



# Final Report PV-Grid Connect e-BRT Charger at Sunway BRT



- 1) Project Overview
- 2) System Design
- 3) System Design
- 4) System Single Line Diagram
- 5) System Configuration List
- 6) PV System Layout
- 7) Equipment specifications
- 8) Energy Savings Achieved
- 9) System Expansion Proposal and Impact

## Location of Sunway BRT

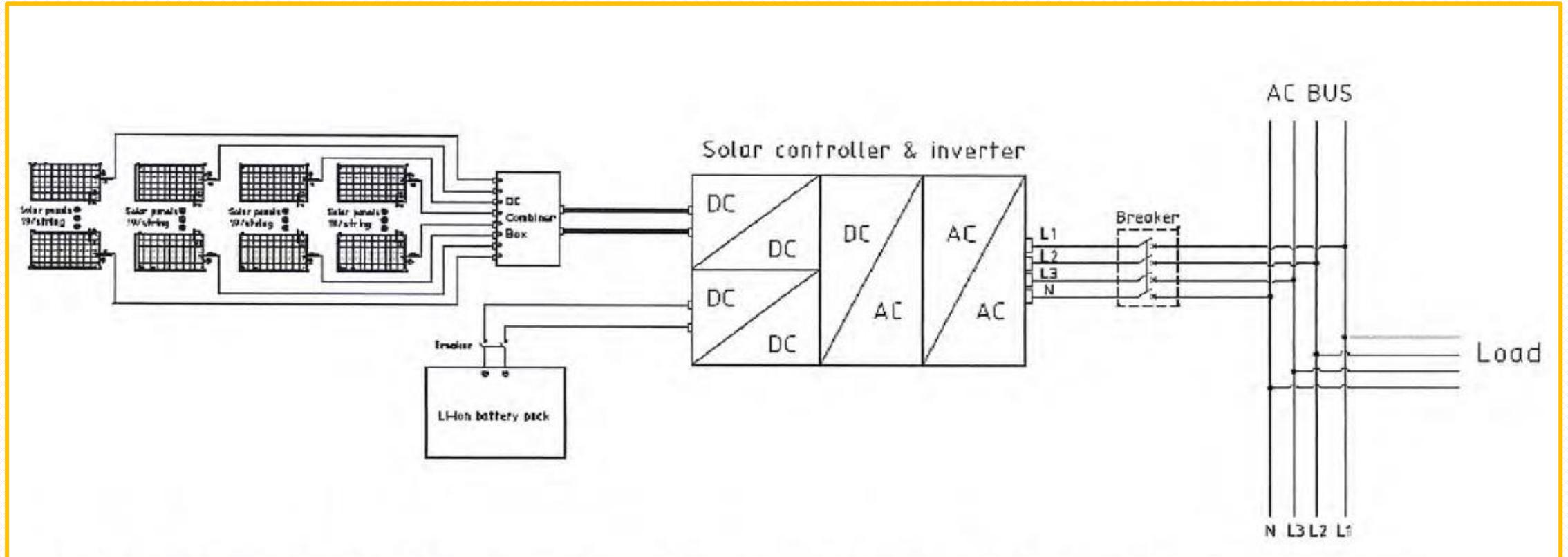


Project name	Solar PV and Energy Storage System at Malaysia BRT Station
Project location	BRT Sunway Depot latitude : N3.05° longitude : E101.6°
PV capacity	20 kW
Energy storage capacity	50kWh
LV voltage	AC 415V/240V
Operation mode	On-Grid

In this PV-Energy Storage System, the proposed PV capacity is 20kW, capacity of battery storage is 50kWh.

The energy generated is mainly supplied to the charging pile. In the day time the PV power is used in priority, the battery and grid will supply power when solar power is insufficient. The whole system will be customized and smart.

