todae solar

Todae Solar's 1.22 MWp Rooftop Solar Photovoltaic Installation for Stockland Shellharbour, NSW.

Visit us online **todaesolar.com.au**

P: **1300 46 7652** E: **solar@todaesolar.com.au**

1.22 MWp Rooftop Solar Photovoltaic Installation

- The Project Highlights
- Design Requirements and Technical Details
- Innovation and Best Practice

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	1.217 MWp Output
Modules	Canadian Solar CS6P-305 305 Watt Poly
# of Modules	3992
Inverters	SMA STP25000-30
# of Inverters	43
Inclination of panels	10˚ (panels landscape)
Orientation of panels	13˚East of North / 57˚East of North
Installation Time	11 weeks
Estimated Annual Output	1,748,325 kWh/ year

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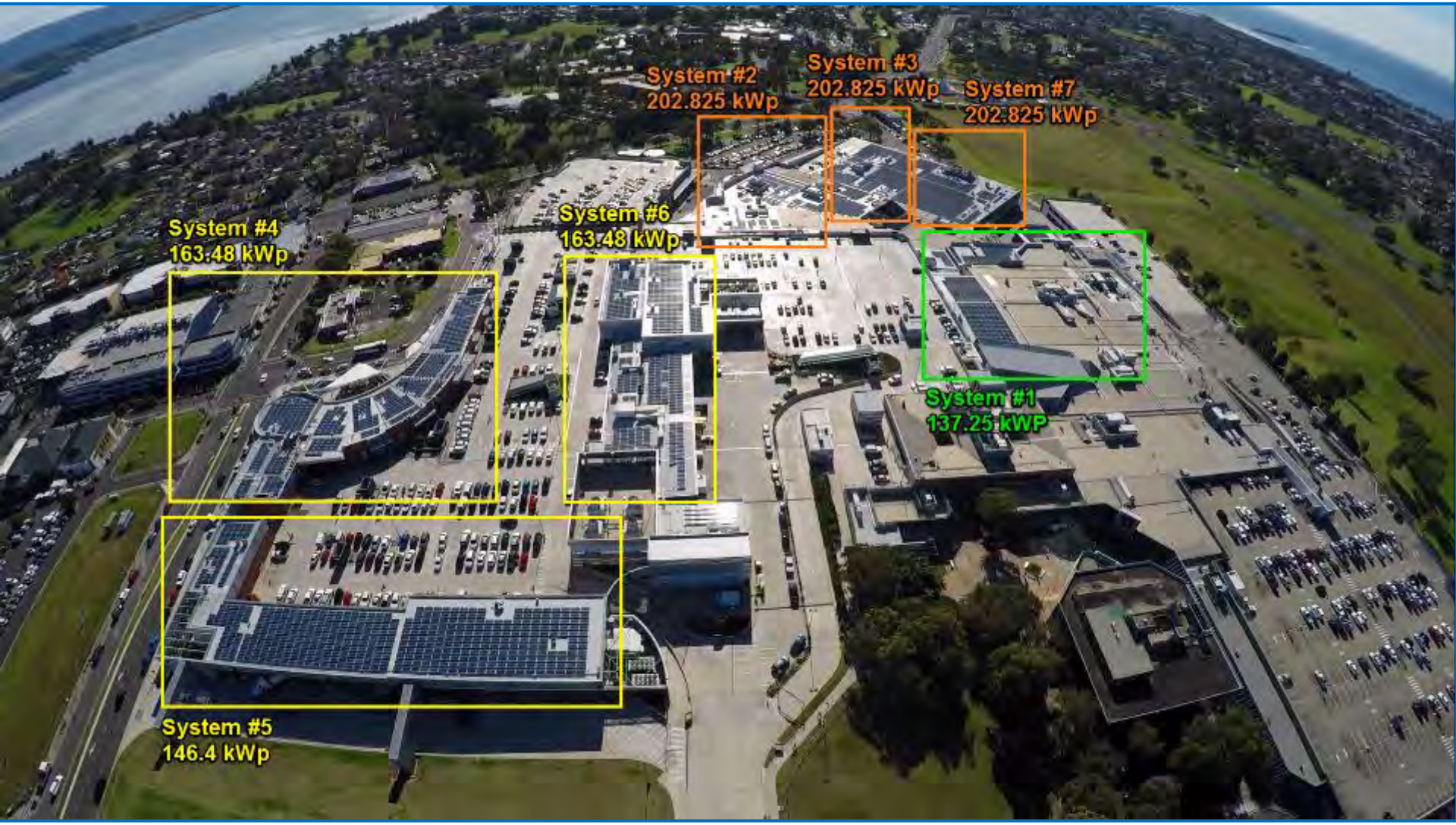

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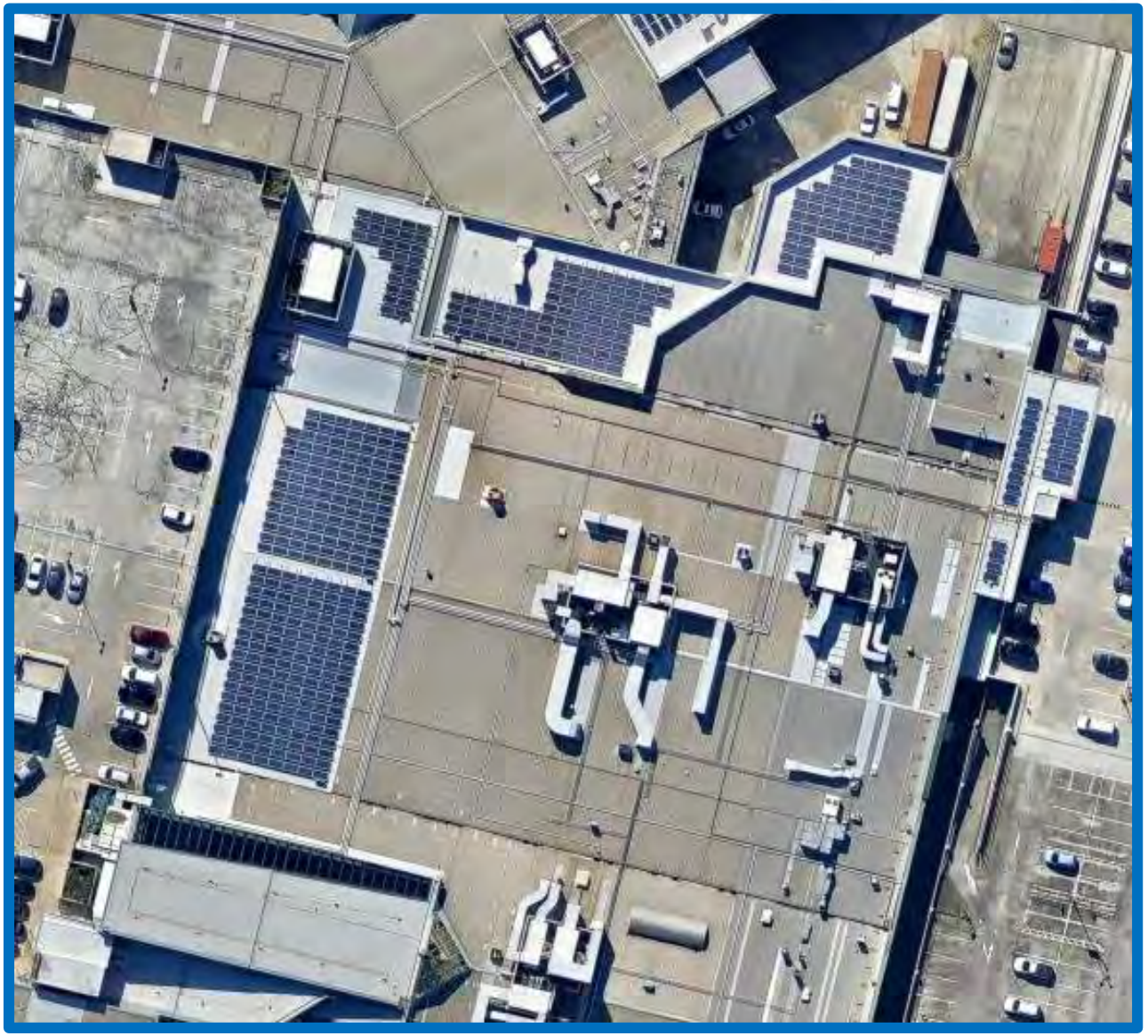

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Todae Solar in partnership with Canadian Solar was selected to design, supply, construct, commission and maintain this unique photovoltaic system on a Shopping Centre with a final power of 1,217.56 kWp utilising 3992 Canadian solar panels (305Wp) and 43 SMA STP25000 inverters.

The most unique and innovative features of the development are:

- ✓ Achieve the 1.2 MWp target using the area available
- ✓ Solar development with renovation / construction happening on the roof
- ✓ Shopping Centre surrounded by public areas and open 24 hours
- ✓ Inverter stations built and installed on the roof
- ✓ Tilt system and non-penetrating fixings
- ✓ Minimised losses from shading (existing elements and panel to panel)
- ✓ 7 connection points across the buildings
- ✓ Installation completed within Stockland record time requirements

1.22 MWp Rooftop Solar Photovoltaic Installation

- The Project Highlights
- **Design Requirements and Technical Details**
- Innovation and Best Practice

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Maximise the system size. Limited usable roof area

The client wanted a system size of 1.2MW.

This was challenging as the solar plant had to be designed with-in restricted areas of available roof space, and areas of roof were being refurbished as the solar installation was taking place.

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Timing

The installation needed to be built and commissioned within strict timeframes.

