



# DuPont Photovoltaic Solutions

## 杜邦光伏技术全面解决方案

傅黎光 中国区经理  
1月12日, 2011



# The Vision of DuPont

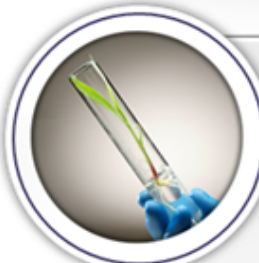
**To be the world's most dynamic science company,  
creating sustainable solutions  
essential to a better, safer, healthier life for people everywhere.**



**We are a market-driven science company.**

# DuPont 2009 Sales by Segment – US\$26.1B\*

**\$8.3 B**



## DUPONT AGRICULTURE & NUTRITION

Pioneer Hi-Bred  
Crop Protection  
Nutrition & Health

Core Markets:  
 • Production Agriculture  
 • Food & Nutrition Products

**\$3.4 B**



## DUPONT PERFORMANCE COATINGS

Core Markets:  
 • Automotive OEM  
 • Collision Repair  
 • Industrial Coatings

**\$1.9 B**



## DUPONT ELECTRONICS & COMMUNICATIONS

Core Markets:  
 • Consumer Electronics  
 • Advanced Printing  
 • Photovoltaics  
 • Displays

**\$4.8 B**

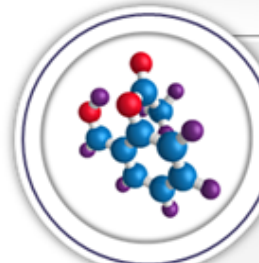


## DUPONT PERFORMANCE MATERIALS

Performance Polymers  
Packaging & Industrial Polymers

Core Markets:  
 • Automotive  
 • Packaging  
 • Electrical/Electronics  
 • Construction  
 • Consumer Durables

**\$5.0 B**



## DUPONT PERFORMANCE CHEMICALS

Titanium Technologies  
Chemicals & Fluoroproducts

Core Markets:  
 • Construction  
 • Specialties  
 • Industrials & Chemicals

**\$2.8 B**



## DUPONT SAFETY & PROTECTION

Protection Technologies  
Building Innovations  
Sustainable Solutions

Core Markets:  
 • Industrial Personal Protection  
 • Construction & Industrial  
 • Military & Law Enforcement

\* Includes \$1.1B in "other" sales including Applied BioSciences.  
Total company sales exclude transfers.

# Megatrends → Opportunities

## Megatrend

## DuPont Solutions



### Increasing Food Production

- Seeds, crop protection, food & nutrition products, and food packaging materials



### Decreasing Dependence on Fossil Fuels

- PV, fuel cell components, energy efficient Tyvek® materials, lightweight composites for transportation, biofuels, biomaterials



### Protecting Lives

- Kevlar®, Nomex® and Tyvek® for worker protection, SentryGlas®, safety services, environmental protection material solutions

