Factory Planning for a start up technology

Based on selected criteria for Oerlikon Solar's PV technology

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Agenda

1. Oerlikon Solar‘s mission & business
2. Factory planning: Development of energy and CDA consumption over time
3. Conclusion & outlook
4. How to trim LCA for the industry?

Oerlikon Solar's mission is to make solar power economically viable.

Oerlikon provides end-to-end (E2E) production solutions…

Front-End

Clean | TCO FC | Laser | Clean | PECVD | Laser | TCO BC | Laser | Voc

Line Automation

Back-End

Contacted Tested Device

Contact | White Reflector | Edge Isolation | Flasher

Encapsulation-Lamination

Cross Contact | Lami-nation | Junction Box | Flasher

…and all critical components for module production…

Laser Scribers (LSS) Define Cells	PECVD (KAI) Deposit PV Material	LPCVD (TCO) Deposit contacts

LSS1200

Laser Scribing Solutions for the Industrial Production of Large-Area Thin-Film Solar Modules

KAI1200

Amorphous and Micromorph® High-Performance Layers for Large-Area Thin-Film Silicon Solar Modules

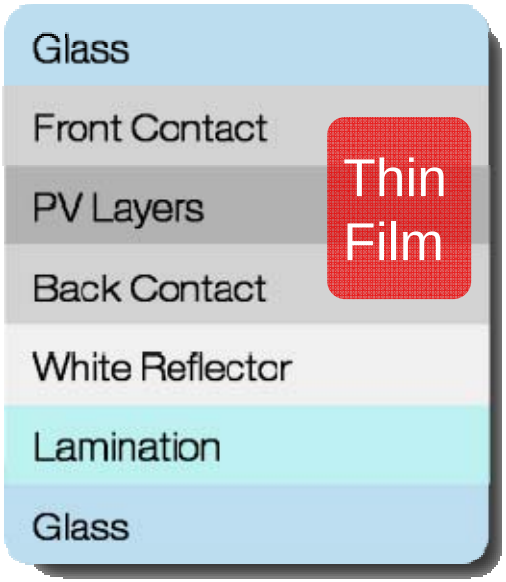
TCO1200

Transparent Conductive Oxide High-Performance Layers for Large-Area Thin-Film Solar Modules

