Australian Solar Institute

Large Scale Solar Research Priorities

Clean Energy Council

Large Scale Solar Policy Roadmap Launch

Mark Twidell

9th September 2011, Melbourne

Solar Energy Score Card in Context of National Energy Objectives

Dimension	Solar	Critical Issue
Clean	✓	No issue — everyone wants Solar to work but can it contribute at scale?
Affordable	?	Large Scale Solar needs specific funding support to bridge the gap to wind and gas.
Reliable	?	"Can the NEM rely on Solar to guarantee supply?" – dispatchability, transmission etc

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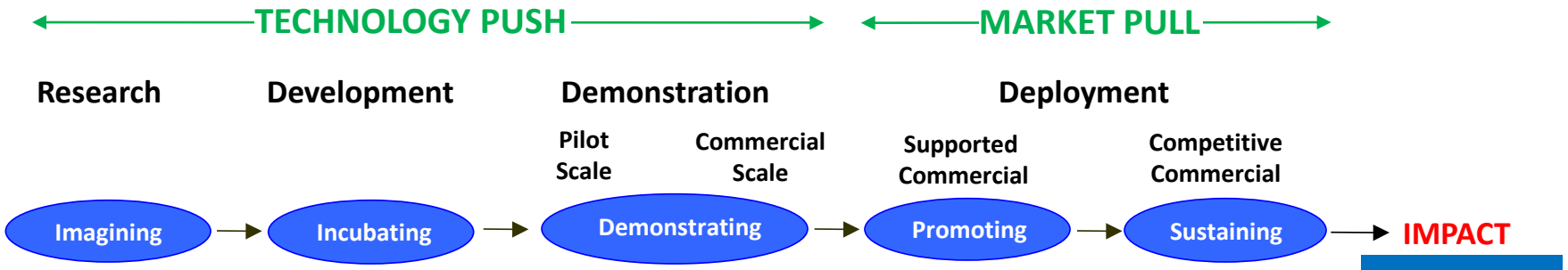
Solar Innovation Chain – Key Challenges



Proving it Works

Higher Efficiency

Lower Cost Materials & Components

Thermal & Chemical Storage

Control Strategies – Demand side management, resource forecasting

Securing Capital

Lower Technology Risk

Proof of Cost

Supply Chain Development

System Integration – improving capacity factors & Yields

Manufacturing Process Improvement

O&M track record

Proving cash flows

Project Finance & Revenue Certainty

Maximising NPV Forecasting, storage, PPA terms

Capturing long term PPA value in uncertain markets – carbon, regulation, ownership structures etc

Cost of ownership, permitting, social acceptance, skills availability etc

Competitive, low-emission energy supply and use

GHG reductions

New industries

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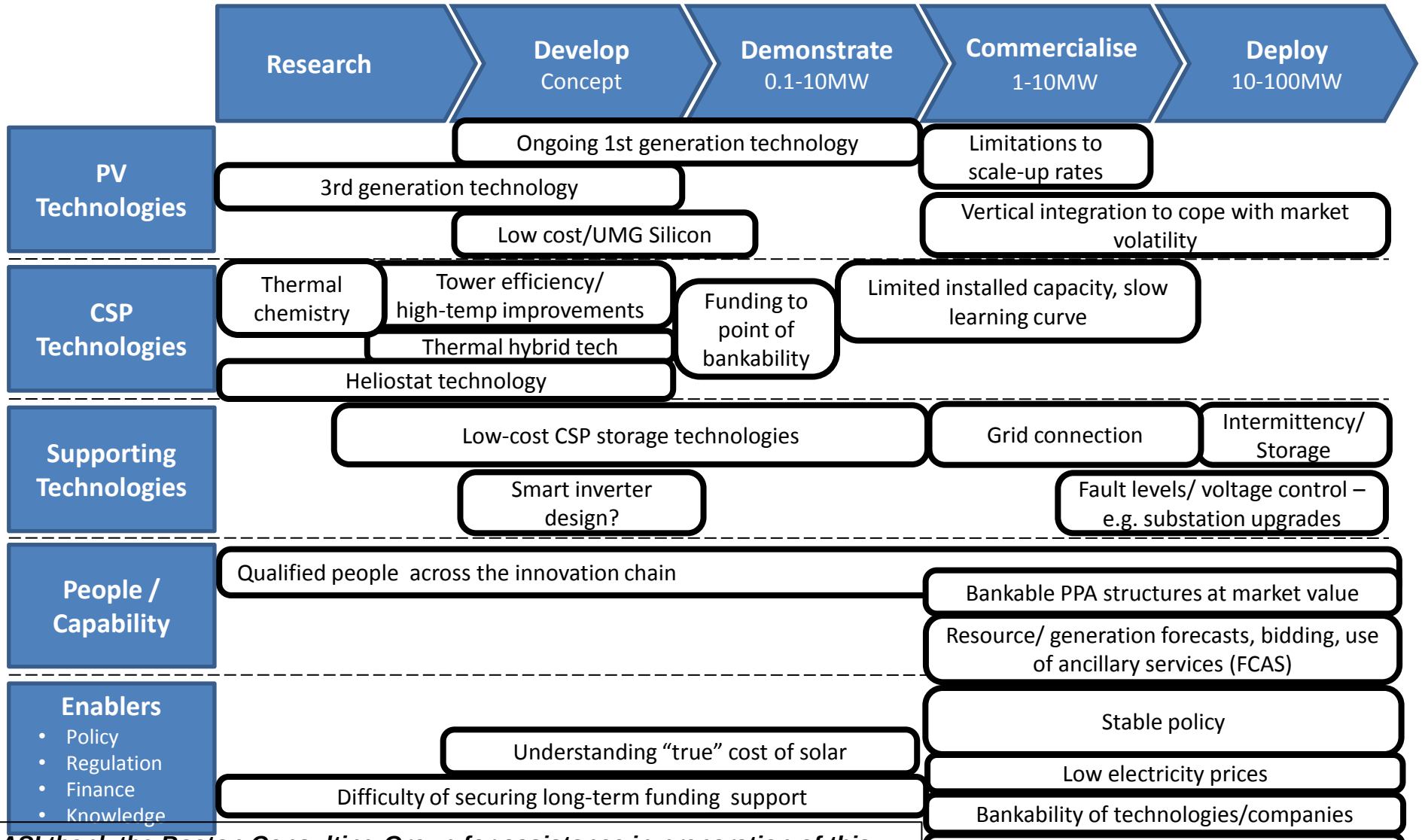
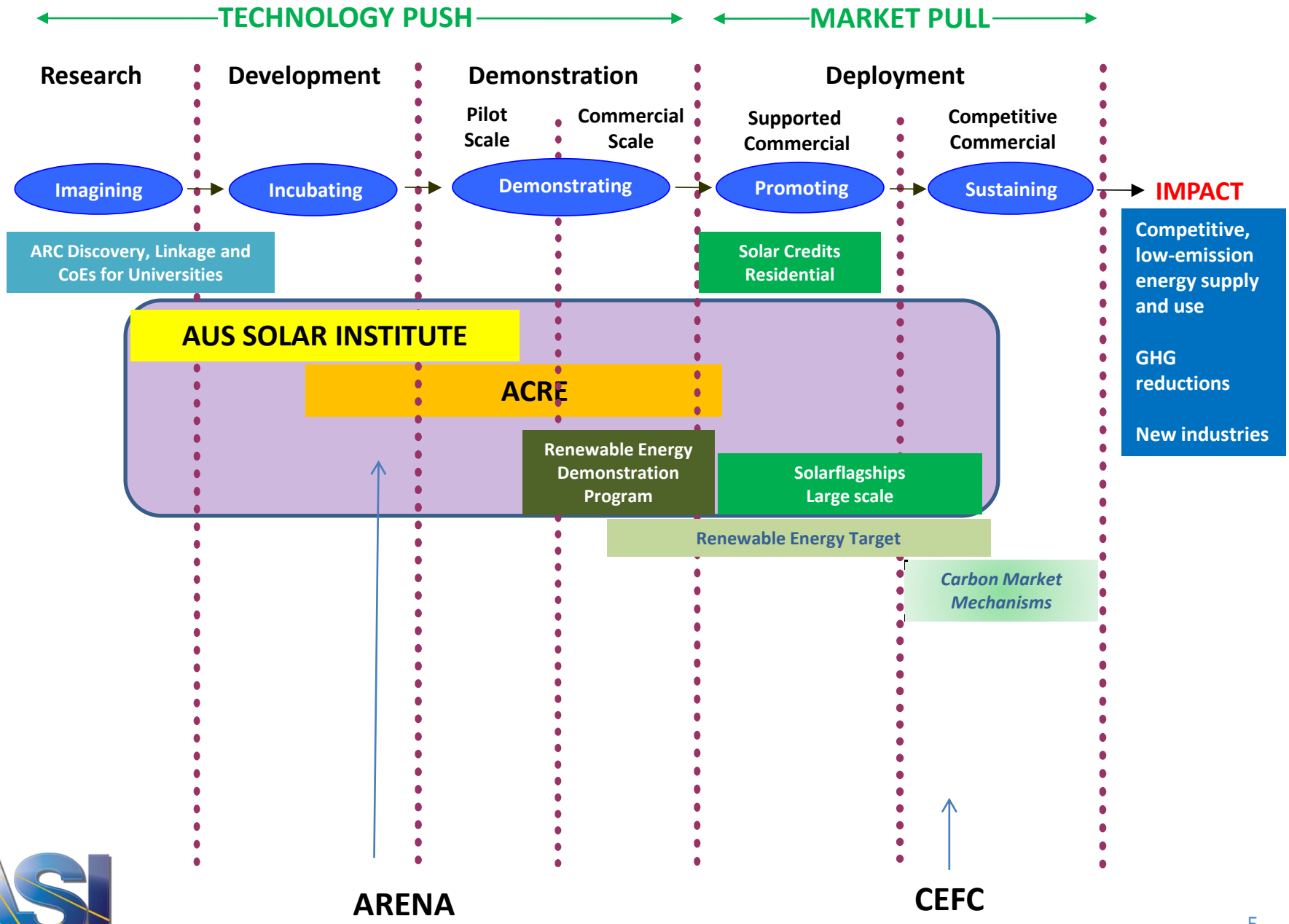
Summary of barriers on the solar innovation chain



