

Data Analytics to Determine Pump Performance using IoT

Presenter: Evan Atkinson, General Manager - SUEZ Smart Solutions (NZ) Simon Bunn, Senior Manager - SUEZ Smart Solutions (NZ)



Outline

Why do we care?
 This Trial
 Visualising Operation
 Additional Analytics
 Outcomes

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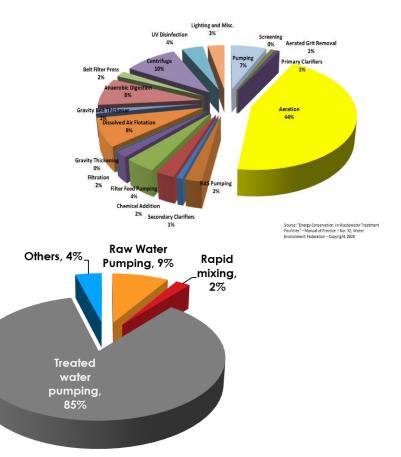
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Drivers for Energy Management in the Water/Wastewater Sector

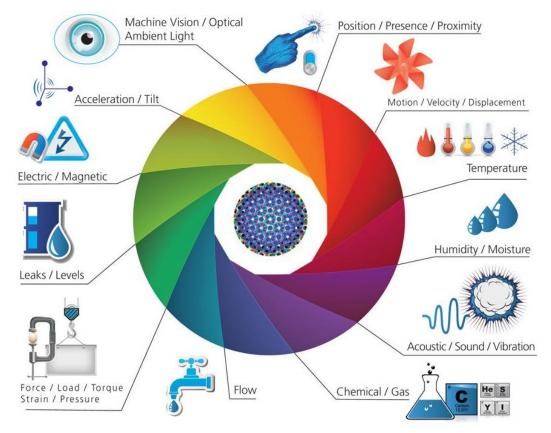
- Water/wastewater consume up to 3% of a nation's energy
- Water/wastewater agencies have been facing increasing energy demand and costs

• Electricity constitutes:

- **25% 40%** of a typical WWTP's operating budget
- 80% + of water treatment and distribution costs



IoT Devices – new opportunity for water and wastewater industries



4 WaterNZ 2019 - Pump Performance Data Analytics using IoT

SUEZ Smart Solutions

An interoperable suite of smart solutions for water & wastewater system operators

Smart W&WW Networks Aquadvanced Suite



Smart Metering / Cities OnConnect / WIZE Platform

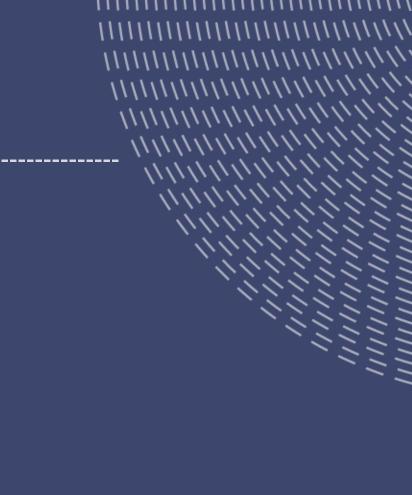


Smart W&WW Treatment Aquadvanced Plant



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The Trial: What did we do?

• Trial two IoT pump meter technologies

Panoramic Power (Centrica)

Gulplug

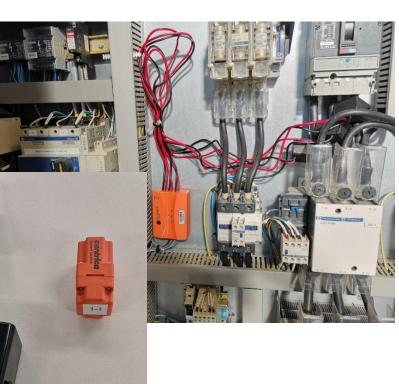
- Parasitic powered sensors
- Data bridge uses IoT to bring data back to cloud
- FTP feed to data lake

O 2 Pump Station Installations

- Four pumps / site
- Single Phase measured
- Three Phase measured on one pump
- 3 months operation

