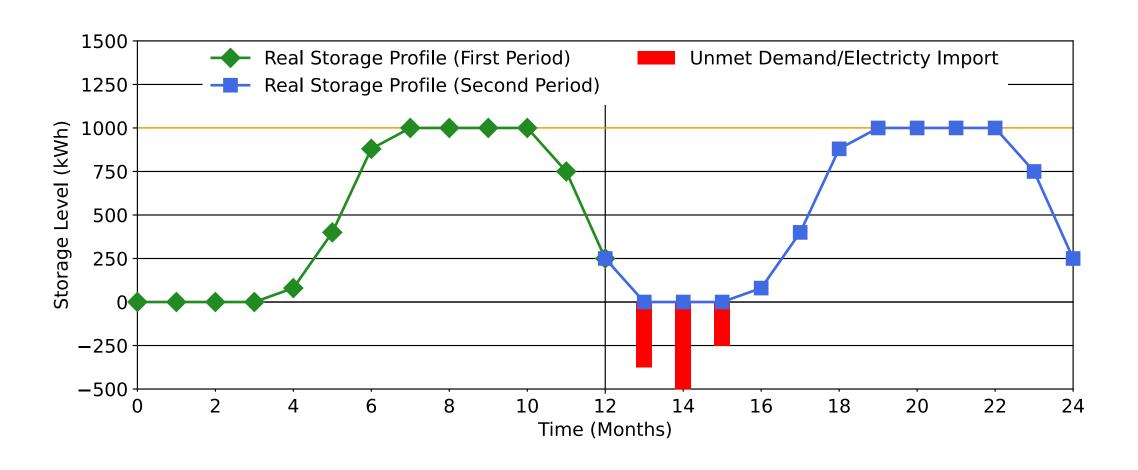


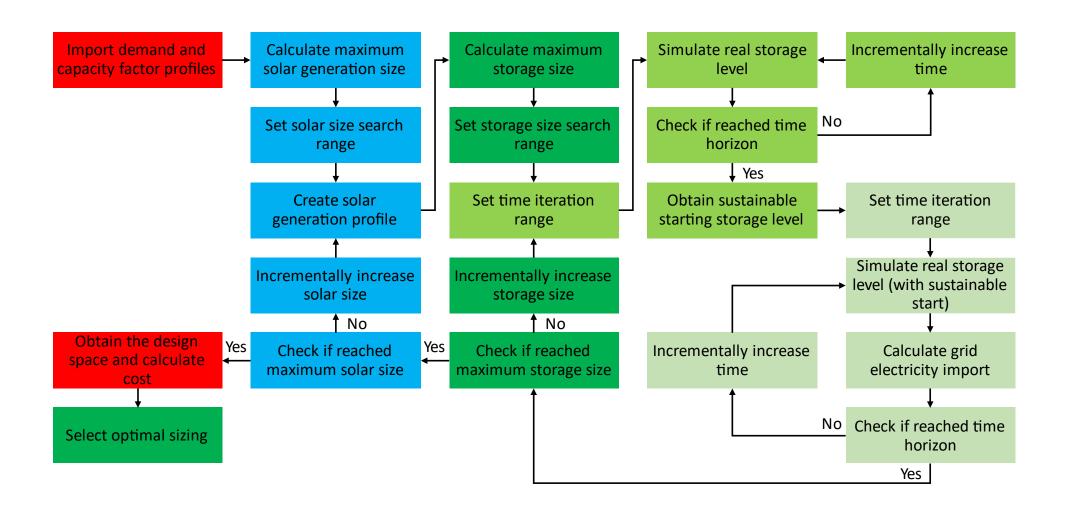
Max Solar PV Capacity =
$$Max\left(\frac{Demand}{Capacity Factor}\right)$$

