



2nd Australian – European Union Research Infrastructure Workshop: Solar Energy

Sarah Miller, CSIRO & Olivia Coldrey, ASI
26-27 June 2012



Outline



Concentrating Solar Power (CSP)

- CSP Activities in Australia
 - Early, recent, current
- CSP Development And Demonstration Funding
 - ASI, ACRE, SFP

Solar Photovoltaics (PV)

- Technology development
- Australian research capability
- Current and future research infrastructure investment
- Solar Flagships – knowledge sharing
- International collaboration
- Australia Clean Energy Future Plan

Early CSP Activity in Australia

- April 1982: Meekathara (WA)
- MAN STEPS-100 Solar diesel power station



Early CSP Activity in Australia

- 1983: White Cliffs (NSW)
 - ANU 25kW DSG dish
- 1998 converted to CPV
 - Solar Systems



Early CSP Activity in Australia

- 2004: Liddell (NSW)
 - SHP CLFR 1MWt
- 2005-2008
 - Ausra 13.5MWt
- 2010-2012
 - Novatec Solar 9MWt



Early CSP Activity in Australia

- 1994: ANU began “Big Dish” development
 - SG3 400m²
- 2009
 - SG3 500m²



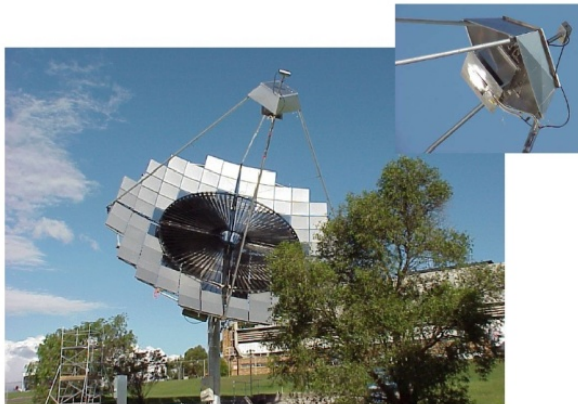
Recent CSP Activity in Australia

- 1994: ANU began “Big Dish” development
 - SG3 400m²
- 2009 - ongoing
 - SG4 500m²



Recent CSP Activity in Australia

- 1997-2002: CSIRO steam reforming methane
 - 20kW dish
- 2004-2006: SolarGas™
 - 500kW tower
- 2008-2012: SolarGas™
 - 20 to 200kW receiver



Recent CSP Activity in Australia



- 2004-2007: Solar Organic Rankine Cycle
 - 80kW ANU trough (1.5m)
- 2006-2009: Advanced Trough & Chiller
 - 35kW NEP trough (1.2m)



ASI proposed in 2007



- Suggested ASI CSP Research Program
 - ST1: High temperature solar steam
 - ST2: Solar enhancement of hydrocarbons
 - ST3: Advanced solar cycles for modular MW
 - ST4: Thermal energy storage for dispatchable solar energy
 - ST5: Distributed polygeneration
 - ST6: Advanced solar thermochemistry

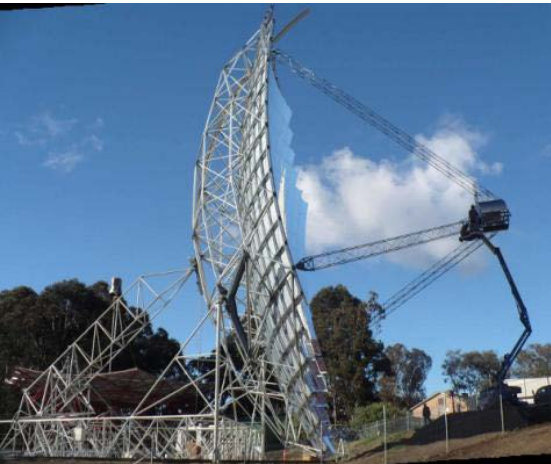
Australian Solar Research Infrastructure



- Foundation Members of the ASI
 - CSIRO (CSP)
 - UNSW (PV)
 - ANU (CSP and rooftop CPVT)
- Foundation Projects
 - To boost research infrastructure

ASI CSP Foundation Project

- Solar Thermal Research Hub
- Air-Brayton Cycle
- CSIRO:
 - New 1.2MW tower
- ANU:
 - Modify SG4 dish



CSP Projects



- Tower
 - Advanced Steam
 - Advanced Storage
 - Brayton Air Turbine
 - Supercritical CO2 Brayton
 - Hybrid Fuels
 - Graphite receiver
 - Tower storage system
 - Phase change test bed
- *APP*
 - *SolarGas™*
- Dish
 - Thermoelectric Generator
 - Receiver design
- Trough
 - Supercritical ORC
 - CCS demonstration
- Other
 - Thermionics
- Scholarships
 - Techno-economic models
 - Phase change storage
 - Solar gasification
 - Heat exchanger

Solar Flagships Program



- Supporting construction and demonstration of 4 large scale solar power stations in Australia
- \$1.3 billion funding (DRET)
 - Develop and share technical and economic knowledge from the program

Education Investment Fund (EIF)

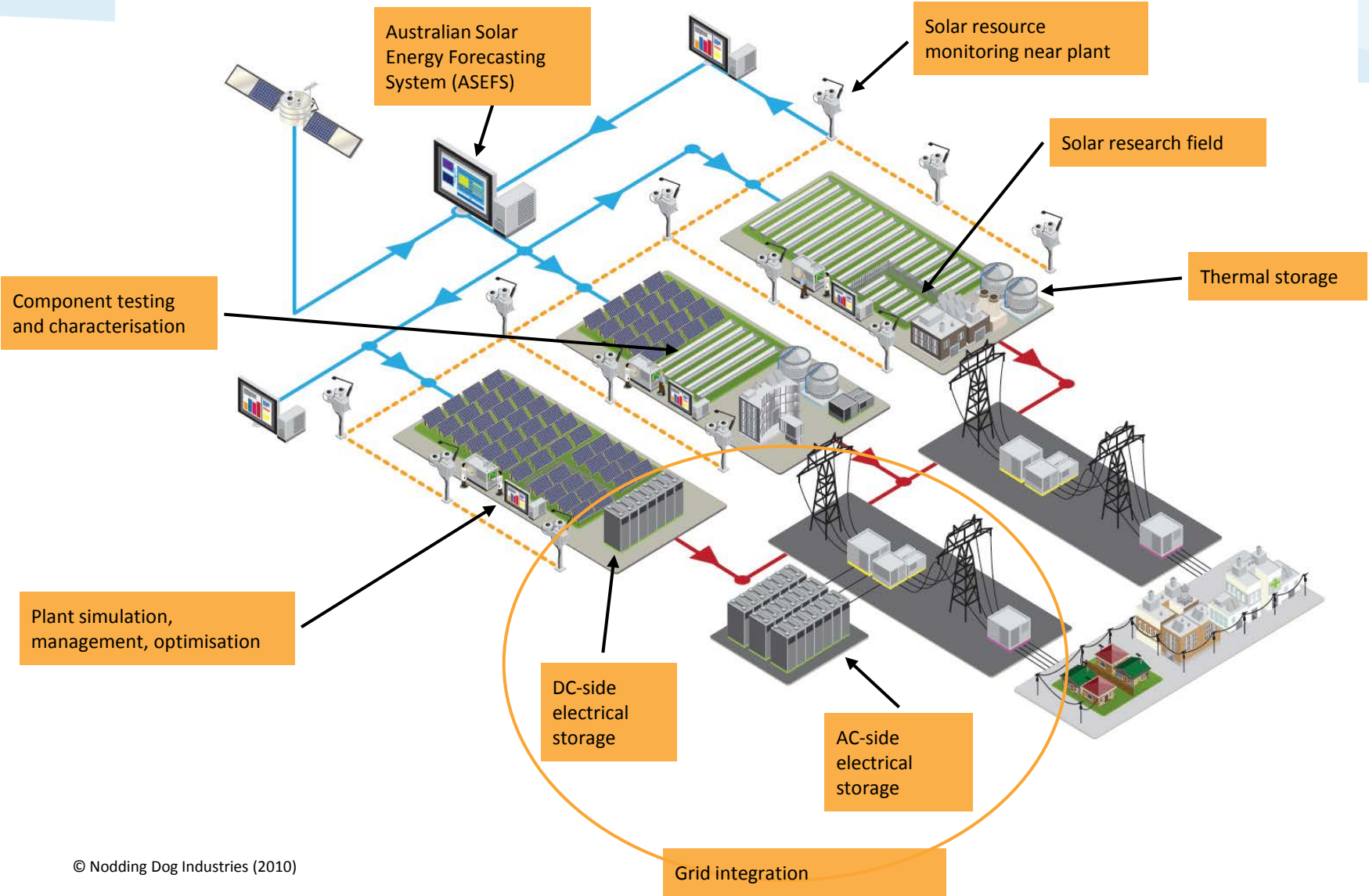
- \$200m for creation of research infrastructure
 - Transformational projects
 - ***Must Support Commercial Project***

