

Solar energy - II

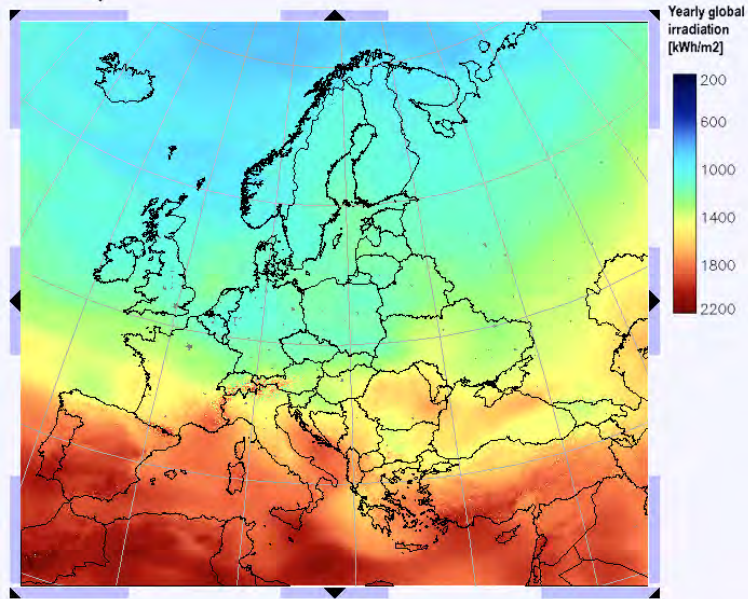
for (heat and) electricity

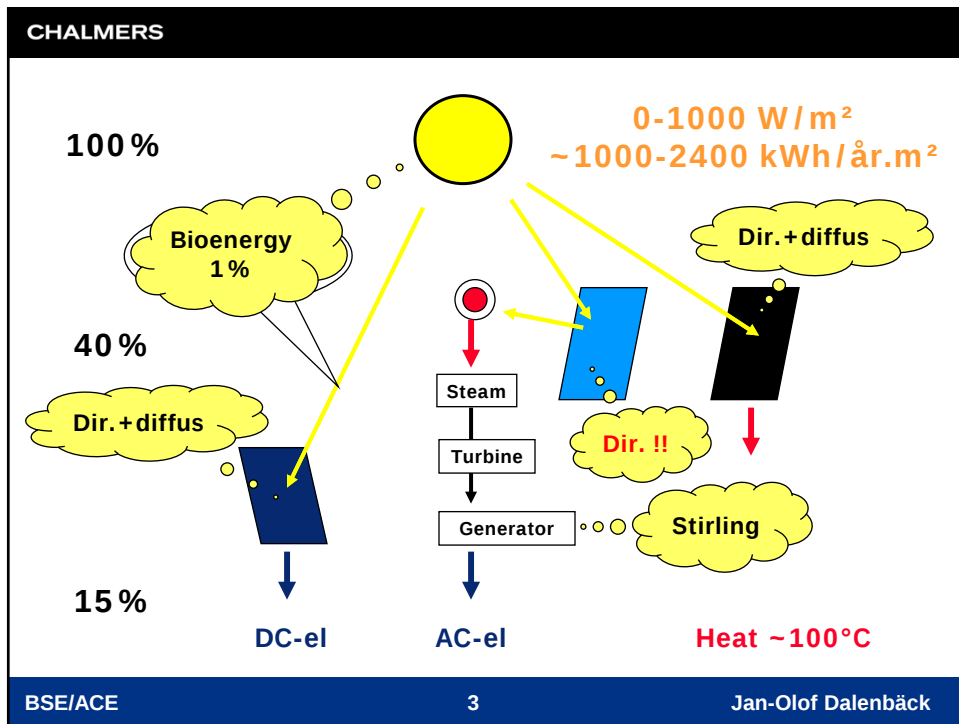
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Professor in Building Services Engineering



