



# **OPPORTUNITIES FOR CHEMICALS AND MATERIALS IN PV**

**Technical Seminar 3 Market Trends  
December 6, 2011  
PV Japan 2011**

**Michael Corbett  
Managing Partner  
Linx Consulting  
[mcorbett@linx-consulting.com](mailto:mcorbett@linx-consulting.com)**



# Outline

---

- 1. Overview of Linx Consulting**
- 2. Understanding Solar Drivers**
- 3. Opportunities for Chemicals and Materials in PV**
- 4. Conclusions**



# Overview of Linx Consulting



# The Value We Bring To Clients

***1. We create knowledge and develop unique insights at the intersection of advanced thin film processes and the chemicals and materials industry***

***2. We help our clients to succeed through our:***

- Experience in global electronics / semiconductor and advanced materials and thin film processing industries:
  - Semi
  - Packaging
  - HBLED
  - LCD
  - PV
  - Electrochemical
- Experience in the global chemicals industry
- Experience at Device Producers
- Experience at OEMs
- Global network and capabilities
- Advanced modeling capabilities



# We Provide High Confidence Decision Support Services – Single Client





# Geographic Reach

**Linx Consulting covers Asia, Europe and the Americas from offices and affiliates in the USA, Shanghai, Tokyo, Seoul, and Singapore**





# Recent Programs in PV

Program	Scope
Analysis of Silver Paste Market & Technology	China / Global
Analysis of Wafer Sawing Materials Market & Technology	China/ Global
Analysis of Polysilicon Market & Production Technology	Global
Developments in Printing Technology	Global
Wafer Analysis by Type	Global
Market Entry Strategy for Backsheets	Europe
Market Entry Strategy for Encapsulants	China
Supply Chain Imbalances (Materials Costs & Price Forecasting)	Global
Module Company Ranking Analysis (Cost Position & Performance)	Global
Analysis of the Concentrated PV Market & Technology	Global
Analysis of the Backsheet Market & Technology (Cost Position & Performance)	Global
Board of Directors Presentations for S&P 500 Companies	USA

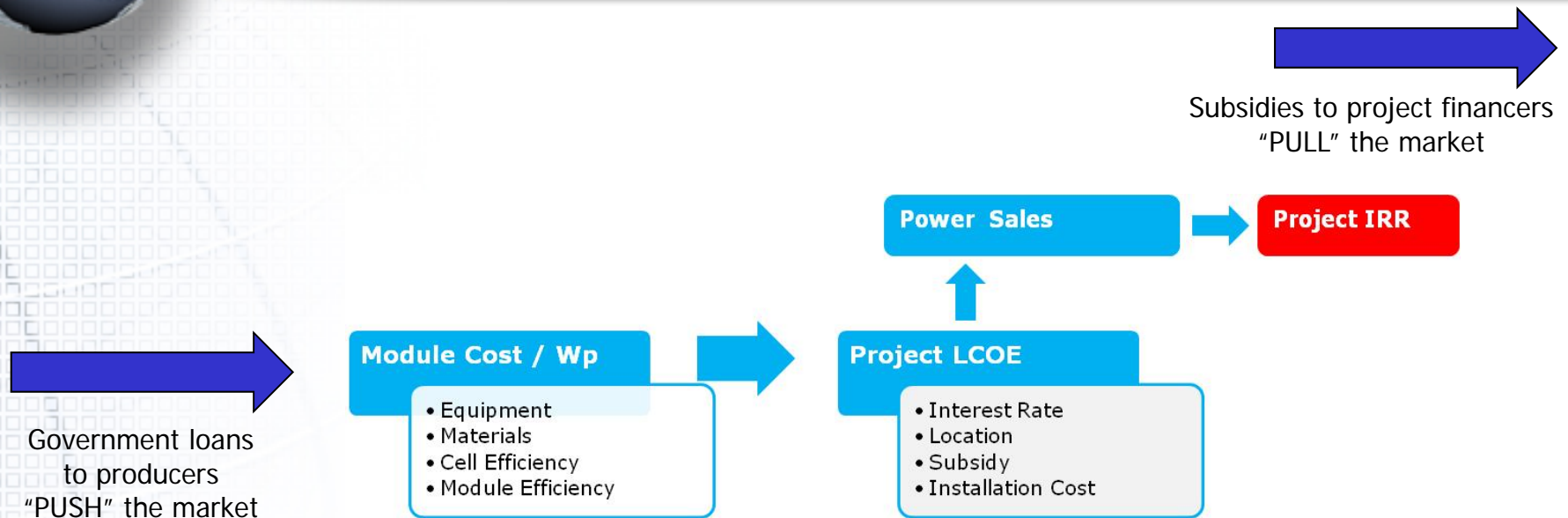


# Understanding Solar Drivers





# PV : Energy Cost Relationship

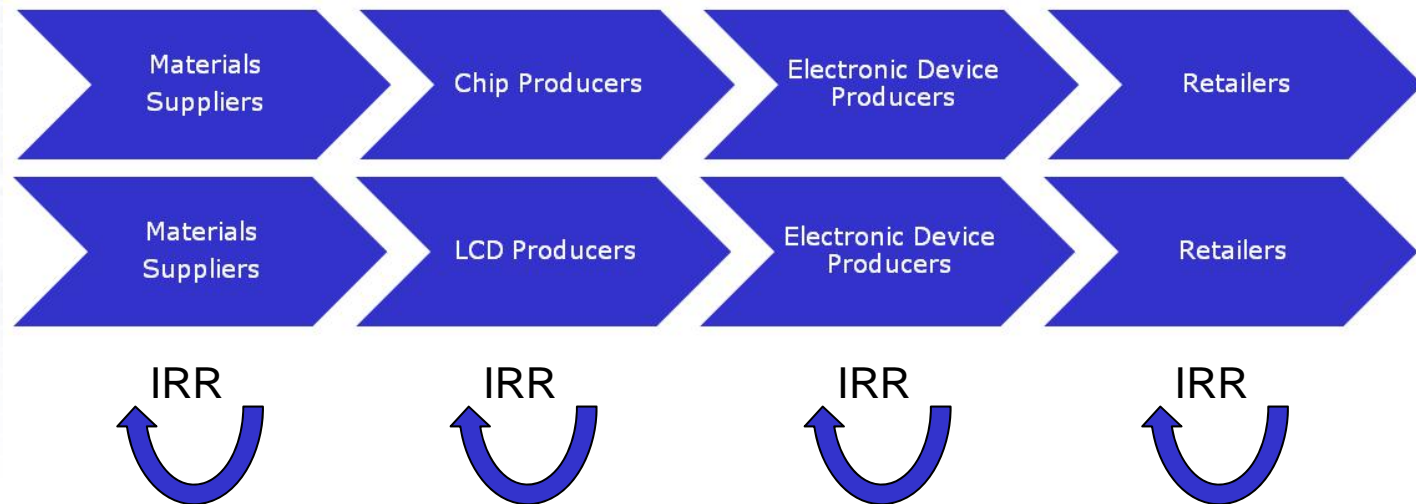


1. **Module selling price** of is **dependant** on end project **interest rates**, **subsidies**, the financial credibility of the project, and installer **IRR** threshold rates. IRR below threshold rates results in pressure to reduce module costs
2. Project IRR has been the **major** industry driver to date. Investments have been made with the faith that with volumes would come scale; supported by government subsidies to module producers (as in the case of China) and subsidies to installers (as in the case of Germany). The logic of subsidy structures is being questioned by many Europeans



# Other Electronic Industry Value Chains – Semiconductors and LCD

- Other electronic industry value chains are more efficient (in theory) with IRR decisions made at each local step; with less government support
- Certainly, there is no “fuzzy” logic around understanding industry drivers and converting \$/Watt to systems returns



- Overall electronics industry drivers include: consumer preferences, increased communications, data storage, reliability, cost, etc.
- Key electronics industry technologies include semiconductors, software, human interfaces, bandwidth, etc.

