

DYE SOLAR CELL RESEARCH and COMMERCIALISATION

**Ross MacDiarmid, Hans Desilvestro, Sylvia Tulloch, and Gavin
Tulloch**

Dyesol Limited
Queanbeyan NSW 2620, Australia

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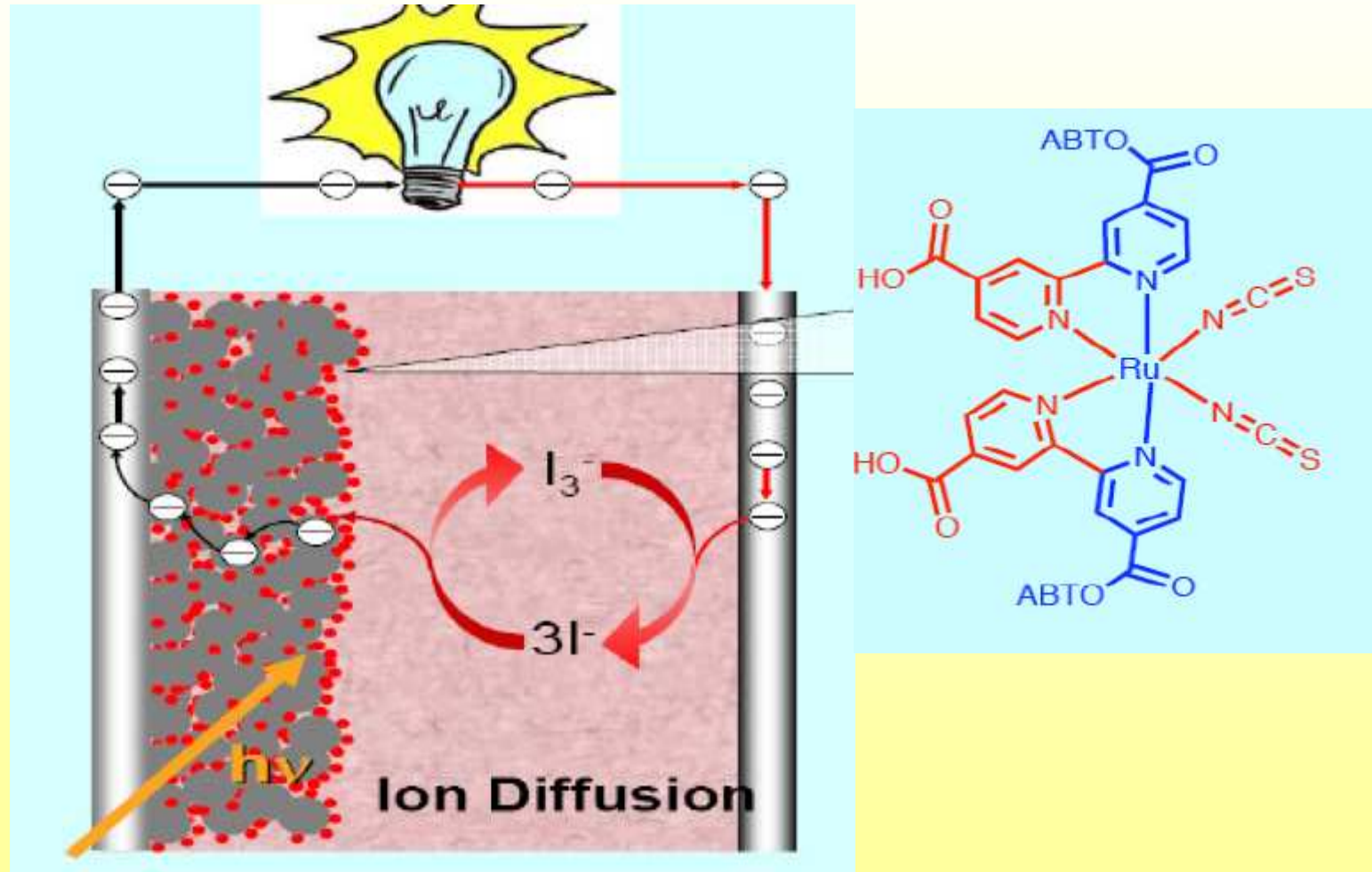
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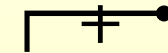
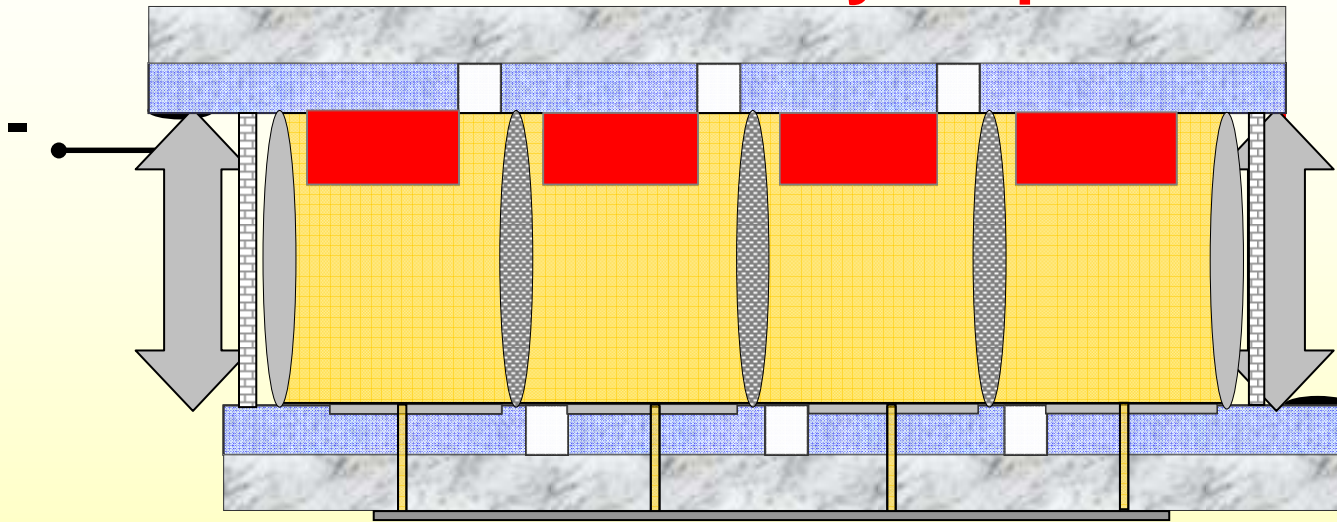
The Solar Market