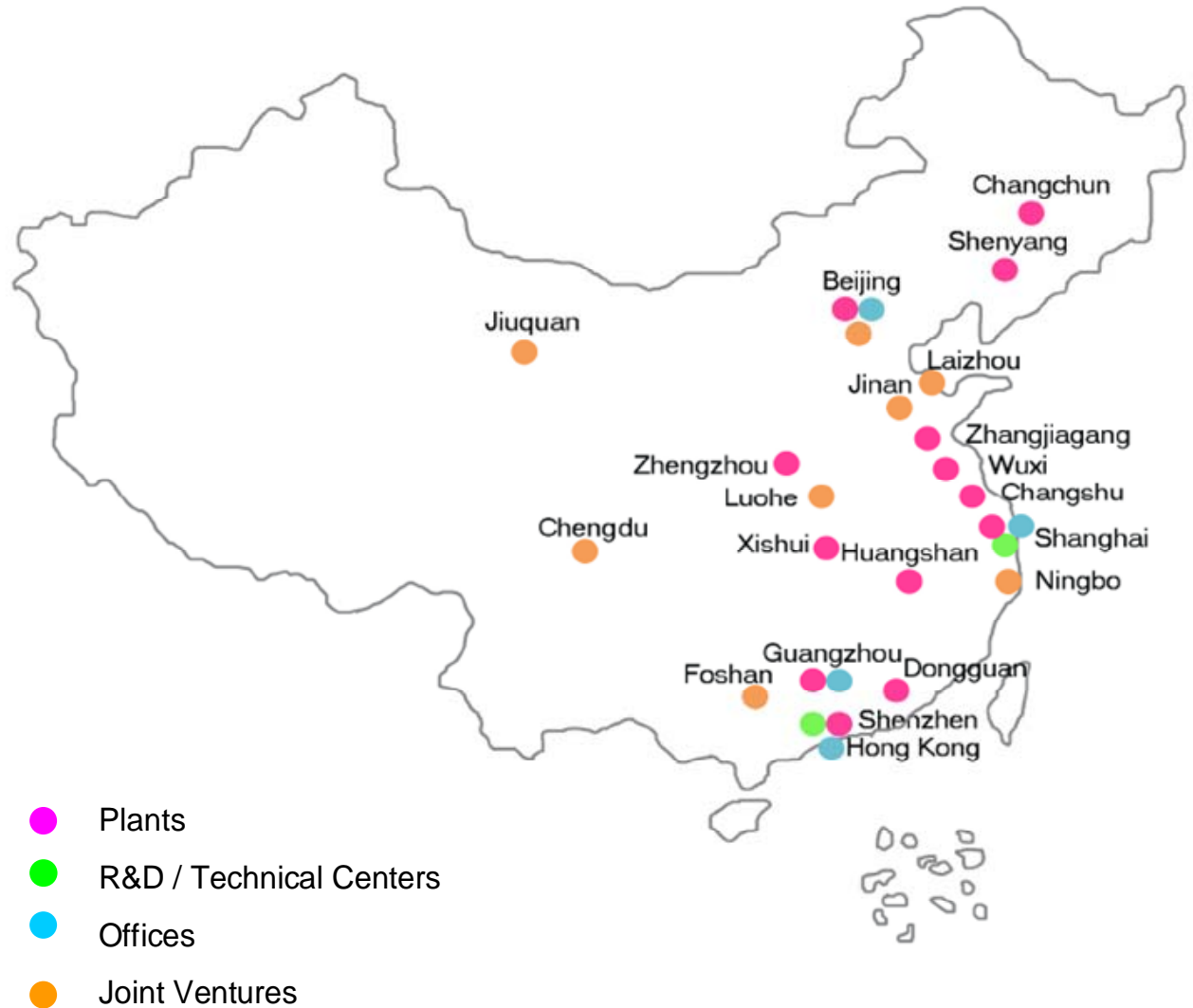


### Growing in Emerging Markets

- Agricultural products, food packaging, materials for construction & infrastructure projects, PV