Solar Flagships Program



- Solar Flagships Projects
 - Must be proven technology
 - Commercially competitive process
 - But wanted researchers to work together
 - Research infrastructure can be transferred to plant
 - Once it has addressed project research needs
 - Disseminate knowledge from the applied research projects

Research and Infrastructure to Facilitate Deployment of Solar Power Stations in Australia



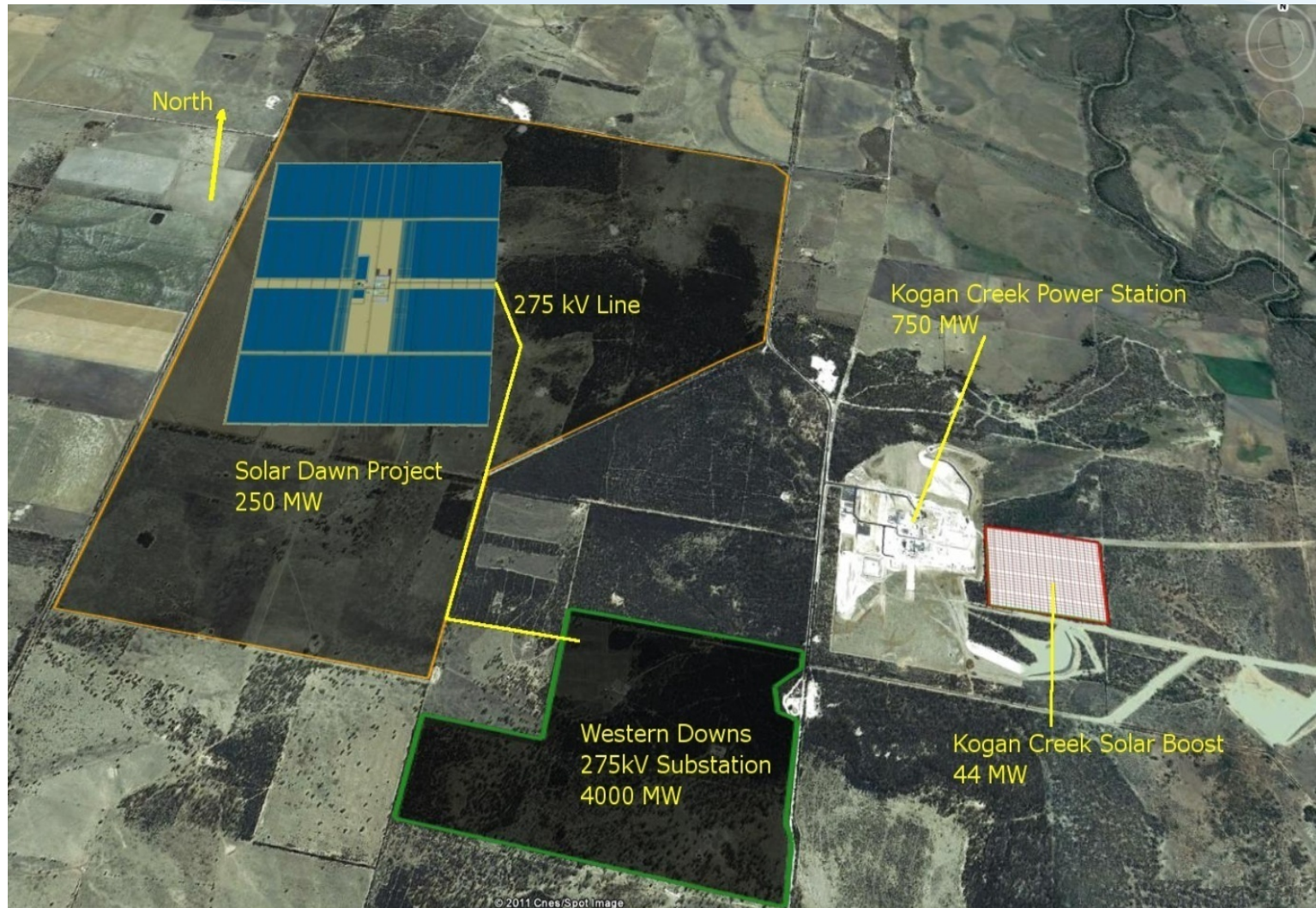
Solar Flagships Project CSP Power Station



- Solar Dawn
 - AREVA Solar, Wind Prospects CWP, CS Energy, UQ
 - 250MW CLFR CST at Chinchilla (Kogan Creek)
 - Cost \$1.2B
 - \$464M from SFP
 - \$75M from Qld Govt
 - EIF \$46M