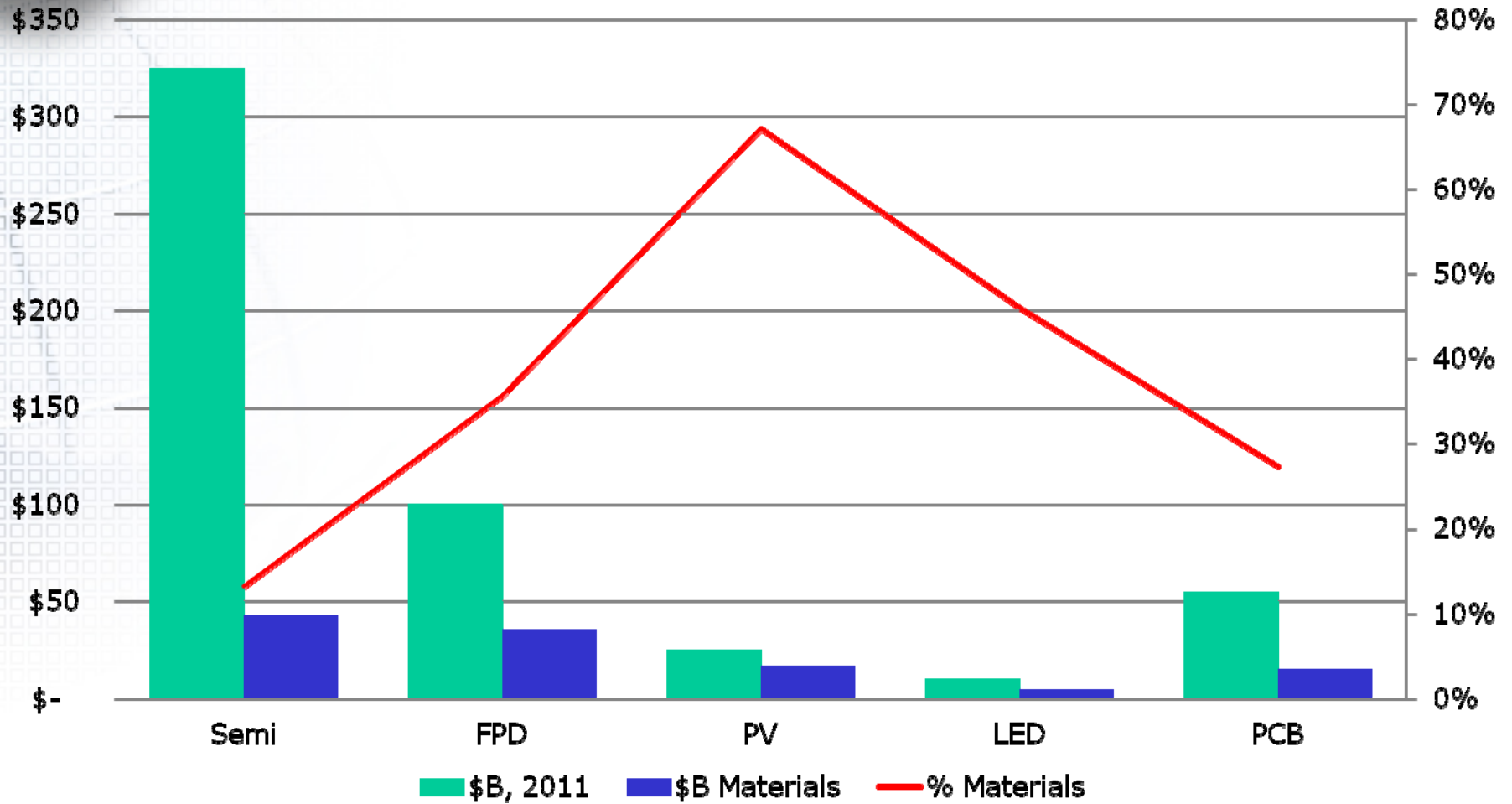


# Electronic Segment Drivers

Segment	Semi	FPD	PV	HBLED
<b>Driver</b>	<ul style="list-style-type: none"><li>• Memory requirements</li><li>• BOPS</li><li>• Portable electronics</li></ul>	<ul style="list-style-type: none"><li>• Human interface</li><li>• Touch panel</li><li>• Viewing angle</li></ul>	<ul style="list-style-type: none"><li>• Environmental</li><li>• Lower cost Wp</li></ul>	<ul style="list-style-type: none"><li>• Environmental</li><li>• Lower cost per lumen</li></ul>
<b>Key technologies</b>	<ul style="list-style-type: none"><li>• Lithography</li><li>• Novel device architectures</li></ul>	<ul style="list-style-type: none"><li>• IPS</li><li>• PVA</li><li>• MVA</li></ul>	<ul style="list-style-type: none"><li>• Semiconductor (various)</li></ul>	<ul style="list-style-type: none"><li>• MOCVD for nitride film growth</li><li>• Phosphors</li><li>• Encapsulants</li><li>• Thermal management</li></ul>



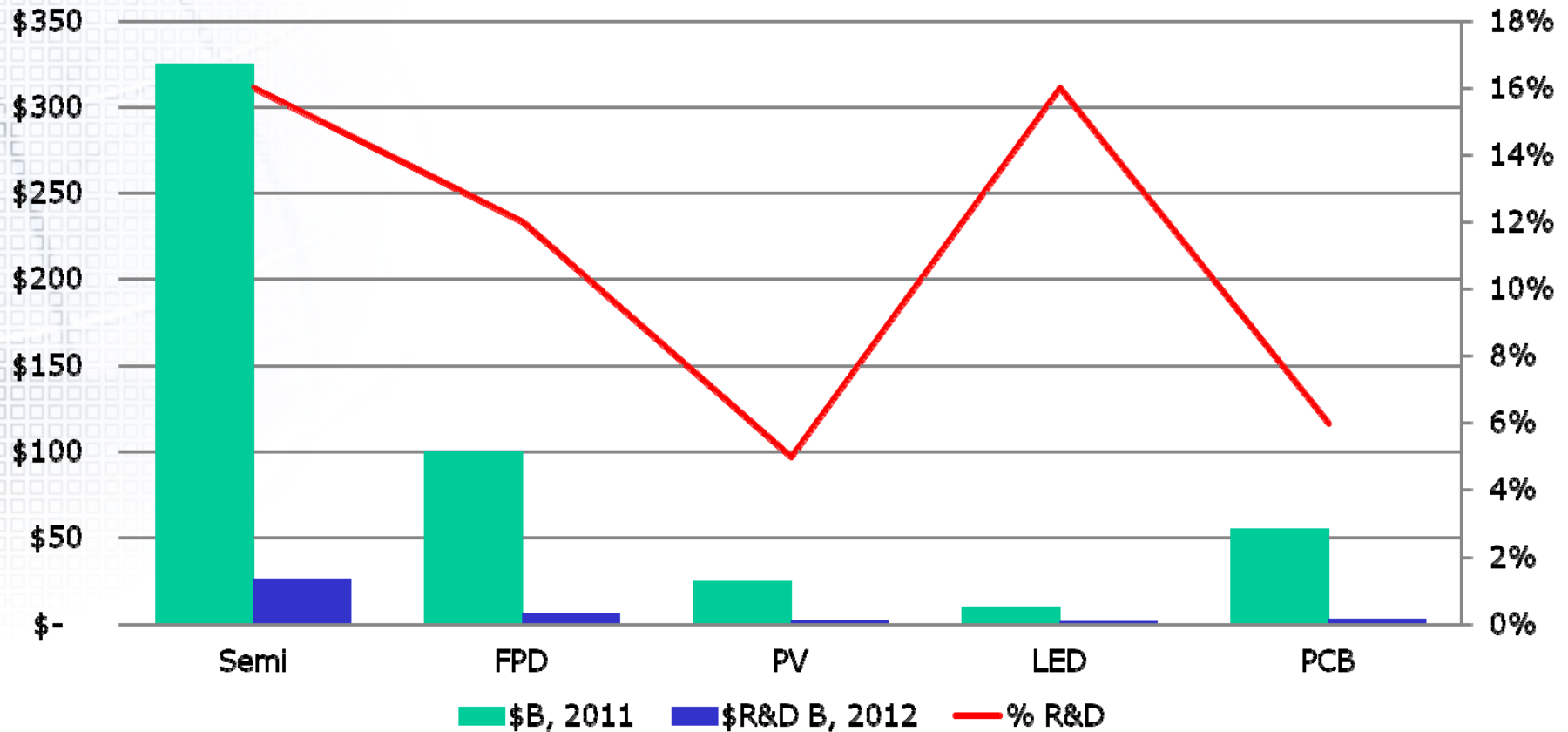
# Electronics Industry – Materials Intensity





# Electronics Industry – R&D Intensity

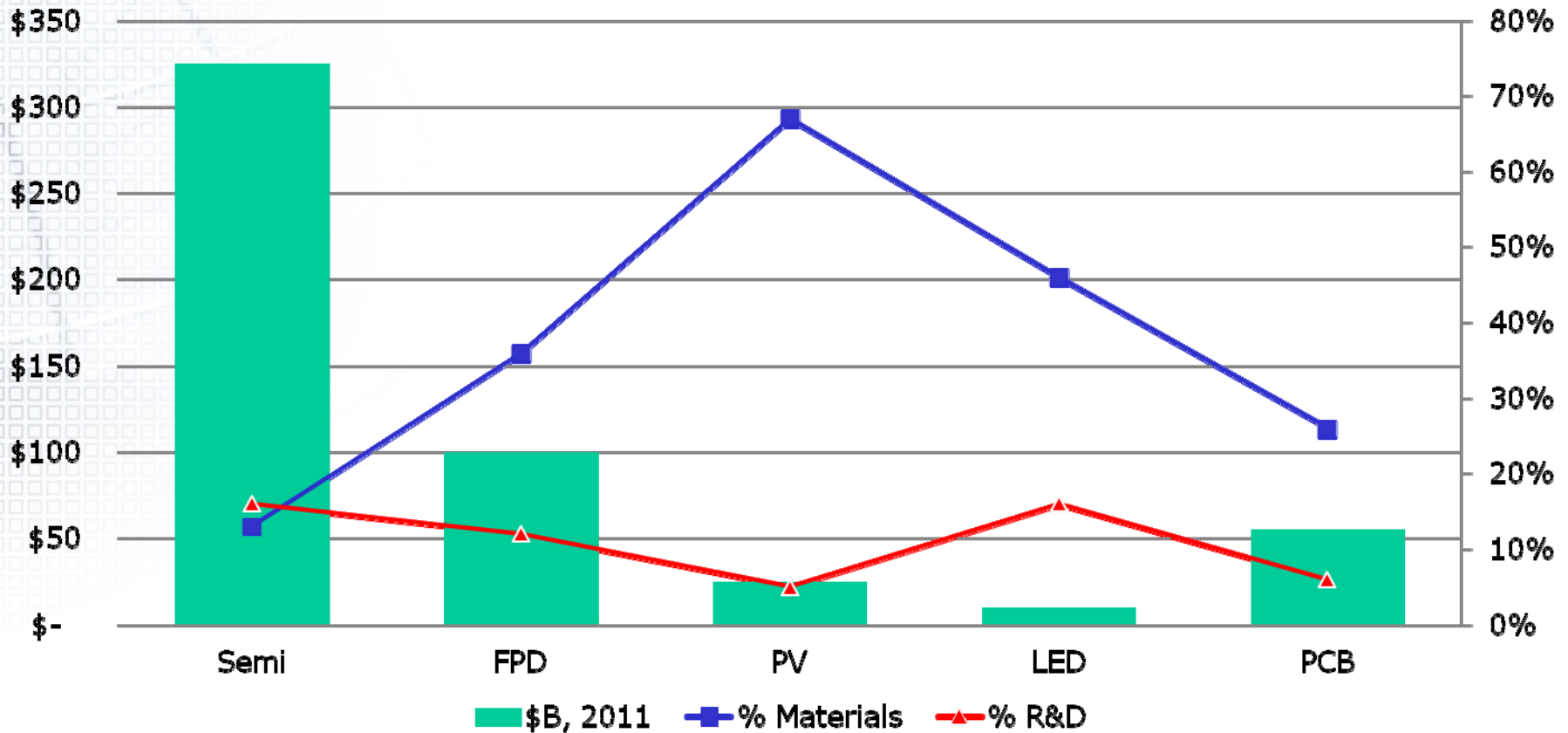
## R&D Estimates for Device Producers, OEMs and Materials Suppliers





