Designing Solar Roofs

Design Guide brought to you by
Tractile, The Designer Solar Roof

Tractile

INTRODUCTION TO TRACTILE

Founded in 2005, Tractile is an innovative Australian company acknowledged as a pioneer and expert in the fields of Building-Integrated Photovoltaic and Thermal (BIPV-T), solar systems, composite materials, product development/ commercialisation, and Intellectual Property management and licensing.

Our multi-award winning Tractile Eclipse Solar Roof is a four-in-one combination of composite roof tile, electricity, hot water and insulation in a seamlessly integrated package with street appeal.

Tractile's leading edge, sustainable and income generating roofing solution makes the future of roofing a reality now with in-house manufacturing, sales, installation and support.

WHAT IS BIPV-T TECHNOLOGY?

BIPV-T (Building Integrated Photovoltaic-Thermal) is the integration of technology within the building envelope that produces both electricity and hot water. This differs greatly from BAPV (Building Added Photovoltaic) and solar thermal solutions that commonly adorn many buildings around the world. BAPV products do not perform any function other than generating electricity, much like solar thermal units only produce hot water.

There are now BIPV technologies that perform dual functions such as standard solar roof tiles and window films, however these will not give the performance of traditional solar panels. This is primarily due to efficiency. As much as PV cells love the sunshine, they do not like the heat – electrical circuits develop resistance with temperature, explaining cooling fans in appliances with electrical motors etc. As soon as solar technology is integrated into the skin of the building, the benefit of BAPV cooling both sides of the panels is lost. Standard BIPV products could suffer from impaired performance and thermal degradation, as they are notoriously difficult to cool.

Tractile has a 7-12% increased energy generation due to the cooling effect of the integrated water channels.

This is where Tractile sets the standard by integrating thermal heat exchange technology into the solar roof tiles to cool the PV modules, which has been shown to increase efficiency by up to 12%. Due to conflicting solar energy requirements of PV and thermal (light and heat), only one of these technologies can be truly optimised. In Tractile's case, this is electricity production.

Just a few commercial examples of BIPV-T technology are currently available on a global scale – only Tractile is a complete roof system.

A deeper look into Tractile BIPV-T

- Tractile's complete roofing solution is designed to optimise electricity generation
- The pre-heated hot water has a maximum temperature of 45 degrees to optimise cooling effect
- Not designed/operated as an efficient solar thermal collector
- Typically more electricity produced per square metre than traditional solar panels due to the water channels cooling the PV
- Integrates seamlessly with the Tractile Eclipse Plain tiles for a complete roof and cladding solution

Other Benefits of a Tractile Roof

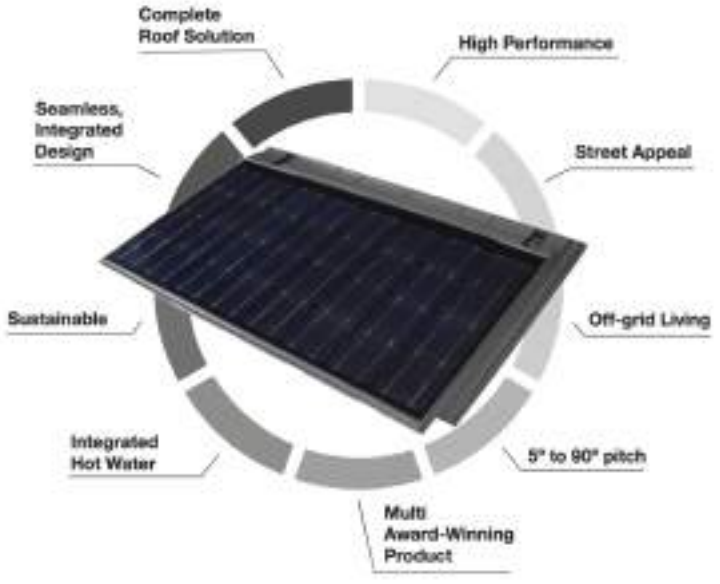
Whilst Tractile's integrated BIPV-T technology sets it apart from any other product, it offers unrivalled benefits as a complete solution, compared with other roofing systems.

