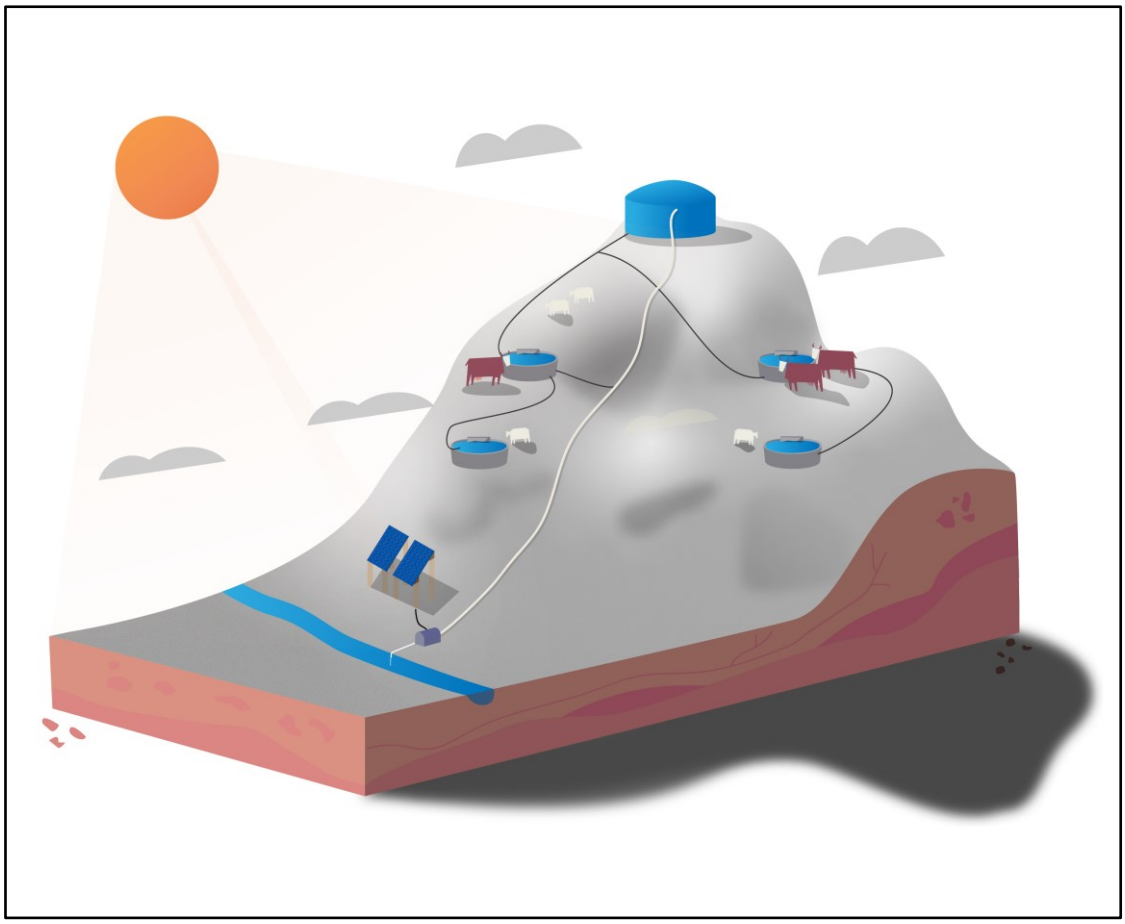
Advantages of a PowerSpout React Pump

for solar-powered water supply to livestock in New Zealand

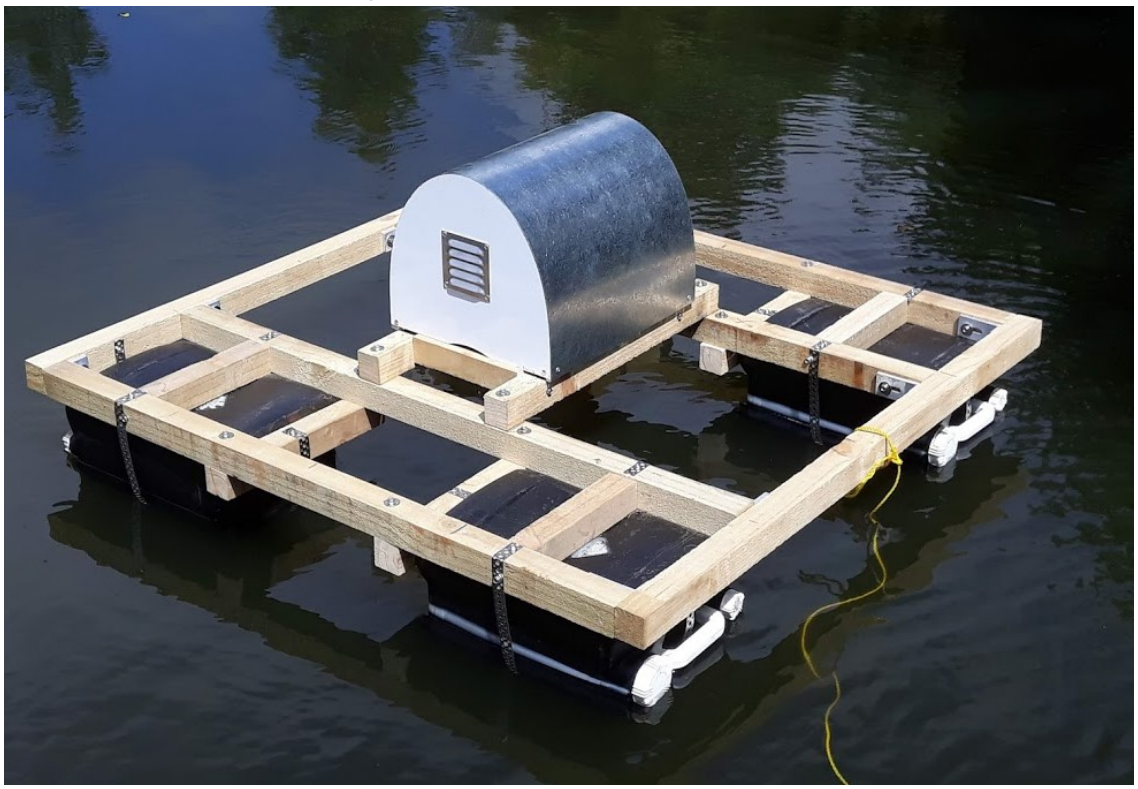
Typical installed PV array

(there are many ways to install solar PV)

Typical ground installation



Typical pontoon installation



Click here to see a video of the React pump working on a pontoon with a 200m lift

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1 Introduction

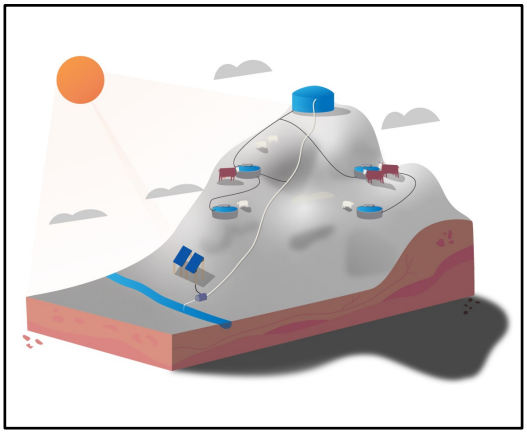
1.1 What is the React pump?

The React pump is an ideal pump for filling livestock watering tanks, being clean, compact, quiet, low maintenance and having low cost of ownership long term.

Made in NZ (from domestic and imported parts), it is easy and safe for a farmer to install without needing permits for water abstraction, building permit for PV erection or code of compliance for the electrical installation. Annual servicing is easy to do yourself, or can also be provided by EcoInnovation (the NZ manufacturer) for a fixed annual cost on a return to base arrangement during the winter season when the pump may not be needed.

1.1.1 What's in the package?

The PowerSpout React pump uses solar power directly from 1, 2 or more small PV arrays at "extra low voltage" (ELV). The brushless motor driving the pump is controlled by an internal circuit, without any need for batteries. This circuit alters the speed of the pump (higher speed more power, lower speed less power) to extract maximum power from the sun under varying light conditions. This is called MPPT (maximum power point tracking) in the industry.



The React pump can pump water up to a tank at any height from 10-300 metres (vertical rise) above the intake.

Stock demand for water will tend to follow the solar cycle. More sun more water, less sun less water required.

