Photovoltaic Solar Energy

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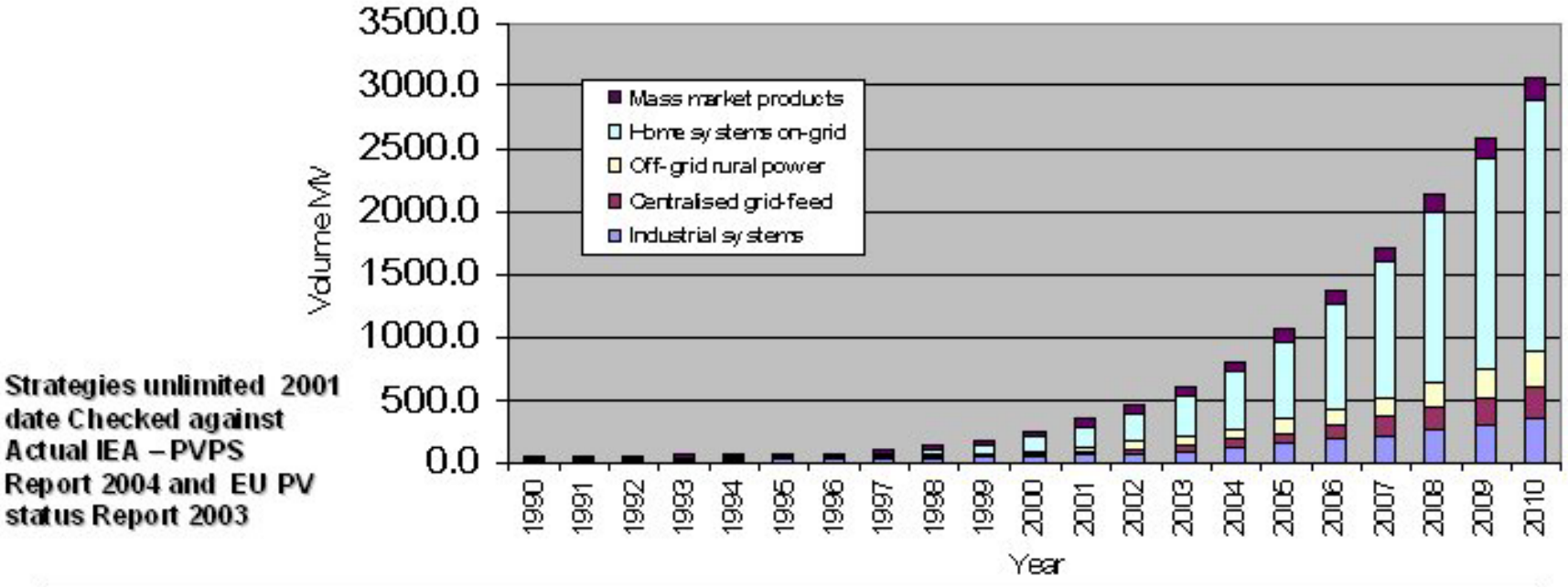
Outline of Talk