**Strong Renewable Product Portfolio Drives Opportunities for Tailored, Differentiated Offerings & Market Partnerships**

# DuPont in China Today After More Than 25 Years History

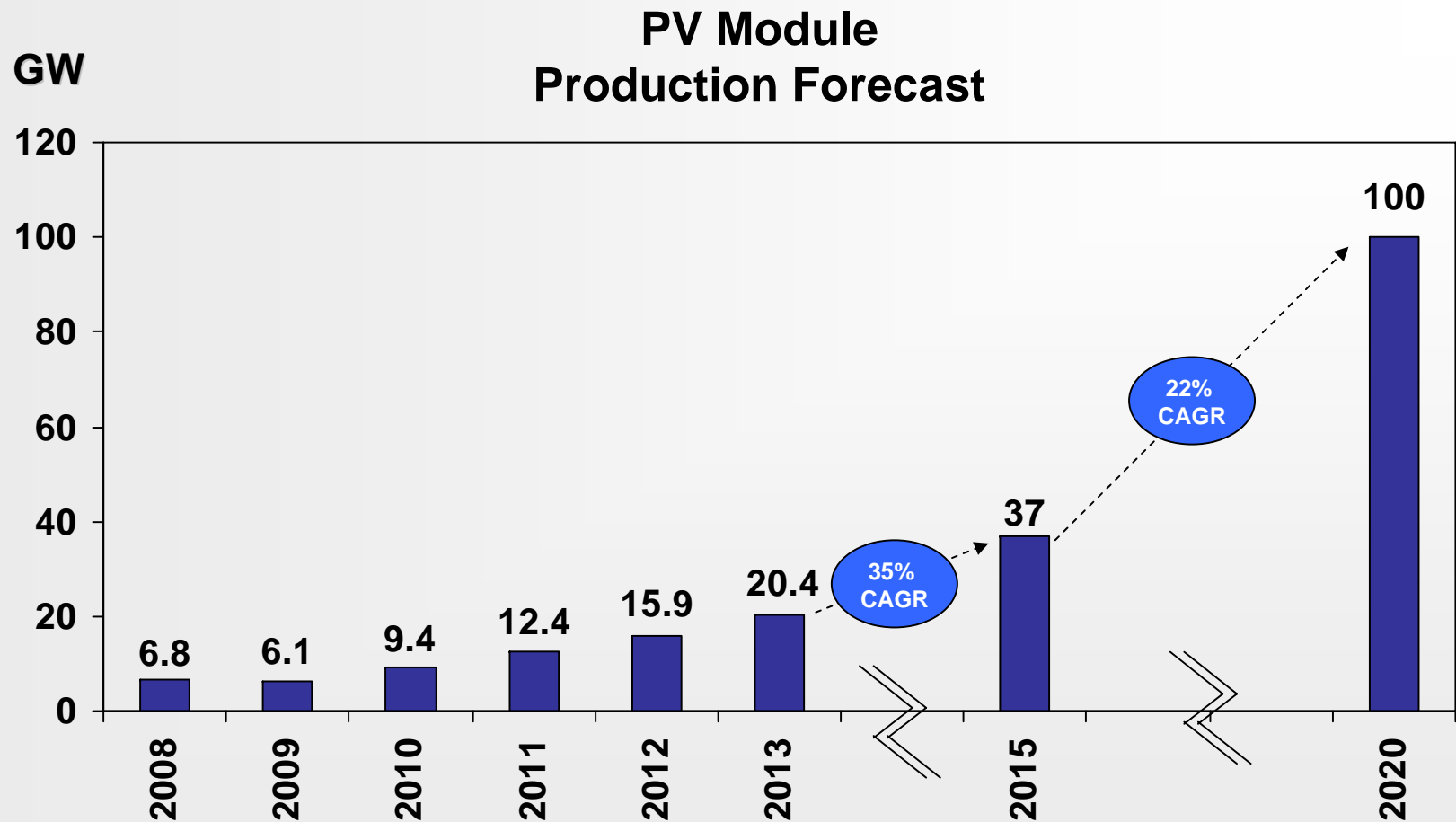


**2009 Sales \$1.84 Billion\*; ~ 6,500 Employees**

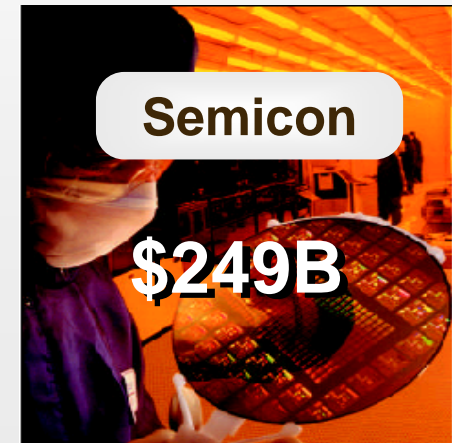
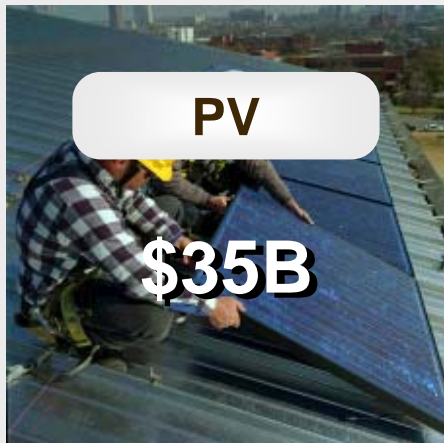
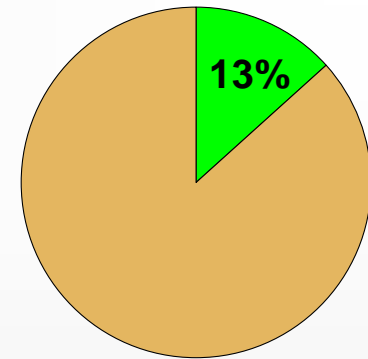
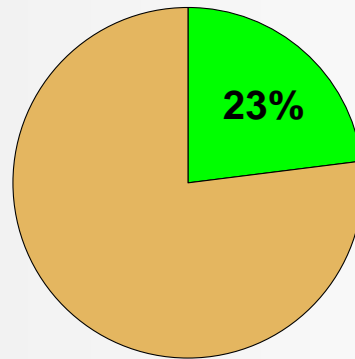
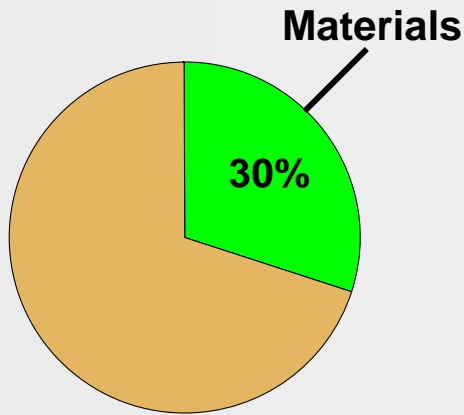
\* Includes Mainland China and Hong Kong; excludes Taiwan. Excludes Pioneer revenue © DuPont



