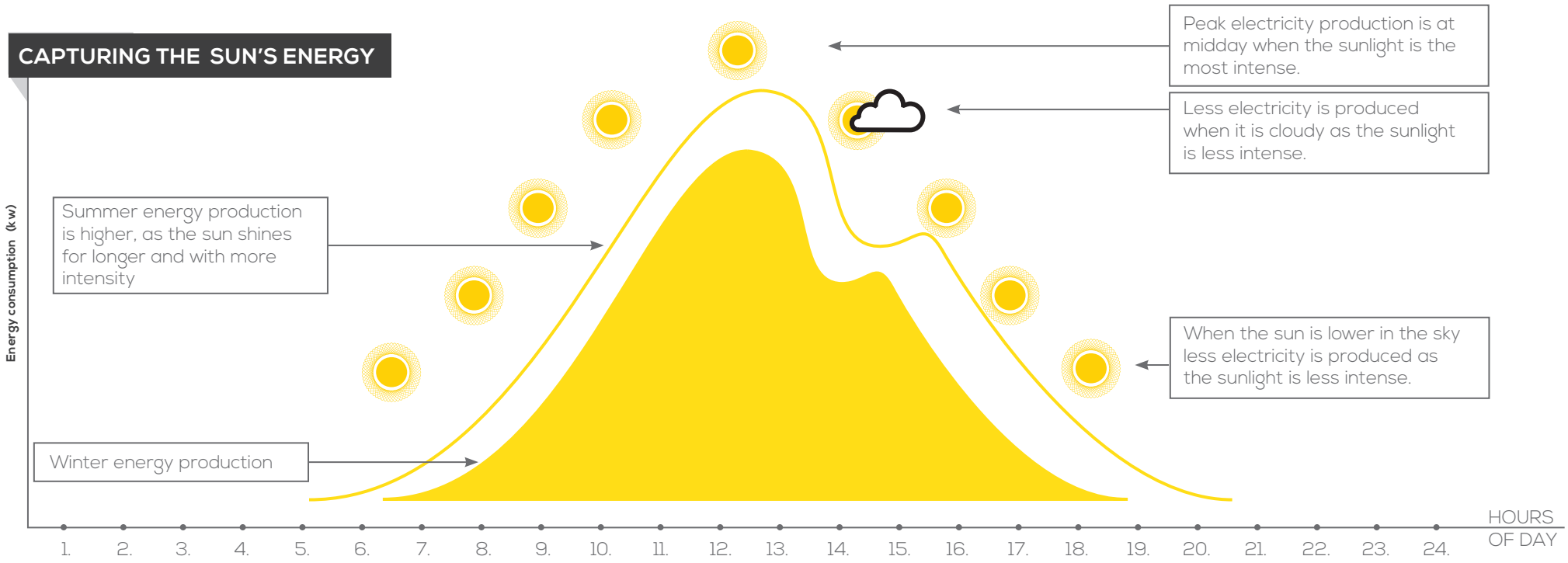
POWERSMART: UNDERSTANDING GRID CONNECTED SOLAR PV.

SOLAR ELECTRICITY: **PRODUCTION EXPLAINED**



- The more intense the sunlight the more electricity produced, so when the sun is low in the sky less electricity is produced. Likewise on cloudy and overcast days, less electricity is produced than on a bright sunny day. Note: Solar PV converts light into electricity so on a cold sunny day it produces just as much electricity as on a hot sunny day.
- The yellow line represents the increased electricity production on a summers day while the solid yellow graph represents winter production. In the winter less electrical energy is produced than during the summer as the sun shines for less hours.
- A solar PV system operates best on sites which get maximum sunshine hours.
  - Northern facing roof
  - No shading from trees or other buildings.

ELECTRICITY **USE PATTERNS** AND **SOLAR PV.**

UNDERSTANDING HOW HOUSEHOLDS USE ELECTRICITY.

Households electricity usage varies during the day depending on what appliances are used.
Key points are:

- Peak household energy usage typically occurs in the mornings and evening when everyone is home: Food is being cooked, computers and TV's are on, people showering, dinner cleanup plus dishwasher.

- Heating water for your house often makes up 30-40% of a household's energy use.
  - Other high energy users include electric: spa and swimming pools, underfloor heating and air-conditioning.