• Visualisation of Performance

- Aquadvanced Energy Monitoring (Dashboard)
- Specific data analytics



The Trial: Site: Consorci d'Aiguies de Tarragona

• Aquadvanced Energy Reference Site

- 100km South of Barcelona
- Located on the Mediterranean coast

• EB6 pump station

- 3x 66kW pumps
- 1x 35kW pump
- 2 hours to install and test

• EB12 pump station

- 4x 75kW pumps
- 1hr to install and test



The Trial: Questions to Answer

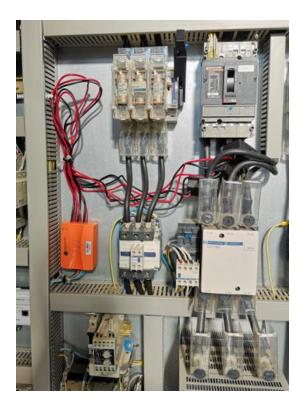
• Effectiveness of IoT power meters

- Ease of installation
- Reliability
- Ease of cloud data extraction

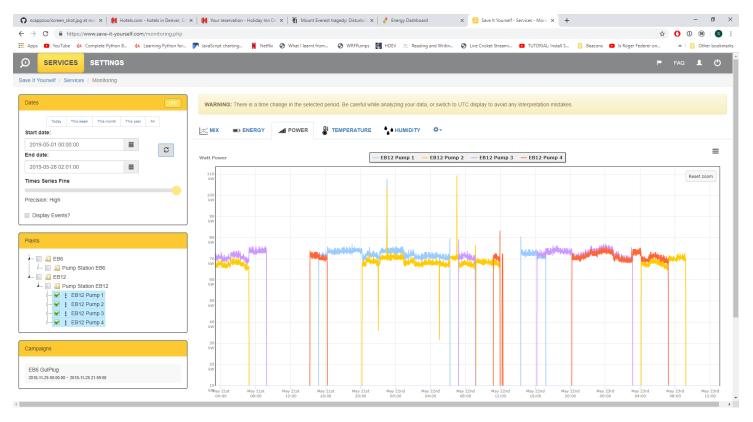
• How are they best used?

- Is sub-metering necessary at all?
- Is 3 phase necessary for pump performance?
- What data resolution is necessary?

• What meaningful energy analytics can be achieved?

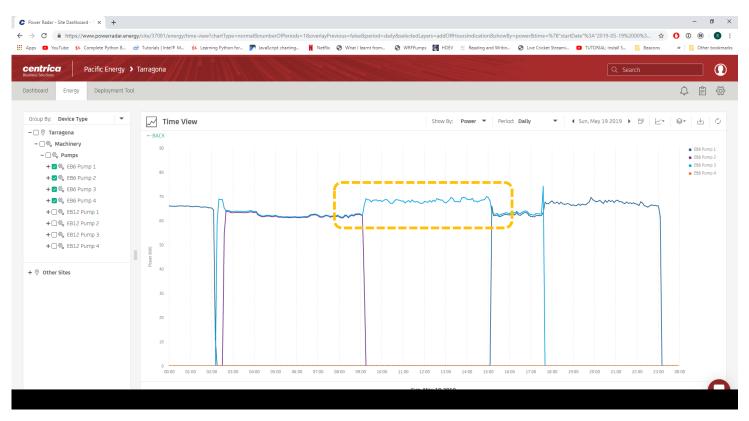


The Trial: Gulplug user interface



10 | WaterNZ 2019 - Pump Performance Data Analytics using IoT

The Trial: Centrica user interface



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Visualising Operation: Energy Monitoring Dashboard: map based view of pump stations

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	real	774.1 kW	'ь/мі	MO		75.7 kWh/l	MI	resteruay	743.7 kWh/ML	Today	743.6 kWh/MI		
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	EB12 Centrica	67 %	290.3 kWh	4.056 kWh/ML/m	756.9 kWh/ML 🔕	160.0 kW	0.192 ML	and a	A A		Vilafrança del Penedès	2	
	EB6 Centrica	67 %	245.1 kWh	4.077 kWh/ML/m	728.3 kWh/ML 😏	265.6 kW	0.168 ML	ural	Conta N	2 Ac Y	133	Parc del	
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13 | WaterNZ 2019 - Pump Performance Data Analytics using IoT

Visualising Operation:

Energy Monitoring Dashboard: pump station health wagon wheel



Visualising Operation: Energy Monitoring Dashboard: using cleaned data

								요• guest
	Navigation ~ Suez	Smart Solutions > CAT	Centrica > EB12 Centri	са				() Monday, August 12, 2019 8:30 AM
\$								*
~	EB12 Centrica	& EB12 P1 Centrica 741.3 kWh/ML	EB12 P2 Centrica kWh/ML	& EB12 P3 Centrica 18.54 kWh/ML	LEB12 P4 Cent 736.6 kWh/ML	trica		
	Energy per	volume						
	Year	717.7 kwr	n/ML	Month	736.4 kw	'h/ML	Vesterday 808.6 kWh/ML	Today 708.0 kWh/ML
	Pumps	Efficiency Today	r Energy Today	PEI Today	Specific Energy Today	Peak kW This Month	Station Energy Use vs Tariff	% time number of pumps are on
	EB12 P1 Ce EB12 P2 Ce EB12 P3 Ce EB12 P4 Ce	entrica % entrica 69 %	1,104 kWh 0 kWh 75.30 kWh 1,366 kWh	4.056 kWh/ML/m kWh/ML/m 0.1009 kWh/ML/m 4.174 kWh/ML/m	741.3 kWh/ML 2 kWh/ML 18.54 kWh/ML 2 736.6 kWh/ML 2	80.00 kW 80.00 kW 80.00 kW 77.95 kW		≈ 50 06/08 08/08 10/08 12/08
							Average PPI (Normalised PEI) Today	Average Station Efficiency Today

15 | WaterNZ 2019 - Pump Performance Data Analytics using IoT

Visualising Operation: Energy Monitoring Dashboard: data analytics view

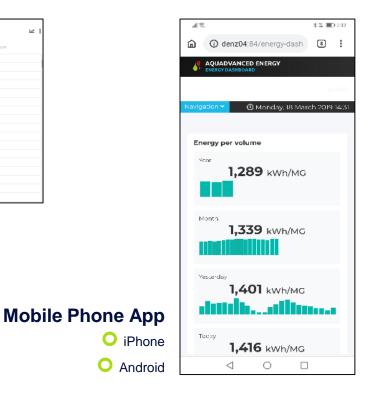


Visualising Operation: Energy Monitoring Dashboard: data export

	YTD 1y ← → From 05/03	/2019 То 12/03/2019 🗸 🤇	memorize		
te	RoyalOak PS > Clean flow	RoyalOak PS > Raw power	RoyalOak PS > Headloss	RO_Suction > Pressure	RO_Discharge > Pressure
05/03/2019 00:00	6.232 MGD	211 KW	168.6 ft	75.46 ft	244.1 ft
05/03/2019 00:10	0 MGD	6.94 kW	153.9 ft	75.46 π	229.3 ft
05/03/2019 00:20	0 MGD	6.85 kW	148.0 ft	81.36 ft	229.3 ft
05/03/2019 00:30	0 MGD	6.80 kW	148.0 ft	81.36 ft	229.3 ft
05/03/2019 00:40	3.840 MGD	133 KW	157.2 ft	78.41 π	235.6 ft
05/03/2019 00:50	3.840 MGD	133 KW	157.2 ft	78.41 ft	235.6 ft
05/03/2019 01:00	3.840 MGD	133 KW	157.2 ft	78.41 ft	235.6 ft
05/03/2019 01:10	3.852 MGD	134 KW	157.8 π	78.41 π	236.2 ft
05/03/2019 01:20	3.852 MGD	134 KW	156.5 ft	79.72 ft	236.2 ft
05/03/2019 01:30	3.852 MGD	134 KW	156.5 ft	79.72 ft	236.2 ft
05/03/2019 01:40	3.828 MGD	133 KW	157.8 ft	78.74 π	236.5 ft
05/03/2019 01:50	3.828 MGD	133 KW	157.8 ft	78.74 ft	236.5 ft
05/03/2019 02:00	3.828 MGD	133 KW	157.8 ft	78.74 ft	236.5 ft
05/03/2019 02:10	3.822 MGD	133 KW	158.1 ft	78.74 π	236.9 ft
05/03/2019 02:20	3.822 MGD	133 KW	158.1 ft	78.74 ft	236.9 ft
05/03/2019 02:30	3.822 MGD	133 KW	158.1 ft	78.74 ft	236.9 ft

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Export to csv for additional analysis



