

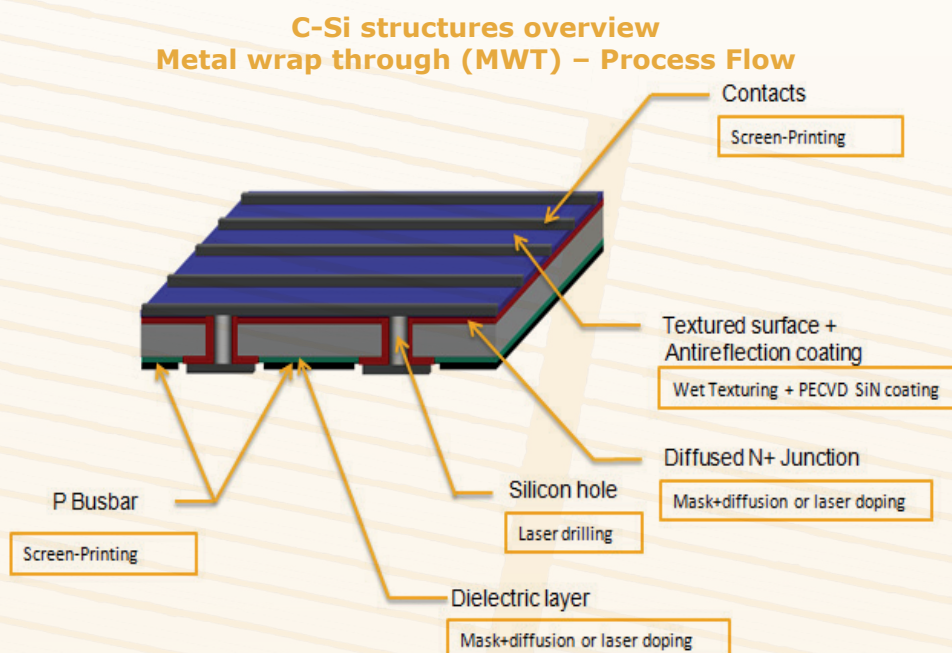
Photovoltaic Technology Roadmap

MARKET & TECHNOLOGY REPORT - SEPTEMBER 2010

*Latest technology trends in crystalline and thin-film solar cells
An overview on the PV industry up to 2015*

STRATEGIES TO REDUCE THE PRODUCTION COST

Making photovoltaics a low-cost source of clean and renewable energy is the main goal for most of developed countries. Many of them have agreed on a 20% renewable energy target by 2020, and some already started to implement aggressive feed-in-tariffs to finance this objective. But the question is how do we get there from what has been achieved so far? What would happen if governments partially stop financing the PV industry through incentive program cuts as in Germany for instance? Can today's technologies be competitive without the incentives or do we need technical evolutions, or even technical breakthroughs to get there?



Source: Dr Daniel Biro – Fraunhofer ISE- PHOTON 3rd PV Production Equipment Conference

KEY FEATURES OF THE STUDY

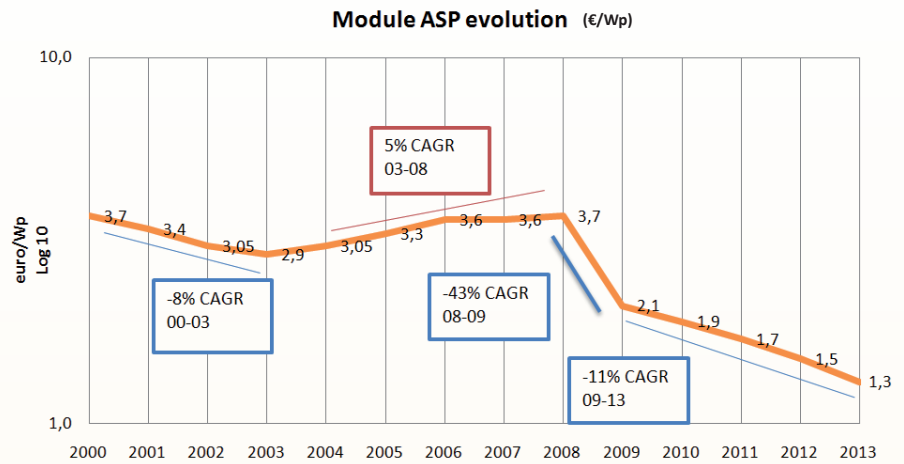
The objectives of this report are:

- To provide market trends on module price, installations breakdown by technology, production capacity utilization
- To provide key technical insights about future technology trends and challenges
- To provide a deep understanding of new improvements that will occur with the current C-Si cell design: emitter profile optimization, fine line metallization, front and rear surface passivation layer optimization and a better surface structuring.

INTRODUCTION

There is no doubt that the government incentive programs helped industrials to achieve, step by step, drastic cost reduction and performance improvements in a very short period of time but without real revolutions. The PV industry has also seen the emergence of large-scale production facilities, international R&D centres, and innovative equipment makers thus resulting in the impressive cost reduction we know.