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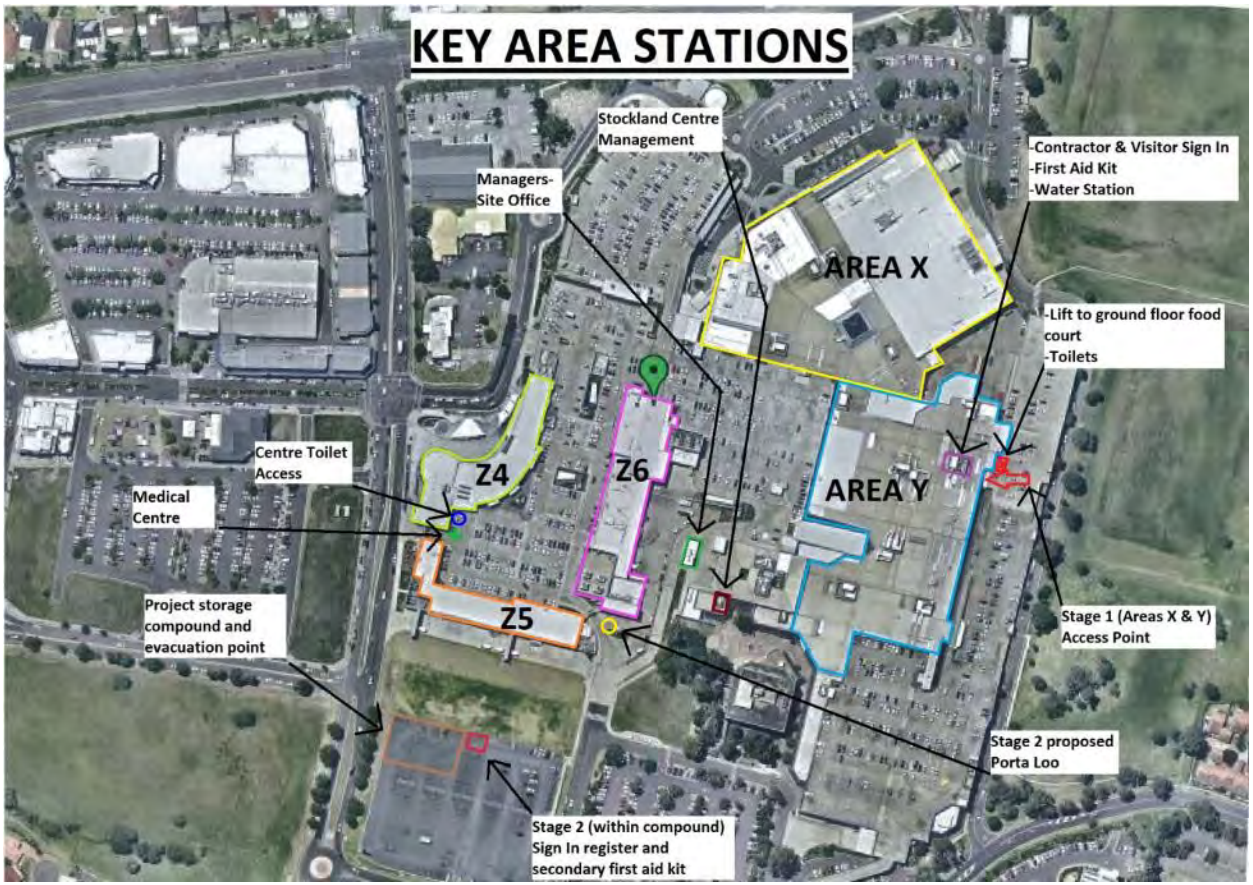
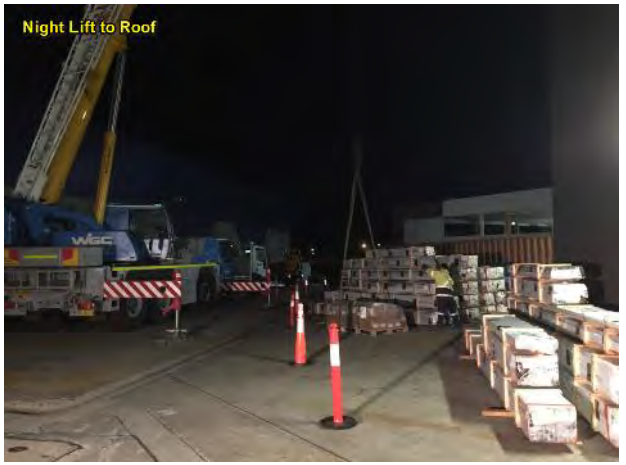
Traffic, access, craning, storage





Stockland Shellharbour strictly required no interference with, or disruption to the vehicle and pedestrian traffic around the shopping centre (when accessing the rooves, storage on site, craning equipment to the roof etc). This was challenging in a shopping centre with public access 24 hours a day, 7 days a week.

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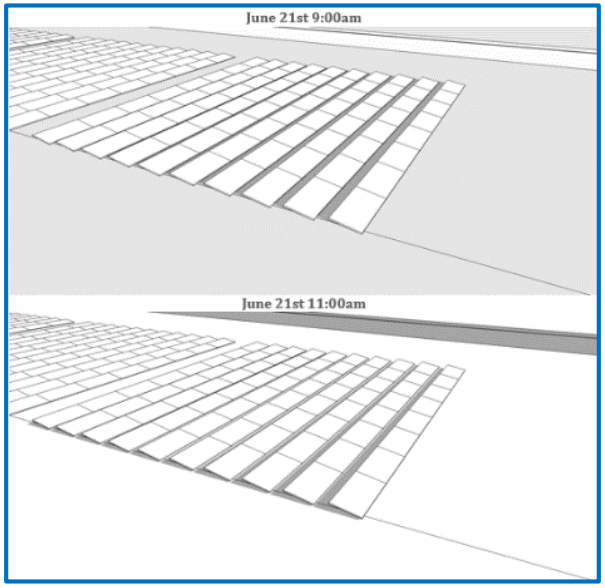
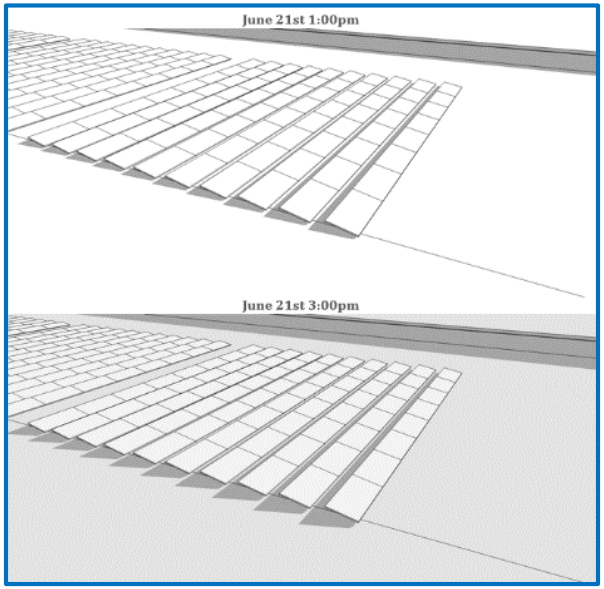
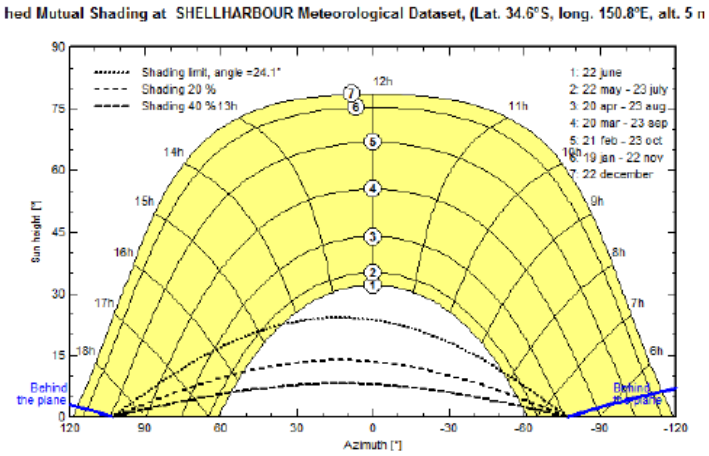
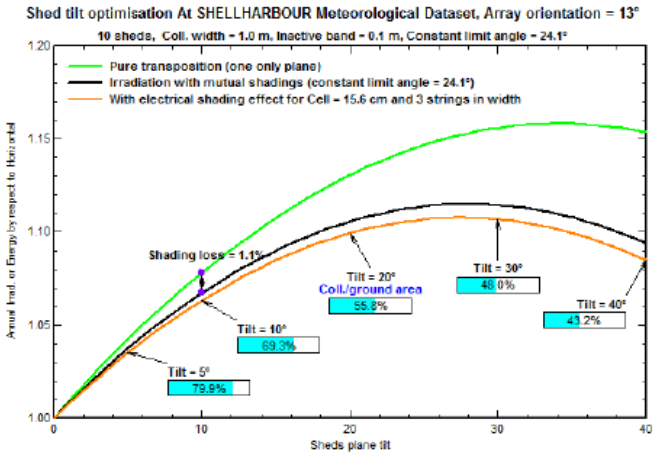
Consideration for shading losses





Shading analysis to obtain minimum distance between panels without compromising performance





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Consideration for shading losses

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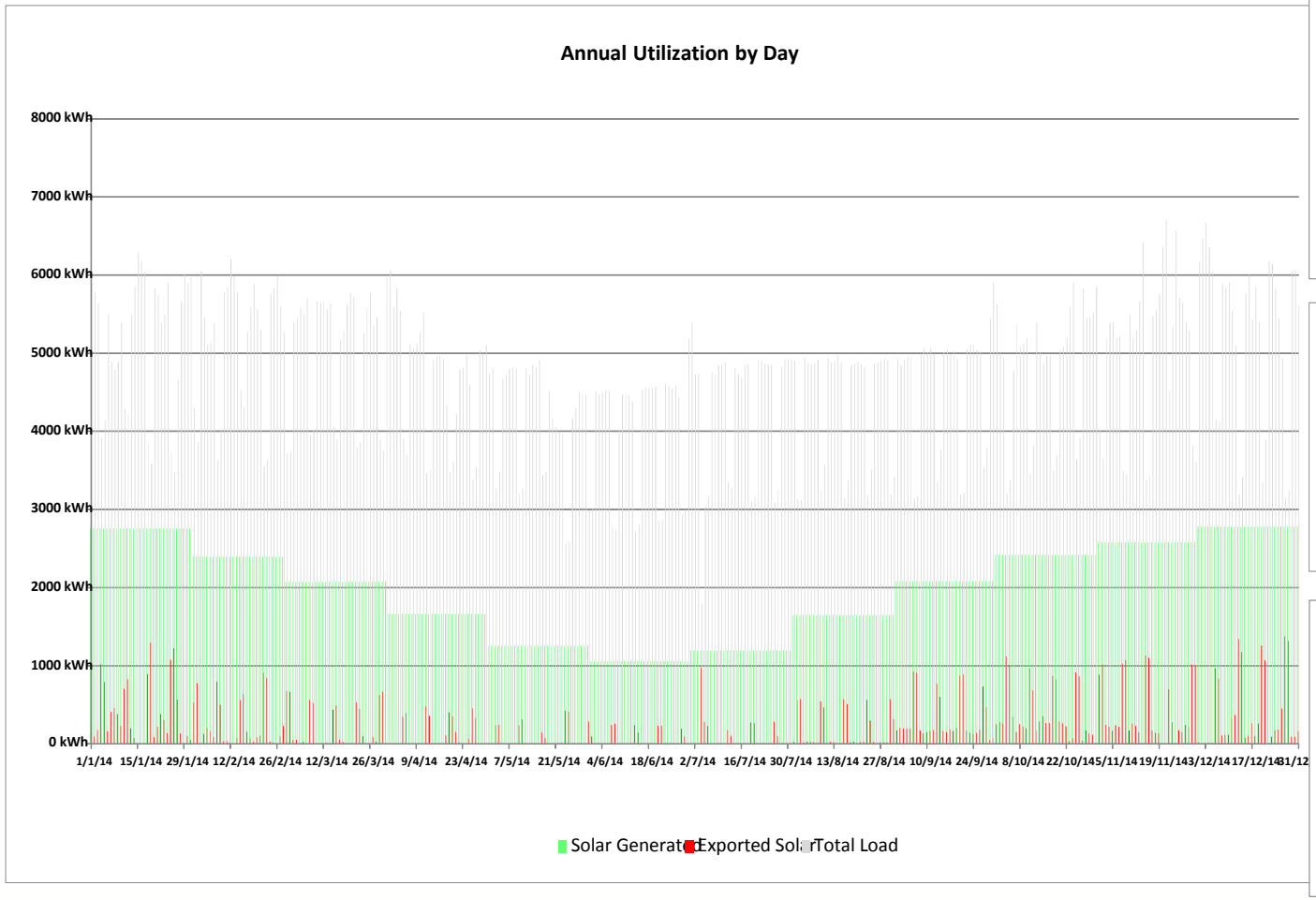
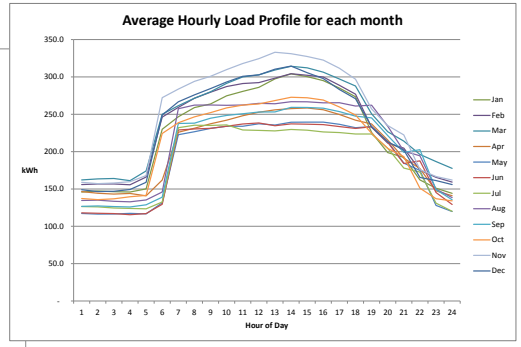
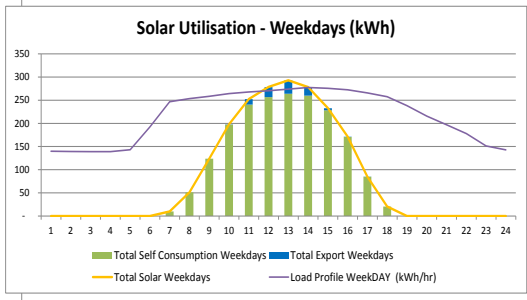
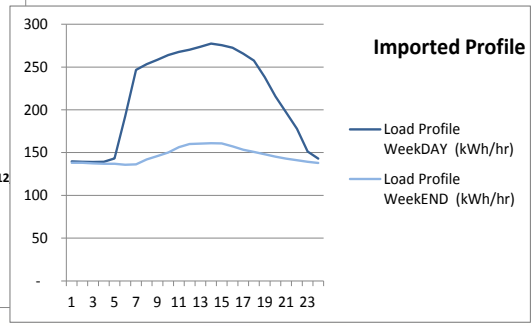
Self-consumption - Load Analysis (Generation to match consumption)