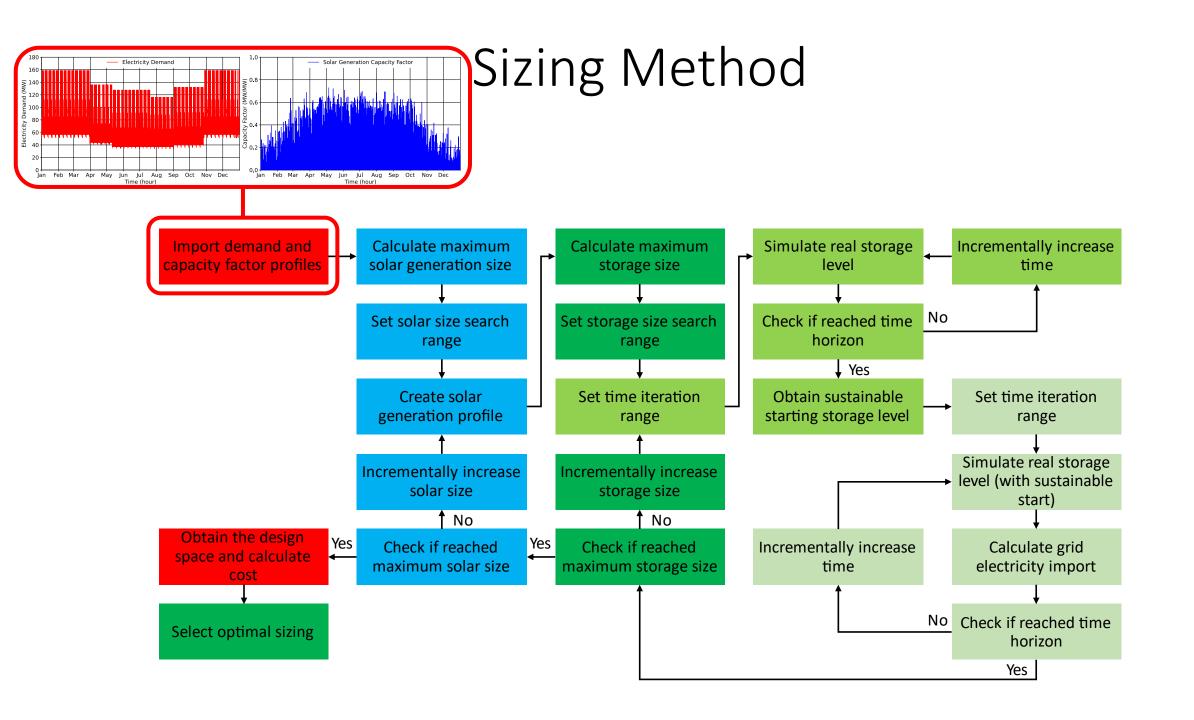
Sizing Method: Storage Size Range

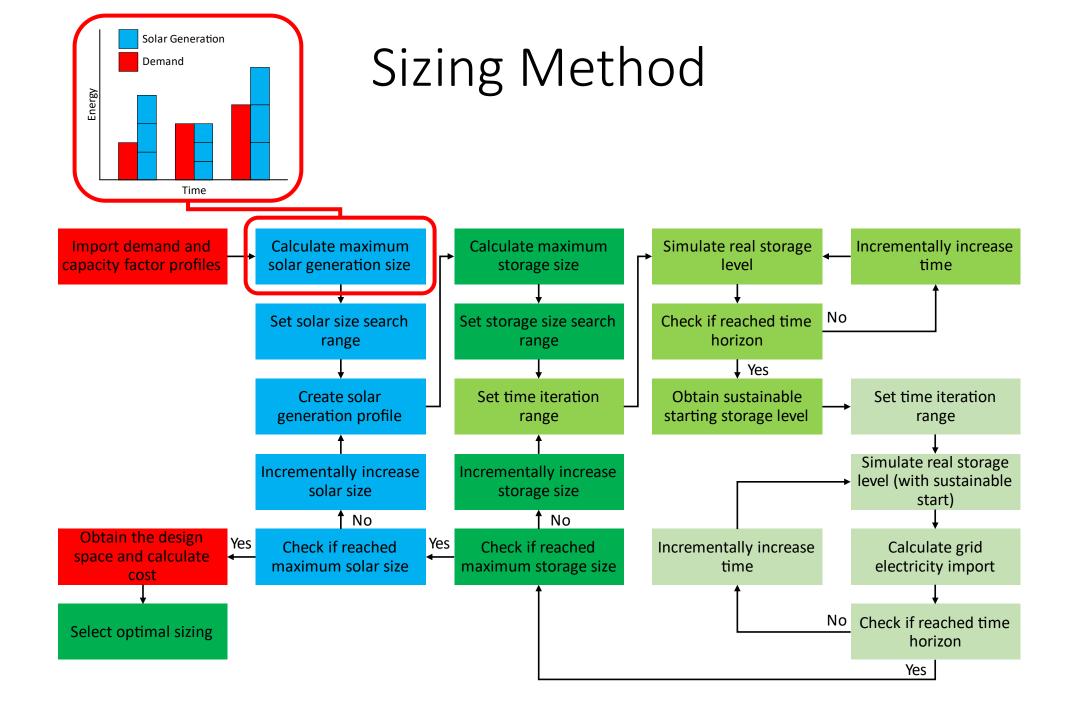


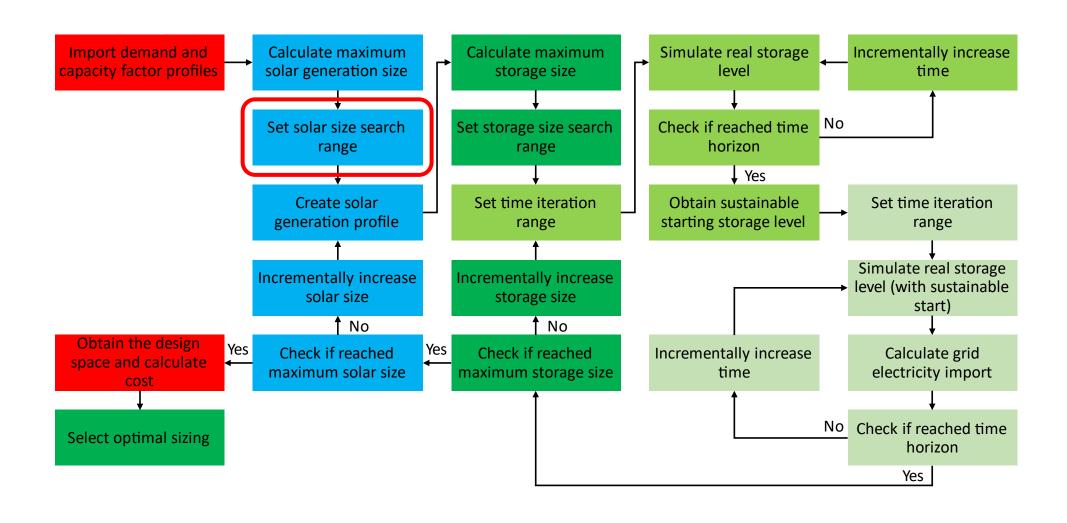
Sizing Method: Electricity Import

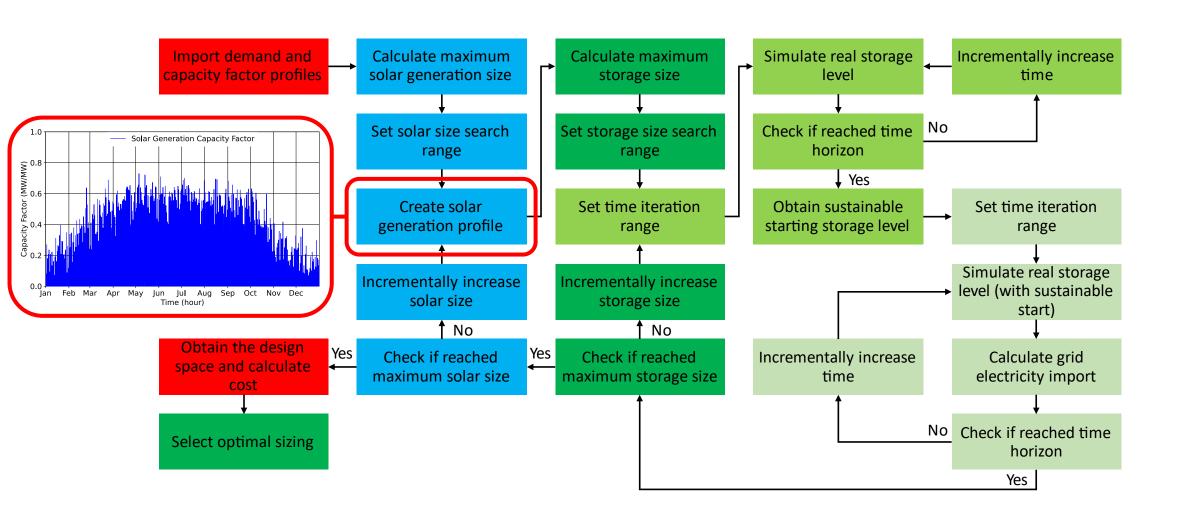


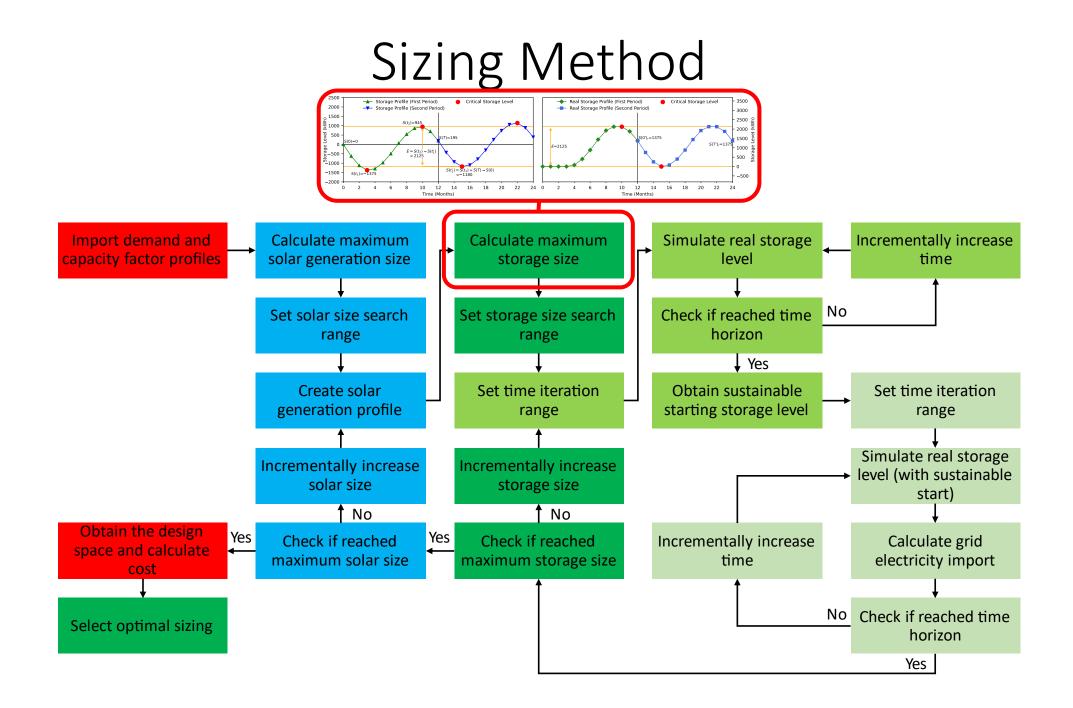