# SYSTEM DESIGN

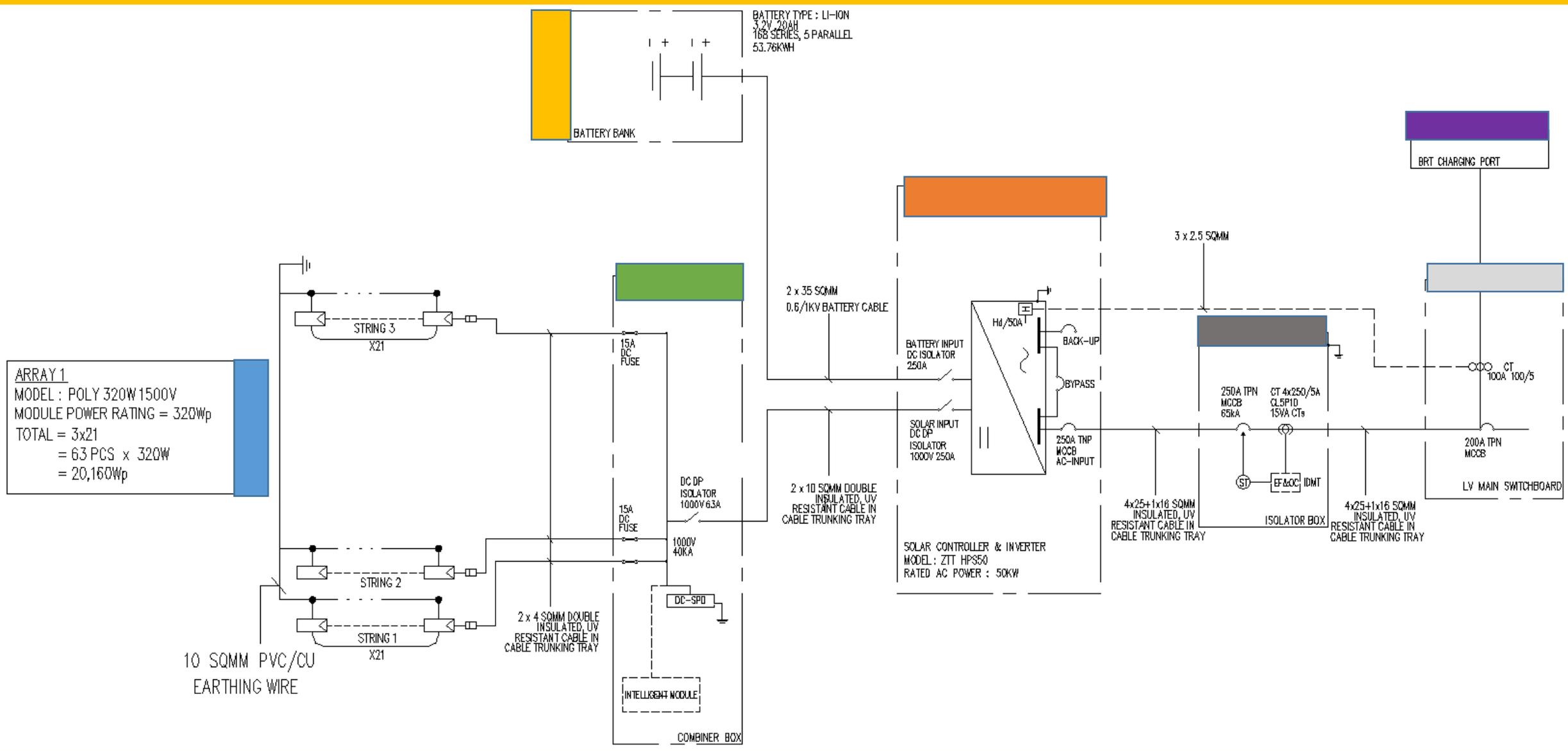


1. Total 63 pcs of PV modules are installed, with 320Wp/module, 21 in one string, total 3 strings
2. Battery Bank Configuration: 216 pcs 3.2V battery cells, 3 strings parallel, nominal voltage 691.2V, nominal capacity 75Ah. Total Energy Storage System (ESS) Capacity, 50kWh