ASI thank the Boston Consulting Group for assistance in preparation of this slide : in particular Philip Hirschhorn – Principle Energy Practice

Government support across the innovation chain



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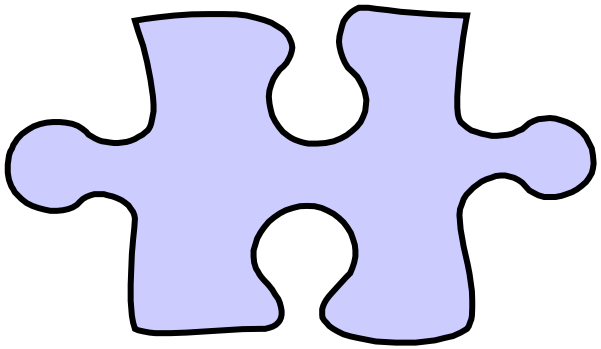


costs...

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

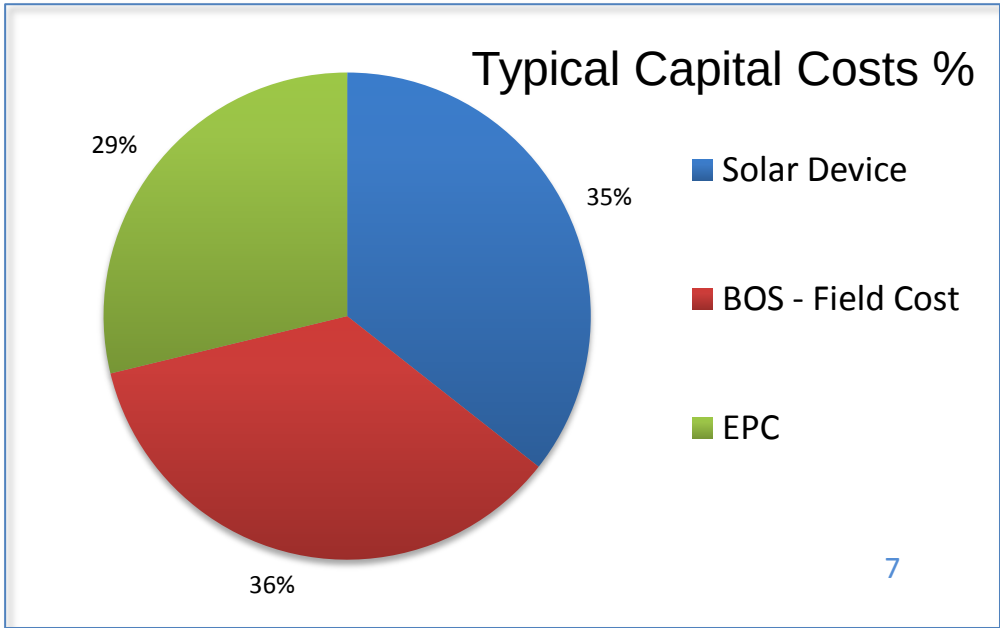
$a → Finance Channel Margins

$b → Other Hardware, Civils, Install , Land, O&M