# Strong PV Market Growth Will Put Demands on Materials Suppliers

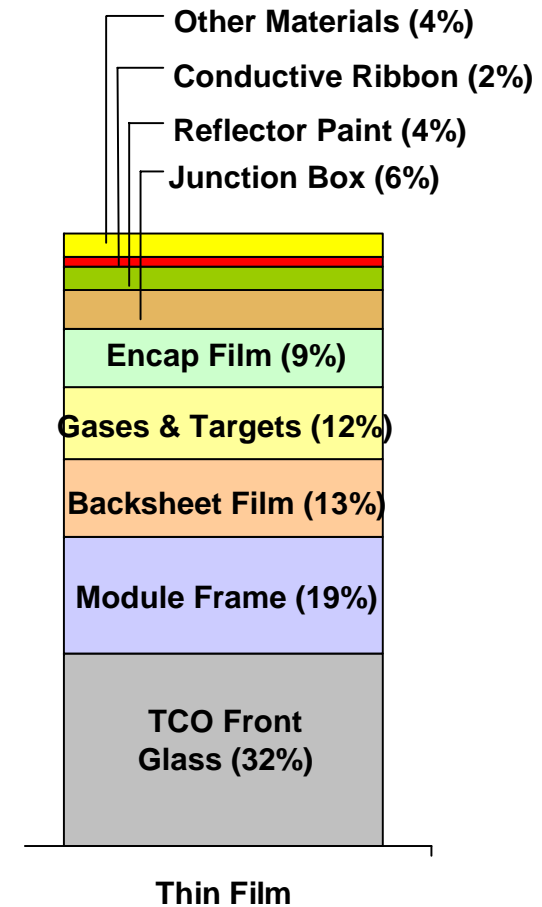
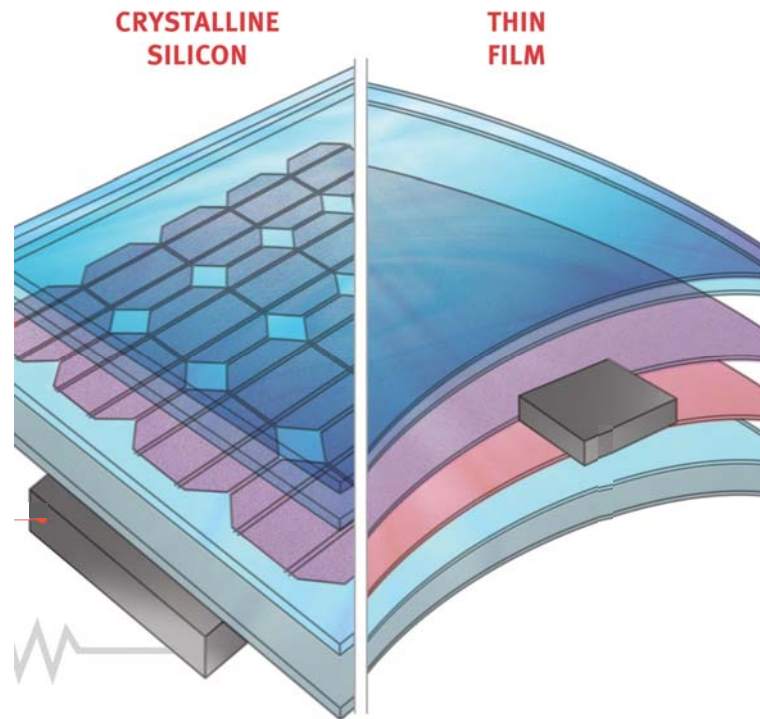
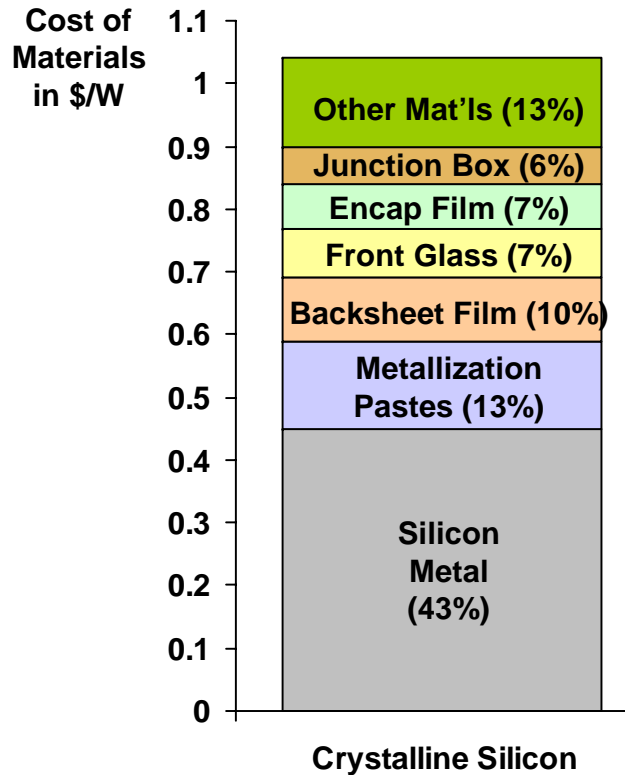


# PV Has Higher Materials Content Compared to Other Electronic Products



# Materials Cost Impact on PV Cells & Modules

## Bill of Materials





# DUPONT – LEADING THE WAY IN PV INNOVATION



1839

## Basic science development

1839 PV effect discovered by Edmund Becquerel



1954 1958 1960 1963

## First commercialization begins: Aerospace

1954 DuPont is the first in the world to manufacture purified silicon  
 1954 Experiments at Bell Labs giving 6% efficient solar cell  
 1955 Bell Telephone launches "solar batteries" using DuPont Si metal  
 1958 Launch of Vanguard I, the first PV powered satellite  
 1960 DuPont introduces Teflon® FEP film  
 1961 DuPont introduces Tedlar® PVF film  
 1963 DuPont introduces Elvax® EVA resin  
 1966 DuPont introduces Kapton® polyimide film



1975 1979 1990 1994

## Large terrestrial programs aided by some governments

1975 DuPont® Tedlar® becomes standard component for PV backsheets  
 1979 DuPont sponsored PV airplane (Gossamer Penguin) flies  
 1990 Germany launches \$500 Mio. 300k Solar Roofs program  
 1990 DuPont introduces metallization pastes for PV cells  
 1994 Japan begins 70000 Solar Roofs program



2004 2006 2008 2009 2010

## Explosive growth phase

2004 Germany introduces feed-in tariffs—EEG  
 2006 Formation of DuPont Photovoltaic Solutions  
 2006 DuPont introduces Tedlar® PV2100 Series  
 2007 Worldwide PV module production exceeds 4GW  
 2008 DuPont opens new PV tech center & lab in Asia—Taiwan & Japan  
 2008 DuPont introduces Solamet® PV159 metallization paste for frontside solar cells  
 2009 DuPont opens new PV technical center—China  
 2009 DuPont announces 6 new innovations in PV materials  
 2009 DuPont invests to double capacity for critical Solamet® photovoltaic metallizations & Tedlar® PVF films  
 2009 DuPont receives DOE grant for ultrabarium process development  
 2010 DuPont opens 2 new PV application labs—Europe & U.S.



