Irrigation energy efficiency

How to analyse your energy costs

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The Energy Guys

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PILOT Energy Audits: Pivots

AIM:
- ✓ data on energy use
- ✓ simple field data

How energy efficient is system?

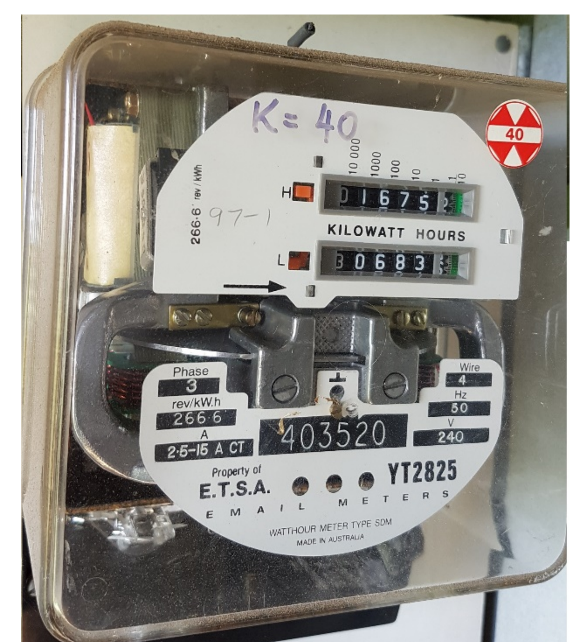
Potential savings?

Best and best use of tariff?

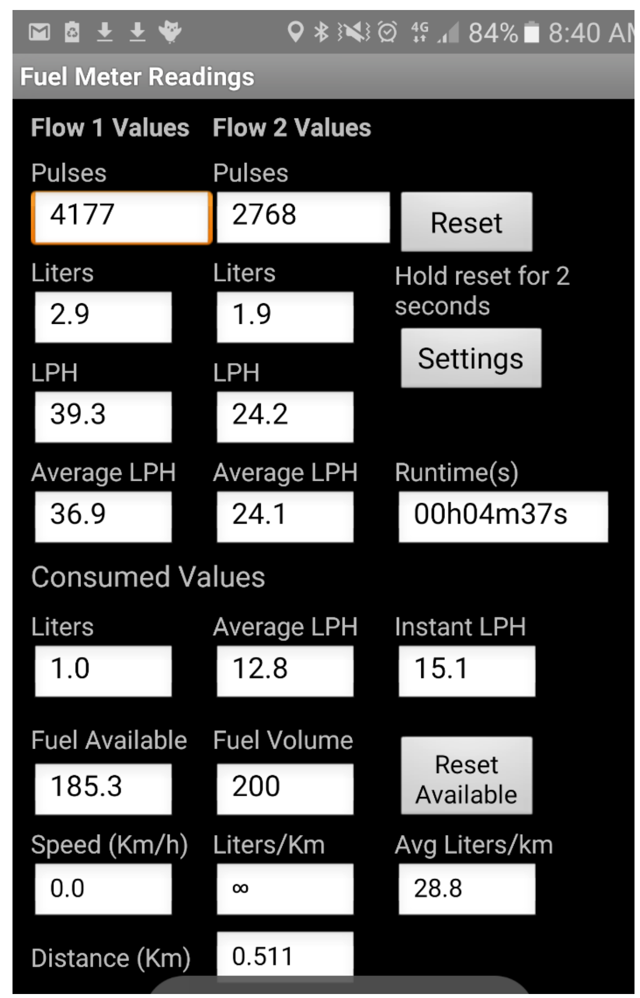
7 centre pivots	Electricity
3 centre pivots	Diesel

What is involved?
- Measure: flow, pressure, energy use
- 12 months power bills

DATA COLLECTION Electricity



DATA COLLECTION Diesel

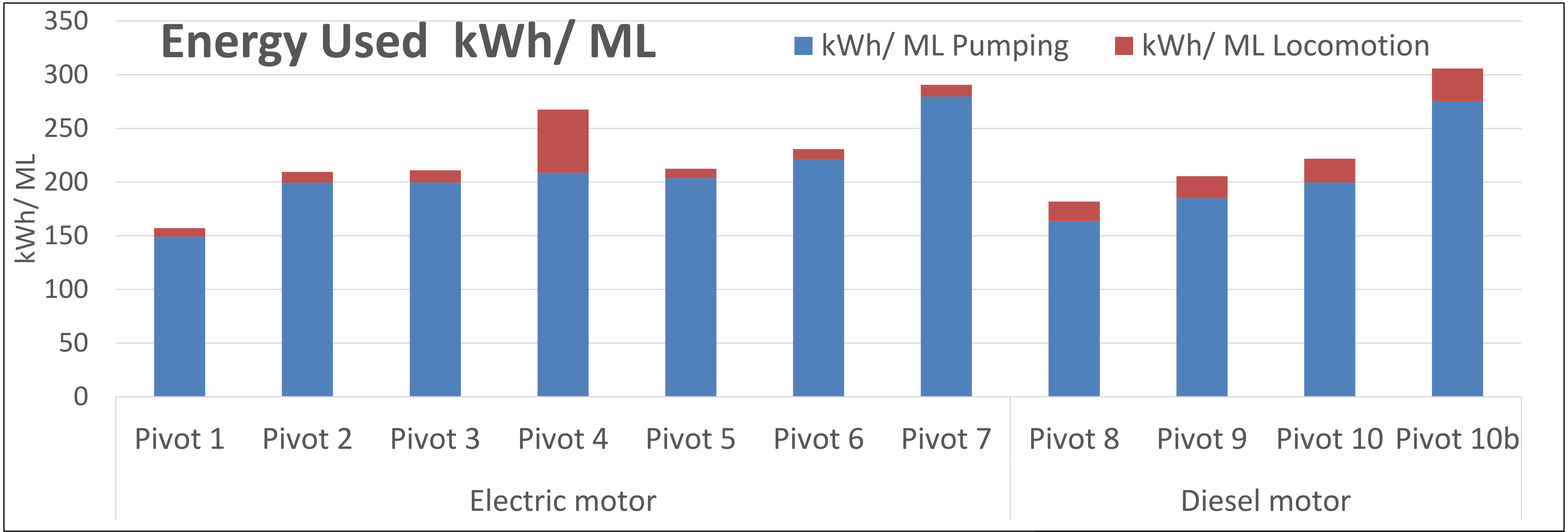


DATA COLLECTION

1. **Flow at pump**
2. **Energy consumed (kWh)** over known time period
3. **Total head: delivery head at pump**
4. **Pressure at pivot**

$$\frac{\textbf{kWh}}{\textbf{ML}}$$

Comparison *variation in consumption*



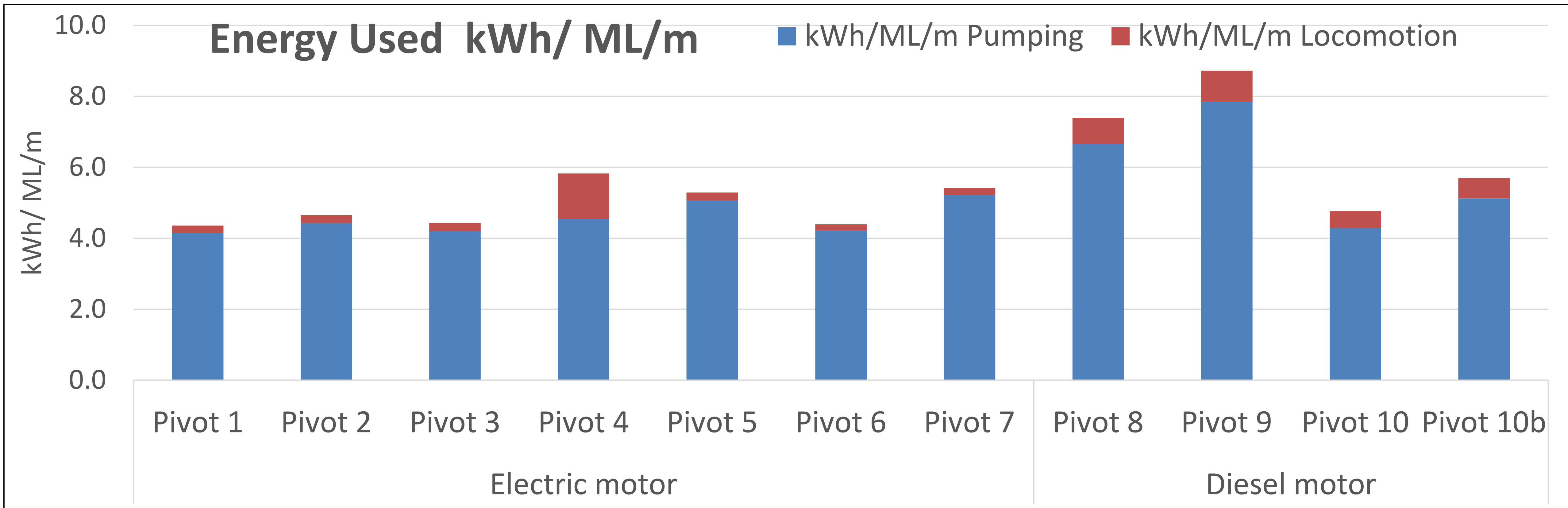
Average 226 kWh/ ML
Range 157 – 306 kWh/ ML