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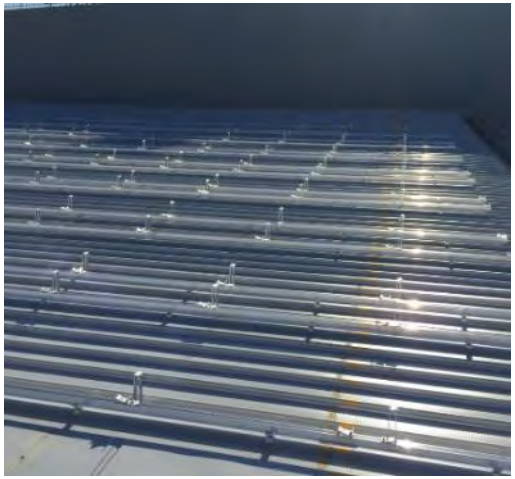
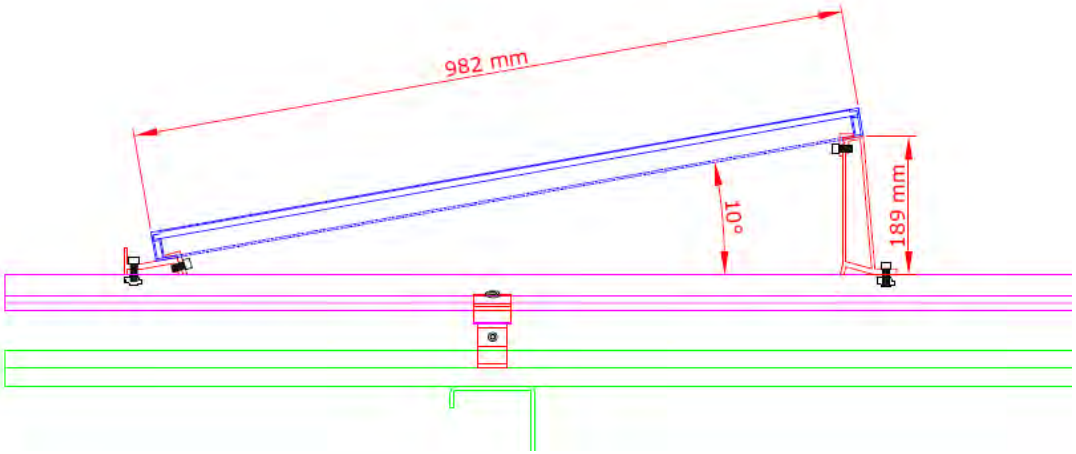
Special mount



- Anodized Aluminium
- 10 degree tilt
- non-penetrating fixings for Klip-Lok roof,
- avoid dissimilar metal corrosion on the roof
- Mount is compatible with purlin distance of 1200 mm running both parallel and perpendicular to panels



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Special mount

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Aesthetics

The solar system had to be visually appealing, and have a low impact on the 'aesthetics' of the Shopping Centre as there are areas where the installation can be seen from car parks and other publicly accessible areas.

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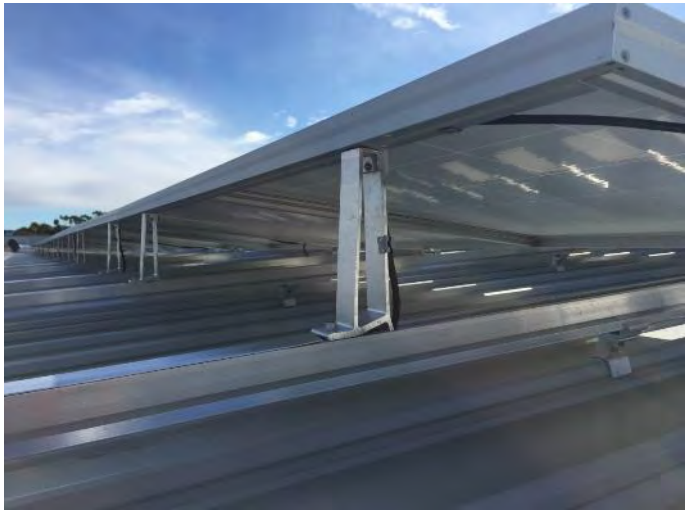
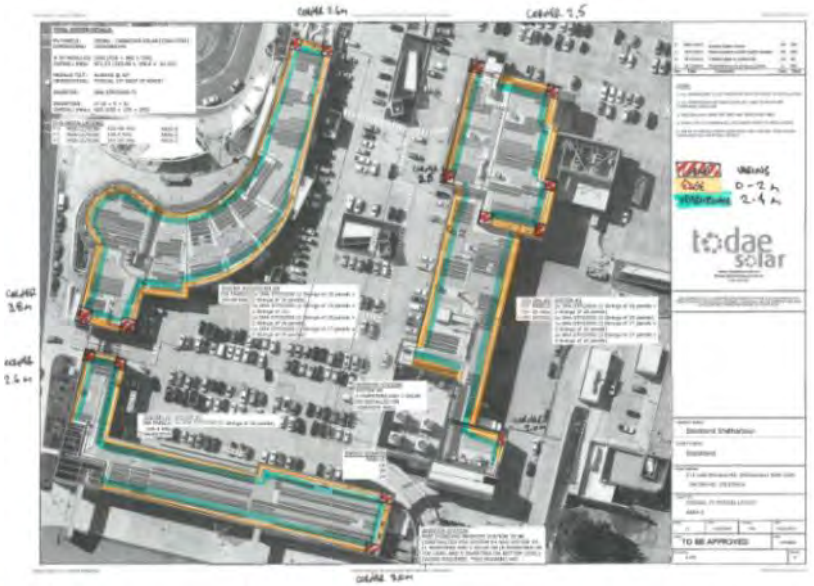
Compliant structural design





Mount to be structurally adequate and certified for being tilted at 10 degrees with dead load (including panels and other components) to be less than 15kg/m2 and uplift to be less than 2kPa.

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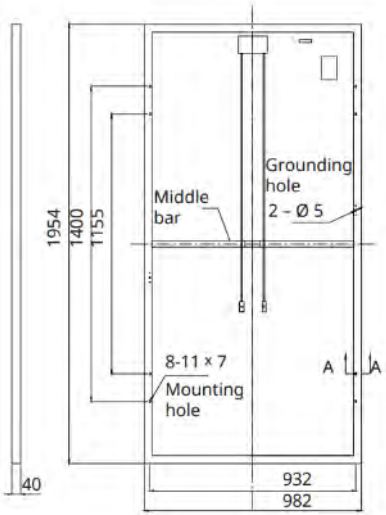
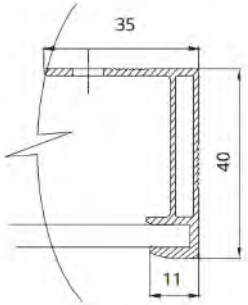
Panel Type

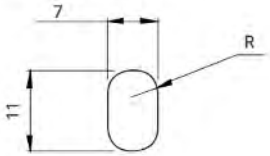
Rear View



Frame Cross Section A-A

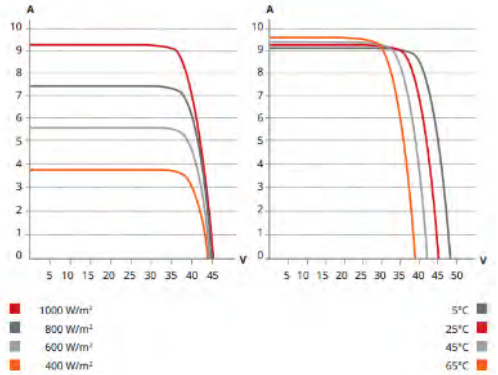


Mounting Hole



System	Panels	Power (kWp)
#1	450	137.25
#2	665	202.825
#3	665	202.825
#4	536	163.48
#5	480	146.4
#6	531	161.955
#7	665	202.825
TOTAL	**3992**	**1217.56**

Electrical Data	CS6X-305P
Nominal Maximum Power (Pmax)	305W
Optimum Operating Voltage (Vmp)	36.3V
Optimum Operating Current (Imp)	8.41A
Open Circuit Voltage (Voc)	44.8V
Short Circuit Current (Isc)	8.97A
Module Efficiency	15.90%
Operating Temperature	-40°C~+85°C
Maximum System Voltage	600V (UL)/1000V (UL)/1000V (IEC)
Maximum Series Fuse Rating	15A
UL Fire Classification	Class C
Power Tolerance	0~+5W



TEMPERATURE | CHARACTERISTICS

Specification	Data
Temperature Coefficient (Pmax)	-0.43%/°C
Temperature Coefficient (Voc)	-0.34%/°C
Temperature Coefficient (Isc)	0.065%/°C
Normal Operating Cell Temperature	45±2°C

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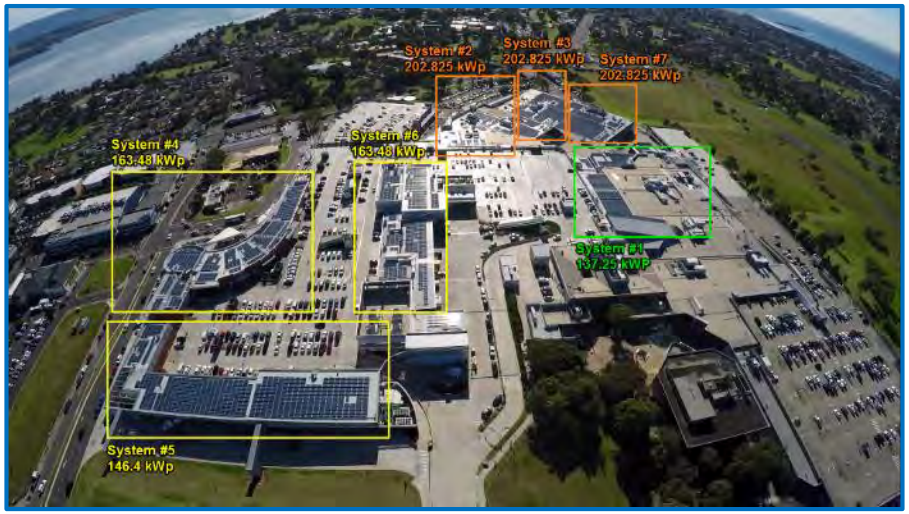
Inverter Type



Solar Sub-system	Number of Inverters
1	5
2	7
3	7
4	5
5	6
6	6
7	7
TOTAL	43

It was decided to use only the SMA STP25000 to make the installation consistent. 43 units in total were used.