Solar Flagships Project CSP Power Station



Solar Flagships Project

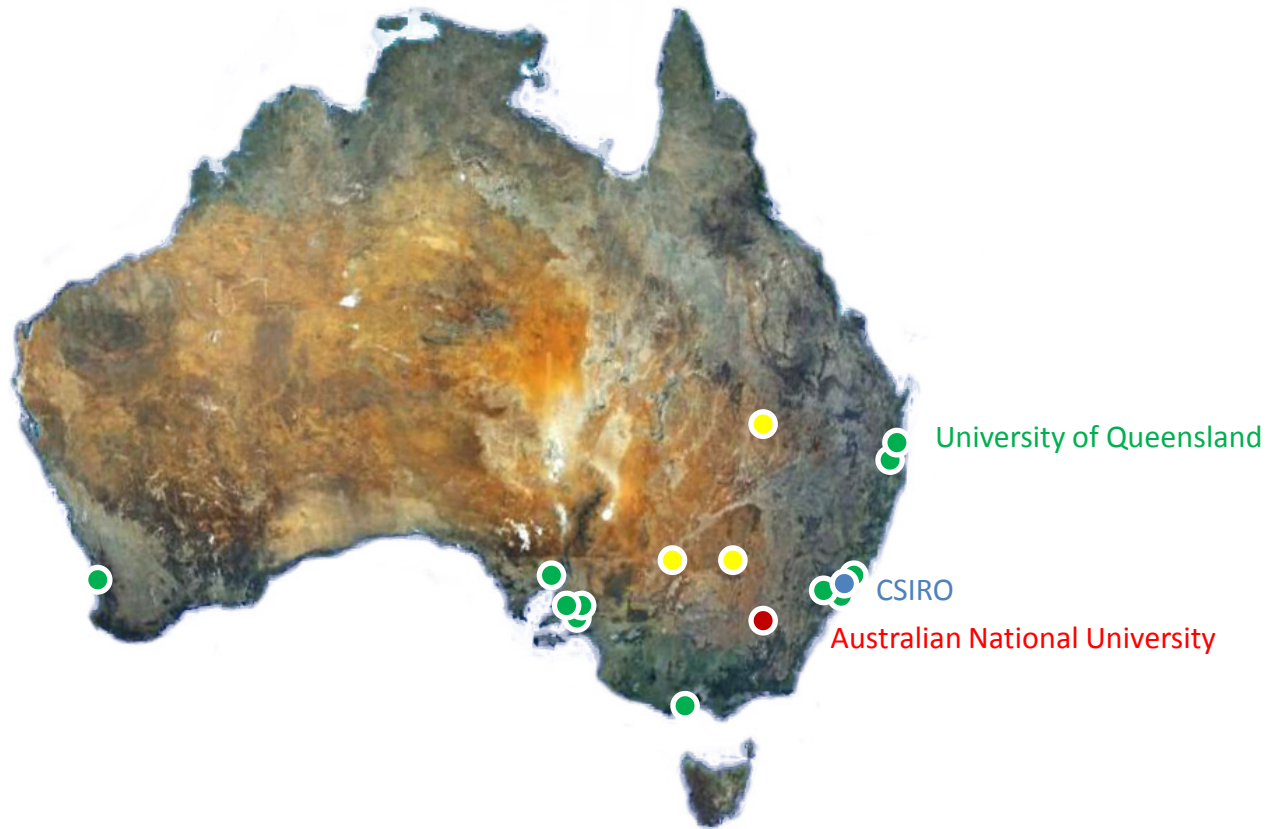
CSP Education Infrastructure Fund



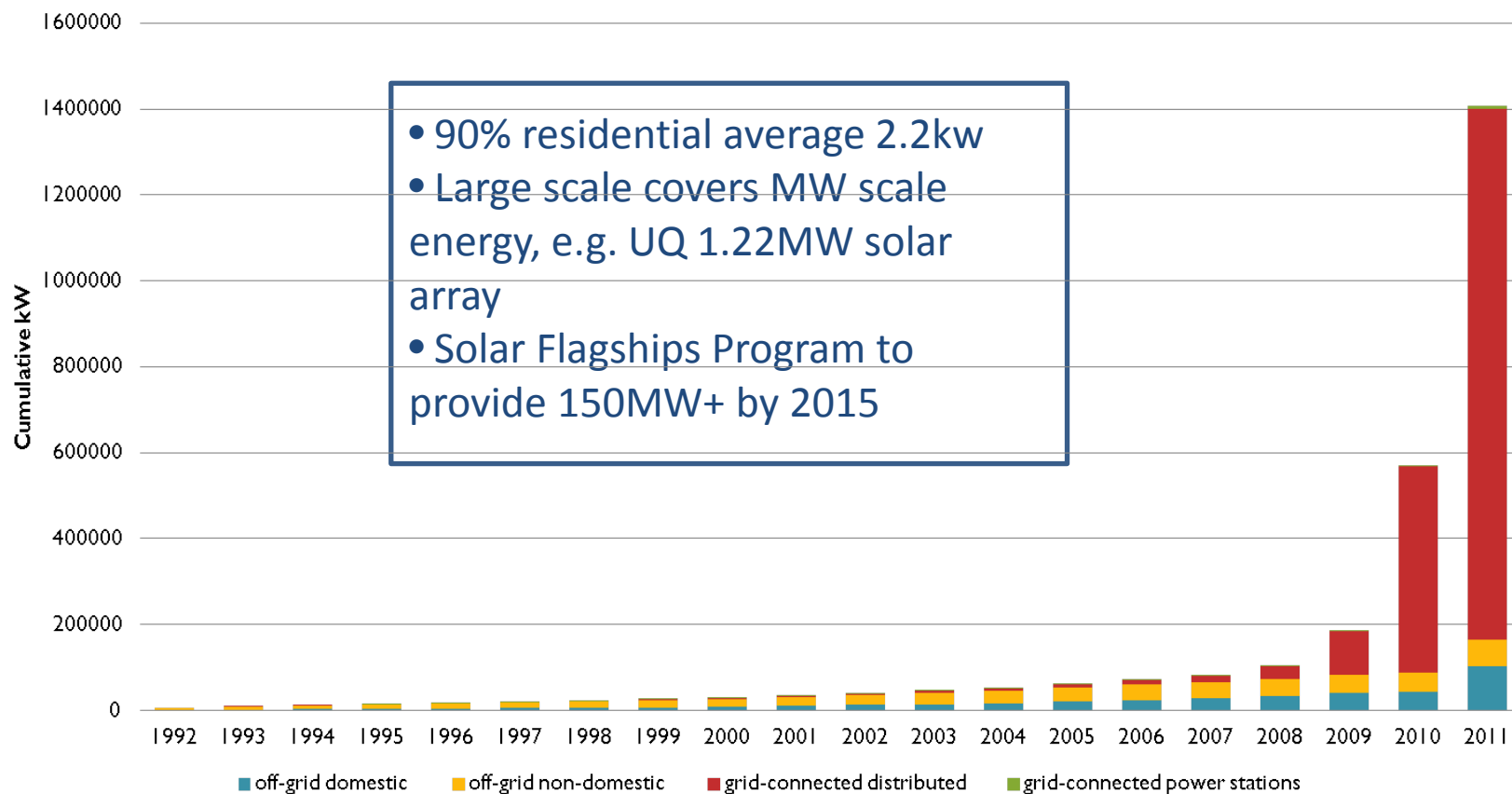
- Infrastructure blocks
 - CLFR array at Chinchilla (25MWt)
 - Data hub and Simulation /Modelling Lab (UQ)
 - Power systems facility (UQ)
 - Energy storage research station (Chinchilla & UQ – ANU partner)
 - Hybrid cooling research station (Chinchilla & UQ)
 - High speed data link from plant to UQ
- Research programs:
 - Plant output optimisation & Grid integration
 - Dispatch forecasting
 - Next generation storage for baseload provision
 - Hybrid cooling
 - Other AREVA priorities
- Research infrastructure located at:
 - CLFR array \$35M
 - Research stations at plant \$11M
 - Operating funds of \$8m over 5 years



Major Activities in CSP



Australian PV market



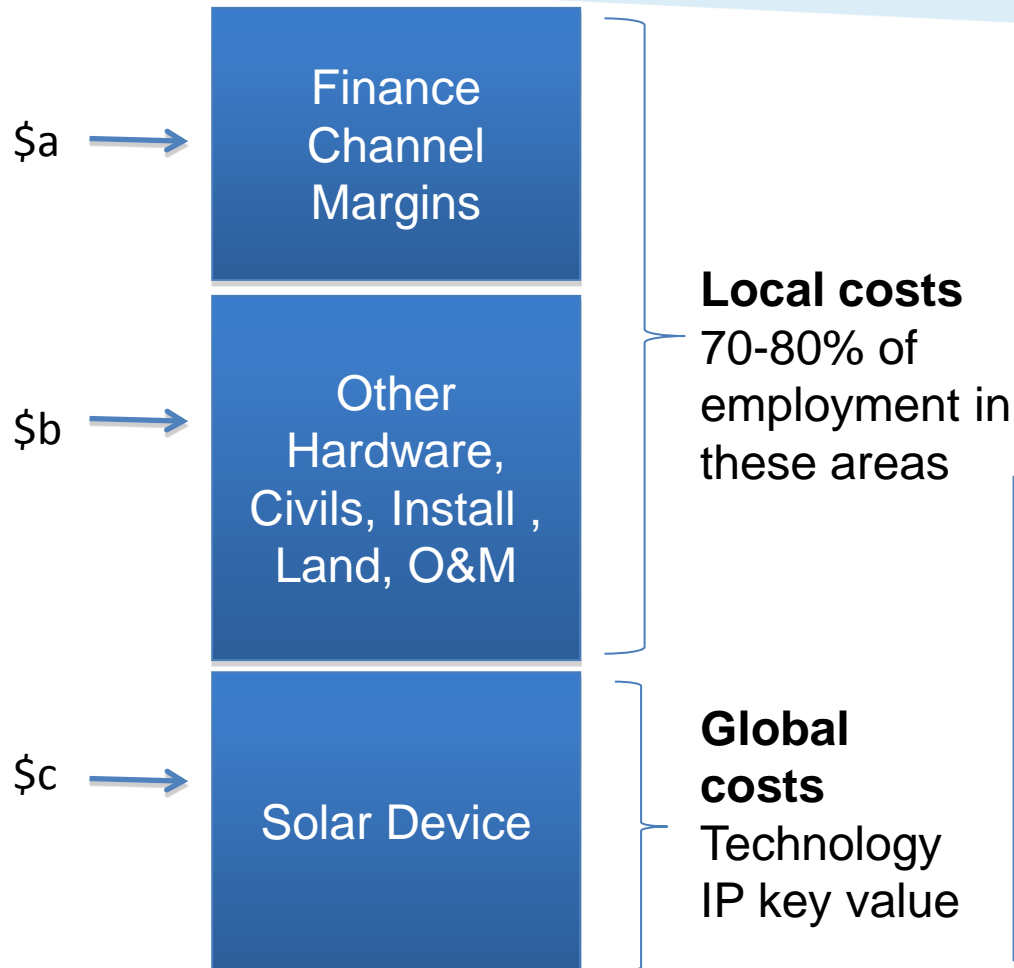
Source: Australian PV Association

Key PV Installations

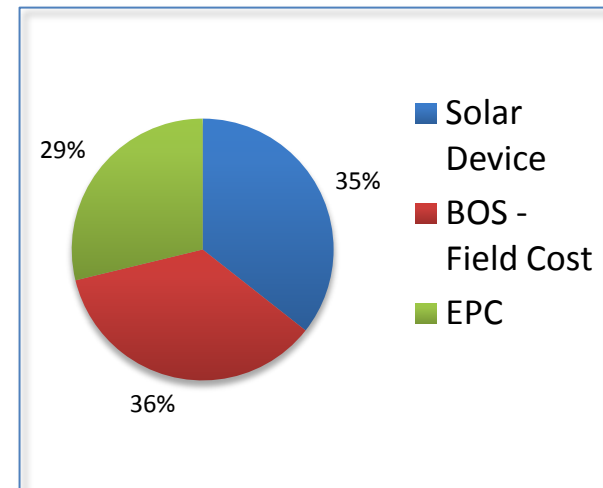
- Adelaide Showgrounds
 - 1MW in 2009
- Desert Knowledge Australia
 - Solar Centre
- Alice Springs (Uterne)
 - 1MW in 2011
- University of Queensland
 - 1.2MW in 2011