# DETAIL SINGLE LINE DIAGRAM (SLD)



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# SYSTEM CONFIGURATION LIST

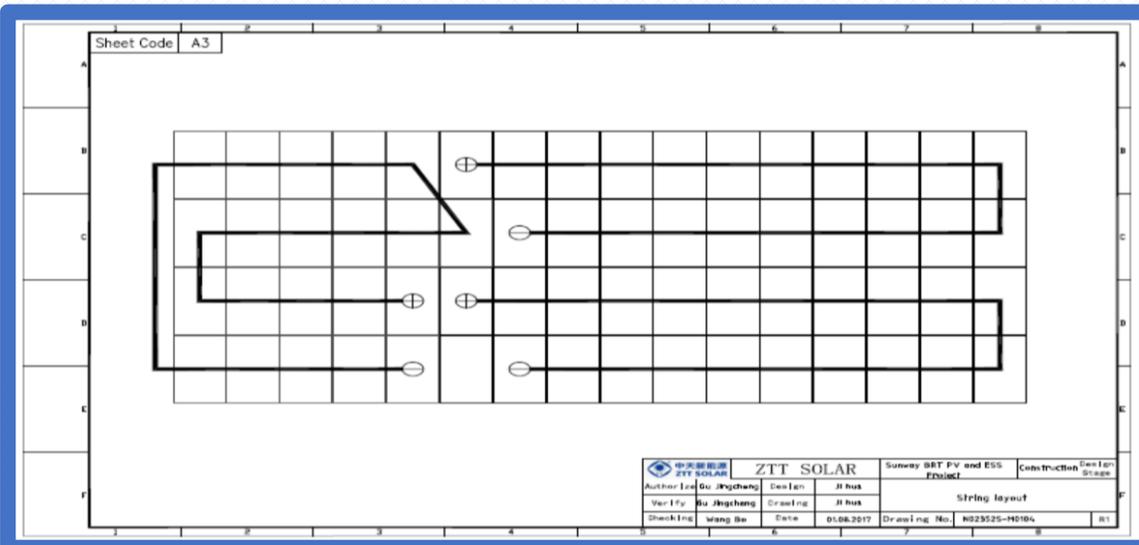


Name		Model	Qty	Unit
PV system	PV module	320 Wp	63	Pcs
	DC combiner box	3 in1out	1	Set
	Mounting system	20 kWp	1	Set
Energy Storage System	Lithium battery	3.2V 25Ah	648	Pcs
	Battery pack	/	18	Set
	Battery cabinet	/	1	Set
	BMS	BMS	1	Set
PV&ESS Hybrid PCS		50kW	1	Set
EMS		EMS	1	Set
AC&DC cable		/	1	Set
Auxiliary material		/	1	Set

# PV MODULE LAYOUT ON THE ROOF

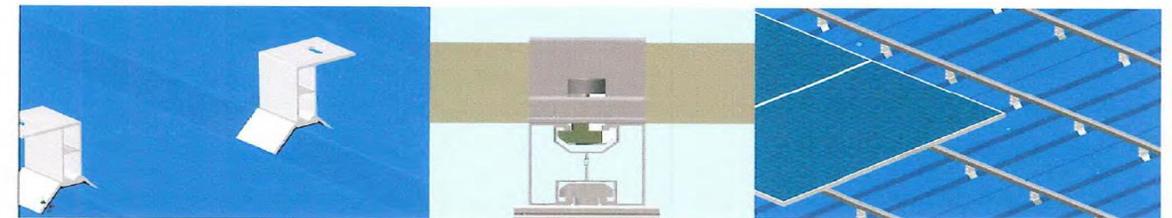


1. Installed PV capacity: 20.16kWp, 320Wp/pcs,
2. Total 63 pcs.
3. The PV Module is installed on the rooftop, tilt angle follow the angle of rooftop.
4. Location of the Solar PV Array is highlighted in blue in the picture.



Based on survey, the rooftop is color steel type  
Installation step:

1. The structural adhesive is used to fix the clamp on the color steel rooftop. For the design we propose, ZTT has successfully applied in many demonstrative project and gained national patent ( ZL 2012 2 0694619.3 ).
2. Track installation, fix the track and module on the clamp.



Installation features:

- Do not destroy the original waterproof layer, no need water treatment;
- Applies to any specification of crystalline silicon module and part of CIS module;
- Installation fast, simple.