This inverter has a good voltage window for large strings of Canadian Solar 305Watt. Using multiple inverters, with multiple maximum power point trackers (MPPTs) accommodated the different orientations of the panels.

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DC Runs

Todae Solar managed to create a string and cable configuration to minimise the DC losses to 1.5%, well under the 3% maximum required in AS5033:2014.

The most critical runs were 230 metres (Array 3.A.1), 210 metres (Array 3.B.1) and 200 metres (Array 4.A.1). Todae Solar used 10mm^2 DC cable for these runs.

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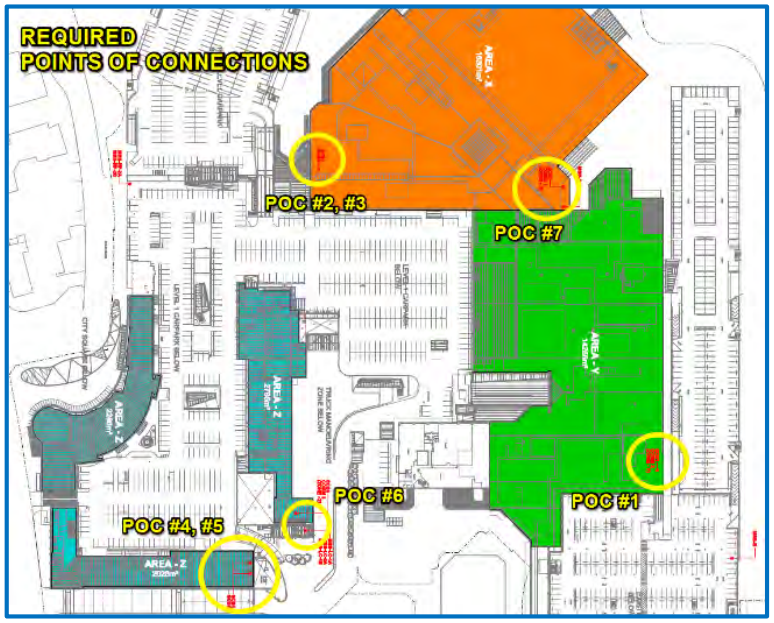
AC Runs



Todae Solar installed the AC runs in an optimised way achieving great savings against the 1% maximum allowed voltage drop.

System	No. Inverters	Current (A)	4C AC Cable (mm2)	Earth (mm2)	Distance (On Site)	Voltage Drop
1	5	181	95	16	28	**0.50%**
2	7	254	185	35	45	**0.58%**
3	7	254	185	35	55	**0.70%**
4	6	217	150	25	50	**0.68%**
5	5	181	120	25	50	**0.69%**
6	6	217	150	25	44	**0.68%**
7	7	254	120	25	30	**0.62%**

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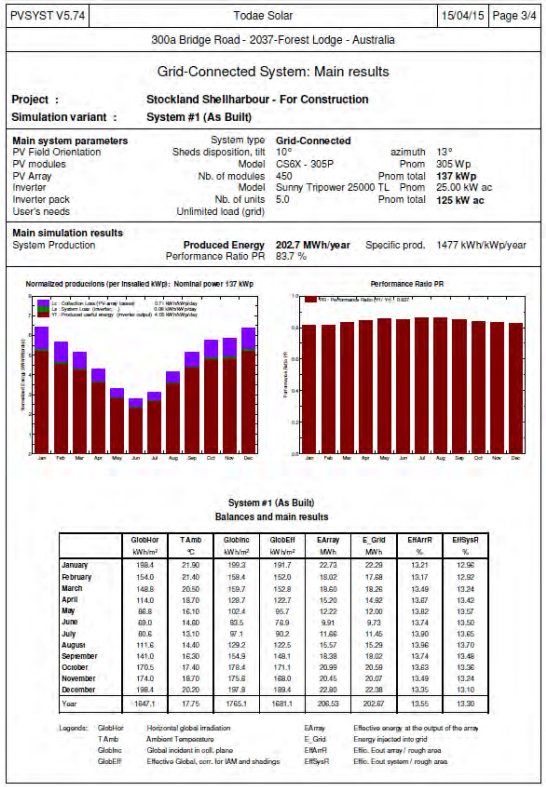
Specific meteorological data, expected generation output by system/inverter, performance guarantees

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Irradiance kWh/ m^2 / month	198.4	154	148.8	114	86.8	69	80.6	111.6	141	170.5	174	198.4	**1647.1**
Average Daily Temperature °C	21.9	21.4	20.5	18.7	16.1	14.6	13.1	14.4	16.3	17.4	18.7	20.2	**17.8**



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300a Bridge Road - 2037-Forest Lodge - Australia

Grid-Connected System: Main results

Project : Stockland Shellharbour - For Construction
Simulation variant : System #1 (As Built)

Main system parameters
System type: Grid-Connected
PV Field Orientation: Sheds disposition, tilt 10° azimuth 13°
PV modules: Model CS6X - 305P Pnom 305 Wp
PV Array: Nb. of modules 450 Pnom total 137 kWp
Inverter: Model Sunny Tripower 25000 TL Pnom 25.00 kW ac
Inverter pack: Nb. of units 5.0 Pnom total 125 kW ac
User's needs: Unlimited load (grid)

Main simulation results
System Production: Produced Energy 202.7 MWh/year Specific prod. 1477 kWh/kWp/year
Performance Ratio PR 83.7 %

Normalized productions (per installed kWp): Nominal power 137 kWp

Performance Ratio PR

System #1 (As Built)
Balances and main results

	GlobHor kWh/m²	TAmb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	EffArrR %	EffSysR %
January	198.4	21.90	199.2	191.7	22.73	22.29	13.21	12.96
February	154.0	21.40	158.4	152.0	18.02	17.68	13.17	12.92
March	148.8	20.50	159.7	152.8	18.60	18.26	13.49	13.24
April	114.0	18.70	126.7	122.7	15.26	14.92	13.67	13.43
May	86.8	16.10	102.4	95.7	12.22	12.00	13.82	13.57
June	69.0	14.60	83.5	78.9	9.91	9.73	13.74	13.50
July	80.6	13.10	97.1	90.2	11.68	11.46	13.90	13.65
August	111.6	14.40	129.2	122.5	15.57	15.29	13.96	13.70
September	141.0	16.30	154.9	148.1	18.38	18.02	13.74	13.48
October	170.5	17.40	178.4	171.1	20.99	20.59	13.63	13.36
November	174.0	18.70	175.6	169.0	20.45	20.07	13.49	13.24
December	198.4	20.20	197.8	189.4	22.80	22.38	13.35	13.10
Year	1647.1	17.75	1765.1	1681.1	208.53	202.67	13.55	13.30

Legends: GlobHor Horizontal global irradiation; TAmb Ambient Temperature; GlobInc Global incident in coll. plane; GlobEff Effective Global, corr. for IAM and shadings; EArray Effective energy at the output of the array; E_Grid Energy injected into grid; EffArrR Effic. Eout array / rough area; EffSysR Effic. Eout system / rough area

Calendar Year	Expected
2016	1,743,954
2017	1,735,234
2018	1,726,558
2019	1,717,925
2020	1,709,336
2021	1,700,789
2022	1,692,285
2023	1,683,824
2024	1,675,405
2025	1,667,028
2026	1,658,692
2027	1,650,399
2028	1,642,147
2029	1,633,936
2030	1,625,767
2031	1,617,638
2032	1,609,550
2033	1,601,502

Performance guarantees were put in place in the contract for the next 5 years.

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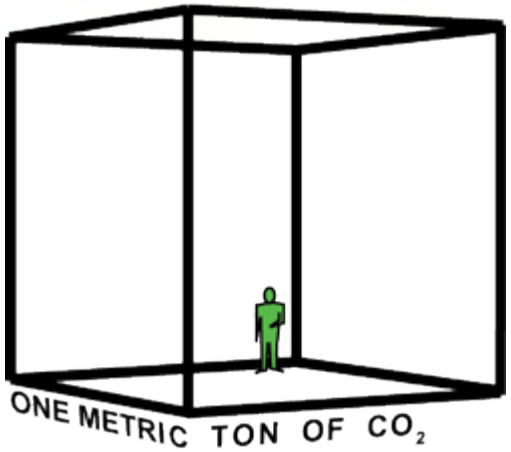
Business Case



- ✓ Important reduction on costs of electricity.
- ✓ Positive cumulative cash flow in just a few years.
- ✓ Up to 15% reduction in electricity purchased from the retailer.
- ✓ 42,000 metric tons of carbon dioxide equivalent emissions will have been avoided (Over the lifetime of the system)
- ✓ Reduced consumption of grid sourced power has the potential to reduce the fixed monthly demand charges from Stockland Shellharbour's electricity retailer.
- ✓ Solar Installation registered as an Accredited Power Station with the Clean Energy Regulator.

1.22 MWp Rooftop Solar Photovoltaic Installation

Monitoring and Weather Stations

Monitoring requirements:

- Independent monitoring (total energy per hours, days, months, years…) for every system
- Monitoring of Inverters and values (power, energy, alarms, faults, DC values, AC Values…)
- For each MPPTs (Voltage, Current, Power)
- Alarms
- Performance, Energy and Yield analysis and reports
- Generation (Energy) at the Point of Connection via Electrical Meter

Two Weather Monitoring Stations were installed at agreed locations to measure the following parameters:

- Global horizontal irradiance
- Irradiance on collector plane
- Ambient temperature
- Module cell temperature
- Wind speed
- Wind direction

1.22 MWp Rooftop Solar Photovoltaic Installation

Monitoring and Weather Stations

This is a comprehensive monitoring system collecting data from 43 inverters across 7 PV systems, 7 electricity meters and 2 weather stations.

