



ASTRI

AUSTRALIAN SOLAR THERMAL RESEARCH INITIATIVE



# Concentrating Solar Thermal TECHNOLOGIES

Supporting the present  
– enabling the future

Developing skills, capability and technology for  
leadership in the decarbonised energy future



# Capturing the value of CST

The sun is Australia's greatest renewable and clean energy resource. Australian CST research is building skills, capability and technologies to harness the power of that resource and foster local industry and economic growth.

According to the International Energy Agency (IEA), Concentrating Solar Thermal technology (CST) will play a major role in the decarbonised energy future.

By 2050, CST is expected to be the main source of electricity in large regions of the world and, with rapid development of CST projects across nations such as Chile, China, India, Morocco, South Africa, and the USA, this technology is coming of age.

Few countries in the world are as well positioned as Australia to capitalise on that global growth and contribute to the technologies that will shape the future of this industry.

That's why, right now, Australian research and expertise is being focused on CST technology development to position Australia for leadership in this sector.

International experience shows that in modern, industrialised markets such as Australia, existing capabilities in civil,

mechanical, thermal and industrial engineering can easily be utilised to address the needs of the CST industry. The design, manufacture and commercialisation of many components of a CST system can be undertaken locally for supply to both the Australian market and export markets.

To unlock this potential however, industry must see reductions in the cost for CST plant construction and operation, de-risking of the technology components and increased technology readiness to incentivise investment and adoption.


The Australian Solar Thermal Research Initiative (ASTRI) is an eight-year, \$87 million international collaboration established to achieve that goal.

Combining the strengths and expertise of leading research institutions, industry bodies and universities, ASTRI aims to transform Australia into a global leader in CST and thermal storage technologies.

“ We are building the capabilities in Australia so that we can manufacture and build power plants here and create export markets, ultimately leading to more jobs.

Professor David Lewis, Director,  
Centre for NanoScale Science and  
Technology, Flinders University

One characteristic of  
**CST plants**  
is the macroeconomic impact of their very high local content, contributing to the country GDP, during both construction and operation of the plants.



# Investing in our **SOLAR FUTURE**

Through highly targeted research ASTRI is delivering the next wave of cost reductions for CST technologies to ensure solar thermal is competitive with other renewable and traditional energy sources, and to develop the Australian capability required to deliver this technology locally and globally.

Since its inception in October 2012, ASTRI has delivered a more than nine-fold increase in the number of CST technology specialists working in collaboration with industry to achieve that aim. There are now more than 140 experts across four states and territories working to unlock CST's potential and identify niche market applications for the technology.

“ As Australia considers its future in a high-penetration renewable energy world, the value proposition of CST technologies grows: as a core stabilising technology for the grid, as a source of dispatchable electricity and as a clear solution to the wind and solar intermittency challenge.

Kieran Jacka, Chair,  
ASTRI Advisory Committee

## CST technology for the Australian market

The value proposition of CST technologies is excellent.

CST technologies have all the attributes needed to become the backbone of a highly decarbonised energy system. The application of CST and its benefits are varied and relevant to a number of priority sectors – for example:

**The electricity sector** where CST technology with thermal storage can perform different roles as needed, from base-load to peaking plants. CST technology doesn't require conventional backup and can provide critical grid stability to enable increased penetration of non-dispatchable renewable technologies such as wind and photovoltaic (PV) technologies.

**CST technology can provide** high temperature process heat, transport fuels as well as other solar chemistry solutions. By including the appropriate amount of thermal storage or hybridisation, these processes can be run at the times of day or night that make most economic and technical sense.

The transformation of solar radiation into heat allows CST technologies to provide a wide range of energy options at varying temperatures and technological complexity to successfully decarbonise Australian industrial operations.

**In traditional sectors currently grappling with the transition to renewables,** CST technology can facilitate integration of hybrid and thermal storage solutions to reduce carbon emissions and enable process transformation.

When hybridised with biomass, a CST system can provide continuous 24/7 clean and renewable heat processes or electricity production for operations in intensive industrial and manufacturing environments.



# Solar thermal impact for

ASTRI has developed a concentrating solar thermal (CST) power plant configuration that could achieve a conservative levelised cost of energy (LCOE) of 12.9c/kWh, which is much lower than CSIRO's 2015 "Australian Power Generation Report" advice of 17.5 to 35.0c/kWh.

The proposed central receiver tower power plant design is based on a 100-MWe closed-loop supercritical carbon dioxide (sCO<sub>2</sub>) Brayton cycle power block, with single-tank phase change material (PCM) thermal storage and sodium (Na) receiver. The novel configuration reflects research outcomes to date and will be further improved.



1

## Reducing capital expenditure

**OBJECTIVE:** TO REDUCE ONE OF THE BIGGEST BARRIERS TO THE UPTAKE OF LARGE-SCALE SOLAR THERMAL POWER STATIONS – THE COST TO BUILD THE POWER PLANT.

**Outcome:** A handful of patents in development related to advancements in heliostat, receiver, storage and power block technology.

**Impact:** New CST component and system technologies ripe for development by Australian industry for local application or international export.

2

## Increasing the capacity factor

**OBJECTIVE:** TO IMPROVE DISPATCHABILITY THROUGH THE DEVELOPMENT OF SOLAR THERMAL ENERGY STORAGE OR NOVEL HYBRID SYSTEMS.

