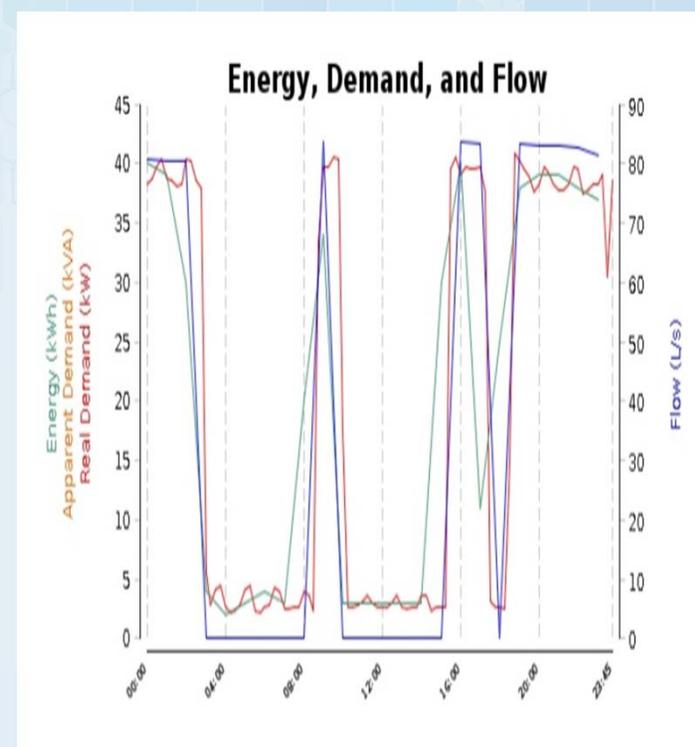


e.RIS Hydro Reports

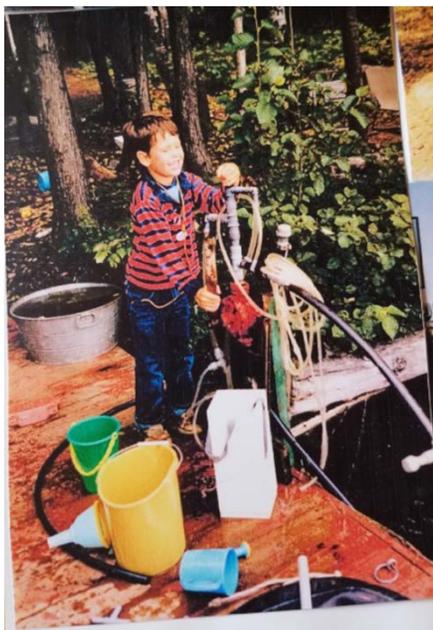
How we used e.RIS to give us daily reports about the amount and cost of the electricity we use to pump water

Graham Nasby & Richard Lester
City of Guelph Water Services

2019 North America East E.RIS Partner Conference
October 10, 2019 – Toronto, Ontario, Canada



What our e.RIS Users Look Like



Graham Nasby, P.Eng.
Water SCADA & Security Specialist

- With Guelph Water Since 2015
- Spent 10 years in consulting
- Fun Fact: Plays Clarinet

Richard Lester, C.Tech.
Water SCADA Specialist

- Joined Guelph Water in 2019
- Spent 4 years as System integrator
- Fun Fact: Has Psychology degree

