water NEW ZEALAND
The New Zealand Water & Wastes Association Waiora Aotearoa
A consistent approach across the 3 waters sector

Data Analytics to Determine Pump Performance using IoT

Presenter: Evan Atkinson, General Manager - SUEZ Smart Solutions (NZ)
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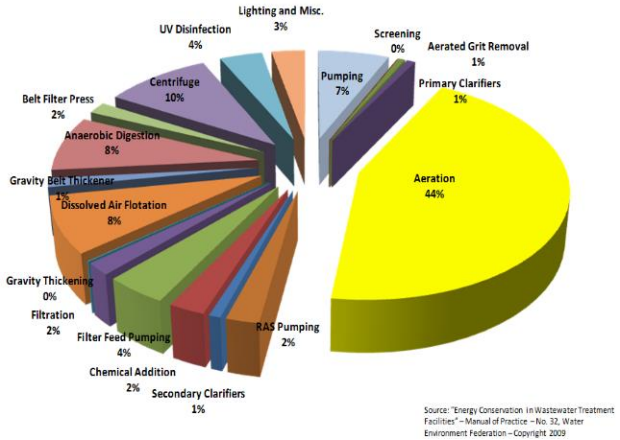
Outline

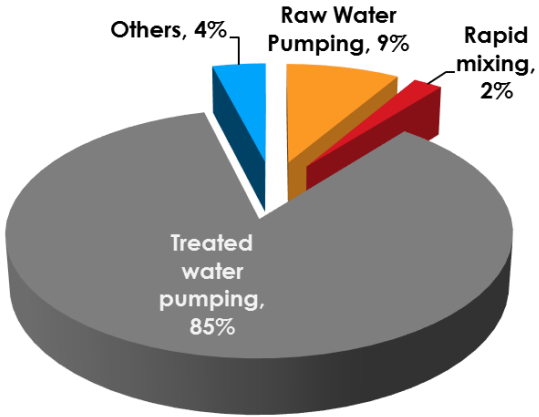
1. Why do we care?
2. This Trial
3. Visualising Operation
4. Additional Analytics
5. Outcomes

Drivers for Energy Management in the Water/Wastewater Sector

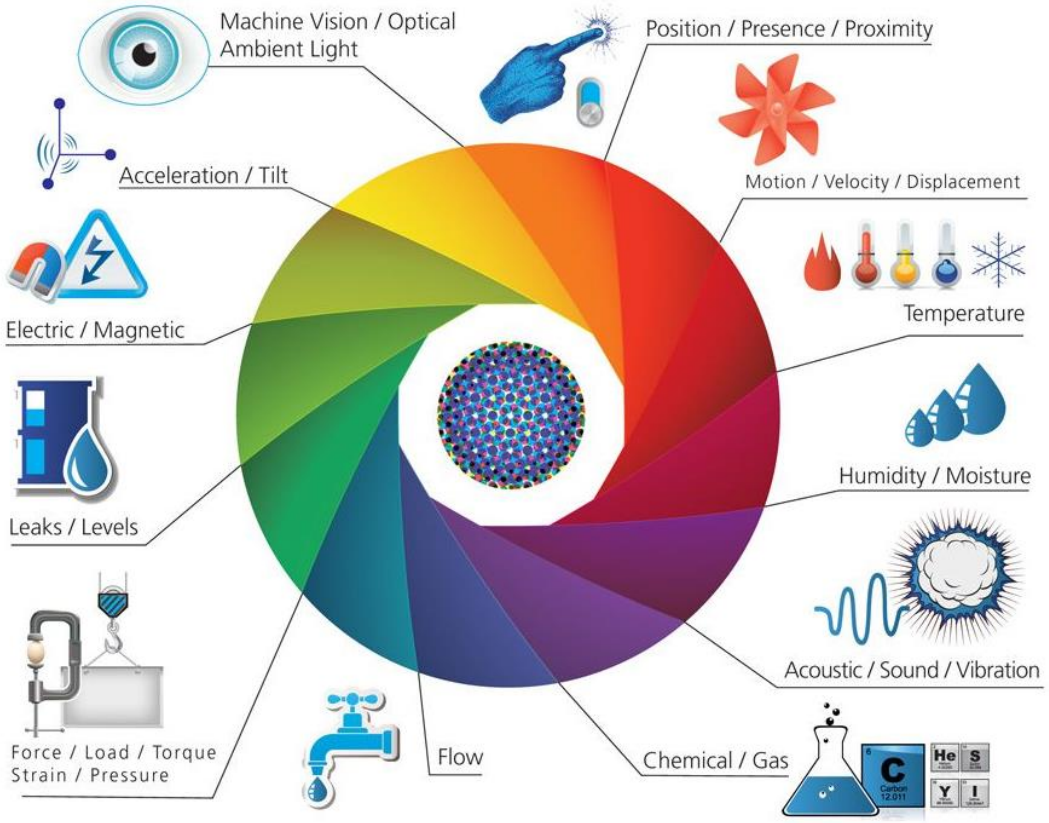
- **Water/wastewater consume up to 3% of a nation's energy**
- **Water/wastewater agencies have been facing increasing energy demand and costs**
- **Electricity constitutes:**
  - **25% - 40%** of a typical WWTP's operating budget
  - **80% +** of water treatment and distribution costs



Source: "Energy Conservation in Wastewater Treatment Facilities" – Manual of Practice – No. 32, Water Environment Federation – Copyright 2009