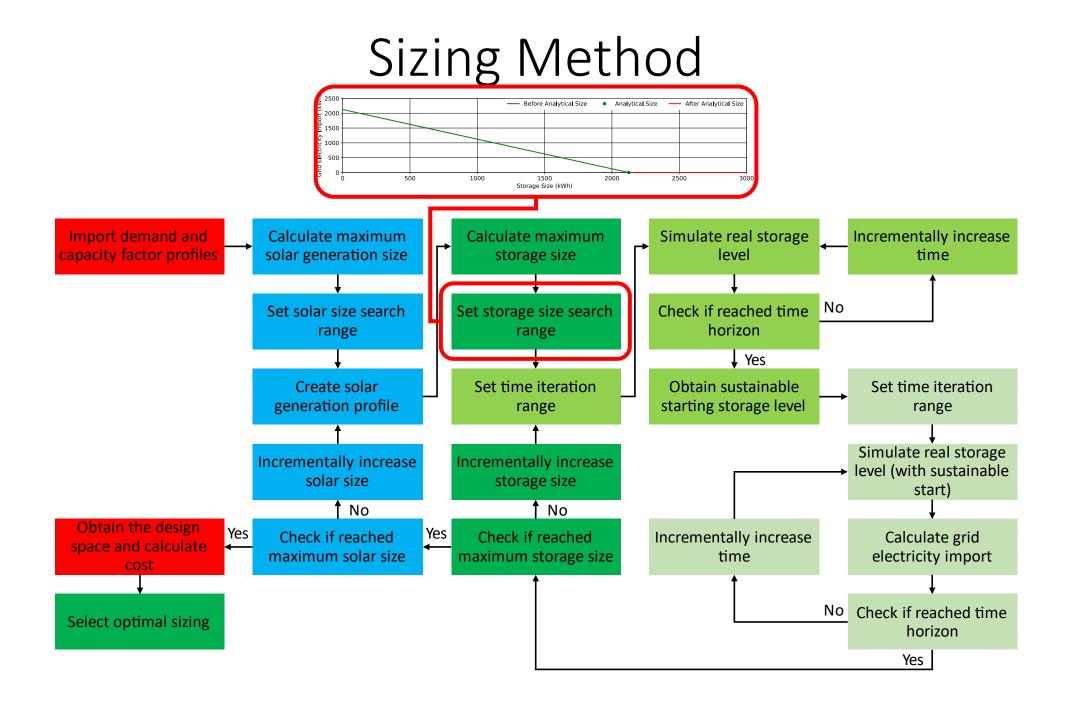


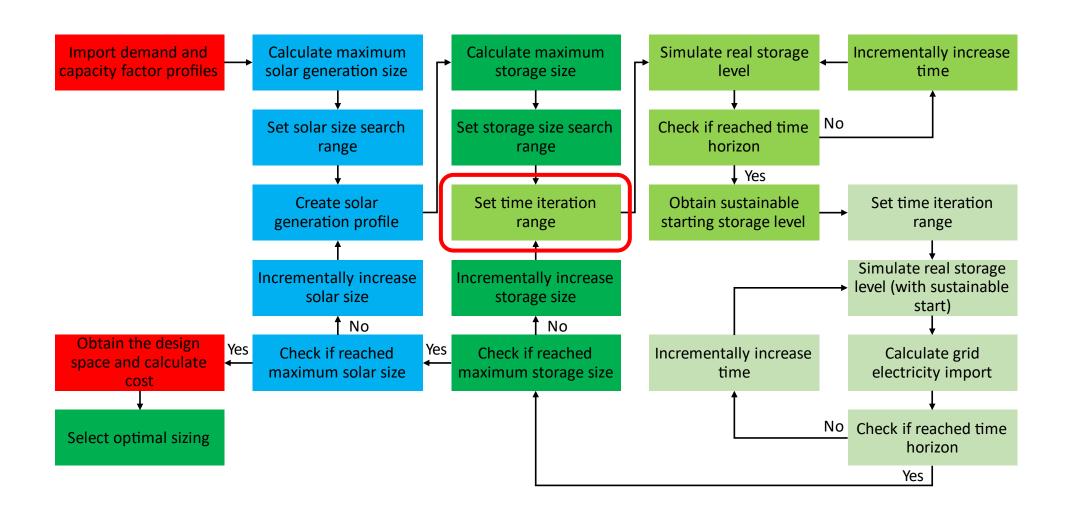


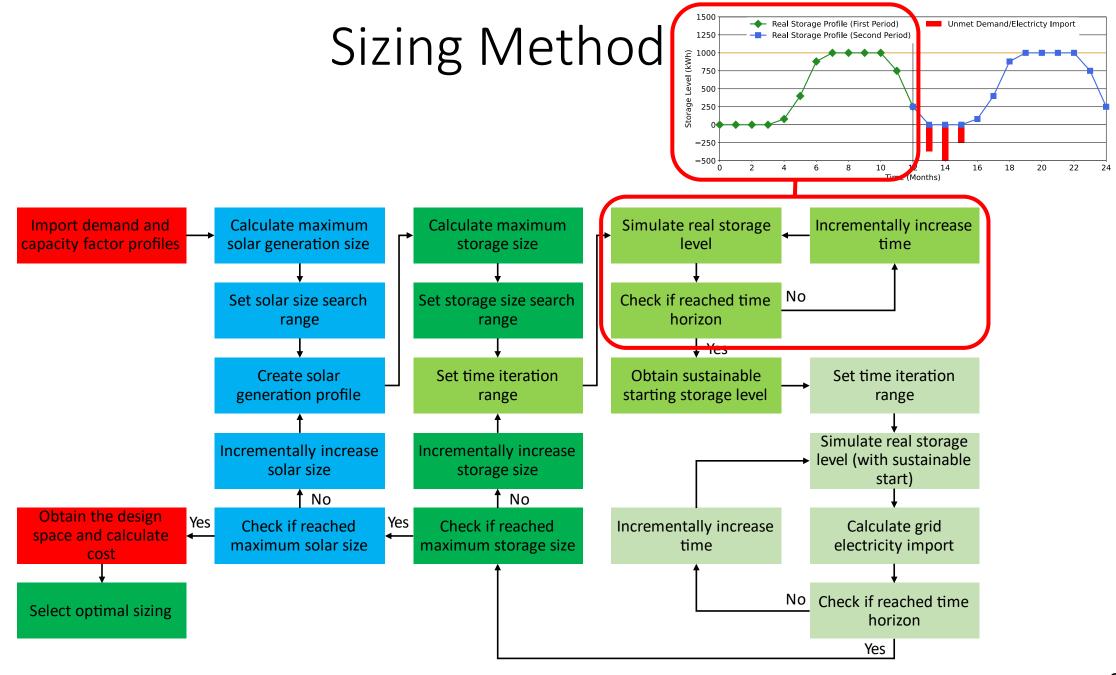


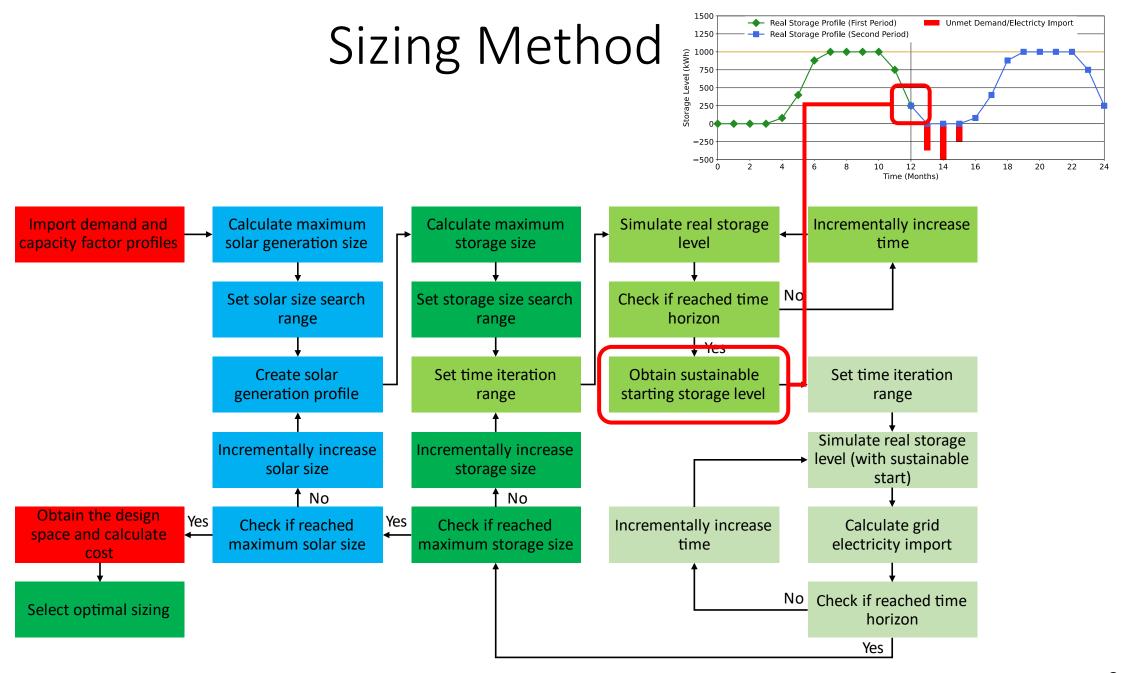


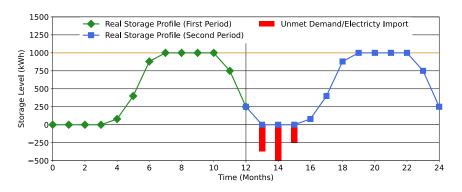


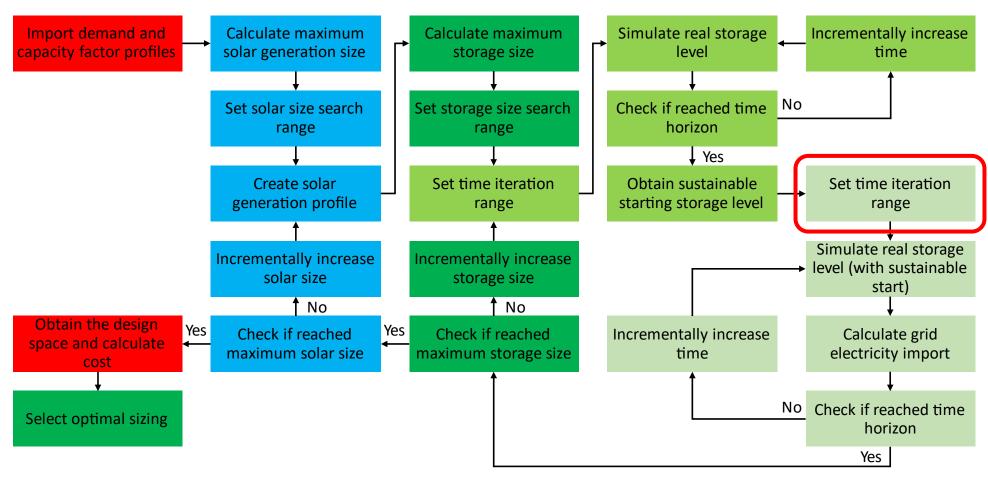