Presentation Outline

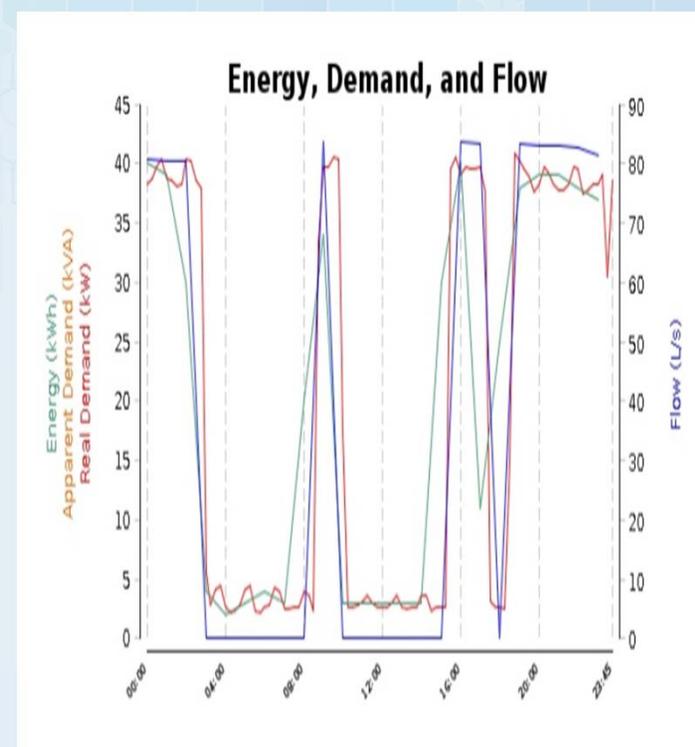
- Goal of Project
- Challenges with monitoring electricity usage
- Data Collection Equipment
- Role of SCADA System
- The Calculations: The HARD Part
- How the e.RIS Calculation Engine Works
- The Results
- How we use it



The Challenge

We are a water utility = a lot of what we do involves pumping water

- How much electricity do we use to pump water?
- How much is this electricity costing us?
- How can we get good/timely data about how we use electricity?
- **Waiting until we get power bills at the end of each month is not helpful**
- The gold standard is to create an automated reporting tool to give us:
 - kWh per m3 produced
 - \$ of electricity per m3 produced
 - Ability to compare one facility to another
 - Ability to compare one operating strategy vs. another
 - Timely information for the operations team
 - Long term reporting to measure performance over time
 - Something that looks nice



Getting the Data

Smart Water Initiative (2013)

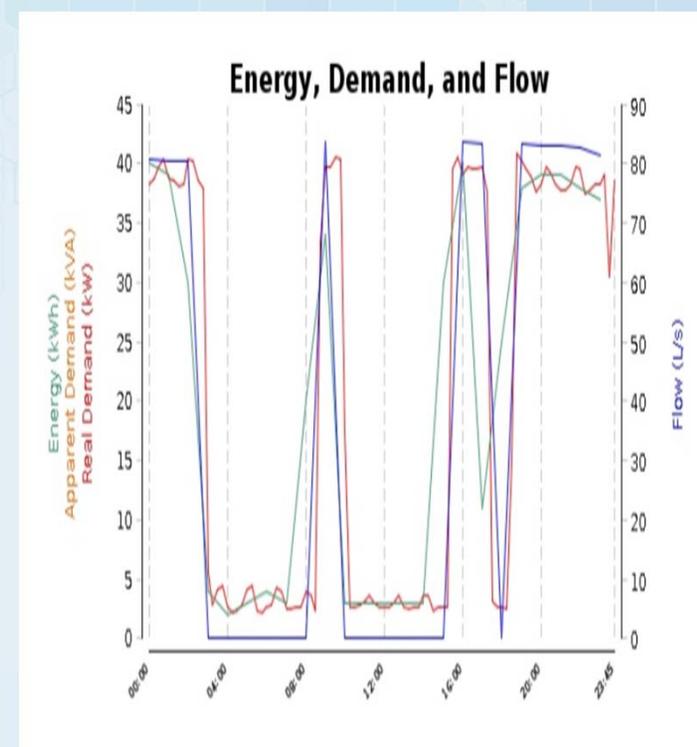
- Grant money was used to install building digital power meters at water facilities
- Custom daily power reports created using available tools at the time
- Reports stopped working in mid-2015 due to data-feed issues

Hydro Bill Analysis Company, online services (available since 2015)

- Service the city uses to analyze power bills
- Web-based tool for downloading and analyzing power bills
- Data is only available at the end of each month, **monthly power totals only**

Online Power Reports 2.0 (2016 – 2018)

- Operational goal to get a better understanding of electricity usage
- Better data feeds available (e.g., IESO now had a live energy cost data feed)
- New calculation engine available in e.RIS
- **Let's do it !**