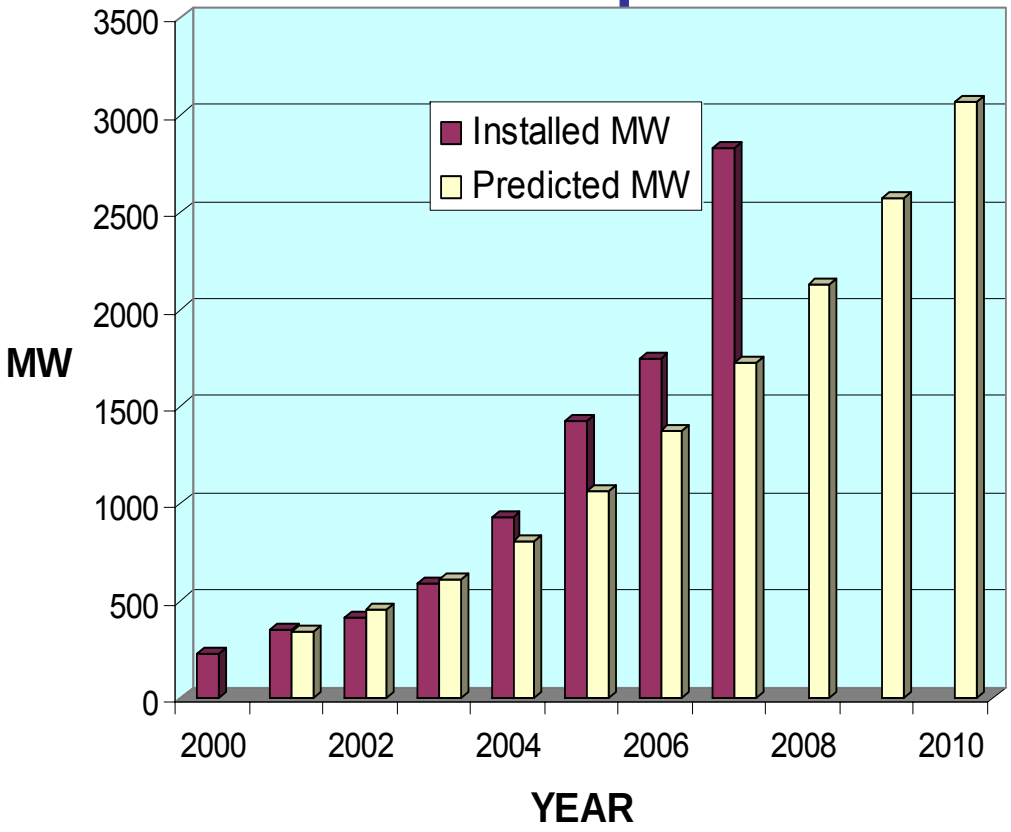
- Current status of PV markets and technology
- Key materials challenges from SRA
- How are we meeting the challenge?
- The way forward

Global Context of expanding PV Market



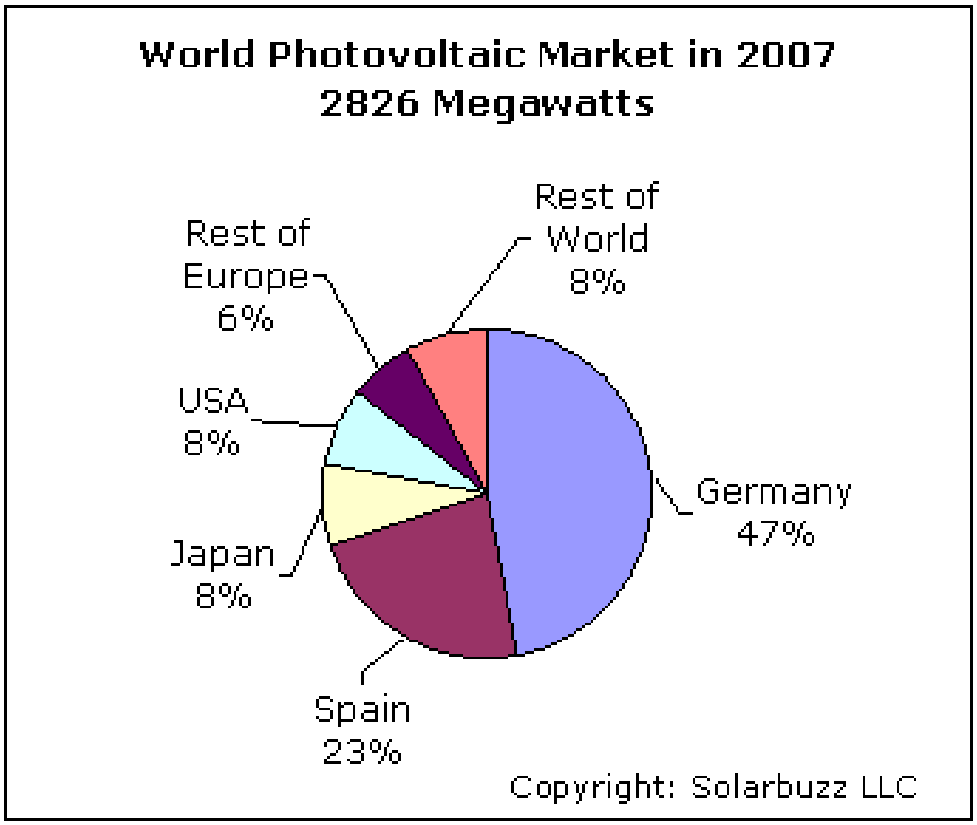
Predicted Market Growth (2001) – adjusted 2003/2004

The reality has exceeded expectations



Over 90% current PV production is crystalline Si, thin film is set to take a larger share