The React pump is designed to be run from solar electricity, but it can also be used with grid-power or an engine-driven generator if desired. (It can be purchased with or without solar panels.)

1.2 Why provide reticulated water to livestock?

Replacing streams and dams with water tanks, pumps, pipes and troughs on hill country farms makes the flow of stock water more efficient. (See also section 6 for more detailed analysis.)

A recent report for the NZ government identifies the following advantages:

- Increased stock numbers.
- Increased lambing (12%) and/or calving percentages.
- Increased slaughter weights.
- Opportunistic stock finishing.
- Saved costs from not having to maintain dams on a regular basis.
- Economics paybacks from 1.5 years (3 year average over 11 farms)

Note that new NZ legislation excludes dairy cattle from access to waterways starting from 2017, and further exclusions will follow in years to come.

1.3 Water pumping methods on farms: When to choose the PowerSpout React pump for livestock water supplies?

Here are some typical scenarios:

1.3.1 Gravity feed water systems

Water is piped from a high level source and no pump is required as gravity does the job. This option is the best solution where possible. But often it will be necessary to pump water.

1.3.2 Grid powered pumping

Where a grid connection is affordable, the React pump can be powered from the grid (no PV panels required) via a mains AC/DC converter. This may be attractive compared to other pumps on high head sites. Where a long wire is needed to reach the pump from the grid, the React pump can be powered via lower cost 80V DC ("ELV") cable. You will need to contact us if you are considering this option, as the MPPT may need to be disabled in the electronic speed controller.