But if large production facilities can play the scale effect card to lower the cost of raw material and increase their yield, many other levers exist in order to reduce the production cost.



In this PV Technology roadmap report, we describe all the different aspects linked to production cost reduction: from cell structure innovations to modification of manufacturing processes. We in fact describe all the existing technologies: From those developed by the University of New South Wales (UNSW), to the metal wrap through (MWT) concept developed by the ECN and industrialized with Solland, to the new emitter wrap through (EWT) technology being developed by Bosh Solar.

Conventional crystalline silicon cells could bump up against their theoretical maximum efficiency of 29% as soon as 2020. Sanyo Electric Co. Ltd., for instance, demonstrated ~23% efficiency with a 10cm² R&D unit of its heterojunction with intrinsic thin layer (HIT) cells last year.

It figures that thinner surface contacts, better transparent conductors, and lower defect density can improve performance by several more percentage points, to likely get commercial efficiency up to about as close as practical to the theoretical limit within about ten years.

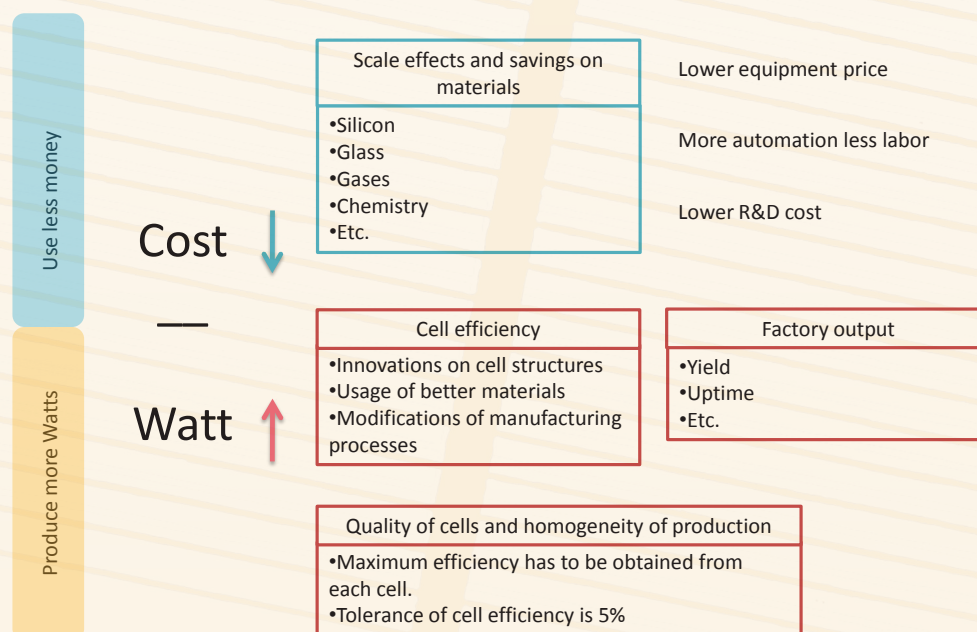


TABLE OF CONTENTS

EXECUTIVE SUMMARY

PV OFFER: MARKET DESCRIPTION AND FORECAST

- Description of the technologies - Family of materials
- Efficiency / Development status by technology- 2008-2010 situation
- Efficiency / Production cost- Early 2010 situation
- Fab capacity utilization by technology
- Breakdown by technology
- Overview of efficiency potentials

PV DEMAND EVOLUTION

- Mid-term forecasts up to 2013

CONCLUSIONS

- Wafer-based technology:
 - o Requirements for higher efficiencies
 - o Cell structure evolution
 - Emitter profile optimization
 - Passivation
 - Passivated cells development Roadmap
 - Identified Players
 - o Manufacturing Technology Cluster Roadmap
- Thin-Film technologies - Cell structure
 - o Equipment providers and proprietary-technology based manufacturers
 - o Identified player

PV TECHNOLOGY ROADMAP: STRATEGIES TO REDUCE PRODUCTION COST

- Moore's Law?
- Price reduction - impact of raw material
- Cost per Watt ratio
- Major levers
- Cost breakdown

DEVELOPMENT TRENDS ON C-SI CELLS

- Introduction
 - o Standard cell
 - o Passivated emitter cell
 - o Metal wrap through cell
 - o Emitter Wrap through cell
 - o Heterojunction with intrinsic thin layer cell
 - o Interdigitated back-junction cell
- Advanced Cell Concept Production
 - o Examples with Solland, Bosh or Stiebel
- New Manufacturing Steps
 - o Metallization
 - o Dopant Diffusion
 - o Silicon Structuring
- New Manufacturing Technologies
 - o Thin wafers
 - o NIL
 - o Inkjet

DEVELOPMENT TRENDS IN THIN FILM SOLAR CELLS

- Breakdown by technology
 - o Amorphous Silicon (a-Si)
 - o Tandem (a-Si/ μ -Si)
 - o Cadmium-telluride (CdTe)
 - o Copper indium gallium (di)selenide (CIGS)
- New manufacturing technologies
 - o Transparent Interlayer
 - o Electrodes structuring
 - Example of Nano-imprint lithography

SPECIFIC PROCESSES/POTENTIAL GAME CHANGERS

BIO



Arnaud Duteil was granted a Master's Degree in Innovation and Technology Management and a Master's Degree in Engineering. He is in charge of photovoltaic market analysis and reports at Yole Développement.