DuPont  
Photovoltaic Solutions



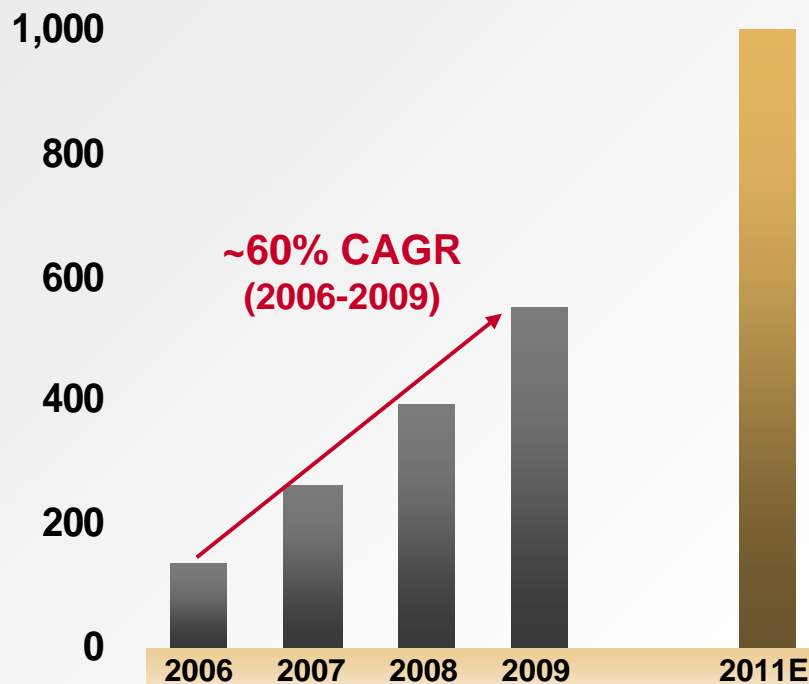
The miracles of science™

# DuPont Photovoltaic Solutions

## Rapid Growth

- Rich pipeline of new products
- Recognized industry leader
- Capacity expansions
- Global reach

Sales 2006-2011E  
\$ in Millions

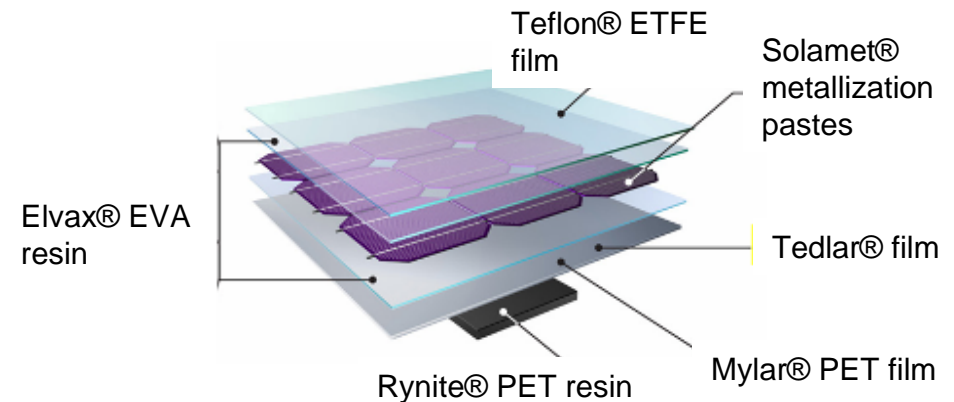


**Goal: >\$1B in Sales in 2011E; >\$2B in 2014E**

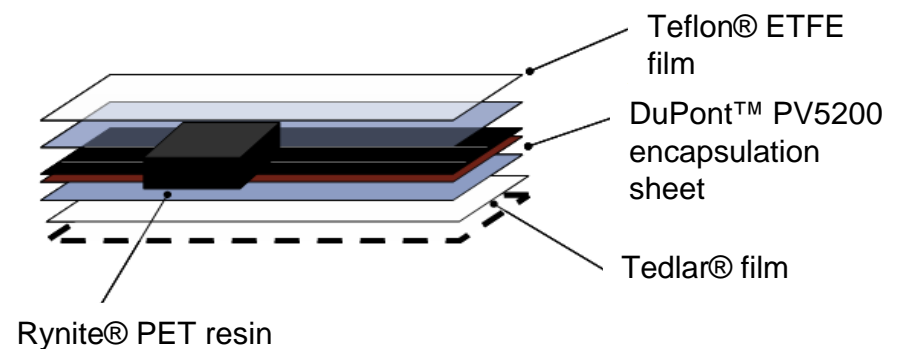
# Materials for Multiple PV Technologies

- Fastest growth in thin film
- Vertical integration by top module producers
- Rapid growth of commercial and utility segments
- Strong need for improved module reliability
- DuPont focus on partnerships, enabling technologies, and end market requirements