Here is an advertisement for a suitable "power supply" that converts grid power to 80VDC

Daily grid connection charges to remote sites can often exceed the value of the power that the pump consumes. The Lines Company operating in the King Country is a good example of this and is a high fixed fee network operator. It may be more economic in some cases for sheep and beef farmers to change from grid power to solar power using the React pump.

1.3.3 Off-grid situations where engine driven pumps are used

Small engine-driven pumps are common in NZ and typically cost $1500-2500NZ complete. When used to fill large storage tanks on 50-200m lifts, they are often not very efficient, as the small pipes can only cope with 0.1-0.5l/s flow rates. The result is very low pumping efficiency and high fuel bills, not to mention the time required to fill the fuel tank each day.

The cost of ownership, fuel and labour to keep small fuel pumps operating can cost a typical sheep/beef farmer over $5000/year/pump. **This means a React pump can pay for itself in a single year in some cases.**

The React pump is ideal for such off-grid situations because it is self-powered and mainly maintenance free for the season. By pumping steadily for long periods it can delivery plentiful water without suffering excessive friction loss in small and long delivery pipes.

1.3.4 Water powered pumping

"Water rams" have been around for many years, and where you have naturally falling water with sufficient head they can work really well (although noisy).

1.4 What are the main advantages of a React pump

- Far more cost effective than the competition.
- Far more efficient than the competition (world best in class, peak pumping efficiency 64%).
- Do it yourself - No builder, electrician or water take permit needed (in NZ).
- Light weight <20kg (no risk of lifting injuries) and 1 person can install it. Easy to move to a workshop for servicing.
- Direct drive (no gearbox to add weight, cost and complexity).
- High efficiency motor (up to 80% efficient).
- Brushless motor (no brushes to wear out in the motor).
- Electronic motor driver (up to 95% efficient) with MPPT (maximum power point tracking).
- High efficiency plunger triplex pump (up to 85% efficient).
- Slow running rpm (in the range 200-1200rpm) makes it quiet and durable.
- Built tough for global export and fits into a DHL export carton.
- Will pump to a set pressure (the point where the ball cock start to close) and then stop.
- Pressure stop point is set via a simple push button. Default setting is 300 head and a 30 minute wait time.
- Quality ceramic Triplex pumps last longer because each individual component does less work. The flow of water from a React pump is relatively constant so no pressure dampener is needed.
- Can pump clean or dirty water (within reason) as plunger pumps are less prone to damage than piston pumps. The plunger does not run in a bore where abrasive grit can become trapped.
- If the super-hard ceramic plungers are ever damaged they are low cost and quick to replace.
- Is light enough to mount on a pontoon that floats on the surface of water of storage dams, lakes and rivers - eliminating the need for high suction lifts. Sucking water from more than 8m below the pump is problematic for **all pumps**.
- A smaller sized pipe can often be used, saving on the installation costs. This plunger triplex pump has increasing efficiency with pumping head. Also the PV utilization efficiency improves with pump loading. This means that a smaller pipe that increases the pumping head (due to pipe friction) from say 100m to 150m head only sees a 10% reduction in the peak flow rate (15.24-14.56 l/min) and not the expected 33% reduction. Refer to example table below that was measured on a sunny summers day (1080W of PV installed).

Time	Watt	Volts	RPM	(kPA) Pressure	(m) Head	Power Out	Eff %	PV Utilization Eff %	Flow l/min
12:30	620	63	1163	1000	101.9	254	41	57	15.24
12:30	720	62	1111	1500	152.9	364	51	67	14.56

- Pump efficiency also increases slightly on overcast days. This may seem odd at first glance. As the pump slows down (1163 rpm sunny day to 660 rpm overcast day) this increases the pump efficiency. Also all the available power from the PV array can be used. This occurs at about 58V. Refer to example table below where the pump efficiency has increased from 41% to 48%.

Time	Watt	Volts	RPM	(kPA) Pressure	(m) Head	Power Out	Eff %
12:30	620	63	1163	1000	101.9	254	41
12:30	300	58	660	1000	101.9	144	48

2 React Pump Features:

2.1 Only one pump is needed for heads from 10-300m (HP upgrade above 160m required).

The lift (head) is automatically adjusted by the MPPT controller.
On low-head sites the pump will speed up to deliver more water, on high-head sites it will slow down to pump less water but to the higher head.
The only variable is the amount of solar PV panels you decide to install.

2.2 Positive displacement oil filled triplex plunger pump

The pump we use is mass-produced for high pressure water applications. They are typically found in forecourt car auto washers. Such triplex pumps are in the highest efficiency class. The mechanical mechanism is submersed oil lubricated, will run for many years and is easily serviced. Spare parts are plentiful and cost effective. The oil and water side are completely separate so there is reduced chance of a water side seal leak displacing the oil.

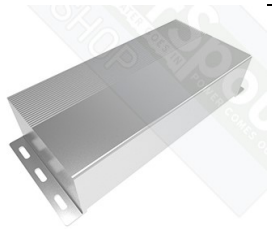
2.3 Direct Drive BLDC motor

The motor we use is a slow speed (200-1200 rpm), direct drive, high efficiency, brushless motor made by Fisher and Paykel that is copper wound and uses ferrite magnet technology. We specially modify the copper winding for this pumping application. This motor is in the highest efficient class.