The large format modular nature of both the Eclipse Roof Tiles and Eclipse Solar Tiles lends itself to a diverse range of architectural styles. From the sleek, ultra modern roof lines to more traditional styles, Tractile offers an aesthetic not achieved by others. Roofs themselves can be prominent features, yet are often after thoughts.

Tractile not only adds street appeal to a project, but potentially increase asset value, particularly with sustainable house design becoming a core feature for future builds. The following benefits help to achieve the world's most advanced roofing solution.

- Design flexibility (5-90 degrees)
- BAL 40 rated
- Corrosion resistant
- Cyclonic Rated –280km/h
- Plain tiles will withstand 65mm hail stones
- Custom colour options
- No fixing penetrations through roof thanks to patented hook system
- Complete roof system
- **INCOME GENERATING ASSET**

Tractile Eclipse Solar Tile



Tractile Eclipse Roof Tile

ENVIRONMENTAL FACTORS

In a time of climate change and global warming, the environment and the affect our buildings have on it should be considered at the outset of every design. By 2050 half of all housing will be built post 2020.

The first step of this process is generating enough energy to offset the requirements of the occupants. Secondly, choosing building materials with low embodied energy to further reduce a new construction's environmental impact. Tractile delivers on both of these opportunities to create sustainable buildings as demonstrated below.

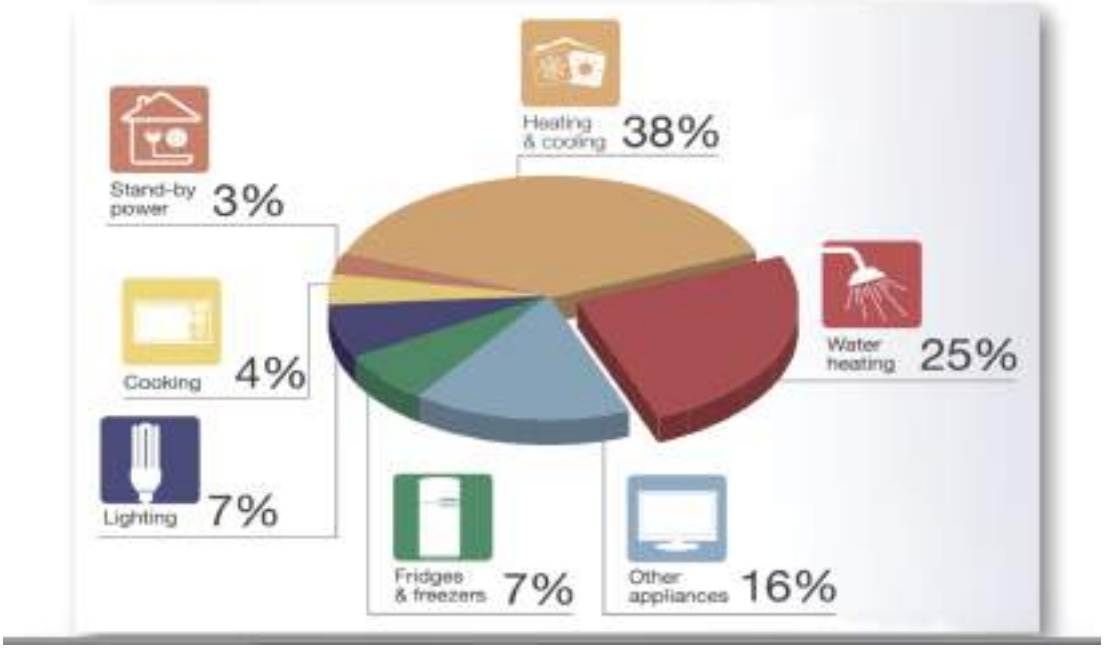
- MJ: Tractile is 8 times more sustainable than concrete and steel.
- Kg of CO2: Tractile is 4.5 times more sustainable than concrete and steel.
- Eco-Indicator Points: Tractile is 5 times more sustainable than concrete and steel.