## Crystalline Si (c-Si) PV cells & modules



## Amorphous Si (a-Si) thin film PV modules



# Strong Pipeline of Materials Innovations will Improve System Efficiency, Cost and Lifetime

## Efficiency

N-type silicon wafers

### **Improved cell metallization**

Higher aspect ratio metallization

Improved anti-reflective coatings

Textured tabbing ribbons

Improved transparent conductive oxides

Better reflector films

Higher blue light transparent materials

More temperature resistant substrates

Thermally conductive substrates

## Lifetime

Improved encapsulants

Improved anti-soiling/fouling coatings

### **More durable backsheets**

Better edge sealing

Higher reliability inverters

Thermally conductive substrates

Microinverters

Flexible moisture barriers

## Cost

Thinner Si wafers

Lower quality UMG (upgraded metallurgical grade) silicon

Faster lamination cycle time

Simpler mounting & racking systems

### **Lower moisture sensitivity encapsulants**

Thinner encapsulant films

Thinner backsheets films

New backsheet constructions

Lighter weight materials

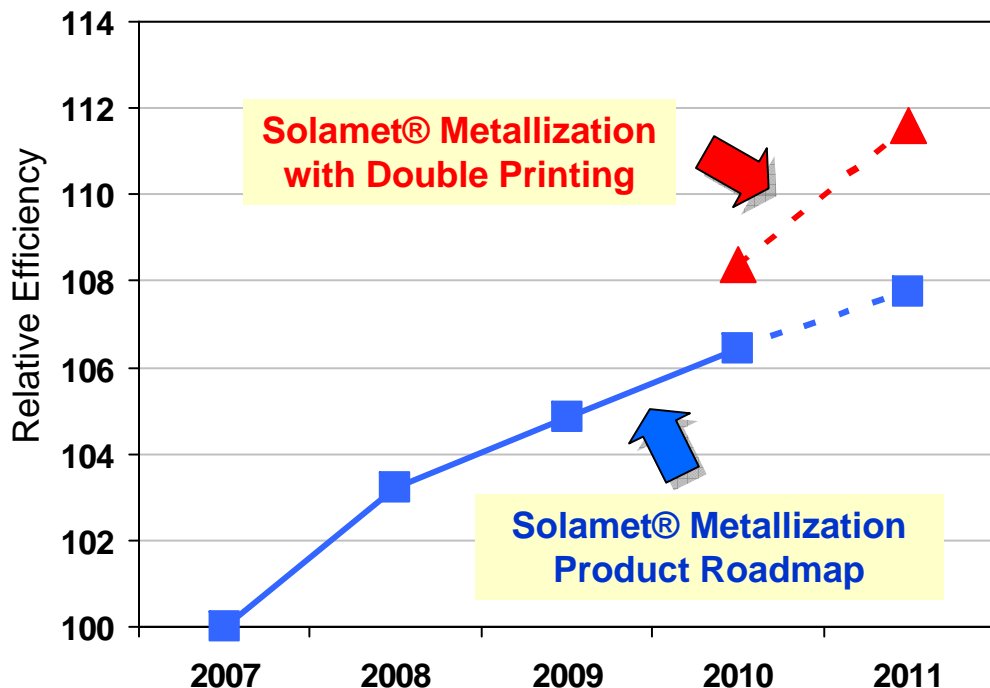
# Materials Innovations for Higher Cell Efficiency

## Materials Innovation

High Efficiency  
Metallization  
Pastes



## Cell efficiency improvements

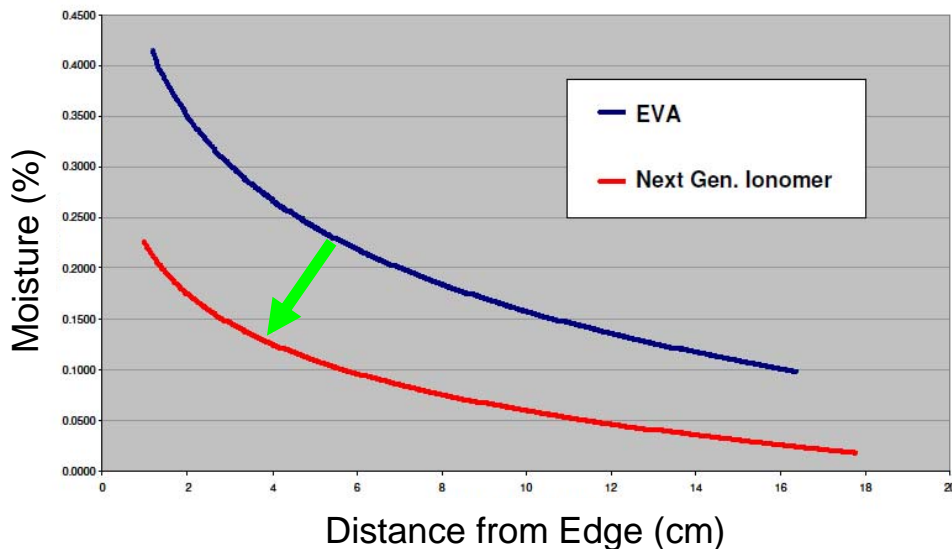


- DuPont Solamet® metallization pastes enable ~2%/yr efficiency improvement
- Double printing technology accelerates efficiency gains