In 2001 46% was on grid domestic. Predicted to become 66% in 2010



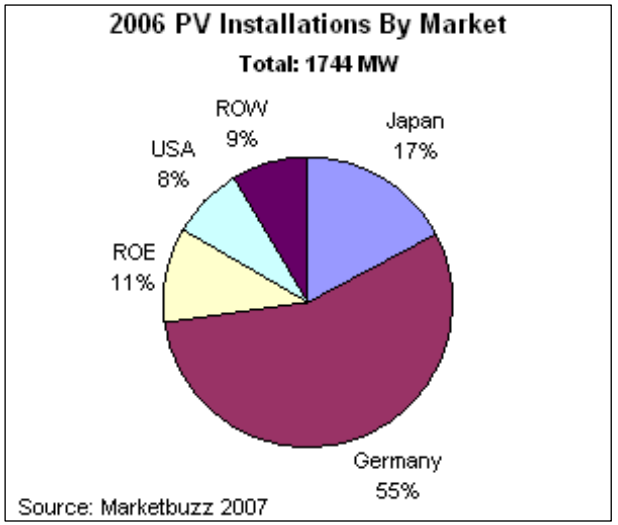
2007 Market Growth:

Worldwide- 62%

U.S. - 57%

Spain - 480%

cf 2006:



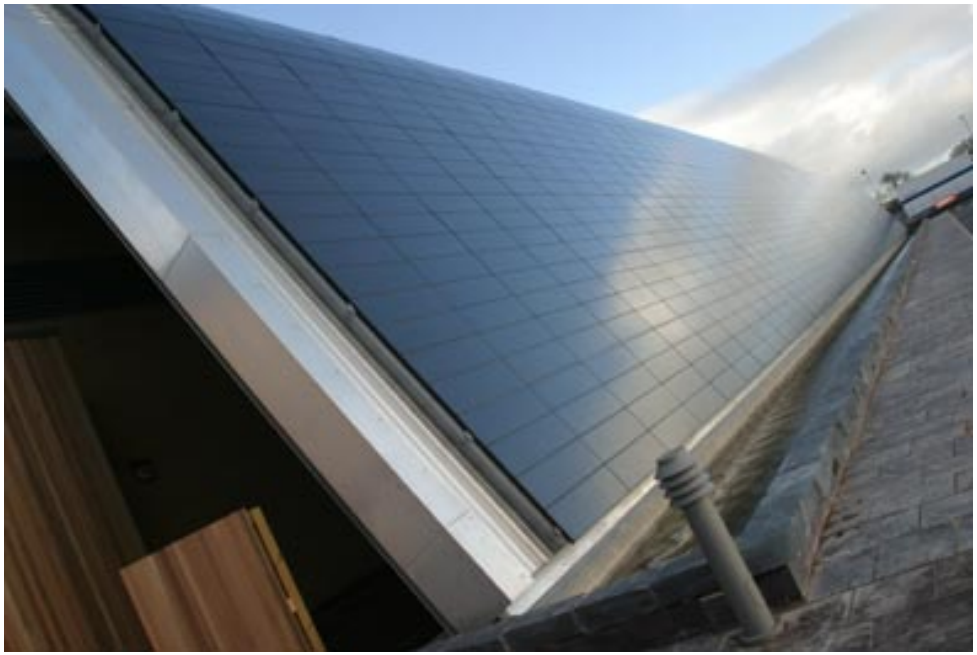
Global context for UK

- The major adopter countries have feed-in tariffs to stimulate the market.
- The adoption rate remains low in the UK but we have significant PV industry.
- The SRA states that 20% of our electricity could readily be generated by solar PV
- Dispel myth that we don't have enough solar energy in the UK!
- In the UK we have available per annum 1,000-1,300 kWh/m^2, in Spain this rises to 2,000 kWh/m^2

Example of thin film PV façade at OpTIC Technium, St Asaph

The PV façade at OpTIC Technium demonstrates novel thin film CIS technology

- 1000 m^2 generating up to 85 kWp of completely clean energy.
- Largest of its kind outside US