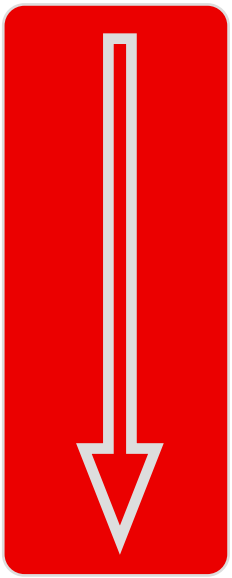
Thin film solar cell basics

Thin Film Solar Modules

Cell Structure



Manufacturing



Technology	Stabilized efficiencies	
amorph	7.0%	90 Wp
micromorph	9.3%	125 Wp

Factory planning

The driving force for PV development is to reach Grid Parity

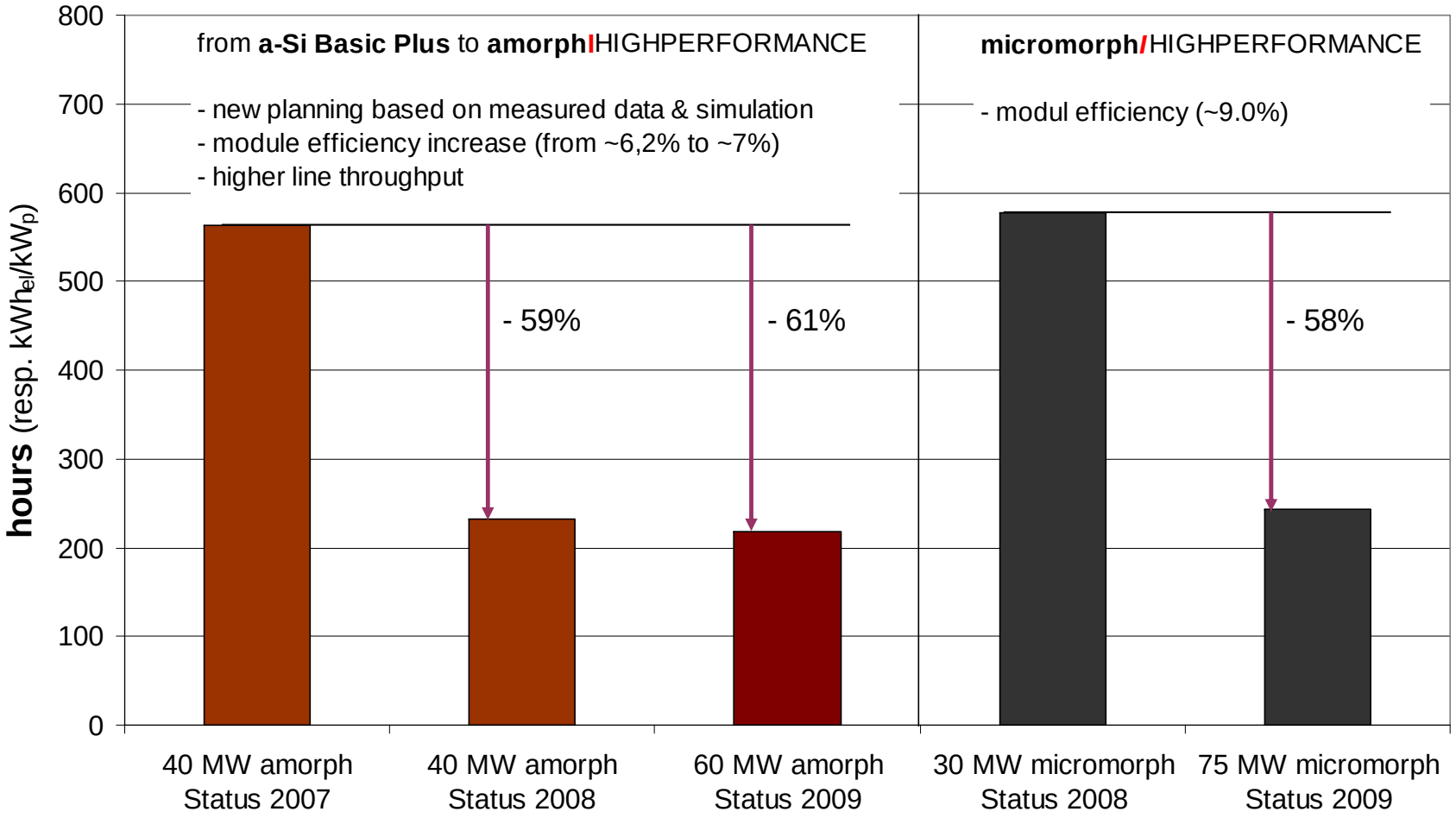
$$\frac{\$}{W_p} = \frac{\text{Total Cost}}{\text{Throughput x Power}}$$

Implications for Oerlikon Solar	Oerlikon Solar's approaches	Effect on the LCA
Reduce total costs	▪ **Simplify production** e.g. eliminate equipments & process steps ▪ **Simplify equipments** e.g. save materials, eliminate or combine process steps ▪ **Optimize factory planning** e.g. harmonize requirements, apply economies of scale	▪ Lower media requirements & consumption
Increase throughput	▪ Increase cycle time	▪ Higher total consumption but ▪ Lower consumption/module
Increase modul efficiency	▪ Investment into R&D ▪ R&D roadmap	▪ Higher output over the lifetime of the module

All actions to meet the cost down pressure go along with a better LCA of the module