IoT Devices – new opportunity for water and wastewater industries



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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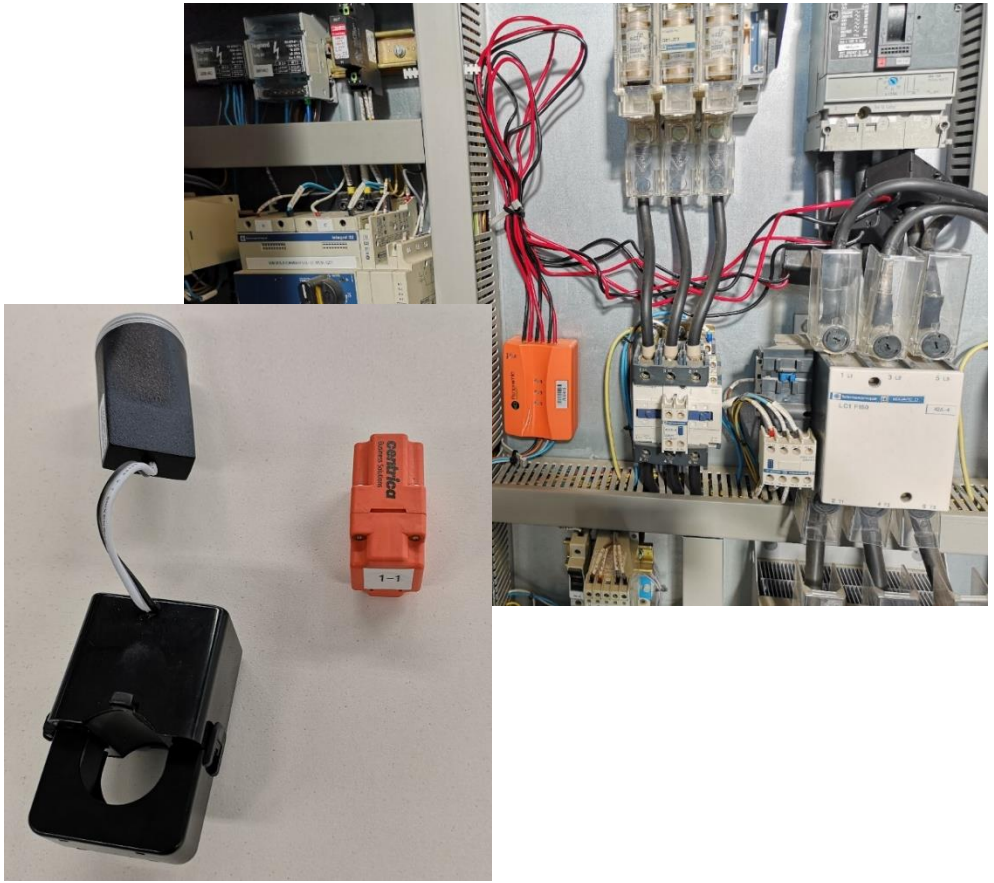
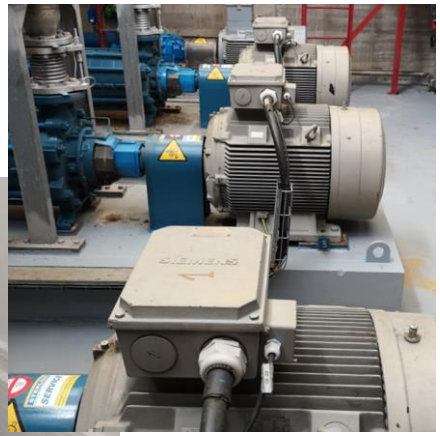
The Trial:
What did we do?

- **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
- **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**



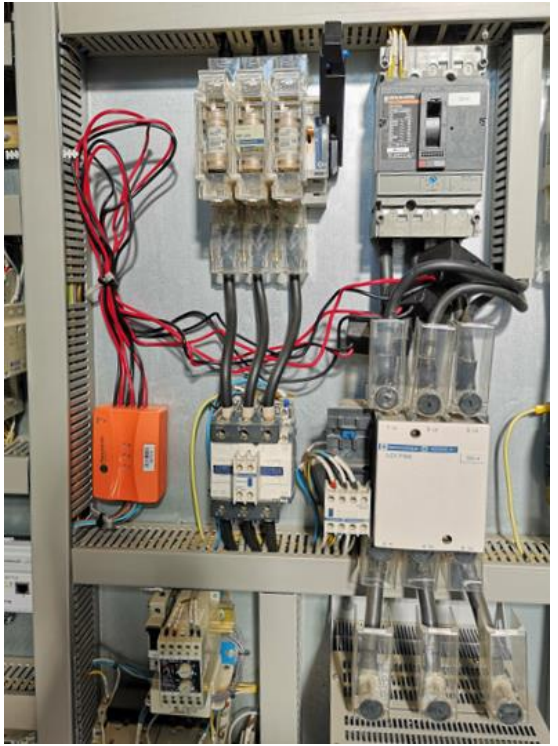
The Trial:
Site: Consorci d'Aiguies de Tarragona