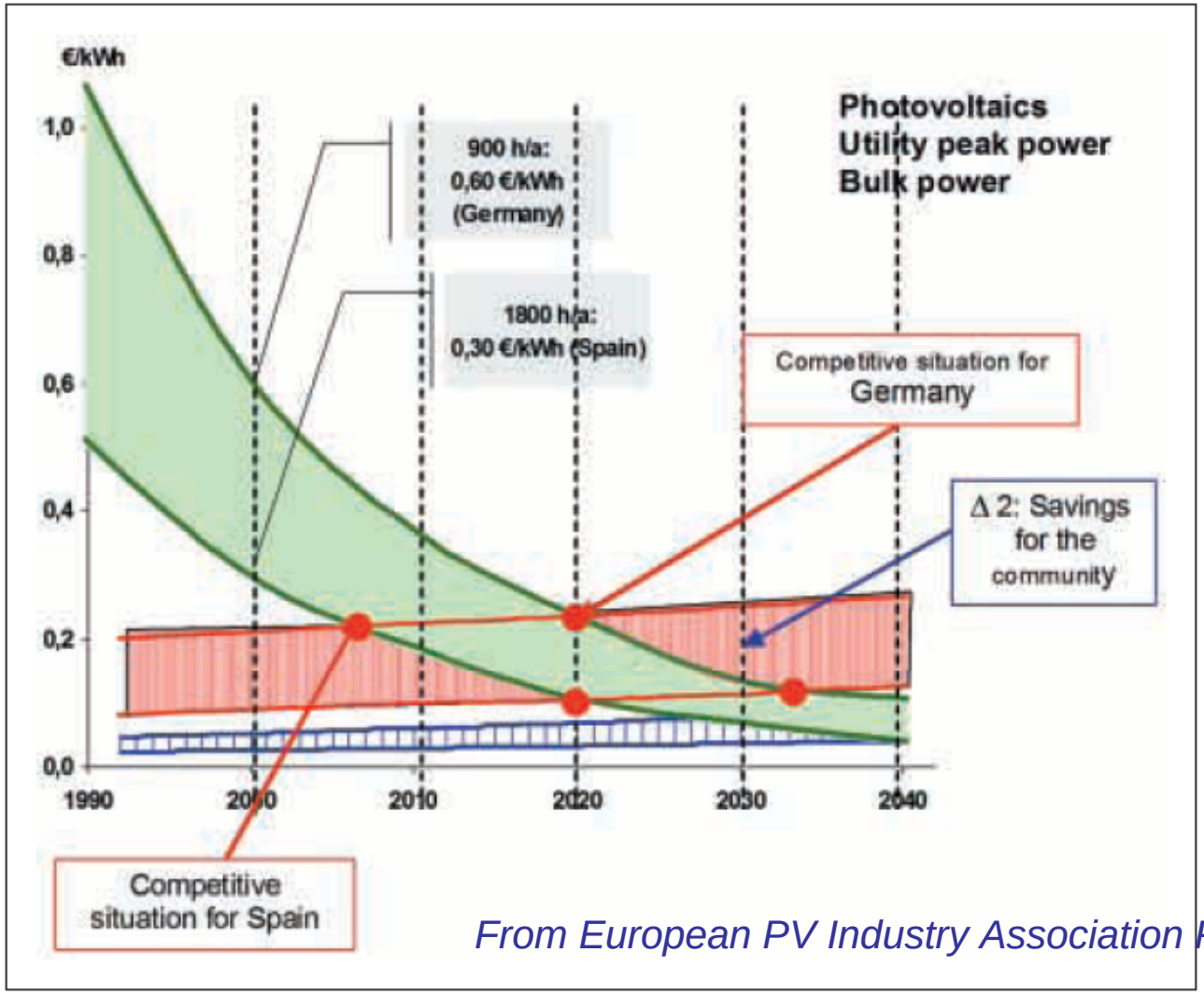


In the first 12 months of operation a total of 65,000 kWh of clean electricity was generated, saving 28 tonnes of carbon emissions from fossil fuelled power stations

Barriers to adoption of PV

- The installation cost of a PV system comprises of the module, balance of systems and installation costs.
- Running costs are low – no moving parts!
- The fuel is free!
- The cost of the energy is calculated by amortizing capital cost over a period of 25 years and estimating total energy yield over that period. Say 2kW domestic installation will generate 1,600 kWh per annum (£8,000) installation cost – price of electricity 20p per unit.