# Electronics Industry – R&D and Materials Intensity

## R&D Estimates for Device Producers, OEMs and Materials Suppliers



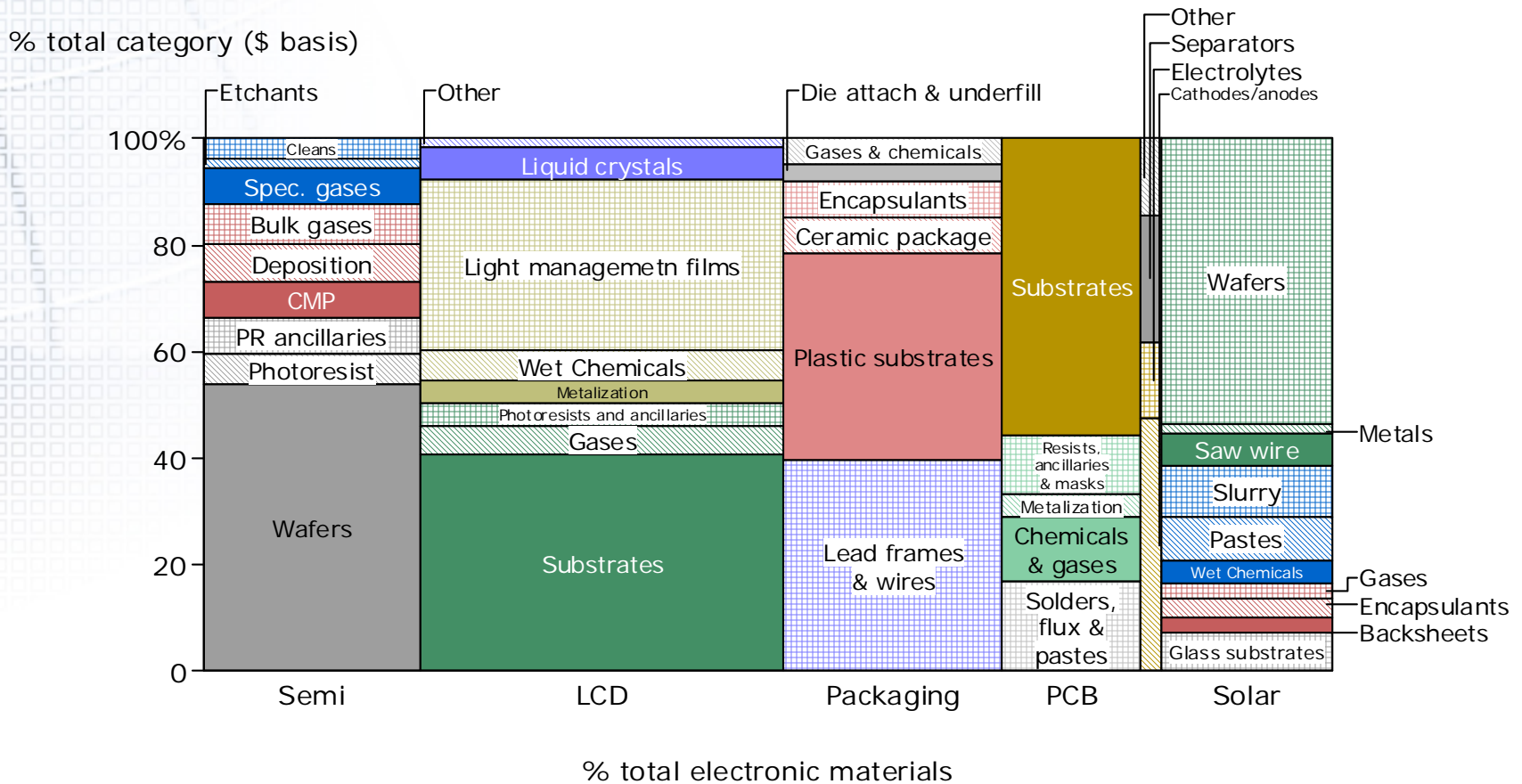


# Opportunities for Chemicals and Materials in PV



# Global Electronic Materials Industry, 2011

- Electronic materials industry is 4X PV Industry in 2011
- Chemicals and Materials in PV is 1/8 the Electronic Chemicals and Materials Industry in 2011

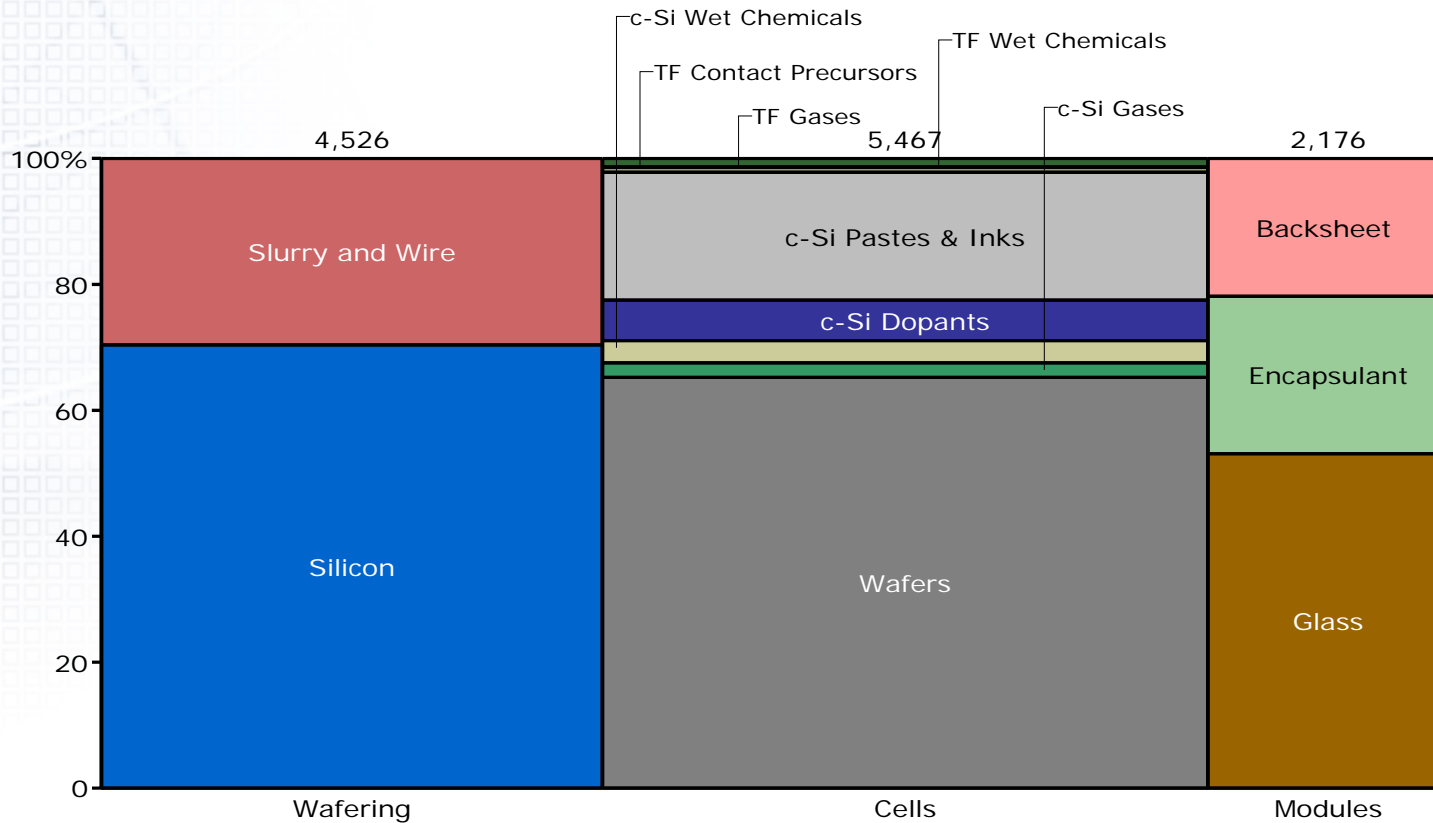






# PV Materials Market, 2011

- Chemicals and Materials in PV is 1/8 the Electronic Chemicals and Materials Industry in 2011