Reduction of electricity consumption over time

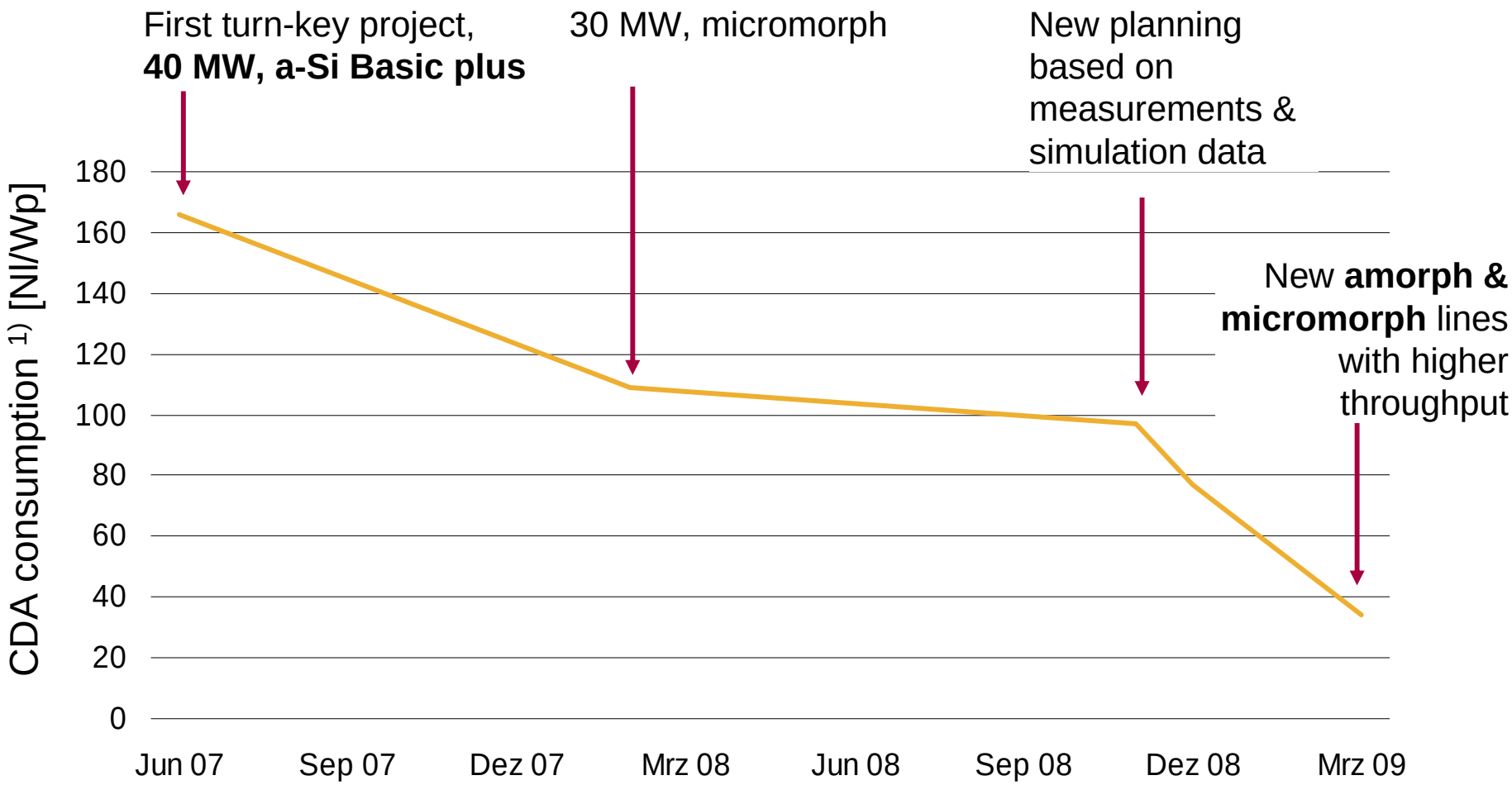
Based on factory planning data for selected projects



Calculated for the electricity consumption of Oerlikon equipments. Factory requires app. 50% additional electricity, materials not included