Water and space heating/cooling are the two primary consumers of household energy. Solar hot water provides the biggest bang for buck when meeting household energy needs and is mandatory in a lot of cases. While solar hot water can be independent during the summer months, it typically requires help for most of the year via additional sources, such as a gas or electric booster.

The first step to reduce the total energy requirements of new buildings is to optimise the design from the outset. This includes things such as building orientation, building envelope sealing, efficient appliances and systems, and most importantly building size.

After all of this has been considered, the base level of household energy requirements can be determined. This is when we look to the energy production of the building to achieve a balanced system design.

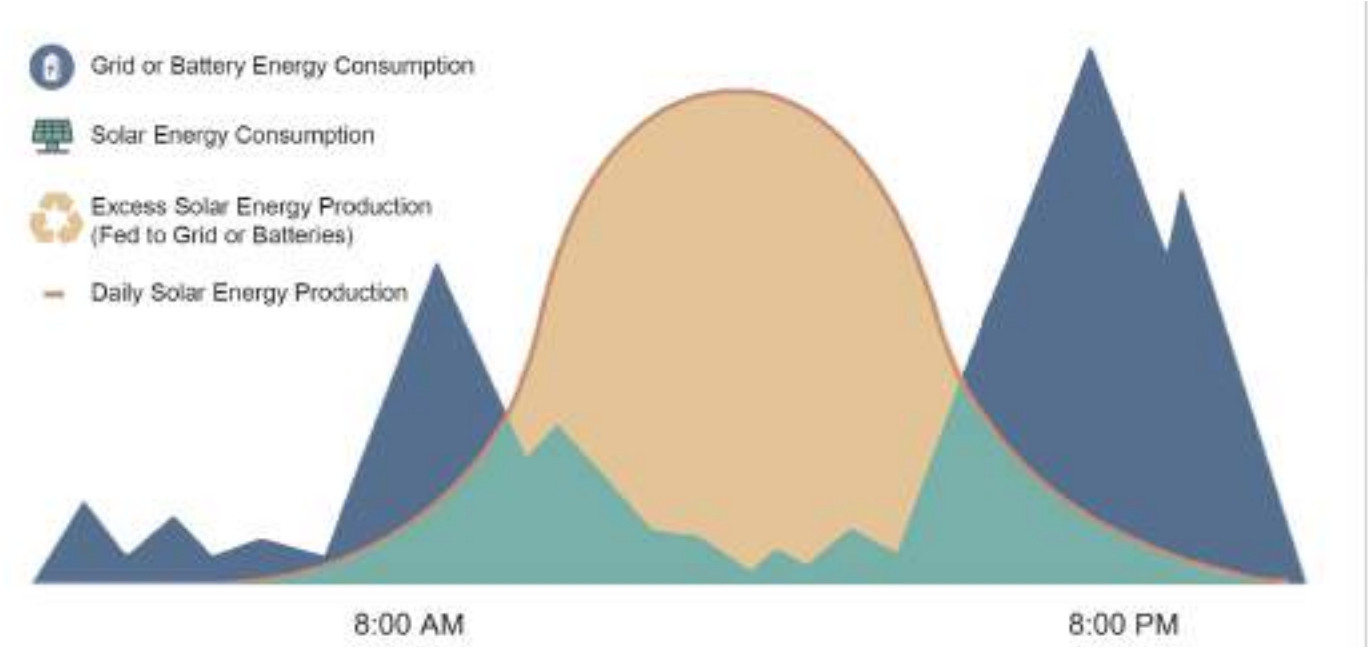
Typical Household Energy Usage



Key things to understand to determine the solar system capacity are:

- Electrical and hot water requirements
- Typical usage / lifestyle /no. of occupants, no. of occupants present during solar hours.
- Efficiency of the building fabric
- Air-conditioning / Hydronic Heating / Pool Heating / Electric Vehicles
- Any other large energy demands
- Pool pumps etc
- Solar shading analysis
- Other roof performance requirements such as BAL 40 / Cyclonic / Extreme Weather Events / Corrosion resistance

A Typical day with a Solar PV System



The above image shows a typical summer's day for an average Australian household. As can be seen, a lot of energy is consumed outside of solar hours. The excess energy generated through the day can be fed back to the grid, however to achieve a balanced system, this energy can be stored in batteries for consumption when it is required.

This is a balanced system, however that does not mean a project can be off-grid. To do this requires a lot of extra thought and expense – but a good system will see grid dependency drop to just a few percent.

Eg. the average Australian household consumes 20kWh of electricity per day. They may consume 10kWh directly during solar hours and 10kWh outside of this. Firstly, it is necessary to match system size with energy requirements, by checking the solar performance for the project's location.

If we take Sydney in this case, a rule of thumb is 1kWp installed facing due north at 30º will generate on average 4kWh of electricity. This would require a 5kWp Tractile system facing due north to generate the 20kWh required along with a 10kWh battery to store the excess energy produced for later use.