- **As a result of GFC a challenging 2009, however -**
- **Focus globally on stimulus packages with emphasis on solar**
- **New mood in USA with Obama election**
- **G8 meetings looking to Copenhagen**
 - **Events around the world becoming a constant reminder of the need for rapid change and the requirement for renewable energy**
- **Growth in solar market up to 2009 has nearly doubled year on year**

How does a dye solar cell work?



Glass Module Assembly Animation 13 key steps



1. Glass cutting
2. TEC isolation
3. Glass drilling
4. Glass cleaning

5. TiO₂ deposition
6. Catalyst deposition
7. Dye application
8. Local Dye Removal
9. Interconnect & primary seal

10. Electrolyte filling
11. Hole Sealing
12. Secondary sealing
13. Electrical connections

The 'Market' for DSC

- **The built environment accounts for nearly 47% of CO2 emissions**
 - The production of building and construction materials represent 10% of that 47%
 - Building use 37%
- **Much of the world's climatic conditions are characterised by:-**
 - Cloudy and overcast skies
- **Many of the world's cities are heavily polluted with dust, smoke and haze a feature of the skyline**

Market applications for DSC and potential size

- **Steel Roofing**
 - Coated steel market - + 1 Billion m², and growing at 7-8% pa
 - Potential for solar coated steel cladding 20% or over 200 ml m² / annum
 - Addressable market - \$10billion per annum
- **Façade market**
 - World flat glass market was 5.2 billion m² in 2007
 - Growth to 2010 is expected at 5% to 6.1 billion m²
 - Given 60/40 view non view
 - Addressable market – 2.4 billion m²
- **Plus the possibility of the spandrel market**

Unique Advantages of DSC

- ***Operating voltage virtually independent of light level, orientation and temperature***
- ***Power all day every day – Delivers kWh/m² (not just W_p @ 25°C)***
- **Integratable into building products**
- **Most environmentally friendly, clean and green PV technology: Much lower embodied energy***
- **Readily available raw materials (in contrast to In, Ga, Te)**
- **Aesthetically pleasing (looks good). Many colours and effects**
- **Transparency option – naturally**

* Reference: M.J. de Wild-Scholten, A.C. Veltkamp; ECN Solar Energy; Environmental Life Cycle Analysis of Dye Sensitized Solar Devices; Status and Outlook; 22nd

