Energy Saver

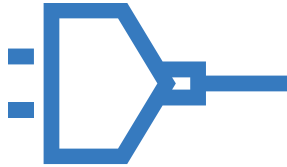
Murray Farm Energy Forum

Solar Pumping

August 2019

Presenter:
Luke Christiansen from 2XE

By the end of this presentation, you will understand:



01 Opportunities for solar pumping

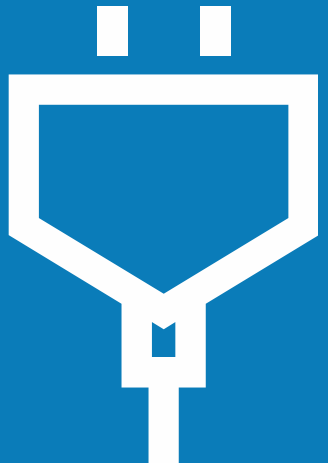
02 Solar pumping solutions

03 The design process

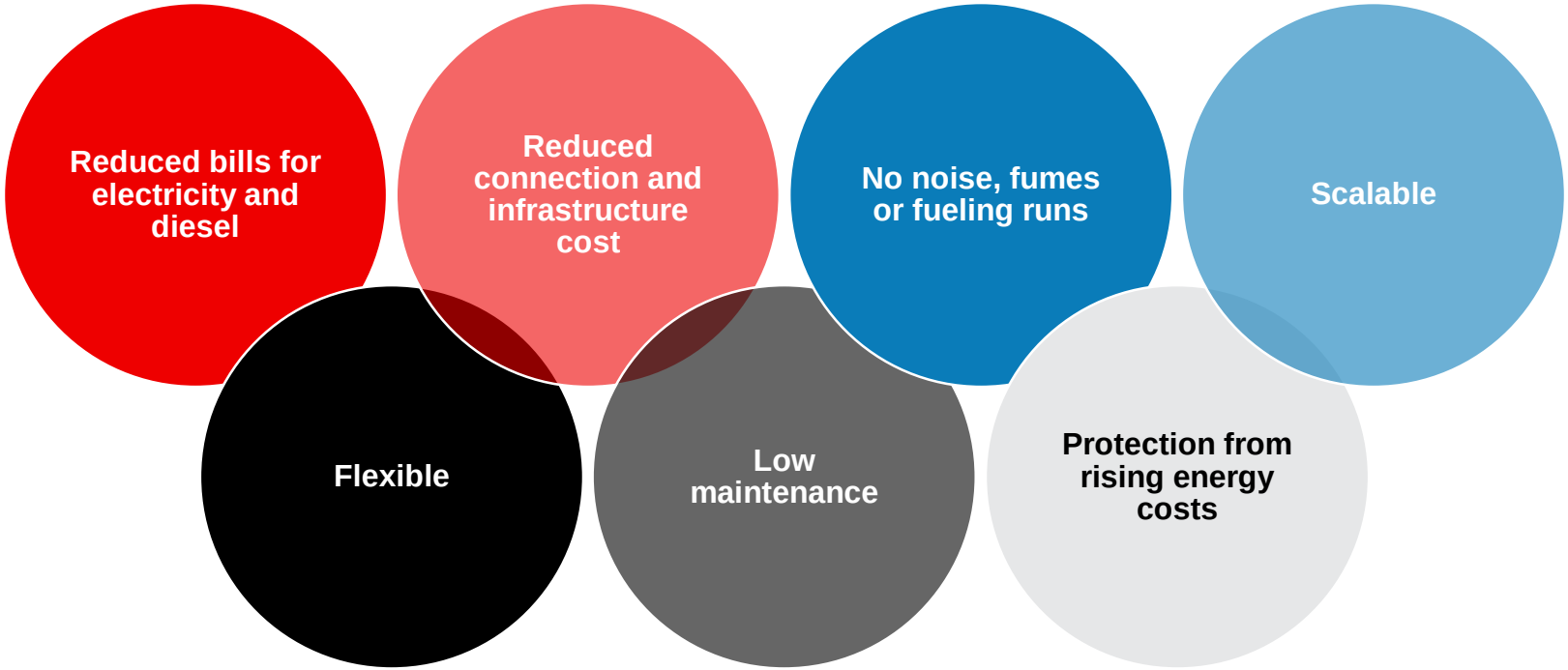
04 Solar pumping economics

05 Where to go for more information

Part 1: Opportunities for solar pumping



Why use solar pumping?



What pumping tasks suit solar power

If you already use electric pumps for irrigation and are grid connected

You pump water to header tanks or dams for stock or domestic use

You have substantial and efficient water storage

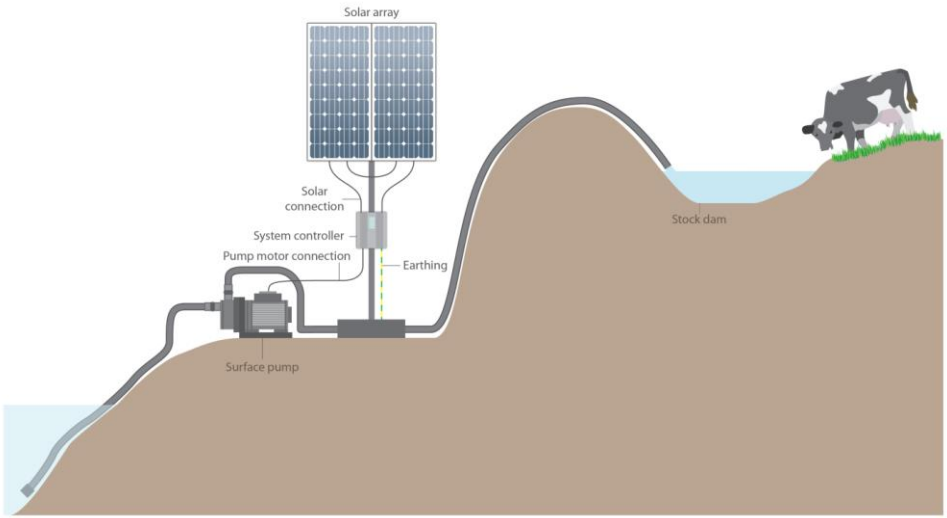
You have a discrete day time pumping task as part of your broader system

You have potential to reduce your electricity usage to a more favourable tariff strcture

Livestock drinking-water supply

Continuous (year round) supply and relatively small volumes make solar pumping well suited for stock pumping

Water can be pumped during the day from a bore, dam or steam into a stock dam or elevated tank.



Domestic water

Solar PV can provide significant savings for domestic and cleaning pumping systems

These systems can be solely for water pumping but are often designed to supply domestic power as part of an integrated system

Irrigation pumping

Approximately 5 million megalitres of irrigation water is used per year in NSW alone (ABS, 2014)

Diesel or grid connected electric pumps lift water from rivers and bores to pressurised distribution systems

While electric pumping is more efficient, high network charges and connection costs have inhibited growth

Irrigation pumping – the business case

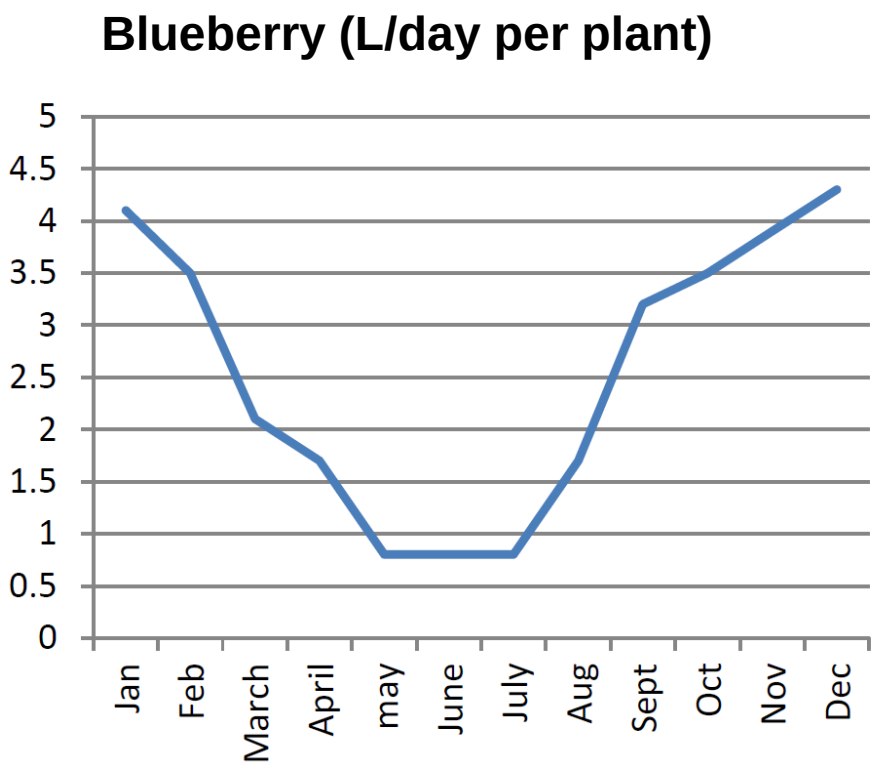
Depends on:
- Number of months pumping per year
-Time of day of irrigation
- Potential to export excess energy
+Many more factors