$c → Solar Device

$$\sum \frac{(\$a+\$b+\$c)}{MWHrs} = \$/MWHr\ (LCOE)$$

$$\frac{\$Lifetime\ Costs}{MWHrs\ Supplied} = \$/MWHr$$



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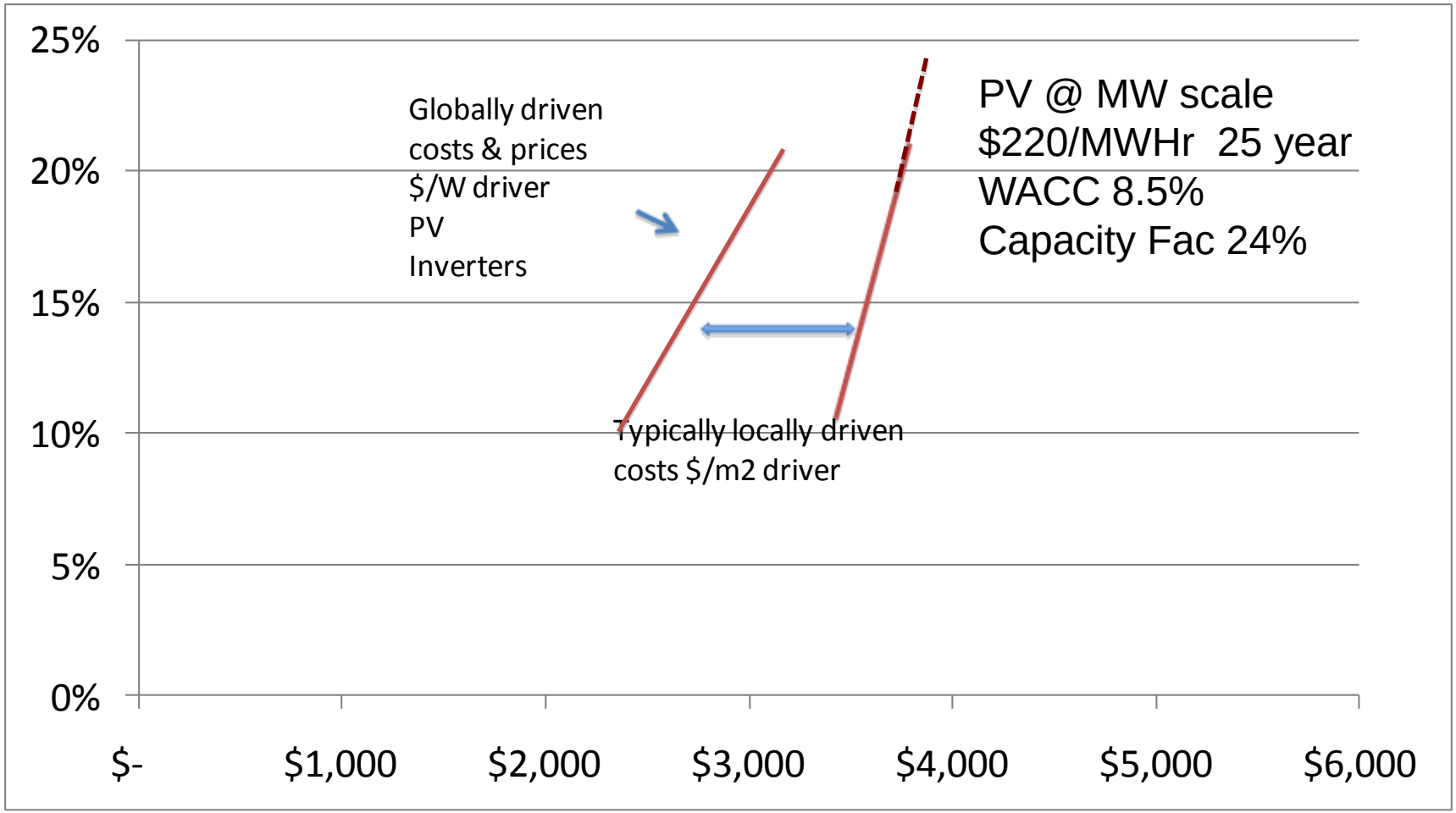
Today Global Factors significant element in Solar LCOE



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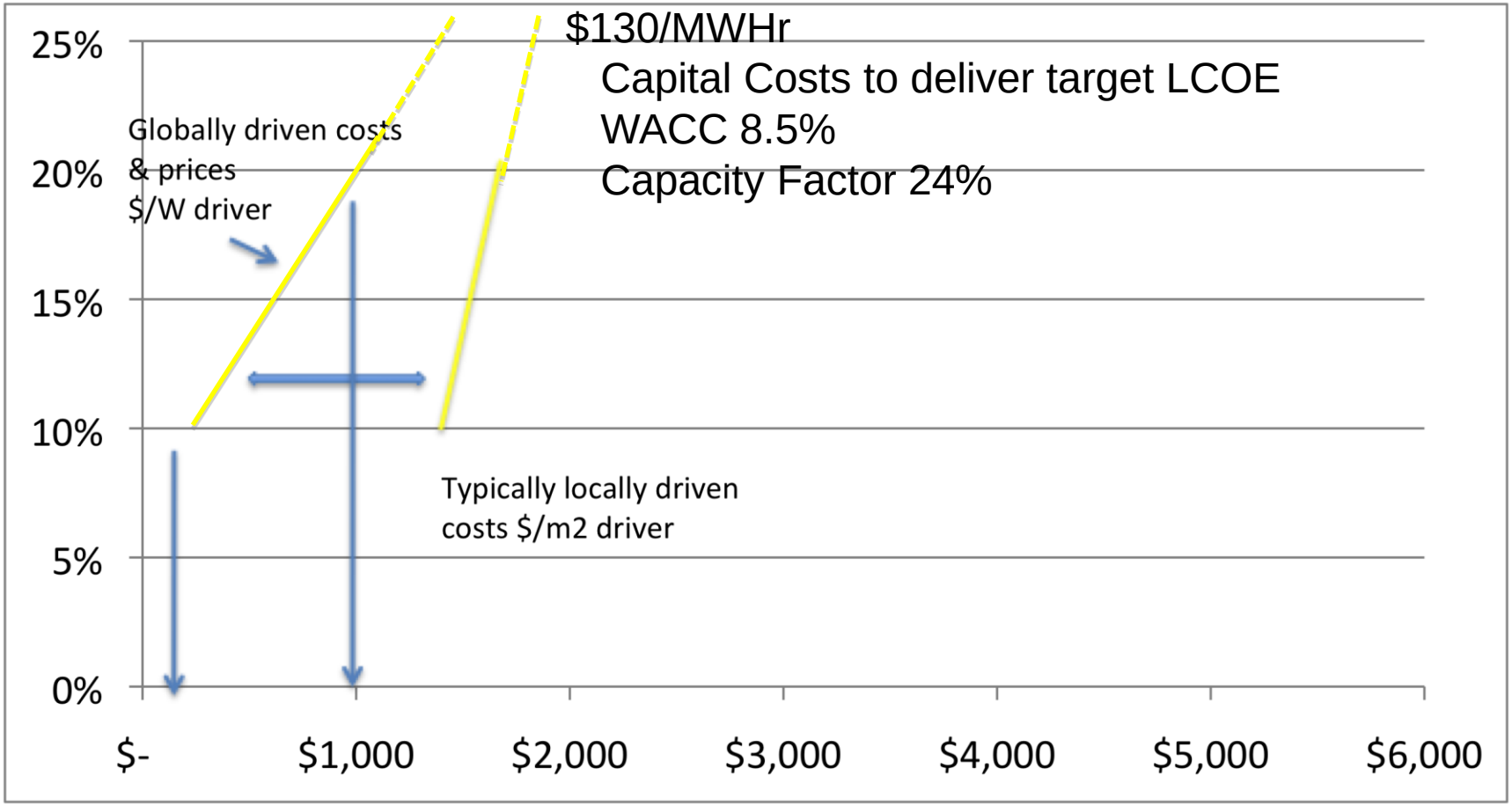
Local area related costs become dominant as technology costs fall