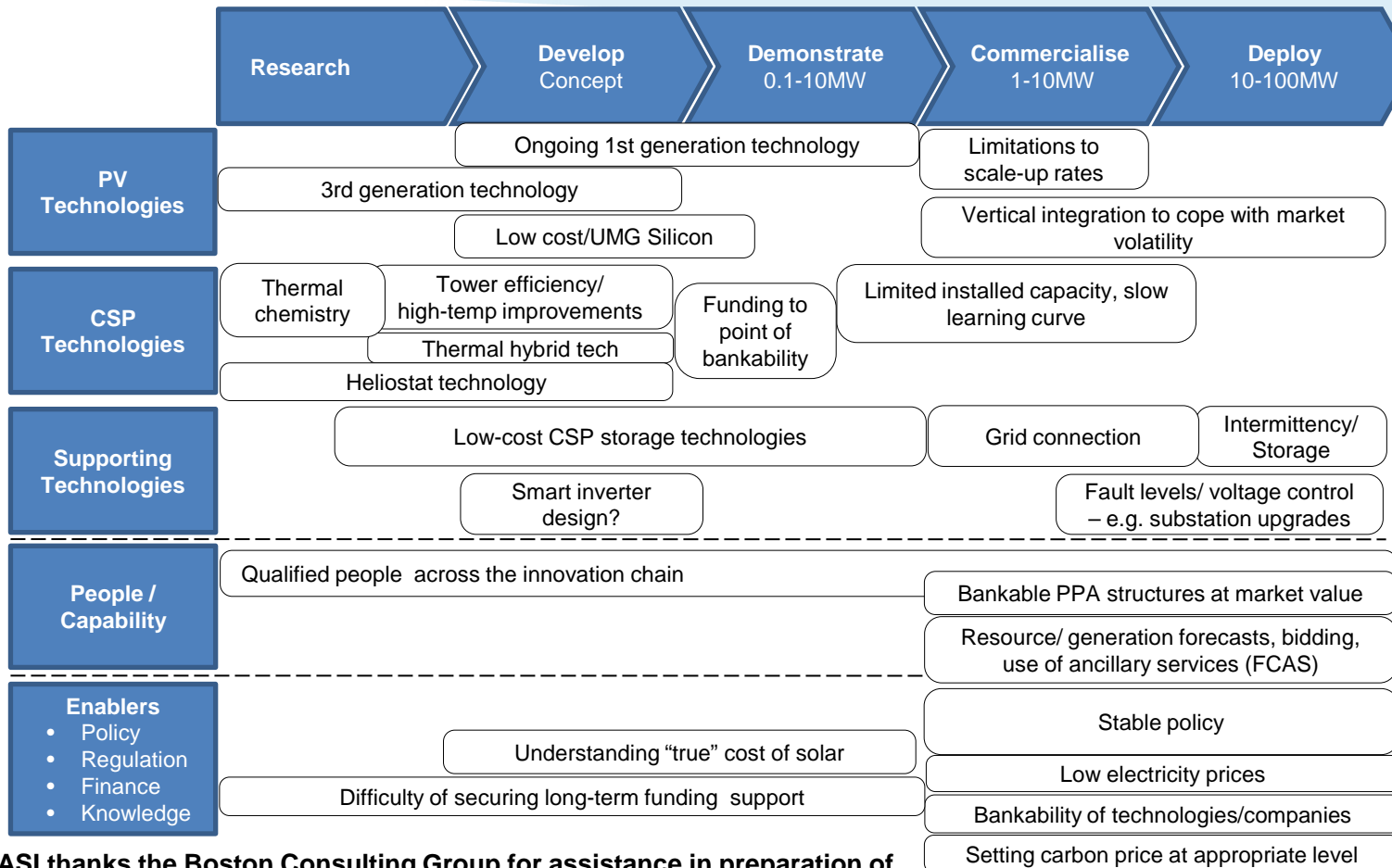
Progress across the full set of costs is required to increase commercial viability and deployment



Typical capital costs



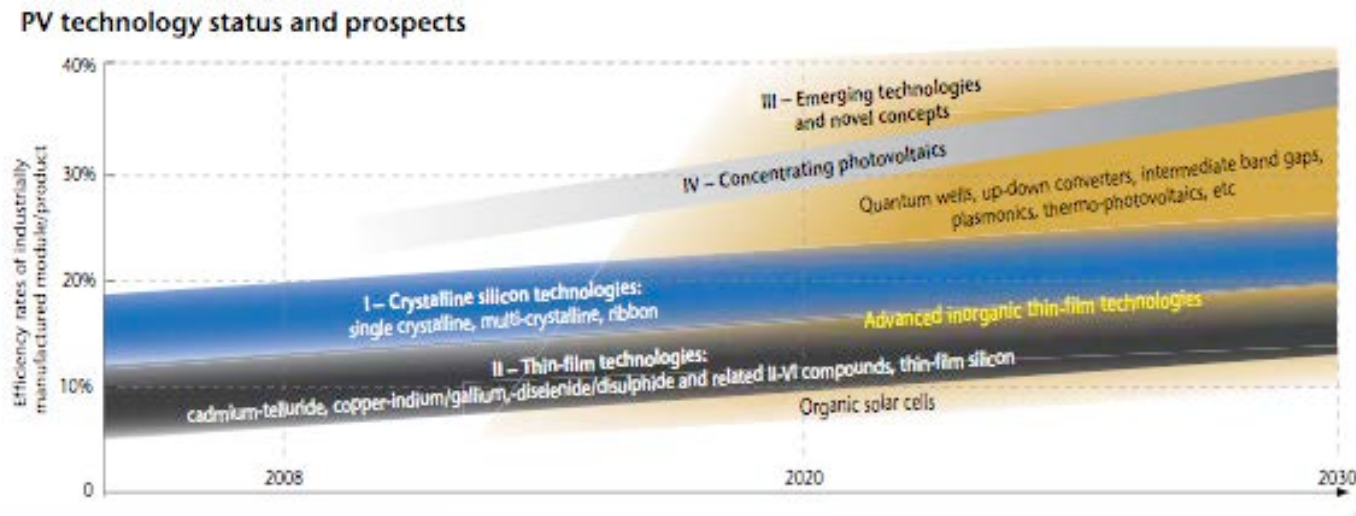
Summary of barriers on the solar innovation chain



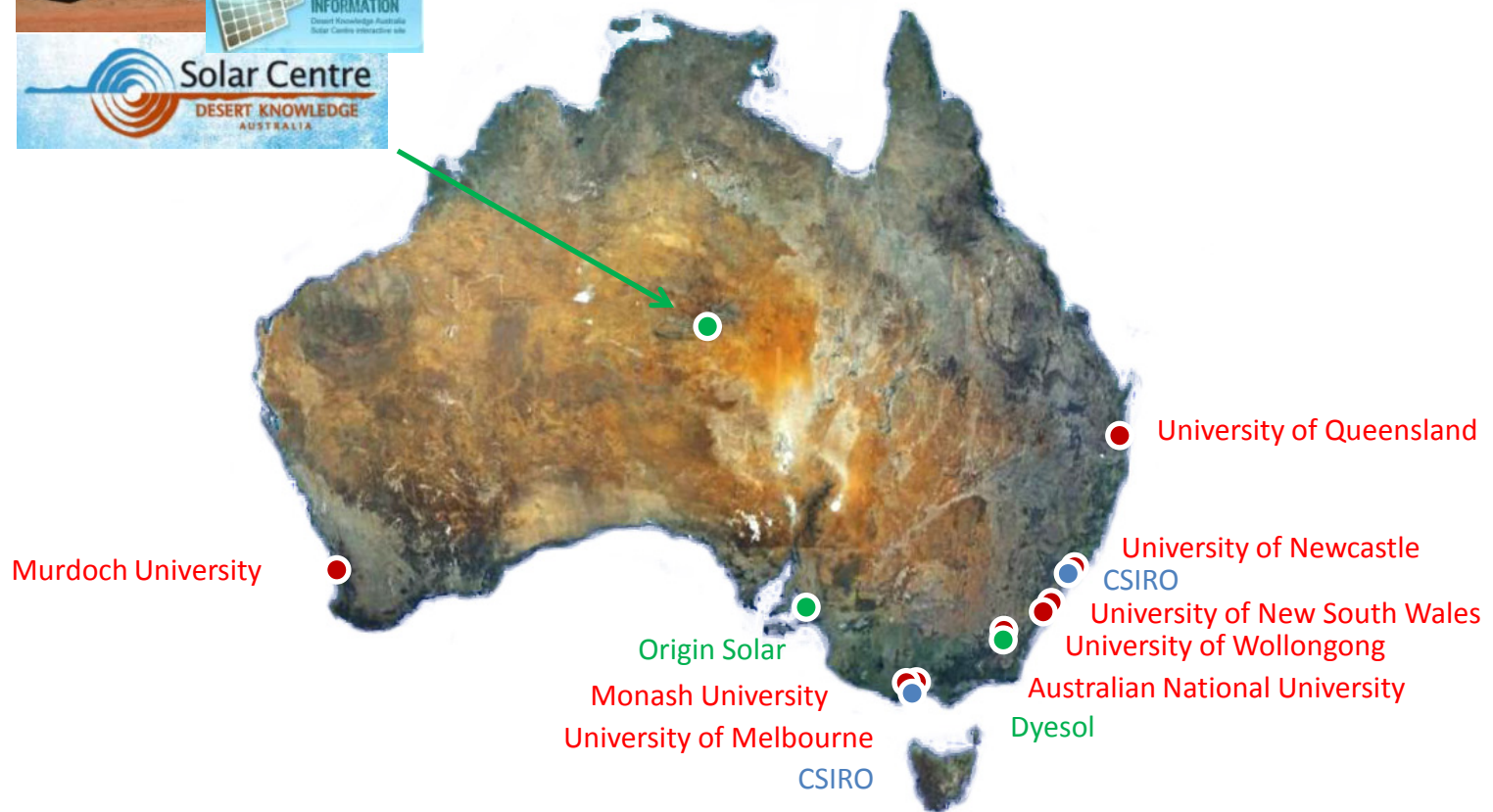
ASI thanks the Boston Consulting Group for assistance in preparation of this slide: in particular Philip Hirschhorn – Principal, Energy Practice