- **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**



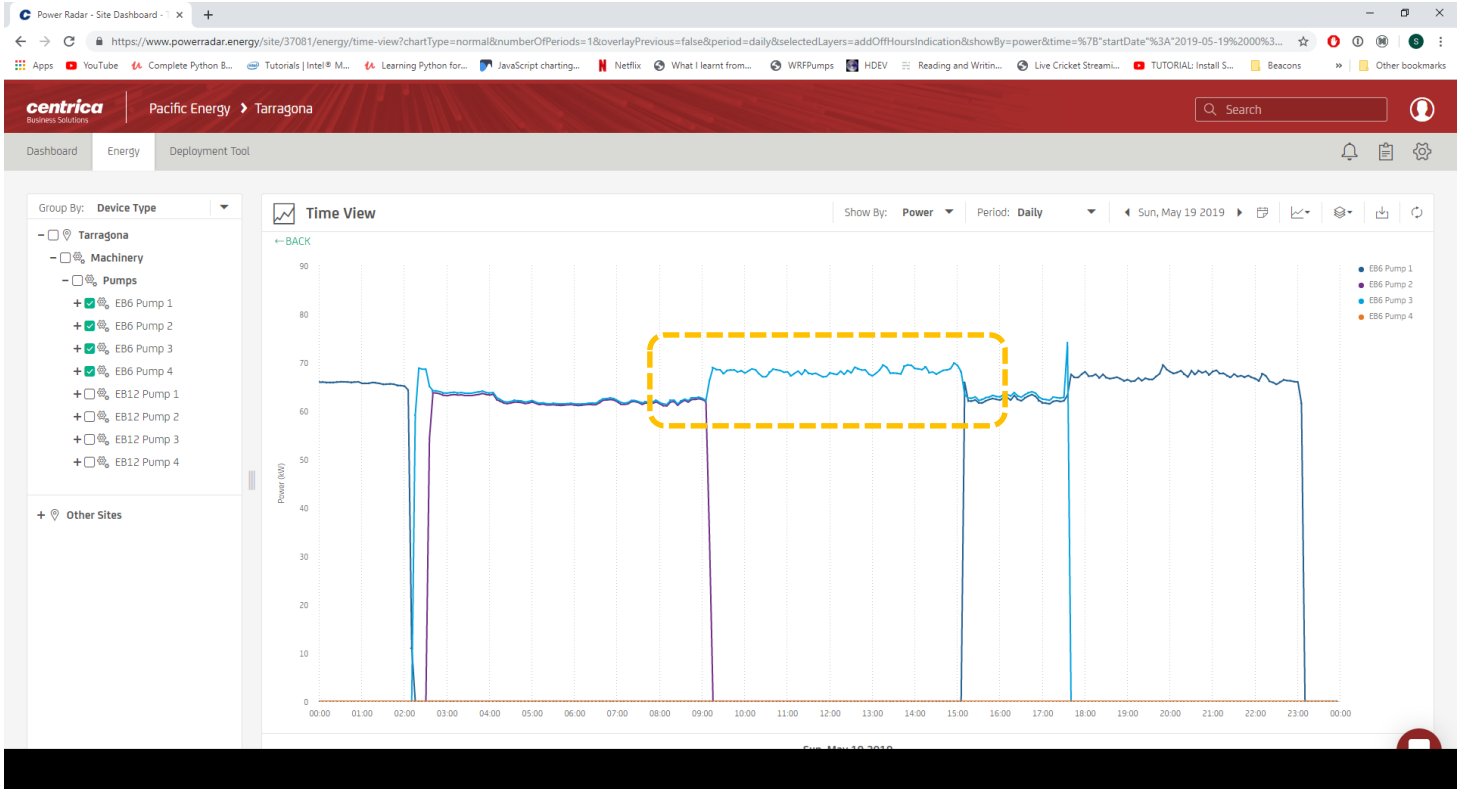
The Trial:
Questions to Answer

- **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

The Trial:
Centrica user interface



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