# Materials Innovations for Lower Module Costs

Materials Innovation	
<b>Ionomer Encapsulant Films</b>	

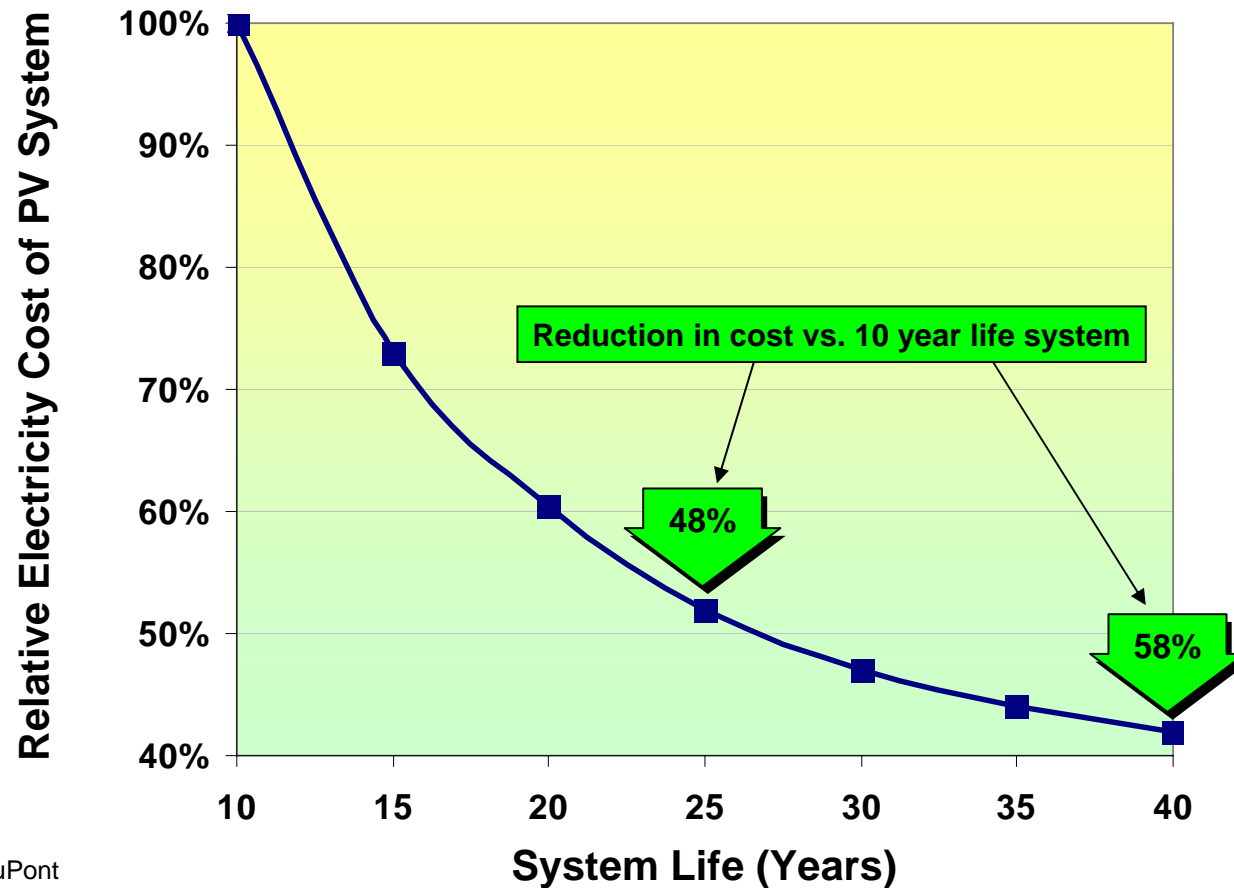
## Lower moisture ingress



- DuPont PV5300 ionomer encapsulant films introduced in 2009
- Unique properties are ideal for glass-glass PV modules
- Cost savings of \$3/panel by elimination of edge sealing

# Materials Choices Drive System Reliability

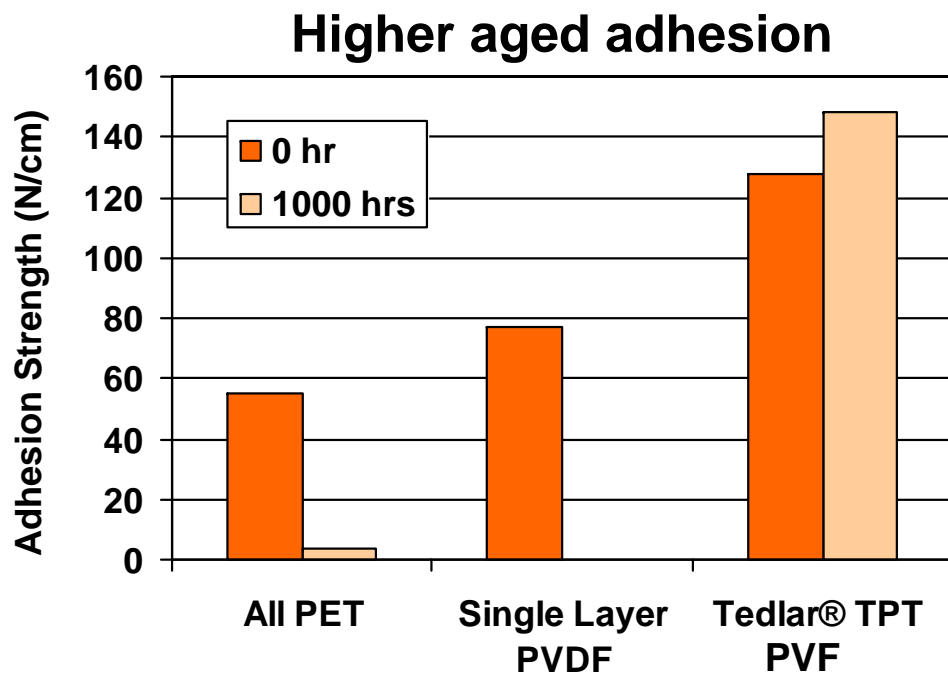
## Longer-Life Systems Deliver Lower-Cost Power



Source: Sunpower; DuPont

**25 Year Warranties Becoming Standard**

# Materials Innovations for Longer System Life



- Backsheets require 25+ year adhesion under operating conditions
- DuPont Tedlar® films have a 25+ year proven track record in the field