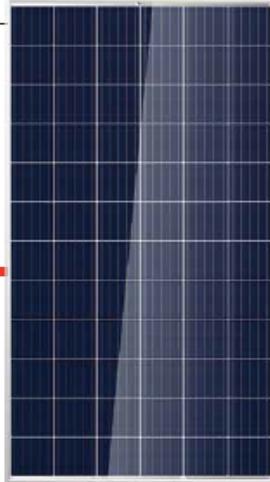
# SOLAR MODULE SPECIFICATION



Mono **Multi** Solutions

## THE TALLMAX

FRAMED 72-CELL MODULE (1500V)



**72 CELL**  
MULTICRYSTALLINE MODULE

**320-340W**  
POWER OUTPUT RANGE

**17.5%**  
MAXIMUM EFFICIENCY

**0~+5W**  
POSITIVE POWER TOLERANCE

Founded in 1997, Trina Solar is the world's leading comprehensive solutions provider for solar energy. We believe close cooperation with our partners is critical to success. Trina Solar now distributes its PV products to over 60 countries all over the world. Trina is able to provide exceptional service to each customer. In each market and supplement our innovative, reliable products with the backing of Trina as a strong, bankable partner. We are committed to building strategic, mutually beneficial collaboration with installers, developers, distributors and other partners.

Comprehensive Products  
And System Certificates

IEC61215/IEC61730/UL1703/IEC61701/IEC62716  
ISO 9001: Quality Management System  
ISO 14001: Environmental Management System  
ISO14064: Greenhouse gases Emissions Verification  
OHSAS 18001: Occupation Health and Safety Management System



**Ideal for large scale installations**

- Reduce BOS cost by connecting more modules in a string
- 1500V UL/1500V IEC certified



**One of the industry's most trusted modules**

- Field proven performance



**Highly reliable due to stringent quality control**

- Over 30 in-house tests (UV, TC, HF, and many more)
- In-house testing goes well beyond certification requirements
- 100% EL double inspection



**Certified to withstand the most challenging environmental conditions**

- 2400 Pa wind load
- 5400 Pa snow load
- 35 mm hail stones at 97 km/h

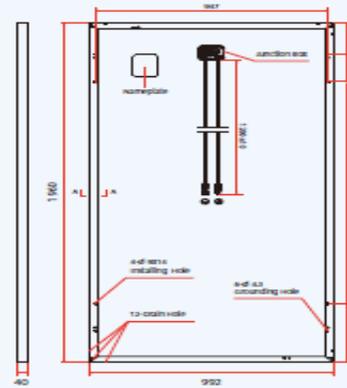
### LINEAR PERFORMANCE WARRANTY



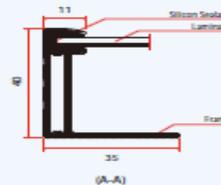
## TALLMAX

PRODUCTS | POWER RANGE  
TSM-PE14A | 320-340W

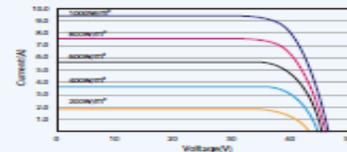
### DIMENSIONS OF PV MODULE(mm)



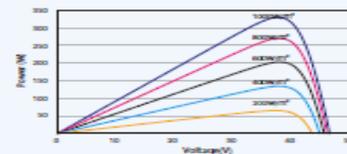
Back View



### I-V CURVES OF PV MODULE(335W)



### P-V CURVES OF PV MODULE(335W)



## FRAMED 72-CELL MODULE (1500V)

### ELECTRICAL DATA (STC)

Peak Power Watts- $P_{max}$ (Wp)*	320	325	330	335	340
Power Output Tolerance- $P_{max}$ (W)	0 ~ +5				
Maximum Power Voltage- $V_{mp}$ (V)	37.1	37.2	37.4	37.6	37.8
Maximum Power Current- $I_{mp}$ (A)	8.63	8.73	8.83	8.91	8.99
Open Circuit Voltage- $V_{oc}$ (V)	45.5	45.6	45.8	46.0	46.2
Short Circuit Current- $I_{sc}$ (A)	9.15	9.19	9.28	9.35	9.42
Module Efficiency $\eta$ (%)	16.5	16.7	17.0	17.2	17.5

STC: Irradiance 1000W/m<sup>2</sup>, Cell Temperature 25°C, Air Mass AM1.5.

\*Measuring tolerance: ±3%.