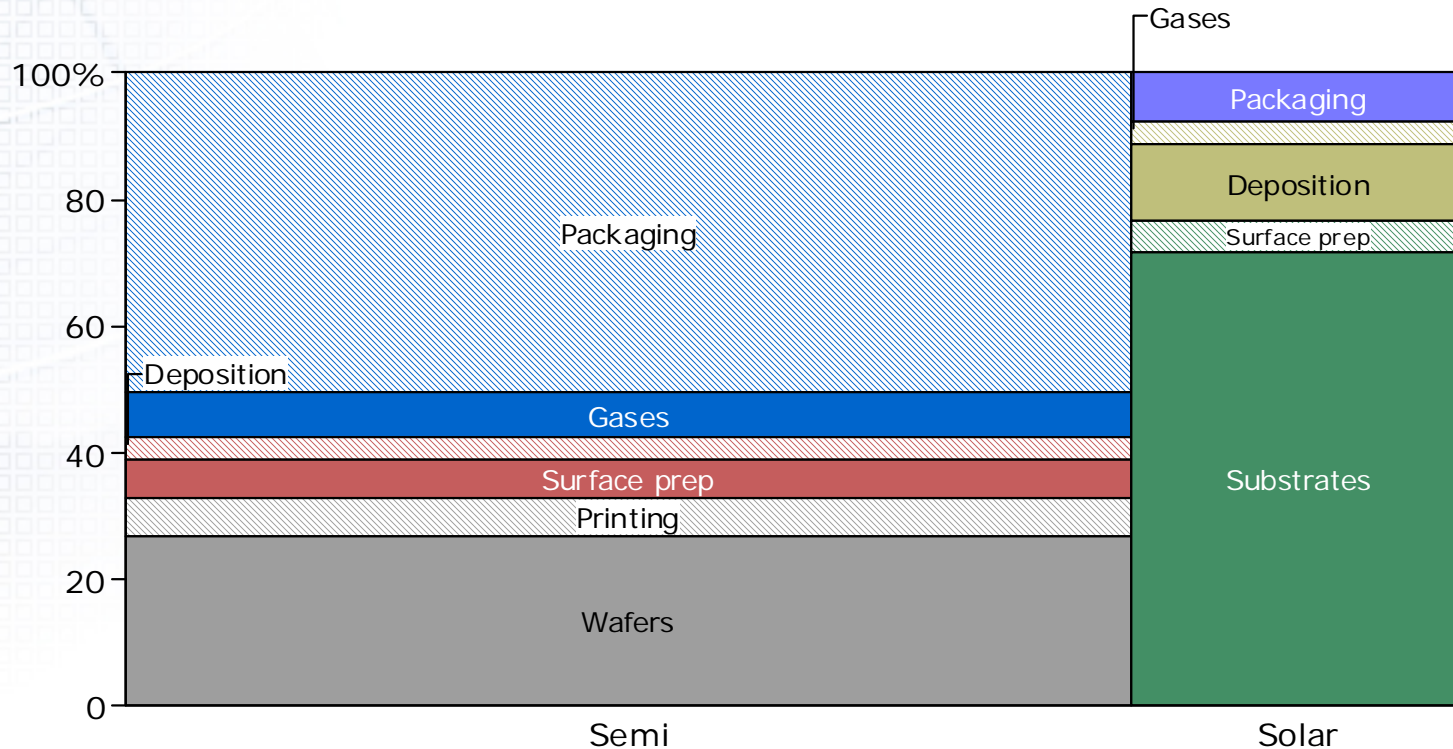




# What Segment Does PV Look Most Like?

## Semi versus PV, 2010

% total category (\$ basis)



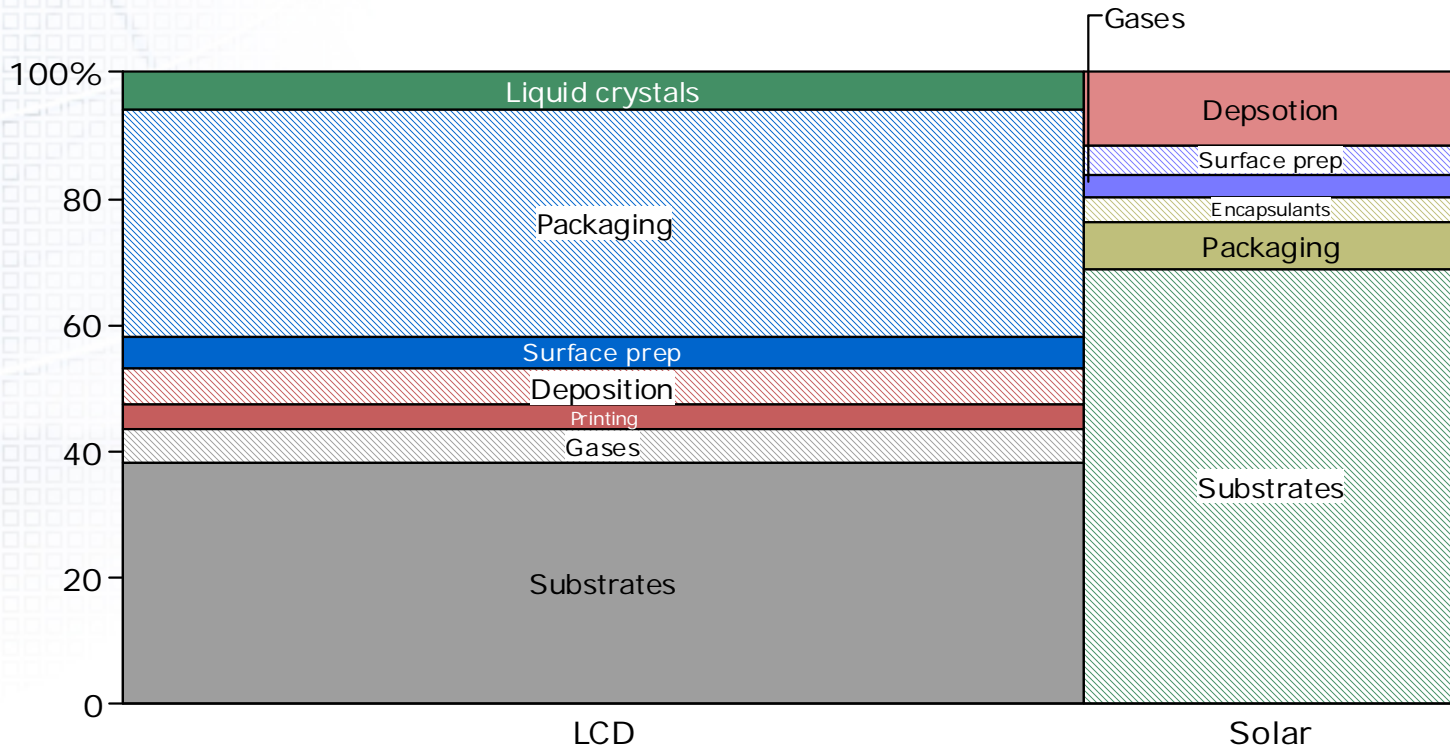
% total electronic materials



# What Segment Does PV Look Most Like?

## LCD versus PV, 2010

% total category (\$ basis)



% total electronic materials

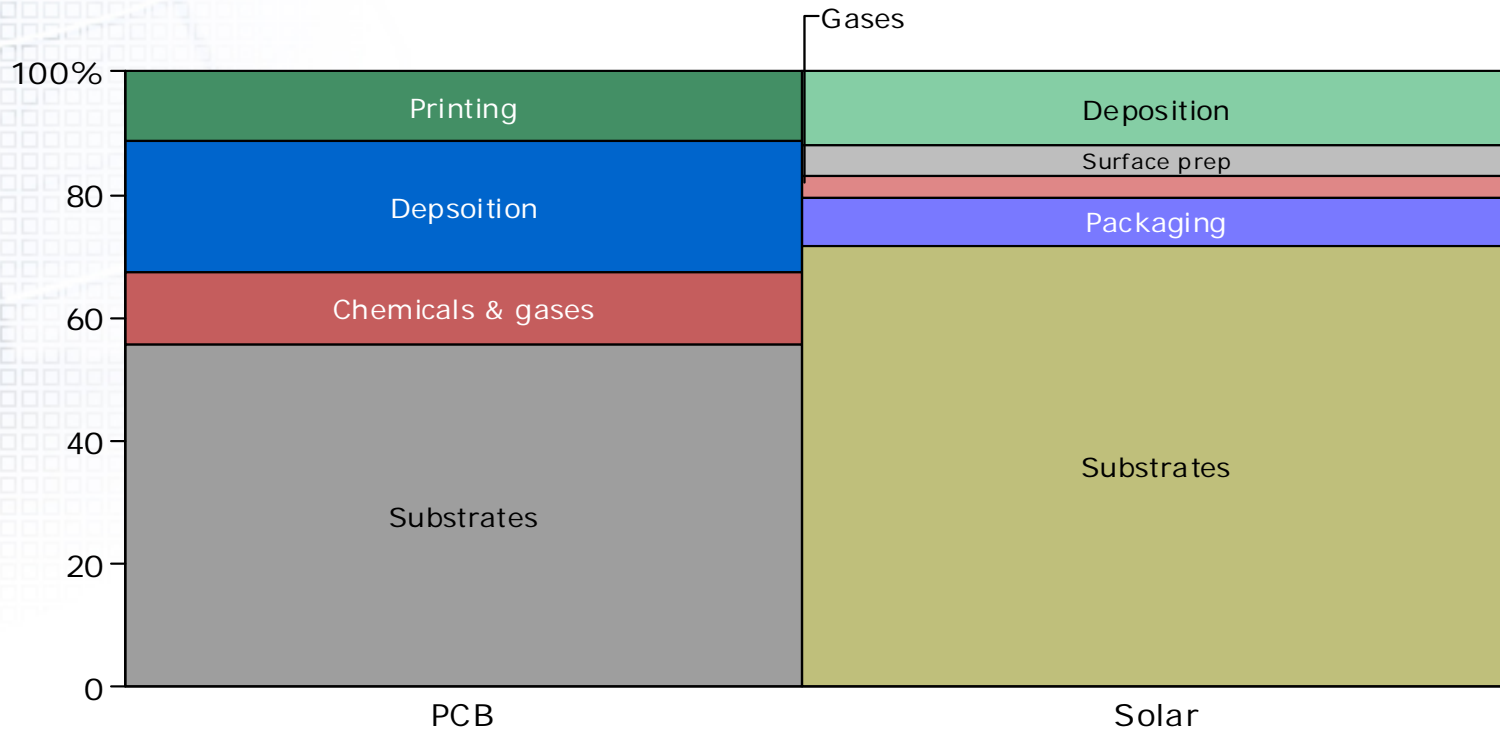


# What Segment Does PV Look Most Like?

## PCB versus PV, 2010

- PCB is the most commoditized of all electronic chemicals and materials markets; with large segments having already moved to China

