

Please limit to 10 min (presentation 7-8 minutes + questions 2 min)
Repeat the question on the first slide

Exercise 1.1 PV for family Müller

Please describe (preferably as a PPT presentation):

Family Bonnet in Lausanne consumes 3500 kWh of electricity in a year.

- a) What should be the nominal power of a PV system in order to generate this amount of energy? (assume south orientation of modules)
- b) What module area is required when the modules have an efficiency of 20%?
- c) What is return-on-investment time for such a grid-connected system in Lausanne in 2024?

Use lecture notes and web resources

Exercise 1.2 Shockley–Queisser limit

Please explain the main steps in derivation of the theoretical limit for the conversion efficiency for unconcentrated light (the Shockley–Queisser limit or detailed balance limit)

Literature:

W. Shockley and H.J. Queisser, "[Detailed Balance Limit of Efficiency of p-n Junction Solar Cells](#)", *Journal of Applied Physics*, Volume 32 (March 1961), pp. 510-519

Also papers and web resources for better explanation

Exercise 1.3 Solar module degradation and failure

Please describe (preferably as a PPT presentation):

- Possible failures of PV modules
- Mechanisms of degradation (light-induced, potential-induced, long-term)
- Statistics and occurrence of different failure modes in modern PV installations

Literature:

IEA-PVPS-T13-30-2025-REPORT-Degradation-and-Failure.pdf

PVeducation.org

<http://pveducation.org/pvcdrom/modules/degradation-and-failure-modes>

other papers & web references

Exercise 1.4 Material availability

Please describe (preferably as a PPT presentation):

- What is the potential of various PV technologies for global-scale electricity generation based on the material availability and current production rates.
- Identify key elements that may potentially limit: c-Si, CdTe, CIGS, OPV, perovskite solar cell technologies.

Literature:

The Future of Solar Energy, AN INTERDISCIPLINARY MIT STUDY, 2015

https://mitei.mit.edu/system/files/MIT%20Future%20of%20Solar%20Energy%20Study_compressed.pdf

"Materials availability for thin film (TF) PV technologies development",

<https://doi.org/10.1016/j.rser.2011.06.012>

And other literature references

Exercise 1.5 Radiative cooling of PV modules

Please describe (on PPT slides):

Choose the best approach for radiative cooling of PV modules, based on both performance and real-world applicability.

Literature:

<https://www.sciencedirect.com/science/article/pii/S0038092X25002087>

<https://www.nature.com/articles/nature13883>

<https://pubs.acs.org/doi/10.1021/acsphotonics.2c01389>

and others

Exercise 1.6 Perovskite PV for space applications

Please describe (on PPT slides):

What is the potential of perovskite PV for space applications (e.g. satellites on the LEO). Consider the following requirements:

- specific power in watts per kg
- radiation hardness
- temperature cycles
- solar spectrum and intensity
- mechanical and operational stability

Literature:

ACS Appl. Energy Mater. 2025, 8, 23, 17246–17256

<https://www.nasa.gov/general/nasa-begins-new-deployable-solar-array-tech-demo-on-pathfinder-spacecraft/>

and other literature resources