### ELECTRICAL DATA (NOCT)

Maximum Power- $P_{max}$ (Wp)	237	241	245	249	252
Maximum Power Voltage- $V_{mp}$ (V)	34.3	34.4	34.6	34.8	35.0
Maximum Power Current- $I_{mp}$ (A)	6.92	7.00	7.08	7.14	7.21
Open Circuit Voltage- $V_{oc}$ (V)	42.1	42.2	42.4	42.6	42.8
Short Circuit Current- $I_{sc}$ (A)	7.39	7.42	7.49	7.55	7.60

NOCT: Irradiance at 800W/m<sup>2</sup>, Ambient Temperature 20°C, Wind Speed 1m/s.

### MECHANICAL DATA

Solar Cells	Multicrystalline 156.75 × 156.75 mm (6 inches)
Cell Orientation	72 cells (6 × 12)
Module Dimensions	1960 × 992 × 40 mm (77.2 × 39.1 × 1.57 inches)
Weight	22.5 kg (49.6 lb)
Glass	3.2 mm (0.13 inches), High Transmission, AR Coated Tempered Glass
Backsheet	White
Frame	Silver Anodized Aluminium Alloy
J-Box	IP 67 or IP 68 rated, 3 Bypass diodes
Cables	Photovoltaic Technology Cable 4.0mm <sup>2</sup> (0.006 inches <sup>2</sup> ), 1200 mm (47.2 inches)
Connector	UTX/MC4 EVO2/TS4 (1500V)

### TEMPERATURE RATINGS

NOCT (Nominal Operating Cell Temperature)	44°C (±2°C)
Temperature Coefficient of $P_{max}$	-0.41%/°C
Temperature Coefficient of $V_{oc}$	-0.32%/°C
Temperature Coefficient of $I_{sc}$	0.05%/°C

### MAXIMUM RATINGS

Operational Temperature	-40 ~ +85°C
Maximum System Voltage	1500V DC (IEC)
	1500V DC (UL)
Max Series Fuse Rating	15A

(DO NOT connect Fuse in Combiner Box with two or more strings in parallel connection)

### WARRANTY

- 10 year Product Workmanship Warranty
- 25 year Linear Power Warranty

(Please refer to product warranty for details)

### PACKAGING CONFIGURATION

- Modules per box: 27 pieces
- Modules per 40' container: 648 pieces

# HPS SPECIFICATION

## Hybrid Power System



Model	ZTT HPS50
Rating	50kW
DC input quantities	
VMAX DC (absolute maximum)	1000V
PV input operating voltage range	480-800V
Maximum operating PV input current	125A
ISC DC (absolute maximum)	125A
BAT input operating voltage range	350V-600V ( MPP voltage-100V )
BAT Maximum operating DC input current	180A
AC output quantities	
Voltage (nominal or range)	400Vac
Current (maximum continuous)	80A
Frequency (nominal or range)	50Hz/60Hz
Power (maximum continuous)	55kW
Power factor range	0.9lagging-0.9leading
Weight unit	600 kg
Ingress Protection	IP20
Environmental category	indoor
Suitability for wet locations	not
Pollution degree	II
Elect.protection class	Class I
Overvoltage category	Category I for AC output category II
Mains connection	Permanent connection
Transformer info	With isolating Transformer
Insulation class	Class H

# BATTERY SPECIFICATION



## BATTERY MODULE SPECIFICATION

Considering the charging /discharging performance of single cell and current limitation, the whole battery system will be divided into 18 battery modules and every module is 38.4V/75Ah. The size of each module is 19 inches and 2.6U with 36 pieces of 25Ah cells.