Cost of PV system is seen as the largest barrier to adoption of PV



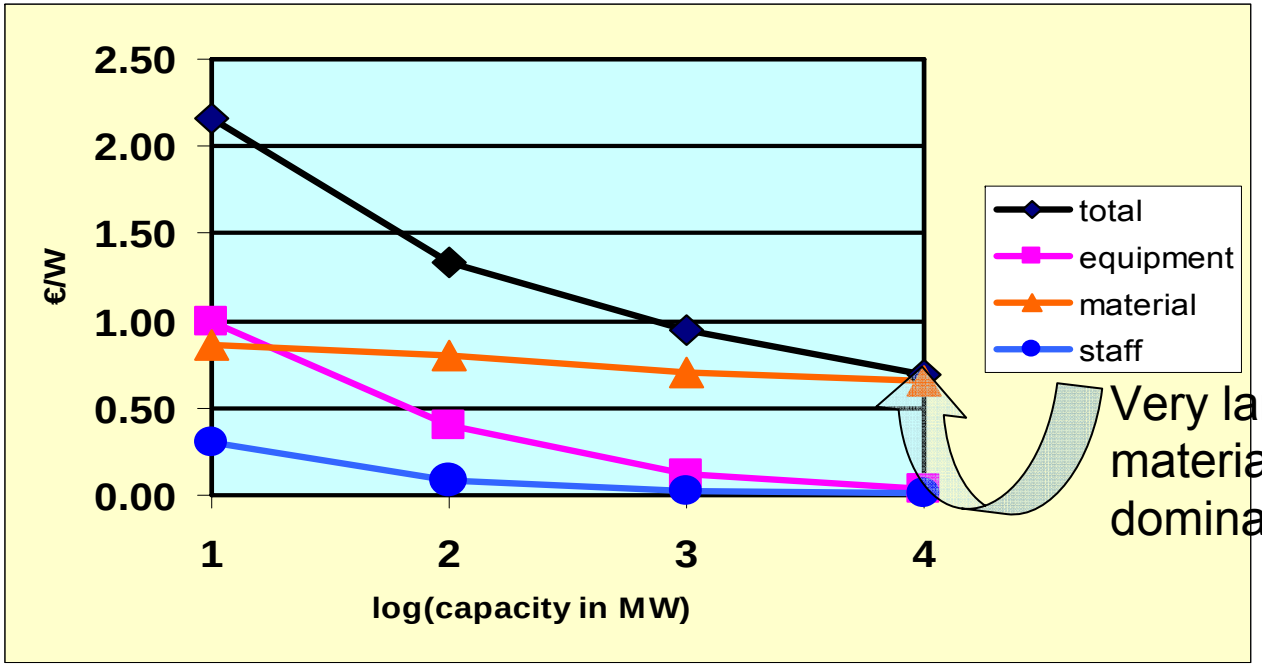
European Industry reviewing target for 12% of total electricity supply from PV by 2020

From European PV Industry Association Road Map

For large volume production the cost of materials becomes the major driver

Current thin film

Current wafer silicon



Very large scale – materials cost dominate

Cost model of Dieter Bonnet for thin film CdTe solar modules PV21

SRA Key Materials Challenges

- Improve efficiency of energy conversion at module level.
- Reduce amount of costly semiconductor materials and efficient materials usage.
- Use cheaper materials.
- Cheaper and lower energy processing combined with high throughput.
- Improved durability and product life

Crystalline silicon

- low-cost solar grade silicon feedstock
- high-quality, low-cost crystallization
- high yield cutting of very thin wafers
- thin-film wafer equivalents

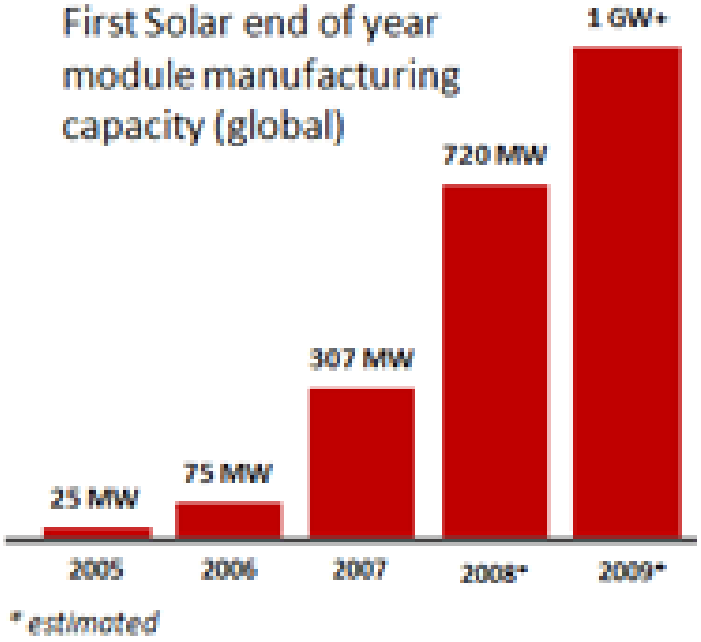
Sharp module factory near Wrexham producing 220 MW/year