We have been running these motors as alternators in our hydro turbines for almost 20 years.
It is the same technology that is inside direct drive washing machines.
Spare parts are plentiful and cost effective.

2.4 Drive electronics

The power from the solar panels is converted and controlled by a mass produced BLDC electronic driver that runs between 50-80V DC.
This 1.5 kW driver is a mass produced part for use on small electric vehicles. The BLDC is common and cost effective.



2.5 Need to lift to heads 500m? Easy! Install an React Pump for every 250m of head.

For more head, another React Pump is installed after each lift. Installing them in a chain like this is called a "series installation". Remember that affordable plastic farm pipes are rated for up to 160m of head (up to 250m is available), so care is needed if pumping above 160m in a single lift. A 160m static head lift, combined with pipe friction, may result dynamic heads up to 200m. 300m head of pressure is the maximum dynamic rating of the React pump.

2.6 Need to pump more water. Easy! Install more than one React pump.

For more flow, another React pump is installed. Installing them next to each other is called a "parallel installation".
Whether you require 5,000 litres per day or 100,000 litres per day, 1-10 React Pumps can do the job required.
The same mass-produced affordable pump can solve water pumping problems on small and large farms.

2.7 Purchase and maintain yourself or join the service/support plan for a fixed annual fee

Customers can choose to maintain their React pump themselves or return it every year under the service/support agreement.

The service/support plan will ensure that your React pump is in top working order provided the annual fee is paid and the React pump is returned every 12 months for service.

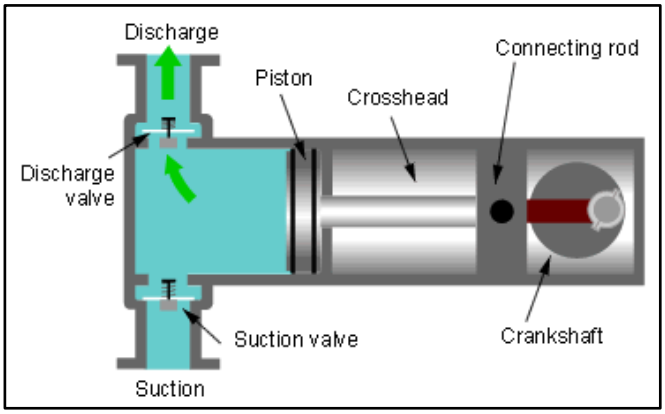
3 React pump options

There is **only 1 option** of the React pump available. Pumps can be used is series and parallel. Each pump can have nominally 500W (2 panels), 1000W (4 panels) or 1500W (6 panels) of solar PV attached. This combination gives a very wide operational window of head a flow. For example 4 x React pump units can be configured to pump water to 1.2km head (15.8 l/min) or 50m head (63 L/min).

If you prefer not to install solar PV to power the pump, options to power from the grid or a fuel generator set are also possible.

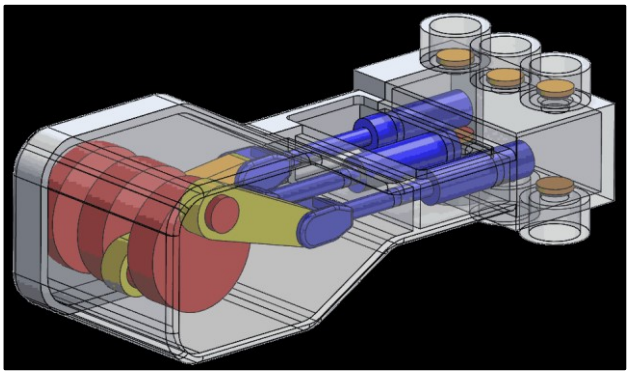
4 Piston pumps versus Plunger pumps

Piston pumps and plunger pumps are reciprocating positive displacement pumps that use a plunger or piston to move media through a cylindrical chamber. Such pumps are capable of handling water that contains solids particles to some extent.



A **piston pump** is a positive displacement pump where the high-pressure seal reciprocates with the piston.

A **plunger pump** is a positive displacement pump where the high-pressure seal is stationary and a smooth cylindrical ceramic plunger slides through the seal. This makes them different from piston pumps and allows them to be used at **higher pressures**. This is why our React pump can pump up to 300m head.



The React pump uses a plunger pump. These simple oil lubricated pumps are in the highest efficiency class with mechanical efficiency in the 80-90% range.

Compared to other solar pumps (centrifugal and helical screw) that run at 1000-6000rpm, the React pump runs at up to 1/5 of this speed, around 200-1200 rpm, greatly prolonging the life of parts.

4.1 Triplex Plunger Pump

Professional level pumps use triplex plunger pumps because they are high pressure and can run for thousands of hours before any maintenance.

They are up to 90% efficient and run cooler as they run slower. In a triplex pump, 3 plungers stroke 120 degrees apart to offer smooth flow over the entire revolution of the crankshaft. Hence there is no need for a pulsation dampener in the system.

Their life span is basically limited only by how well you maintain them. The easy to access pump head and easy to replace valves make repair and maintenance simple and economical.