Solar powered irrigation systems are a significant investment and require a detailed site analysis

Irrigation pumping – the business case

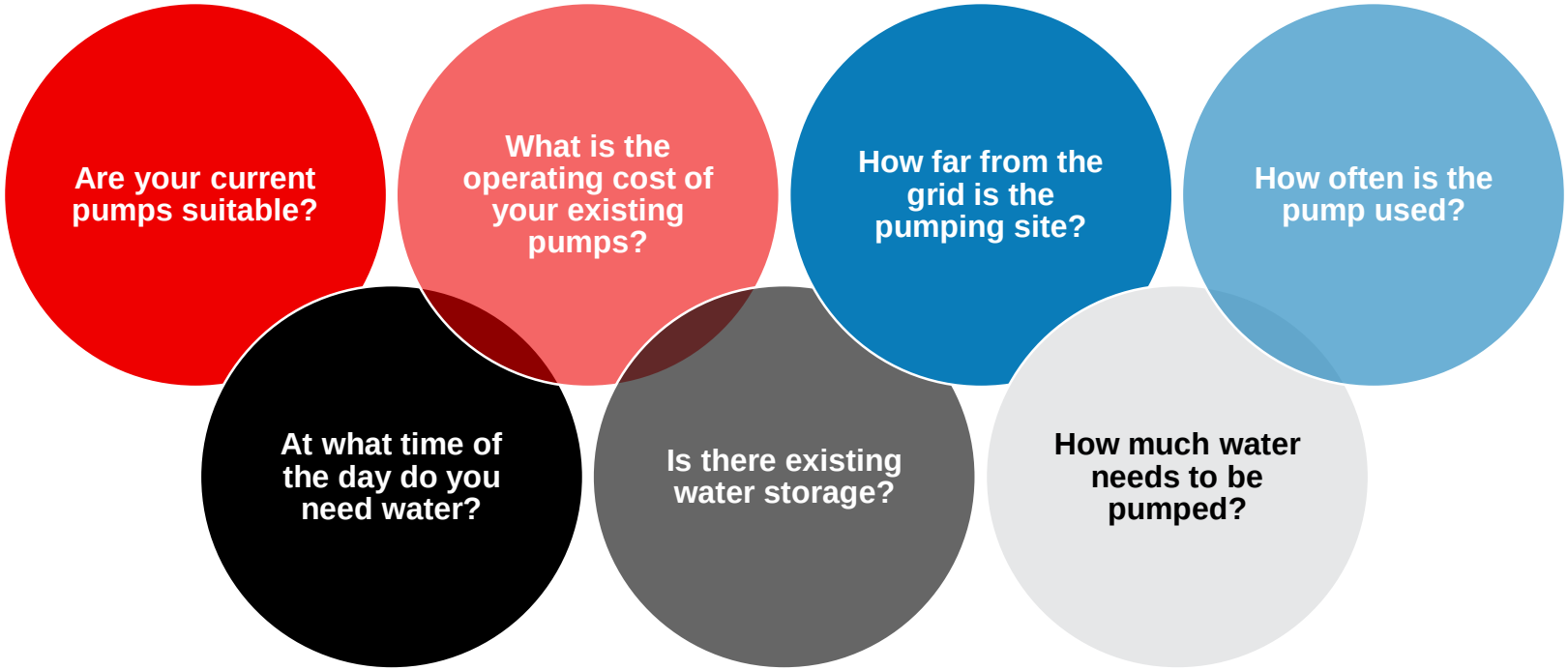
Irrigation requirements vary based on crop – some are well suited to solar pumping

If pumping is seasonal or irregular, try to identify ways to use your solar when it's not used, i.e. farm electricity or export to the grid



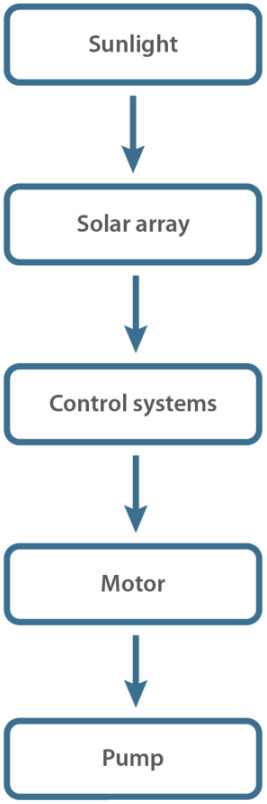
(Source: PrimeFacts, NSW DPI)

Irrigation pumping – what to ask yourself



Part 2: Solar pumping solutions

Solar pumping system



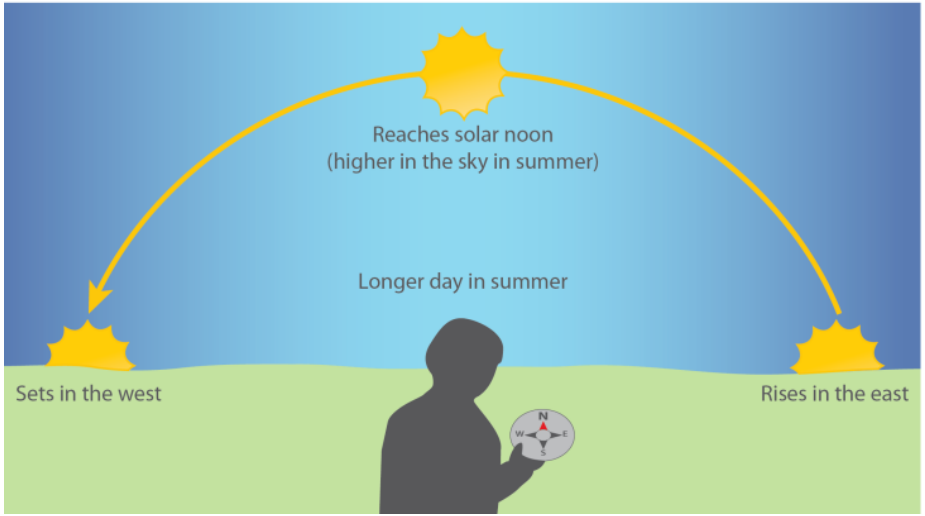
Sunlight

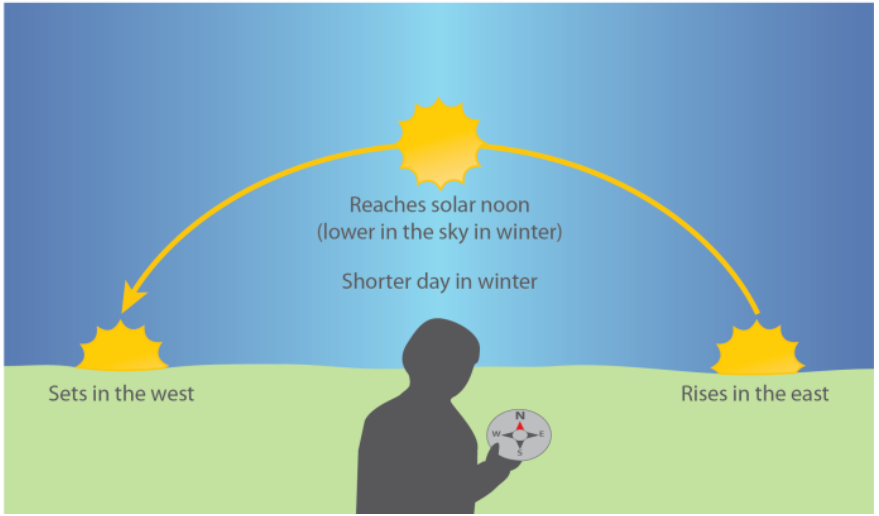
Solar irradiation

Fun fact: Earth intercepts 1,800,000,000,000,000kW of solar energy.

To compare, the US can only generate 700,000,000kW

Solar declination angle





Solar array – panel types

Monocrystalline

- made from silicon slices (wafers) cut from a single large crystal
- typically black
- reputation for higher efficiency
- more expensive to produce