Thin film PV: a-Si, CdTe, CIGS

- Improving efficiency of thin film PV modules.
- Improve production throughput and yield.
- Implementation of in situ monitoring and process control
- Increase production scale.
- Better understanding of module lifetime issues.
- Increase materials utilisation.
- Incorporation of innovative materials.
- Improved characterisation techniques, in particular for thin film polycrystalline materials.

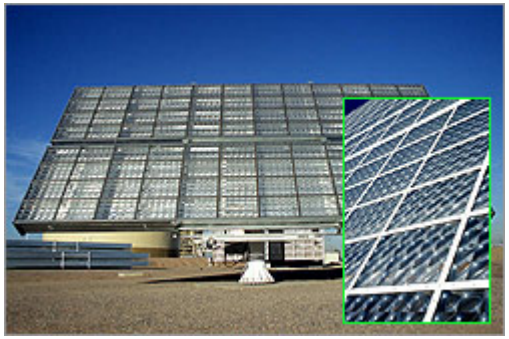
First solar is leading the way with high volume thin film PV manufacture

Commissioned: February 2006; December 2005
Region: Gescher, Germany
Project Size: 1.4 MW
Project Developer: COLEXON Energy AG



Concentrator PV

- Optical design of lenses from cheap materials such as plastics.
- The development of efficient photo luminescent concentrators and light guiding to the PV collectors.
- Development of improved methods for characterising optical conversion materials for concentrators.
- Materials integration.



20kW concentrator STAR centre Arizona

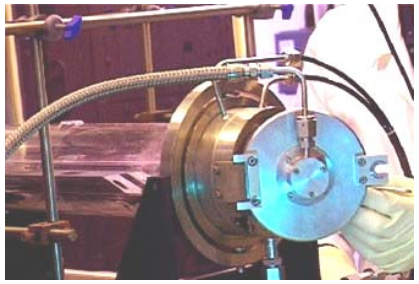
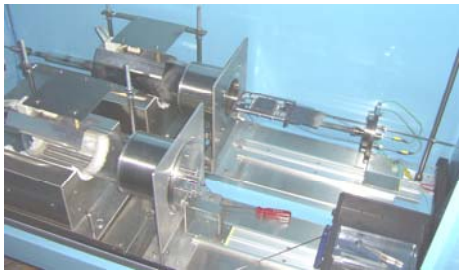
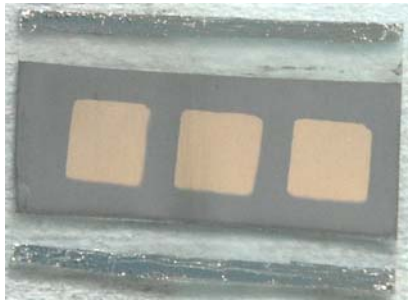
Excitonic PV

- Understanding the charge conduction (excitonic) conduction mechanisms.
- Replacing liquid redox couple with suitable polymer (development of new p-type polymers).
- Effective utilisation of the solar spectrum.
- Development and evaluation of new materials.

G24i DSC solar cells for mobile phones

How are we meeting the challenge?

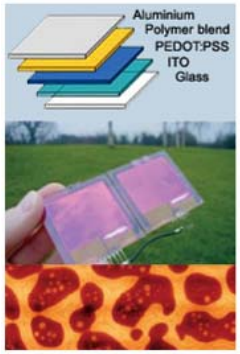
- EPSRC Supergen programme
- Other EPSRC initiatives such as Energy Feasibility etc.
- TSB Energy Materials call
- Carbon Trust Accelerator programme