% total category (\$ basis)



% total electronic materials



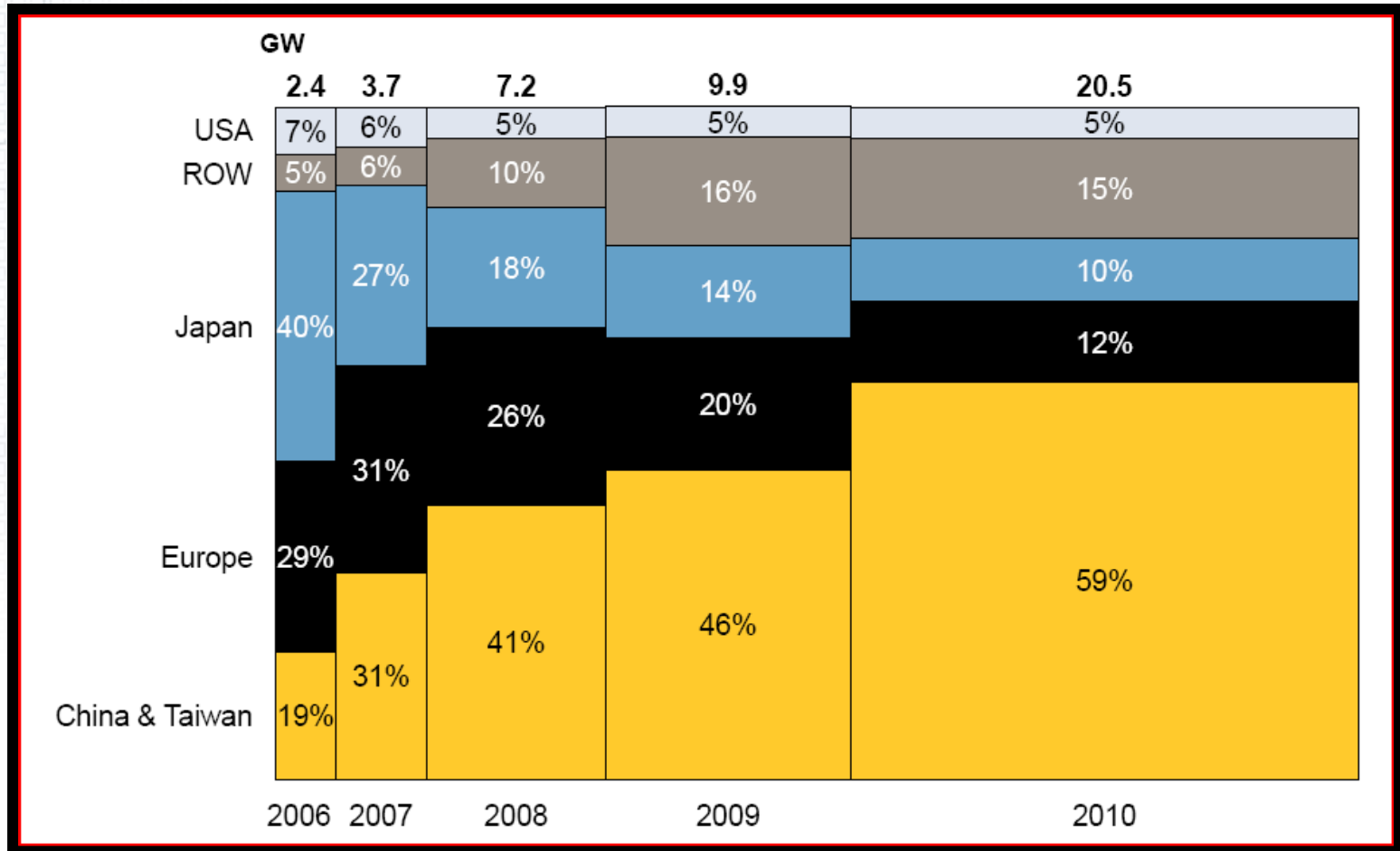
---

## Conclusions



# As Production Has Moved to China, There Has Been Greater Commoditization

- Geographic Distribution of PV Capacity

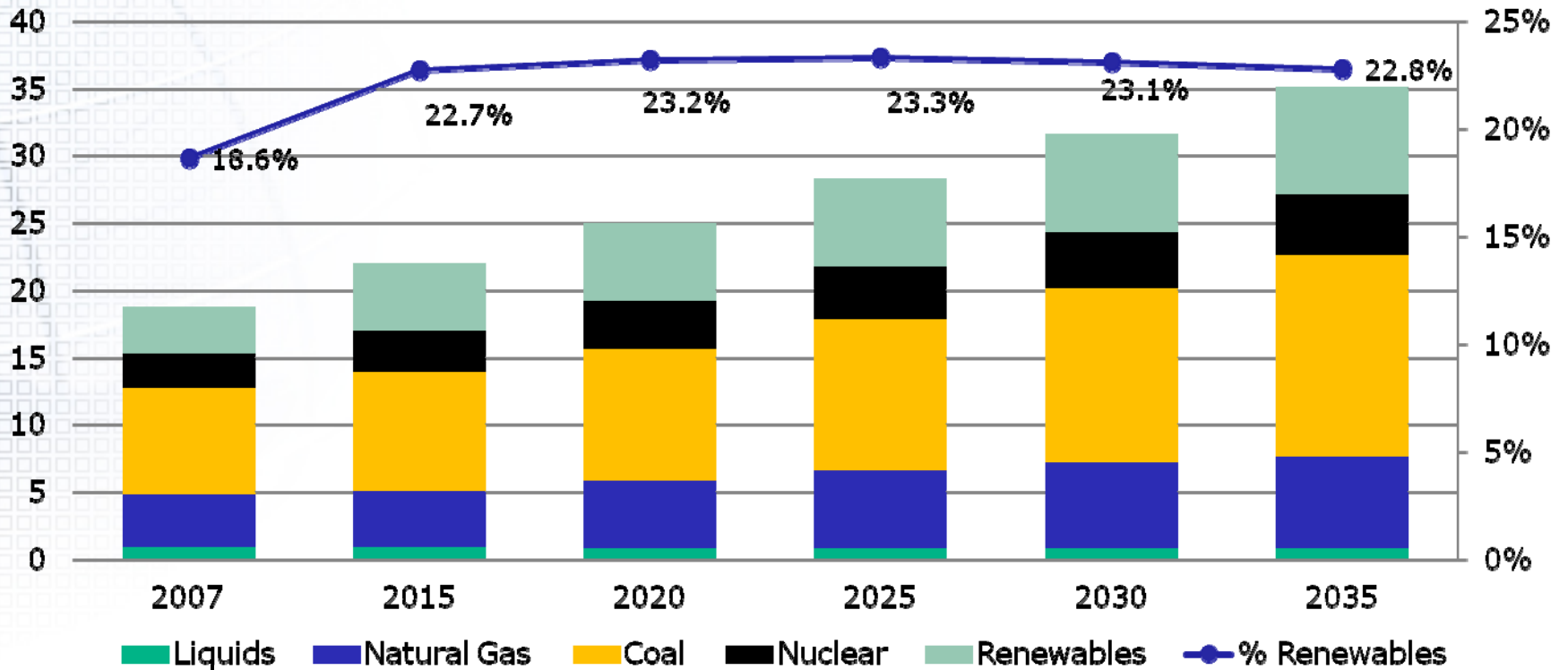


Source REC Company reports



# Renewables Play an Important Role in Future Energy Supply Growth

Net Electricity Generation by Source, (trillion kWh)



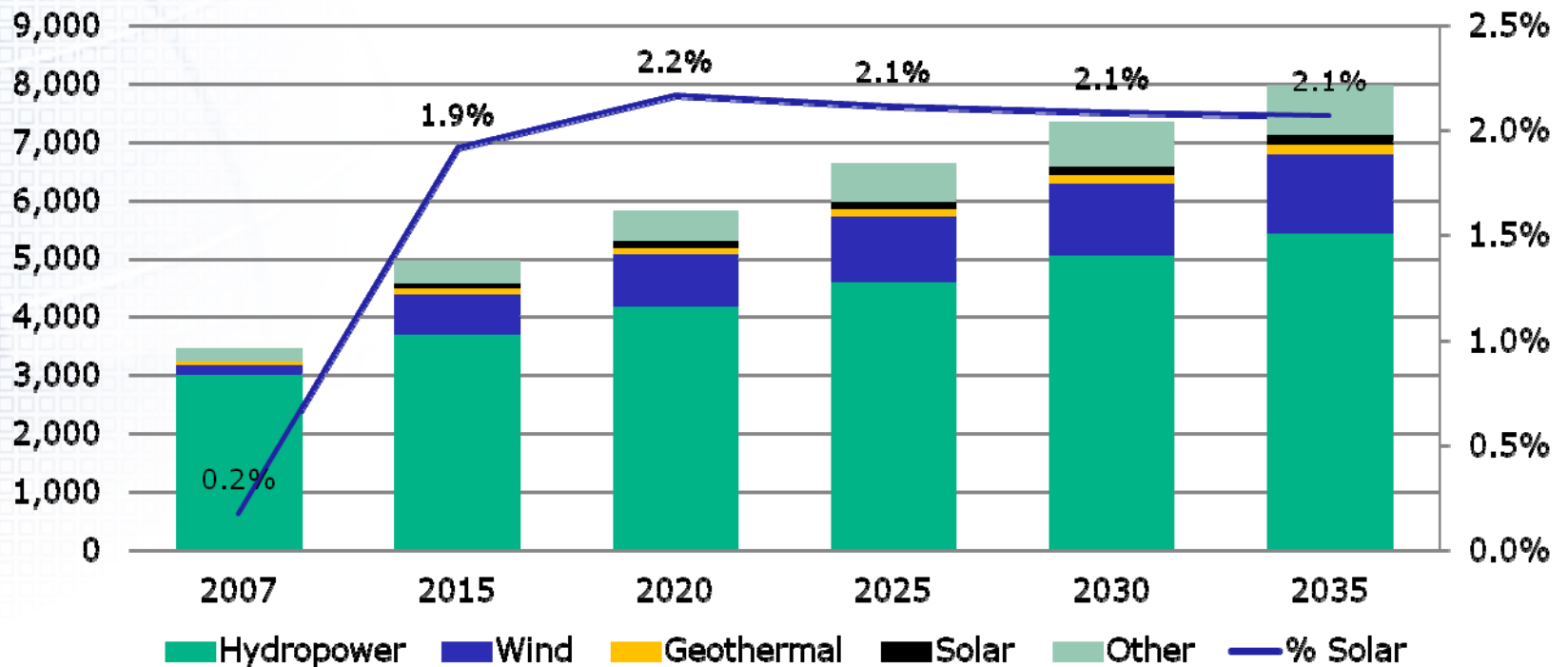
Power Generation CAGR 2015 to 2035 = 2.4%