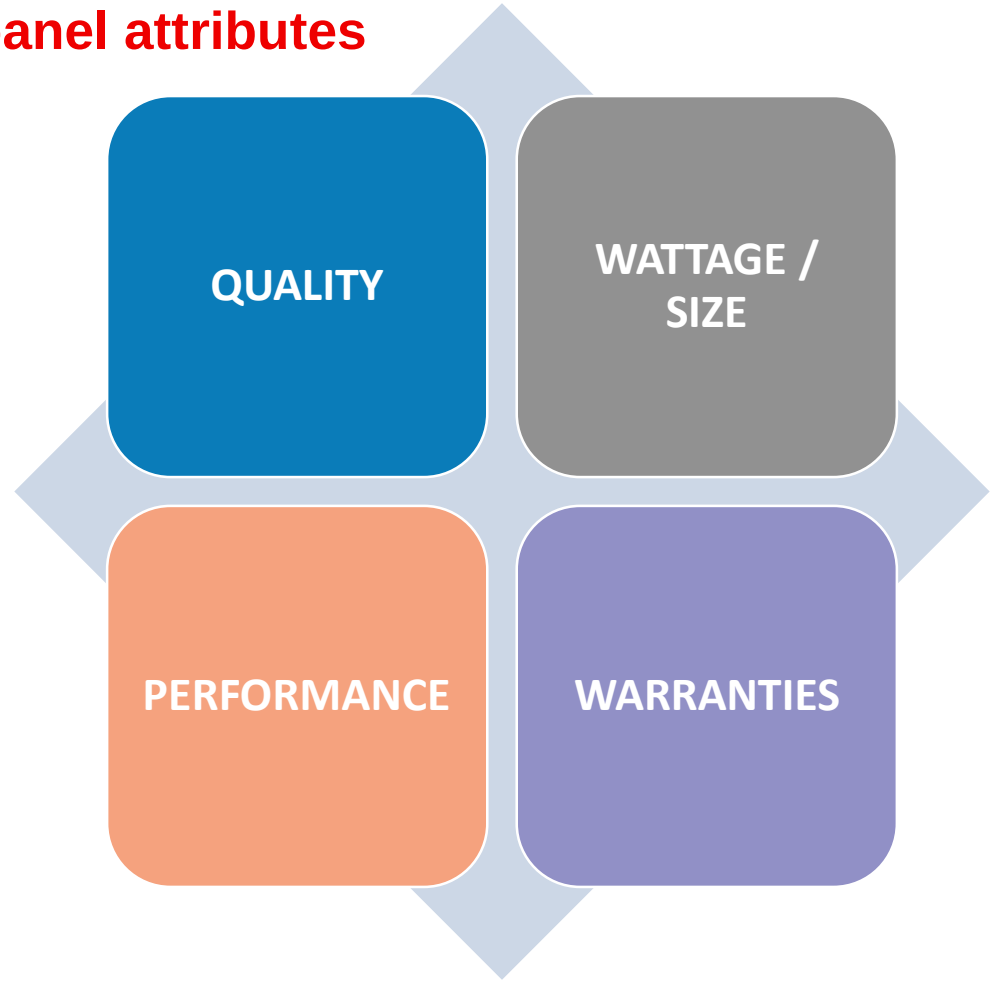
Polycrystalline

- cut from blocks of cast silicon rather than single large crystals
- cheaper to produce
- cheaper to buy
- typically dark blue

Thin Film

- layers of semiconducting and conducting materials are deposited directly onto metal, glass or plastic
- cheapest
- least efficient
- better at high temps

Solar array - panel attributes



Solar array - mounting

Ground-mounted

Typically your best option!

Roof-mounted

Floating

Pole-mounted

Solar array – tilt angle and tracking

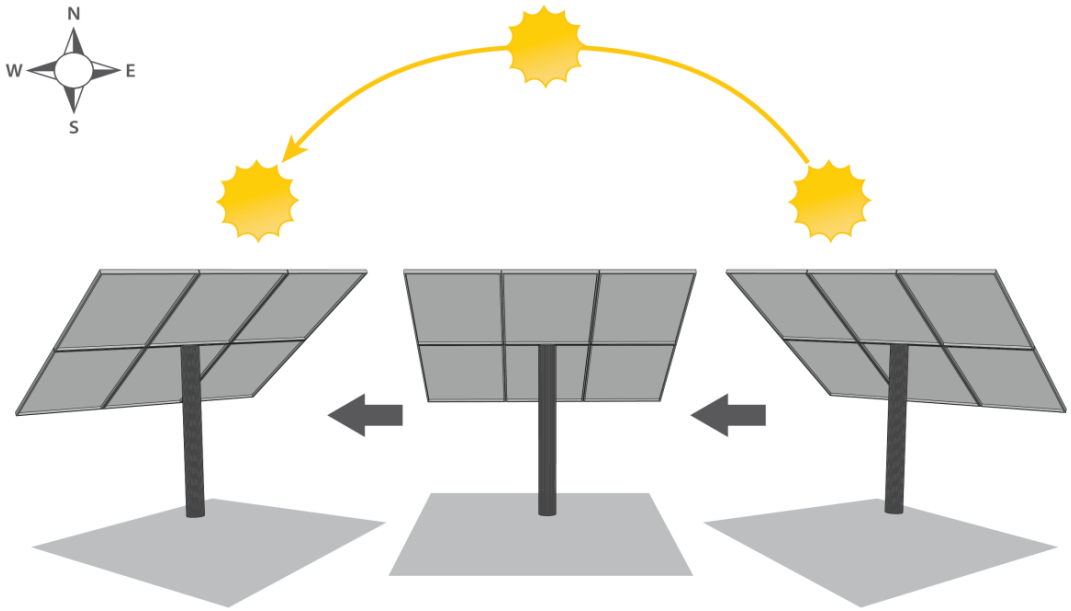
Table 3: Monthly comparison between different mounting options.

Month	Fixed tilt, equal to site latitude (PSH)	Manual tilt, adjusted each month (PSH)	Single-axis tracker (PSH)	Dual-axis tracker (PSH)
January	6.05	6.52	7.48	8.06
February	5.57	5.72	6.79	7.05
March	5.43	5.43	6.55	6.62
April	4.79	4.84	5.63	5.70
May	3.74	3.89	4.23	4.36
June	3.30	3.54	3.67	3.88
July	3.88	4.12	4.38	4.61
August	4.96	5.08	5.83	5.99
September	5.46	5.46	6.44	6.47
October	5.90	5.99	7.17	7.33
November	5.68	6.02	6.79	7.17
December	5.69	6.35	7.14	7.83
Yearly average	**5.04**	**5.25**	**6.01**	**6.25**
Percentage increase	**-**	**4.2%**	**19.3%**	**24.2%**

Solar array – tracking

More expensive

Prone to failure – need to have a good maintenance schedule!



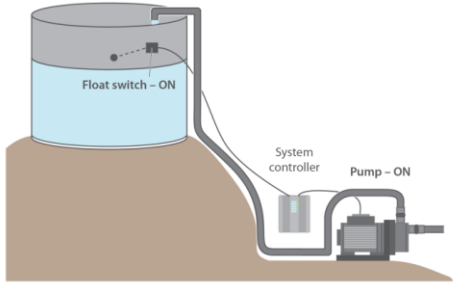
System controllers

Solar controller / Maximum Power Point Tracker

- Used to match the arrays output with the required current or voltage of the motor
- Also known as a current booster

Pump controller

- An electronic controller that turns the pump on and off.
- Usually activated by a float switch
- Can integrate a maximum power point tracker



Solar inverters

- Converts DC electricity produced by the solar panels into AC electricity
- Can then use AC electricity with the grid and AC pumps/motors
- This output can be combined with other power sources

System controllers - inverters

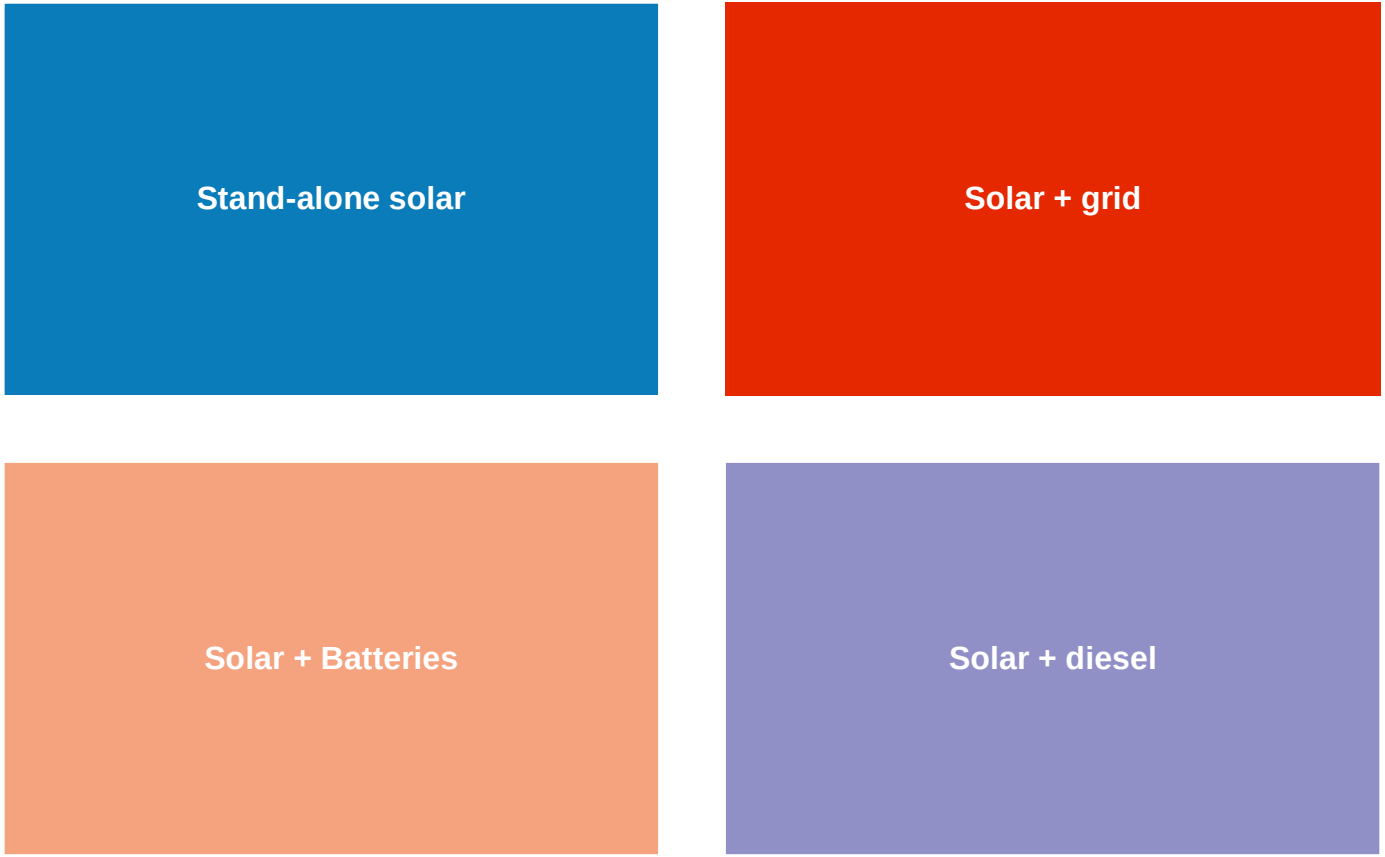
String inverters

- connected to a series (string) of solar panels
- 1 per solar system
- converts DC to AC for the solar system as a whole