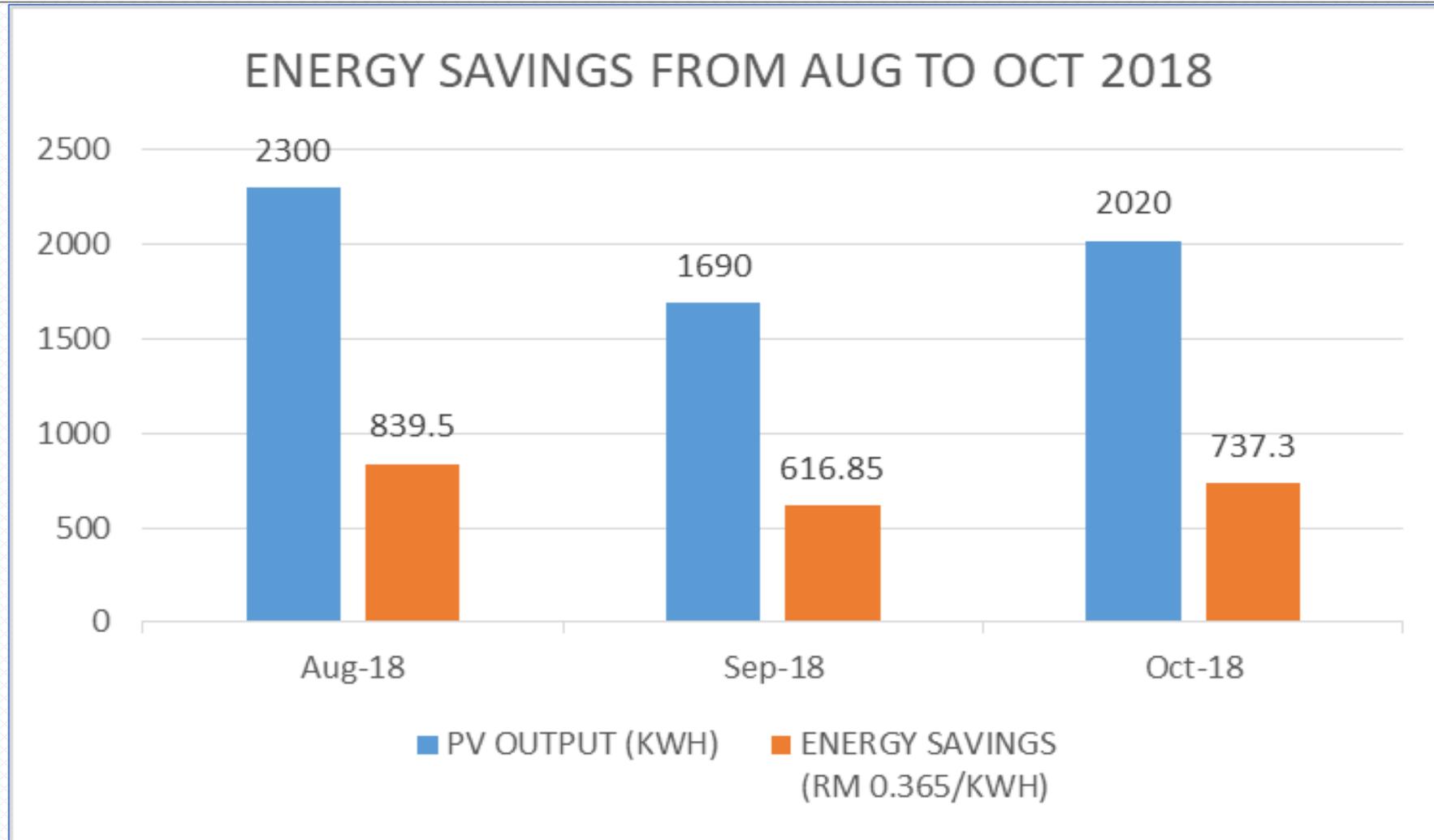
**50kWh battery module parameters table**

No.	Item	Parameter	Note
1	Nominal voltage(V)	38.4	
2	Nominal capacity(Ah)	75	
3	Nominal energy (Wh)	2880	
4	Charging terminal voltage (V)	3.7 (Single cell)	
5	Charging terminal voltage(V)	2.5V(Single cell)	
6	Combination	3P12S	
7	Single cell amount(PCS)	36	
8	Size	482mm*550mm*117 mm	2.6U