- ***Pros***: Very efficient. Stationary seal means increased life, less prone to leaks and much higher pressures. Lower operating speed allows it to run cool and this again increases operating life.
- ***Cons***: There really are very few. Such pumps used to be very costly this has changed in recent years. These pumps cannot be used underwater down a deep bore hole. But you can use a low cost submersible bore pump to do this part of the lift and the React pump for the high head that follows.

4.2 Why are most other pumps submersible bore type?

Globally, most water resources are sub-surface. Bore pumps can be used on bores, wells, streams, lakes and dams. Because bores are of a small diameter such pumps typically employ centrifugal or helical rotor types. This compact size requirement means they have to be high speed for direct drive. However high speed is not good for long life expectancy.

In NZ and many other farming countries, most pumped water is from springs, streams, rivers, lakes and small farm dams. This is because bores are costly to drill and taking water this way (for farm stock drinking needs) is normally not permitted and requires consent. Also bore water can contain unwanted minerals. For an NZ government document on bores read here.

4.3 Bore hole abstraction permit/consent

Permission is generally required both to drill a bore and to use the water. Both consents are granted by regional councils in NZ. Taking too much groundwater can affect other bore water supplies in the area, reduce water levels at the surface and even cause salt water to be drawn into an aquifer from the ocean. For the same reasons, permission is needed to increase the amount taken beyond what has been consented. In some areas there is a lower limit below which water abstraction is a 'permitted activity' and no consent is needed. This depends on the local circumstances. The local regional council can advise on their specific requirements. Be ready to tell them how much water is required and the location it will be drawn from.

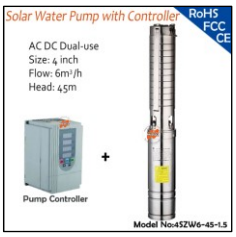
4.4 Taking surface water permit/consent

Almost all councils in NZ make the taking water for *domestic and stock supplies* a **permitted activity**. As such, pumps like the React pump can be installed **without any permit required**. There may be a few exceptions for waterways of endangered species, so always check first.

In general taking water from a river, stream, lake or aquifer *for use in production, processing, irrigation* requires consent. This can be a costly and time consuming undertaking often with significant ongoing annual compliance fees.

5 Water Pumping Solutions – including the Competition

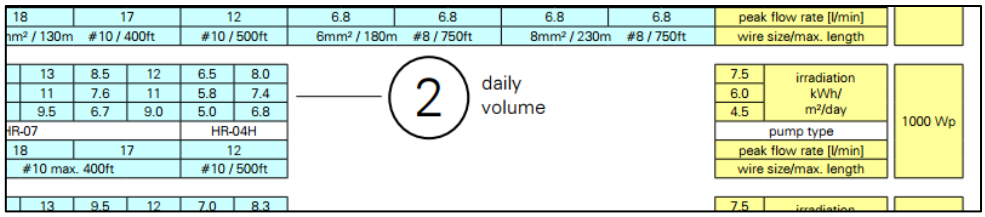
In NZ these are some of the main options.

5.1.1 The Lorentz range of pumps Lorentz manufacture a large range of quality pumps (designed in Germany and made in China) imported and distributed into NZ. Click here for a link of suppliers.	
5.1.2 The ePump The ePump manufactured in NZ by Isaac's Pumping and Electrical from domestic and imported parts.	
5.1.3 The React pump The PowerSpout React pump is made in NZ by EcoInnovation from domestic and imported parts.	
5.1.4 End client imported Chinese pumps On international web sites there are a large number of solar centrifugal PV pumps available, mainly for heads in the range 10-60m. Above 60m lift your options are more limited. Most of these pumps are low cost disposable units with delivered prices from $150 US upwards (pump & controller only).	
5.1.5 Pumpstore.co.nz The www.pumpstore.co.nz sell a range of solar pumps of Chinese origin from $289 to $2145 NZ.	

5.2 Examples @ 120m lift for each pump option

Please note this may not illustrate the peak efficiency of our pump, but is a practical example for a simple comparison that can be easily made. Our comparisons are made based on peak flow as we do not have performance data for operation in reduced solar insolation.

5.2.1 Lorentz PS1200 HR-07 – helical rotor pump



Details on the theory of this pump type click here

With 1000W of PV, 120m head and 17l/min peak flow.

Pumping power = head (m) x Flow rate L/hr x 9.81 (m/s^2) / 3600
= 120 x (17 x 60) x 9.81 / 3600 = 333.5W
PV power peak utilisation efficiency = 333.5/1000 = 33.3%
(Helical rotor pumps have a higher efficiency than centrifugal pumps.)