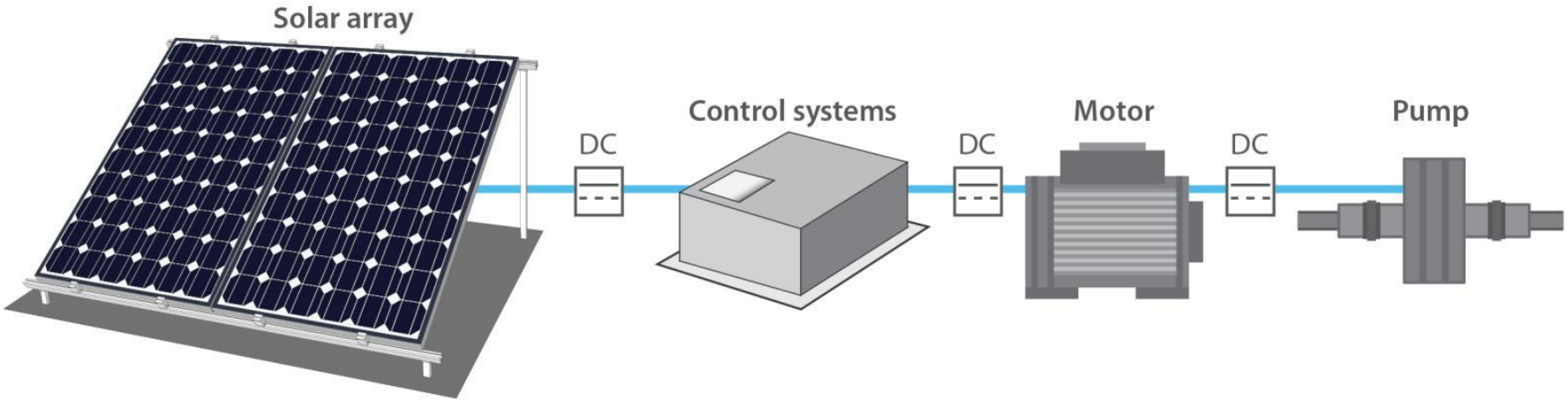
Microinverters

- mounted on the back of a solar panel to make the panel itself a grid-interactive module
- 1 per solar panel
- no DC wiring in the system at all; standard AC cables are simply run to each panel for connection

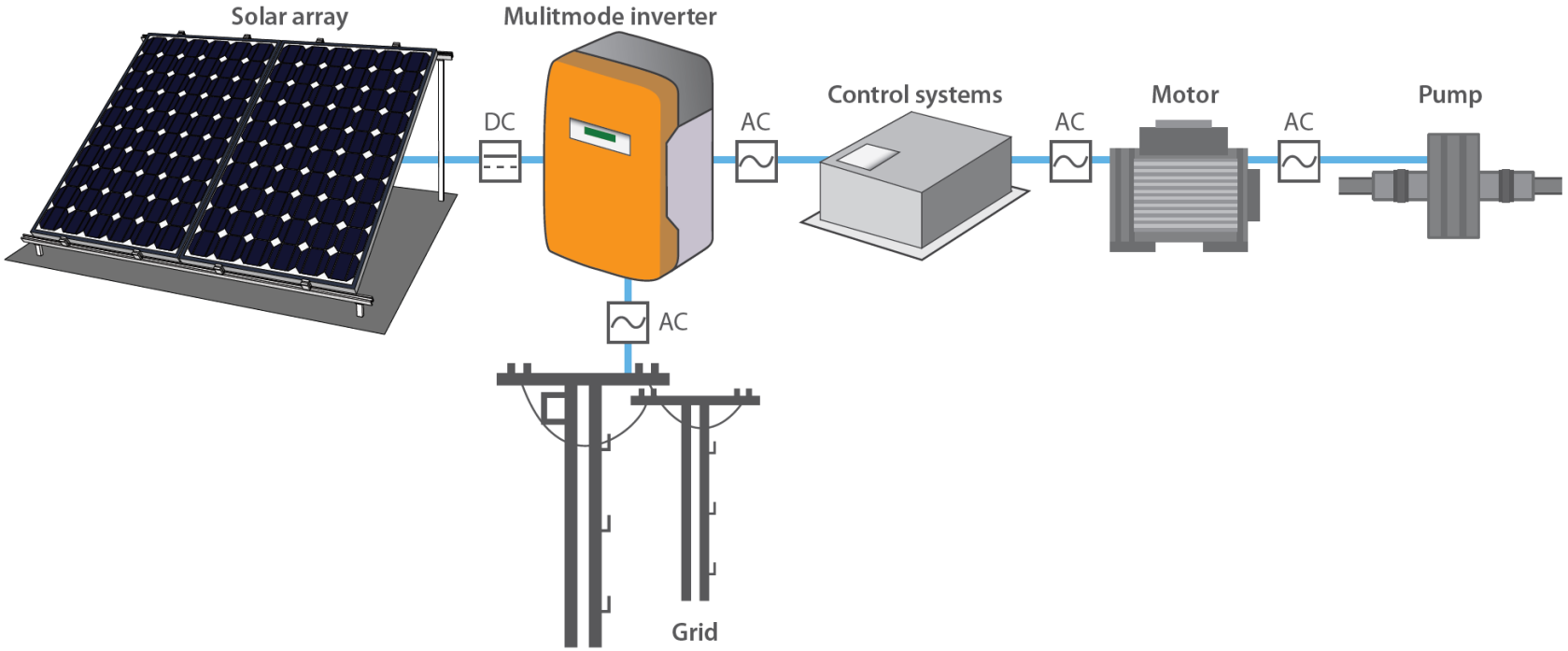
Solar pumping configurations



Solar (stand-alone)