Source: US DOE, International Energy Outlook, 2010



# However, Solar PV is Still a Small Part of the Renewable Picture

Renewable Generation by Source,  
(billion kWh)



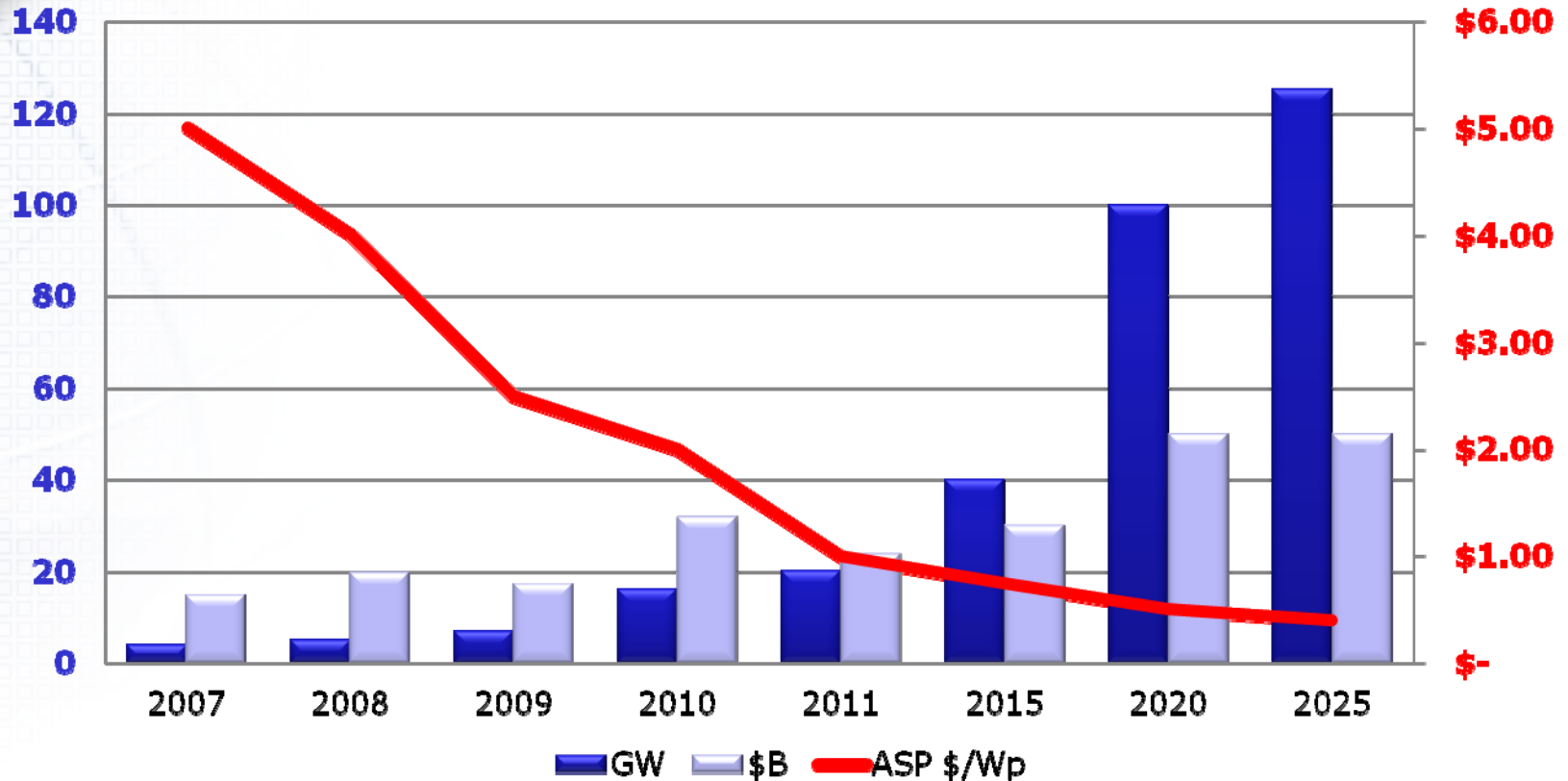
Renewables Generation CAGR 2015 to 2035 = 2.4%  
Solar Generation CAGR 2015 to 2035 = 2.8%

Source: US DOE, International Energy Outlook, 2010





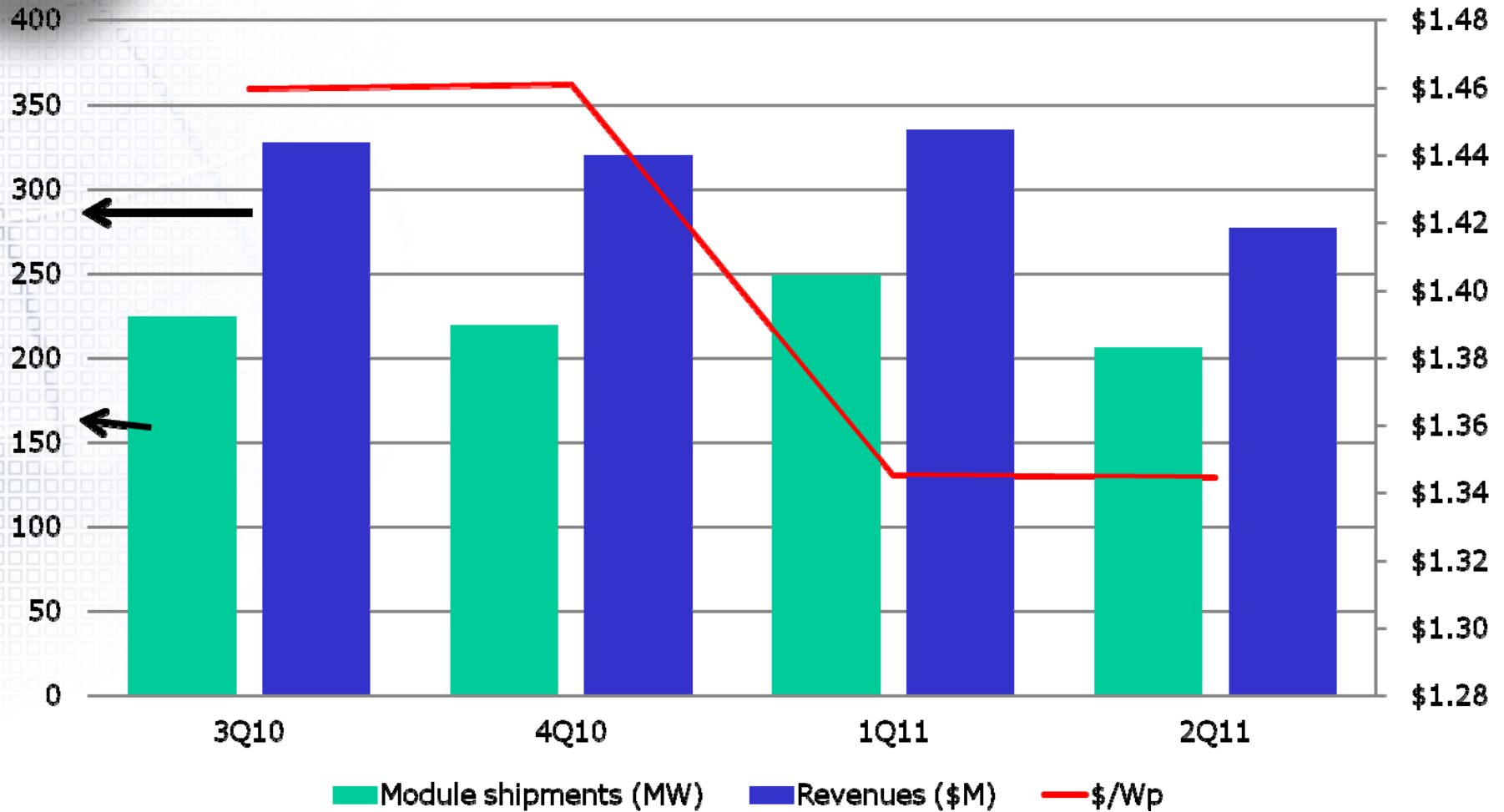
# Whilst the Amount of Energy Generated from PV Grows, the PV Modules Market May Max Out



