



In the spotlight: Australian solar energy R&D outcomes and achievements in a global context

2018 ASIA-PACIFIC SOLAR RESEARCH CONFERENCE

December 5



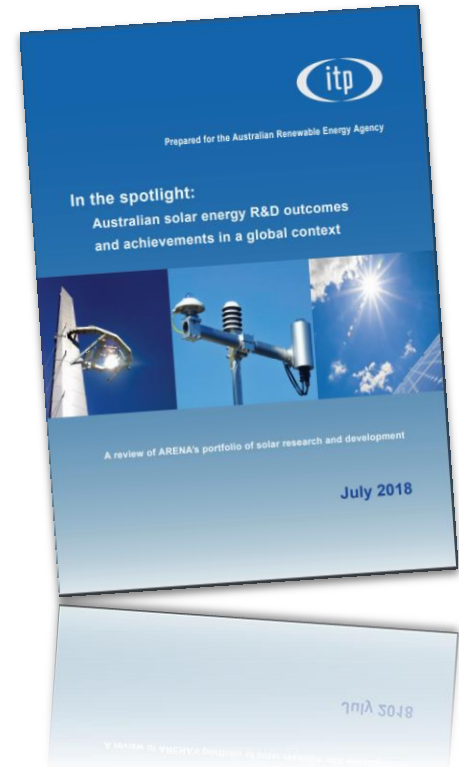
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Chief Operating Officer

COO, previously Head of Big Solar team and General Counsel

In the spotlight: Australian solar energy R&D outcomes and achievements in a global context

- Review of all ARENA solar R&D to December 2017
- Over 300 projects surveyed
- Available on our Knowledge Bank



ARENA exists to accelerate Australia's shift to affordable and reliable renewable energy.

ARENA's target:

- Ensure private sector has the **technology and tools to deliver secure and reliable renewable energy** at lower cost and more value.
- Provide **knowledge, data and skills to decision makers in both government and the private sector** to navigate the shift to renewable energy.
- Facilitate **increased collaboration** in the energy sector.

ARENA's activities:

- **Funding** research, development, demonstration, commercialisation and deployment of renewable energy technologies
- **Knowledge Sharing:** provision of advice to inform decision making and accelerate industry learning
- **Facilitation Collaboration** within the energy sector and energy users.

ARENA AT A GLANCE

\$1.19B INVESTED

396 PROJECTS

\$4.01B VALUE

\$2.82B INVESTMENT LEVERAGE

SOLAR PV
\$634M

SOLAR THERMAL
\$145M

GRID INTEGRATION
\$111M

HYBRID
\$98M

BIOENERGY
\$59M

STORAGE - BATTERIES/PHEV
\$52M

WAVE/TIDAL
\$48M

GEOTHERMAL
\$41M

50%

Reduction in large-scale solar construction costs - \$2.50/W to \$1.25/W



\$1: \$2.37

Average investment leverage



Study R&D Demo Deploy
\$1: \$1.57 \$1: \$1.71 \$1: \$1.78 \$1: \$3.59

Investment leverage across innovation chain

797MW

Total capacity created through investment



\$83M invested
23 projects
\$233M project value

\$37M invested
6 projects
\$72M project value

\$176M invested
38 projects
\$1.1B project value

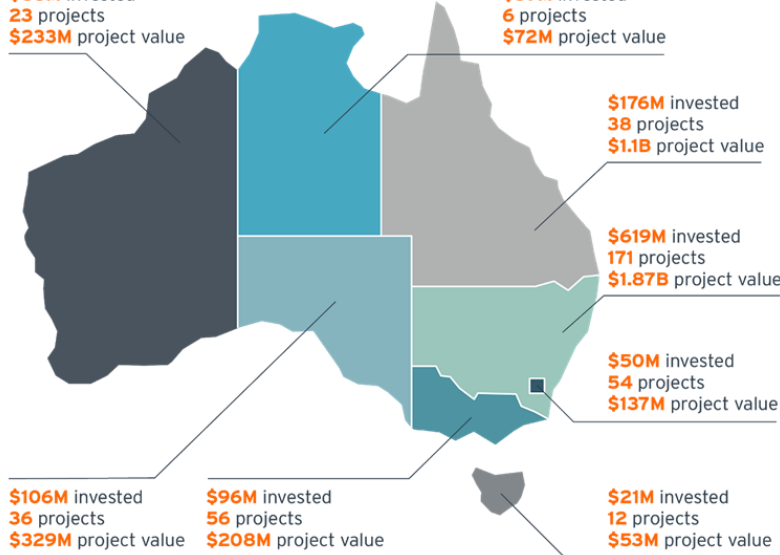
\$619M invested
171 projects
\$1.87B project value