DATA COLLECTION

1. Flow at pump
2. Energy consumed (kWh)
3. Total head: delivery head at pump
4. Pressure at pivot

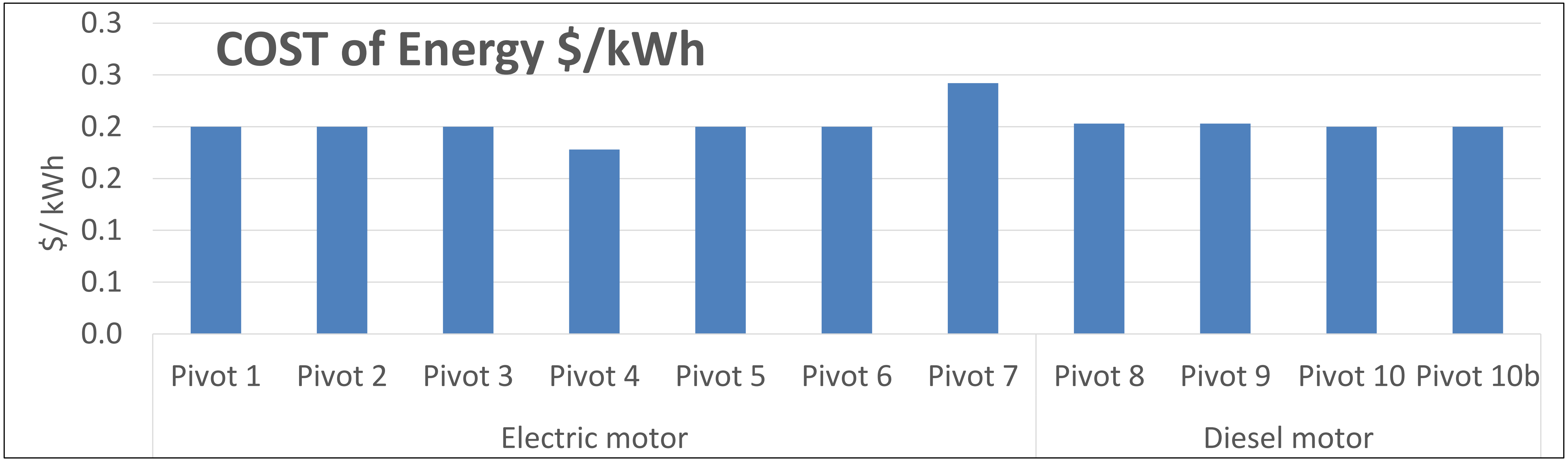
→ kWh / ML / m total head

Comparison *variation in consumption*



Average 5.5 kWh/ ML/ m
Range 4.4 – 8.7 kWh/ ML/m

Unit cost of energy

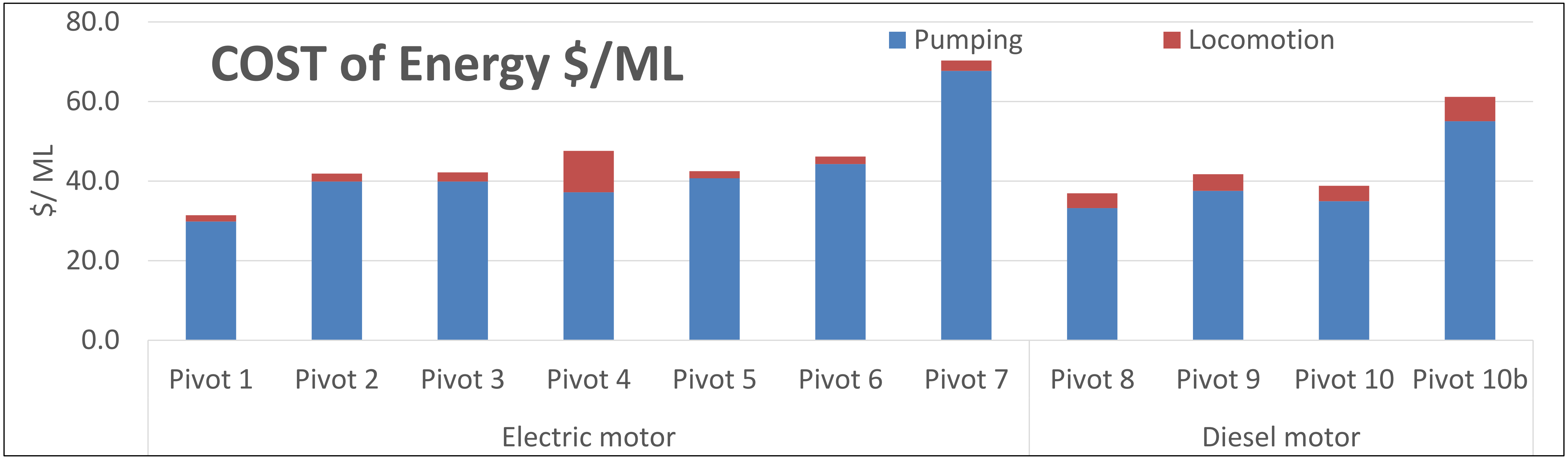


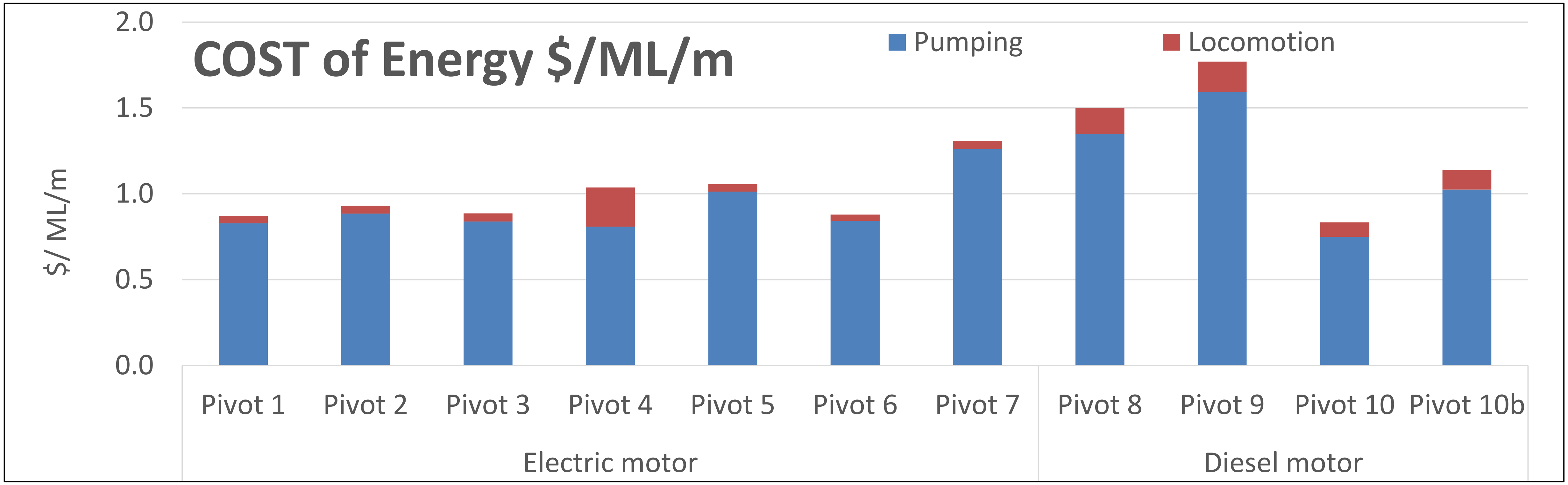
<u>DIESEL</u>

Typically diesel uses between 0.24 – 0.45 Litres/ kWh

Adopted: 0.30 Litres/ kWh

Comparison of total energy costs





DATA COLLECTION

1. **Flow at pump**
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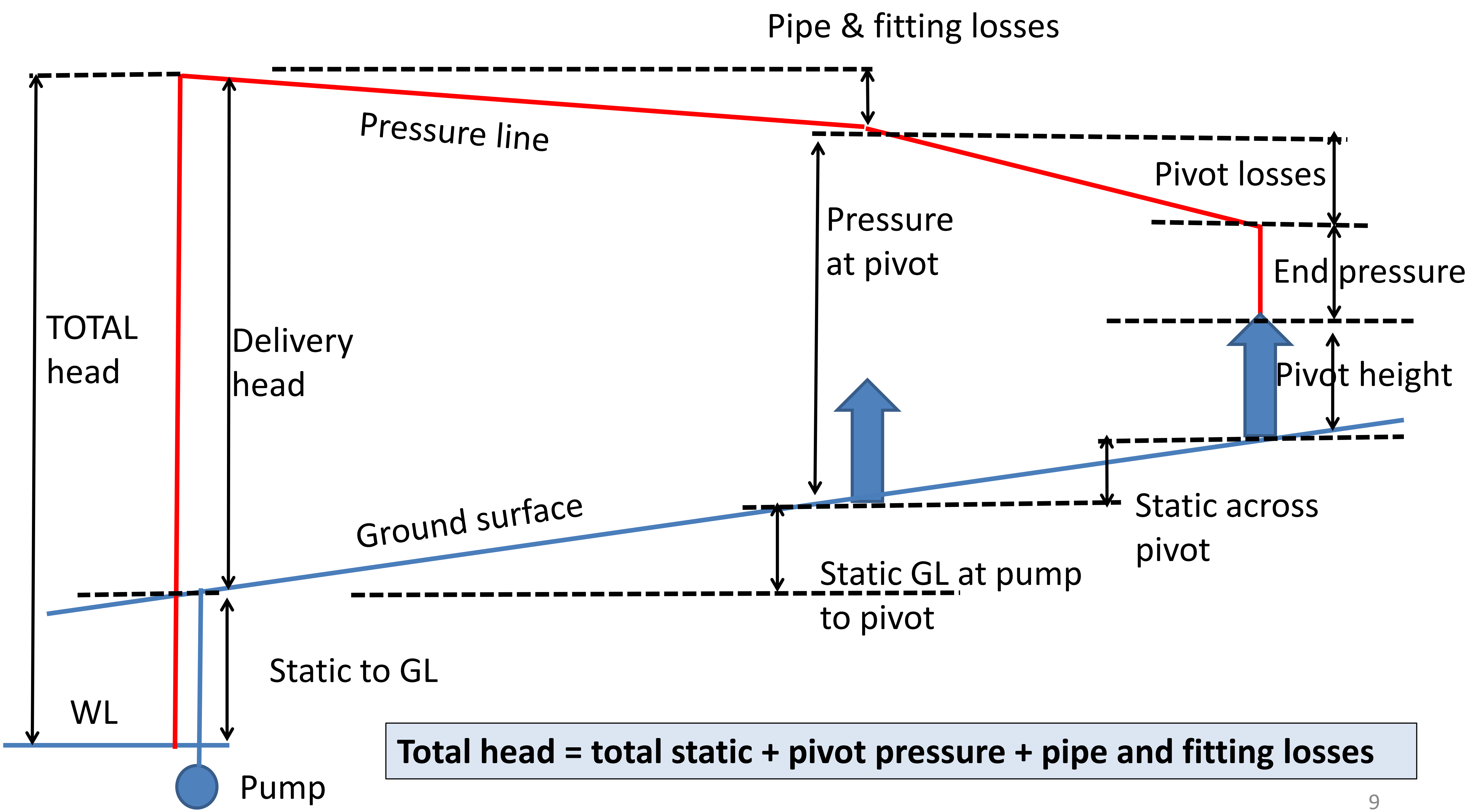