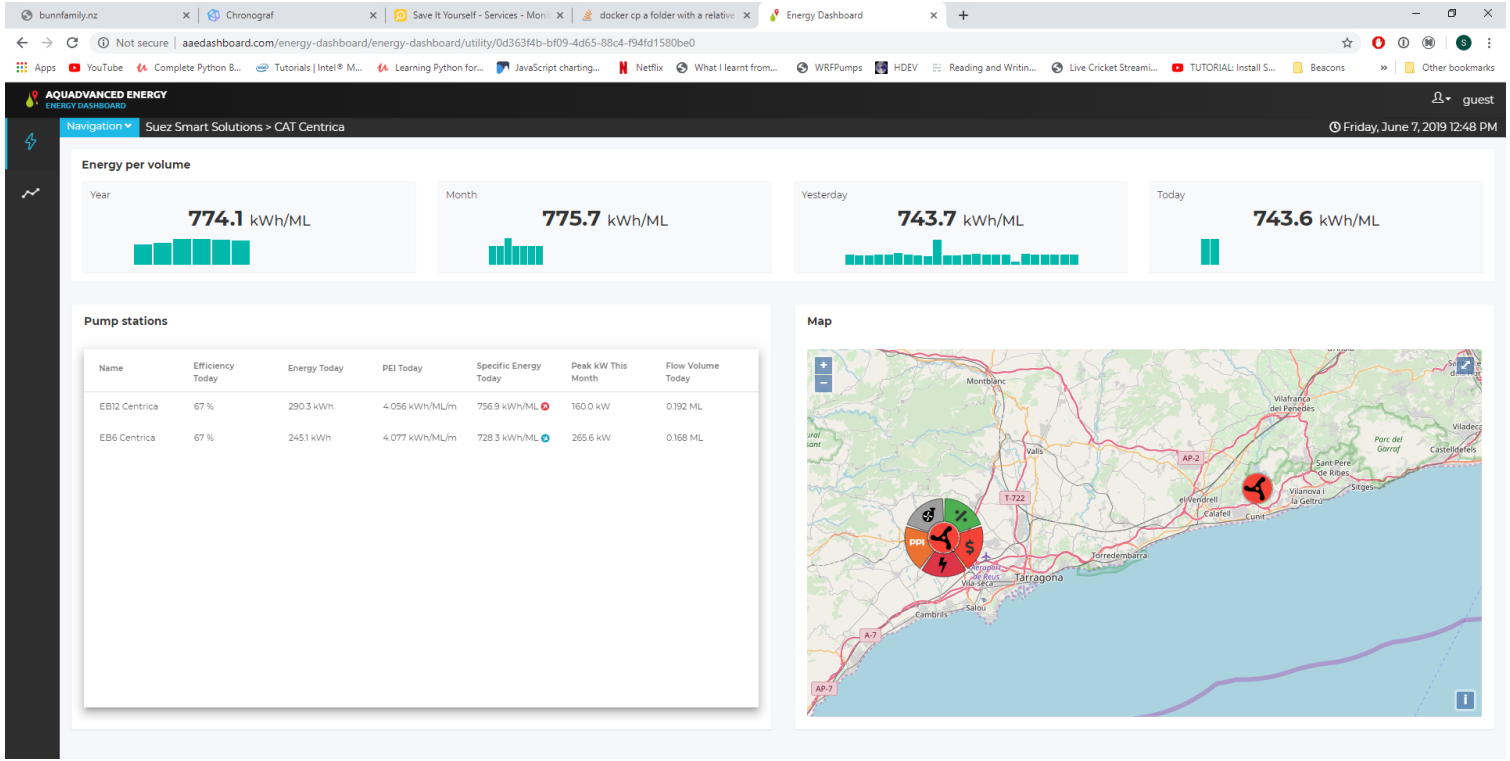
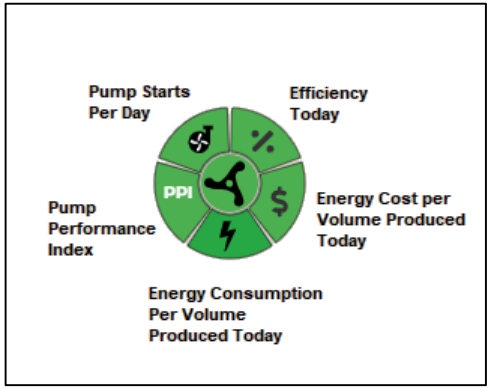
Visualising Operation:

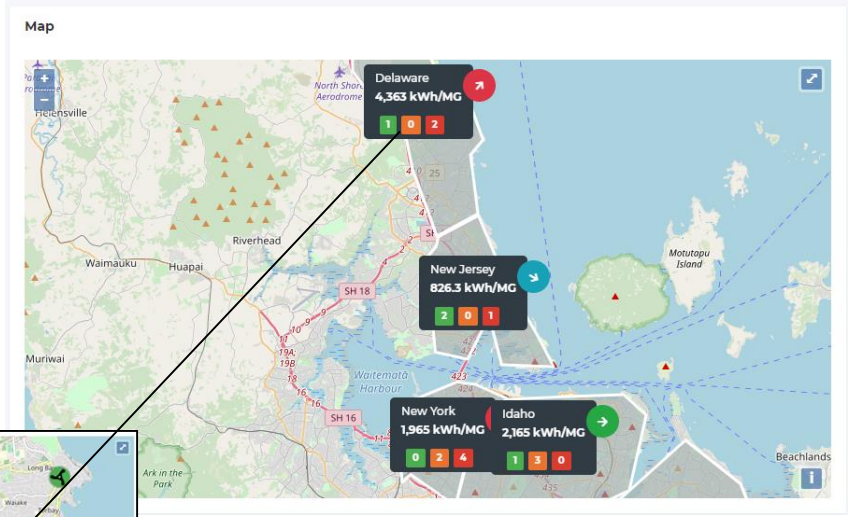
Energy Monitoring Dashboard: map based view of pump stations

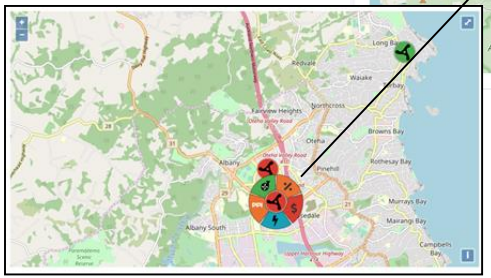


Visualising Operation:

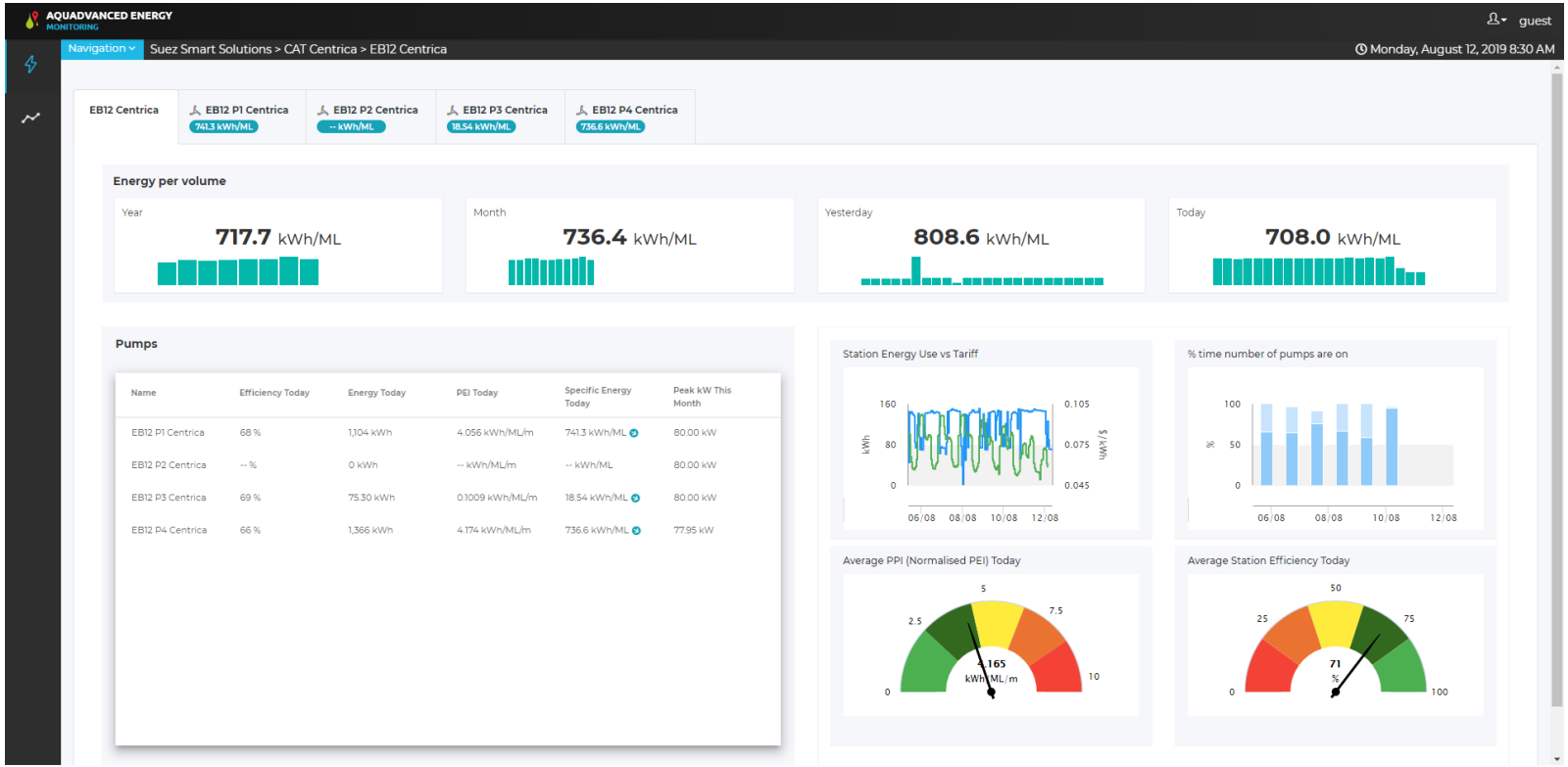
Energy Monitoring Dashboard: pump station health wagon wheel







Visualising Operation:
Energy Monitoring Dashboard: using cleaned data



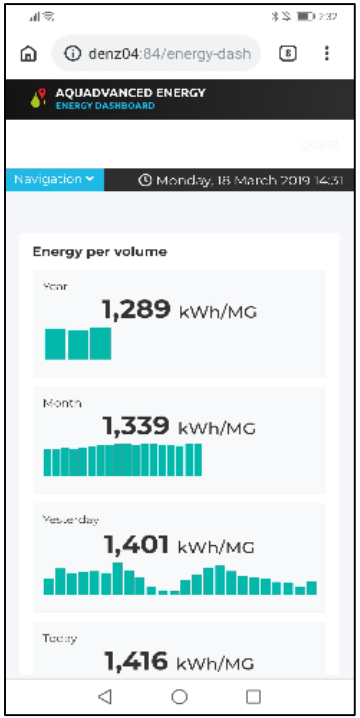
Visualising Operation:
Energy Monitoring Dashboard: data analytics view

Visualising Operation:
Energy Monitoring Dashboard: data export

Date	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 ft	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 ft	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 ft	78.41 ft	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 ft	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 ft	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
05/03/2019 02:40	3.810 MGD	133 kW	158.8 ft	78.74 ft	237.5 ft