Current high level strategic technology roadmaps

- Today's technology will continue to evolve, lowering costs and increasing efficiency
- New technology emerging that will accelerate trends



Major Activities in Photovoltaics



UNSW School of Photovoltaic and Renewable Energy Engineering

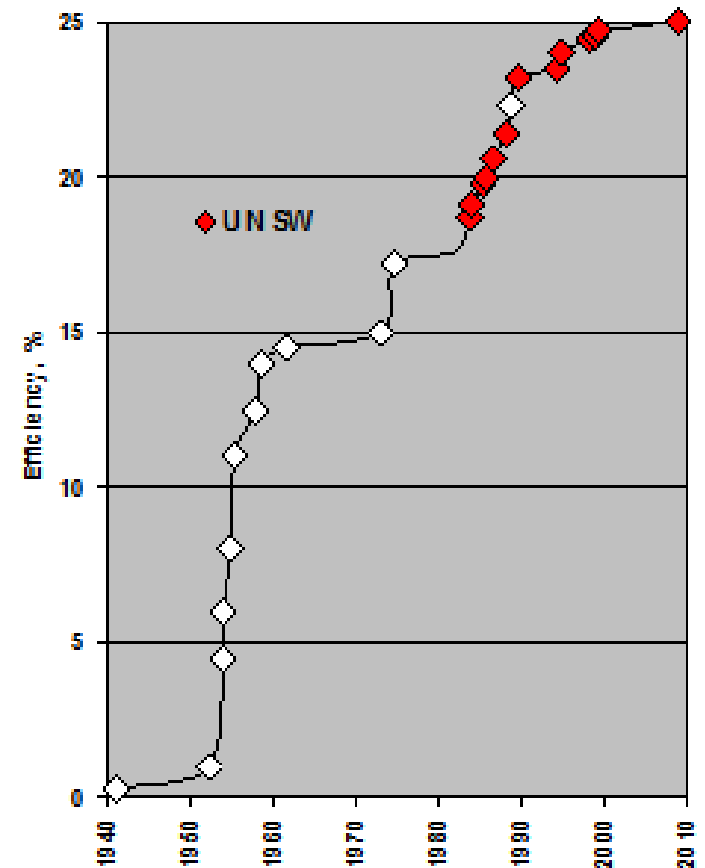


- PV research since 1974
- Set numerous world records
 - 2008 First Si cell 25.0%

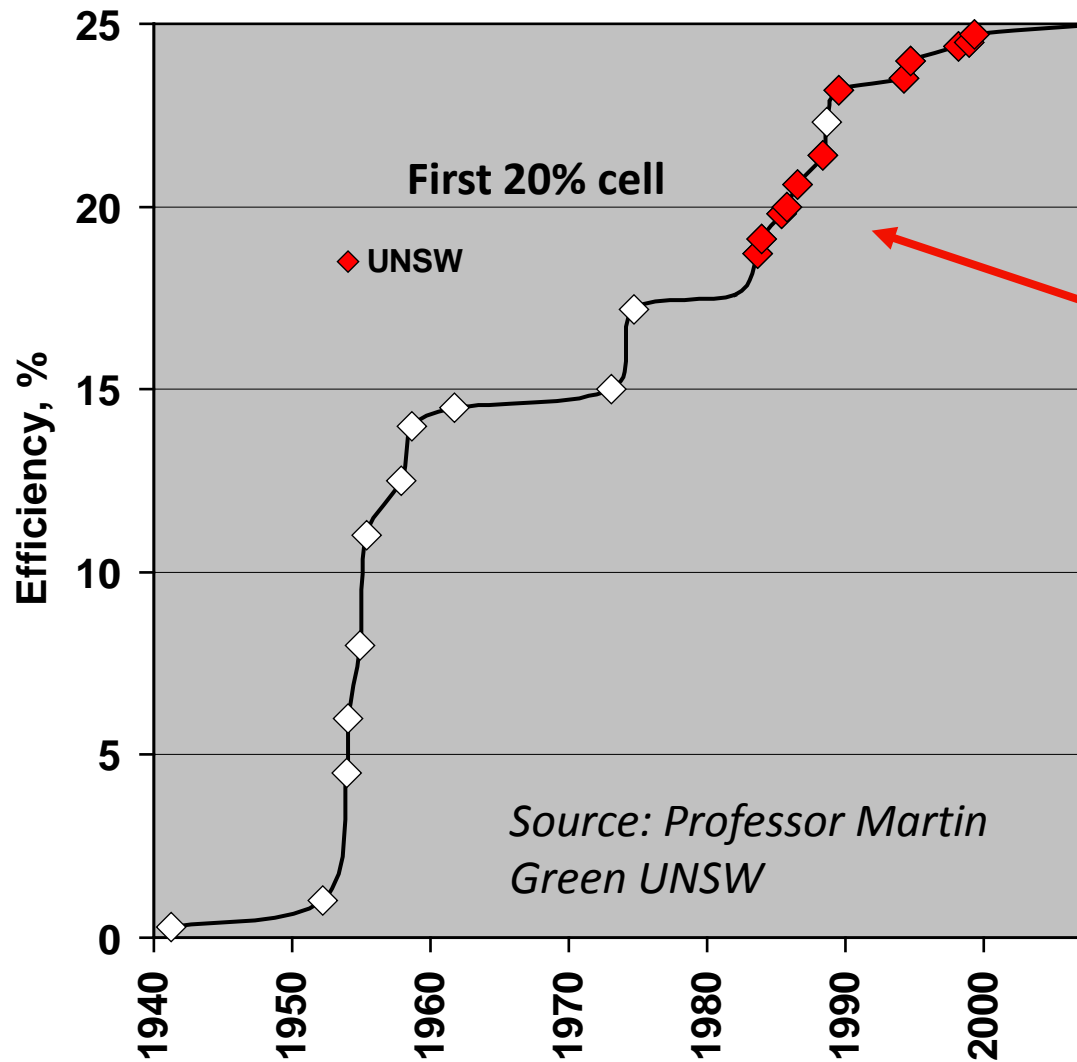


Prof. Martin Green

Dr Zhengrong Shi (Suntech)