Recommendations on how to maximise your solar usage:

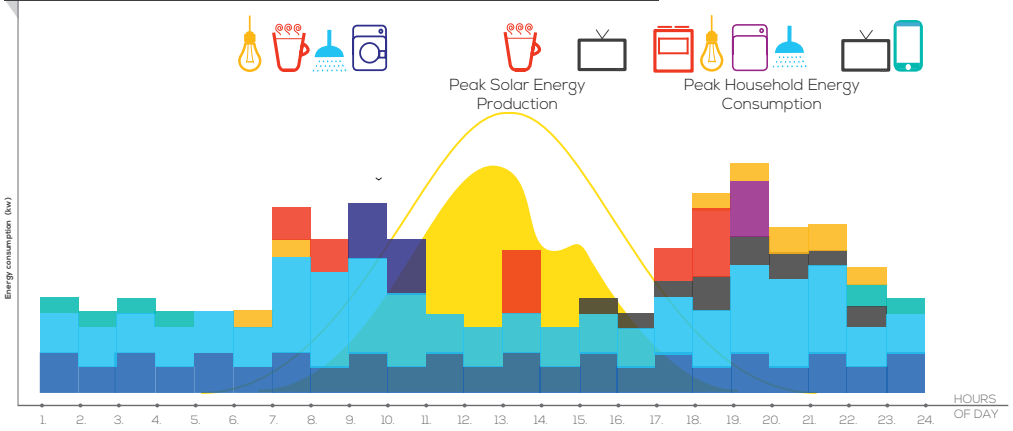
- Installing a timer on the hotwater cyclinder so it only comes on during the day and is heated using electricity produced from the solar PV system.

- Installing a power diverter, which takes electricity that is being exported and diverts this electricity to heat your electric hotwater cyclinder.

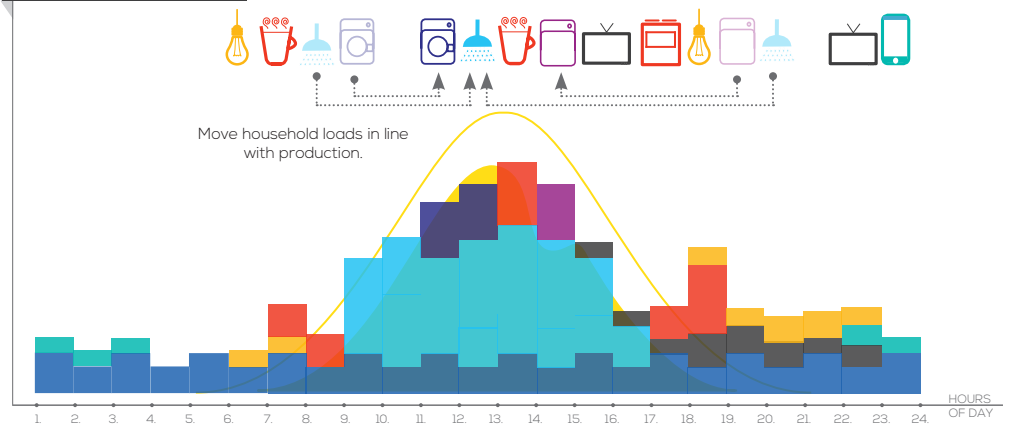
- Use delay and/or timers on appliances such as: dishwashers, washing machines. clothes dryers, and heatpumps so they come on during the day when the sun is shining.

- Battery technology can be used to store electricity produced in the day to be used at times of higher demand.