Reduction of CDA consumption over time

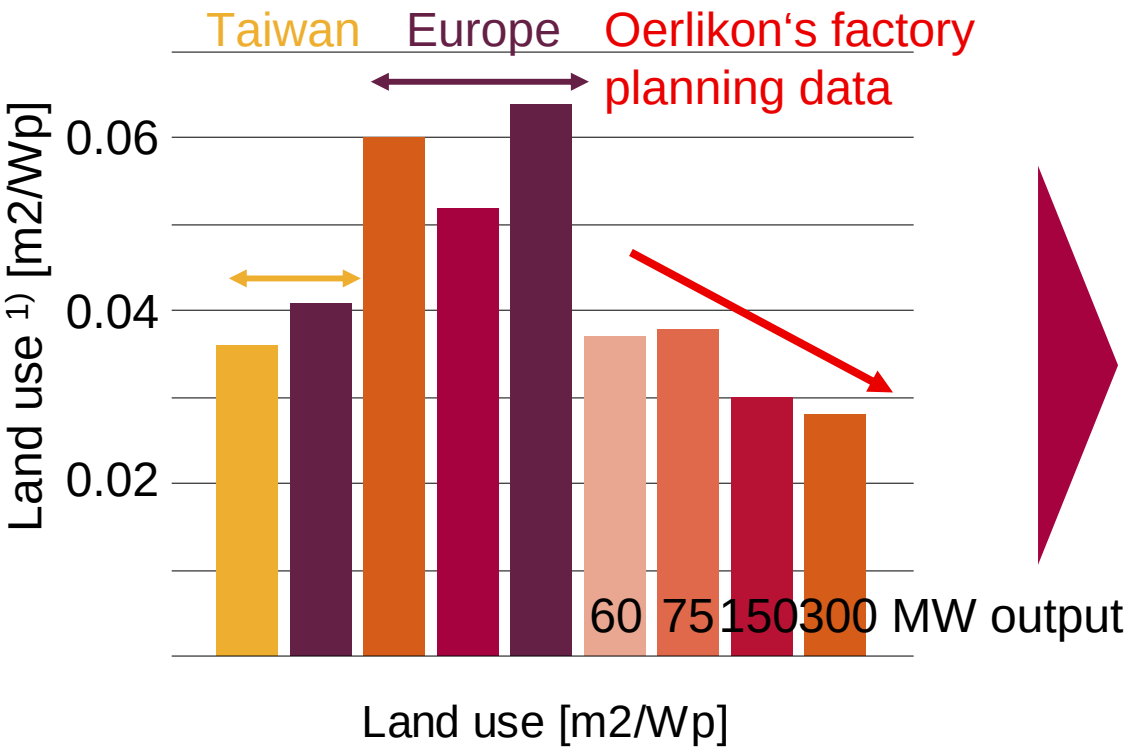
Based on factory planning data for selected projects



1) calculated for the CDA consumption of Oerlikon Solar's equipments.

Land use for factories with comparable outputs

Based on selected projects and factory planning data



- In Taiwan, estates are small. So, customers must fit the factory onto a much smaller area
- Customers in Europe have higher land use compared to Taiwan
- Scaling effects are relatively small and only appear for bigger factories (60 MW to 300 MW)

1) calculated for the output of one year for the respective project

Conclusion & outlook

Significant improvements but still a long way to go

The factory planning for utilities such as electricity and CDA was given little attention in the beginning, the primary focus was to run the process. This lead to an oversizing of cables, transformers and pipes (contribution to grey energy).

- **Electricity and CDA** could be reduced significantly by measuring the consumption under production conditions.
- Increase of throughput and module performance also contributed to the reduction per W_p.
- External restriction (e.g. small estates) and a clever factory planning probably contribute more to a better land use than scaling effects.

Outlook:

- To achieve grid parity, Oerlikon has to continuously reduce its consumptions by simpliying processes & equipments.

How to trim LCA for the industry?

- **Provide simple decision tools for engineers**
  How can I reduce the environmental impacts of my equipment/process? What materials have big impacts, which have less?

- **Do not spread LCA‘s with high uncertainty among society**
  It is difficult for society to assess uncertainty. A wrong message easily fixes in the common knowledge.

- **Maintain its excellent reputation**
  Take care that LCA‘s are not abused and loose their reputation.

oerlikon
solar

Thank you