Capital Installed Cost per kw

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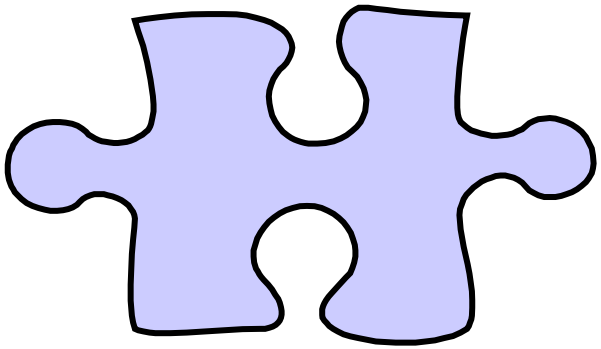
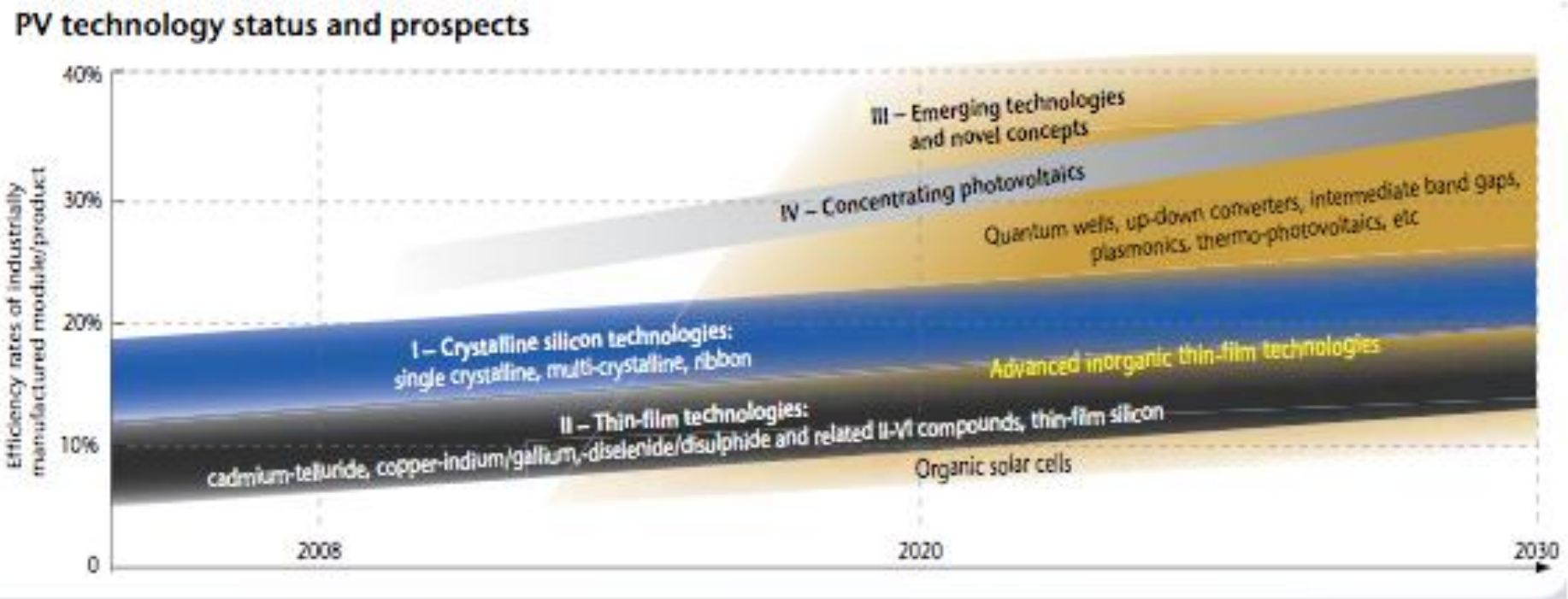


Efficiency...

High level strategic technology roadmaps are in place

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



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Area related “Field” costs are significant – PV & CST Increasing Efficiency of Conversion

PV Eff 10% 72k m²

15% 52k m²

20% 34k m²

Area required for a 6.5MW PV Power Plant at various efficiencies

Source : Sunpower Corporation.

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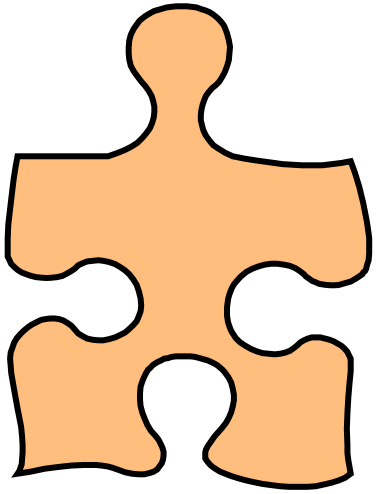

Technical issues for market acceptance...

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Technical Integration Challenges

- Short term intermittency – PV
- Dispatch to capture higher prices and market value for firm capacity
- Site selection variables that determine plant revenue
  - Local demand profiles and market price
  - Radiation – DNI in case of CST
  - Availability of hybrid resource to provide firmer supply
  - Network interaction – marginal and peak loss factors, congestion risk

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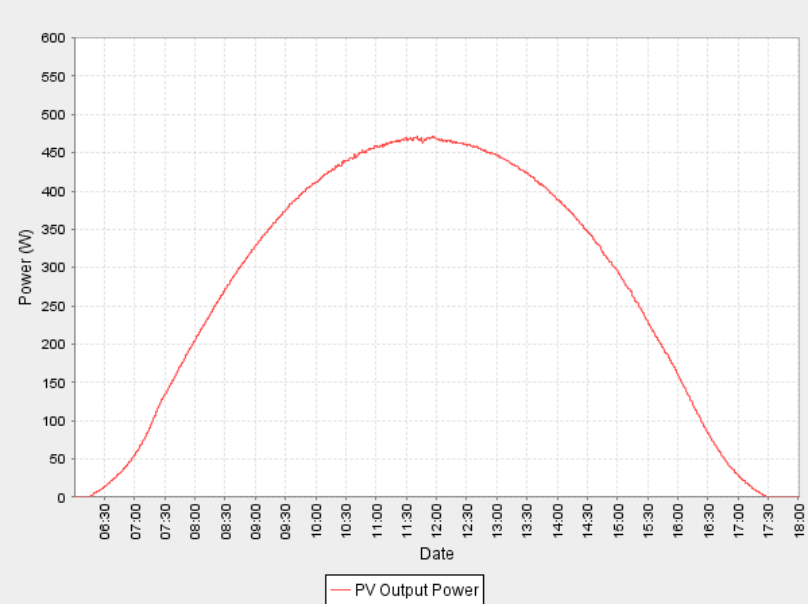
Daily Intermittency PV – Power (kW)

Solar power generated on a sunny day



Solar power generated on a cloudy day

Source CSIRO. Distributed Energy Team 2010

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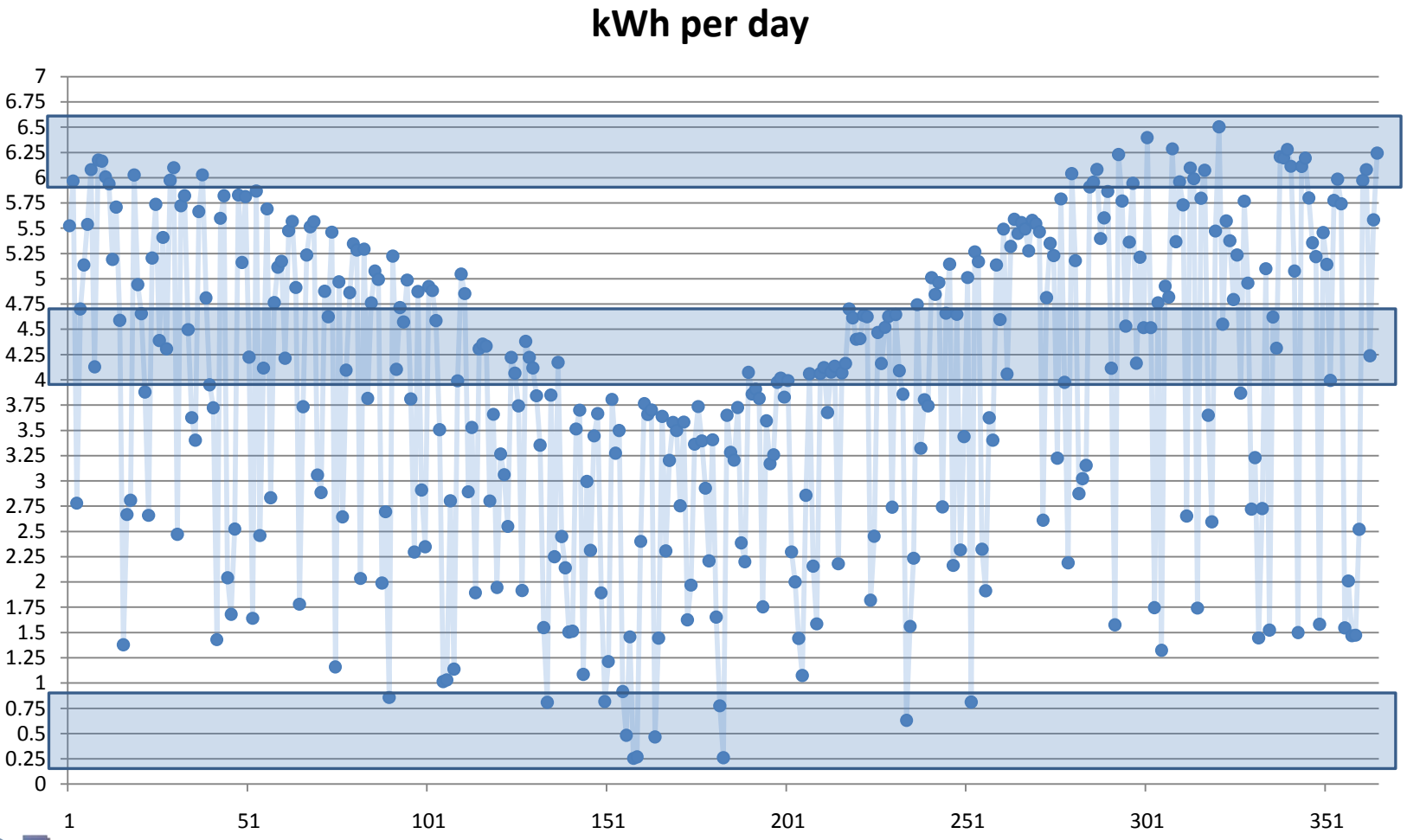
Yearly Intermittency PV & CSP