Data Collection Equipment



Digital Power Monitors



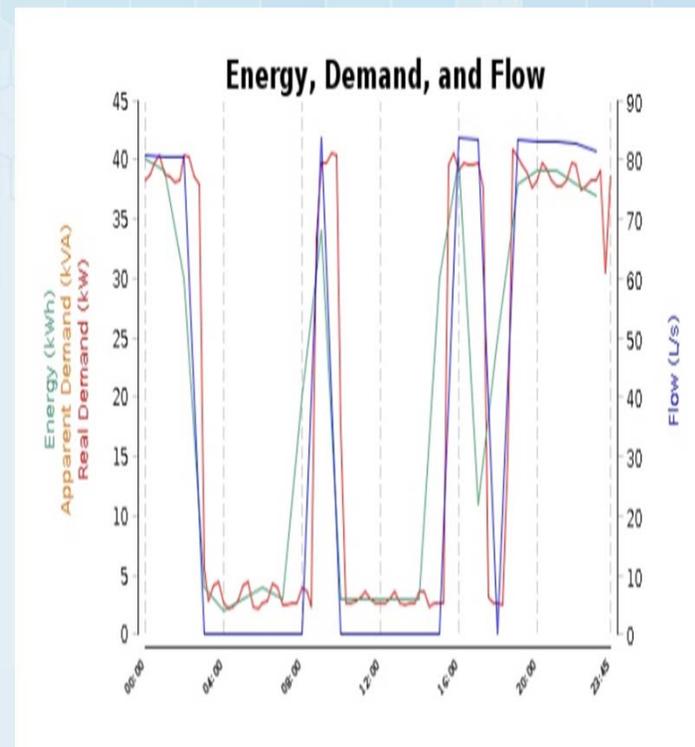
Plant PLC's
(Flow Data)



Pump Motor Starters



Polls Data 30 seconds



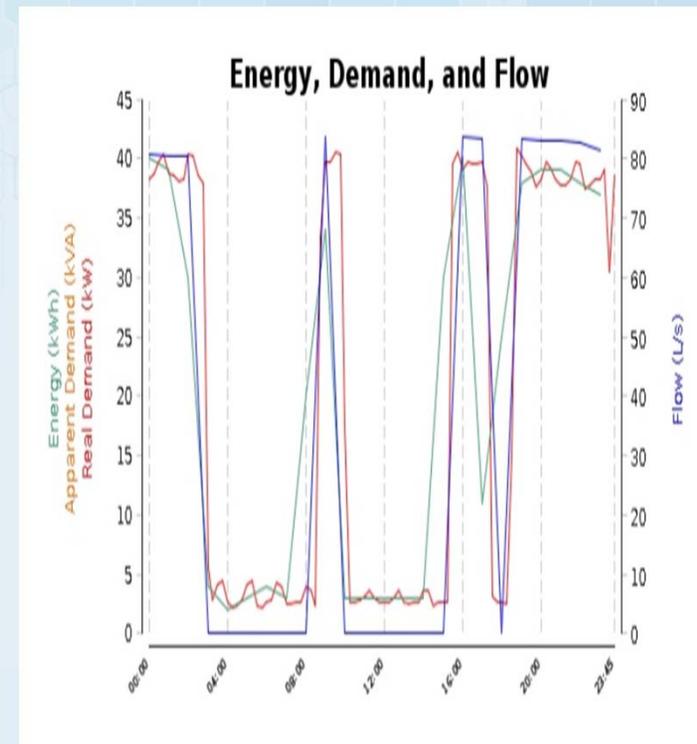
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Data from SCADA