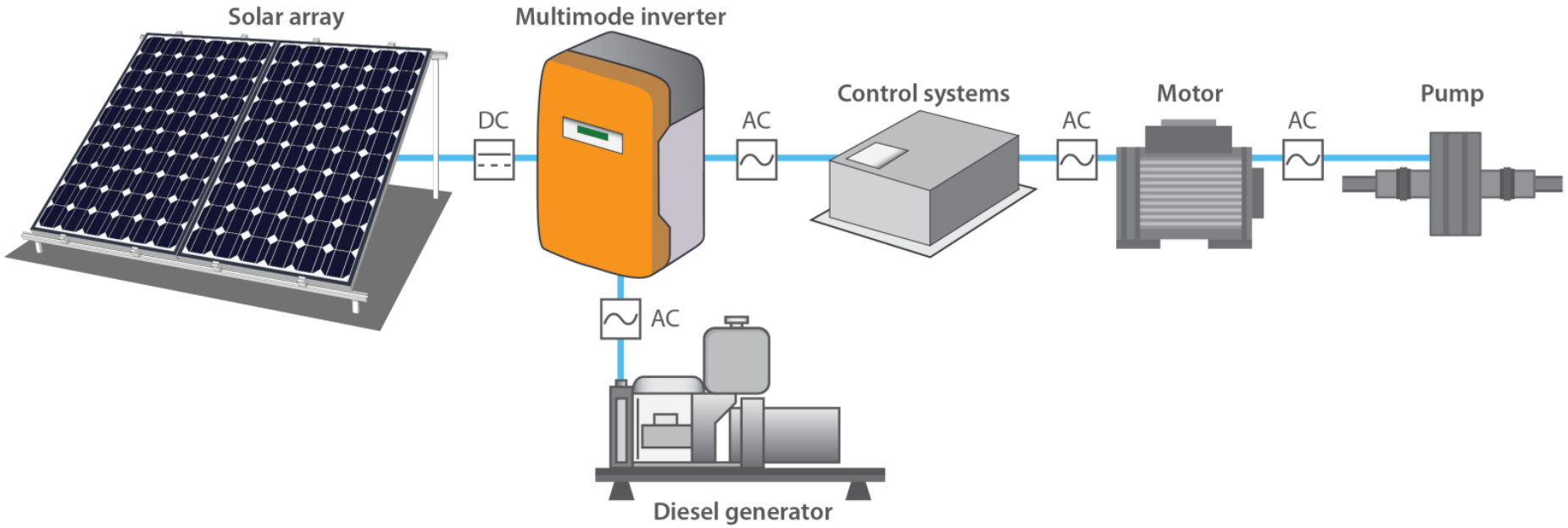


Solar with grid

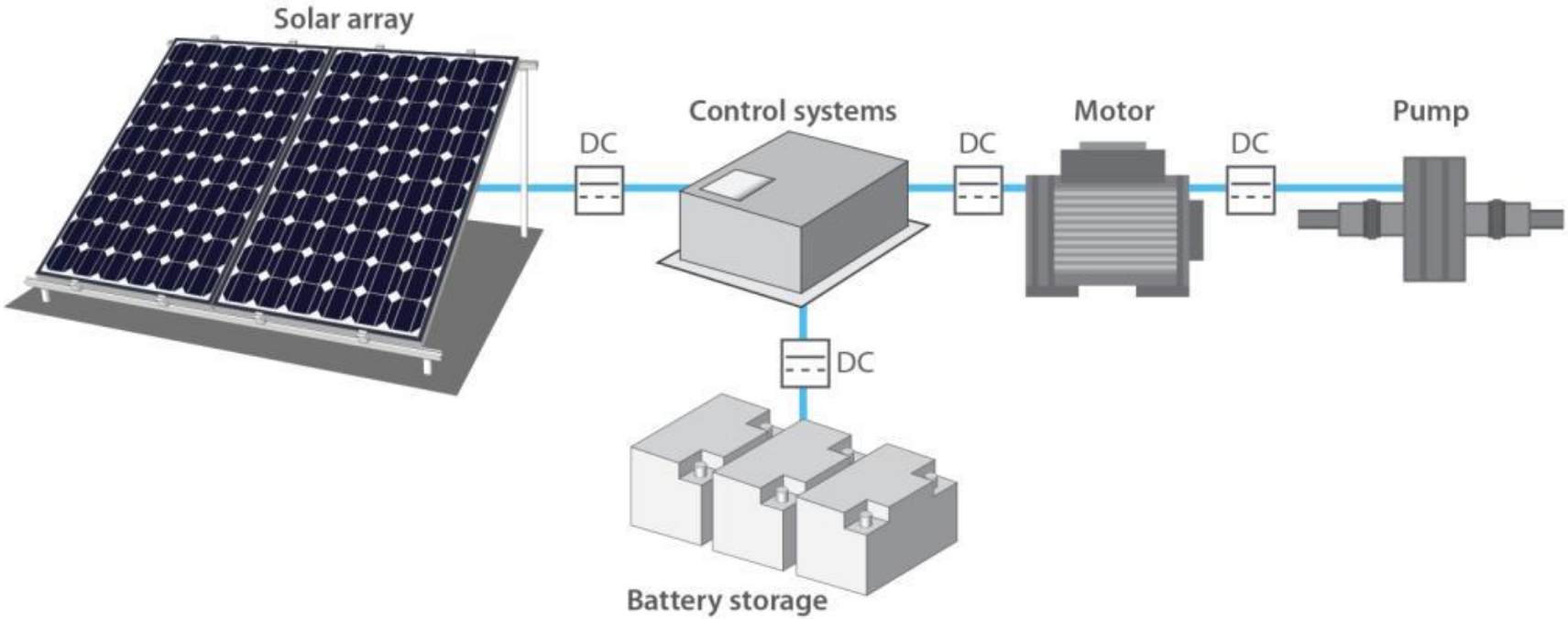


A grid connected solar pumping configuration using a combination of solar and grid power as the energy source

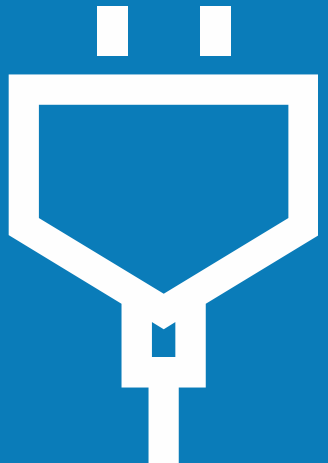
Solar + diesel generation



Solar + batteries



Part 3: The design process



Considering installing solar pumping?

General energy assessment:

Commission a general energy assessment to accurately document the pumping quantity, cost and time-of-use of your irrigation system

Address efficiency first:

Address efficiency savings first, e.g.

- Poor layouts
- Pipe diameters
- Pump size
- Maintenance

Check water storage:

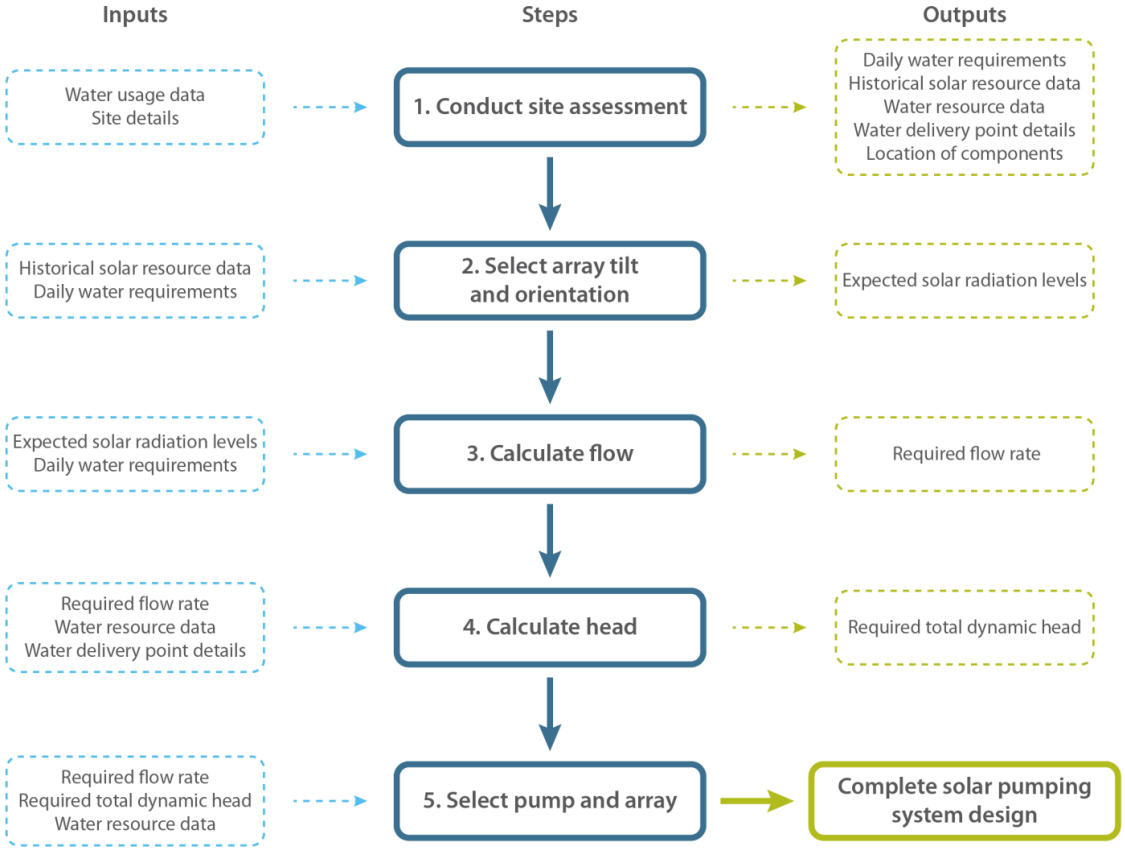
Check your water storage infrastructure to minimise leakage and evaporation.

Take stock of your total water storage.