WHO SHOULD BUY

- Marketing executives will find key figures and concepts for their strategic plan and product offer.
- Technical managers and directors will find a complete description on the PV manufacturing processes evolution in order to find new business opportunities either in the wafer-based or thin-film markets.

COMPANY INDEX

Solland, ECN, Kyocera, Nedo, SunPower, NREL, Photovoltech, IMEC, AMAT, Advent Solar, Sandia National Lab, SunTech Power, UNSW, Schott, Nanogram, Innovalight, Solyndra, Philips Miplaza, Oerlikon, Kaneka, Veeco, Ulvac, Centrotherm, Canon Anelva, Von Ardenne, Roth and Rau, First Solar, Intevac, Energo Solar, EPV, Kalixo, Abound Solar, Antec Solar, Arendi, Heliosphera, Inventux, Mitsubishi, Sharp, Sunfilm, Auria Solar, E-Ton, GET, Bosh Solar, UniSolar, Flexcell, Xjet, Optomec, Schmid, Rena, Georgia Tech, Schmalz, Semitool, Fraunhofer, Synova, Toyo Advanced Technologies, Evergreen Solar, SiGen, Rofin, Day 4 Energy, X-jet, University of Konstanz, etc.

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Contact:

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The present document is valid 12 months after its publishing date: 1st September 2010.

BILLING CONTACT

First name: Last name:
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Created in 1998, Yole Développement is a market research and strategy consulting firm analyzing emerging applications using silicon and micro manufacturing. With 20 full time analysts tracking MEMS, Microfluidics, Compound Semiconductor, Power Electronics, Photovoltaic, Advanced Packaging and Nanomaterials, Yole Développement supports companies and investors worldwide to help them understand markets and follow technology trends.

SERVICES

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- Collection of market & technology reports
- Players & technology databases and market data
- Manufacturing cost simulation tools
- Component reverse costing analysis
- More information on Yole.fr in reports section

MEDIA

- Critical news, bi-weekly: Micronews
- In-depth analysis & Quarterly Technology Magazines: MEMS Trends - 3D Packaging PV Manufacturing
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1.1 The Contracting Parties undertake to observe the following general conditions when agreed by the Buyer and the Seller. ANY ADDITIONAL, DIFFERENT, OR CONFLICTING TERMS AND CONDITIONS IN ANY OTHER DOCUMENTS ISSUED BY THE BUYER AT ANY TIME ARE HEREBY OBJECTED TO BY THE SELLER, SHALL BE WHOLLY INAPPLICABLE TO ANY SALE MADE HEREUNDER AND SHALL NOT BE BINDING IN ANY WAY ON THE SELLER.

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2.2 Some weeks prior to the release date the Seller can propose a pre-release discount to the Buyer

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2.4 The mailing is operated through electronic means either by email via the sales department or automatically online via an email/password. If the Product's electronic delivery format is defective, the Seller undertakes to replace it at no charge to the Buyer provided that it is informed of the defective formatting within 90 days from the date of the original download or receipt of the Product.

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Bank code: 30056

Branch code: 00170

Account n°: 0170 200 1565 87

BIC or SWIFT code: CCFRFRPP

IBAN: FR76 3005 6001 7001 7020 0156 587

To ensure the payments, the Seller reserves the right to request down payments from the Buyer. In this case, the need of down payments will be mentioned on the order.

3.4 Payment is due by the Buyer to the Seller within 30 days from invoice date, except in the case of a particular written agreement. If the Buyer fails to pay within this time and fails to contact the Seller, the latter shall be entitled to invoice interest in arrears based on the annual rate Refi of the «BCE» + 7 points, in accordance with article L. 441-6 of the French Commercial Code. Our publications (report, database, tool...) are delivered only after reception of the payment.

3.5 In the event of termination of the contract, or of misconduct, during the contract, the Seller will have the right to invoice at the stage in progress, and to take legal action for damages.

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4.1 The Buyer or any other individual or legal person acting on its behalf, being a business user buying the Products for its business activities, shall be solely responsible for choosing the Products and for the use and interpretations he makes of the documents it purchases, of the results he obtains, and of the advice and acts it deduces thereof.

4.2 The Seller shall only be liable for (i) direct and (ii) foreseeable pecuniary loss, caused by the Products or arising from a material breach of this agreement

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b) any claim attributable to errors, omissions or other inaccuracies in the Product or interpretations thereof.

4.4 All the information contained in the Products has been obtained from sources believed to be reliable. The Seller does not warrant the accuracy, completeness adequacy or reliability of such information, which cannot be guaranteed to be free from errors.

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