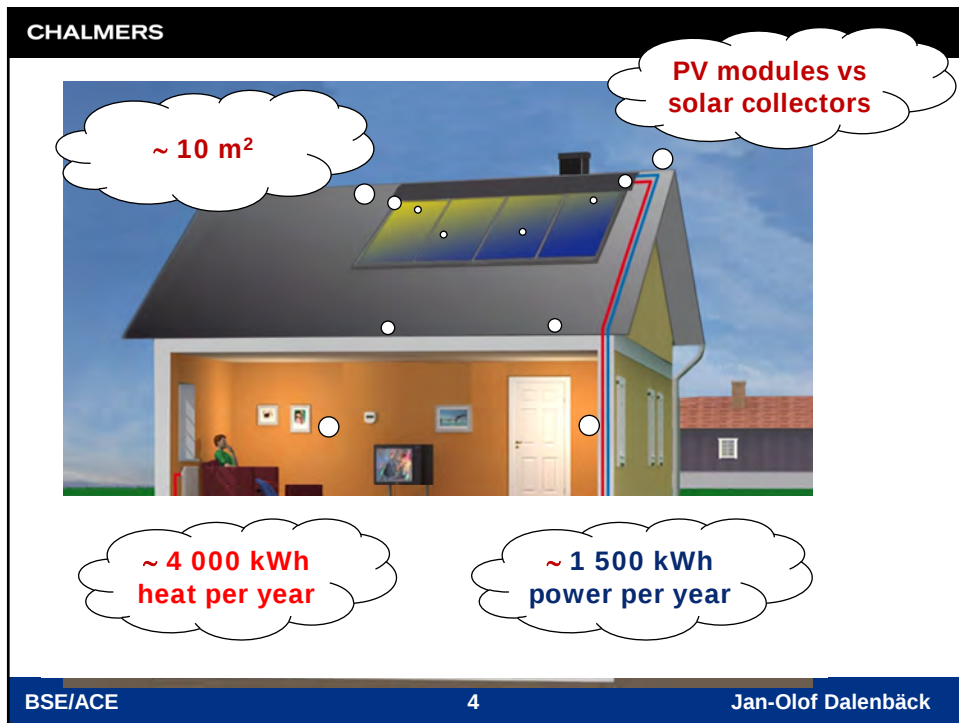
www.svensksolenergi.se

CHALMERS – Sep 28, 2020



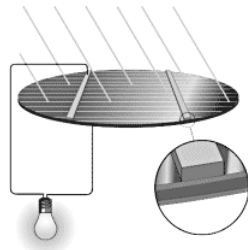
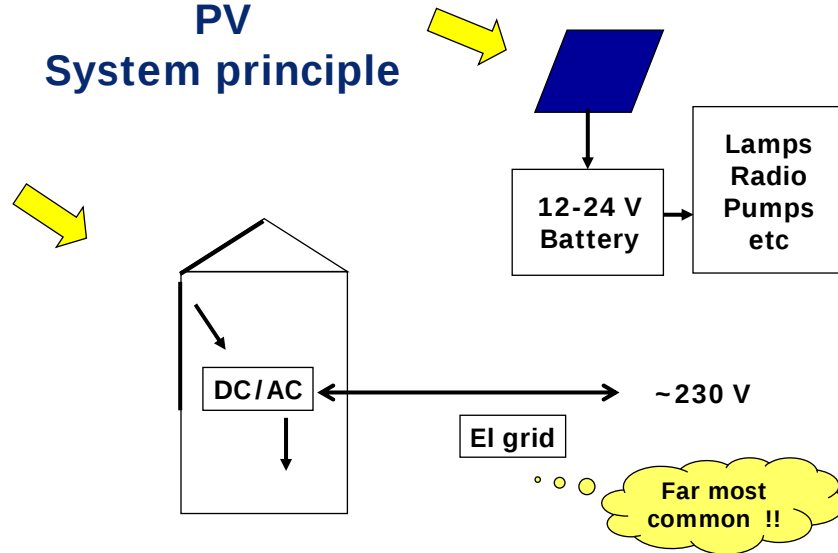