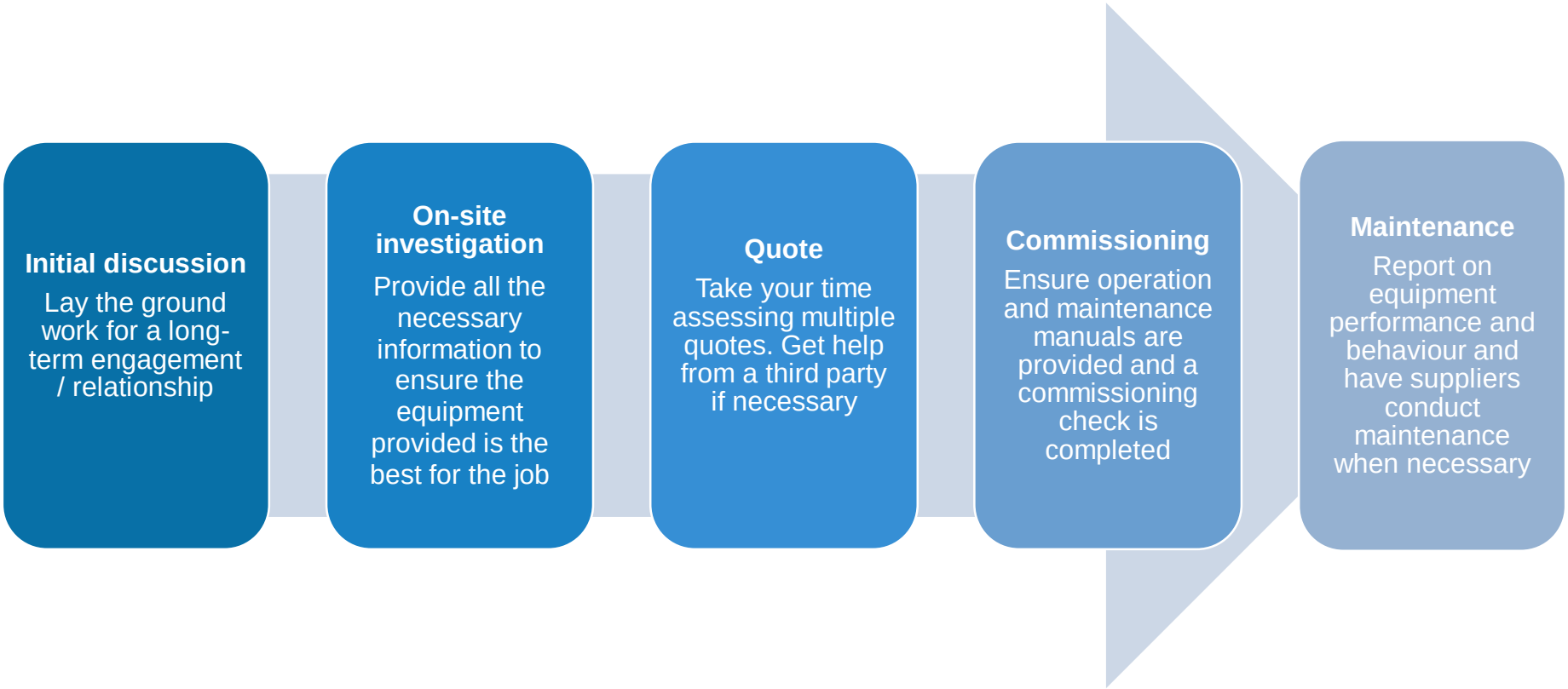
Contact:

Get in touch with your irrigation supplier first to understand your pumping requirements. Then contact a solar pumping provider

The design process



Working with suppliers



Make sure the installer is Clean Energy Council Accredited

System Maintenance

Solar module cleaning:

The array should be installed with a minimum tilt of 10° to allow for self cleaning.

If the array is visibly dirty, clean it with water and a non-abrasive material.

Cabling check:

Have cabling checked for any loose connections or damage.

Always make sure the system is turned off when checking cabling

Mounting system:

Check the mounting system to ensure it's stable.

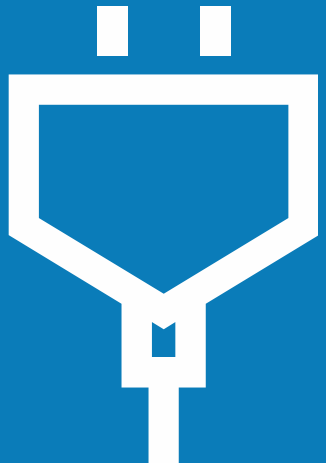
If you have a tracking system, check the motors and hinges.

Vegetation maintenance:

Make sure vegetation growth is restricted so it doesn't block the solar system.

Grazing animals may be suitable to keep grass levels low – as long as they can't chew through any cables.

Part 4: Solar pumping economics



Life cycle cost (LCC)

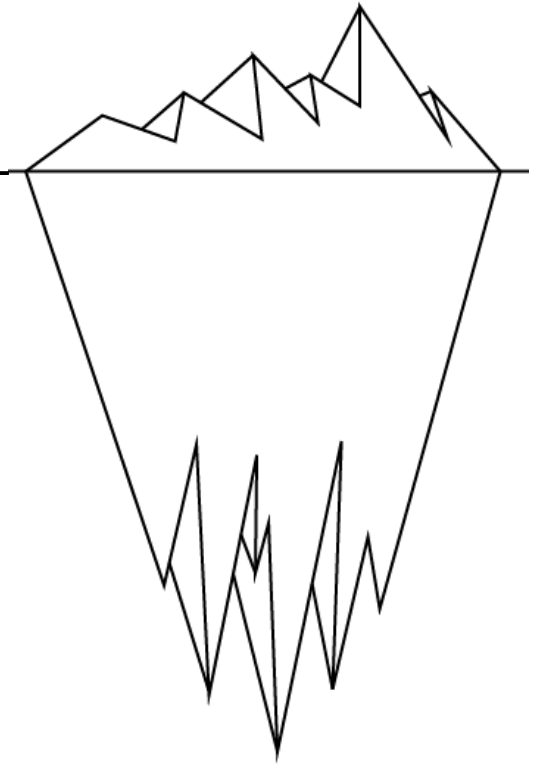
Purchase /

Energy / Materials / Water /

Labour / Training /

Maintenance / Repairs / Insurance /

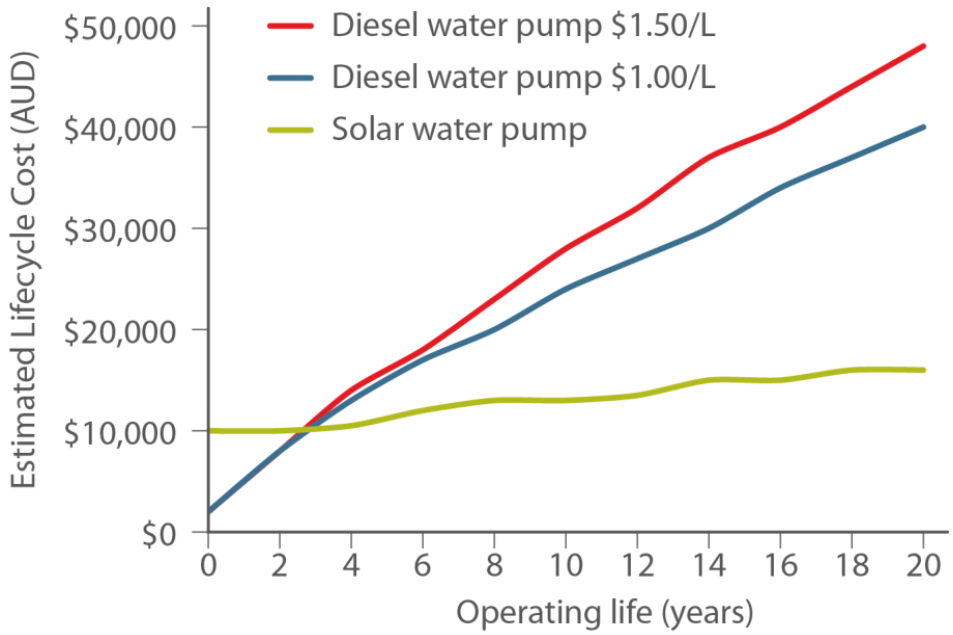
Decommissioning / Disposal /



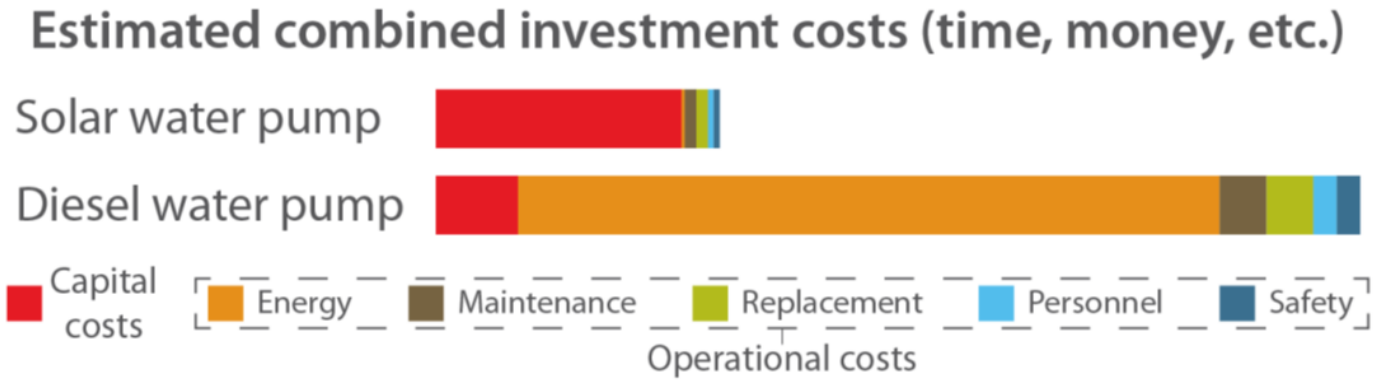
Cost differences between solar and diesel

Criteria		Solar pumping system	Diesel pumping system
Capital costs	**Equipment costs**	Equipment includes array, array mounting, system controllers, electric motor/pump, wiring, piping	Equipment limited to a generator (where applicable), motor/pump and piping
	Installation costs	Installation includes both pump and piping installation, and array and wiring installation	Installation limited to a generator (where applicable), pump and piping installation
Operating costs	**Energy/fuel costs**	None	Energy costs depend on the size of the pump, how often the pump is used and system efficiencies. Projected price increases should be included. These can represent up to 85% of the lifetime costs of a diesel pump
	Ongoing maintenance	Maintenance costs are limited to the array (minimal), the pump and the electric motor	Scheduled maintenance of the generator/diesel motor, including refuelling, oil changes, checking pressures, cleaning air filters, lubricating parts; pump maintenance also required
	Equipment replacement	Solar modules offer a 20- to 25-year performance guarantee to 80-85% output. Solar pumps and controllers offer a warranty ranging from 12 to 24 months, with an expected operating life of five years	Diesel generator would be expected to need replacement every 20,000 hours, on average, between 5,000-50,000 hours, depending on the quality of the engine and how well it has been maintained (AC pumps carry a warranty of 12-24 months)
	Personnel costs	Limited site visits are required as maintenance is minimal	Site visits are required for refuelling, starting up/shutting down the generator, and for more extensive maintenance
	Safety risks	Limited safety risks with the operation of a solar pump	Safety risks associated with fuel storage and transport; fire risk at pump

Comparison of Life Cycle Costs



Need to consider the life cycle cost



This is an indicative example only!