Adhesion Change

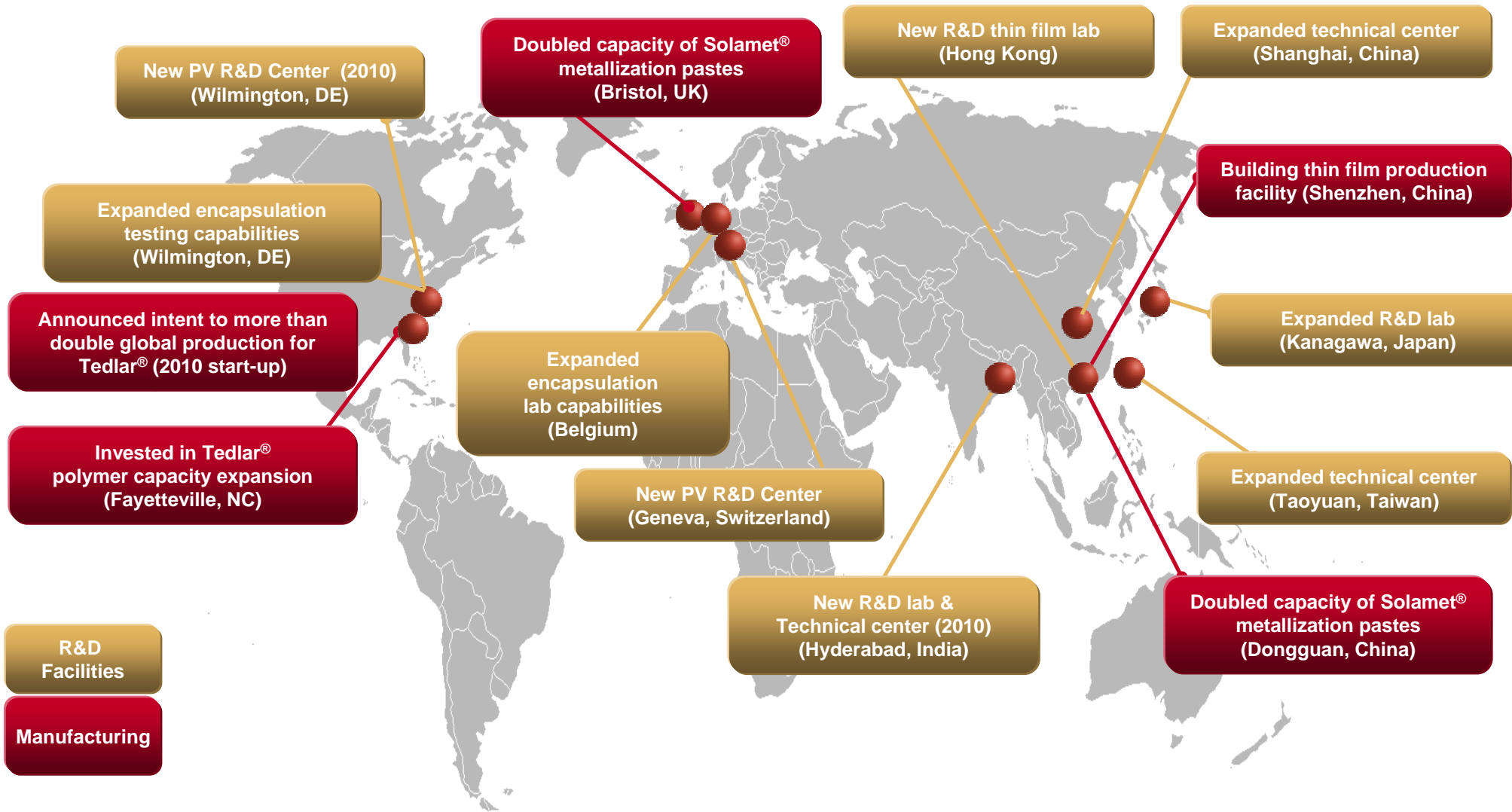
93% ↓

100% ↓

16% ↑



# Well Positioned for Growth in PV



**New Investments Consistent with Growth Strategy**



# DPVS is Aggressively Investing in China

## DuPont China Photovoltaic Technology Center in Shanghai

- Opening ceremony on May 4<sup>th</sup> 2009
- Comprehensive capabilities including solar cell, module and reliability labs
- Technical support to local customers
- Strong innovation pipeline for advanced PV materials
- Partnership with local customers and universities for open innovation



## DuPont Apollo Shenzhen Thin Film Module & Systems Integration Business

### Locations

*HQ and R&D Center*  
Science Technology Park  
Hong Kong



*First Manufacturing Plant*  
Guangming Area  
Shenzhen



### Products & Services

*Thin-Film Photovoltaic  
Modules*



*Tailor made PV  
System Solutions*



# The Future for the PV Industry is Bright

- ✓ **Driving cost reductions to achieve grid parity is critical to PV industry growth**
  
- ✓ **Materials are essential to PV industry's future roadmap:**
  - **Improved Efficiency**
  - **Reduced Cost**
  - **Longer Lifetime**
  
- ✓ **Materials companies serving the PV market need:**
  - **Strong technology & fast-paced innovation capability**
  - **Sufficient capital for capacity expansions**
  - **Global footprint to serve customers' growth**



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