Source: US DOE, International Energy Outlook, 2010, Seeking Alpha, DOE SunShot perspectives



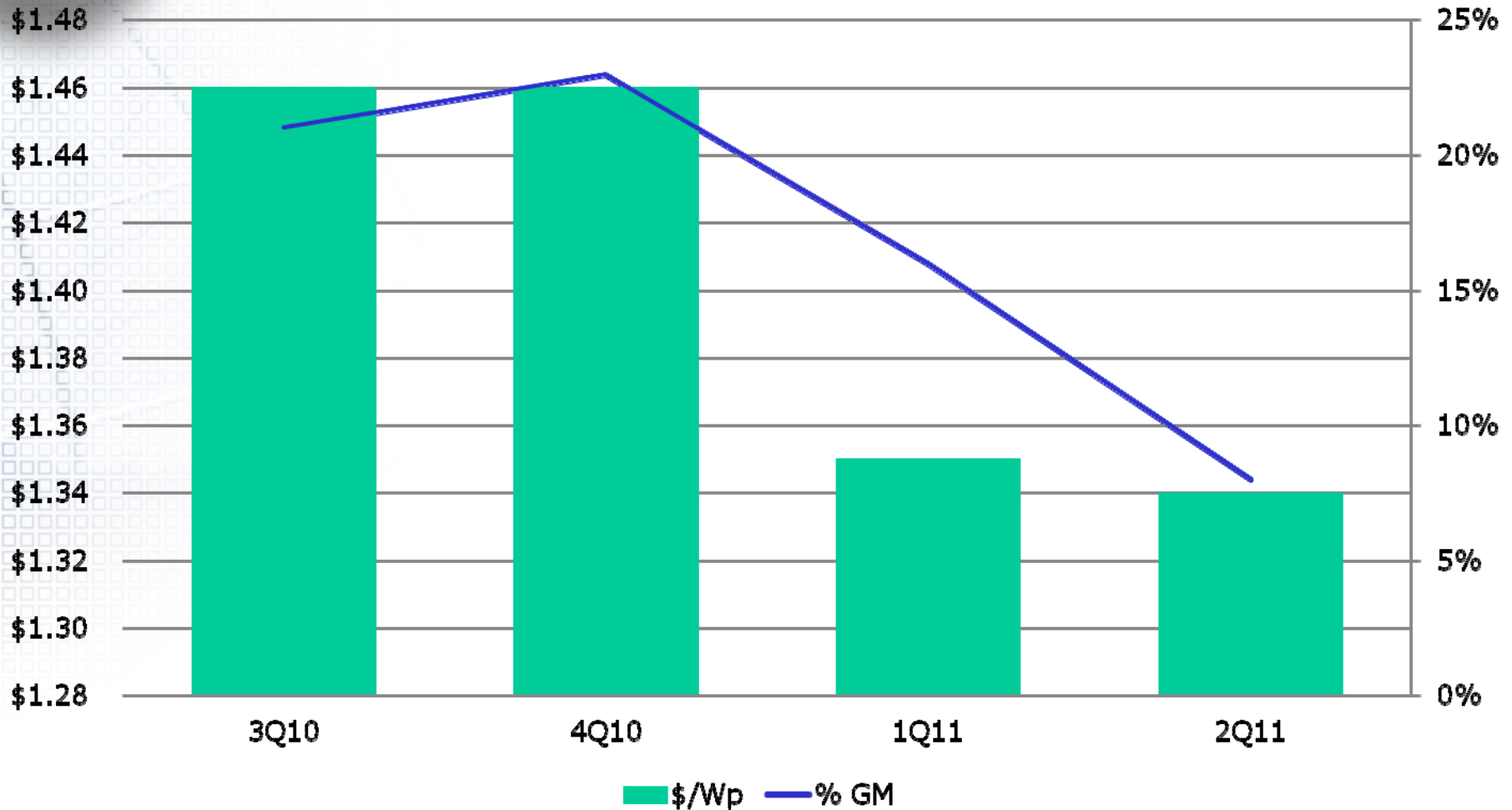
# Lowered Module Prices Keep Hanwha's Revenues Flat



Source Hanwha Solar One Company reports



# Gross Margins are Falling with Module Prices, Possibly Below Reinvestment Levels

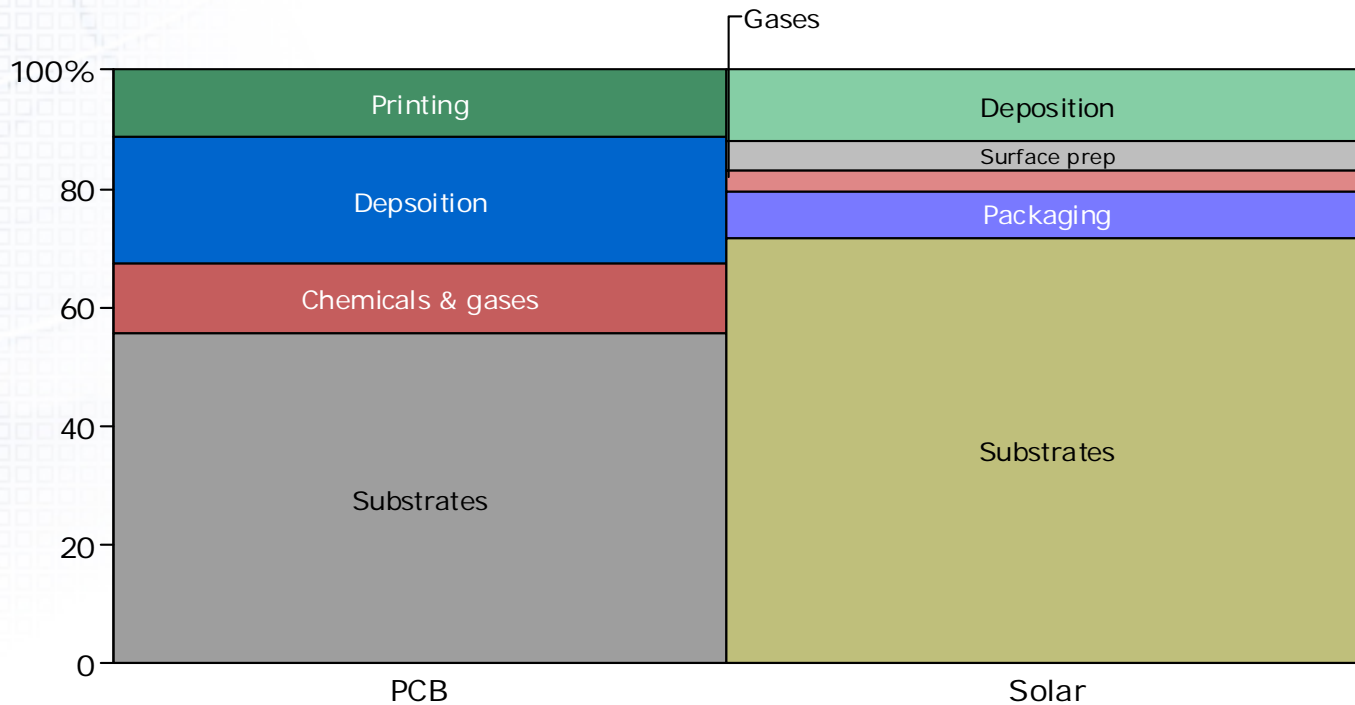


Source Hanwha Solar One Company reports



# To Keep Up with Module Price Decreases, Scale Becomes a More Critical Factor

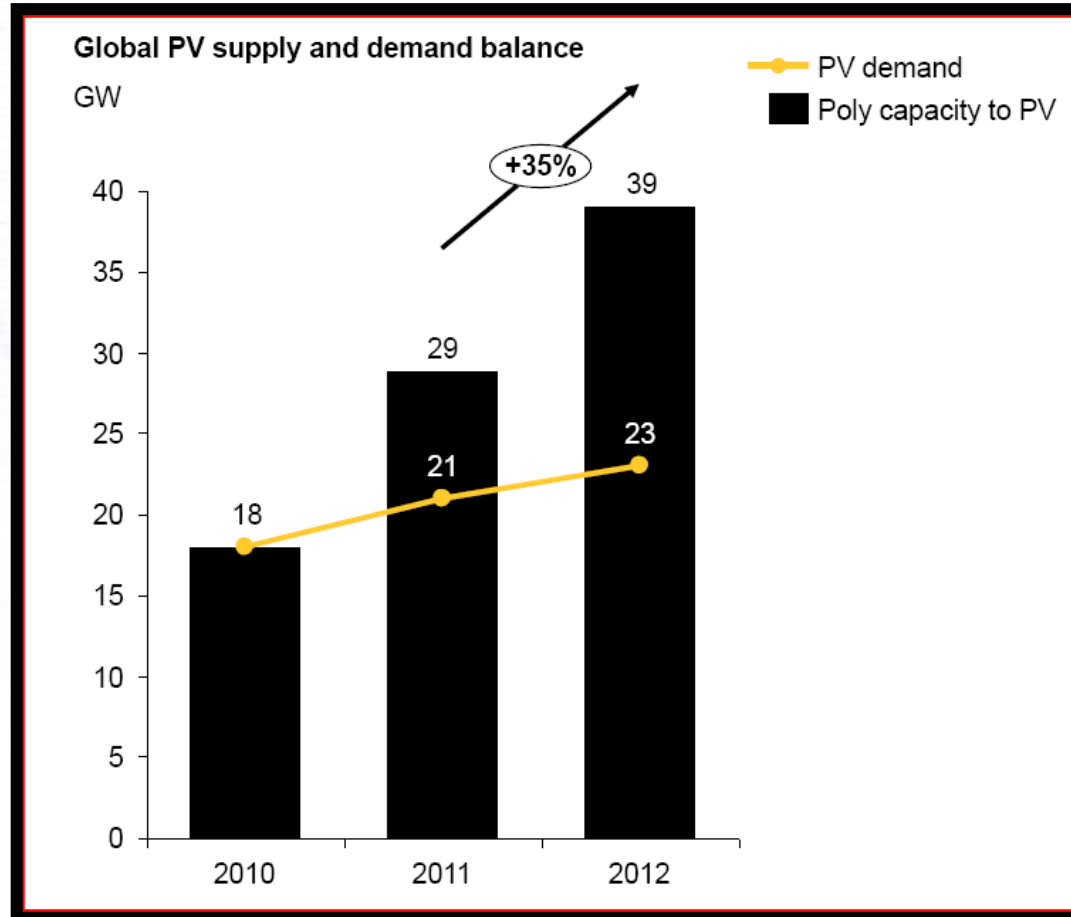
% total category (\$ basis)



% total electronic materials



# Oversupply of Commodities Drives Lower Pricing as in the Case of Polysilicon



- Polysilicon pricing has dropped more than tenfold on the spot market and is at levels that question re-investment economics

Source REC Company reports



# Integrations Drives Profitability from the Industry

## PRODUCTION VALUE CHAIN



Yingli is the largest vertically integrated PV module manufacturer from polysilicon to module in the world.