# ENERGY SAVINGS: 3 MONTHS RESULT



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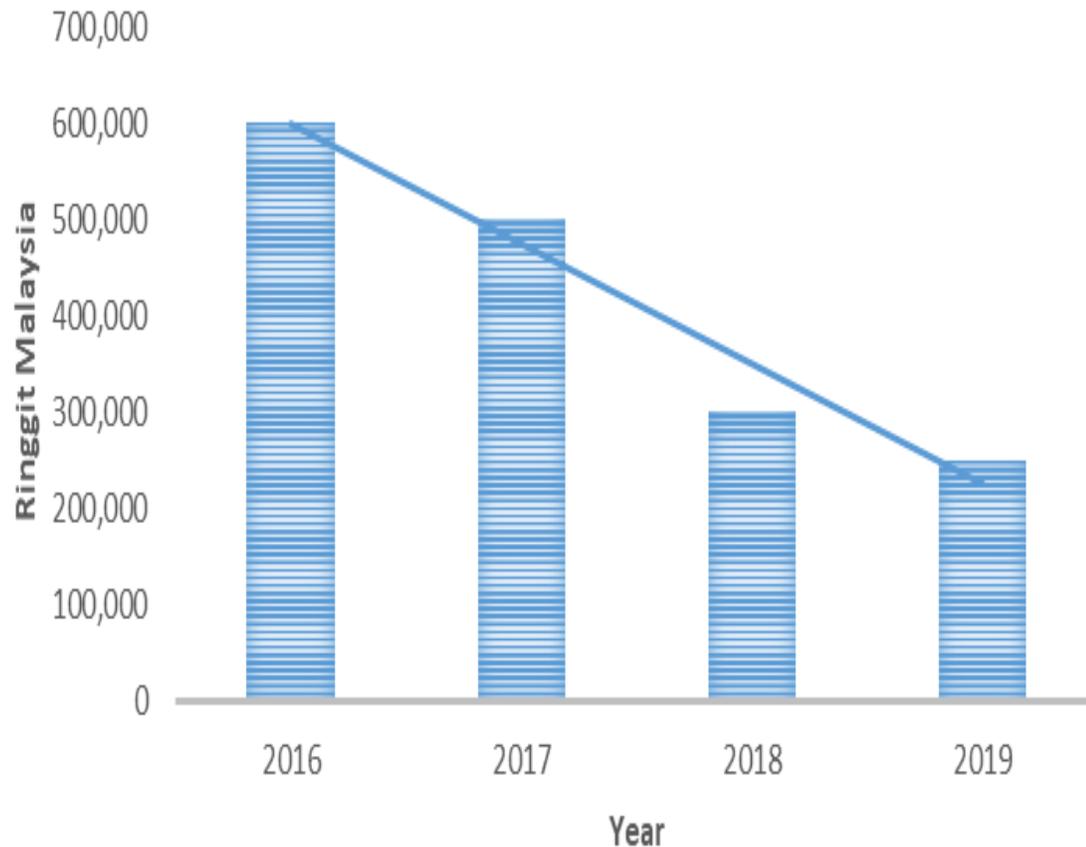


ITEMS	Aug-18	Sep-18	Oct-18
<b>PV OUTPUT (KWH)</b>	2300	1690	2020
<b>ENERGY SAVINGS (RM 0.365/KWH)</b>	839.5	616.85	737.3

# SYSTEM EXPANSION PROPOSAL



## SYSTEM COST (RM) TRENDLINE



1. Assume HPS system to be expanded from 50 kW to 250kW AC
2. Energy Storage System to be able to support load consumption from 8pm to 12am everyday
3. Total Investment estimation: RM 1.2 million

### PROJECT ECONOMIC IMPACT

1. Total Energy Savings will be  $RM3,500 \times 12 = RM 42,000$  per year
2. Maximum Demand Reduction: 250kW AC
3. Maximum Demand Savings per month:  
 $250kW \times RM30.3 = RM 7,575$  per month
4. Maximum Demand Savings per year:  
 $RM 7,575 \times 12 = RM 90,900$
5. Total Savings per year = RM 132,900
6. Return of Investment = 9 years

# Conclusion

- The contract has successfully delivered in the design, development and deployment of an integrated solar photovoltaic and energy storage charging system for electric buses aimed at demonstrating the feasibility of operating EVs that run on renewable energy.
- On a scale-up application, the project benefit will be three-prongs:
  - i. Reduction of grid energy used in charging the buses
  - ii. Reduction of overall maximum demand to BRT Sunway electricity supply
  - iii. Higher reduction of GHG emissions from fossil fuel