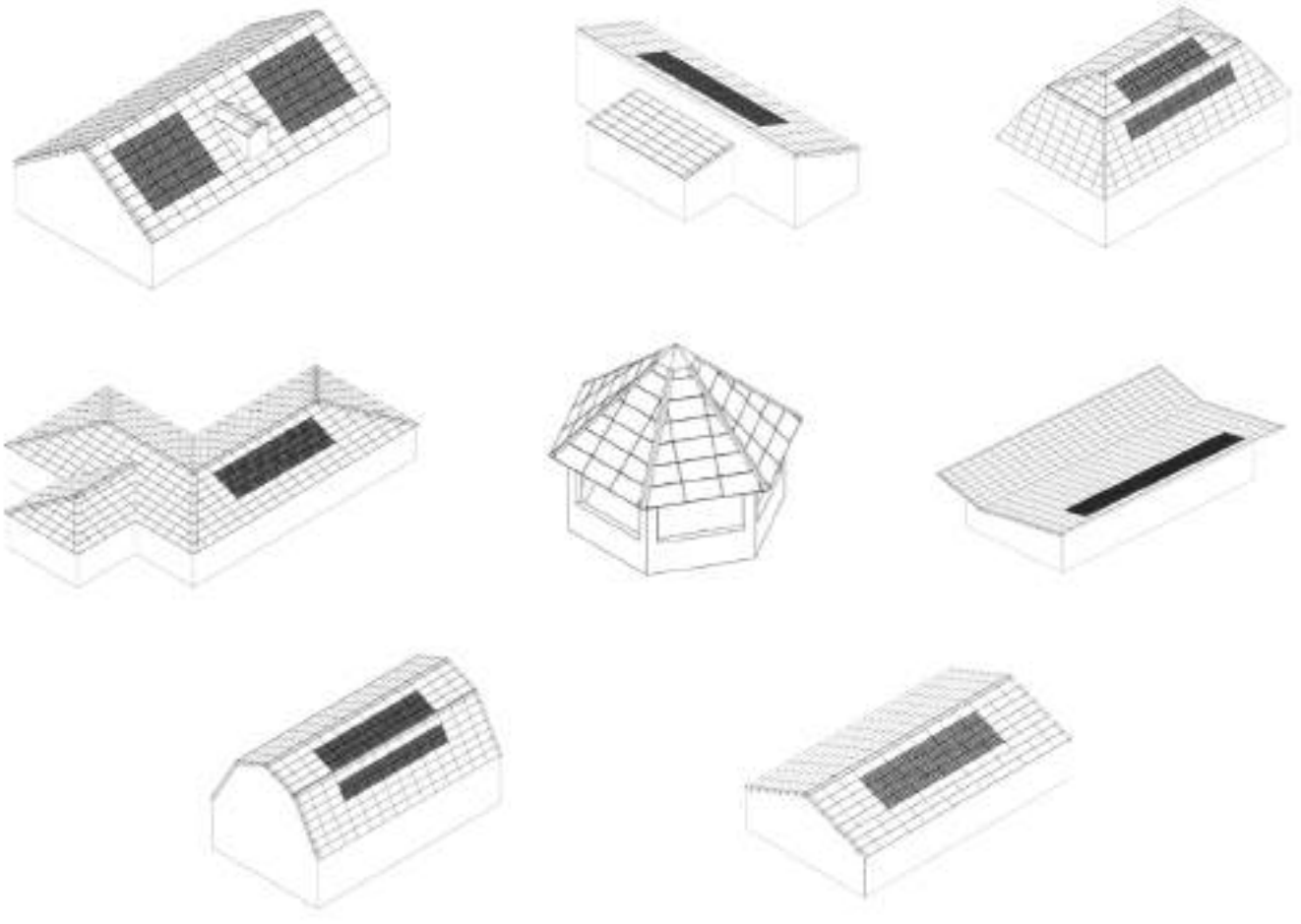
ROOF DESIGN OPTIONS

Roof design in accordance with the building's site requirements such as light, ventilation and shading is a critical consideration, often considered before energy production.

And let's not forget a roof's primary function is to provide shelter from the elements – it needs to keep out the wind and rain.

The design flexibility of the Tractile system allows all roof configurations to be easily constructed, including roofs with near vertical sections, or even low slung skiilions or gables.

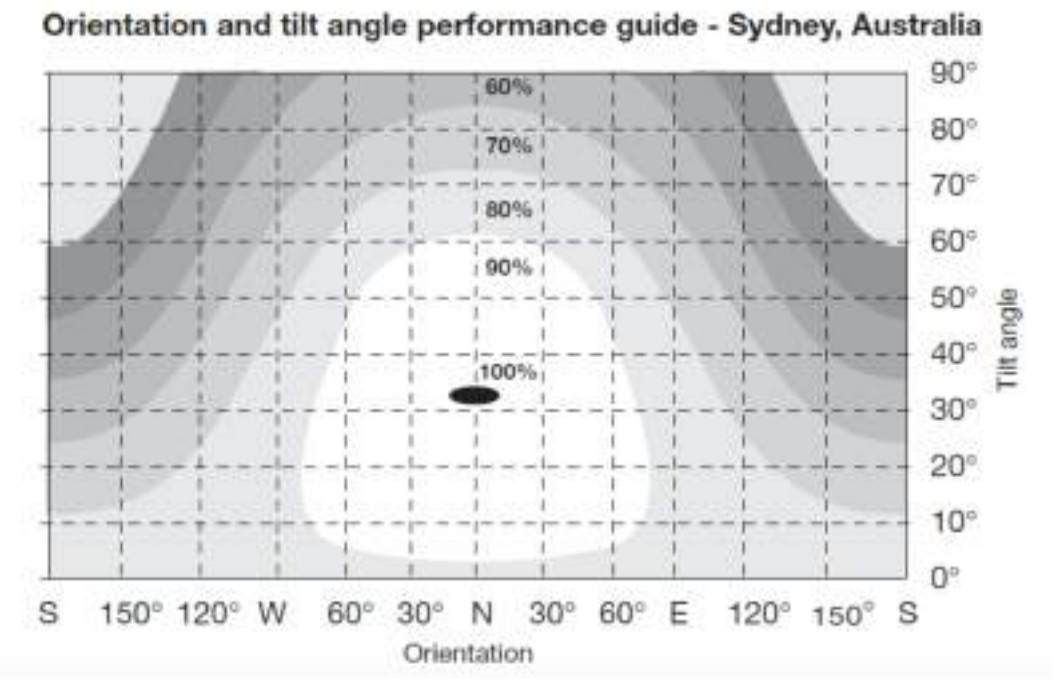
Consider the possibilities below.