Source CSIRO. Distributed Energy Team 2010

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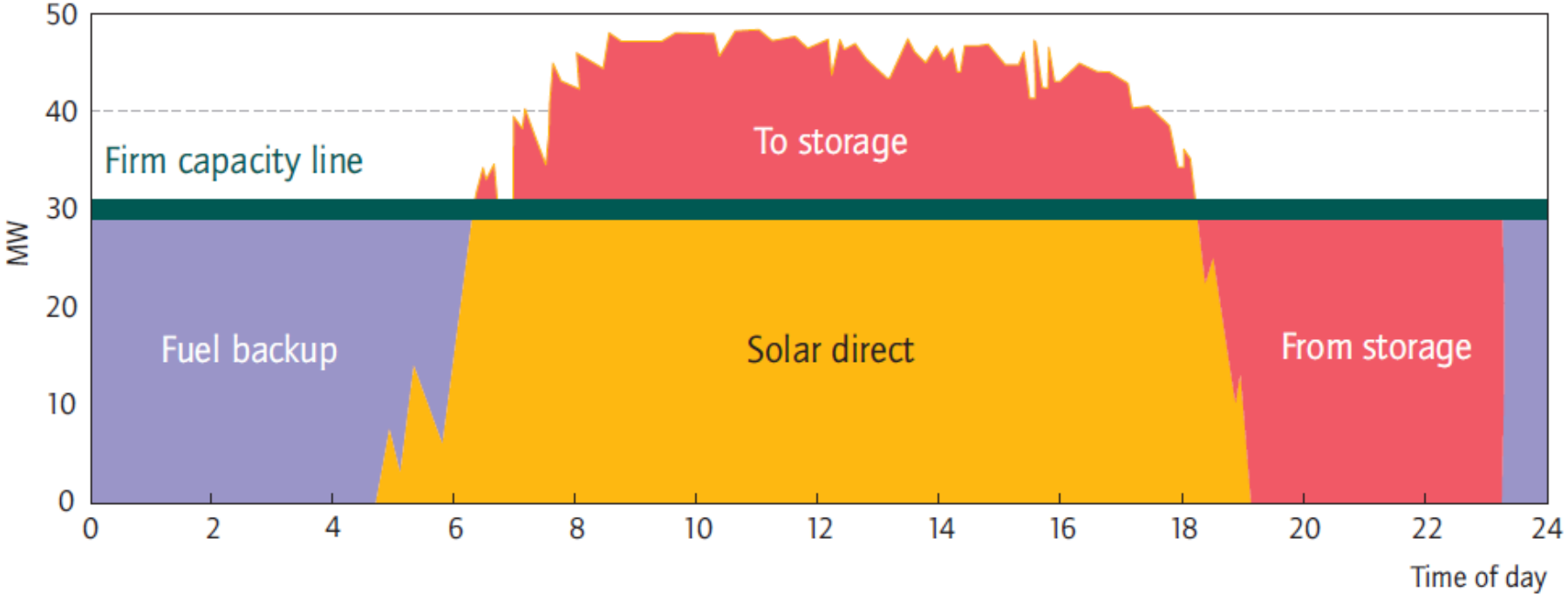
Large scale CSP proponents offer prize of firm supply through storage and hybrid application



Source: Geyer, 2007, *SolarPACES Annual Report*.

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Solar Flagships will help with Market Integration Challenges and Understanding

- Understanding impacts of Scheduling, Short term intermittency and value of forecasting – AEMO
- Understanding opportunity for short term storage to Dispatch to capture higher prices and market value for firm capacity
- Importance of site selection variables that drive plant revenue
  - Local demand profiles and market price
  - Radiation – DNI in case of CST vs Grid Access
  - Availability of hybrid resource (<15%) to provide firmer supply
  - Network interaction – marginal and peak loss factors, congestion risk

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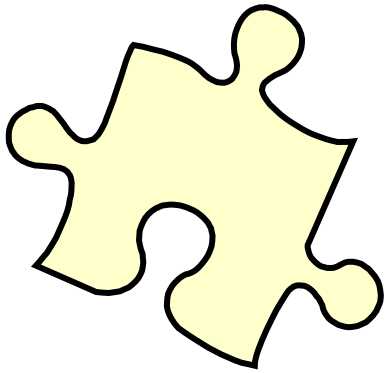
- Do...learn...do...



Market scale through deployment drives the cost learning curve

Technology	Installed capacity	Recent / Projected Growth Rates
Wind	c200 GW	27%pa / 20% pa
PV	c40 GW	60%pa / 25% pa
CST	c1.1 GW	10% / >100% pa

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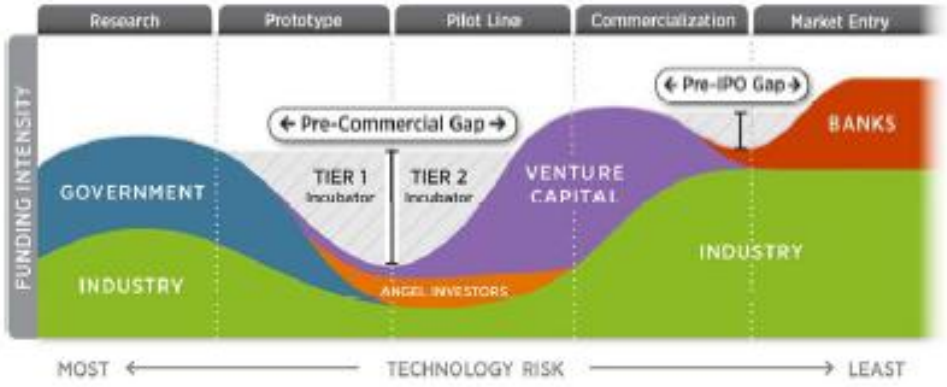
Data IEA IEA input to the Clean Energy Ministerial April 2011
Solarbuzz , CSP Today
Original Format A/Prof K Lovegrove - IT Power