Total head = total static + pivot pressure + pipe and fitting losses

Pivot 1

Measured

Flow	105.7 L/s
Delivery head	170 kPa (17m = 24 psi)
kWh	59.8 kWh in 1 hour

From bills

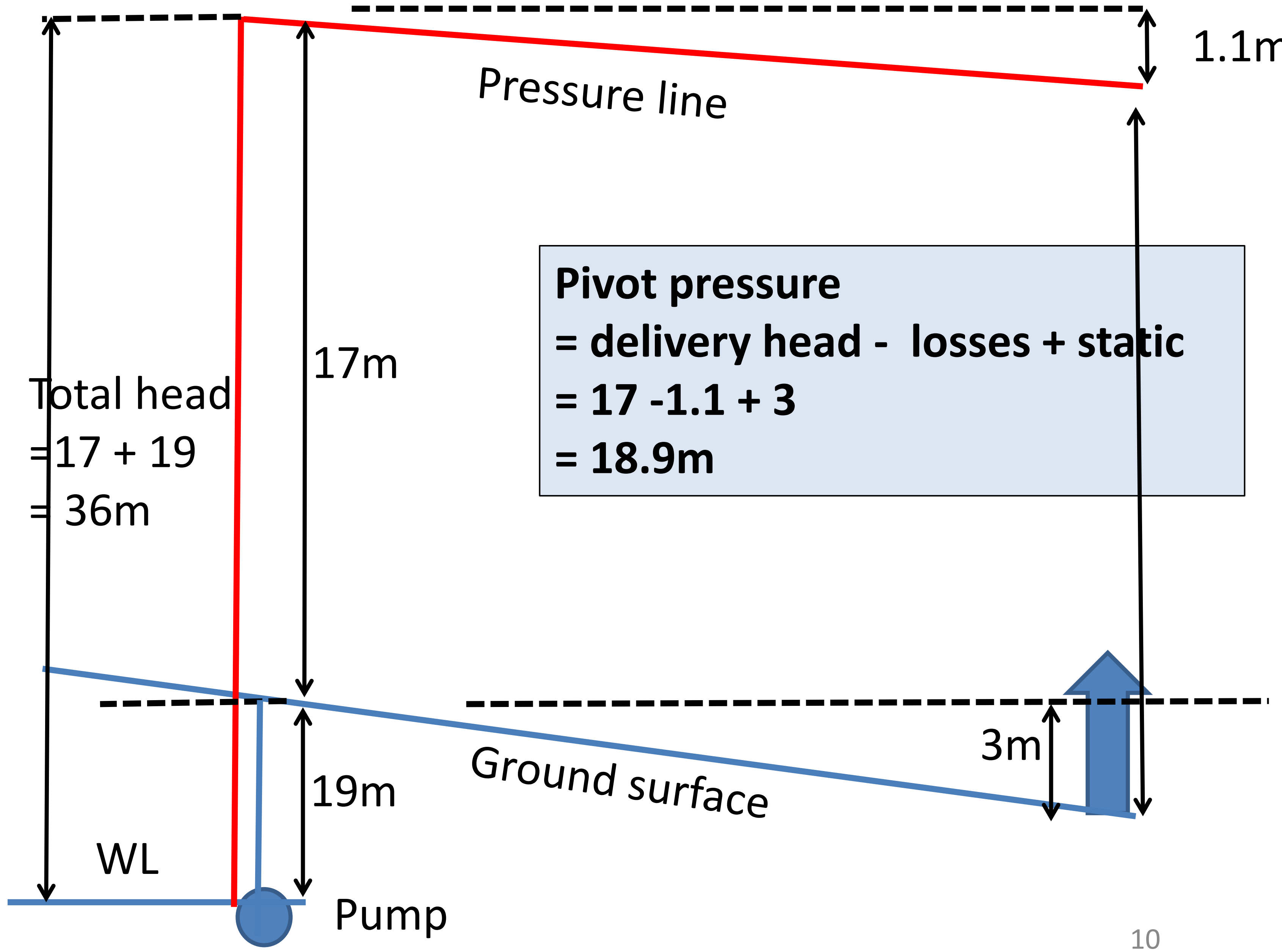
$ 0.20 / kWh

Estimated

Depth to WL	19m
Static to pivot	-3m
Pipe losses	1.1m
Locomotion use	3.0 kW
Motor efficiency	90%

Benchmarks (pumping)

149 kWh/ ML
4.14 kWh/ ML/m
$ 39.9/ ML
$ 0.84 / ML/m

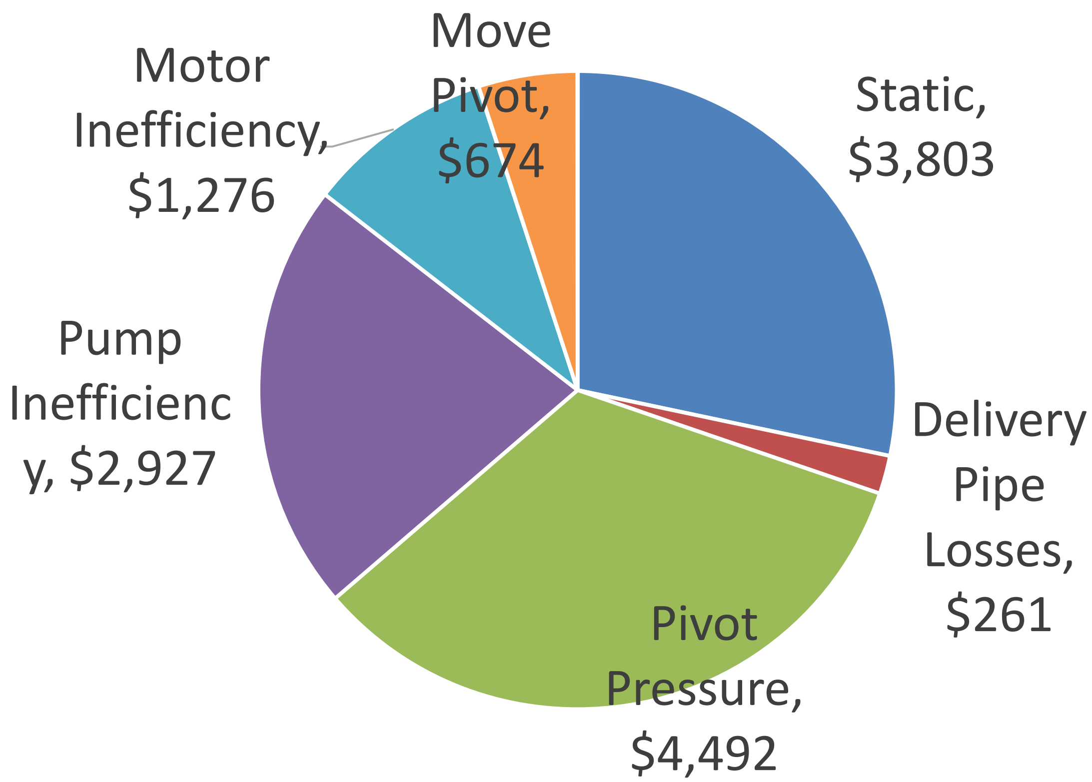


Pivot pressure
= delivery head - losses + static
= 17 -1.1 + 3
= 18.9m

Pivot 1

Pump effic (%)

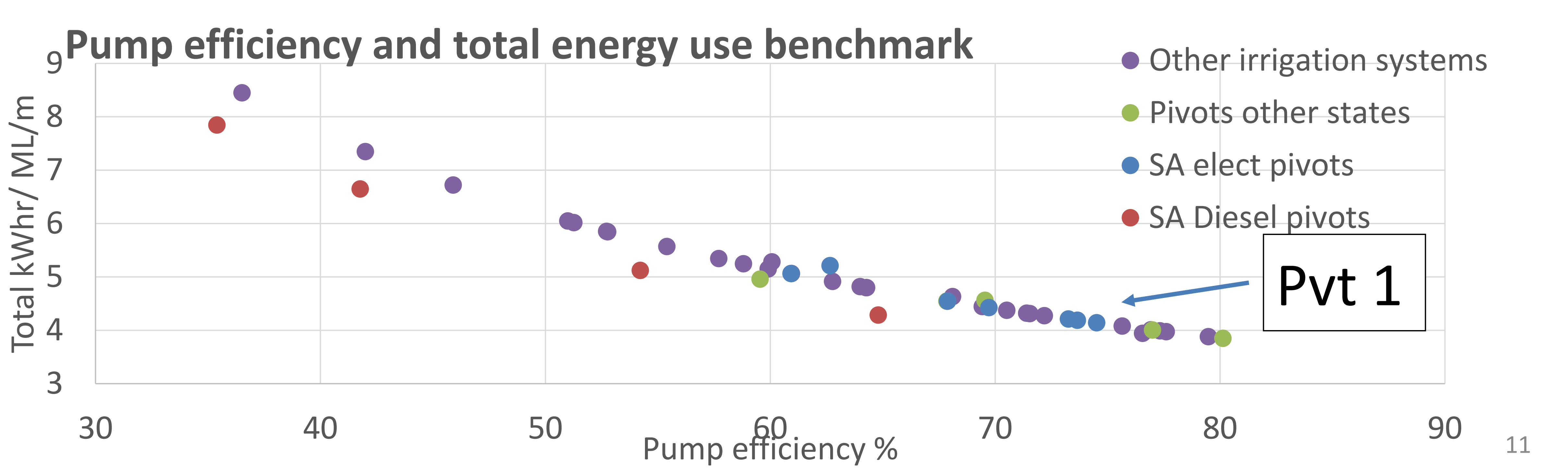
$$= \frac{\text{VOLUME (L/s)} \times \text{Total HEAD (m)}}{\text{kWh for pump drawn from grid} \times \text{motor effic (\%)}}$$



Using data:

1. **Flow** = 105.7 L/ s
2. **Total head** = 36 m
3. **kWh from meter** = 59.8 kWh
4. **kWh for pump** = 59.8 – 3 = 56.8 kW
5. **Motor efficiency** = 90 % (from plate on motor)

6. Pump efficiency = $\frac{105.7 \times 36}{56.8 \times 0.90}$ = **74.4 %**



Pivot 1 ACTIONS

Potential energy efficiency improvements

1. Reduce pressure at pivot	v low = no improvement
2. Improve pump efficiency	v high = no improvement
3. Improve motor efficiency	High efficiency motor 94% Potentially save $ 344/ yr
4. **Improve uniformity**	no catch can data available

Tariff improvements?

1. Currently on “contestable” tariff with network charges
2. Demand fees currently based on kWh consumption
3. Average tariff currently $ 0.178/ kWh for consumption

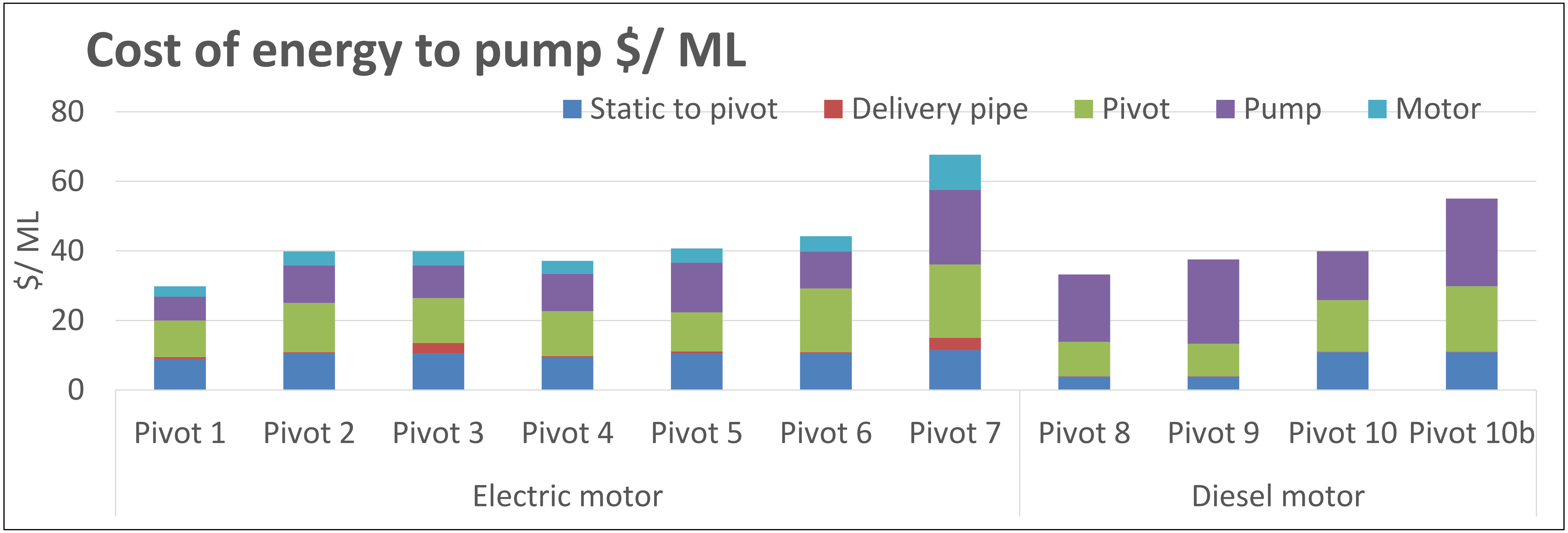
4. IN FUTURE: will be required to go on to a kVa demand tariff