- **Export to csv for additional analysis**

- **Mobile Phone App**
  - iPhone
  - Android



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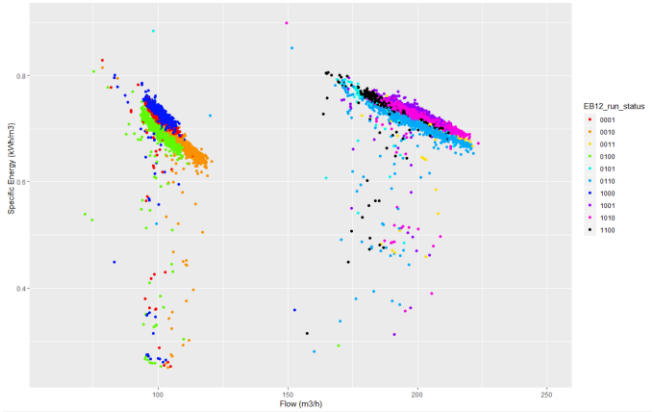
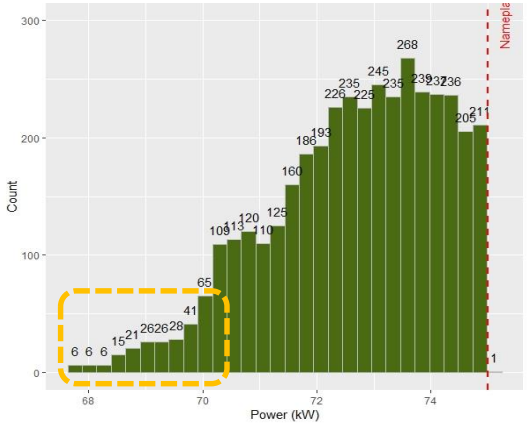
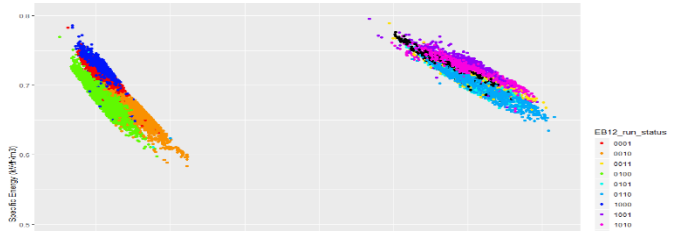
Additional Analytics:

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



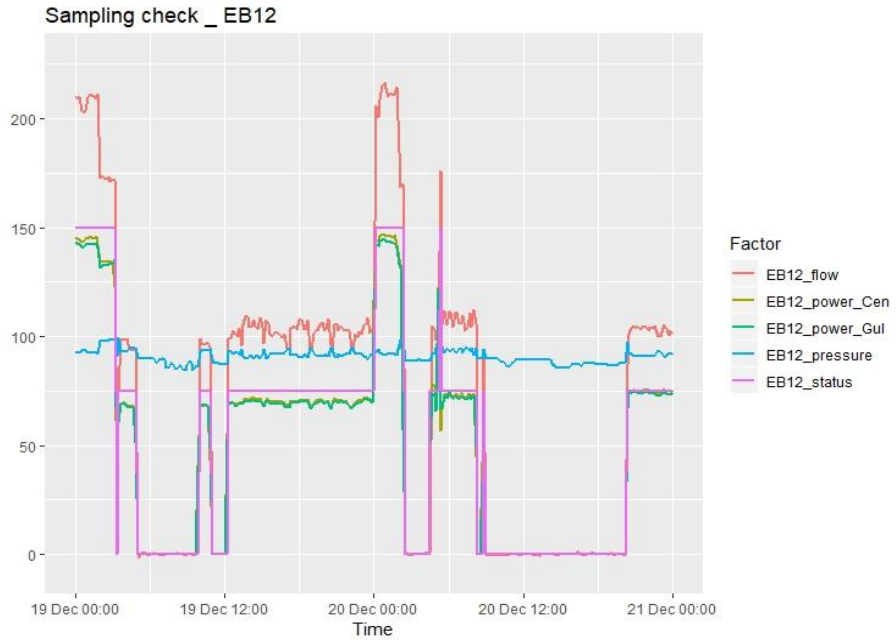




Additional Analytics :

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

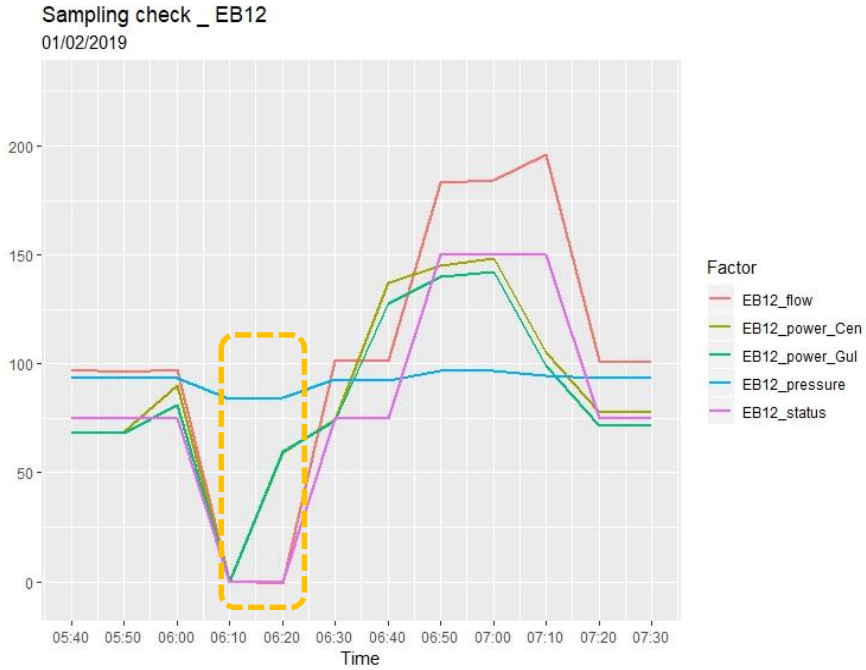


>>> Initially this plot looks good

Additional Analytics:

Data timing becomes critical between different data sets

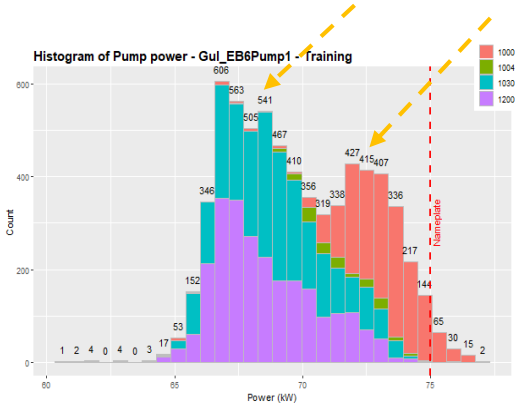
- Mis-alignment between data sets
- When calculating kWh/Volume:
  - No flow but power => infinitely bad
  - Flow but no power => high efficiency
- Note that each data set is correct in itself, so cleaning can only occur on result of calculation
- Removing bad data can introduce new errors

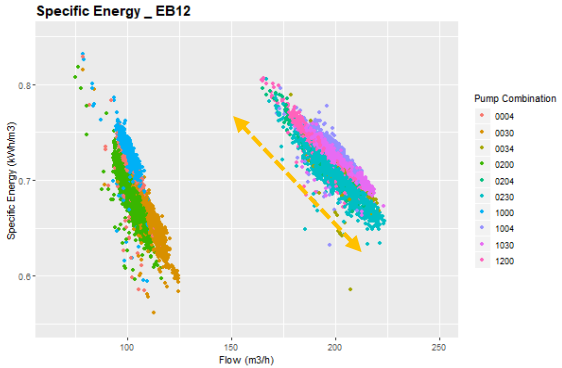


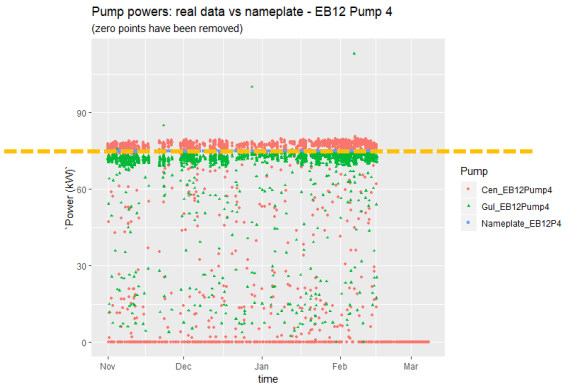
>>> However, zooming in reveals issues…

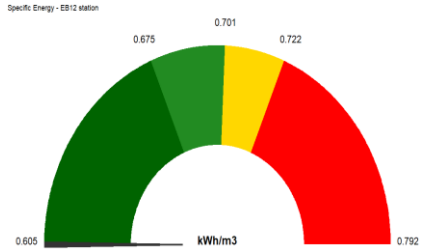
Additional Analytics :

Four key insights from analysing pump energy consumption:







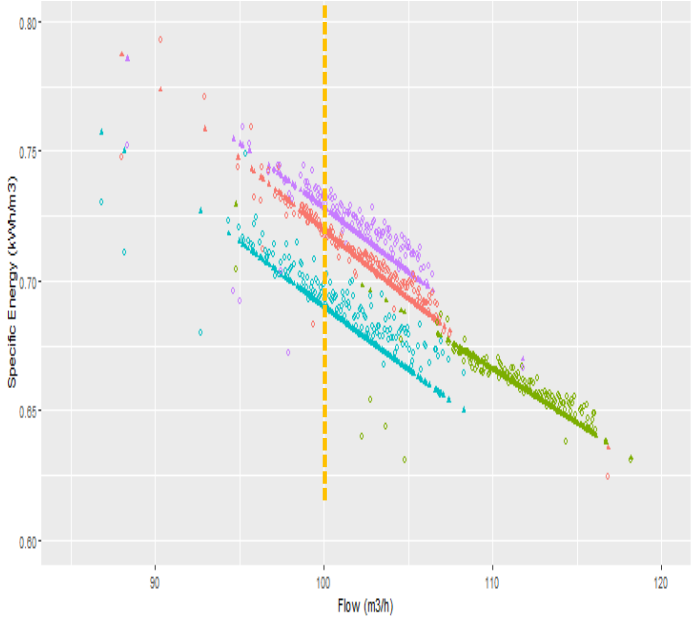


Count	A0	A1	A2	A3	A4	Count (eliminated points)	% eliminated
10847	0.605	0.675	0.701	0.722	0.792	62	0.57

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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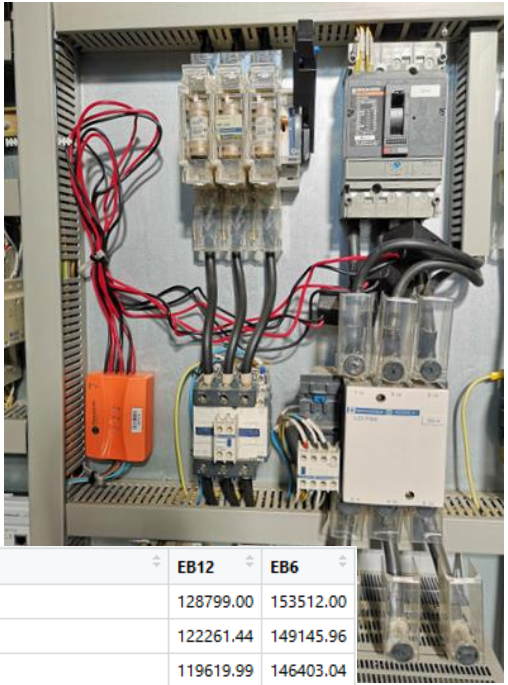
Outcomes:
Using IoT Power Meters

- **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 <u>good</u>**
  - 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

- **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.