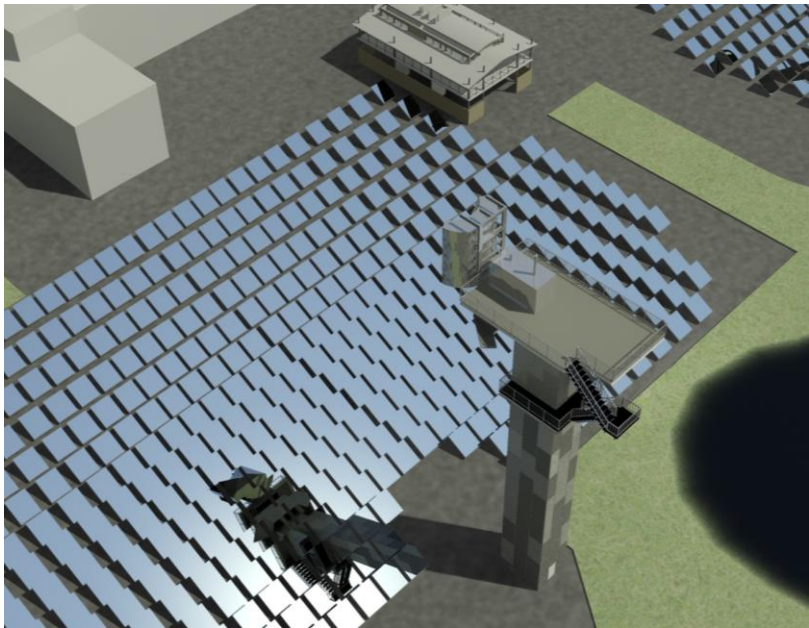
New technology requires demonstration to gain "bankable" capital market support – e.g CSP Tower

- R&D Pilot Phase
  c$5m 400kW prove basic operation
- Phase 1 Demonstration
  1MW $10m - prove yield
- Phase 2 Pre Commercial Demonstration
  4-5MW $30m – prove reliability & revenue
- Phase 3 Early Commercial Operation - 50MW $200m prove financial return

Capital Finance Key Barrier



Source : US DoE 2011



Prize – Competitive Solar Electricity with hybrid / storage integration to provide firm supply

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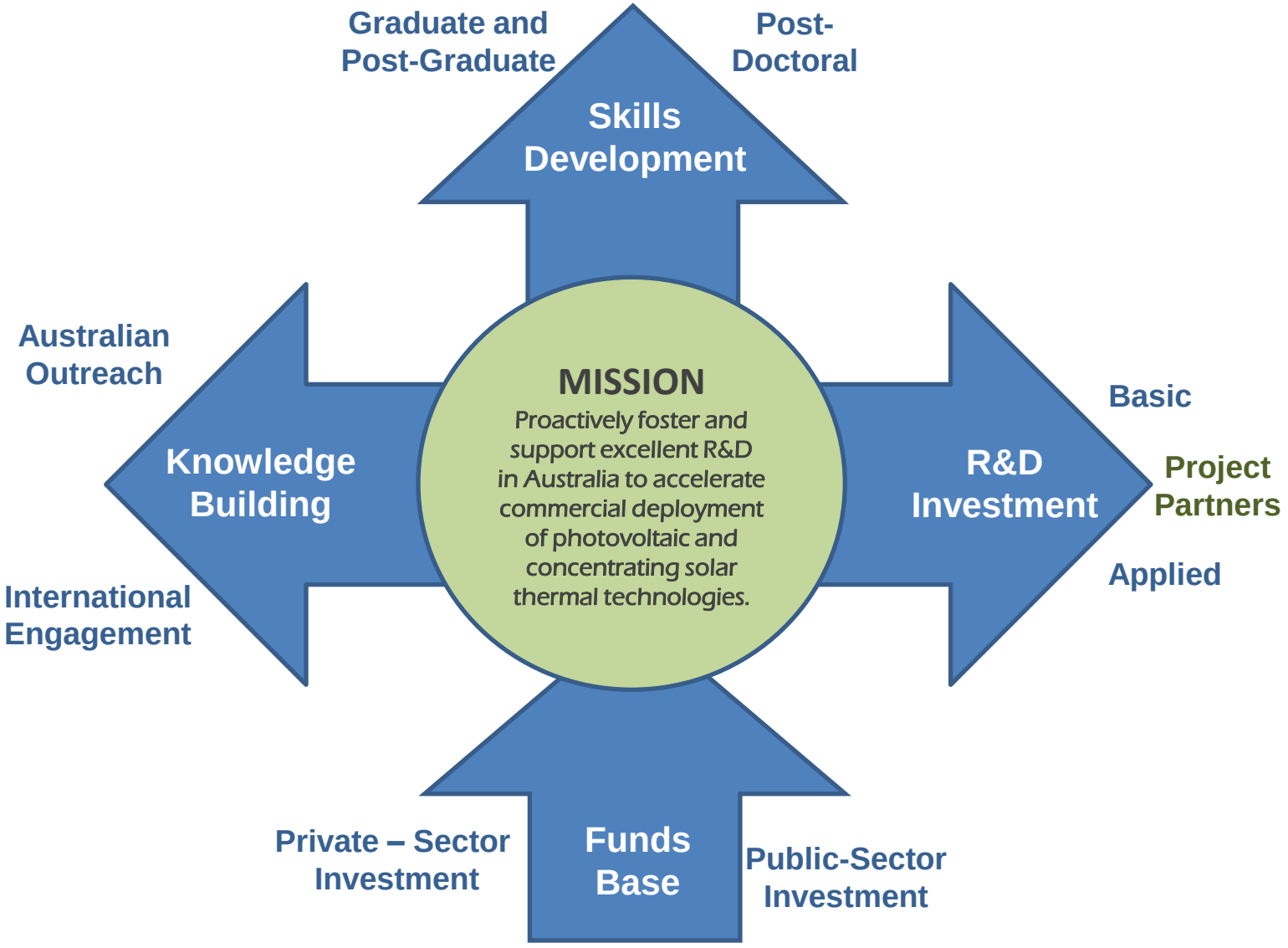
ASI – Our Strategic Focus Areas