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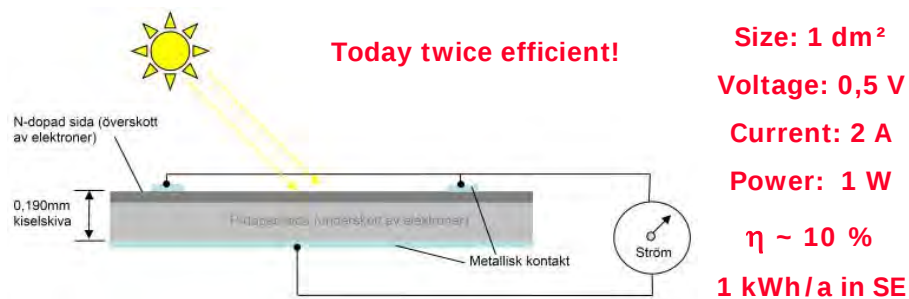
PV System principle



- Solar (PV) cell: Silicon plates, misc. metals ..
- Module: Solar cells connected to each other ..
- Solar radiation is absorbed in the solar cell (semi-conductor) .. creates a potential .. electrones move and create a current .. electricity .!

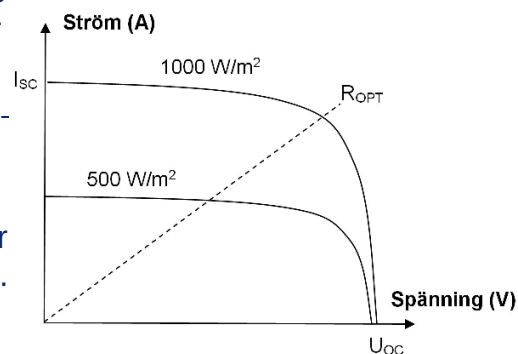
Solar cell - Semiconductor

- Photons (light) carries energy down in the cell to the electrons that make them jump/move ..
- A circuit will guide the electrons .. a current is created ..



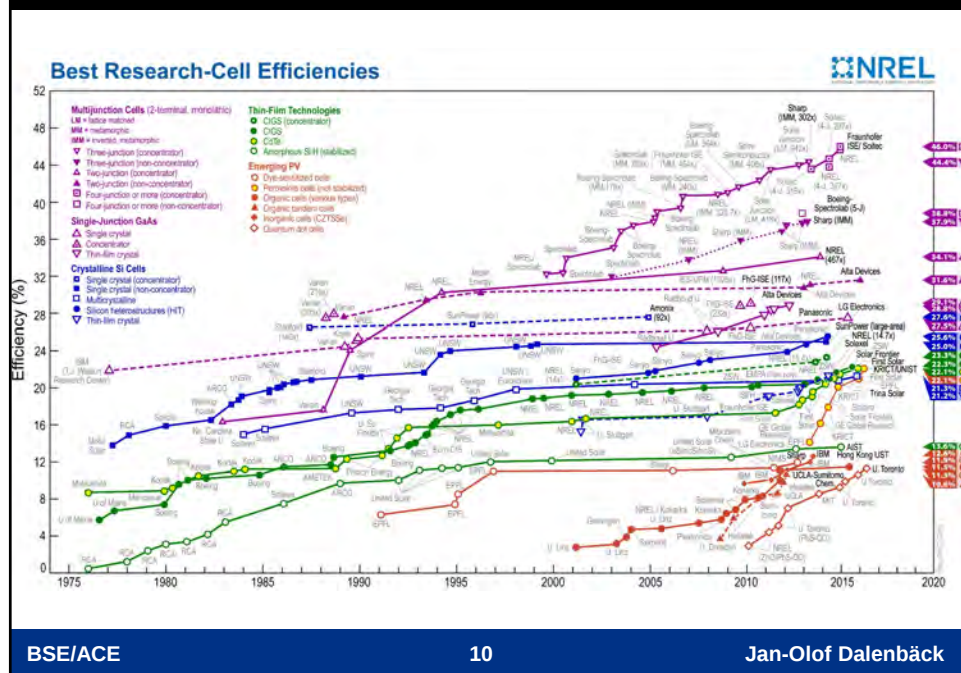
PV characteristics

- U_{OC} - open circuit voltage
– not dependant on solar radiation intensity ..
- I_{SC} - short circuit current -
proportional to solar radiation intensity ..
- R_{OPT} – resistance/load for
optimum energy output ..