**Outcome:** Various phase change materials explored and compact systems identified that reduce storage costs and provide better matching of temperature to the power cycle requirements.

**Impact:** Improved solar (derived) thermal energy availability to increase annual hours of electricity production for when it is needed most by the grid.



# INDUSTRY



2

## Improving CST system efficiency

**OBJECTIVE:** TO IMPROVE SOLAR THERMAL POWER PERFORMANCE BY EMPLOYING NOVEL HIGH-TEMPERATURE CYCLES.

**Outcome:** Development of compact, high efficiency systems that offer better performance at smaller plant sizes.

**Impact:** Scalable CST system configurations capable of producing electricity at market competitive costs.



3

## Adding product value

**OBJECTIVE:** TO IDENTIFY NEW AND IMPROVED CST POWER PLANT OPERATING METHODS TO REDUCE COSTS AND INVESTIGATE NICHE MARKET APPLICATIONS OF CST TECHNOLOGY IN THE AUSTRALIAN CONTEXT.

**Outcome:** Definition of processes and methodologies for establishing cost-effective operations and maintenance regimes.

Establishment of cost targets for CST systems for production of solar fuel.

**Impact:** New market opportunities and applications of CST technologies.

Solutions to support decarbonisation of existing energy networks and industrial processes.



# OUR strategic focus

ASTRI is focused on achieving its economic goals through highly targeted research programs across four strategic focuses.

- 1 Increasing the capacity factor – extending operating hours to sell more electricity to the grid;
- 2 Reducing capital expenditure for CST power plants;
- 3 Improving efficiency of CST components and overall systems; and
- 4 Adding product value: through (a) developing new, high value solar thermal products and non-electricity applications of CST technology and (b) improving O&M technologies to increase yield and reduce cost.

## Uniting the strengths of Australia and the United States to fast track the commercialisation of solar thermal technologies

To develop a viable CST industry, Australia needs a multi-faceted strategy focused, first and foremost, on improving the cost competitiveness of CST technologies. This, in turn will improve the investment appeal and reduce the capital risk for development.

ASTRI has brought together a diverse range of energy research skills and experience to deliver a unique solar thermal capability in Australia focused on precisely that goal.

Through collaboration with industry and our international research partners, ASTRI is working to develop disruptive technologies that will dramatically reduce the investment, operating and maintenance costs of CST technologies and set new benchmarks for the solar thermal industry.

To ensure rigour and consistency in ASTRI's outputs, the team has developed and continues to refine a set of relevant standardised metrics and models for Australian conditions. These overarching economic models allow accurate and informed commercialisation decisions to be made throughout the CST research and development lifecycle.

ASTRI has created uniformed cost parameters, standardised solar weather data for modelling and is ensuring Australian modelling scenarios link with the systems used by global leaders in CST technology development such as CST experts at the National Renewable Energy Laboratory (NREL) and Sandia National Laboratory (SNL) in the United States to ensure international compatibility and best practice technology development.

“ASTRI R&D is focused on creating over the horizon energy solutions with global impact. Our R&D is feeding a technology pipeline for new CST innovations enhanced through strong collaborations between researchers and industry both here in Australia and internationally.

Professor Paul Meredith  
Australian Research Council  
Discovery Outstanding  
Research Award Fellow  
Director UQ Solar



# Australia is ready to develop an internationally competitive CST industry

- **One of the most important direct solar radiation resources in the world** with enough niche markets for CST technology applications to provide the necessary opportunities at the local level to nurture a national industry, ready to compete in international markets;
- **A workforce with substantial training, experience, and expertise** in the main areas required to design and deploy commercial CST systems – civil, mechanical, thermal, and industrial engineering;
- **An innovative educational and research system**, which ranks among the best in the world, well connected at the international level, with excellent research and testing facilities in many of the areas of interest for CST technology development;
- **A national laboratory**, CSIRO, with the required expertise in CST technologies, testing capabilities, size, international standing, management expertise, and scientific leadership to lead the Australian education and research community in achieving excellence in the field of CST technology;
- **A proven track record** from CSIRO and its University research partners to meet quantitative and qualitative goals aligned with the expressed goals of the scientific, political and business communities, as well as the ambitions and aspirations of the Australian public; and
- **Strong commercial and political ties** with many of the most relevant markets for CST technologies (China, India, USA, South America, Middle East, North Africa and Europe) and a strategic location with respect to the most important markets.

“ASTRI will harness these strengths to create an energy future where CST technology builds industry, creates jobs and can transition Australia to a low-carbon, renewable economy on a global stage.

## Our collaboration partners

### FUNDING PARTNER

ARENA



Australian Government  
Australian Renewable  
Energy Agency

### AUSTRALIAN PARTNERS



Australian  
National  
University





## Partnering with ASTRI

ASTRI is keen to develop mutually beneficial relationships with industry to help develop projects related to the various processes involved in CST power plant build and operation.

If you are interested in learning more about how you can collaborate with ASTRI please contact us.

“ Australia has one of the best solar resources in the world. It is a natural fit for an international solar thermal research collaboration to use this resource and our expertise to make solar power the cheapest, cleanest and most reliable energy source it can be.

**Dr Manuel Blanco, Director of ASTRI**

Photo: istockphoto.com

### FOR FURTHER INFORMATION

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