SUPERGEN PV Consortia

SUPERGEN

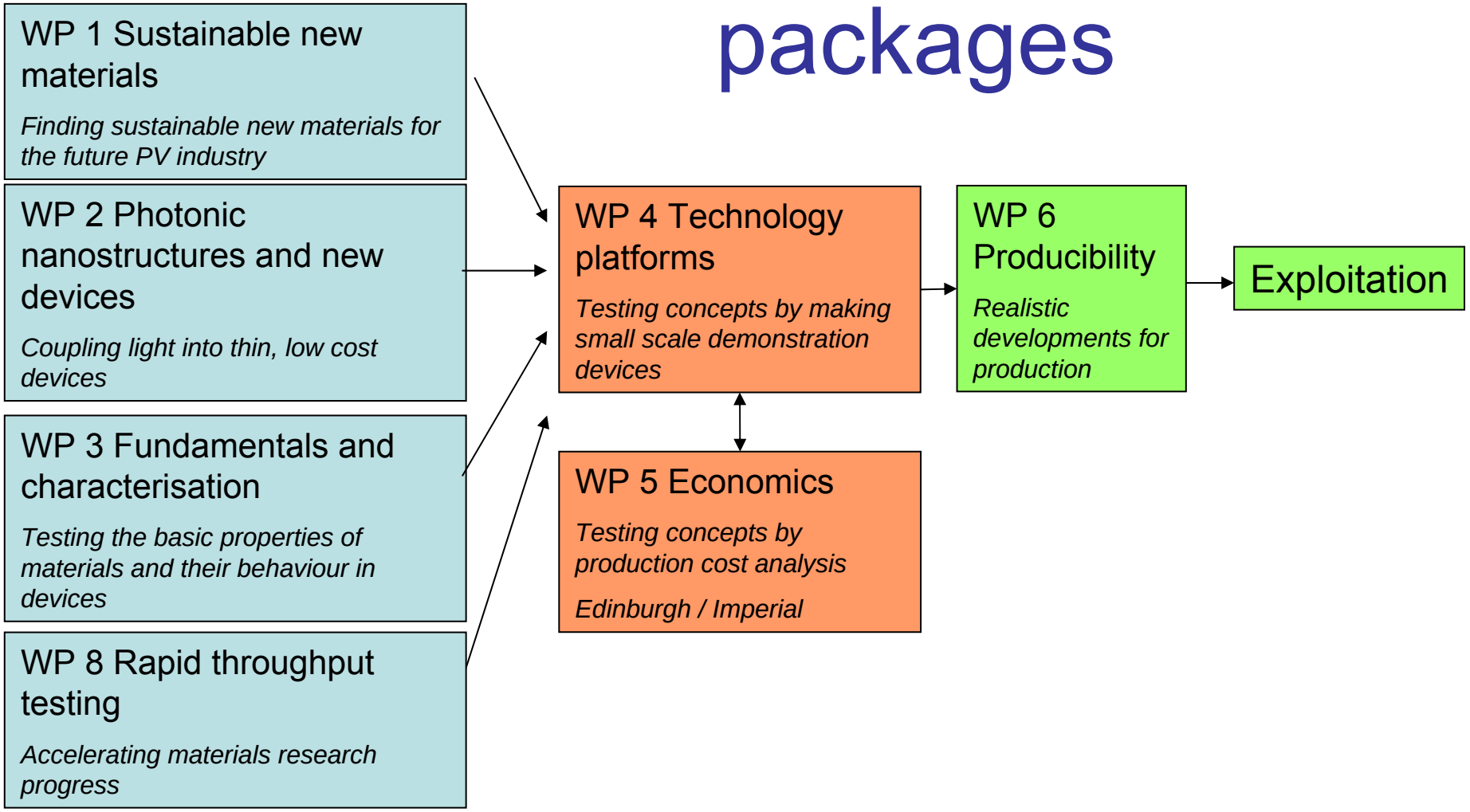
PV21



Photovoltaic Materials for the 21st Century
PV-21
Thin film inorganic and new concepts in PV

The Excitonic Solar Cell
Organic and dye sensitised solar cells

PV – 21 Work packages



How are we doing?

- Building more internationally competitive R&D teams.
- A better focus on key materials technology issues.
- Critical need for facilities to test materials processes on a larger scale.
- Still lacking funding to look at integrated materials issues for module level fabrication