The Sunny Portal system is robust, clear and easy to analyse.

This is vital for preventive and corrective maintenance, and analysis reports required by the client.

1.22 MWp Rooftop Solar Photovoltaic Installation

Monitoring and Weather Stations

Daily Yield of Inverters

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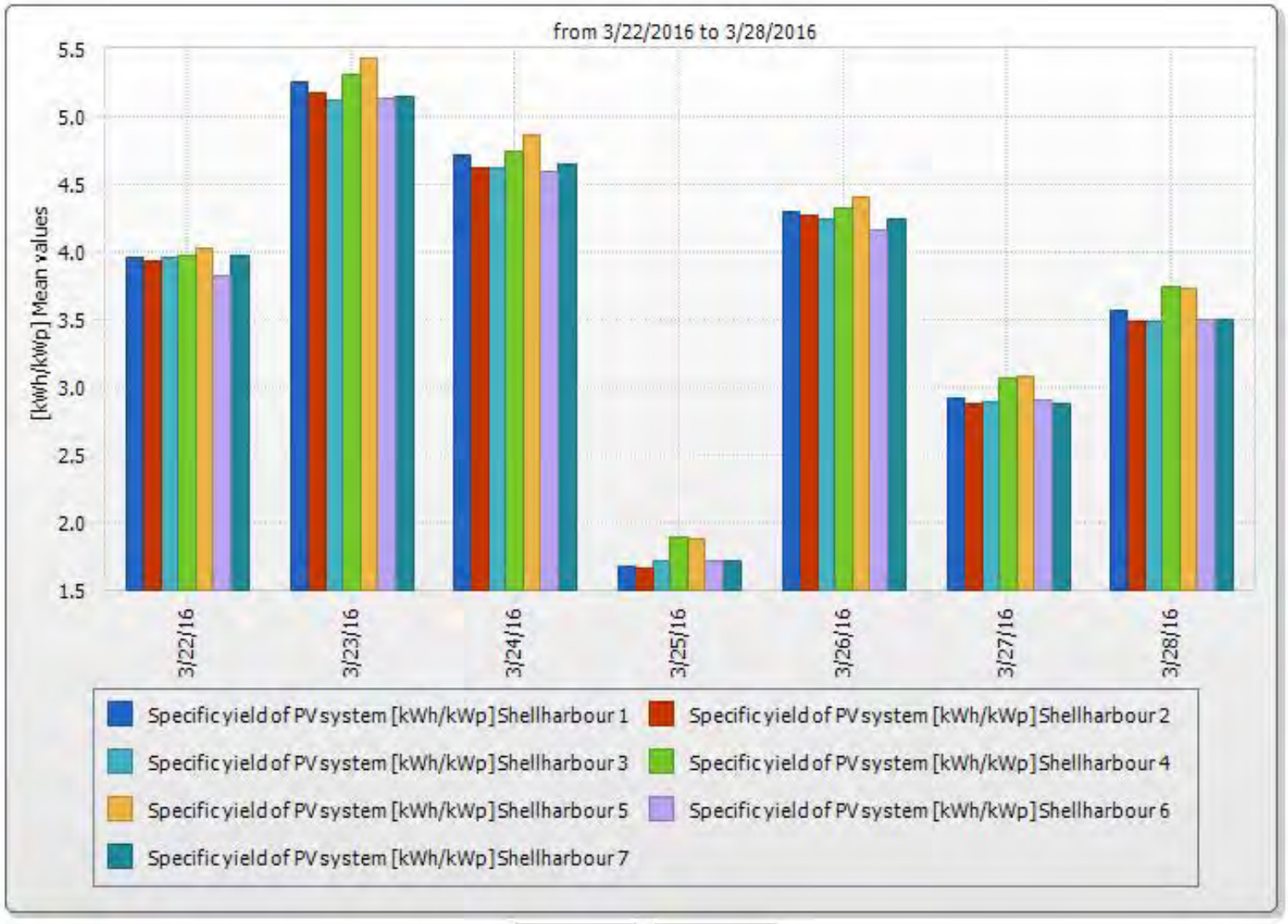
Monitoring and Weather Stations

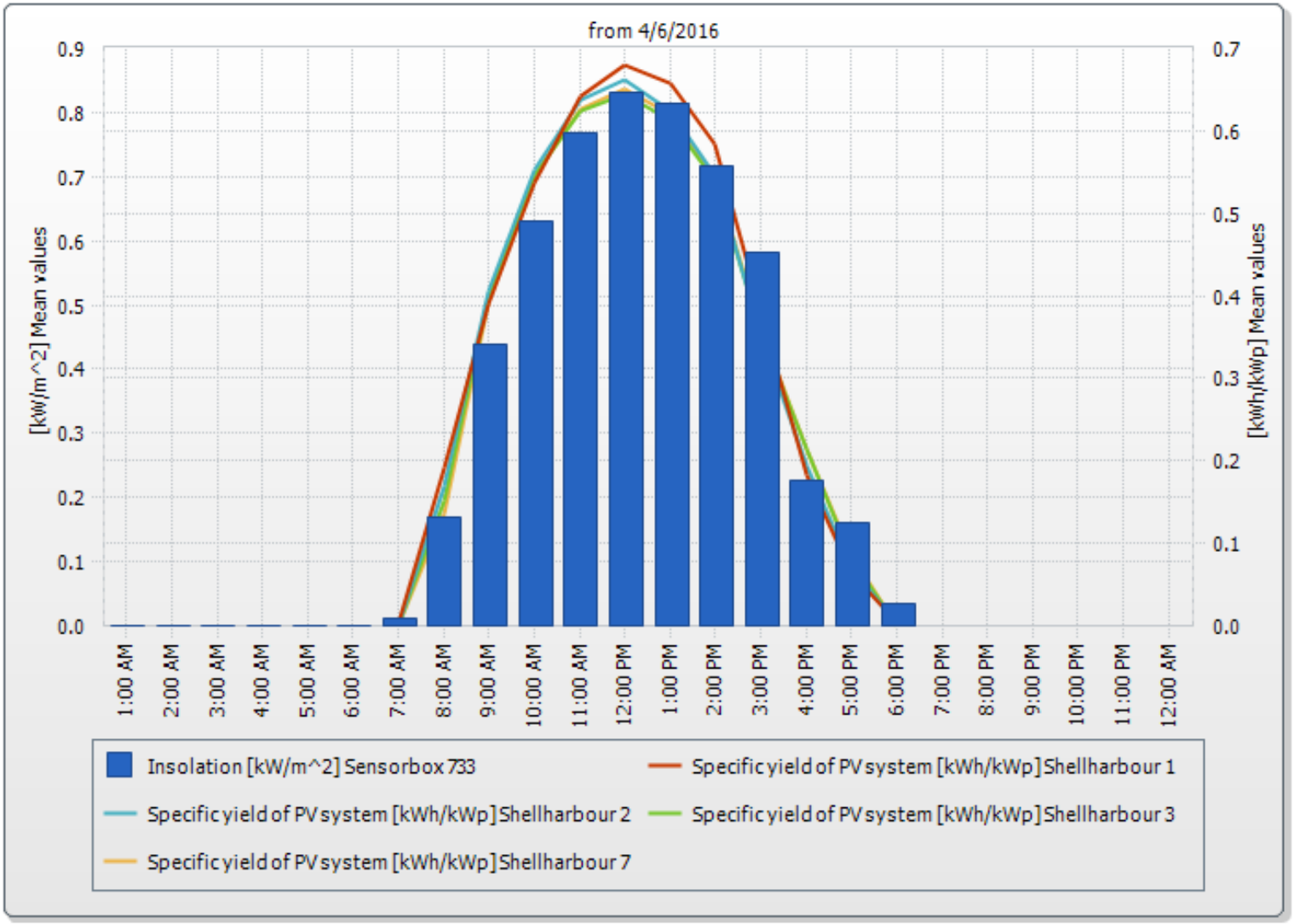
Daily Yield of Systems



1.22 MWp Rooftop Solar Photovoltaic Installation

Monitoring and Weather Stations

Hourly Yield of Systems and Irradiance



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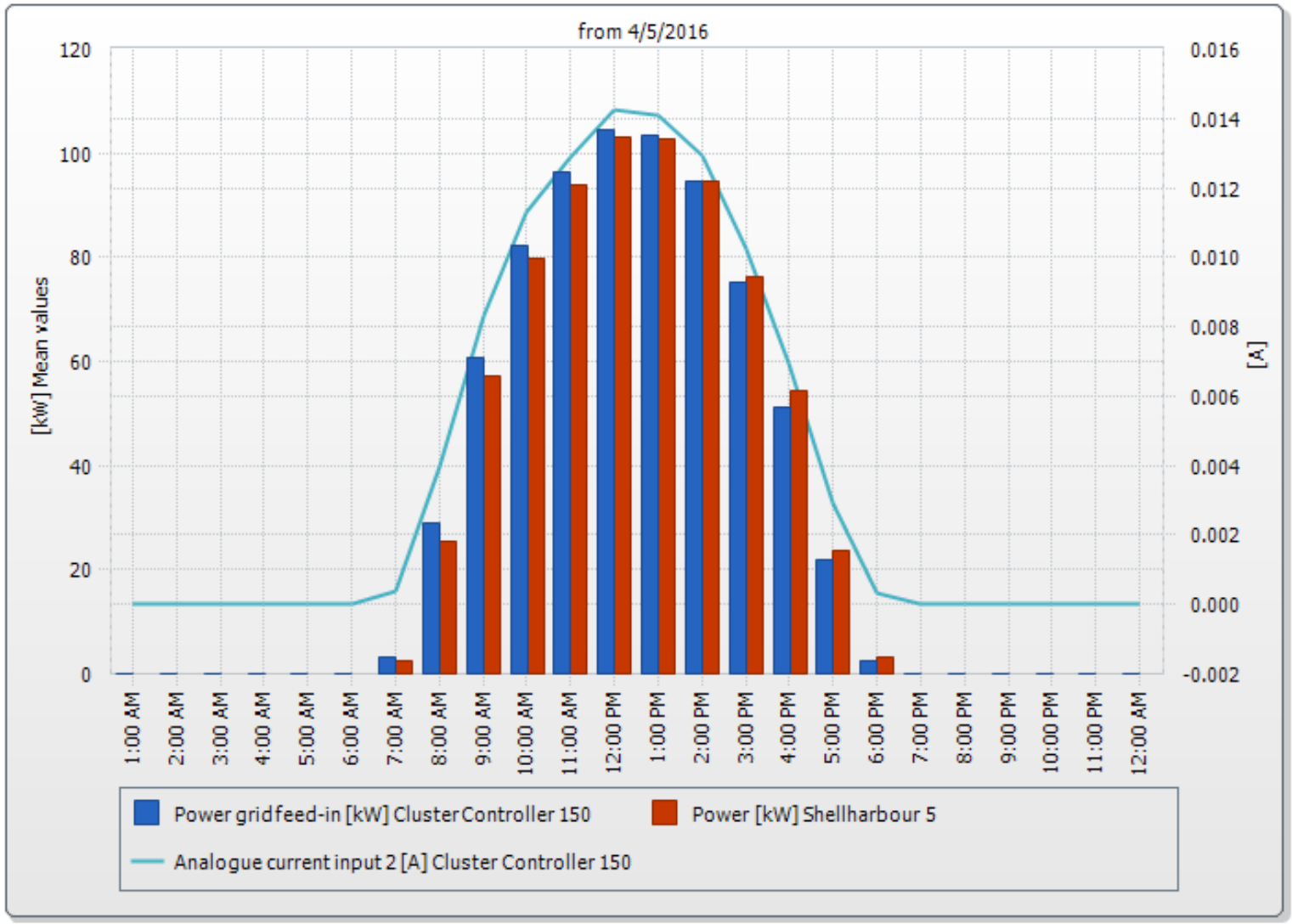
Monitoring and Weather Stations