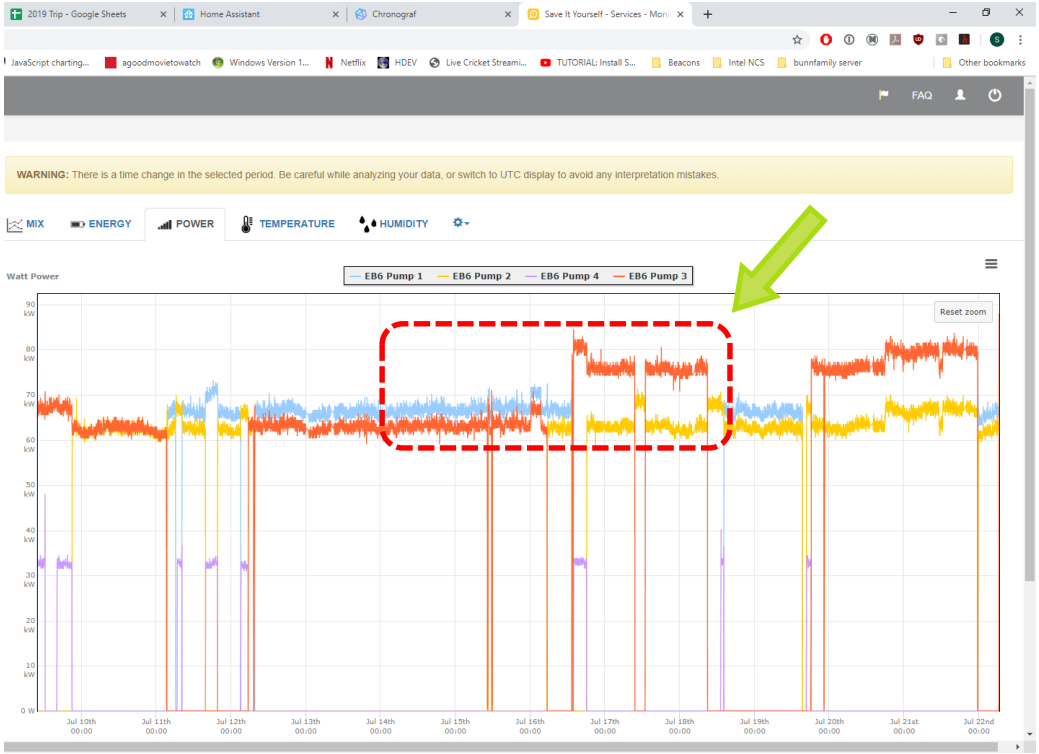


Energy	EB12	EB6
Actual	128799.00	153512.00
Centrica (raw)	122261.44	149145.96
Centrica (cleaned)	119619.99	146403.04
GulPlug (raw)	120121.43	153746.81
GulPlug (cleaned)	117596.54	151115.12
Difference (Centrica (cleaned) - Centrica (raw))	-2641.46	-2742.92
Difference (GulPlug (cleaned) - GulPlug (raw))	-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

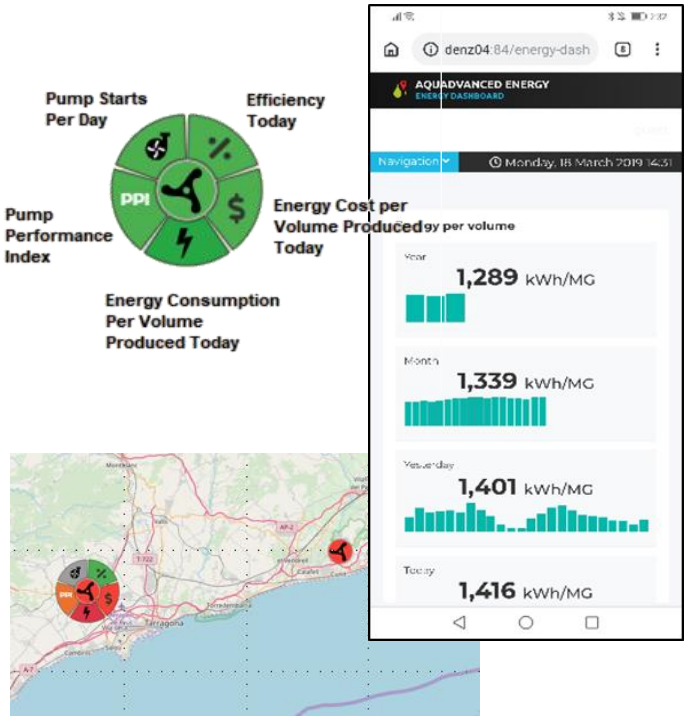
- Example of fault identification
- Capacitor Failure on power correction bank (Spike in Energy use for Pump 3 – Orange)
- Failed power correction capacitors can catch fire
- Discovery possible because submetering
- Having the data makes this possible Automatic event detection to alert users



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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