BIOMASS FOR BIOENERGY

Hybrid Solar-Biomass Plants Factsheet

What are hybrid solar-biomass plants?

There is a growing number of renewable electricity generation solutions currently being deployed in Australia, including concentrated solar thermal (CST). Hybridisation of CST technology with combustion technologies has the potential to be cost-effective, providing baseload energy while contributing to greenhouse gas mitigation. The climate benefits are improved when sustainably sourced biomass is used for combustion instead of fossil fuels such as diesel. We refer to these systems as hybrid solar-biomass plants (HSB).

Figure 1: Hybrid Solar-Biomass Plant in Les Borges Blanques, Spain © COMSA

In CST, unlike photovoltaic systems, solar energy is concentrated into a central receiver through the use of mirrors and collected with a thermal energy carrier (e.g. water/steam, oil, molten salts). The stored thermal energy can then be used as a thermal energy source to generate power compatible with a biomass boiler, similar to coal-derived electricity. Most CST plants incorporate between 3-15 hours of thermal energy storage. There are immediate opportunities for smaller CST projects (1-5MW) in the distribution network or off-grid; however, larger generation is not yet economically viable[1].

Use of biomass in HSB reduces or eliminates the need for storage systems. Combustion of biomass is a mature technology deployed in many power plants operating globally. In addition to electricity, heat is also generated in HSB systems, which can be used for a number of different applications. The potential for greater usage of both biomass and CST for energy generation in Australia has been highlighted recently. The Clean Energy Finance Corporation estimates investment opportunities in bioenergy between $3.5 billion and $5 billion - in energy from urban waste, agricultural waste and forest residues[2]. For CST, without policy changes, it has been estimated that by 2040 up to 4 GW capacity will be installed. With minimal policy intervention, it is estimated that by 2040 an additional 1 GW capacity will be installed in regional Australia, in locations at the fringe of the power network which could go off-grid in the future[3].

What are the key advantages of HSB plants over standalone CST?

- 24 hours a day operation (dispatchable power) with constant base-load and higher output during the day aligning with higher energy demand also during the day.
- Flexibility of building smaller plant sizes (5 MWe-50 MWe vs. >50 MWe for stand-alone), resulting in reductions in construction time, investment risk, and initial investment.
- Effective operating hours and energy generation are about 2.8 times higher than in conventional CST of similar size.
- Higher steam cycle efficiency (more energy for the same input); resulting in reduced investment needs per unit of power.

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- Steam turbine can operate continuously, avoiding the daily shut down/start up, achieving greater overall efficiencies.
- Through lower investment costs, areas with less than optimal solar irradiation may be considered – in NSW such areas are typically closer to transmission lines and energy demand.
- Allows for local increase of renewable energy, reducing the need to import energy in regional areas, with associated cost reductions in transmission lines.

Are there operational examples of HSB?
The concept of hybridising solar energy with other energy sources is not new. However, HSB plants are a relatively new concept. An example of an operational plant is the Termosolar Borges plant in Spain (Figure 1).

The Borges plant is a 22.5 MW biomass-solar hybrid power plant generating 98,000 MWh/year, providing electricity for 27,000 homes, saving approximately 24,500 tons of CO_2 annually. The main biomass sources for the three boilers are forest biomass, biomass crops and agricultural residues. The total intake is 66,000 tons per year at an average of 45% moisture content. The biomass is shredded and dried before being burned in the boiler, which operates at 37% efficiency. The total investment was €153 million, with about 40 permanent workers operating the plant.

What makes hybrid solar-biomass systems potentially suitable for renewable energy generation in NSW?
Previous work[4] has suggested significant potential for certain regions of Australia to benefit from HSB systems. For NSW specifically, many regions have abundant biomass available and reliable high solar irradiation. The availability of biomass is well documented –for example, in the AREMI tool (Australian Renewable Mapping Infrastructure), the spatial availability of residues from various sources is shown across NSW[5]. Use of residues provides a number of potential co-benefits – reduction of wastage, increasing value-adding and also supporting the generation of locally derived energy. One area of NSW which has been the target of a previous study was Griffith[6], which has a high direct normal irradiance (DNI) and abundant biomass. The case study was based on an HSB plant with a total capacity of 30MWe (15MWe biomass and 15MWe CST). The economic analysis revealed that the HSB plant would result in at least a 43% cost reduction compared to a CST alone option.

Figure 2: Concentrated Solar Thermal (CST) set up that is part of the Hybrid Solar-Biomass Plant in Les Borges Blanques, Spain © IDOM

The flexibility in plant size and feedstock types means that there may be many opportunities across NSW for the establishment of HSB plants, which ideally can be integrated with existing industry that requires heat or cooling in their operations. Importantly, such systems may provide an option for regions in NSW to become self-sufficient in energy generation, without relying on fossil fuels.

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What research is NSW DPI doing on hybrid solar-biomass systems?

NSW DPI Forest Science is partnering with the University of Technology Sydney (UTS) to identify especially suitable regions for the establishment of HSB plants. This study will build on previous work[7], which highlighted the potential for the technology in NSW, by using more refined biomass datasets available at a regional level. The work will combine in-depth analysis of biomass availability, DNI profile and a range of parameters required to support techno-economic assessments. As part of this study, we will also engage with communities to discuss the opportunities and barriers for HSB plants in their region. This research is part of NSW DPI's Climate Change Research Strategy (https://www.dpi.nsw.gov.au/climate-and-emergencies/climate-change-research-strategy).

Potential impacts of the research

- Informing policy-makers of the potential of a renewable energy option that has so far been largely ignored.
- Provide prospective investors with confidence from the detailed techno-economic assessments.
- Support the development of pilot plants in selected regions.

For further information, please contact

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[2] Bioenergy Australia and KPMG (2018). Bioenergy state of the nation report. https://s3-ap-southeast-2.amazonaws.com/piano.revolutionise.com.au/news/vabsvwo5pa8jnsgs.pdf

[4] See for instance: Peterseim, J. H., Hellwig, U., Tadros, A., & White, S. (2014). Hybridisation optimization of concentrating solar thermal and biomass power generation facilities. *Solar Energy*, *99*, 203–214.

[5] See for the Australian biomass for bioenergy assessment (ABBA) project: https://arena.gov.au/projects/the-australian-biomass-for-bioenergy-assessment-project/. The collected biomass data is included in the AREMI-map: https://nationalmap.gov.au/renewables/

[6 and 7] Peterseim, J.H.M. (2014). Enabling concentrating solar power in Australia: An investigation of the benefits and potential role of concentrating solar power and non-conventional fuel hybrid plants in Australia's transition to a low-carbon energy future. University of Technology Sydney.