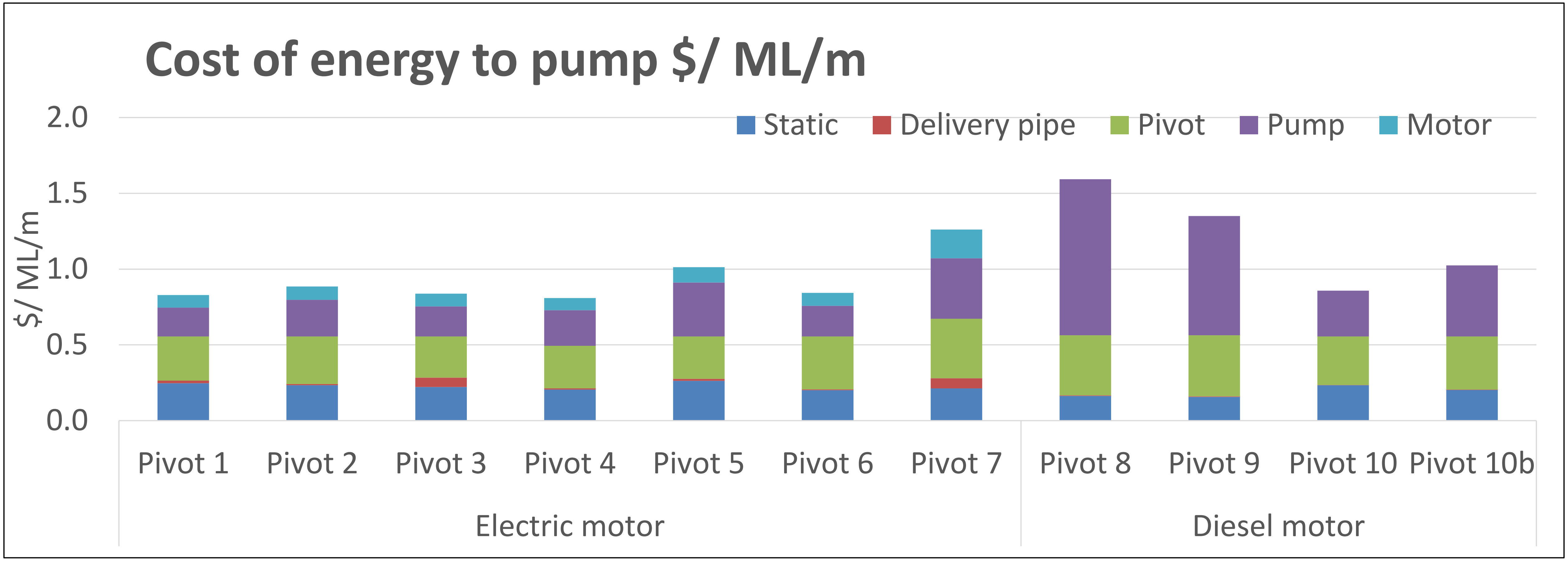
Energy Efficiency of motors

MEPS = Minimum Energy Performance Standard

Australian Standards

kW motor	MEPS	High Effic Motor
	%	%
22	91.2	92.4
30	92.0	93.1
37	92.5	93.6
45	92.9	93.6
55	93.2	94.2
75	93.9	94.8
90	94.2	95.0


Cost of energy to pump $/ ML
80
60
40
20
0
$/ ML
Static to pivot
Delivery pipe
Pivot
Pump
Motor
Pivot 1
Pivot 2
Pivot 3
Pivot 4
Pivot 5
Pivot 6
Pivot 7
Pivot 8
Pivot 9
Pivot 10
Pivot 10b
Electric motor
Diesel motor


Cost of energy to pump $/ ML/m
2.0
1.5
1.0
0.5
0.0
$/ ML/m
Static
Delivery pipe
Pivot
Pump
Motor
Pivot 1
Pivot 2
Pivot 3
Pivot 4
Pivot 5
Pivot 6
Pivot 7
Pivot 8
Pivot 9
Pivot 10
Pivot 10b
Electric motor
Diesel motor

Pivot 7

Measured

Flow	53.2 L/s
Pivot head	310 kPa (31m = 45psi)
kWh	55.7 kWh in 1 hour

From bills

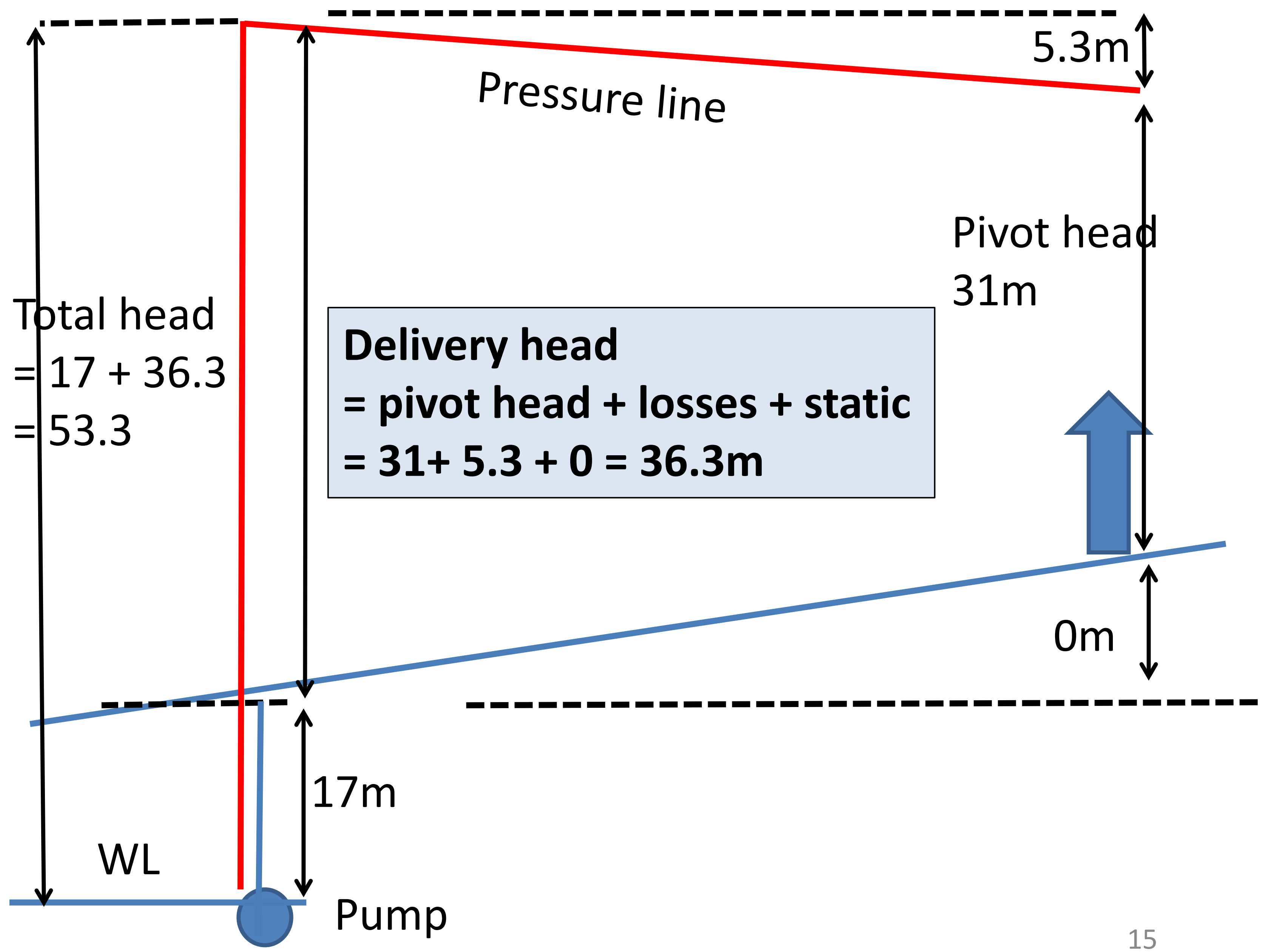
$ 0.24/ kWh

Estimated

Depth to WL	17m
Static to pivot	0m
Pipe losses	5.3m
Locomotion use	2.0 kW
Motor efficiency	90%

Benchmarks (pumping)

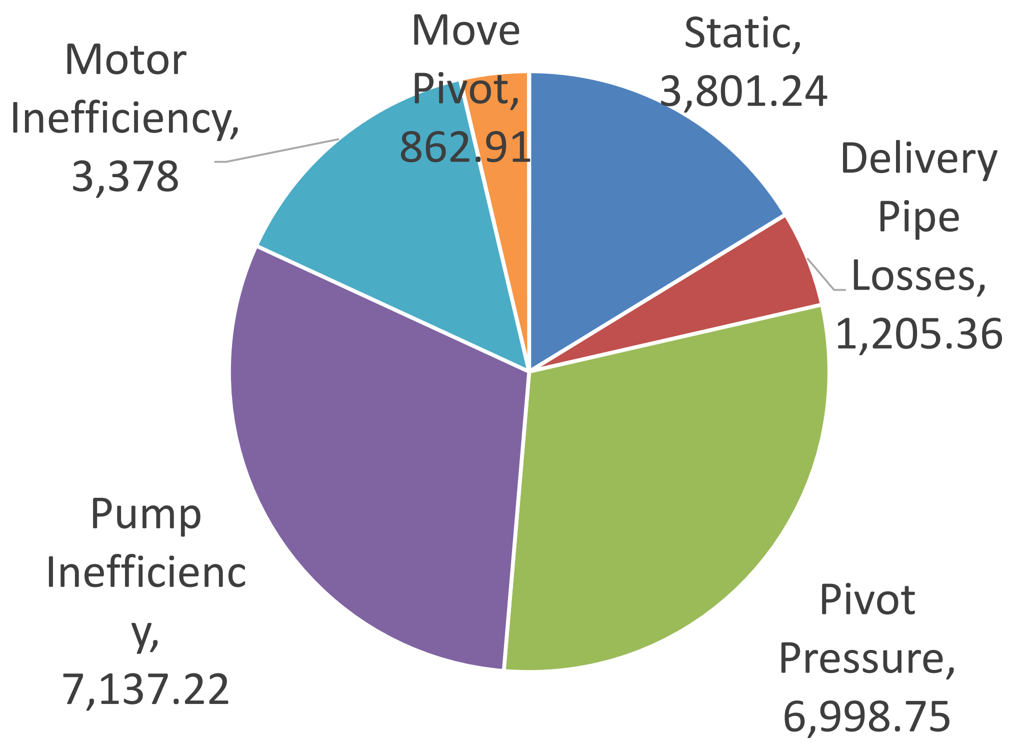
280 kWh/ ML
5.22 kWh/ ML/m
$ 67.7/ ML
$ 1.26 / ML/m



Pivot 7

Pump effic (%)