7.1.1 Data Sources and Properties

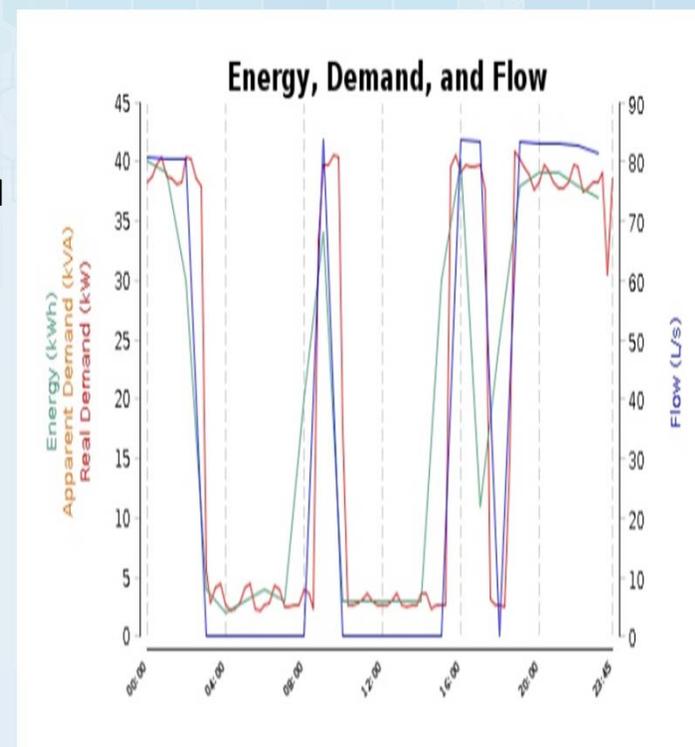
Label	Units	Tag Provider	Tagname	Description	Sampling Mode	Sampling Interval
Real Demand	kW	PH*	WDESCADA.%%PM01PMQNP.F_CV	Average demand used over fifteen minute intervals	average*	PT15M*
Apparent Demand	kVA	PH	WDESCADA.%%PMM100QAPF_CV	Average apparent demand used over fifteen minute intervals	average	PT15M
Energy	kWh	PH	WDESCADA.%%PM01PMQKW.F_CV	Energy used over an hour	periodTotal*	PT1H*
Flow	L/s	PH	WDESCADA.%%G001FIQ01.F_CV	Well Flow	Interpolated*	PT1H

(%: denotes the station; see Guelph Waterworks tagging standard)



Power Calculations

- **Measuring Electricity Usage is EASY...**
- **Calculating Power Costs is HARD!**
- **Ontario has one of the most complicated electricity pricing schemes in the world**
- **Connection Charges**
- **Transmission Charges**
- **Distribution Charges**
- **Energy Usage**
- **Peak Charges**
- **Ontario Hourly Energy Prices**
- **Time of Day Adjustments**
- **Global Adjustment**
- **Global Adjustment Estimates**
- **End of the Month Balancing**
- **Etc.**



Power Calculations

Hydro One	
<50kW	>50kW
General Service – Energy (aka Two Tiered)	General Service – Demand
Arkell 08	Arkell 06
Arkell 14	Arkell 07
Arkell 15	
Guelph Hydro	
<50kW	>50kW
Time of Use	General Service
Calico	Burke Well
Carter	Clythe Creek
Clair Booster	Downey
Dean	Emma
Helmar	Membro
Queensdale	Paisley
Robertson	Park
	Univeristy
	Water Street
	Woods

Hydro One – General Service -Energy

Hydro Cost

Energy Cost Today

Accumulating kWh

- >>First Rate (<750kWh)
- >>Remaining Rate (>750kWh)
- >>Debt Retirement Charge
- >>Service Charge
- >>Distribution Volumetric Rate
- >>Transmission Network Charge
- >>Transmission Connection Charge
- >>Loss Factor
- >>Wholesale Market Rate
- >>Rural Rate Assistance
- >>SS Admin Charge

Hydro One – General Service -Demand

Hydro Cost

Energy Cost Today

Accumulating kWh

- >>Debt Retirement Charge
- >>Wholesale Market Rate
- >>Rural Rate Assistance
- >>Service Charge
- >>SS Admin Charge
- >>Loss Factor

Instantaneous Power

- >>Distribution Volumetric Rate
- >>Transmission Connection Charge
- >>Transformer Allowance

Guelph Hydro – Time of Use

Hydro Cost

Energy Cost Today

Accumulating kWh

- >>On Peak Rate
- >>Off Peak Rate
- >>Mid Peak Rate
- >>Distribution Volumetric Rate
- >>Transmission Network Charge
- >>Transmission Connection Charge
- >>Debt Retirement Charge
- >>Loss Factor
- >>Wholesale Market Rate
- >>Rural Rate Assistance
- >>Monthly Service Charge
- >>SS Admin Charge
- >>OEP Charge
- >>Loss Factor Rate