Australian technology and research capability world leading



Australian alumni now leaders in a global industry



UNSW **Tech Transfer**

Trina, Solarfun CTO

Suntech/ Sunergy/ JA Solar/ Sunrise Global



ANU CoE



UNSW PV CoE/ Suntech CTO



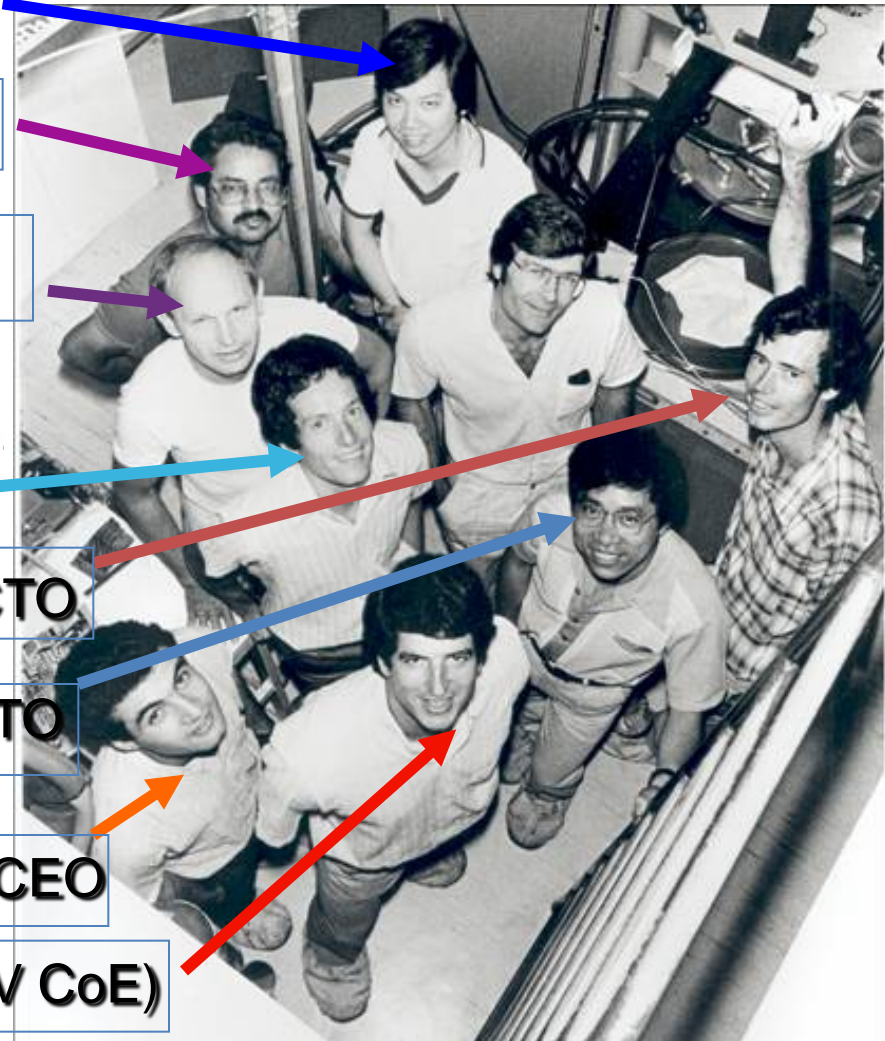
China Sunergy CTO



CSG Solar CEO



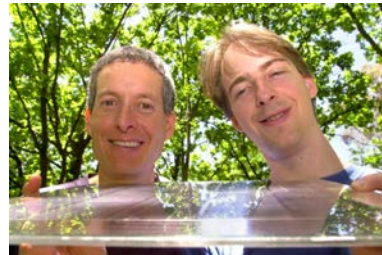
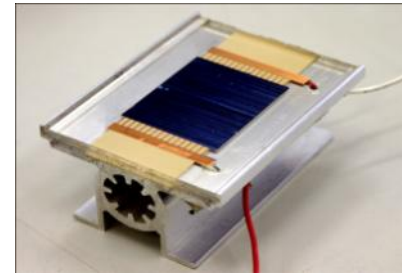
PV Centre of Excellence (PV CoE)



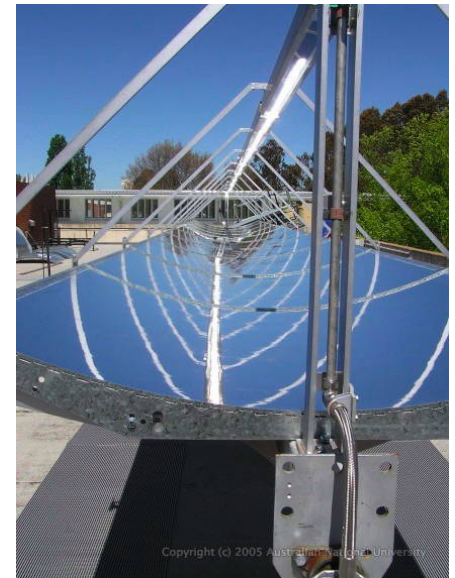
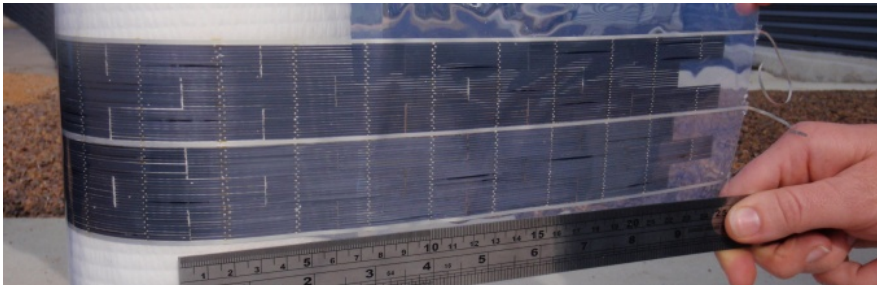
ANU Centre for Sustainable Energy Systems



- Sliver cells
 - lightweight, flexible and transparent
- CHAPS
 - Combined Heat and Power Systems



Prof. Andrew Blakers and Dr Kalus Weber

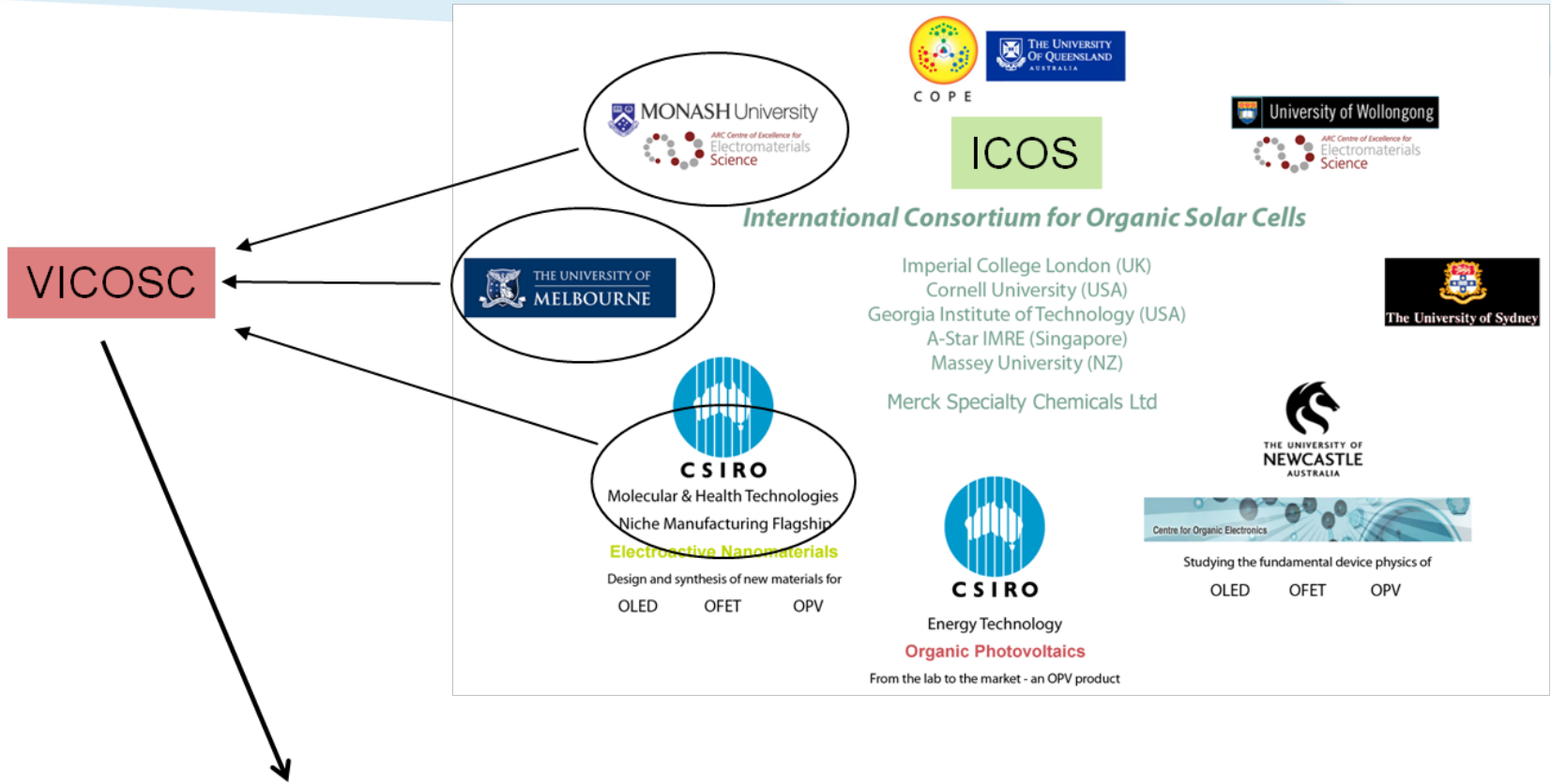


Organic Photovoltaics Dye-Sensitised Solar Cells

- Materials discovery
- Printable electronics
- Device design and characterisation
- Major outdoor testing facility



