2020/ARP006 SunDrive Copper Metallisation Demonstration Project

Lessons Report: SunDrive's Start-up Experience

Company Name: **Sundrive Solar Pty Ltd**

Company Location: **Kirrawee, NSW**

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Introduction

SunDrive is a technology start-up company currently based in Kirrawee, NSW. The company's overarching goal is to realise the full potential of solar photovoltaics (PV) and accelerate the uptake of solar energy around the world. The technology at the heart of SunDrive is an alternative to traditional silver-based metallisation for industrial solar cell manufacturing that completely replaces silver with copper – a metal that is approximately 1000x more abundant and 100x cheaper than silver.

As the international community pushes towards TW-scale solar production capacity, the criticality of minimising cost by using cheaper and more abundant materials for solar PV generation is an increasingly important issue. Furthermore, with current commercial solar technologies reaching their efficiency limits and next-generation cell technologies demanding even greater silver usage, a growing cost and supply risk presents a significant challenge for the evolution of the solar industry. SunDrive's technology directly addresses this critical issue, whilst also providing performance benefits beyond that achievable with existing silver-based commercial technologies.

With this ARENA project, SunDrive is working to demonstrate its cell technology potential and translate this to commercial-size modules, whilst also developing a working prototype production line of its propriety metallisation sequence. This report will provide some details on SunDrive's unique experience of taking a concept from a university laboratory to a commercial venture, as well as the important lessons and takeaways that may help guide other start-ups.

Taking Technology from University to a Start-up

The development of SunDrive's technology began in 2014 with co-founder Vince Allen's PhD at the world-renowned solar research school at the University of New South Wales (UNSW). Along with his supervisors - the late Professor Stuart Wenham and Professor Alison Lennon - the fundamentals of SunDrive's copper metallisation technology were conceived. A critical factor in the decision to start SunDrive and further develop this technology outside a university environment was the support and encouragement provided to Vince by his supervisors. This included the freedom to research multiple different technological approaches in a much shorter period than is usually allowed through university research. Recognising the commercial potential of the technology, they supported Vince heavily during the formative years of SunDrive.

After deciding to further develop this technology outside the university, the next step was to secure the rights to the necessary IP that had been developed at UNSW. New South Innovations (NSi – the knowledge exchange and technology transfer company within UNSW) was supportive in negotiating the licensing of the relevant IP. The licensing agreement allowed SunDrive to obtain an exclusive world-wide perpetual license for a key piece of IP underpinning SunDrive's technology in exchange for a small equity position in the company. It was important during this stage to have the support and backing of those who could see the technology potential at such an early stage of development. SunDrive benefited from having the early support of both seasoned academics with in-depth understanding of commercial solar manufacturing (and the associated challenges/opportunities) as well as those with a stronger focus on commercialisation, who could understand the technology potential from a market perspective.

Securing Initial Investment

With the relevant IP for SunDrive's technology secured, the next step was to attract the necessary investment required to begin developing the technology independently. Initially, SunDrive was self-funding its own technology development out of a garage in Maroubra. However, it was important that

the first external investment in SunDrive was from someone who understood the technology, the challenges it was addressing, and the extensive market/business potential should it succeed.

Through Professor Wenham, SunDrive's co-founders met with Chinese-Australian solar scientist and entrepreneur Dr Zhengrong Shi. With an extensive background in both solar technology research and commercialisation (as founder/CEO of Suntech Power, the biggest solar manufacturer in the world in 2010-2011), Dr Shi was perhaps the best person to provide the first external investment in SunDrive. Not only did he understand the solar industry and market opportunity (including personal experience in transitioning a solar technology from university research to commercial solar manufacturing), but he was also acutely aware of the technical challenges that SunDrive's technology was addressing. Suntech aggressively pursued copper metallisation for many years with its Pluto cell technology, but technical difficulties hindered its success. Witnessing first-hand the improvements provided by SunDrive's technology, Dr Shi was convinced in the technology's potential and within a month of visiting SunDrive's garage had agreed to make the first investment in SunDrive in June 2015.