\$50M invested
54 projects
\$137M project value

\$106M invested
36 projects
\$329M project value

\$96M invested
56 projects
\$208M project value

\$21M invested
12 projects
\$53M project value



25%

Contribution to the Government's Mission Innovation targets



A-Lab

14 collaborative events attended by a total of organisations
159 Ideas funded



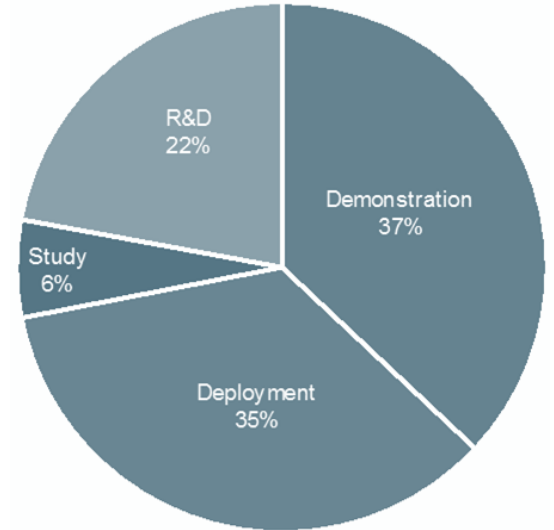
270 Researchers supported
90 PHD students supported
Renewable Energy efficiency improvements and cost reduction research



In 2016/17 renewable energy jobs grew by **1/3 to 14,820**

Solar R&D has always been important in ARENA

- About 22% of funding focuses exclusively on R&D, with some other projects also containing R&D components
- \$291m was allocated across 314 projects with a solar R&D component.



PV	CST	Enabling	Total
209 (\$165.87m)	67 (\$96.03m)	38 (\$29.1m)	314

Mapping our focus in solar R&D

ASI
(Inherited)

Round One:
Solar Excellence

Round Two:
Industry/Researcher
Collaboration

Round Three:
Accelerating PV

- Equal R&D funding for PV and CST

Top PV research areas::

- PV coating
- Silicon
- Silicon / perovskite

Top PV research areas:

- Modelling
- Performance enhancement
- Deployment

Top PV research areas:

- Manufacturing cost
- Efficiency improvement

Top CST research areas:

- Allam cycle
- Receivers

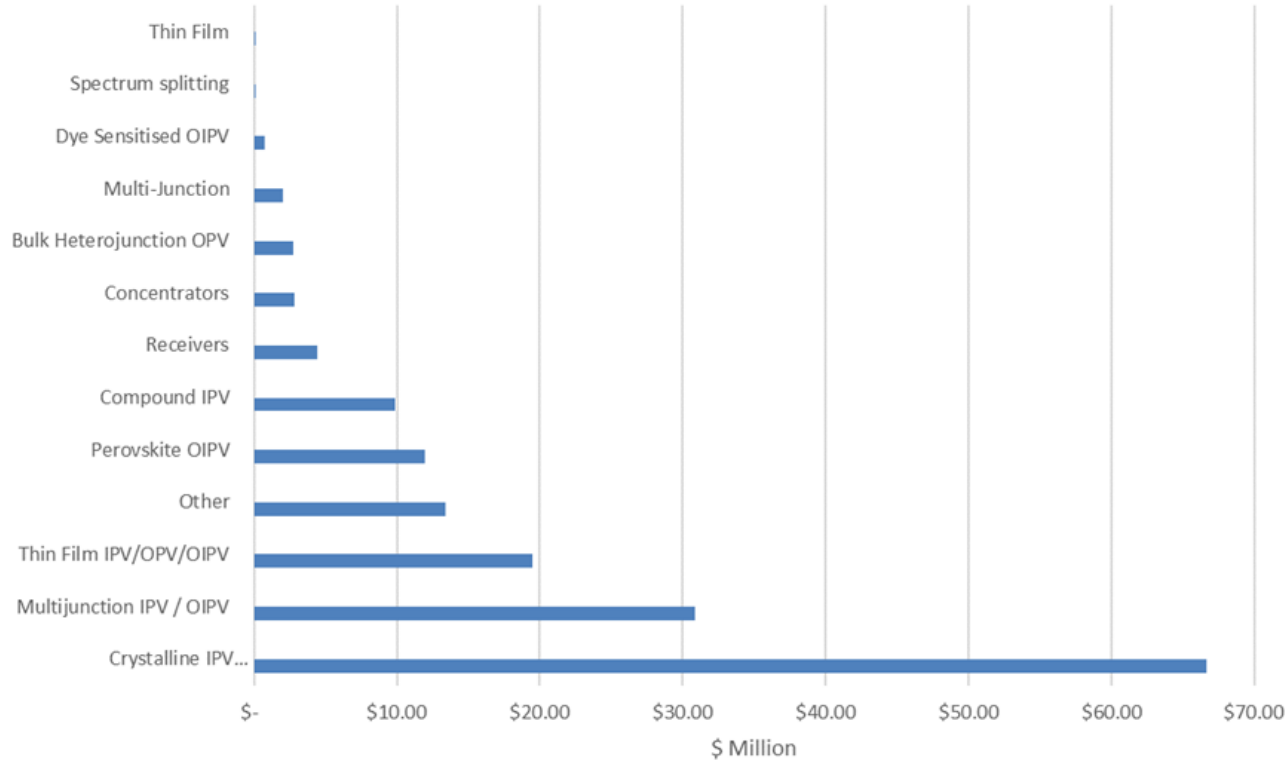
Top CST Research areas:

- All design components

Battery integration

Battery integration

Allocation of \$165m Funding by PV Type (2009-2017)



In PV, we have prioritised work on efficiency improvement and cost reduction (2009 - 2017)

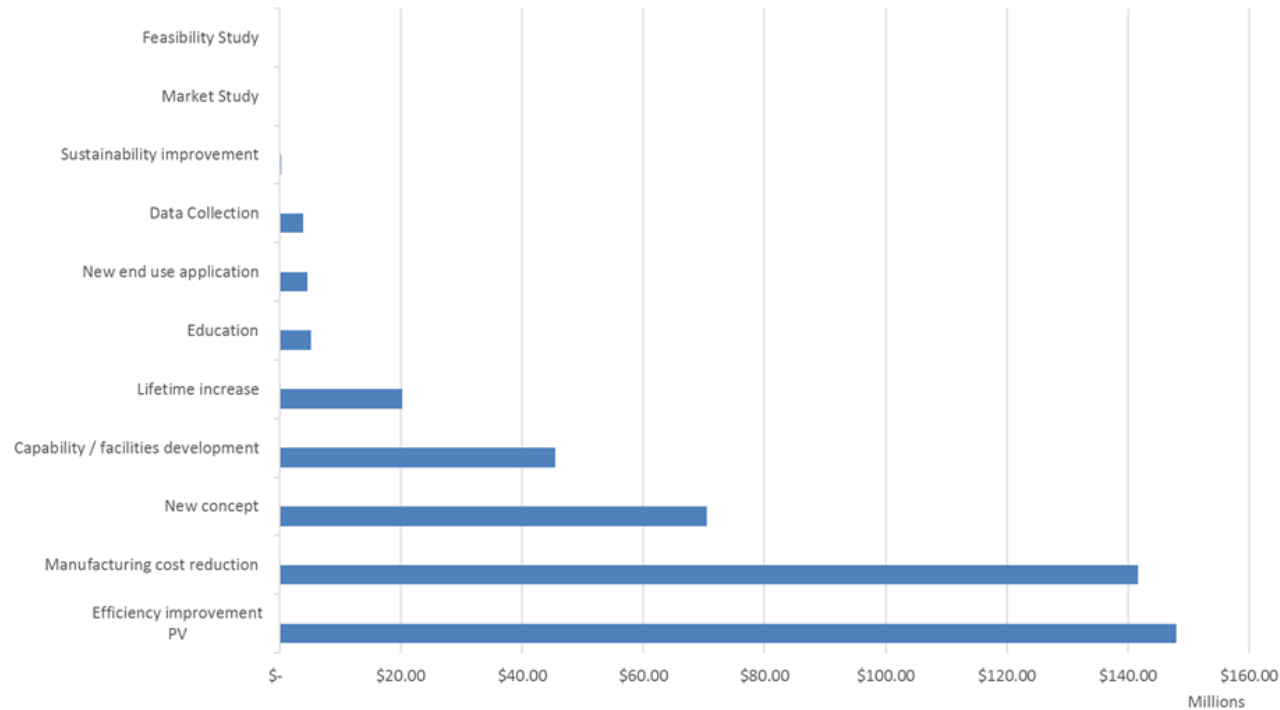


Figure: Allocation of \$440m of PV R&D total expenditure by primary goal.