5.2.2 The React pump

5.2.2.1 Fitted with 1080W of PV.

Pumping power = head (m) x Flow rate L/hr x 9.81 (m/s^2) / 3600
= 120 x (14 x 60) x 9.81 / 3600 = 275W
PV power peak utilisation efficiency = 274/1080 = 25.4%

5.2.2.2 Fitted with 540W of PV.

Pumping power = head (m) x Flow rate L/hr x 9.81 (m/s^2) / 3600
= 120 x (11.5 x 60) x 9.81 / 3600 = 226W
PV power peak utilisation efficiency = 226/540 = 41.8%

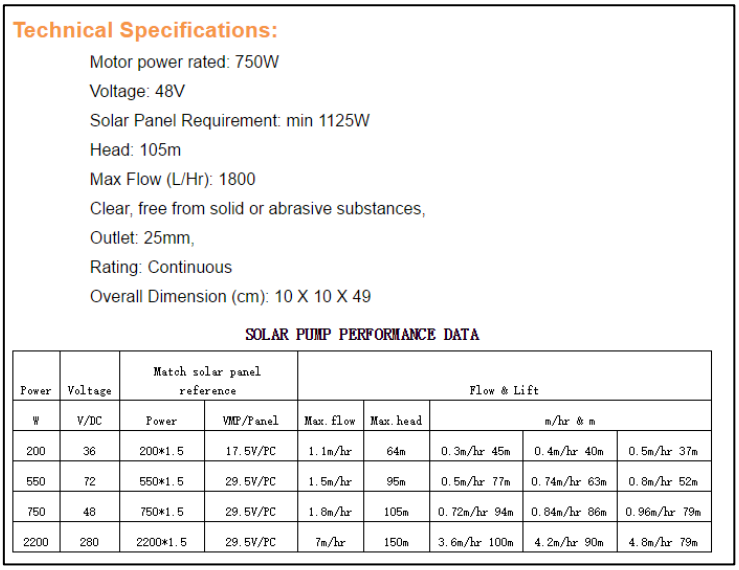
5.2.3 The ePump

The ePump difference

- Built to withstand the harshest environments
- Three models
  - 60 metre pumping 23 ltrs per minute
  - 120 metre pumping 15 ltrs per minute
  - 40 metres pumping 30 ltrs per minute
- Eliminates regular checks for maintenance and refuelling
- Environmentally responsible alternative
- Labour efficient
- No ongoing power or fuel costs

Pumping power = head (m) x Flow rate L/hr x 9.81 (m/s^2) / 3600
= 120 x (15 x 60) x 9.81 / 3600 = 298.3W.
1800W of PV is supplied with the pump
PV power peak utilisation efficiency = 1800/289.3 = 16.4%

5.2.4 The pump store



Technical Specifications:

Motor power rated: 750W
Voltage: 48V
Solar Panel Requirement: min 1125W
Head: 105m
Max Flow (L/Hr): 1800
Clear, free from solid or abrasive substances,
Outlet: 25mm,
Rating: Continuous
Overall Dimension (cm): 10 X 10 X 49

SOLAR PUMP PERFORMANCE DATA

Power	Voltage	Match solar panel reference		Flow & Lift				
W	V/DC	Power	VMP/Panel	Max. flow	Max. head	m/hr & m		
200	36	200*1.5	17.5V/PC	1.1m/hr	64m	0.3m/hr 45m	0.4m/hr 40m	0.5m/hr 37m
550	72	550*1.5	29.5V/PC	1.5m/hr	95m	0.5m/hr 77m	0.74m/hr 63m	0.8m/hr 52m
750	48	750*1.5	29.5V/PC	1.8m/hr	105m	0.72m/hr 94m	0.84m/hr 86m	0.96m/hr 79m
2200	280	2200*1.5	29.5V/PC	7m/hr	150m	3.6m/hr 100m	4.2m/hr 90m	4.8m/hr 79m

750W version with 1125W of PV
Pumping power = head (m) x Flow rate L/hr x 9.81 (m/s^2) / 3600
= 94 x 720 x 9.81 / 3600 = 184.4W.
PV power peak utilisation efficiency = 1120/184.4 = 16.5%
(Note this is at 94m and not 120m as per the other 3 examples.)

5.3 Published Peak Efficiency

- React pump (piston diaphragm oil lubricated) 64%
- Lorentz (centrifugal) 48%
- Lorentz HR helical rotor (depends on model) 60-64%
- Pump Store (not published) 25-35% estimated
- ePump (not published) 25-35% estimated

The React pump has the highest peak efficiency. It is clear that the React pump and the Lorentz PS1200 HR-07 have very similar performance at the 120m comparison we have made. The performance of all other pumps listed is much lower.

5.4 Pump comparisons based on an estimate of likely installed costs to give a $/W peak flow comparison

Name	Pump Type	Motor Type	Pump or system cost $NZ	PV Size Watts	PV cost $NZ	Frame cost $NZ	Balance of system $NZ	Concrete foundation costs $NZ	Labour costs $NZ	Total Cost	Peak flow 120m @ l/min	$ spent per l/min peak @ 120m
React (twin)	Triplex plunger	Brushless	3699	2080	1872.0	468.0	468.0	520.0	1248.0	8275	28.0	295.5
React (single)	Triplex plunger	Brushless	1999	1040	936.0	234.0	234.0	260.0	624.0	4287	14.0	306.2
Pumpstore	Centrifugal	Brushless	1080	1125	1012.5	253.1	253.1	281.3	675.0	3555	9.4	378.2
*Lorentz PS1200 HR-07	Helical rotor	Brushless	4500	1000	900.0	225.0	225.0	250.0	600.0	6700	17.0	394.1
ePump	Piston (single)	Brushed	10995	1800	inc.	inc	inc	450.0	1080.0	12525	15.0	835.0