With Dr Shi's international commitments, SunDrive wanted to also bring on board someone deeply involved in the local start-up ecosystem and preferably also from the solar industry. Through UNSW's entrepreneurship team and NSi, SunDrive's founders met with Sylvia Tulloch, founder of DyeSol (at the time, Australia's most advanced solar R&D company that was also listed on the ASX) and an active member of the local start-up community. With her extensive experience in company management, growing her own start-up and investing in other start-ups, as well as government interaction, Mrs Tulloch offered extensive knowledge to SunDrive that would prove invaluable in the following years as it grew and developed its technology. Both Mrs Tulloch and Dr Shi joined SunDrive as board members in 2015.

Technology Development: Start-up vs University

The process of technology development in a lean start-up differs greatly from that in an established research institution or university. As with any independent research venture, this independence has come with numerous advantages and challenges, including:

Advantages

- **Speed:** the iteration cycle for technology development is generally much faster in a self-governed start-up, bypassing a lot of "red tape" and internal policy that can heavily impede the progression of research within many universities. This also applies to collaborations with industry partners, who often operate on a faster iteration cycle than universities. A start-up is often able to better adapt and keep pace with industry partners.
- **Adaptability:** necessity is the mother of invention. With limited resources in the early stages of a start-up company, everything is built, tested and iterated from the ground up – processes, equipment and even characterisation tools. SunDrive has facilitated this adaptation by hiring its employees from a wide range of fields with varying degrees of experience and expertise. SunDrive has learnt that it is not about your qualifications, it's about your ability.
- **Goal Definition:** everyone within SunDrive is working cooperatively on a singular goal, which simplifies operations and minimises dilution of resources amongst different projects. Whereas a university has multiple disconnected projects competing for equipment access/tool time/funding, a start-up can pool its resources and ability to achieving more clearly defined goals.
- **Wholistic Viewpoint:** whilst university research can often focus on technologies that, while impressive, may never be commercially viable products, technology development within a start-up is all focussed

on improving a technology for market. Thus, every stage of technology development is performed with the end-goal in mind – commercialisation.

Challenges

- **Resource scarcity:** especially early on, with limited funding, technology development in a start-up environment can be difficult. Without access to important processing tools and characterisation equipment, adequate technology development can be reliant on self-designed tools (requiring their own iteration cycle) and/or access to external resources through collaboration which can also slow the iteration cycle.
- **Time Pressure:** since a start-up is often under pressure (status of market value proposition, pressure from competitors and investors) to deliver a product to market as quickly as possible, this can often put significant pressure on the iteration cycle. Whilst this does speed up the technology development, it can also impede the ability to provide detailed analysis of results which may help better dictate the development cycle.
- **Learning curve:** there are a lot of things taken for granted in university research that are significant challenges for a lean start-up. Necessary access to sophisticated equipment (processing and characterisation) and services (ultra-pure water, compressed dry air, nitrogen, wastewater treatment) has meant SunDrive has had to build its facilities and services to allow its technology development to progress. SunDrive began its operations in a garage, and now runs a self-designed cleanroom.
- **Anonymity:** the primary downside of operating outside a university is that it removes the safety net of institutional reputation. This can be challenging when sourcing components and early-stage fundraising, particularly through government funding programs. As a start-up, SunDrive has decidedly made a habit of demonstrating its capabilities to investors to compensate for its low profile, building its own track record.

Whilst there are challenges to technology development within a lean start-up, the experience and reputation SunDrive has grown through multiple successful funding rounds has made many of these challenges more manageable.

Forming Collaborations

Collaborations can be essential for a start-up – they not only provide deeper access to the industry they are hoping to enter, but also facilitate faster technology development by providing access to resources that are unavailable without some form of collaboration. Collaboration with research institutions and industry partners has been critical to major advances in SunDrive's technology development, from the scaling of its technology from lab-size to industrial-size wafers right up to the recent world-record efficiency SunDrive achieved in September 2021.

As a small start-up, it can be a daunting prospect to approach larger companies and research institutions. An invaluable asset early on in this process was leveraging SunDrive's existing network of connections to begin those interactions. Maintaining a good network of connections with the university helped in the early stages of technology development and is an excellent resource for initiating conversations with companies/institutions. In the solar industry, companies will often approach research institutions to investigate new technologies for commercial potential. One of SunDrive's current collaborators had approached UNSW with an interest in exploring copper plating, and that connection was passed onto SunDrive.

SunDrive was also able to leverage the connections of its investors with ties to the industry. Once again, companies looking into copper metallisation for their solar technologies were directed to SunDrive through introductions by industry connections (namely Dr Shi in the early stages, who is highly regarded in the international solar community). Whilst having those existing connections to industry and research help get a foot in the door, having a technology that addresses a big market also helps attract those collaborations.