Electrical Meter Monitoring



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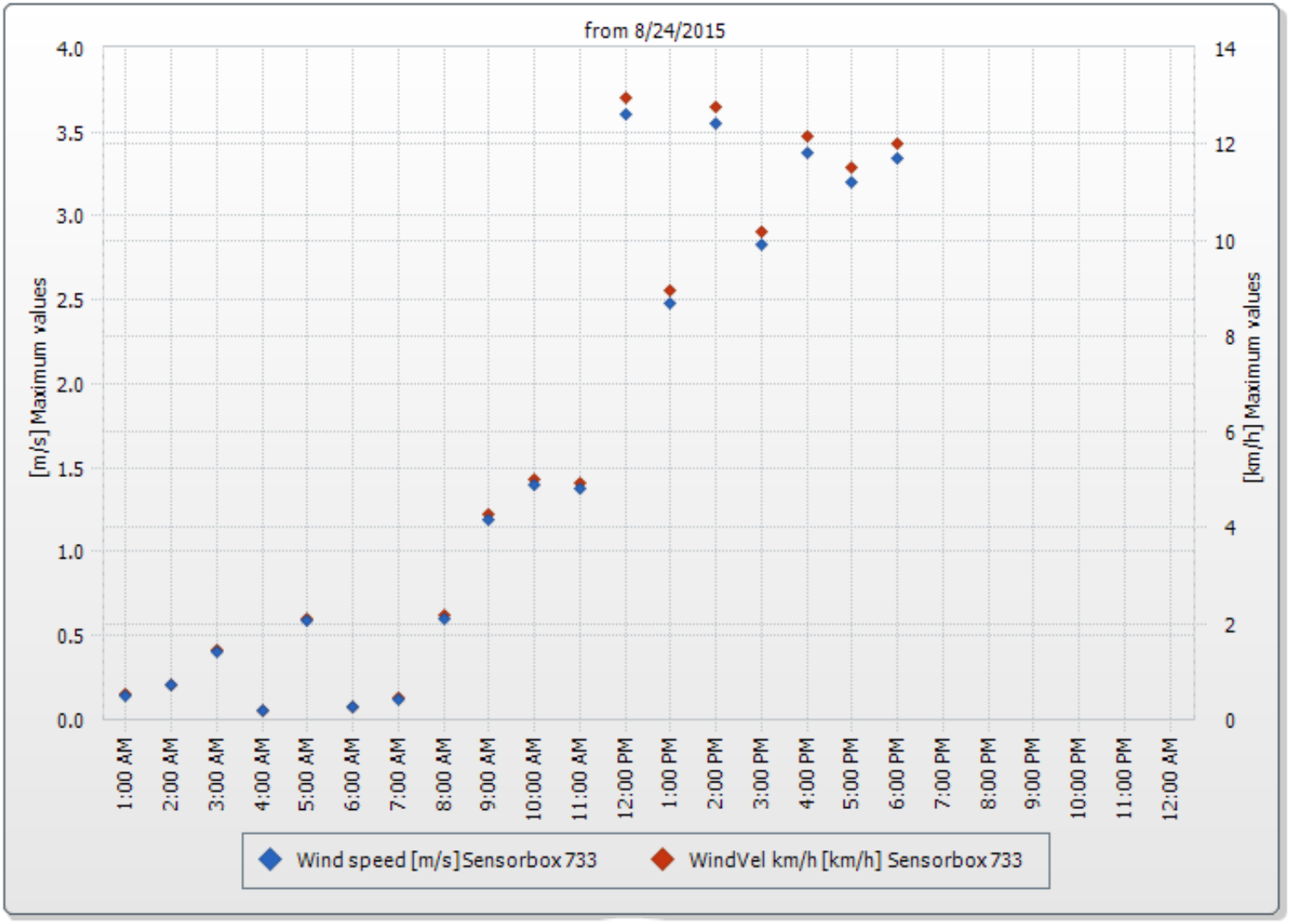
Monitoring and Weather Stations

Wind Speed



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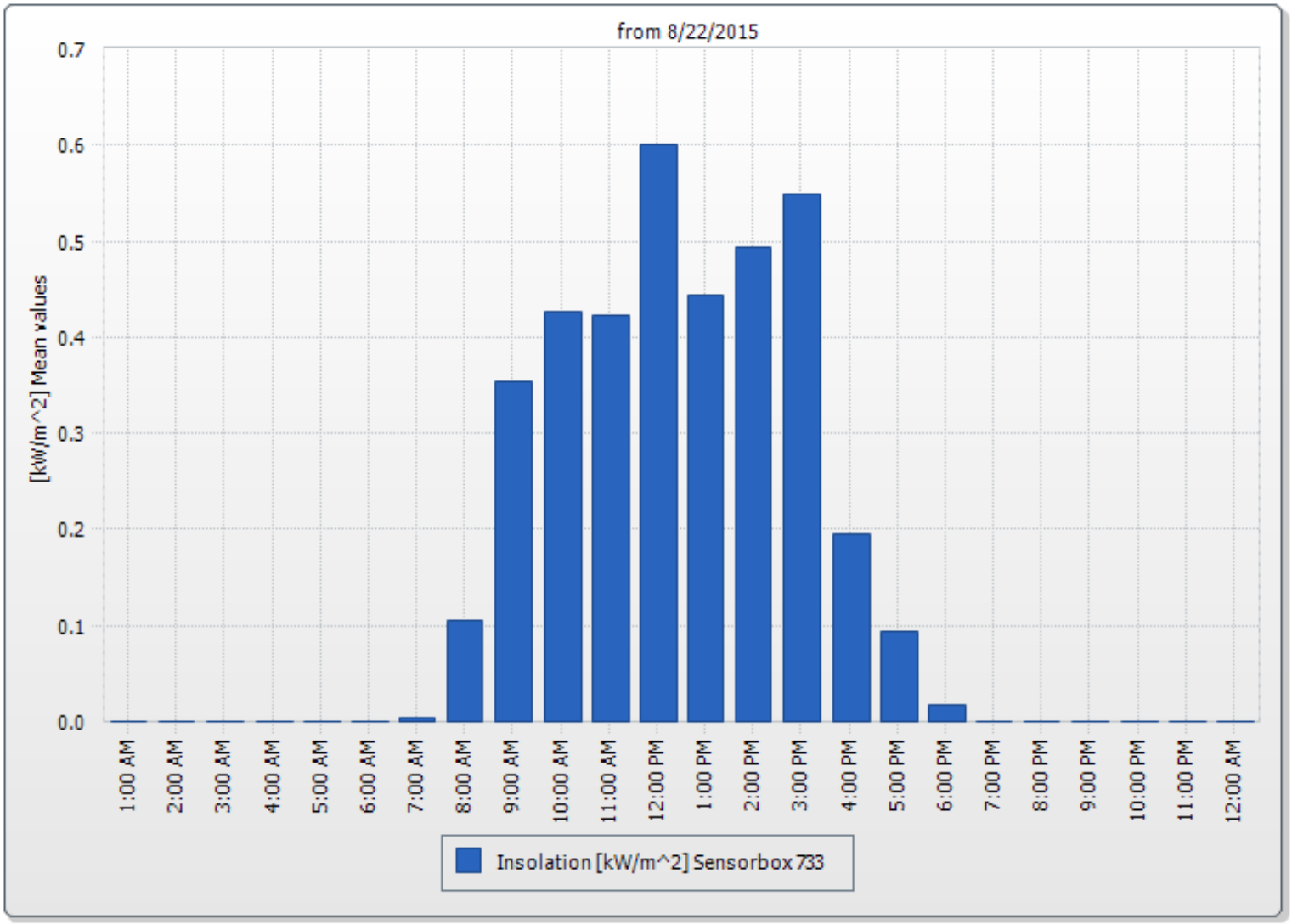
Monitoring and Weather Stations