Solar (PV) cells

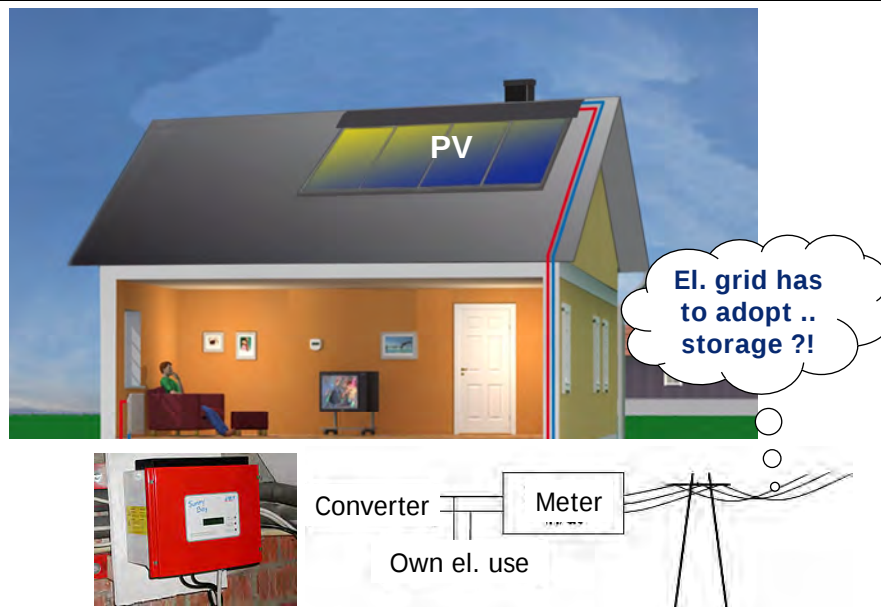
- **Trad. silicon cells (Si)**
 - Mono crystalline – perfect symmetry – high efficiency
 - Poly crystalline – less symmetry – cheaper – lower efficiency
- **Thin film cells** – a thin layer light sensitive material – cheaper (less material) – lower efficiency – shorter life time ?
 - aSi – amorf silicon – disordered crystals
 - CIGS or. CIS – copper (Cu) indium (In) gallium (Ga) selenid (Se)
 - CdTe – kadmium (Cd) tellurid (Te)
- **2-3-4 junction cells** – several layers – eff. > 40 %
- **"Grätzel cell"** – wet sol-dye + electrodes
- **Polymer cells** – can be "printed" eff. >10% i labb ..



PV systems on buildings

Residential / Commercial

Building mounted / integrated



PV - I

- PV generate electricity .. Mainly during the summer months ..!
- All grid connected buildings have the "same" electricity system.. !?
- Placing of modules ..?
- Roof integration/mounting ..
- Sun shading, facades .. ??
- Types .. Classes .. ?
- Different appearance ..

- Monocrystalline silicon
- Polycrystalline silicon
- Thin film (CIGS)



PV - II

- $\sim 100\text{-}150 \text{ W/m}^2$; $\sim 100\text{-}150 \text{ kWh/yr/m}^2$
- $\sim 800\text{-}1100 \text{ kWh/yr/kW}$
- Dimension for own use .. !?
- Sell electricity to the grid .. !?
(Feed.in.tariffs in Germany)
- Call for tender ..!?
- Ask for IEC-certification
- Ask for references !



Medicus

EKSTA





Gavlegårdarna 2011



Library Linköping



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Inverter
 Note! Become warm !
 Inside – Outdoors ?

Maint. flat roofs (Gårdsten 2013)



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Derome – Varberg Energi - 2018



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PV systems on ground

"Power plants"





- Österlen
- 440 kW – 2012
- Combo wind power
(same grid transformer)

- Mälarenergi
- 1 MW - Tracking
- Along E18



- “Solsidan”
- Varberg Energi
- 2.7 MW - 2016
- Along E6
- Combo
wind power
(connected to
the same grid
transformer)



2017-07-22 / JOD

- Jämtkraft + Östersundshem
- 3 MW - Andelsförening - 2019



Svenska solparker

- 2016: Solsidan – Varb. Energi ~ 3 MW
- 2018: Solevi – Göteborg Energi - >5 MW
- 2019: Sjöbo – Svea Solar - >6 MW
- Östersund – Jämtkraft+ - 3 MW
- 2020: Linköping – Swedbank - 12 MW
- Strängnäs – HSB - 14 MW
- 2021: ??
- 2022: ? .. > 100 MW .. ?