Other advantages of DSC panels

- Multifunctional
 - Electrical power generation
 - Heat insulation
 - Noise insulation
 - Light moderation/ filtering

DSC Technology Validation

The National Technology Roadmap for Sensitized solar Cells (NREL Management Report NREL/MP-520-41739 June 2007)

“Sensitized solar cells, in some of their forms, have considerable advantages over other technologies:

- (1) They are very tolerant to the effects of impurities*
- (2) This relative impurity tolerance and simplicity allow for easy, inexpensive scale-up to non-vacuum- and low-temperature-based high-volume manufacturing via continuous processes (e.g., screen-printing, spraying, pressing, or roll-to-roll production);*
- (3) The materials are inexpensive and effectively limitless;*
- (4) They operate optimally over a wide range of temperatures;*
- (5) Their efficiency is relatively insensitive to the angle of incident light; and*
- (6) The range of applications are numerous*

World wide interest in DSC

A Technology is known by the company it keeps

Organisations who selected DSC over other PV technologies:

- **Corus (British Steel)**
- **Petronas**
- **Permasteelisa**

Other organisations with strong DSC Programs

- **Hyundai**
- **Sony**
- **Toyota**
- **Samsung**

Dyesol

Realising the opportunities

- **Partnerships with leading multi national corporations addressing global markets**
- **Business model underpinned by international trends in environmental and energy use legislation**
- **Early stage revenues from exposure to pre-production projects and sales of materials and equipment**
- **Collaborations with prominent research institutions and Universities around the world**
- **Working with key suppliers to improve the performance of materials**

DYESOL

- **Who are we**
 - Listed on ASX in 2005 but founded in 1995
 - Raised over \$40m with \$9m in May
 - From 8 people in 2005 to 63 people world wide today
 - Operations / offices in :-
 - UK
 - Italy
 - Korea (JV)
 - Singapore
 - Switzerland
 - Japan
 - Australia (Queanbeyan)

DYESOL

- **Highly qualified staff with PhDs and Masters qualifications and 550 man years of experience with DSC**
- **The chair of our Technical Advisory Board is Professor Michael Graetzel the inventor of DSC**
- **Focus**
 - **UK – working with CORUS on the steel coating project**
 - **Korea - JV with TIMO working on a glass project**
 - **Australia (Queanbeyan)**
 - **Glass application development / accreditation**
 - **Metal application development**
 - **Flexible (Surevolt) development**
 - **Materials production – dye, titania paste and electrolyte**
 - **Equipment design and production / assembly**

Achievements to date

- **Significant progress on glass ‘accreditation’ towards achieving >20 years for BIPV**
 - **Through**
 - Accelerated environmental testing
 - Accelerated long term testing
 - Understanding loss and failure mechanisms
 - Addressing materials, design and process issues by working with the leading Corporations in their specific area of expertise
 - **Long term stability**
 - Excellent long term stability at industrial cell level – more than 20k hours light soaking at elevated temperature

Achievements to date

- **Have hit all milestones with the metal roofing program in the UK**
- **Grew revenue by 30% in 2008/09**
- **Dyesol included in the top 100 low carbon pioneers of CNBC Europe in 2008**
- **In 2008 Dyesol was included among the 6 top performing listed solar companies out of 70 companies listed world wide**
- **We were a state/ territory winner of the Export awards and will be a National finalist in Nov 09**