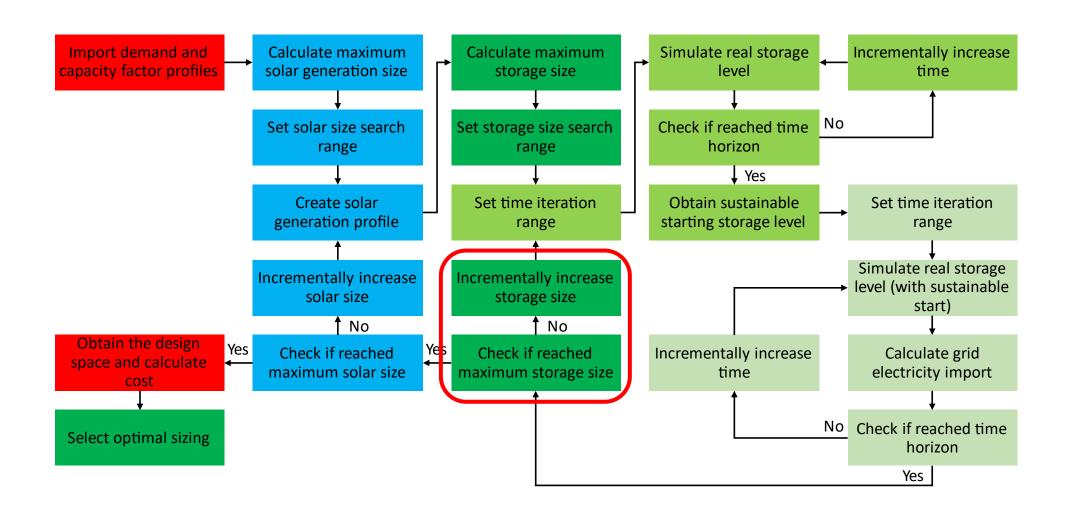


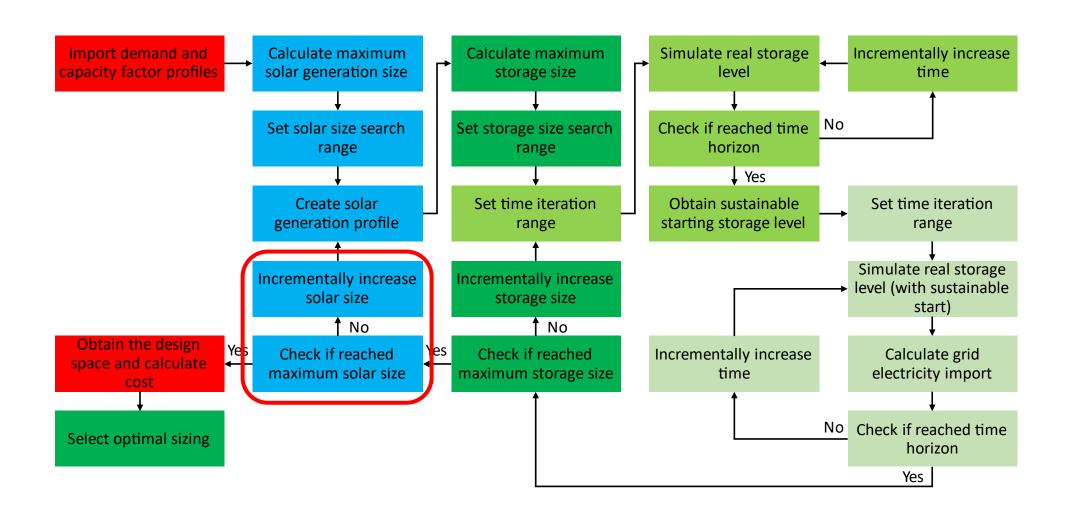


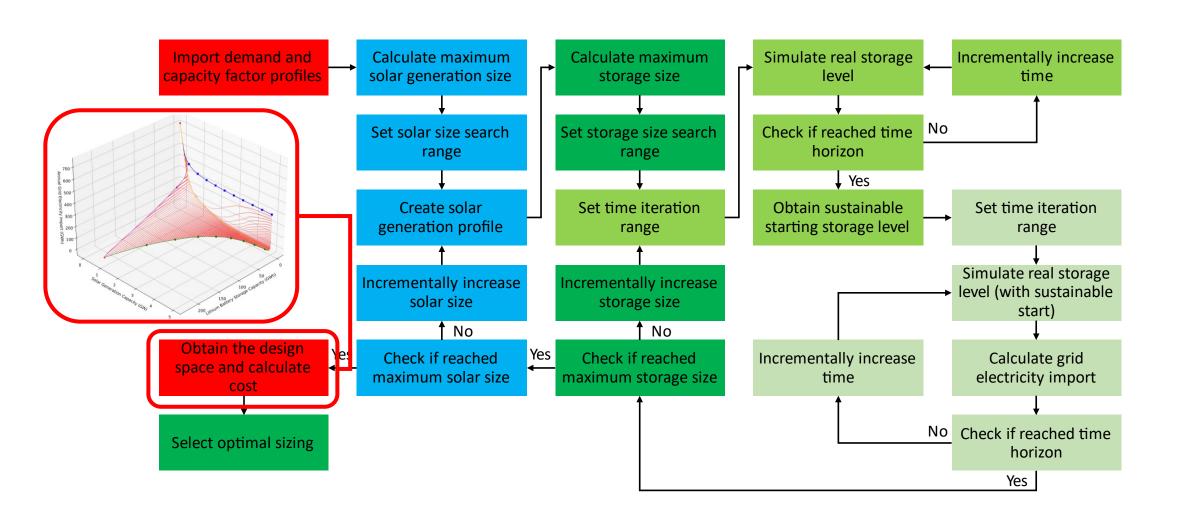


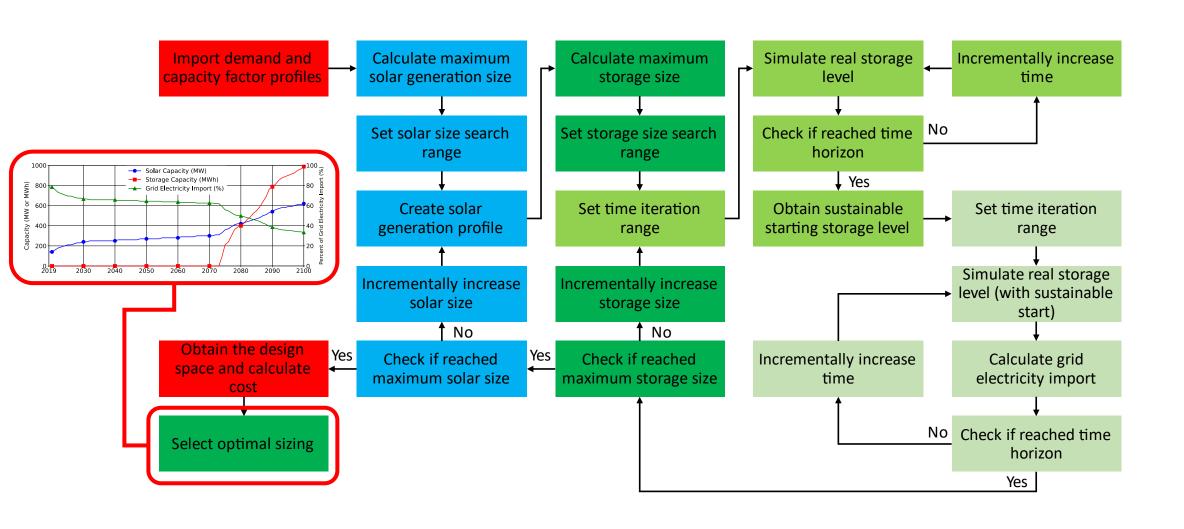


Real Storage Profile (First Period) Unmet Demand/Electricty Import Sizing Method Real Storage Profile (Second Perio (kWh) 750 16 18 20 22 Import demand and Calculate maximum Calculate maximum Simulate real storage Incrementally increase capacity factor profiles solar generation size storage size level time No Check if reached time Set solar size search Set storage size search range horizon range ↓ Yes Create solar Set time iteration Obtain sustainable Set time iteration generation profile starting storage level range range Simulate real storage Incrementally increase Incrementally increase level (with sustainable solar size storage size start) No No Obtain the design Yes Yes Check if reached Check if reached Incrementally increase Calculate grid space and calculate maximum solar size maximum storage size time electricity import cost No Check if reached time Select optimal sizing horizon Voc