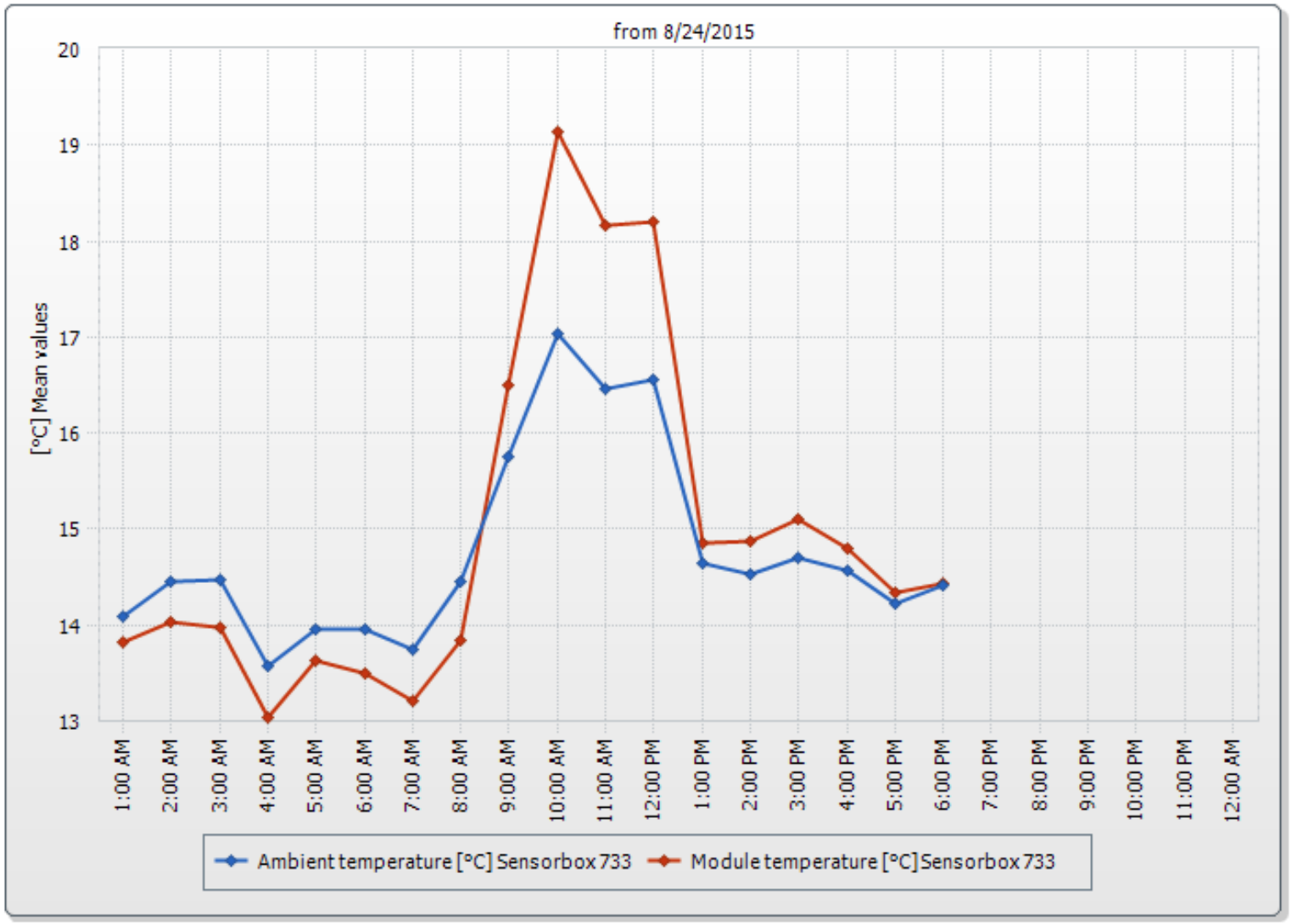
Irradiance



1.22 MWp Rooftop Solar Photovoltaic Installation

Monitoring and Weather Stations

Module Temperature



1.22 MWp Rooftop Solar Photovoltaic Installation

Other Design and Project Requirements

- **Maintenance (preventive and corrective)**
  - Maintenance by Todae Solar for five years, coupled with system performance warranties and detailed energy generation and maintenance reports
- **LGC Claims and Administration**
  - Todae Solar is responsible for the application and administration of LGCs.
- **Testing at Completion**
  - Testing at Completion included: Mechanical (Roof Inspection, Inspection of Installed Equipment…) / Electrical (Wiring Inspection and Insulation, Voc and Isc testing…)
- **Acceptance Tests**
  - Insulation resistance, Functional and operational checks on energised control equipment and circuits, Earth resistance measurement, Solar Isolation Device Test, Integrated tests to demonstrate operation of the automatic connection and disconnection of the Solar PV Systems to/from the main electricity network and as per the authority requirements, Inspection and testing of communication systems and display
- **Documentation prior and post-installation**
  - Reports, Drawings, Certificates, Approvals, As-Builts, Operation & Maintenance Manual, Training Manual, Warranties, Testing Documents

1.22 MWp Rooftop Solar Photovoltaic Installation

- The Project Highlights
- Design Requirements and Technical Details
- **Innovation and Best Practice**

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Innovation during initial design creating the PV layout in 3D

The Todae Solar Engineering department initially created an accurate 3D design of the building and surroundings adding the 3992 panels and the mounting.

This is an innovative approach during the design process that allows better visualization and checking of the system design early in the process.

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Prebuilt enclosures for DC Isolators and fuses

Due to the tight deadline Todae Solar implemented solutions to speed up the installation time as much as possible.

For example, rooftop enclosures for DC isolators and fuses were prewired and labelled before being delivered on site.

DC isolators for the inverter stations were pre-built in an enclosure, pre-wired and delivered on site so the installation team had to simply fix on the wall and connect.

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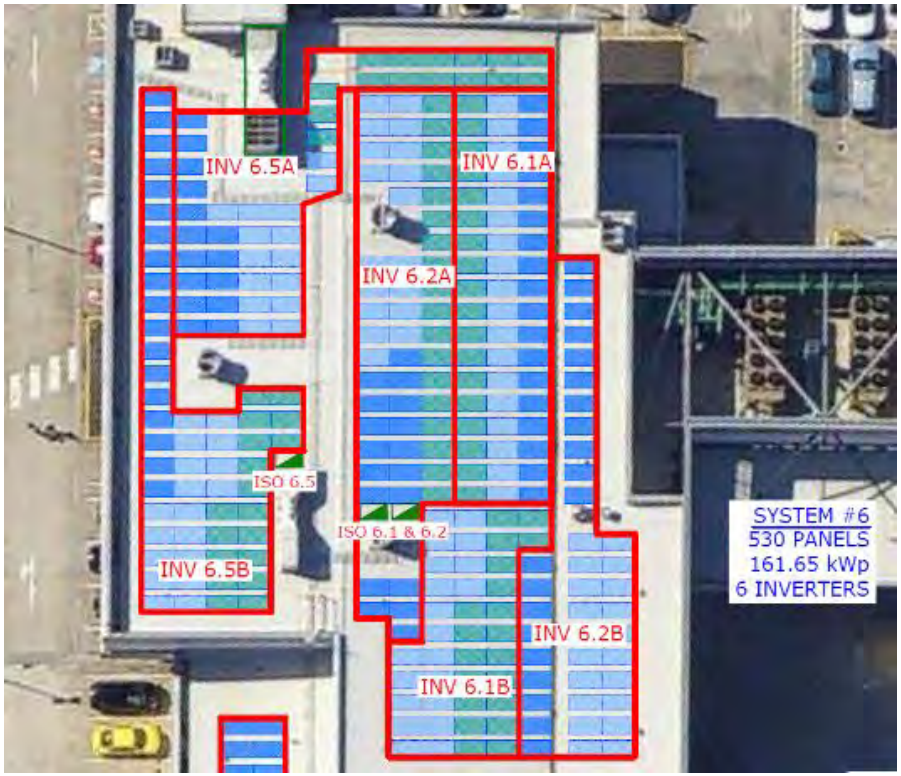
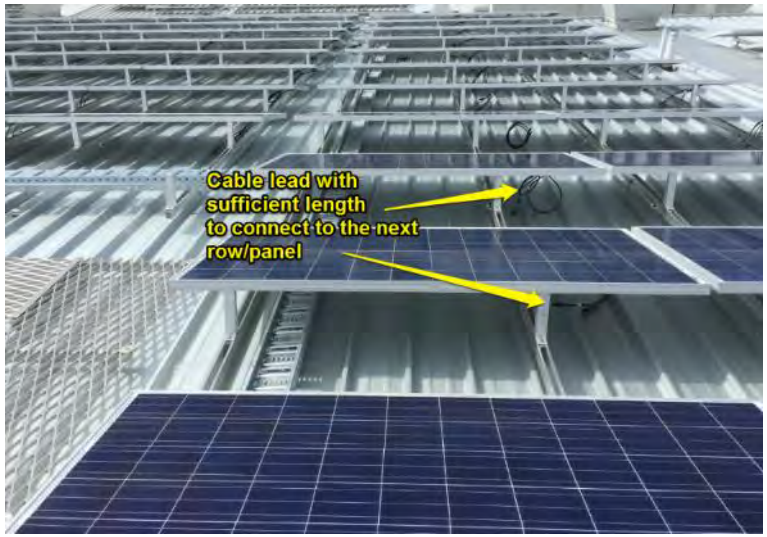
Longer solar panel leads allowing strings to be connected between rows





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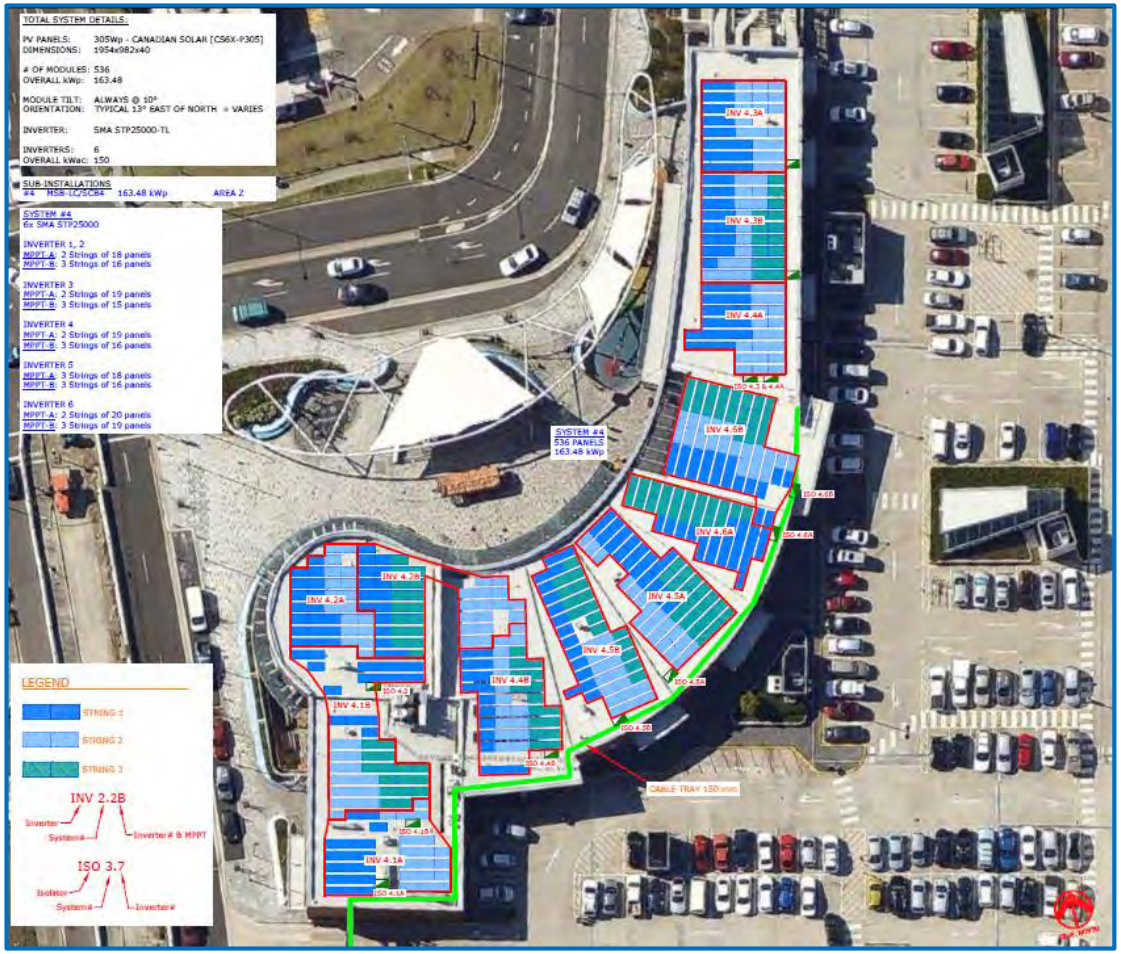
Configurations of inverters / Flexible string layouts in a challenging roof



SMA inverters allowed flexible electrical design around the challenging physical panel layout design.
Electrical string configurations to match panel layouts on challenging roofs areas.