Key Outcomes

PV

- **Low cost, high performance materials**
- **Novel / better encapsulation**
- **Establishment of research facilities**

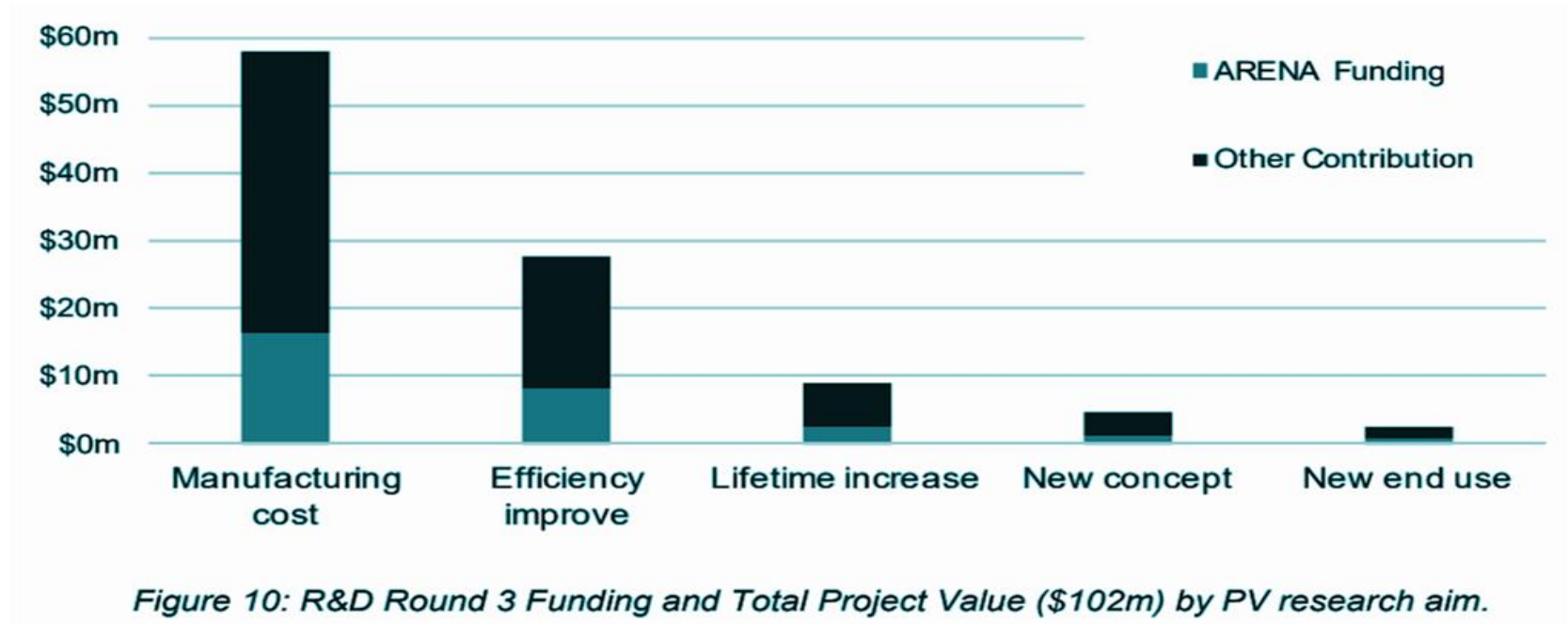
CST

- **New designs**
 - Improved receiver efficiency
 - Low cost heliostat components
- **New concepts**
 - Storage materials
 - Power cycles

Enabled

- **System performance data and forecasts**
- **New integration and enabling technologies**
- **Commercialization**

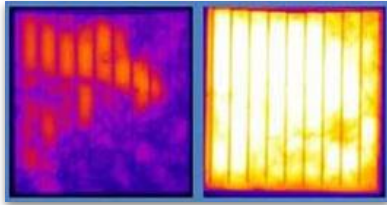
ARENA incentivises collaboration across Government with researchers



ARENA's role in knowledge sharing is a shared value with universities.

Patents filed	Licences entered into	Presentations	Journal and other publications	PhDs	Postdocs
148	21	1235	1693	220	341

Some ARENA projects you would have heard of:



UNSW
Hydrogenation



Vast Solar
CST plant



Fulcrum3D
sky-cam

Summary of key outcomes

- Maintained Australia's lead in solar research
- Enhanced educational credentials and outcomes
 - Both serve to create or reinforce strong links with international industry
- Established a range of world-class, industry-scale research facilities
 - These will provide the foundations for future research- industry collaborations
- Tackling key background issues of energy market design, technology integration, data collection and management, energy forecasting and storage

ARENA's next targets for solar R&D funding

- **Commercialisation of R&D**
 - In collaboration with CSIRO's ON Prime 6 program (opening 4th Feb)
 - 'Kick-start' funding to support research based innovations
- **End of life for solar PV systems**
 - Regeneration, reduced disposal costs or commercial opportunities
 - Better up-front design
 - Mid-2019
- **Solar PV R&D funding round**
 - To be scoped in consultation with the research sector





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