ROOF ORIENTATION - IT'S NOT THAT CRITICAL

An example of a family's electricity consumption in Sydney is, on average, 24 kWh per day. The available roof is unshaded, has a due West orientation, 20 degree pitch and 50sqm of available roof space

As noted before, 1kWp generates on average 4kWh per day, therefore a 6kWp system is required under standard test conditions. Looking at the adjacent graph, a west facing roof at 20 degrees has 80% efficiency.



Therefore to meet this families requirements, a 7.5kWp Tractile system is needed (6kWp/80%), which would require 45sqm of roof space. Combined with a suitable battery, this would meet most of this families energy requirements. FYI 6m² of Tractile Eclipse Solar Tiles = 1kWp

DETAILED DESIGN CONSIDERATIONS

After pitch, orientation and system size have been determined, there are a few other details to finalise roof design for optimal solar performance.

In most cases, a whole roof of Tractile Eclipse solar tiles is never needed. As a guide, between 10-20% of the gross floor area is needed for energy production. A 200 sqm property may require 30sqm (5kWp) of solar to meet its energy requirements (15%). Tractile Eclipse Plain Tiles are therefore utilised to complete the roof for a seamless integrated design. **NB Tractile Eclipse Solar Tiles do not work with other roofing products/systems.**

Tractile tiles are always laid from the eaves up, L-R. Tractile Eclipse plain tiles can be easily cut to suit all roof designs, including hips and valleys etc. Flashings and details are as per traditional tiling methods and can be more modern in appearance such as barge soaker flashings, or traditional matching barge tiles.

Skylights and other penetrations can be easily integrated, however some thought is required where any projections through the roof such as flues may overshadow neighbouring solar tiles.

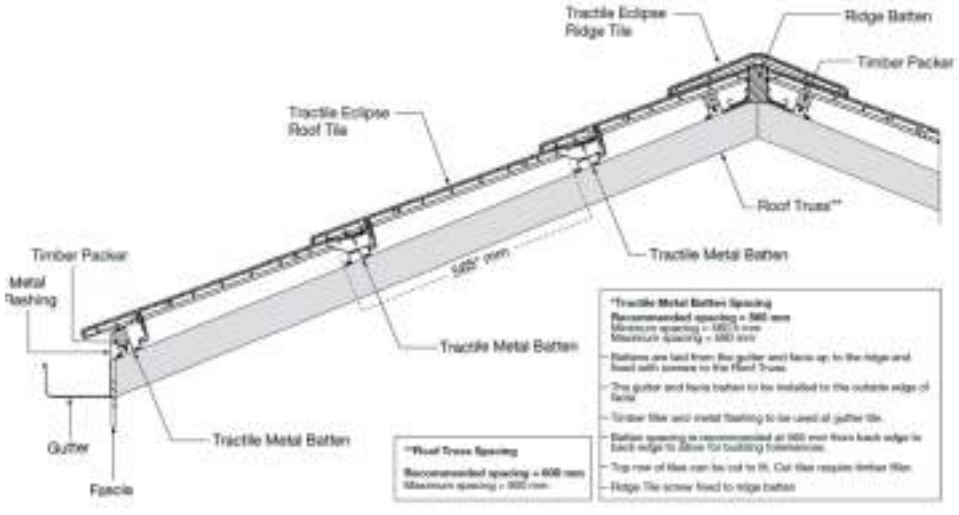
With Tractiles large format dimensions, it is simple to overlay onto your designs and renders. Using a 1050mm wide x 565mm high grid in plane can show exactly how many solar tiles you can achieve on your roof. To make it easy, 1 Tractile Eclipse Solar tile = 100W so you would require 50 tiles for a standard 5kWp system, requiring approximately 30sqm of roof area in plane. Remember Tractile tiles are laid from the eaves/gutter line up. NB As a guide allow for a 60mm overhang into the gutter past the fascia for the bottom row of tiles.