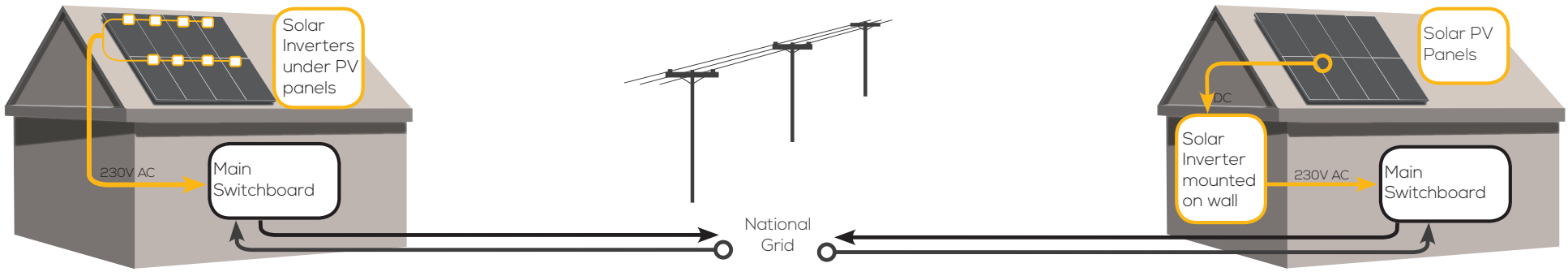
TYPICAL HOUSEHOLD ENERGY USE AND SOLAR PRODUCTION.



MAXIMISING SOLAR PV RETURN



MICRO INVERTERS COMPARED TO **STRING INVERTERS**



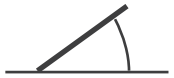
MICRO INVERTER SOLAR PV SYSTEM

- Micro inverters are mounted under each panel converting DC electricity to AC electricity at each panel.
- Wiring from the panel to the Main Switchboard doesn't need to be housed in conduit as it is transporting 230V AC rather than high voltage DC current.
- As a micro inverter is mounted behind each panel it is easy to add more panels and inverters at a later date.
- From testing at PowerSmart we have found micro inverters to be up to 5% more efficient than string inverters.
- PowerSmart recommends micro inverter solar PV systems in situations where shading can't be avoided or a staged installation is needed.
- Micro inverter systems tend to be slightly more expensive than string inverter systems.

STRING INVERTER SOLAR PV SYSTEM

- A string inverter (or inverters) is mounted on the wall close to the main switchboard - mounting information is on page 5.
- Wiring from the panel to the Main Switchboard therefore needs to be housed in conduit as it is transporting high voltage DC.
- String inverters are sized to the number of panels on the roof so it is not possible to add more solar PV panels to the system without adding another inverter or increasing the size of the current inverter.
- Power output is averaged across all the panels in the string which results in slightly less (about 5%) production.
- String inverters tend to be easier to service as the inverter is mounted on the wall, not the roof.
- Historically string inverters are less expensive than micro inverters.

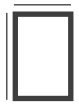
THINGS TO CONSIDER: DESIGNING A SOLAR PV SYSTEM



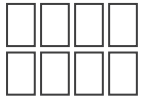
For optimal performance in New Zealand panels should be mounted on the roof or a ground mounted frame at between 25 - 30 degrees.

If solar PV panels are mounted at less than 10 degrees they will need to be cleaned more regularly as rain water is not as efficient at keeping them clean. On a low pitched roof, a tilt mounted system is recommended, this is slightly more expensive than traditional flush mounting.

Ideally solar PV panels need to be facing as close to North as possible. Roof aspects of Northwest, North and Northeast will provide the best performance.



Panels dimensions are: 1650mm x 990mm



Different size systems require different amounts of space on the roof to mount the panels. Some examples are:

- 2 kW system: 12m2
- 3 kW system: 19m2
- 4 kW system: 24m2
- 5 kW system: 31m2

With a String inverter an area is needed to mount the inverter close to the main switchboard. Inverters vary in size depending on manufacturers but the inverters PowerSmart use are typically 435mm wide x 470mm high x 176mm deep and need 300mm of clear wall space around them. Inverters weigh from 16kg and so adequate nogging needs to be in place to support this weight.

Batteries are becoming increaslingly part of the conversation with people installing solar PV systems. The technology is well advanced and being led by companies such as Tesla, Panasonic, LG and Enphase. Battery technology is constantly improving and we have seen massive progress over the last 12 months, to the point where we at PowerSmart are now happy to recommend installing batteries. They are still quite an expensive option and therefore are likely to be suitable for a select group of people at this time. All our systems are 'battery ready' and are able to be connected to batteries at a later date.