The way forward

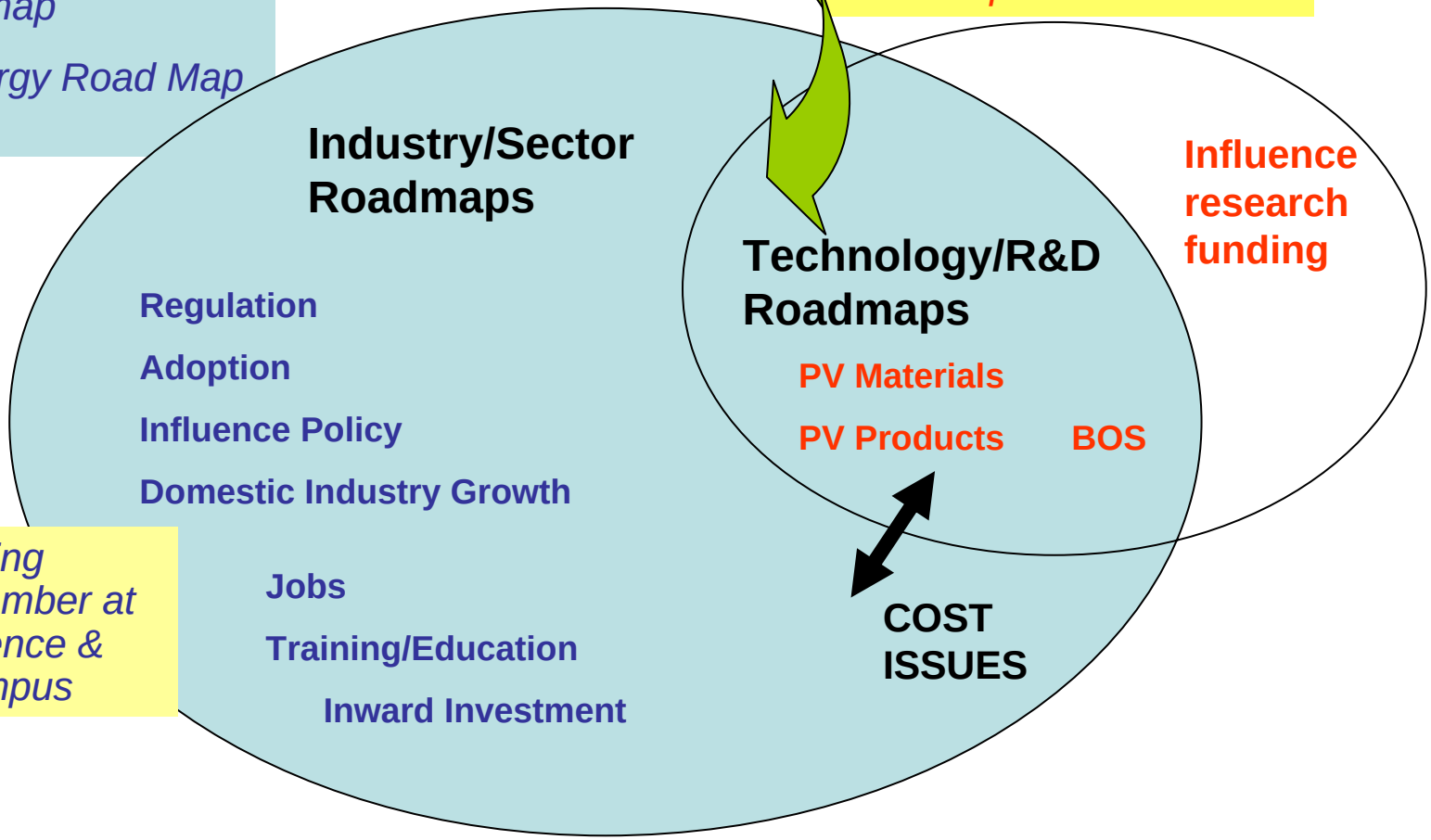
- Adoption of PV needs to be taken more seriously in the UK.
- Opportunities for growth of PV materials industry needs will be linked to innovation and adoption of PV in the UK
- Will need larger scale technology facilities to demonstrate new PV production methods.
- Photonics KTN PV Road Map event on 18/19 November Daresbury Science & Innovation Campus, Cheshire
  - to address issues of PV Industry and PV adoption in the UK

CSER

- *US Photovoltaic Industry Roadmap*
- *EPIA Roadmap*
- *Australian Photovoltaics Industry Roadmap*
- *PV Solar Energy Road Map for Wales*

Materials UK SRA

- *UKERC Research Road Map for Photovoltaics*
- *PVNET European Roadmap for PV R&D*



UK Roadmapping 18th/19th November at Daresbury Science & Innovation Campus

Conclusions

- The SRA has set a challenging agenda for UK PV R&D
- Greater national and international collaboration to meet challenge
- The SRA should underpin the growing UK PV industry
- We need to learn the lessons of our European neighbours in linking PV adoption to growth of industry