- PV has been priced at $0.9 $NZ/W for tier 1 panels.
- PV Framing cost has been estimated at 25% of PV cost if not supplied.
- Balance of system costs have been estimated at 25% of PV cost if not supplied.
    - Breaker(s), wire, connectors, conduit, cable clip, power meter, flow meter, enclosures, signage etc.
- Concrete foundation & labour costs are estimated at 25% of PV array size if required.
- Labour costs are based on 1 person 8-hour day per 1000W of PV installed at $75NZ/hour.
- *Cost of Lorentz pump has been estimated here as they do not widely advertise costs.
- Prices exclude GST and freight.

The above table is indicative of likely relative costs between various products. **Readers should do their own research to validate the numbers used.**

6 Advised reading for hill country farmers on the topic of water reticulation

Information that follows (unless stated otherwise) has been extracted from these main documents:

- Economic Evaluation of Stock Water Reticulation on Hill Country
- Clean Water - NZ Government Policy Document 2017
- NZ Farm Facts Compendium 2016

6.1 Water Reticulation Study: Benefits of Stock Water Reticulation

This study prepared for the Ministry for Primary Industries and Beef + Lamb New Zealand lists these benefits from replacing streams and dams with **water tanks, pumps, pipes and troughs** on hill country farms:

- Improved farm performance following the installation of water reticulation was due to:
    - Increased sub-divisional fencing.
    - Better grazing management.
    - Improved pasture utilisation.
    - Better pasture production.
    - Improved stock numbers and performance.

Farmers interviewed also stated the following:

- Dam water supplies are often low quality, can dry up and often require stock to be rescued. This issue was eliminated.
- Farmers noted the “peace of mind” that the water scheme gave them (and their staff).
- Most farmers had environmental plans, and noted that the stock water reticulation and subdivision made implementing the plan easier, especially with fencing off waterways.
- Good stock water reticulation lessened the impacts of drought.

6.2 The NZ Law

The Animal Welfare Act (1999 NZ) requires managers of livestock to provide "proper and sufficient food and water". This is why the abstraction of water for stock drinking is a permitted activity if from surface water.

6.3 NZ Government Policy on Waterways

Stock exclusion from Waterways (2017 onwards):

<table>
<tr><th>Farm/stock type</th><th>Plains (0-3˚)</th><th>Undulating / rolling land (>3-15˚)</th><th>Steeper land (>15˚ and over)</th></tr>
<tr><td>Dairy cattle (on milking platforms) and pigs</td><td colspan="3">1 July 2017 for waterways over 1 metre wide on all slopes
1 July 2020 for waterways less than 1 metre wide on the plains</td></tr>
<tr><td>Dairy support (on either land owned/leased by the dairy farmer or third party land)</td><td colspan="2">1 July 2022 for all waterways on the plains regardless of size and waterways over 1 metre wide on rolling land</td><td>Only where break feeding, by 1 July 2022</td></tr>
<tr><td rowspan="2">Beef cattle and deer</td><td>1 July 2025 for all waterways regardless of size</td><td>1 July 2030 for waterways over 1 metre wide</td><td></td></tr>
<tr><td colspan="3">Where break feeding, by 1 July 2022</td></tr>
</table>

If only sheep farming there are no proposed requirements for stock exclusion from waterways. Fines for non-compliance are $2000 for each event (then a reasonable time will be allowed to remedy). Hence, it is likely that sheep and beef farmers will not fence any waterways but that paddocks adjacent to waterways will only be used for sheep (cattle excluded). This may still require some fencing on the farm to be done. Cattle only farms will have to fence all water ways > 1m wide on land of < 15 degree slope by 2030 at the latest.

6.4 Typical stocking rates in the Water Reticulation Study

- Steep hill country or low fertility soils typically have 6 to 10 stock units per hectare.
- Easier hill country or higher fertility soils typically 7 and 13 stock units per hectare.
- Most hill country farms have between 5,000 and 35,000 stock units.
- The average farm in the stock water reticulation study had 10,000 stock units and 100 paddocks.
    - Average stocking rate was 9 stock units per hectare
    - Average farm was 40% cattle and 60% sheep
    - Average lambing rate 136%

The farms used in the water reticulation study are about twice the size of the average sheep and beef farm in NZ.

6.5 Typical national stocking rates

Farms by farm type 2012

	NUMBER OF FARMS[1]	AGRICULTURAL AREA (000 HA)
Dairying	12,150	2,415
Sheep & Beef Farming	25,113	9,328
Cropping	3,297	284
Deer Farming	1,128	287
Pig Farming	225	11
Poultry	135	3
Total	42,048	12,327
Other (including forestry)	16,020	2,067
TOTAL ALL FARM TYPES	**58,068**	**14,394**

1 Includes non-commercial smallholding farms.
Source: Statistics New Zealand, 2012 Agricultural Census

25113 sheep and beef farms.