## BENEFITS OF VERTICAL INTEGRATION

- Unparalleled quality control from raw material through modules
- Prevents margin stacking while mitigating supply chain risk
- Fast commercialization of new products and increased cost competitiveness

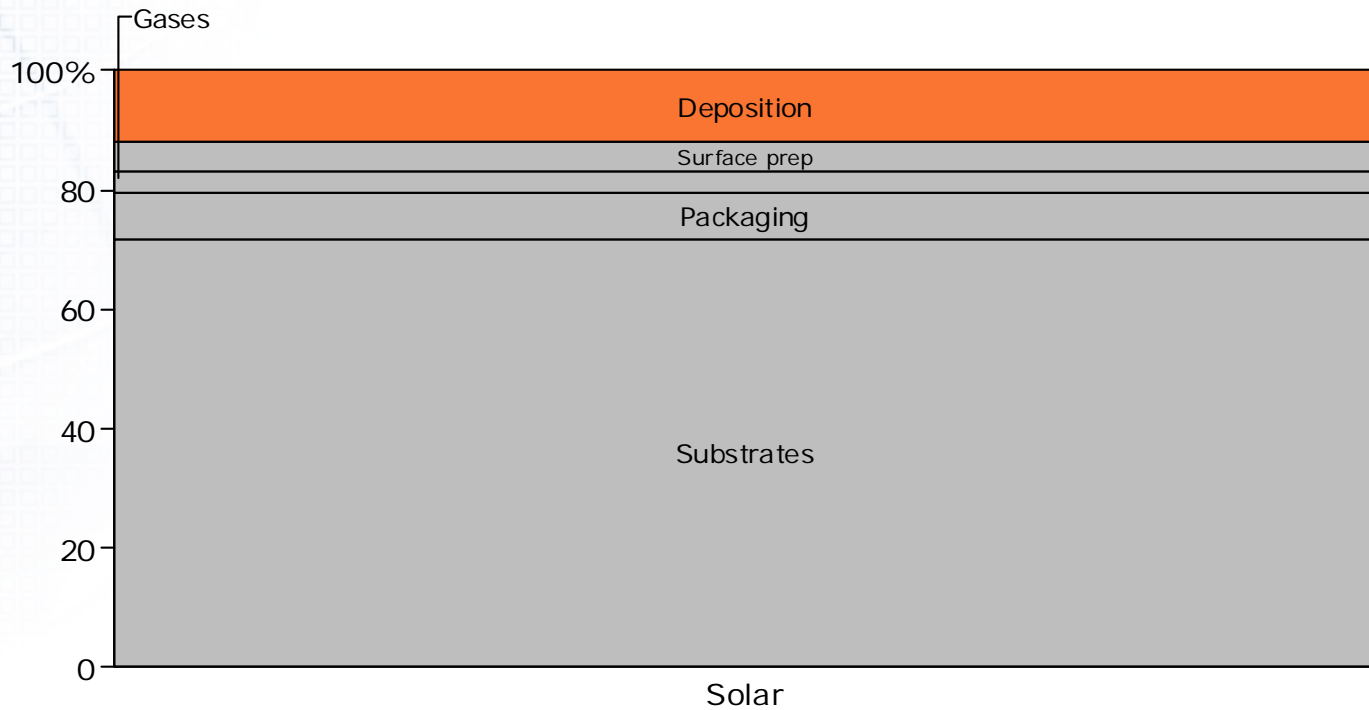
- Vertical integration along Si value chain is key
- Expect glass and polymer systems to become commoditized
  - Polymer systems include backsheets, backsheet components and encapsulants

Source Yingli

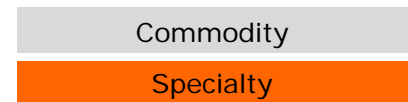


# PV Materials are Mostly Commodities Today; Deposition Materials are Mostly Specialties

% total category (\$ basis)

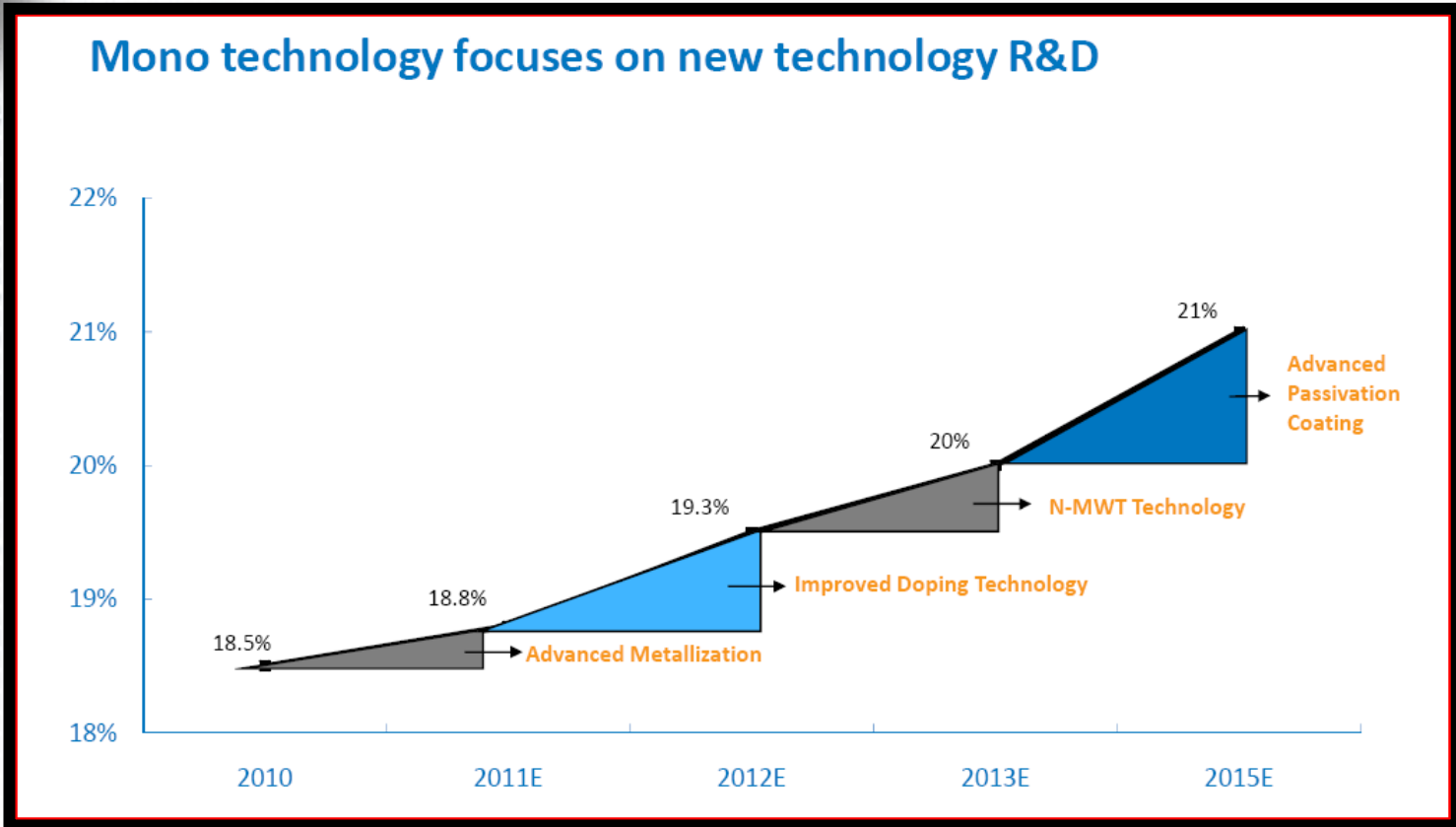


% total electronic materials





# There are Still Opportunities for Innovation Driven Materials and Architecture



- Deposition materials include passivation materials, ARCs, pastes, novel metalizations, including:
  - Light induced plating
  - Electroless
  - Direct plating on Si

Source Yingli





## Conclusions: PV Model is Under Pressure

- Many chemicals and materials segments in PV are becoming / have become commoditized
  - Volume as a strategy is difficult as module prices still have to continue coming down
- Opportunities for new materials are difficult as it takes time to implement them due to module life concerns
- It is unrealistic for PV manufacturers' to expect that their materials and equipment suppliers will drive their R&D for an extended period of time; due to current margin situation
  - However, there is still room for chemicals and materials suppliers as well as OEMs to pay for more of the R&D in larger segments such as LCD and semiconductors
- The operating margins of many value chain participants are below that required for reinvestment
- Chemical and materials suppliers need to chose their shots and development activities very carefully