R&D Investment, Skills Development and Knowledge Building



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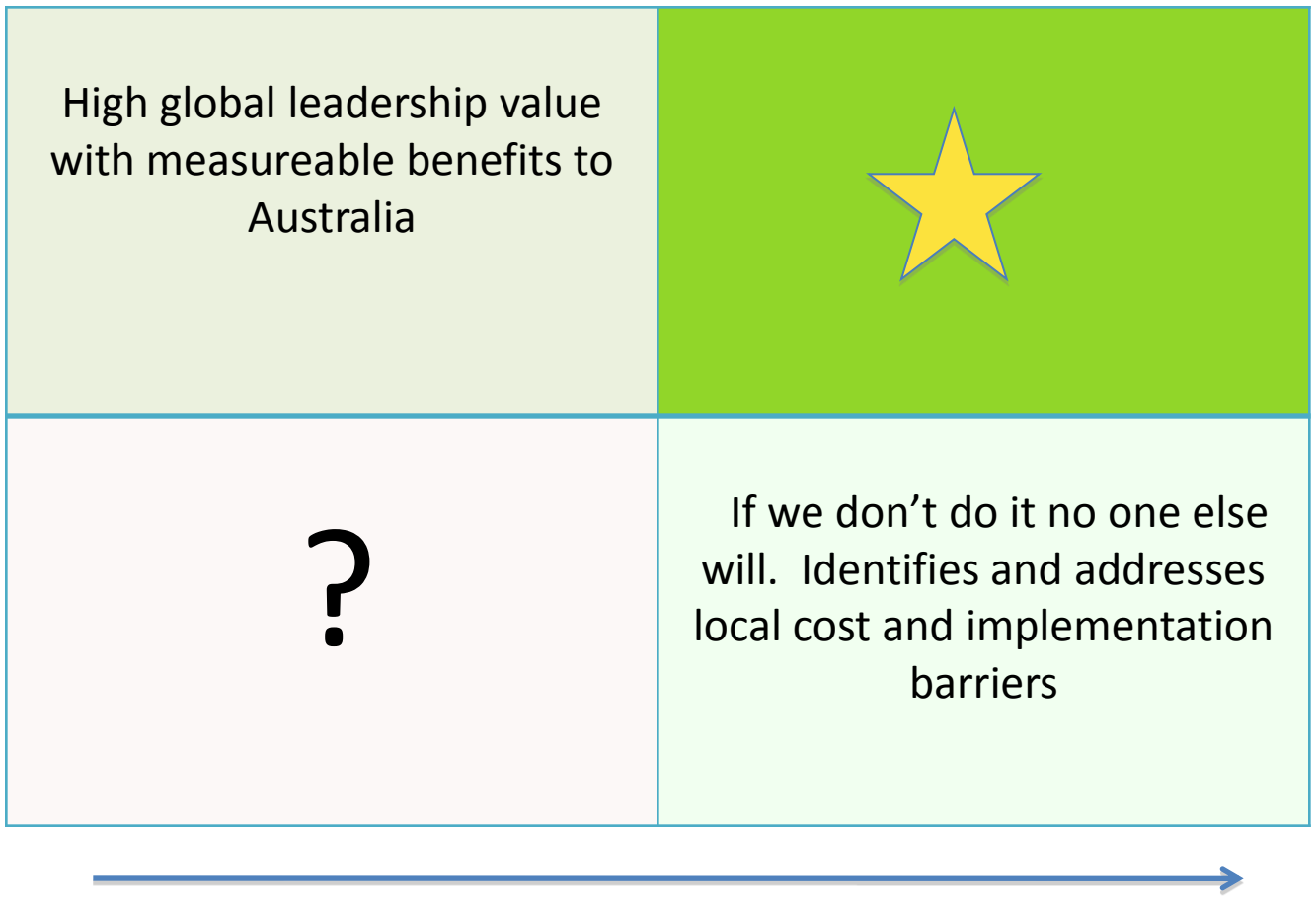
Portfolio Planning

Opportunity for global research leadership with flow on commercial benefits



Impact of research on future solar deployment in Australia

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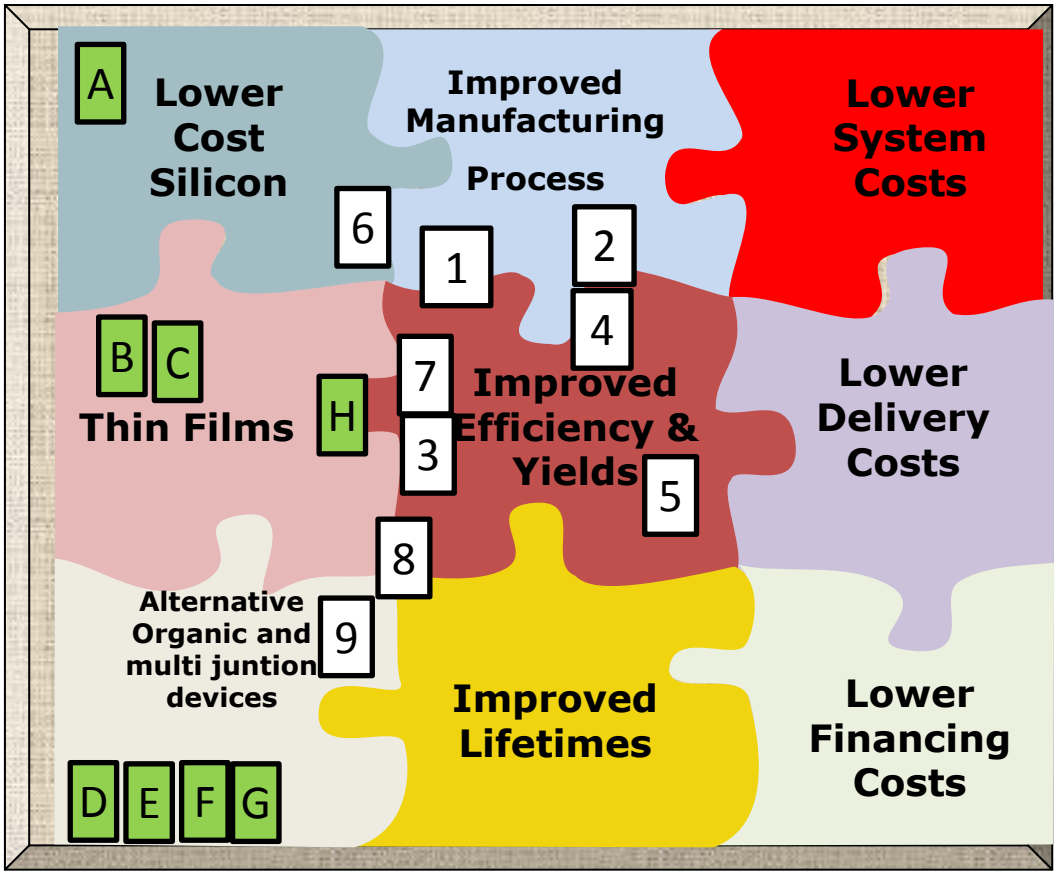
PV R&D Portfolio Mapping

$41m ASI leveraging c$155m

Today

Round 1

1. ANU Solar labs
2. UNSW SIRF
3. ANU Plasmonics
4. UNSW Core
5. UNSW Suntech
6. ANU SLIVER
7. BT Imaging Inline Inspection Tools
8. Sapphicon
9. UQ OPV



Round 2

A. UNSW Low-cost silicon
B. ANU Industry Ready N-Type Si Solar Cells
C. CSG Next Gen Si on Glass
D. UNSW Hot Carrier Cell
E. UNSW 40% Efficient PV Power Tower Receiver
F. UniMelb OPV
G. UNSW Quantum Dots
H. USyd Upconversion

Goal

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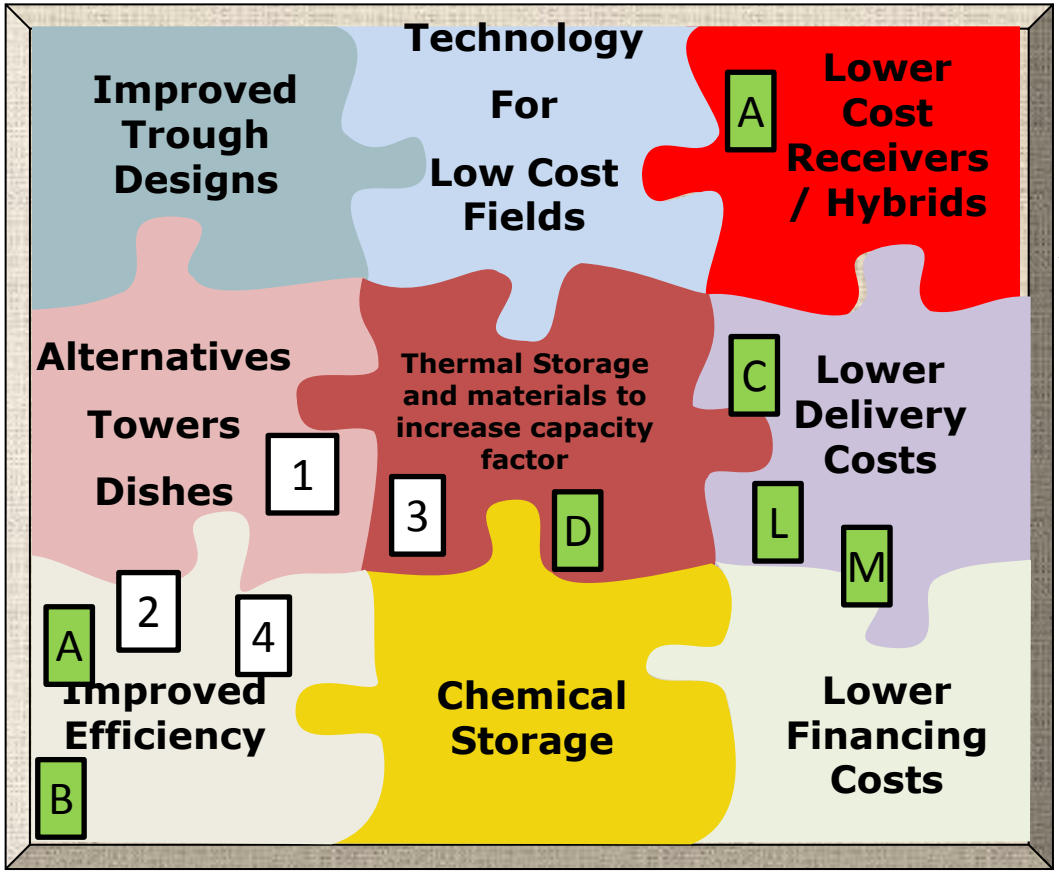
CSP R&D Portfolio Mapping