- Denmark
- 60 MW - 2015
- Near Copenhagen
- Operated by SMA





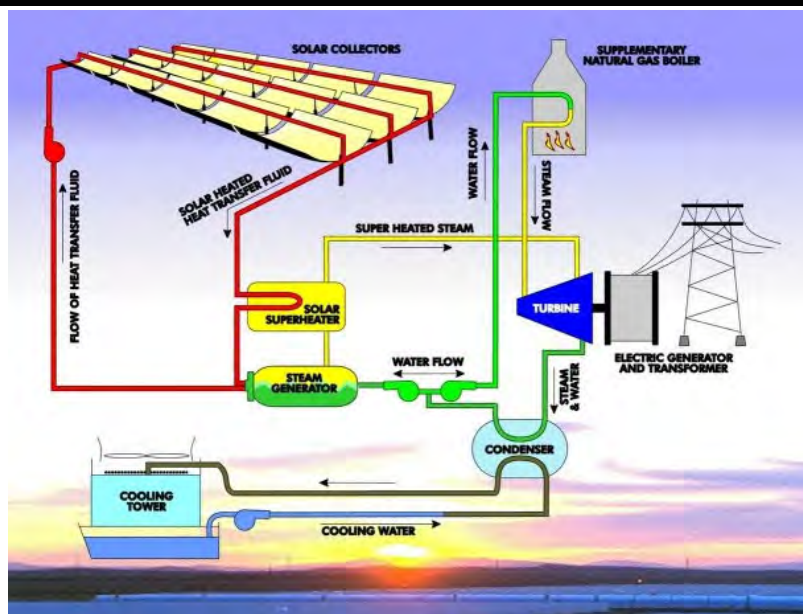
Misc. PV [MW] - 2015

- **3 – Largest plant SE**
- **15 – NO installed**
- **60 – Largest plant DK**
- **120 – SE installed**
- **~ 800 – DK installed**
- **~ 1 000 – Largest plants !!!**
- **~ 40 000 – DE installed**
- **~ 100 000 – Europe installed**
- **> 220 000 – Globally installed**

Conc. Solar Power / Electricity

Works on the direct solar radiation
(not the diffuse part !)

"Sunbelt" countries
South of Spain - California



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Concentrated Solar Power (CSP)

Turbine from Sweden ?

60 MW_e - Nevada 2007
(354 MW_e 1984-90)

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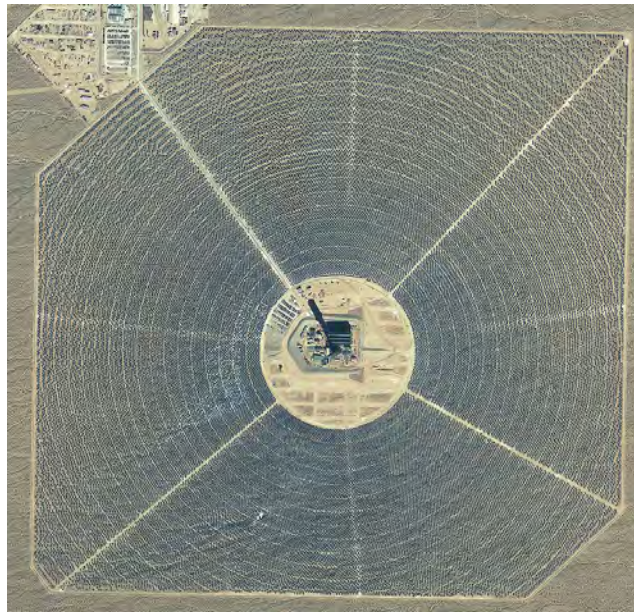
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Tower with steam generator

Heliostats (Mirrors)

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Parb. dish with Sterling engine

.. from Sweden ?