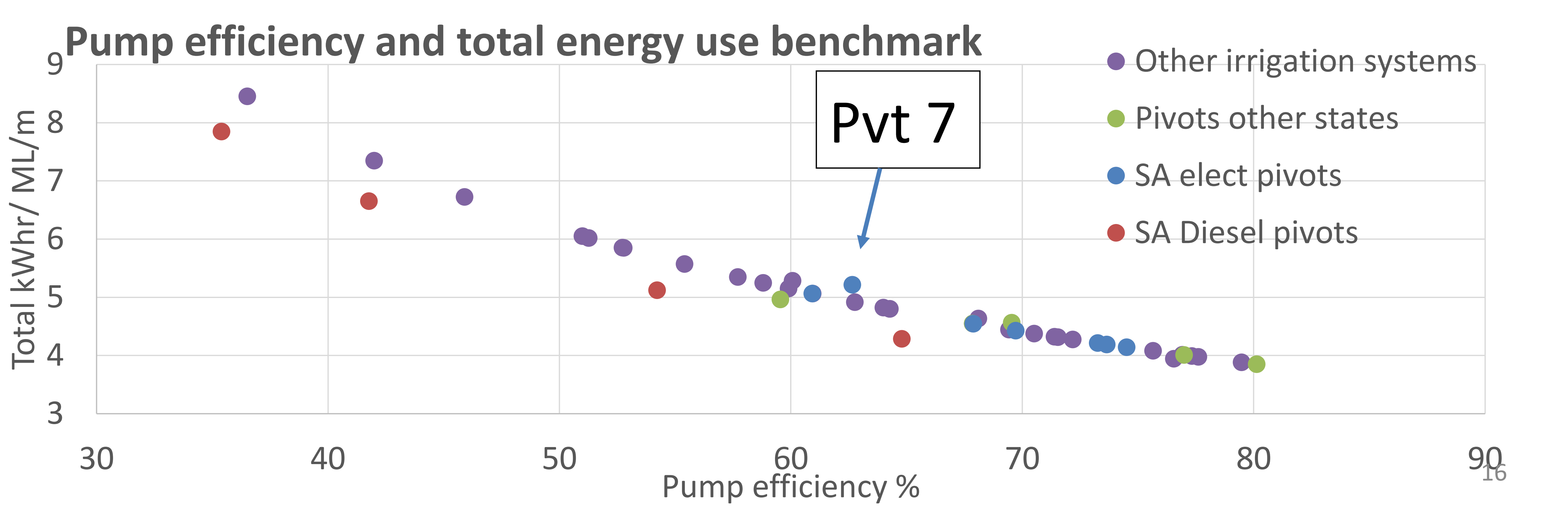
$$= \frac{\text{VOLUME (L/s)} \times \text{Total HEAD (m)}}{\text{kWh for pump drawn from grid} \times \text{motor effic (\%)}}$$



Using data:

1. **Flow** = 53.2 L/ s
2. **Total head** = 53.3 m
3. **kWh from meter** = 55.7 kWh
4. **kWh for pump** = 55.7 – 2 = 53.7 kW
5. **Motor efficiency** = 85 % (from plate on motor)

6. **Pump efficiency** $= \frac{53.2 \times 53.3}{53.7 \times 0.85} =$ **62.1 %**



Pivot 7 ACTIONS

Potential energy efficiency improvements

1. **Reduce pressure at pivot**
   - measured pressure higher than other pivots
   - Flat ground
   - If possible to reduce to 25m, save $ 1670/ year
   - assumes pump at same efficiency

2. **Improve pump efficiency**
   - If efficiency can be improved to 70%
   - Savings of $ 1480/ year

3. **Improve motor efficiency**
   - High efficiency motor 94% replace assumed 85%
   - Potentially save $ 1300/ yr if no other changes made

Pivot 7 ACTIONS

Potential energy efficiency improvements

4. Improve UNIFORMITY OF APPLICATION

- Du 51% and Cu 86%
- BUT: average 5.1 mm measured when expected 6.0 mm
- **If pivot is run on basis of expected average application**
    - No improvements to energy costs by improving uniformity
    - But production improvements

- **If pivot is run so that areas of lower application receive the expected depth,** there is considerable energy savings possible
    - Pivots costs $ 70.3/ ML applied (includes locomotion)
    - Every 5mm over-applied (2.0 ML over 40Ha) costs $ 141
    - If occurs 20 times a years, this costs an extra $ 2,800/ year in pumping

Pivot 7 ACTIONS

Tariff improvements?

1. Currently “bundled” tariff
2. < 100 MWh/ yr used
3. Average tariff currently $ 0.23/ kWh for consumption

4. Better rates can be obtained via:
   - Energymadeeasy.com.au
   - Broker

5. Currently using 64% offpeak, 36% peak

   BUT watering: 7pm – 7am = believed to be offpeak
   PLUS 4 hours/ week peak used

   HOWEVER 36% PEAK use equals 4 hours/ day PEAK
   When checked with Networks: 9 pm – 7 am
   Retailer 11pm – 7am

Pivot 10 and 10b DIESEL

<u>Measured</u>	Pvt 10 1500 rpm	Pvt 10b 1700 rpm
Flow	76.6 L/s	76.6 L/s
Delivery head	29.6m	36.7m
Pivot head	26.4m	33.5m
Diesel	15.3 L/ hour	21.1 L/ hour

From bills

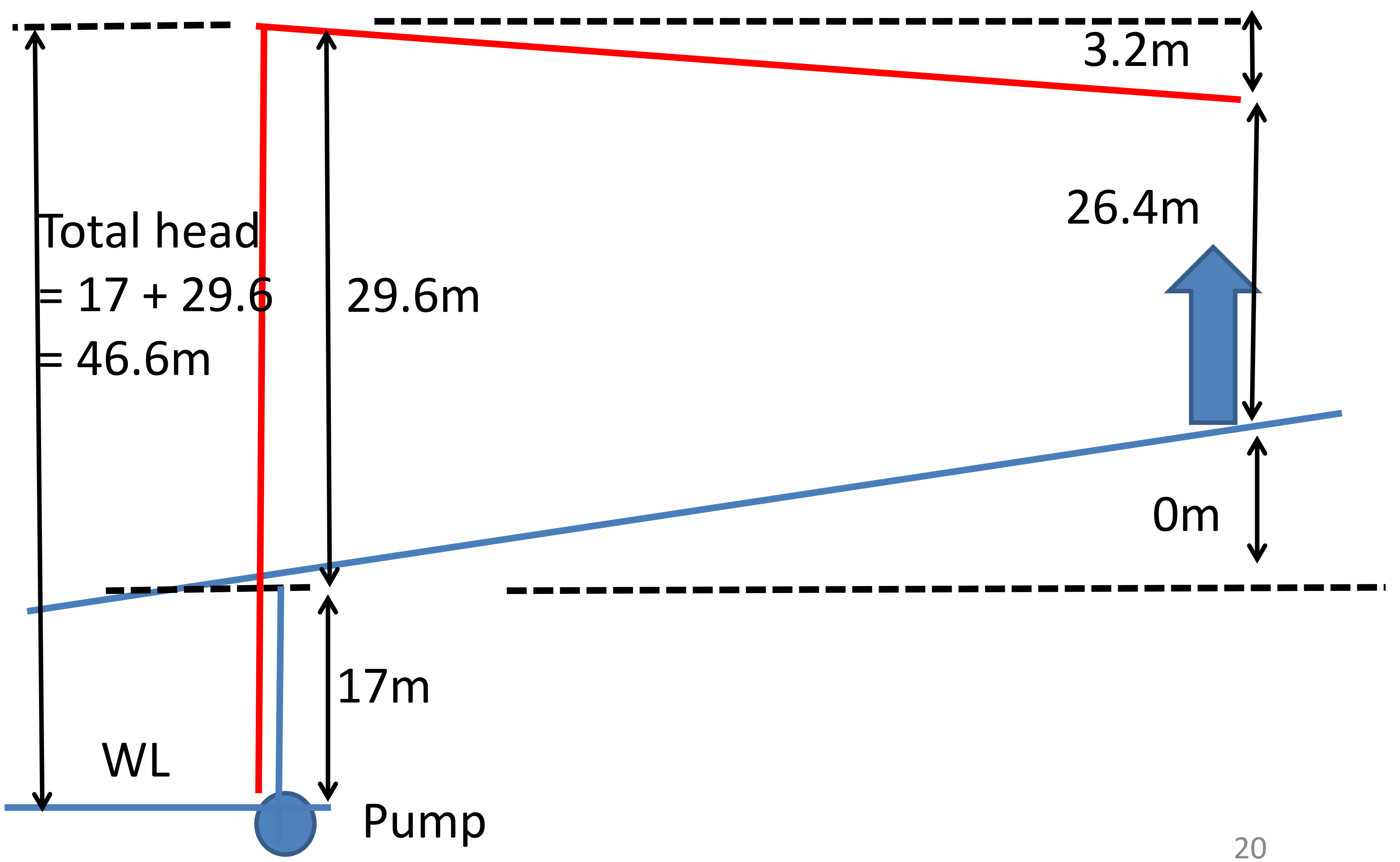
$ 0.80/ L after rebates

Estimated

Depth to WL	17m
Static to pivot	0m
Locomotion use	10%
Motor efficiency	0.25 L/ kWh

Benchmarks (pumping)

	10	10b
kWh/ ML	200	275
kWh/ ML/m	4.3	5.1
$/ML	34.9	55.0
$/ML/m	0.75	1.02

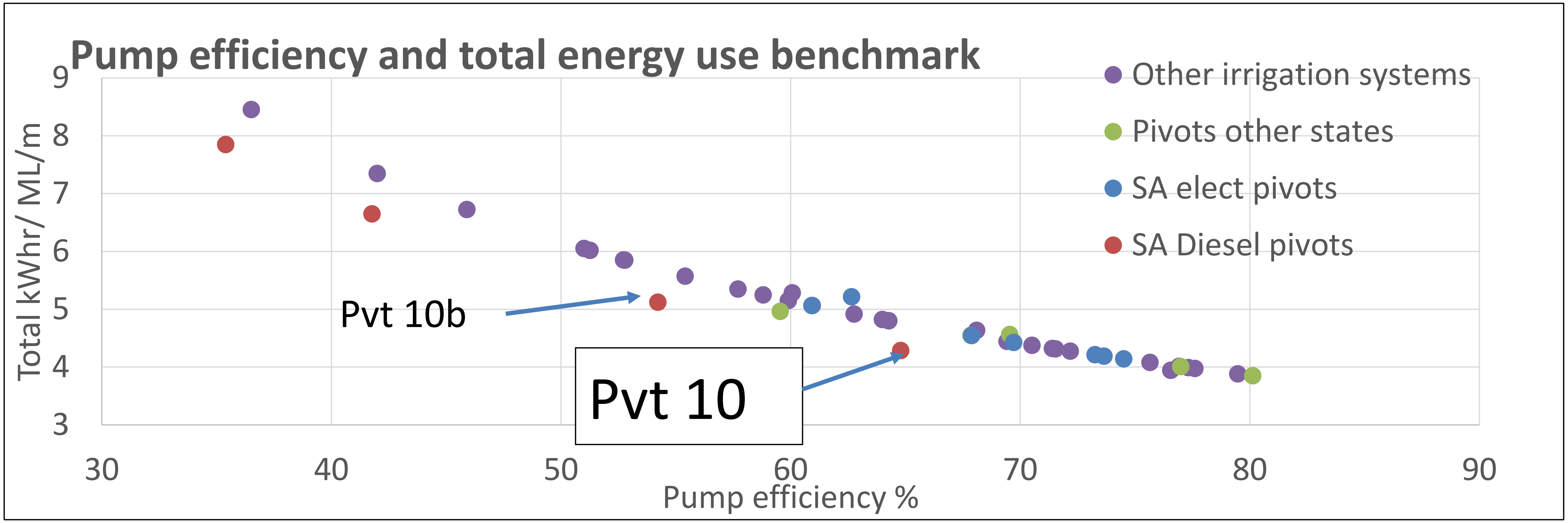


Pivot 10

Pump effic (%)

$$= \frac{\text{VOLUME (L/s)} \times \text{Total HEAD (m)}}{\text{kWh for pump} \times \text{motor effic (\%)}}$$

Using data:	Pvt 10	Pvt 10b
1. **Flow**	76.6 L/ s	76.6 L/s
2. **Total head**	46.6 m	53.7m
3. **kWh for pump**	55.1 kW	76.0 kW
4. **Pump efficiency**	**64.8**	**54.2%**