$24.7m ASI leveraging c$54mm

Today

Announced Round 1

1. CSIRO Foundation
2. CSIRO Core Steam
3. CSIRO Core Storage
4. Uni Newcastle Thermionic Devices



Round 2

CST

A. CSIRO Air Turbines
B. CSIRO Thermodynamic Topping Cycles
C. ANU Roof Mounted Hybrid CST
D. Graphite Energy Storage

Enabling

L. CSIRO – Intermittency
M. UNSW – Forecasting

Goal

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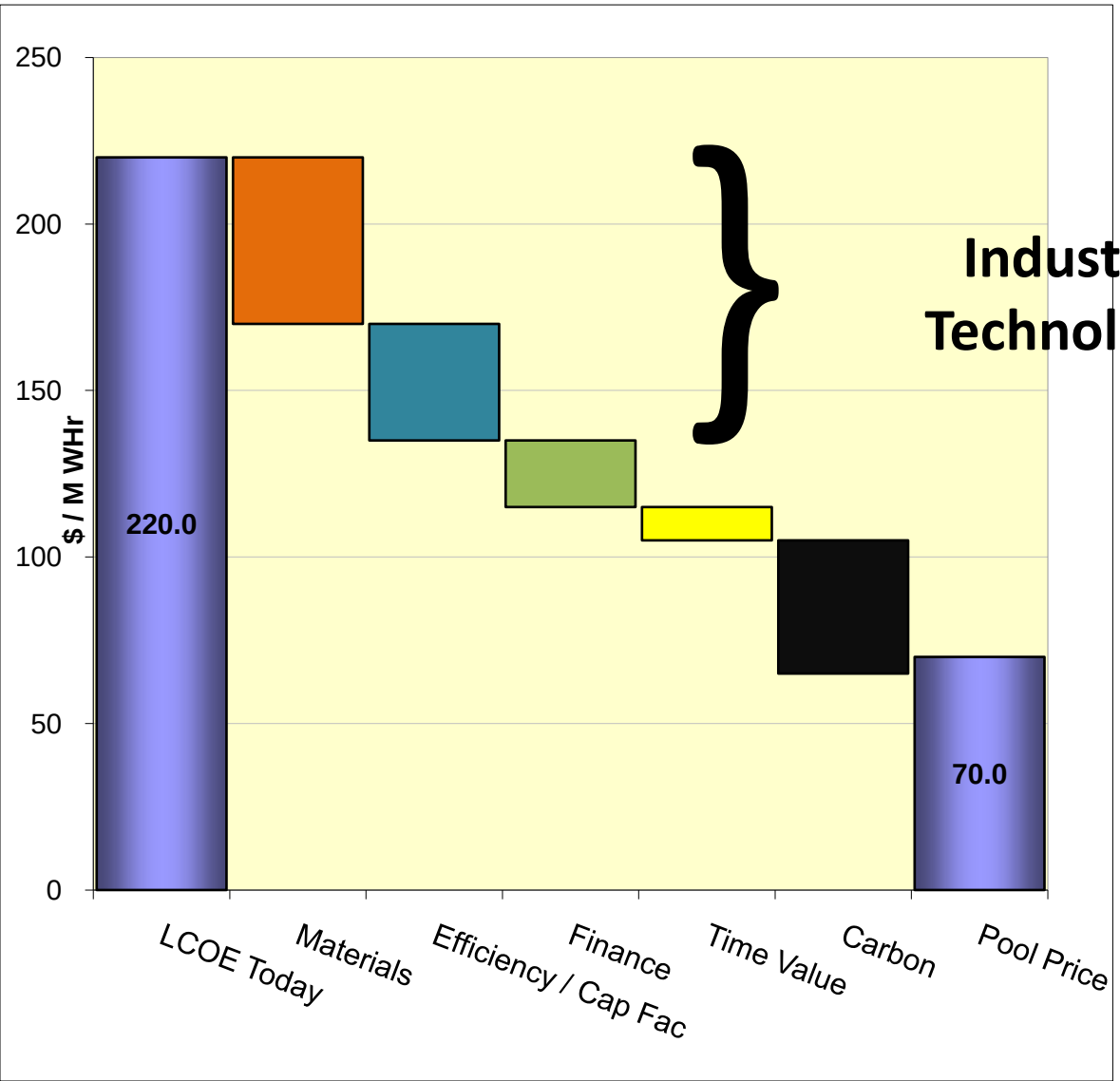
Indicative large scale solar path to wholesale pool price parity



Industry Scale and Technology evolution

Energy Market Reform & Evolution

Timeframe :2020

Key Observations

- PV & CST LCOE need to reduce by 40-60% to operate in technology agnostic market where Renewable PPA targets are in region of $115 – 135MWHr
- Institutional confidence required on integration and forecasting of an intermittent resource
  - Market price signal for firm capacity will influence debate and investment in integrated storage technology . On site storage today increases the marginal cost of solar electricity.
- Two main drivers of LCOE assuming comparable cost and access to finance between technologies
  - Installed capital costs - function of area (efficiency) and major component $/W elements.
  - Capacity factors – location, tracking.

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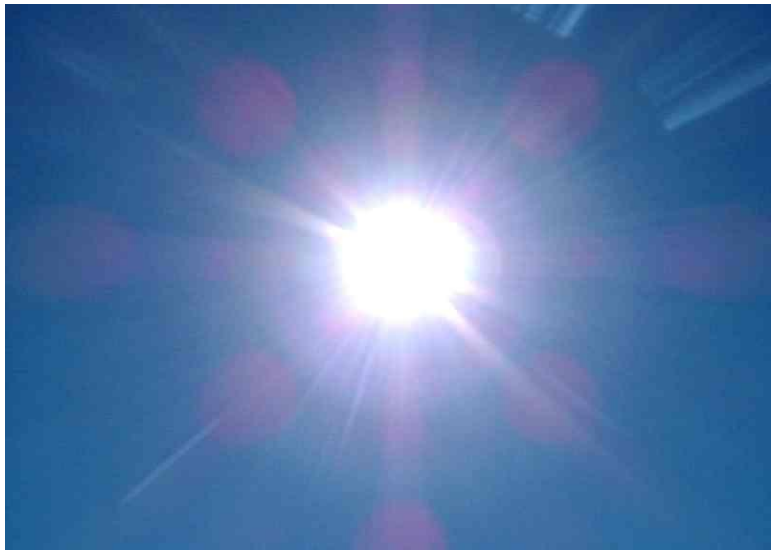
Contact



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