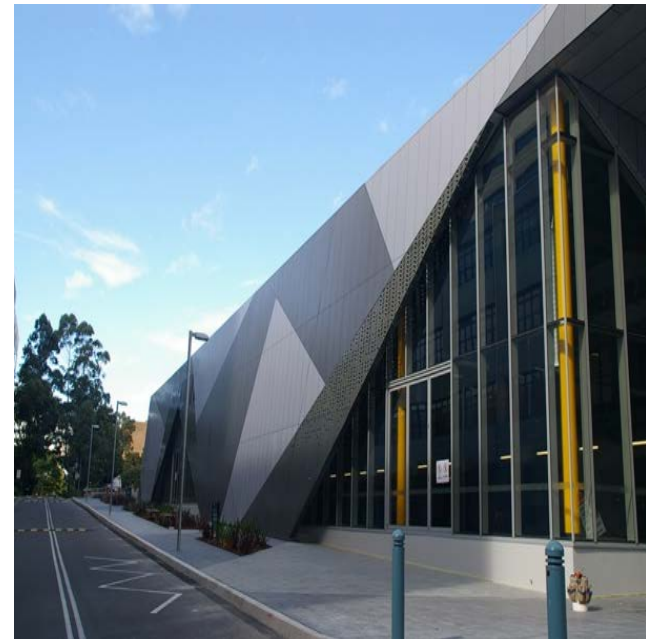
OPV & DSSC: Consortia



University of New South Wales: Solar Industrial Research Facility (SIRF)



- UNSW, Suntech Power, Roth and Rau, BT Imaging
- Silicon solar cell production line showcasing screen printed Si monocrysalline and multicrystalline cells, and laboratory for developing and demonstrating industrial scale advanced technologies
- Space to introduce toolsets in advanced cell and module process technologies
- \$5m ASI Foundation Project funding
- Additional \$4m for \$12.8m project with NewSouth Innovations to implement laboratory proven advanced cell process technology in the industrial environment of the SIRF



University of New South Wales: Tyree Energy Technologies Building



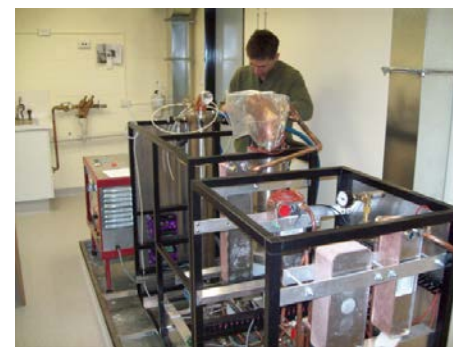
- DIISRTRE Education Investment Fund
- 6-Star energy-efficient building
- solar photovoltaic technologies
- sustainable clean fuels
- smart grids, energy storage
- energy economics and policy analysis



Australian National University: Process and Characterisation Solar Research Facility



- Silicon processing laboratory compatible with industry needs
- Class 4 Laser laboratory
- Characterisation Rooms
- Hybrid Solar Laboratory
- Outdoor test facility
- A\$5m ASi Foundation Project funding



Solar Flagships Project PV Power Station



- AGL Utility PV Project
 - AGL, FirstSolar, UQ
- Power Station
 - 103MW at Broken Hill (NSW)
 - 56MW at Nyngan (NSW)
 - Cost \$450M
 - \$130M from SFP
 - \$65M from NSW Govt
 - EIF \$41M



Solar Flagships Project

PV Education Investment Fund



- Infrastructure blocks
 - 3.275MW FirstSolar Array (UQ)
 - 2 x 630kW tracking station
 - 630kW storage station + 125kW DC interconnection station
 - 630kW operations optimisation station
 - 630kW design optimisation station
 - Power Systems Interface Laboratory (UNSW)
 - Data hub and Power systems test facility (UQ)
- Research programs:
 - Facility construction and commissioning program
 - System design program
 - Tracking and optimisation program
 - Forecasting and market operations program
 - Maintenance optimisation program
 - Energy storage and power systems stability research program
- Medium-term aim
 - National pilot-scale facility for PV systems testing and optimisation

Solar Flagships- Knowledge Sharing



- ASI is Australian Government's Knowledge Sharing Agent
- Knowledge capture and dissemination to reduce barriers to, and accelerate the future uptake of, large scale solar generation in Australia

Specific outcomes:

- further understand planning, construction and operation of large scale solar power plants within major electricity grids
- assist optimisation of business models for planning, constructing, generating and operating large-scale solar power plants
- assist grid integration of solar energy generation
- develop Australian know-how
- improve community understanding and acceptance of solar power

Australian Solar Institute: funding international collaborative solar research



- Australia-Germany Collaborative Solar R&D Program
- United States – Australia Solar Energy Collaboration
 - High-level, bilateral solar R&D collaboration
 - Up to A\$50m Australian Government contribution
 - High level objective to accelerate innovation in PV and CSP technologies through research collaboration, **beyond that which researchers in either country can achieve independently**
 - Information exchange
 - Research and laboratory exchange programs
 - Funding of country-specific portions of joint research projects
 - A\$12m for seven Foundation Projects, leveraging A\$32m
 - Strategic Research Initiative

Australia-Germany Collaborative Solar R&D



- \$0.5m ASI funding for \$1.6m Project 'Expanding the value proposition for Building Integrated Photovoltaics: Thin-film Building Integrated Photovoltaic Thermal retrofitting of buildings
- Australia's Bluescope Steel Ltd, Germany's Fraunhofer Institute for Solar Energy Systems ISE (Germany), The Sustainable Buildings Research Centre at The University of Wollongong (Australia)
- Develop a systematic approach and methodology to optimise the design configuration and sizing of building integrated PV thermal (BIPV-T) systems to suit installation on Australian buildings.



United States – Australia Solar Energy Collaboration Strategic Research Initiative



- **Long-term support** for collaborative national PV and CSP research programs, in partnership with U.S. research institutions and industry
- 4-8 year program funding to underpin collaboration
- Highly innovative and competitive research that will lead to **breakthroughs in lowering the cost of solar energy**
- Partner with and **engage industry** to identify and provide pathways for commercialisation of technology
- **Build human capacity:** provide high-quality education and training environments for the next generation of researchers and industrial engineers
- **Knowledge transfer** through public education of solar energy technologies and research outcomes

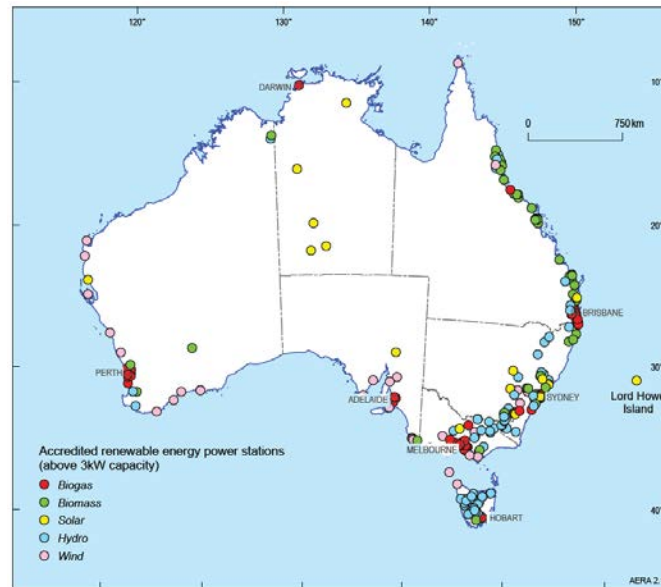
Clean Energy Future Plan



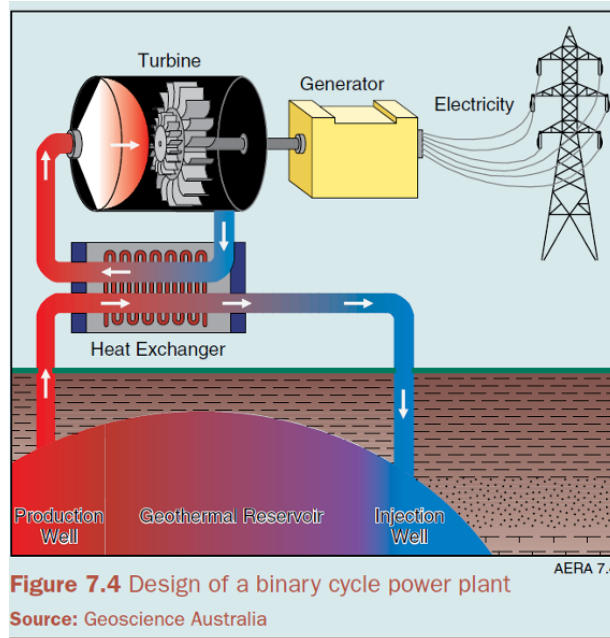
- Carbon price commences July 1, 2012
 - Broad-based, national coverage
 - Fixed price period to June 30, 2015 (A\$23 per tonne, rising at 2.5% p.a. in real terms)
 - Emissions trading scheme from July 1, 2015
 - Link to international carbon markets
- Industry and household transitional assistance
- New governance structure
- Complementary measures
 - Renewable energy
 - Energy efficiency