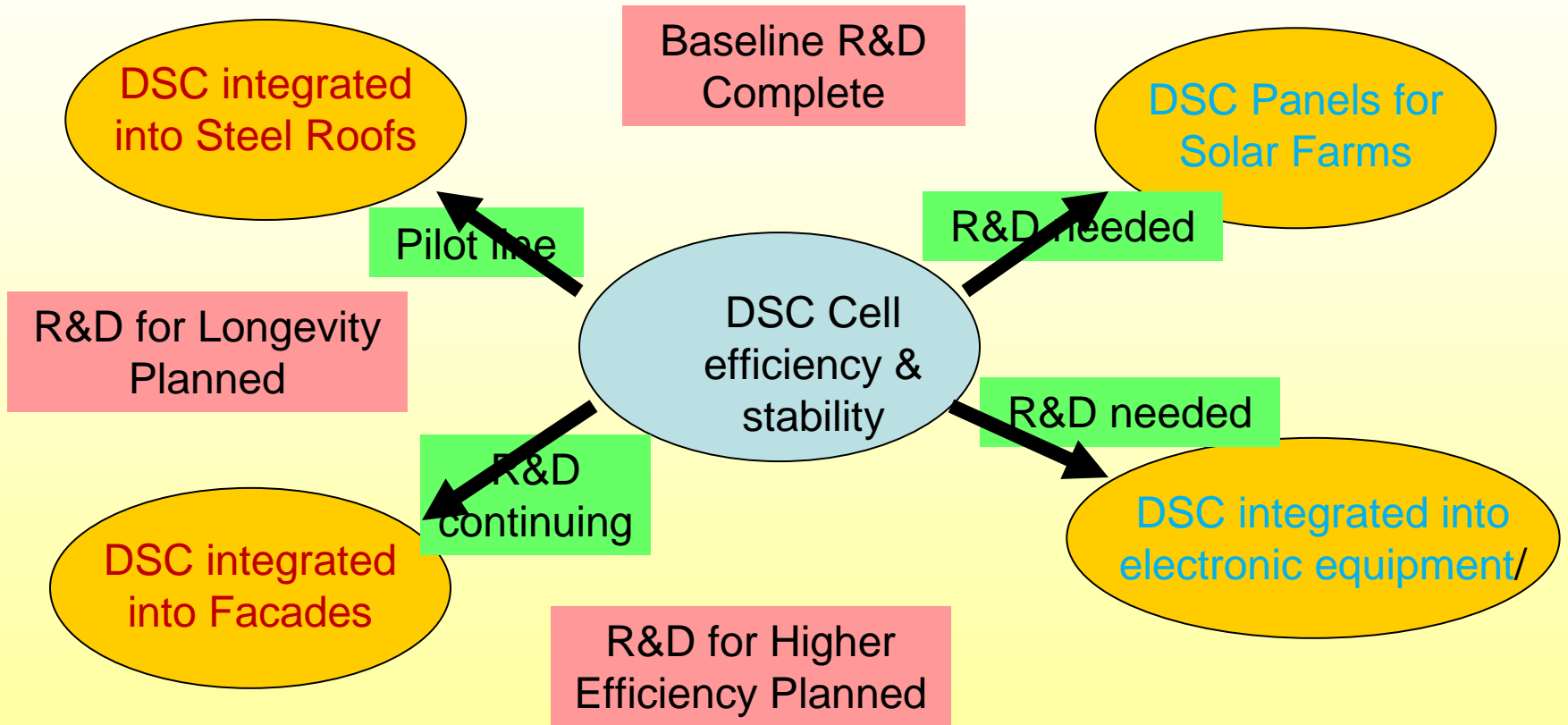
Partnerships and programs

- **Solar Coated Steel Cladding – Corus/Tata**
- **Solar Façades – Permasteelisa, ERG Renew Consortium**
- **Solar Glass Products – Timo (Korea), Nesli (Turkey)**
- **SureVolt Flexible, Foldable, Portable – Defence, Civil, Sensors, Electronics**

Pathway to further development

- **2009-11**
 - Improve dye performance to absorb greater than 700nm
 - Optimise titania particle size, morphology, chemistry to impact on the open circuit voltageLeading to DSC efficiency improvement to 10%
- **2012- 16**
 - Improve HOMO/LUMO matching of the dye with the semi conduction band and the redox couple
 - Increase Jsc by 25- 30% through improved dyes, titania layers, current collection designs and anti reflective layersLeading to DSC efficiency improvement to 14%

DSC Technology Development Roadmap Status



Scale Up and Packaging

From cells to modules - some challenges

- **Cell-to-cell interconnects**
 - Stable and low resistance, independent of module thermal expansion
 - Corrosion-protection
- **Sealing of larger areas**
 - Glass vs transparent polymer
- **Flatness of glass**
- **Reliability in all weather conditions**
- **Scale-up based on robust, high-speed, low-cost processes**
- **Meeting standards e.g. IEC 61646**

Conclusions

- **First applications based on inherent strengths of DSC technology**
 - Better performance under non-ideal light conditions
 - Aesthetic appeal
 - Colouration/transparency
- **DSC is particularly attractive for BIPV applications: steel roofs and façades**
- **Demonstrated cell technology has achieved long term stability \Rightarrow > 20 years. Program planned to demonstrate modules longevity and reliability.**
- **Most materials required for DSCs are available at or below target costs in sufficient quantities to GW p.a.**
- **The Partnership model will result in the large scale uptake of Dyesol materials**



Photographer - Thomas Bloch

www.dyesol.com

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