House Phasing:

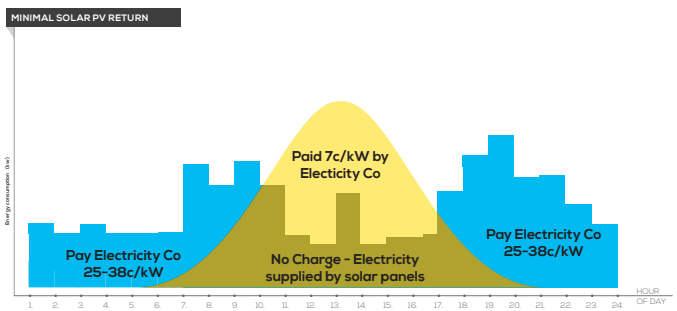
- Single phase homes require 1 or 2 single phase string inverters, depending on the solar PV system size.
- Double phase homes require 2 single phase string inverters to supply solar to both phaases.
- Three phase homes require a 3 phase string inverter.
- Micro inverters can be used on 1, 2 or 3 phase homes and are recommended for multi-phase homes to ensure most accurate distribution of solar to each phase.

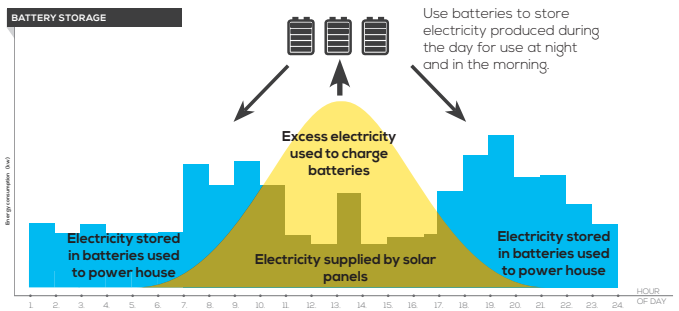
CHANGING ELECTRICITY USE: **SMALL HOME CASE STUDY.**

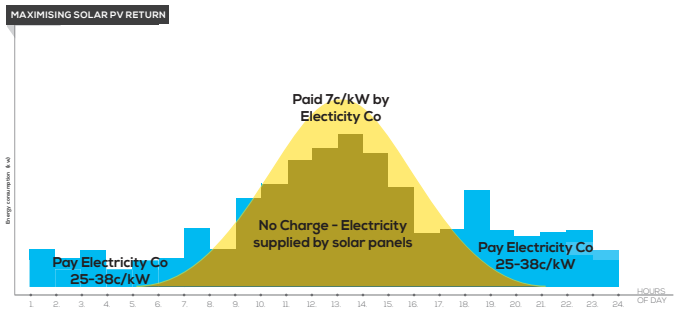
Solar PV systems typically produce more energy during the day than households use. Although PowerSmart designs systems to minimise export, homeowners can maximise their returns through internalising as much of their energy use as possible or investing in batteries to store excess electricity produced during the day for use at night or early morning.

YEARLY SAVINGS BY CHANGING HOW YOU USE YOUR ELECTRICITY = $936

NB: This is a theoretical example to show how moving your electricity loads can lower your powerbill. Individual households results will vary.







FOR THE MORE TECHNICALLY MINDED

NORMAL HOUSEHOLD ENERGY USAGE

	Quantity	Rate	Total
Average Daily Household Energy Demand	32 kWh		
Average Daily Solar Energy Produced	16 kWh		
Solar Electricity Exported to Power Company	13 kWh	$0.07	$ 0.91
Solar Electricity Used to Power Household	3 kWh	$0.00c	$ 0.00
Electricity imported from Power Company	29 kWh	$0.33	$9.57
Total Daily Electriciy Bill			$8.66
Total Monthly Electricity Bill			**$259.80**

HOUSEHOLD ENERGY USAGE WITH MOVING LOADS

	Quantity	Rate	Total
Average Daily Household Energy Demand	32 kWh		
Average Daily Solar Energy Produced	16 kWh		
Solar Electricity Exported to Power Company	3 kWh	$0.07	$0.21
Solar Electricity Used to Power Household	13 kWh	$0.00	$0.00
Electricity Imported from Power Company	19 kWh	$0.33	$6.27
Total Daily Electricity Bill			$6.06
Total Monthly Electricity Bill			**$181.80**