Australian Renewable Energy Agency (ARENA)

Consolidates \$3.2 billion funding for renewable
energy technology innovation



ARENA - Functions



Financial assistance

Analysis and sharing of
knowledge and
information

Advice to Government

Fostering collaboration

Clean Energy Finance Corporation (CEFC)



More information is available at:
www.cefcexpertreview.gov.au

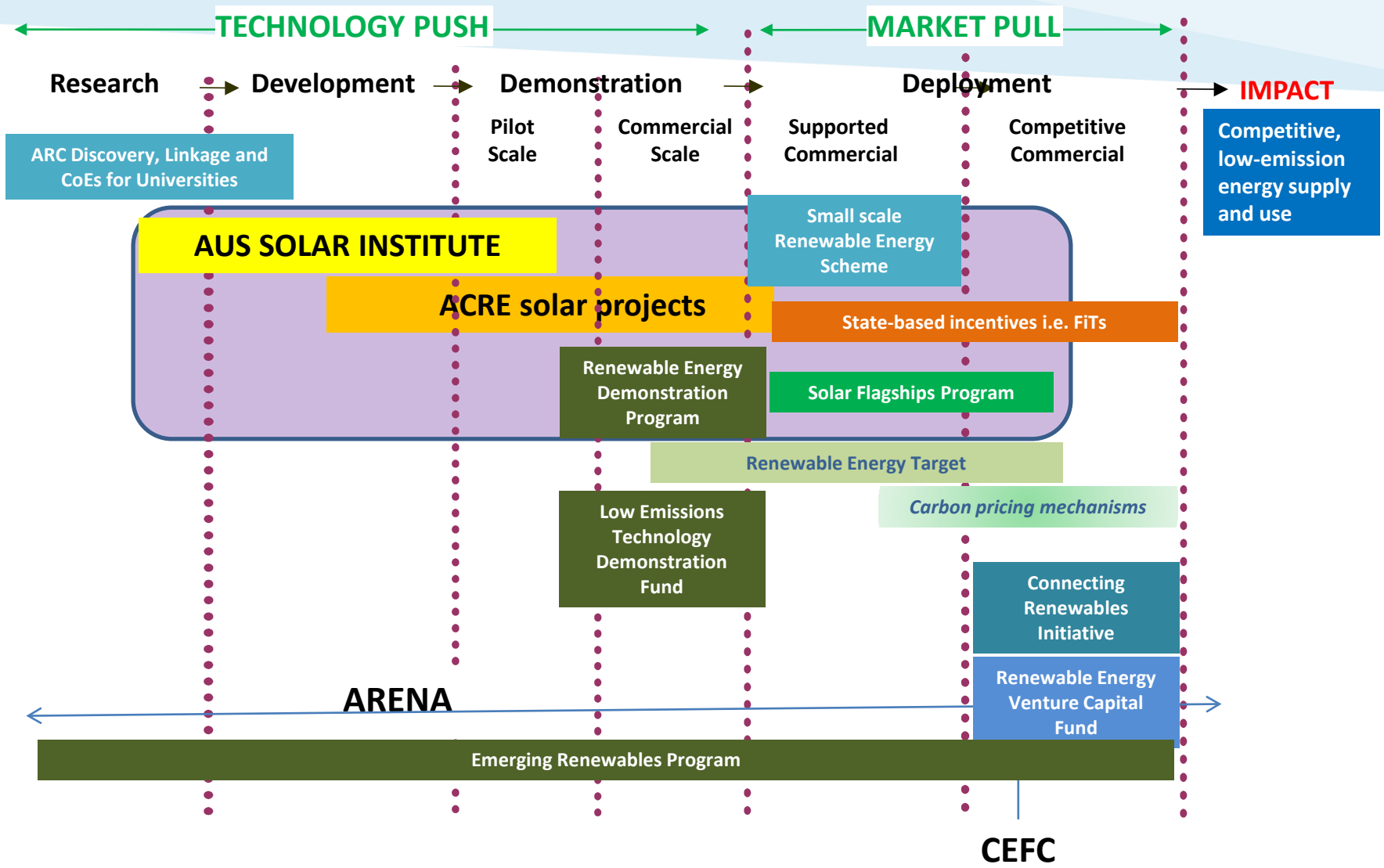
**New \$10 billion source of
finance for clean energy
technologies**

Commercially oriented

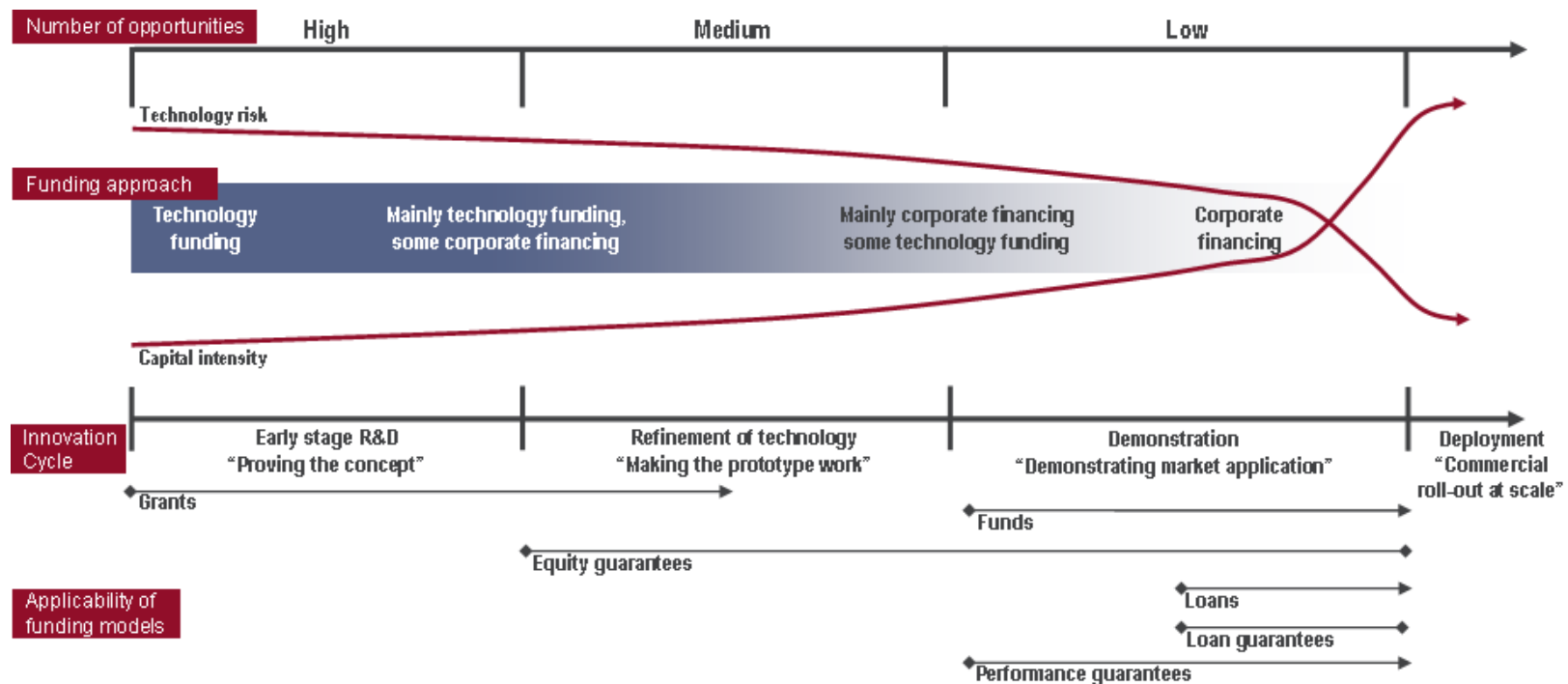
- positive overall return on investments

**To commence lending on
1 July 2013**

Policy framework- market drivers



Financing solar innovation from R&D to deployment



Summary



- Pipeline of major solar research infrastructure
- Historically strong capability in PV research
 - UNSW
 - ANU
 - Cohesive OPV and DSSC community
- Emerging capability in CSP research
 - CSIRO strong
 - Need to build university capability & community
- Current priorities
 - open access to research infrastructure
 - defined and agreed focus areas for collaboration
 - people exchange: “collaboration is a contact sport”
- Positive policy framework for renewables



CSIRO

Sarah Miller

CSP Science Development

Australian Solar Institute

Olivia Coldrey

Investment Director

Thanks!

www.australiansolarinstitute.com.au

www.csiro.au/solar