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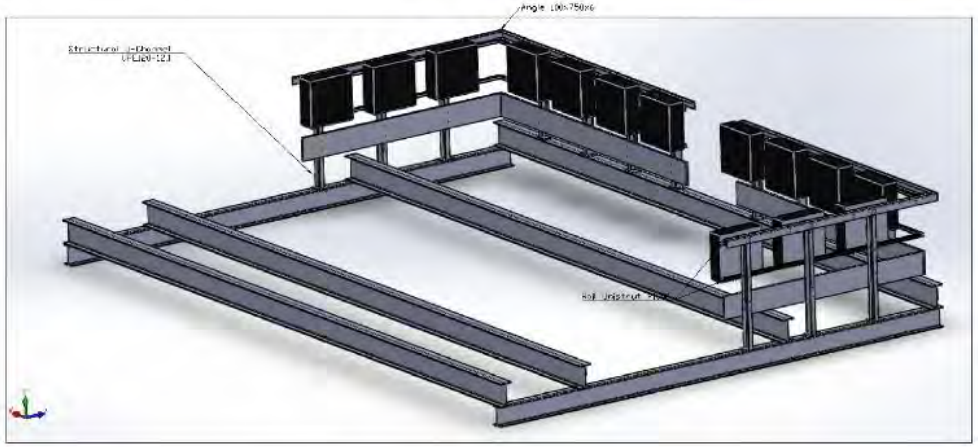
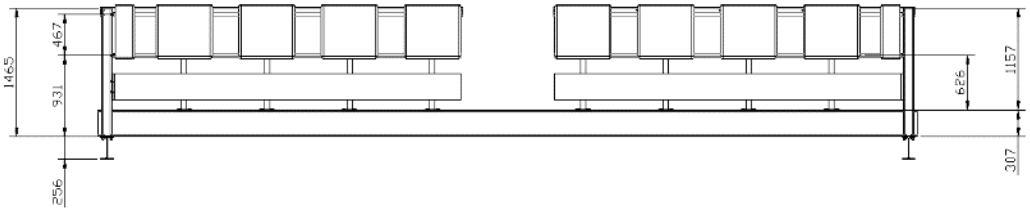
Inverter Stations





Outdoor Inverter Stations were designed, built and certified by Todae Solar considering:

- Loads
- Limited Space
- No fixings on the roofs
- Locations
- Corrosion
- Areas of exclusion (some walls from tenants couldn't be used)
- Impacts on cable losses
- Proximity to Point of Connection
- Timing/Deadline

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Inverter Stations

Inverter Station	Systems	No. of Inverters	Type
A	1	5	On roof
B	2, 3	14	On roof
C	7	7	On roof
D	4, 5	11	Concrete Wall (Public space)
E	6	6	Concrete Wall (Restrictive area)

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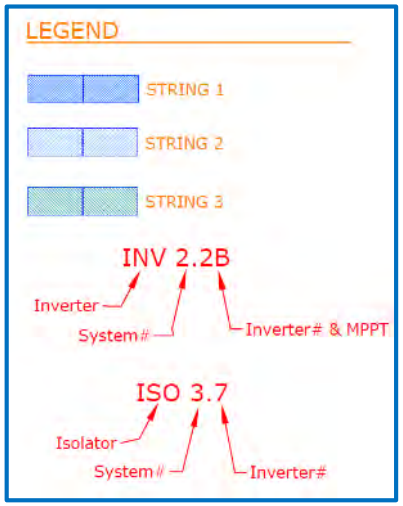
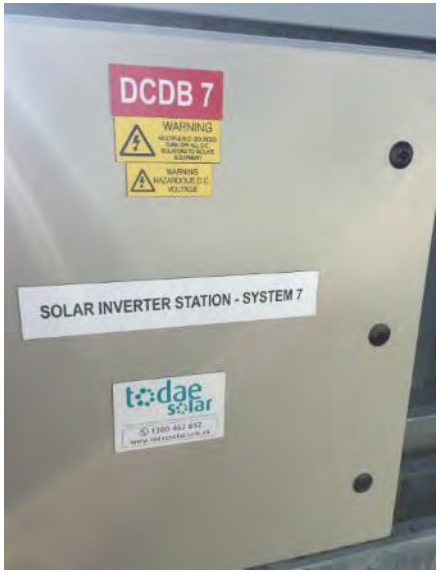
Exceptional Signage and Detailed Labelling for preventive and corrective maintenance





All signage on switches, isolators and within distribution boards and switchboards have to be in accordance with AS 4777 and AS/NZS 5033 and Service and Installation Rules of New South Wales.

As there are 7 systems installed at one Shopping Centre premises, labelling clearly and accurately reflects which devices control which equipment.

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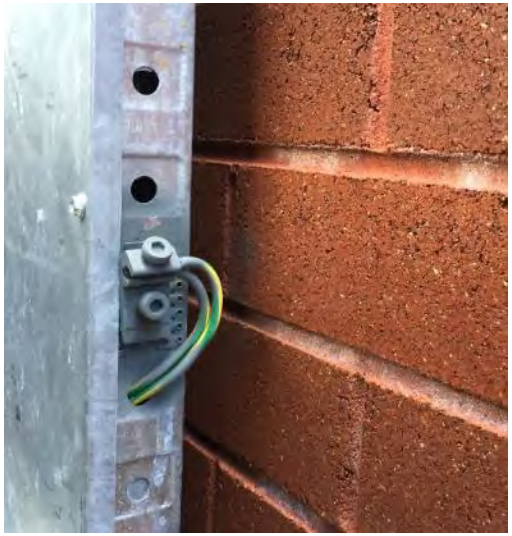
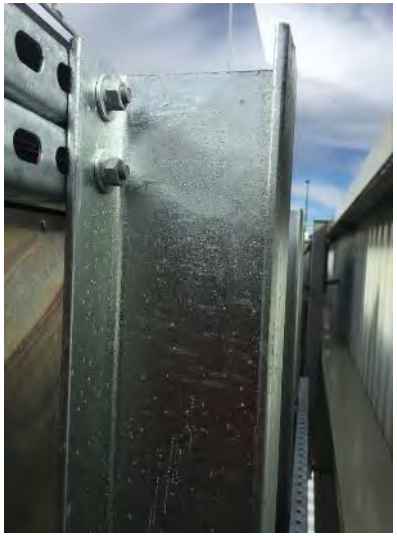
Techniques to minimise corrosion





Panels and Inverters certified for installation in close proximity to ocean

Mount and Fixing Components in Anodized Aluminium

Spray Galvanized paint on grounding lugs

Hot Dipped Galvanized Cable Tray

Elements for Inverter Structure HDG

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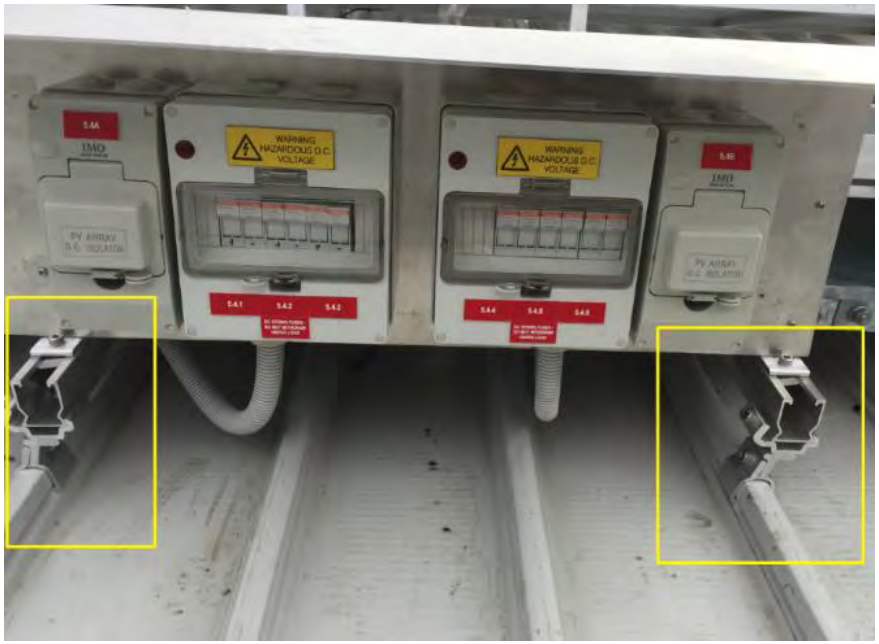
Roof penetrations (none in this project)



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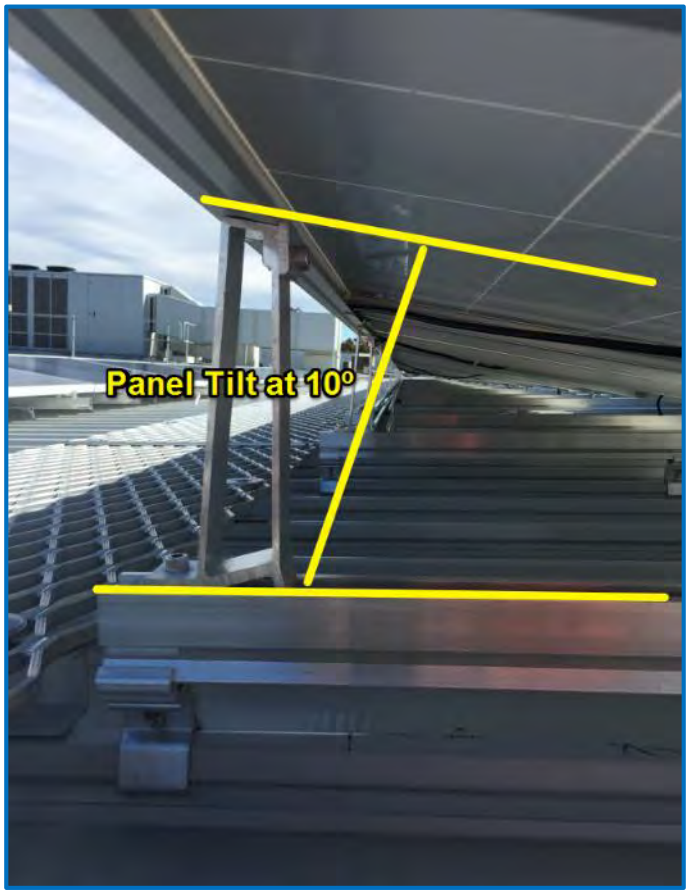
Natural ventilation of panels (20mm gaps, tilt)



Following the guidelines from the solar panel manufacturer a 20 mm gap was left. The inclination of panels at 10 degrees contributes to better performance and less losses due to natural ventilation.

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Cables management

To simplify the installation while achieving best practice, the AC and DC cable trunking was carefully selected to improve the visuals, quality and performance of the system while ensuring mechanical protection.

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SOURCE: HTTP://WWW.ILLAWARRAMERCURY.COM.AU/STORY/2996154/STOCKLAND-TO-BUILD-2M-ROOFTOP-SOLAR-SYSTEM/

Stockland Shellharbour are installing Australia's largest single-rooftop solar system

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As a high quality example of commercial solar this system:

- ✓ Proves solar is a valuable financial investment and business asset to the client
- ✓ Robust Performance Guarantee to confirm the quality of the installation and generation
- ✓ Weather Stations as a method of overseeing the performance of the power station for the future years
- ✓ Self-Consumption and Distributed Generation a reality for large plants from the technical, legal and financial perspectives
- ✓ WHS incident free installation
- ✓ Performing above expectation
- ✓ An example of best practice in solar PV installations
- ✓ Installation & Design (Nomination for CEC Awards / Stockland Green Globe Awards / NSW Green Awards)
- ✓ Exceed client expectations
- ✓ Large Photovoltaic Power Stations integrated in Public Spaces

THANKS FOR YOUR ATTENTION!