Average size 371 ha from above, Land Information NZ for 2012 has the average sheep and beef farm listed at 678 ha (if smaller beef only farms are accounted separately).

If we assume the average stocking rate for hill country farms is 8 SU/ha then the average farm has 5424 SU. If sheep are 1 SU at 60% and beef cattle 5 SU at 40% then the average sheep and beef farm has about:

- 3254 Sheep
- 434 Beef cattle

7 Typical water requirements

Table 1: Estimates of water requirements for livestock (ANZECC 2000)

Type of Livestock		Average daily consumption (litres/head)	Peak daily consumption (litres/head)
Sheep			
	Lactating ewes on dry feed	9	11.5
	Mature sheep on dry pasture	7	8.5
	Mature sheep on green pasture	3.5	4.5
	Fattening lambs on dry pasture	2.2	3
	Fattening lambs on green pasture	1.1	
Dairy Cattle			
	Dairy cows in milk	70	85
	Dairy cows, dry	45	60
	Calves	22-25	30
Beef Cattle*			
	Breeding Cow	30	45
	Yearlings	20	30
	Calves	10	20
Deer*			
	Mature Hind	5.7	11
	Hind 15-27 months	5.4	11
	Mature stag	6.6	13
	Stag 15-27 months	6.3	13
	Yearling	10	15
Horses			
	Working	55	70
	Grazing	35	45

Assuming:

- average beef cattle consume 20 l/head
- average sheep consume 5 l/head

Note – the ratio of beef to sheep make little difference to the calculated water requirements.

The average NZ sheep and beef farm will require:

- 3254 Sheep x 5 l/head = 16270
- 434 Beef x 20 l/head = 8680
- Total = 24950 l/day

A standard roto-moulded plastic water tank holds 25,000 litres. An average farm will need 1 tank per day if all animal water is delivered to troughs via a single tank. On farms of this size just 1 tank is unlikely. The reality is that stock require little supplementary water on wet days and the requirement of 1 tank per day is likely to be the average summer requirement. Demand will tend to follow the solar cycle, more sun more water, less sun less water required.

As such a solar powered pump is a very good option. If we assume for this example:

- Hilltops on a farm are at 180m above valley bottom.
- 50% of the water needs on the lower rolling part of the farm (up to 30m) are met with a grid powered water pump.
- Higher hilly parts of the farm are met with solar pumps and tanks at two high locations.

Then each location needs about 6000 l/day at 150m lift and with a 25,000 litre tank would have 4 days of storage. This storage is required to meet the needs of peak demands, severe drought cover and for maintenance down time.

In this case **two** of our React pumps (30m above the valley floor) with tanks (150m above the water resource) would meet the needs of the farm. If the solar pump delivery falls a little short or future demand increases, then the PV array can be easily increased from 1kW to 1.5kW to ensure that on those sunny but dry overcast days the pump is delivering the most that it can.

Should even more water be needed then another React pump can be added in parallel to double the amount that can be pumped.

For backup and to supplement in times or severe drought (high demand) a small petrol pump or generator kept in storage for backup is good advice.

7.1 Typical capital cost for a solar water reticulation scheme:

- Solar Pump(s) and PV array(s).
- Storage tanks.
- Pipe.
- Troughs and fittings.
- Earthworks (tanks levelling and burying of pipes).
- Contract labour.
- Fencing (e.g. around water storage tanks, PV panels and pumps).
- New paddock fencing as required.

7.2 Typical operating costs

- Repair and maintenance to solar pump (refer to our service plan).
- Insurance cover if required.

8 Testing

EcoInnovation has been exporting hydro turbines (fitted with the same Smart Drive motor parts) for almost 20 years. They have proven to be extremely reliable.

We have been working on the React pump solution for almost 5 year using the same Smart Drive motor design. We launched an early diaphragm version about 2.5 year ago. Although this worked well we learned that there are areas that can be made even better:

- It was time consuming to make which made it more costly than it needed to be. This is because we fitted it into the same casing as our PLT hydro turbine, which was not a perfect solution.
- The cam-offset had to be set to the farmers head (site pressure), most farmers did not have accurate head data, and this caused delays and frustrations in trying to make sales.
- Diaphragms ultimately fail without warning. After a certain number of cycles the diaphragm will rupture. Plunger and piston pumps give you plenty of warning that a service is needed as water will drip from the seals at a location (designed to collect leakage) where you can see it.
- The oil and water side could mix if the diaphragm failed, so water would then displace the oil and the pump could be ruined. This cannot happen with the new React pump pump.
- It required a pressure dampener and the pump ran with some pressure pulsation induced vibration. So the operating rpm range was limited to <600 rpm.
- It was not simple to set the pressure that you want the pump to stop at when the header tank is full.

The new React pump solves all these problems. So we stopped manufacture of the diaphragm pump and focused our efforts on the new React pump triplex version. Those with the earlier diaphragm version should contact us for a free product exchange.

- Click here to see a video of the final React pump design working on a pontoon at 200m head.
- Click here to see videos of the React pump installation on a ground frame.