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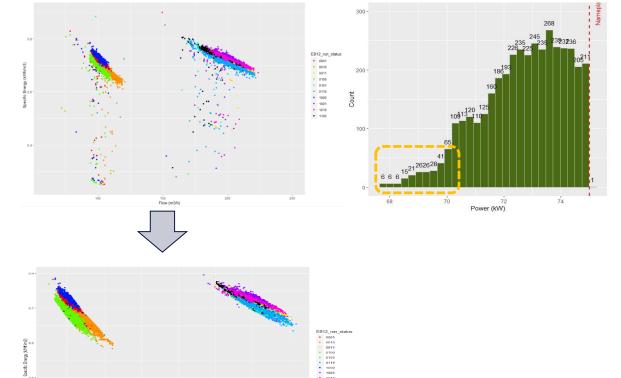
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5. Outcomes

Additional Analytics:

Data cleaning to remove erroneous values

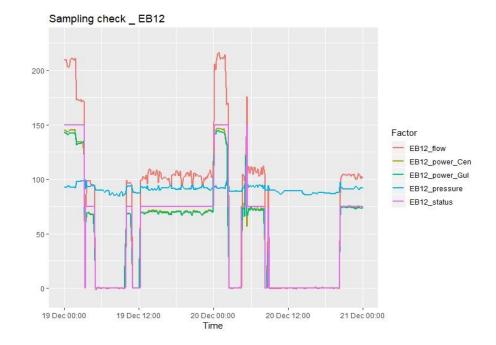
- Many initial efforts fall over due to date errors and inaccuracies
- Simple cut function removed 6% of data points, almost all bad values and only impacted total energy calculated by 0.4%
- More sophisticated data cleaning is often required
- Always check that cleaning does not remove useful data



Additional Analytics :

Data timing becomes critical between different data sets

- Initially this data plot looks good
- Data is received from:
 - SCADA: 1 minute samples
 - IoT: 10 minutes samples
 - Energy Supplier: 15 minute

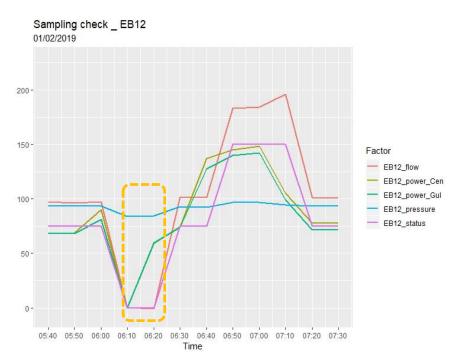


>>> Initially this plot looks good

Additional Analytics:

Data timing becomes critical between different data sets

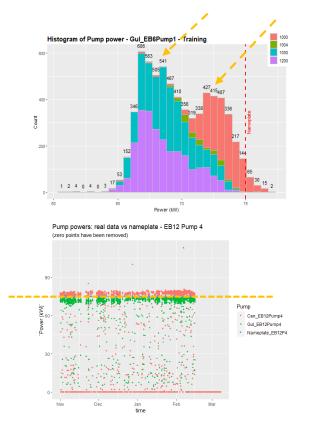
- Mis-alignment between data sets
- O When calculating kWh/Volume:
 - No flow but power => infinitely bad
 - Flow but no power => high efficiency
- Note that each data set is correct in itself, so cleaning can only occur on result of calculation
- Removing bad data can introduce new errors

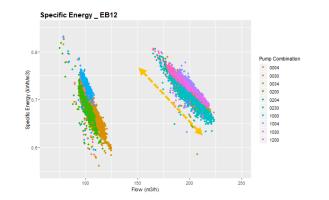


>>> However, zooming in reveals issues...

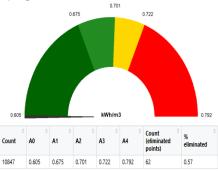
Additional Analytics :

Four key insights from analysing pump energy consumption:





Specific Energy - EB12 station

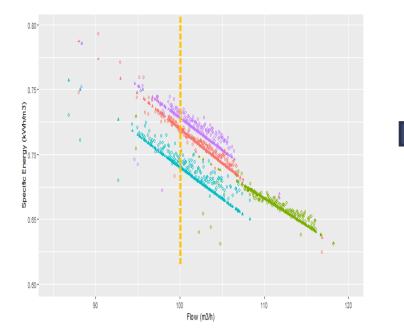


22 | WaterNZ 2019 - Pump Performance Data Analytics using IoT

Additional Analytics:

Provide guidance as to which pump is best to run

• Data fit of Specific Energy vs. Flow for each pump



Pump #	Specific Energy (kWh/m3)	Energy Savings (kWh per month)	Cost reduced per month (€)
#1 (Running)	0.73	N/A	N/A
#2	0.69	2741.75	€ 286.86
#4	0.72	621.35	€ 74.86

• Calculated Benefit of changing to a more efficiently pump

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Outcomes: Using IoT Power Meters

• Both Gulplug and Centrica Meters were effective

- Easy to install. <2hr for a pump station
- Cloud data storage was accessible (with FTP feed)
- Note: They only transmit data when current flowing (pump is on)

Accuracy was good

- Submeter totals compared with energy supplier meter 15 min values.
- Less than 2% difference in total kWh
- Difference likely only ancillary energy use in pump station

O Do you need 3 phase? Is Power factor an issue?

- This will depend on the site
- For Tarragona, Power Factor correction kept PF at 0.998 + 0.005
- No tangible benefit noted in this trial from using 3 phases.



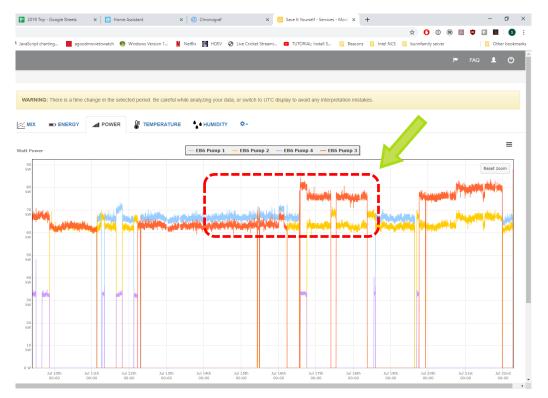
Energy	EB12 [‡]	EB6 [‡]
Actual	128799.00	153512.00
Centrica (raw)	122261.44	149145.96
Centrica (cleaned)	119619.99	146403.04
GulPlug (raw)	120121.43	153746.81
GulPlug (cleaned)	117596.54	151115.12
Difference (Centrica (cleaned) - Centrica (raw))	-2641.46	-2742.92
Difference (GulPlug (cleaned) - GulPlug (raw))	-2524.89	-2631.70
% Difference (Centrica (cleaned - raw)/raw)	-2.16	-1.84
% Difference (GulPlug (cleaned vs raw)/raw)	-2.10	-1.71
% Precision loss (Centrica (cleaned - raw)/actual)	-2.05	-1.79
% Precision loss (GulPlug (cleaned vs raw)/actual)	-1.96	-1.71



Outcomes:

Benefit Example: Fault detection example using IoT sub-metering

- Example of fault identification
- Capacitor Failure on power correction bank (Spike in Energy use for Pump 3 – Orange)
- Failed power correction capacitors can catch fire
- Discovery possible because submetering
- Having the data makes this possible Automatic event detection to alert users



Outcomes:

Recommendations: start recording your energy use

- 1. You can start with name-plate power;
 - But don't trust the nameplate label, do a nominal power test (with pump on)
 - This value is combined with connection to SCADA data to record anomalies
 - More can be done with more information...

2. Site Power is an improvement

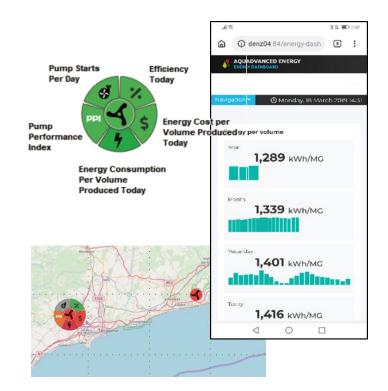
- Requires assumptions to assign power to each pump
- Need to account for ancillary power consumption at the site.

3. Single phase current @ 10 minutes samples is ideal

- Provides actual Specific Energy (real efficiency)
- Provides peak kW, but does require cleaning (a good tool)
- Allows Dashboard to provide guidance

4. Recommendation

- · Get started with energy management with whatever you have
- Ideally implement sub-metering to allow rich insights and guidance
- IoT parasitic meters are a good option.





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