Pivot 10 ACTIONS

Potential energy efficiency improvements

1. **Ensure correct revs set**
   - Higher **revs cost $ 8,750/ year based on 7.9 ML Ha/ yr**

1. **Reduce pressure at pivot**
   - measured pressure slightly higher than other pivots
   - Some static across pivot requires higher pressure
   - If 20m is achievable, saves $ 1800/ year
   - assumes pump at same efficiency

2. Improve pump efficiency
   - If efficiency can be improved to 70%
   - Savings of $ 900/ year

3. Improve motor efficiency
   - Assumed 0.25 L/ kWh, if higher improved pump efficiency

Pivot 10 ACTIONS

Potential energy efficiency improvements

4. Improve UNIFORMITY OF APPLICATION

- Du 85% and Cu 90%
- BUT: average 6.8 mm measured when expected 6.0 mm
- **If pivot is run on basis of expected average application**
  - No improvements to energy costs by improving uniformity
  - But production improvements

- **If pivot is run so that areas of lower application receive the expected depth**, there are energy savings possible
  - Pivots costs $ 34.9/ ML applied
  - Every 1mm over-applied (0.62 ML on 60Ha) costs $ 22
  - If occurs 20 times a years, this costs an extra $ 440/ year in pumping

Electricity Tariffs SMALL

Small Retail Customers →

<u>Charges based on</u>
- kWhr consumed
- service charges
- tariffs "bundled"
- quarterly bills

Non-contestable
= bundled rates

Undergoing change
in most states

<u>Types of tariff for Small Retail Customers</u>

General rate = flat rate per kWhr
Time of use = rate for peak and offpeak = higher service fees
Controlled load = flat rate for specific equipment (offpeak)

Threshold
for Small Retail customers in SA

→ **160,000 kWhr/ year**

Time of Use tariffs:
typical times for peak and offpeak

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
9:00 PM	9:00 PM	9:00 PM	9:00 PM	9:00 PM	9:00 PM	9:00 PM
10:00 PM	10:00 PM	10:00 PM	10:00 PM	10:00 PM	10:00 PM	10:00 PM
11:00 PM	11:00 PM	11:00 PM	11:00 PM	11:00 PM	11:00 PM	11:00 PM
Midnight	Midnight	Midnight	Midnight	Midnight	Midnight	Midnight
1:00 AM	1:00 AM	1:00 AM	1:00 AM	1:00 AM	1:00 AM	1:00 AM
2:00 AM	2:00 AM	2:00 AM	2:00 AM	2:00 AM	2:00 AM	2:00 AM
3:00 AM	3:00 AM	3:00 AM	3:00 AM	3:00 AM	3:00 AM	3:00 AM
4:00 AM	4:00 AM	4:00 AM	4:00 AM	4:00 AM	4:00 AM	4:00 AM
5:00 AM	5:00 AM	5:00 AM	5:00 AM	5:00 AM	5:00 AM	5:00 AM
6:00 AM	6:00 AM	6:00 AM	6:00 AM	6:00 AM	6:00 AM	6:00 AM
7:00 AM	7:00 AM	7:00 AM	7:00 AM	7:00 AM	7:00 AM	7:00 AM
8:00 AM	8:00 AM	8:00 AM	8:00 AM	8:00 AM	8:00 AM	8:00 AM
9:00 AM	9:00 AM	9:00 AM	9:00 AM	9:00 AM	9:00 AM	9:00 AM
10:00 AM	10:00 AM	10:00 AM	10:00 AM	10:00 AM	10:00 AM	10:00 AM
11:00 AM	11:00 AM	11:00 AM	11:00 AM	11:00 AM	11:00 AM	11:00 AM
Midday	Midday	Midday	Midday	Midday	Midday	Midday
1:00 PM	1:00 PM	1:00 PM	1:00 PM	1:00 PM	1:00 PM	1:00 PM
2:00 PM	2:00 PM	2:00 PM	2:00 PM	2:00 PM	2:00 PM	2:00 PM
3:00 PM	3:00 PM	3:00 PM	3:00 PM	3:00 PM	3:00 PM	3:00 PM
4:00 PM	4:00 PM	4:00 PM	4:00 PM	4:00 PM	4:00 PM	4:00 PM
5:00 PM	5:00 PM	5:00 PM	5:00 PM	5:00 PM	5:00 PM	5:00 PM
6:00 PM	6:00 PM	6:00 PM	6:00 PM	6:00 PM	6:00 PM	6:00 PM
7:00 PM	7:00 PM	7:00 PM	7:00 PM	7:00 PM	7:00 PM	7:00 PM
8:00 PM	8:00 PM	8:00 PM	8:00 PM	8:00 PM	8:00 PM	8:00 PM

(green)	**Off Peak tariff**	**98 hrs/wk**
(yellow)	**Peak tariff**	**<u>70hrs/wk</u>**
		168 hrs/wk

Electricity tariffs LARGE

Large Retail Customers →

Bills broken into components
Monthly
Based on kVa for larger users
kVa = kW/ power factor

Contestable
=
retailers can "contest" for business

Bill itemises components

Component	Fixed/ Negotiable	Rate based on
Retail energy use	Negotiable	kWhr used
Network fees	Fixed	kVa + service fee (in past = kWh)
Environmental fees	Fixed	kWhr used
Market fees	Fixed	kWhr used
Metering & service charges	Partly Negotiable	Daily fee

Sample Contestable bill

Negotiable rates

Fixed rates

- mixture of kWh and kVa
- kVa can be monthly, annual
- depends on tariff

POWER FACTOR
(typically 0.70 - 0.95)

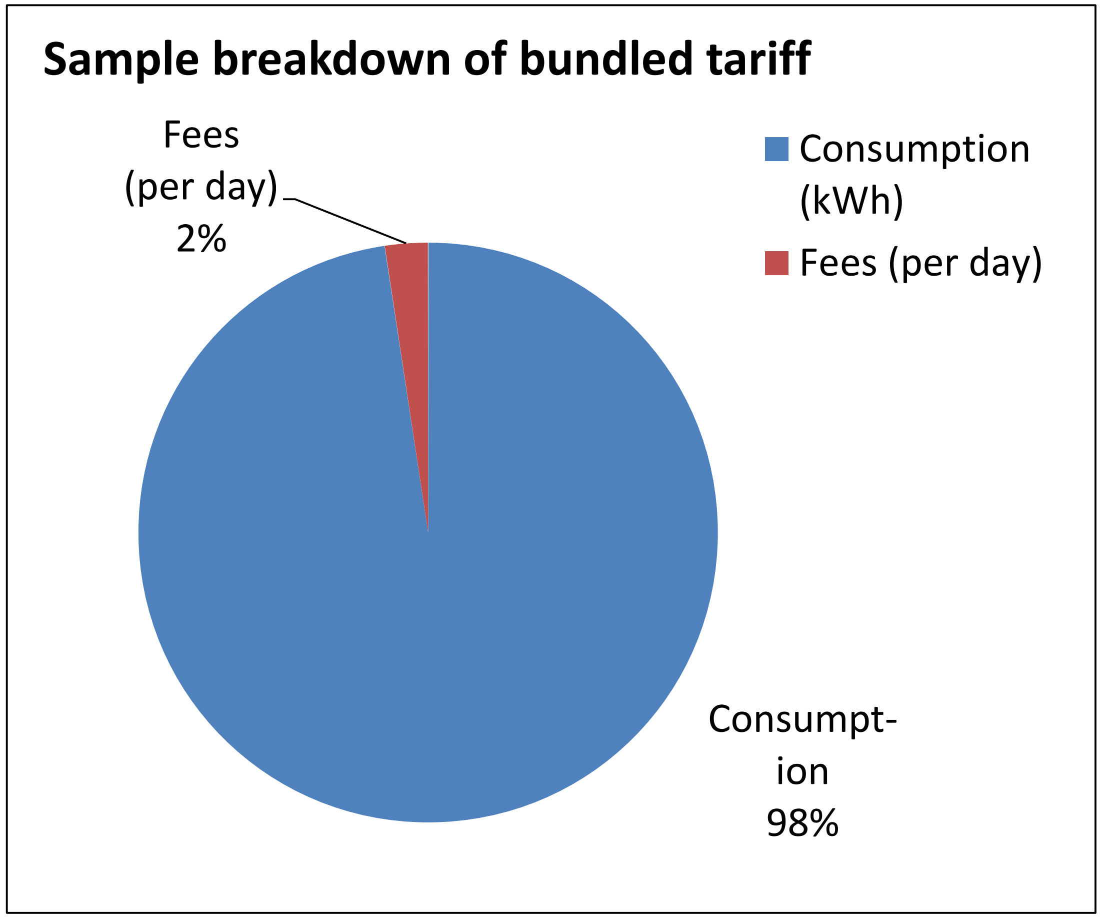
kVa = kW/ power factor

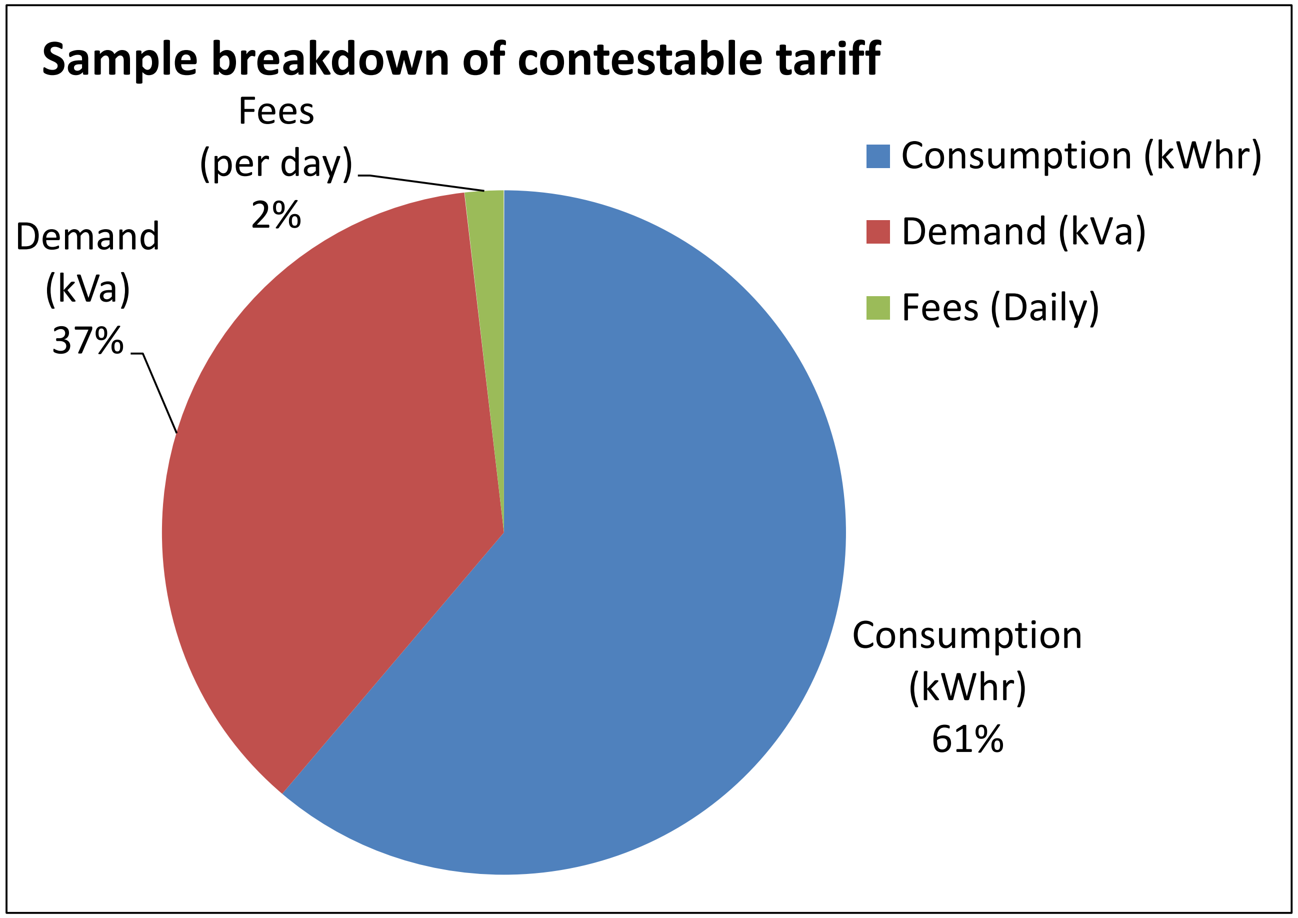
kWhr: $ 18,881 = $ 0.137/ kWhr
Demand: $ 5,556
Fees $ 131