Fostering these collaborations is essential to maintaining a good trajectory of technology development. Whilst the results of experiments and advances in technology development often in themselves help maintain good collaborations, SunDrive found that having a strong face-to-face presence, with regular engagement, was an important part of growing new collaborations and forming trusted working relationships. This included the co-founders frequently travelling internationally to visit collaborators for in-person meetings and discussions and maintaining regular correspondence on progress and collaboration goals. Fostering these collaborations as a technology advances is even more important – especially as a company moves from R&D closer towards commercialisation. Often the later stages of technology development require more resources and having trusted relationships with industry partners allows for larger experiments and batch testing.

Growing Capital Investment

Obtaining the necessary funding for further technology progression can be a complicated and time-consuming process. After the initial funding provided by Dr Shi's angel investment, SunDrive began developing its formal pitch deck in preparation for its first institutional investment round. UNSW's entrepreneurship team aided in both refining SunDrive's pitch deck, as well as introducing the company to various potential investors.

An important takeaway from SunDrive's previous funding rounds was the importance of technology demonstration. Just as it worked with securing Dr Shi's investment, inviting potential investors to visit SunDrive's operations and witness the technology first-hand (copper plated solar cells, tool prototypes, etc) is an invaluable way of demonstrating the capabilities of both the technology as well as the team behind it.

With each funding round, securing further investment is dependent on achieving the goals of the previous round. By setting clearly defined goals and metrics to define the success of each round, it is easier to demonstrate to both new and existing investors of your track record of technology development. It is important to set ambitious yet achievable goals for each round of technology progression to maintain a successful track record. For a hardware start-up with a comparatively slow iteration cycle compared to high velocity software ventures, it is also crucial to have the support of patient investors with longer term investment aspirations that are willing to support a start-up throughout its commercialisation journey.

Finally, the importance of public investment through government programs should not be understated. Successfully applying for government funding programs not only provides an alternative source of investment, but it also can be highly influential in securing the necessary private investment required for each stage of technology development. Furthermore, public investment in locally developed technologies (especially clean technologies) boosts public awareness that Australia is supportive of local clean technologies and start-ups. This encourages more companies to pursue clean technology ventures, thus supporting the growth of the entire Australian industry landscape.

Summary of Lessons Learnt and Future Outlook

Overall, there are a number of key takeaway's from SunDrive's start-up experience that may be of benefit to other clean technology ventures. While every company is different, there are parallels with every start-up experience. The main lessons from SunDrive's experience are:

1) Early on have (i) someone in your corner who deeply understands the technology, the challenges, and the international market potential (in SunDrive's case, Dr Zhengrong Shi), and (ii) someone on hand who is actively involved in local start-ups who can help with legal, finance, accounting, management – ideally with experience in the same field (in SunDrive's case, Sylvia Tulloch).
2) When spinning a technology out of a university, maintain those connections and relationships. Universities can be an invaluable resource in supporting early-stage start-ups through support, guidance and providing connections to potential collaborations and future recruits. Universities can also help secure government funding through collaborative projects.
3) When it comes to building the team, SunDrive has noticed that ability usually means more than qualifications. Technology development can benefit from experience outside the field that the technology may be designed for.
4) Foster new collaborations through a strong face-to-face presence and regular engagement. This helps build a trusted working relationship, which will allow sustained collaboration as a technology grows and resources required increase.
5) Demonstrating a technology firsthand means more than a good pitch. Let investors and collaborators see the capabilities of both the technology as well as the team behind it.
6) Set technology goals for each round so that each subsequent funding round is off the back of a successful previous round with a proven track record.
7) A mix of public and private investment is vitally important. Not only does one assist in securing the other but public funding can provide greater public support and awareness of novel technologies that can boost the market potential in Australia.

In Australia, support for clean technologies has been growing significantly in recent years. There is a general consensus towards sustainable practices and carbon neutrality in the wake of recent international climate reports and net zero commitments. The Covid pandemic has also shined a spotlight on issues such as energy security and bolstering local supply chains. With growing public support for sustainable technologies, and big cleantech investment funds being raised internationally (Breakthrough Energy Ventures, Lowercarbon VC), the future for investment in clean technologies is bright. With more government support, Australia could be home to a revolutionary new industry to support the country's transition to a net zero economy.