Case study

ecotech ENERGY
Precision Solar Solutions

Sarah Burke – Business Development Manager

Case study: Ecotech Energy

ecotech ENERGY
Precision Solar Solutions

PUMPING LOAD AND WATER REQUIREMENTS

Pumping Load	55 kW	Power Source?	Diesel
Water Pumped per Hour	788 kL	Diesel Consumption per Hour	25 L
Target Annual Pumped	2,500 ML		
Actual Annual Pumped	2,048 ML	Variable Speed Drive?	YES
Water Storage?	NO	VSD Cut-in (% Pumping Load)	40%

PUMP OPERATION

This tool runs as follows:
- without water storage: the Solar PV will pump water when there is enough sunlight during irrigation times only
- with water storage: the Solar PV will pump water at anytime there is enough sunlight and fill the storage for irrigation during irrigation times

Pumping Months			Irrigation Times	
January	☑		January Pumping Start Time	6:00
January Days per Week		5	January Pumping End Time	18:00
February	☑		February Pumping Start Time	6:00
February Days per Week		5	February Pumping End Time	18:00
March	☑		March Pumping Start Time	6:00
March Days per Week		5	March Pumping End Time	18:00
April	☑		April Pumping Start Time	7:00
April Days per Week		1	April Pumping End Time	17:00
May	☑		May Pumping Start Time	7:00
May Days per Week		2	May Pumping End Time	17:00
June	☑		June Pumping Start Time	7:00
June Days per Week		3	June Pumping End Time	16:00
July	☑		July Pumping Start Time	7:00
July Days per Week		3	July Pumping End Time	16:00
August	☑		August Pumping Start Time	7:00
August Days per Week		3	August Pumping End Time	17:00
September	☑		September Pumping Start Time	7:00
September Days per Week		3	September Pumping End Time	18:00
October	☑		October Pumping Start Time	6:00
October Days per Week		7	October Pumping End Time	18:00
November	☑		November Pumping Start Time	6:00
November Days per Week		7	November Pumping End Time	18:00
December	☑		December Pumping Start Time	6:00
December Days per Week		7	December Pumping End Time	18:00

SOLAR PV SYSTEM

LOCATION

Postcode	4415		
Latitude	26.6°S	Longitude	150.2°E

FRAMEWORK

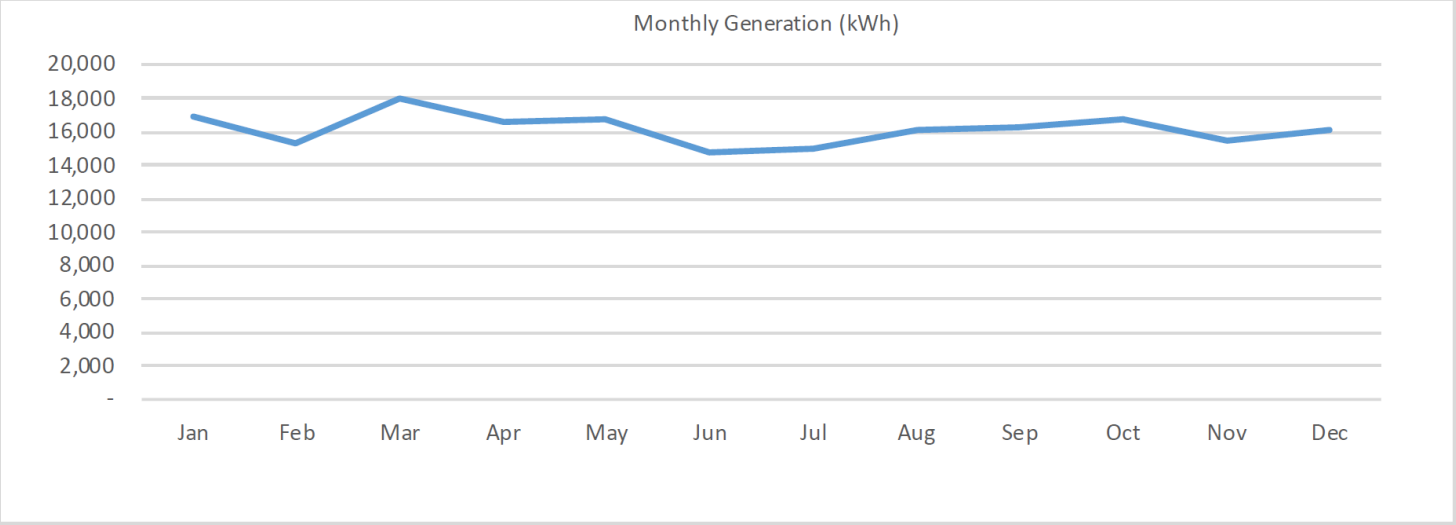
Fixed Tilt or Tracking	Fixed Tilt (N)

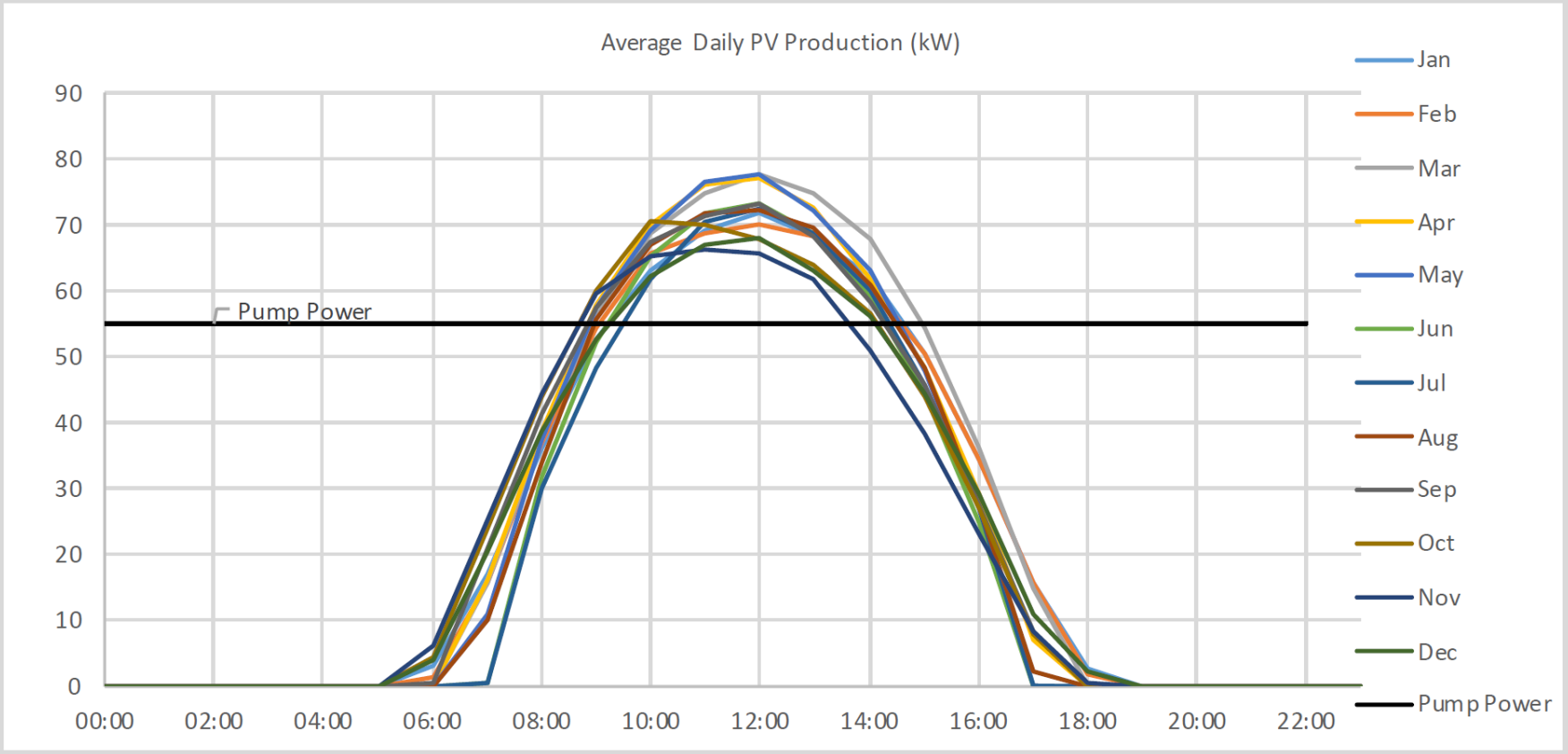
SYSTEM DETAILS

PV System Size (kWp)	100	PV System Annual Degradation	0.7%
PV System Lifetime	25 years	PV System Installation Year	2019