Average annual tariff with all costs
Use + Demand + fees = $ 0.23/kWh

Account Number	xxxxxxx		NMI	xxxxxxxx	
Supply Address	xxxxxxx				
Supply period	1 Apr - 30 Apr 16				
	Quantity	Unit	Rate	Rate (incl loss factor)	Total
			$/ unit	$/ unit	$
Energy Charges					
Peak	35978	kWh	0.1175	0.1316	4736.40
Offpeak	102107	kWh	0.0575	0.0644	6578.04
Sub-total					**11314.44**
Network Charges					
Network peak	35978	kWh	0.0423		1521.87
Network offpeak	102107	kWh	0.0423		4319.13
Annual Demand	100	kVa	20.37		2037.00
Annual Demand	150	kVa	13.36		2004.00
Annual Demand	137.8	kVa	10.72		1477.22
Additional Demand	6.96	kVa	5.43		37.79
Sub-total					**11397.00**
Renewable Energy Charges					
E&REC- SRES	138085	kWh	0.004438	0.0050	686.60
E&REC - LRET	138085	kWh	0.00591	0.0066	914.34
Sub-total					**13035.74**
Other Charges					
AEMO Pool fees	138085	kWh	0.000358	0.0004	55.39
AEMO Ancillary Charge	138085	kWh	0.00045	0.0005	69.62
Metering Charges	31	days	2.60274		80.68
Retail service fee	1	month	50.63		50.63
Sub-total					**256.32**
					24,568.70
Highest actual metered demand period is 391 kVa recorded on 31/12					
Power factor at highest metered demand was 0.92					

Tariff components





Impact of tariff type

If DEMAND is based on kVa = saving kWh (energy efficiency) has lower value

= replacing kWh with diesel has lower value

BUT Diesel may be used to eliminate kVa fees

Managing tariffs SMALL

Small Retail customers

Need to regularly check rates

Check most suitable type of tariffs: General, TOU, controlled loads

→ retailers will not do it for you

www.energymadeeasy.com.au

Tariff comparison			ERM	Origin	AGL		
					Winter	Summer	TOTAL
Tariffs	Peak	c/kWh	37.64	38.29	37.36	41.26	
	Offpeak	c/kWh	15.84	22.45	22.52	22.52	
	Supply	c/day	57	75	75.41	75.41	
	Discount	%		20%	16%	16%	
	Peak	c/kWh	37.6	30.6	31.4	34.7	
	Offpeak	c/kWh	15.8	18.0	18.9	18.9	
Use	Peak	kWh/ yr	10000	10000	6000	4000	10000
	Offpeak	kWh/ yr	35000	35000	22000	13000	35000
Cost	Peak	$/ yr	3764	3063	1883	1386	3269
	Offpeak	$/ yr	5544	6286	4162	2459	6621
	Supply	$/ yr	208	274	275	275	550
	TOTAL	$/ yr	9516	9623	6320	4121	10441
	Average tariff		0.21	0.21	0.23	0.24	0.23

Managing tariffs LARGE

Large retail customers

- negotiate new contract prior to expiry of current contract
- forward contracting to take advantage of price dips
- check demand and capacity charges: these can be reset

ENERGY BROKERS

- review best tariffs for given consumption
- can assist negotiate small and large contracts
- assess electricity markets = opportunities for forward contracting

Some provide analysis of monthly use and costs ("energy managers")

- ✓ checks actual consumption and demand
- ✓ check tariffs working as intended
- ✓ provide warnings or alerts

Selection of broker

- recommendation from another farmer
- obtain quotes from 2 or 3 brokers, be clear about:
  - all fees and costs
  - what is included: analysis, reporting, forward contracting

Examples www.specialistenergy.com.au
www.emsenergysavings.com.au

Tariffs

		Farm 1	Farm 2	Farm 3	Farm 4	Farm 5
Annual kWh		785000	145075	191355	33853	44300
TYPE BILL		**Large**	**Large**	**Large**	Small	Small
Peak Demand		kVa	kWh	kWh	-	-
Peak % kWh		23%	67%	64%	33%	24%
Off-Peak % kWh		77%	33%	36%	67%	76%
$/ kWh PEAk		0.195	0.310	0.310	0.323	0.407
$/ kWhr OFFPEAK		0.125	0.126	0.126	0.172	0.197
$ for kWh		110684	36250	46822	7484	10961
$ for kVa		66827				
$ for fees		3335	270	1703	213	213
$/ kWhr	based on $ for kWh	0.141	0.250	0.245	0.221	0.247
	based on $ TOTAL	0.230	0.252	0.254	0.227	0.252

Tariffs New Network Tariffs

Energy bill =

Energy Cost/ Retail costs

+ Network costs

+ Market /environmental costs

+ metering, supply fees

Network tariffs 2016/ 16		**Agreed Demand**	**Actual Demand**
Supply	$/ day	11.134	no charge
kWhr used	$/ kWhr	0.031	0.045
Annual Demand Block 1	$/ kVa/day	0.319	
Annual Demand Block 2	$/ kVa/day	0.263	
Additional Demand	$/ kVa/ day	0.128	
Summer Peak	$/ kVa/day		0.491
Shoulder	$/ kVa/day		0.244
Offpeak	$/ kVa/ day		no charge

Tariffs

Agreed kVa demand tariff

- "Annual Demand" is based on ½ hour between 12noon and 9pm work days for Nov – March
- "Additional demand" is based on ½ hour outside of above times and dates ie
  - 9pm – noon Nov – March AND
  - 24 hour for rest of year
- So one peak demand spike between Nov-Mar 12noon – 9pm will set demand for whole period (ie no reset each month)
- The same holds for additional demand
- There is a flat rate for consumption (kWh)
- The AGREED kVa Demand tariff has a supply fee

Actual kVa Demand Tariff

- "Peak Demand" is based on ½ hour between 4pm and 9pm work days for Nov – March
- "Shoulder Demand" is based on ½ hour between 12 noon – 4pm, all year
- "Offpeak Demand" is based on ½ hour outside these times
  - 9pm – noon Nov – March AND
  - 4pm – noon for April – Oct
- The Demand is reset each billing period (month)
- So one high demand in one month will not impact on other months
- There is a flat rate for consumption (kWh)
- Actual kVa demand has NO supply fees

There are 19 hours/day where PEAK Demand is NOT charged

There are 15 hours where ONLY OFFPEAK demand is charged.

Applying NEW Tariffs

			If use as past	If all offpeak	Minimise peak
			kWh/ yr	kWh/ yr	kWh/ yr
	Peak + shoulder kWh		29,939		13,406
	Offpeak kWh		84,008	113,947	100,541
RETAIL COSTS	TOTAL kWh		113,947	113,947	113,947
			$	$	$
Peak	17.68	c/ kwh	$ 5,292		$ 2,369
Offpeak	9.16	c/ kwh	$ 7,691	$ 10,432	$ 9,205
Supply	35	$ / mnth	$ 420	$ 420	$ 420
Metering	120	$/ mnth	$ 1,440	$ 1,440	$ 1,440
Market charges					
AEMO	0.055	c/ kwh	$ 63	$ 63	$ 63
Enviornmentals	1.720	c/ kwh	$ 1,960	$ 1,960	$ 1,960
			$ 16,865	$ 14,315	$ 15,457
Network costs	**AGREED DEMAND**		$ 19,844		
	ACTUAL DEMAND		$ 18,108	$ 5,128	$ 18,108
TOTAL COSTS	**AGREED DEMAND**		$ 36,709		
ex gst	**ACTUAL DEMAND**		$ 34,974	$ 19,442	$ 33,565
	AGREED DEMAND	$/ kWh	**0.32**		
	ACTUAL DEMAND	$/ kWh	**0.31**	0.17	0.29

POWER FACTOR

POWER FACTOR
- motor draws kW from grid
- transformer/grid “sees” this as kVa
- **kVa = kW/ power factor (PF)**
- the lower the PF the higher the kVa
- If demand is based on kVa charges = lower PF = higher costs

Transformer
higher PF = lower kVa = more kW at transformer

PF typically 0.65 - 0.95

POWER FACTOR correction equipment (PFC) ➡ cost-effective to 0.95

EXAMPLE

Farm 1 Power factor = average 0.89 – 0.91 with peak demand at 395 kVa
50 kvar PFC equipment improves PF to 0.95 reduce peak demand to 373 kVa
Typical cost $ 4,000 + gst + installation Saves $ 2,500/ year

INTERVAL data = record of kW + power factor every 30 minutes = Smart meter

Power Control Engineers in Newcastle, NSW
- ✓ Assess if installation of PFC equipment is cost effective
- ✓ Provide part numbers so that a local electrical can install

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POWER FACTOR

power factor (PF) = real power/apparent power

REAL POWER = the capacity of the circuit for work (kW)

APPARENT POWER = current x volts (kVa)

[IMPACT of Power Factor]

low power factor

- more current
- larger wires etc,
- higher cost to grid

More worked examples

	2015 kVa	2015 PF	0.95 with PFC kVa	15.415 $/ kVa $ saved
Jan	93.90	0.89	88.0	91.4
Feb	94.40	0.87	86.5	122.5
Mar	92.14	0.91	88.3	59.8
Apr	98.60	0.89	92.8	89.6
May	104.23	0.90	98.7	84.6
Jun	105.83	0.90	100.3	85.9
Jul	103.12	0.92	99.9	50.2
Aug	102.19	0.91	97.9	66.3
Sep	103.70	0.93	101.5	33.7
Oct	100.72	0.90	95.4	81.7
Nov	101.63	0.90	96.3	82.5
Dec	94.32	0.85	84.7	148.5
		Total saving $		996.6