The exposed height of the tiles can be adjusted up to 585mm to enable full tiles to be used and to eliminate small cuts at the ridge/apex.

Tractile tiles can also be laid in any bond pattern from inline, to ½ lap and every other possible scenario thanks to the inherent design flexibility.

A design note to highlight is the horizontal bull nose edge to the tiles is generally the more prominent feature, especially when the tiles are laid inline (one on top of the other).

The horizontal joins are a little more prominent when a bond pattern is employed such as half lap. Roof colour also plays a part here.



BALANCE OF SYSTEM COMPONENTS

What are the plumbing and electrical requirements for a Tractile roof, generating electricity and pre-heated hot water.?

On the electrical side of things, all that is required are a few cables in a conduit from the roof to the nominated inverter location. We recommend these are located internally, such as in a garage wall or utility room etc. The inverter simply takes the electricity produced from the solar panels and converts it into usable energy. They are typically set up to prioritise the house needs, then battery charging and any surplus is exported to the grid.

On new builds, we recommend installing the inverter first, before adding batteries.

The owners can then see what they consume directly and what is available for storage, enabling correct battery sizing for better returns and performance. Inverters, batteries and electric vehicle (EV) chargers are typically wall mounted and do not require excessive space depending on the final system designs.

The plumbing design is dependant on the number of systems that need to be supported by the integrated water channels – for example domestic hot water (DHW), hydronic heating and pool heating. For all systems, a couple of insulated flow and return pipes need to run to the roof from the nominated plant location – more pipes for larger arrays. For a simple DHW install, the pipes from the roof circulate into a heat exchange hot water tank (internal coil) – typically 300-500L capacity.

This tank can then have a heating element fitted to utilise the electricity produced by the solar tiles or can feed an instantaneous gas booster or other system. These tanks typically require about 1sqm of space and are again ideally located internally or at the least under cover.

For multiple hot water demands, a “thermal battery” is used, such as the Rotex tank pictured. These work by passing all the required pipes through the tank to collect the heat – the water in the tank does not circulate or mix with any potable water. Again, these tanks can be boosted by an integrated heating element or by another separate plant as required.

For example, a house requiring DHW, hydronic slab heating and pool heating can be serviced from one tank, typically 500l capacity. These systems are highly efficient and enable the pre-heated water and electricity generated by the tiles to be utilised saving thousands on energy bills normally associated with these energy hungry systems. For these larger plumbing systems, we encourage designers to engage with us early in the design process so that the relevant requirements can be planned into the overall system designs.

Tractile the designer solar roof, brings the future of roofing, here, now.

A Tractile roof is an income generating asset that literally pays for itself (ie. the whole roof). Maximising the sustainability and profitability of new dwellings and replacement roofs is a smart investment. Who will want to own a property without solar in years to come?

On top of these functional benefits, Tractile's street appeal is enhanced with sleek, large format, low profile tiles, creating a seamless look.

Our integrated pre-heated hot water and ability to withstand increasingly common severe weather events makes Tractile an obvious choice when designing solar roofs.

To receive further information about your specific project, including pricing, please go to www.tractile.com.au/contactus or call 1300 008 722.

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EXPLANATION OF TERMS

- kWp= Kilowatt peak = unit of capacity, maximum amount of power that can be produced or is consumed. Example:
- A 5kWp solar PV system has maximum generation capacity of 5kW at STC
- An air-conditioner with a 2.6 kWp capacity (or 2 HP) uses a maximum of 2.6kW when under full load
- kWh= Kilowatt hour = unit of energy, is total energy generated or consumed over a period. Example:
- A 5kWp solar PV system generates in Sydney on average 20kWh per day
- An air-conditioner with 2.6kWp capacity uses 7.2kWh if it runs for 3 hours under full load