SYSTEM OUTPUT

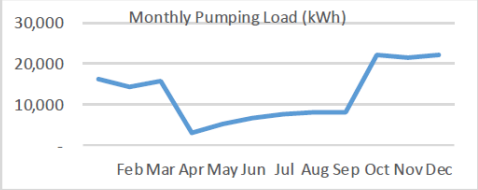
Annual Production (kWh)	193,785	Average Daily Output (kWh)	531

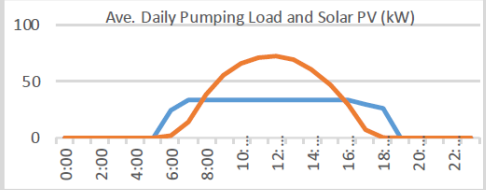



Average Daily PV Production (kW)
90
80
70
60
50
40
30
20
10
0
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
Pump Power
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Pump Power

PUMPING AND SOLAR SUMMARY

Pumping Load	55.0 kW	Average Daily Usage	413.2 kWh
PV System Size	100.0 kWp	Average Daily Solar Prod.	530.9 kWh
Target Annual Pumped	2,500 ML	Potential Pumping Annual	2,048 ML





FINANCIAL INPUTS SUMMARY

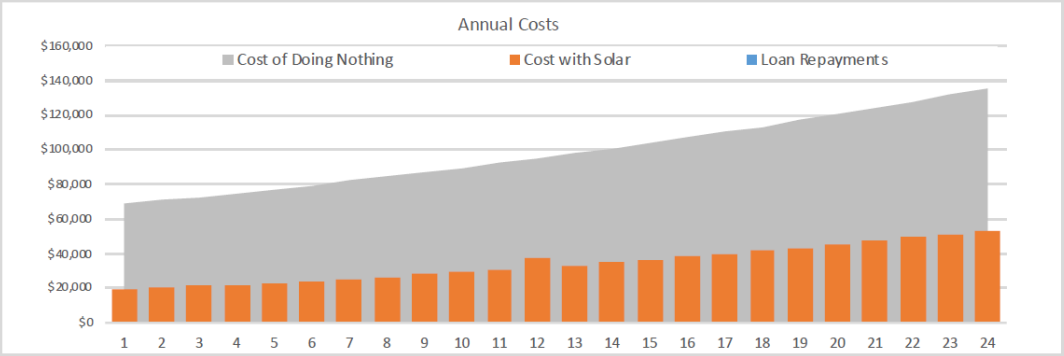
Solar PV Pumping System Cost	$ 200,000.00	Cash or Finance?	Cash
System Cost (after rebates)	**$ 146,800.00**		
Annual PV Maintenance Cost	$ -	Monthly Repayment	
Diesel Price	$1.00/L	Inflation	3% p.a.
Diesel Price Escalation	3% p.a.	NPV Discounting Rate	7%

SOLAR PV PUMPING SAVINGS

Payback Period	2.9 Years	Cost of Diesel Pumping	$0.45/kWh
NPV	$ 519,470	Cost of Solar PV Pumping	$0.10/kWh
Savings over System Lifetime	$ 1,477,967		

In year 1 the Solar PV Pumping system will save you an estimated:

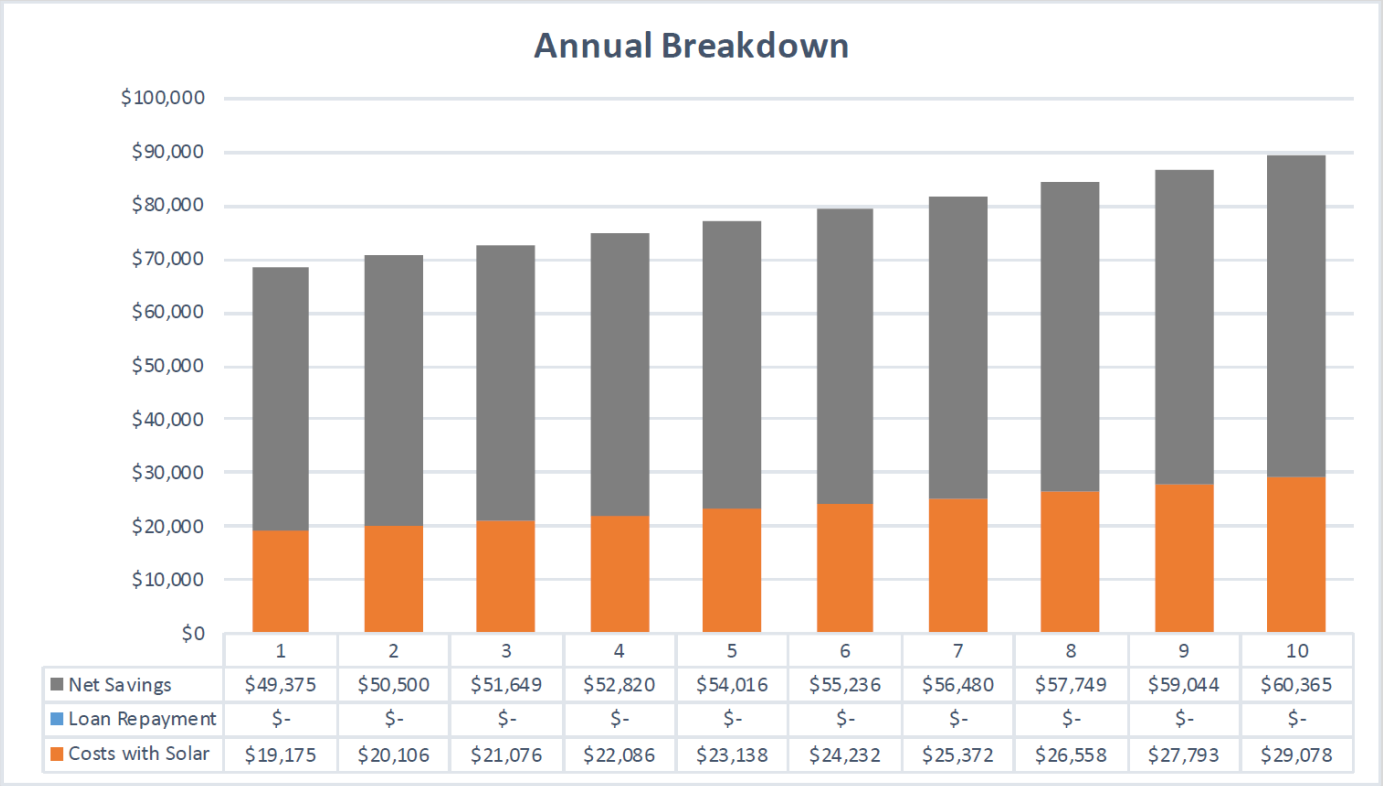
Diesel (L)	49,375	Total pumping costs saved:	$ 49,375.00



SOLAR PV PUMPING PROJECT CASHFLOW

Year 1

Cost With Solar	$ 19,175	Savings	$ 49,375
Cost Without Solar	$ 68,550	Loan Repayments	$ -
		Net Savings	$ 49,375



	1	2	3	4	5	6	7	8	9	10
Net Savings	$49,375	$50,500	$51,649	$52,820	$54,016	$55,236	$56,480	$57,749	$59,044	$60,365
Loan Repayment	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Costs with Solar	$19,175	$20,106	$21,076	$22,086	$23,138	$24,232	$25,372	$26,558	$27,793	$29,078

ecotech ENERGY
Precision Solar Solutions

Part 5: More resources

Links to more resources

AgInnovators - Solar-powered pumping in agriculture - https://www.aginnovators.org.au/sites/default/files/Solar%20-powered%20pumping%20in%20agriculture.pdf

AgInnovators – Solar Powered Pumping Factsheet - https://www.aginnovators.org.au/sites/default/files/Solar%20powered%20irrigation%20pumping_0.pdf

NSW Farmers - Why solar stacks up for farmers - https://www.nswfarmers.org.au/NSWFA/Posts/The_Farmer/Innovation/Why_solar_stacks_up_for_farmers.aspx

Clean Energy Regulator – Small-scale Technology Certificates - http://www.cleanenergyregulator.gov.au/RET/Scheme-participants-and-industry/Agents-and-installers/Small-scale-technology-certificates

Guide to Installing Solar PV for Business and Industry - www.solaraccreditation.com.au/consumers/purchasing-your-solar-pv-system/solar-pv-guide-for-businesses.html

Solar Quotes - www.solarquotes.com.au

Questions?

Luke Christiansen

luke@2xe.com.au

"Mr. Osborne, may I be excused? My brain is full."

Thank you