		Feb 28	Jan 31	Dec 31	Nov 30	Oct 31	Sep 30	Aug 31	Jul 31	Jun 30	May 31	Apr 30	Mar 31
Current kVa and PF	Peak	178	187	177	185	176	164	167	166	157	164	163	175
	Shoulder	181	189	195	193	195	182	162	163	151	178	180	192
	Offpeak	176	179	171	182	174	167	154	149	149	158	161	175
	PF	0.838	0.816	0.833	0.892	0.852	0.896	0.923	0.92	0.923	0.889	0.843	0.834
Proposed kVa and PF	PF 0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
	Peak	157.0	160.6	155.2	173.7	157.8	154.7	162.3	160.8	152.5	153.5	144.6	153.6
	Shoulder	159.7	162.3	171.0	181.2	174.9	171.7	157.4	157.9	146.7	166.6	159.7	168.6
	Offpeak	155.3	153.8	149.9	170.9	156.1	157.5	149.6	144.3	144.8	147.9	142.9	153.6
Rates $/ day	Peak	0.2673	0.2673	0.2673	0.2673	0.2673	0.2673	0.2673	0.2673	0.2673	0.2673	0.2673	0.2673
	Shoulder	0.2673	0.2673	0.2673	0.2673	0.2673	0.2673	0.2673	0.2673	0.2673	0.2673	0.2673	0.2673
	Offpeak	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611	0.0611
Savings $/ month	Peak	157.1	218.6	180.6	90.6	150.4	74.8	39.3	43.4	35.8	87.3	147.2	177.1
	Shoulder	159.7	220.9	199.0	94.5	166.7	83.0	38.2	42.7	34.4	94.7	162.6	194.3
	Offpeak	35.5	47.8	39.9	20.4	34.0	17.4	8.3	8.9	7.8	19.2	33.2	40.5
SAVED $		352.3	487.3	419.5	205.4	351.1	175.1	85.8	95.0	78.0	201.2	343.0	411.8
SAVED $	3205.5												

Diesel option

<u>Is it worth it?</u>

Generally, for SMALL RETAIL energy users, **if grid power is available at a site**

- installation of a **diesel genset is not cost –effective**
- diesel gensets normally use between 0.25 – 0.45 L diesel / kWh generated
- $ 0.25 – 0.45/ kWhr, based on $1.00/ L diesel (after rebates)
- if demand fees not managed, this could be similar to grid costs
- PLUS **ongoing maintenance + recurring capital costs** for diesel are significant

HOWEVER

For LARGE RETAIL energy users on CONTESTABLE BILLS → **diesel MAY be worthwhile investigating, IF:**

- very seasonal consumption
- high ANNUAL PEAK DEMAND
- low power factor

→ **High annual average total $/ kWh rate**

<u>kWhr/ ML/ m benchmarks:</u>

Electricity:	range 3.7 – 7.3	average 4.9
Diesel:	range 4.0 - 8.7	average 5.1

Solar PV

THERE IS NO BENEFIT IN INSTALLING SOLAR PV

- if irrigation runs overnight
- if the system is run for 4 or 5 days and nights, then switched off for several days
- there is a long "off-season" when no irrigation takes place

The benefit of solar PV is limited by:

- the seasonal consumption of electricity by the irrigation pumps in the off-season.
- the existing daily irrigation pattern: if irrigation cycles start at 9:00pm for 10 -12 hours.

SOLAR PV and peak demand

Solar PV may not be a reliable to reduce **Annual** Peak Demand

Solar PV plus **Monthly** Peak Demand tariff

- ➢ can reduce the summer Peak Demand significantly
- ➢ any subsequent demand spikes would only affect that particular month.

Solar and batteries

- ➢ potential to reduce consumption and demand fees
- ➢ Solar plus batteries would greatly reduce the risk of a spike in Peak Demand
- ➢ more of a guarantee that any Peak Demand reductions are permanent.

Solar PV

SCENARIO WHERE SOLAR PV MAY BE WORTHWHILE
Can irrigation scheduling maximise the solar PV generated?

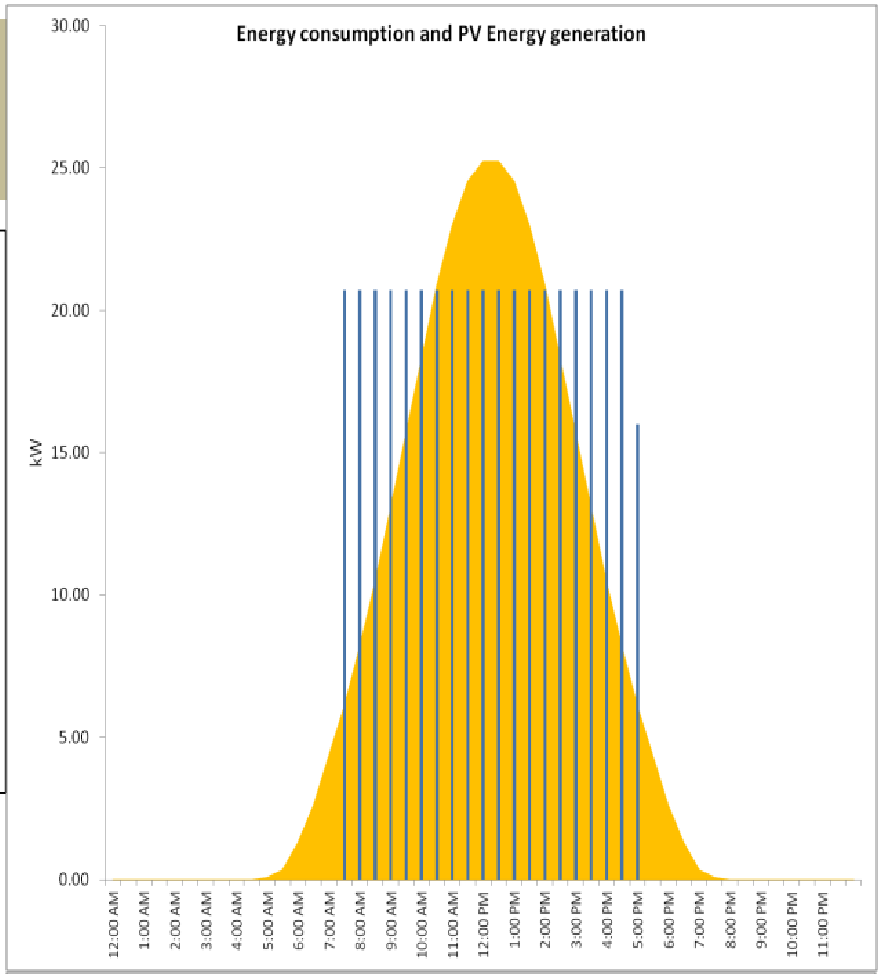
- irrigation occurs primarily when the sun shines.

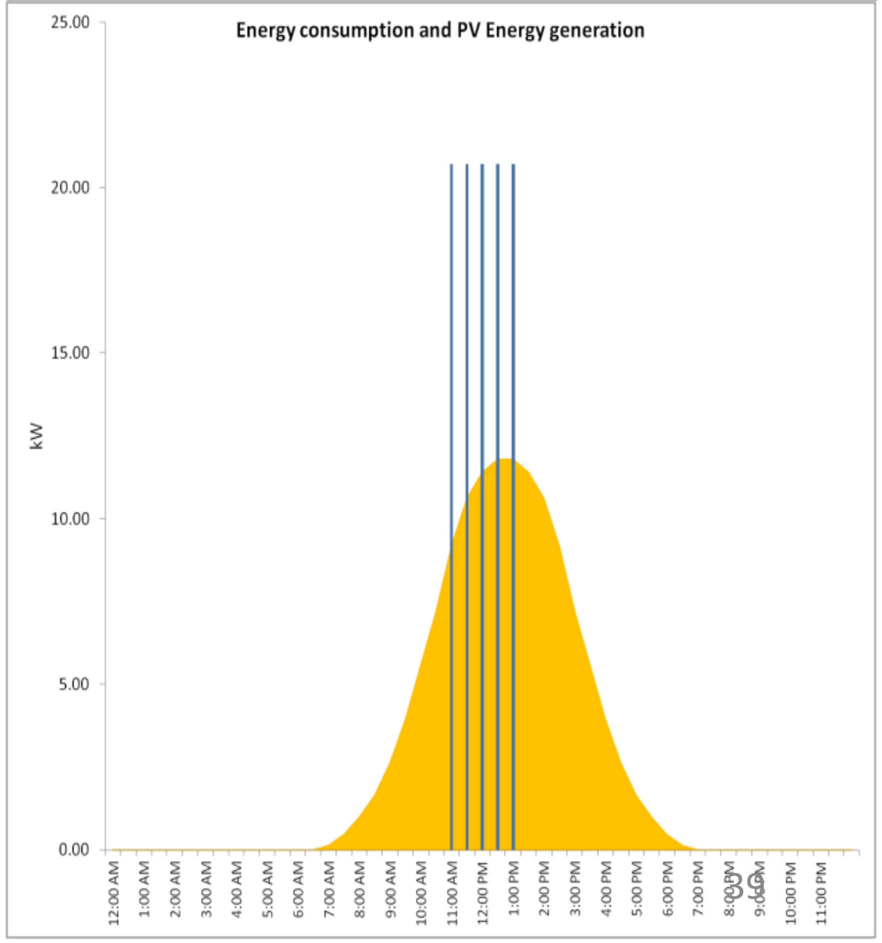
Simplified analysis

- potential of solar PV to offset grid electricity

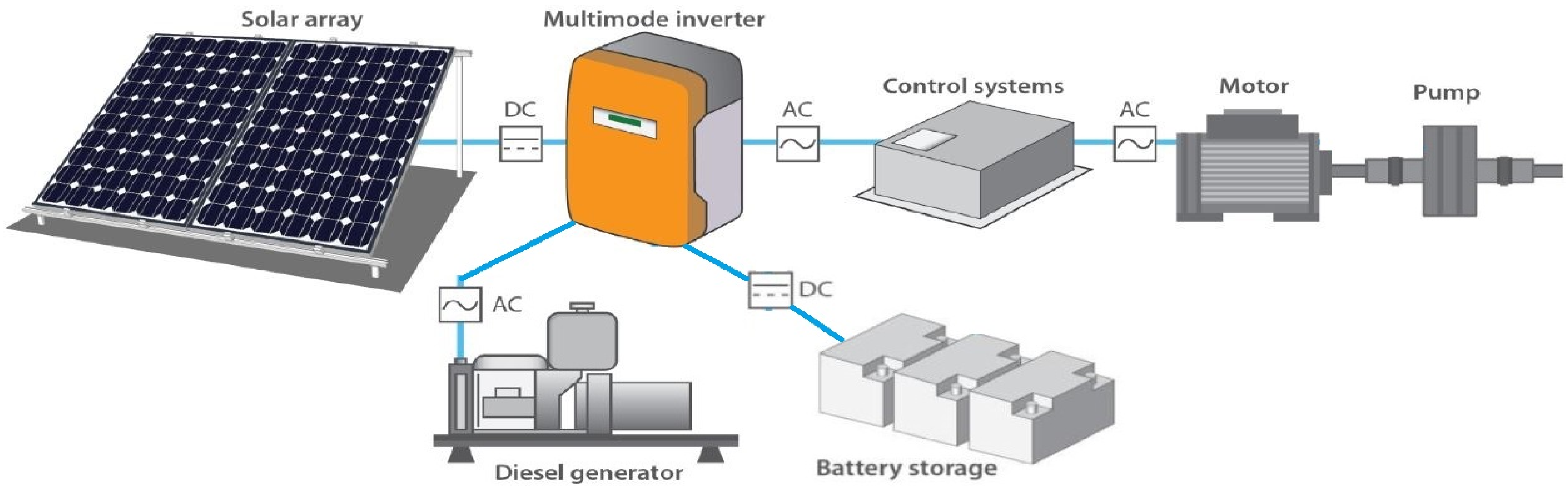
Farm	Size of solar PV	Indicative payback
Farm 1	300 kWp	12 years
Farm 4	30 kWp	7-9 years

NOTE this is an approximate analysis and more detailed review must be carried out before proceeding with solar PV.





Diesel / Solar PV HYBRID



Diesel generators → Solar PV controllers

Diesel motors ✕ Solar PV controllers