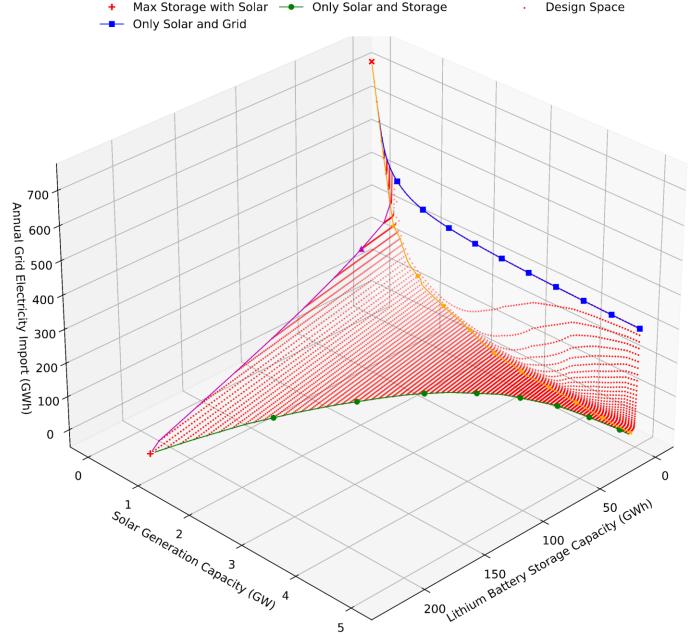


Design Space

Increasing solar size reduces grid electricity import. However, the reduction has a limit, as solar do not generate energy at night

For a particular solar size, increasing storage reduces grid electricity import. The initial reduction is large, but later reduction shows diminishing return

Small solar size cannot support independent energy system, the first solar size that can support the system also requires the largest storage

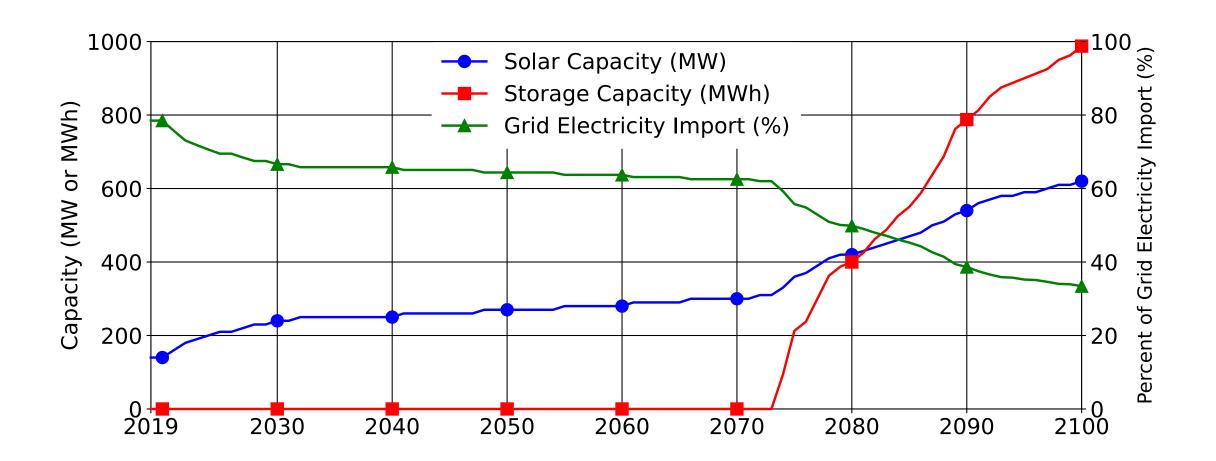


→ Max Storage with Solar and Grid

Transition

Only Grid

Future Trend



Conclusion

Currently

Solar PV is economically competitive, but lithium battery storage is still too expensive.

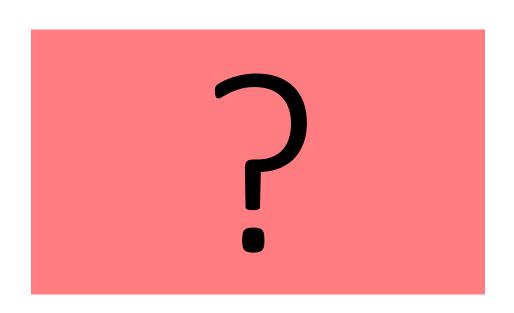
Future

Solar and storage will take up greater portion of the energy system, as their prices continue to drop.

However

Flexible grid electricity is needed, to meet some demands too costly for solar and storage.

Question and Contact



Contact

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