Guelph Hydro – General Service

Hydro Cost

Energy Cost Today

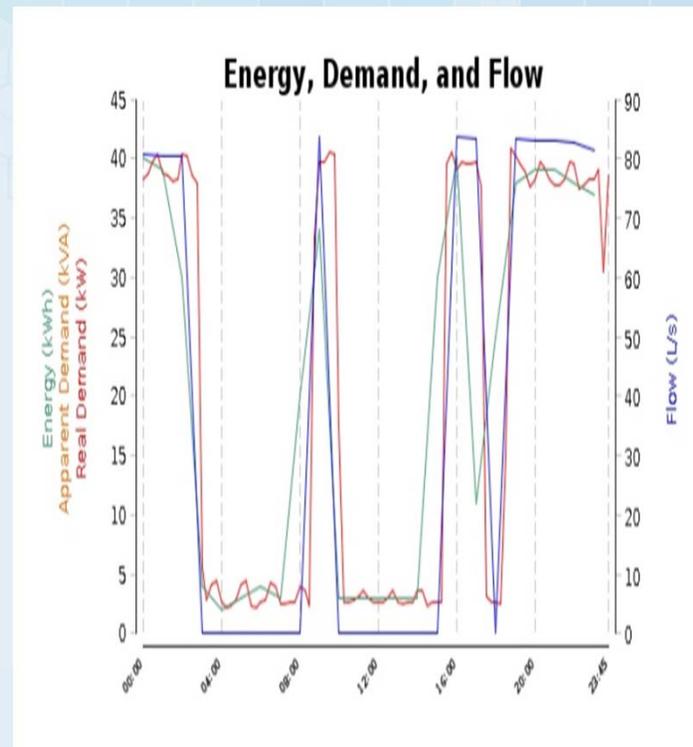
Accumulating kWh

- >>Debt Retirement Charge
- >>Wholesale Market Rate
- >>GA Rate Rider
- >>Service Charge
- >>SS Admin Charge
- >>Loss Factor

Power Cost Today

Instantaneous Power

- >>Distribution Volumetric Rate
- >>Transmission Connection Charge
- >>Transformer Allowance



Power Calculations – One Site Example

Hourly Energy Cost_(First Rate) = Hourly Energy Used * First Rate

When the total energy for the month has exceeded 750kWh then:

Hourly Energy Cost_(Remaining Rate) = Hourly Energy Used * Remaining Rate

In addition to the normal two tier rates there are also a number of extra rates that are associated with energy usage. Some of them directly apply to the energy used and make the Non-adjusted Rate:

Non-adjusted Rate = Distribution Volumetric Rate + Debt Retirement Charge

So that;

Hourly Energy Cost_(Non-adjusted) = Hourly Energy Used * Non-adjusted Rate

Others rates are applied to the adjusted energy used:

Adjusted Hourly Energy Used = Hourly Energy Used * Loss Factor

The adjusted rate is determined as follows:

Adjusted Rate = Transmission Network Rate + Transmission Connection Rate + Wholesale Market Rate + Rural Rate Assistance Rate

Which creates a fourth Hourly Energy Cost calculation:

Hourly Energy Cost_(Adjusted) = Adjusted Hourly Energy Used * Adjusted Rate

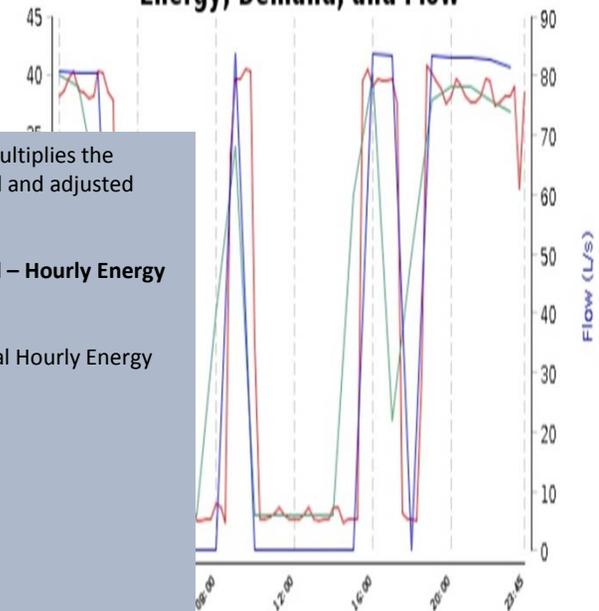
One more Hourly Energy Cost calculation is created which multiplies the second tier rate by the difference between the non-adjusted and adjusted energy used:

Hourly Energy Cost_(Difference) = (Adjusted Hourly Energy Used – Hourly Energy Used) * Remaining Rate

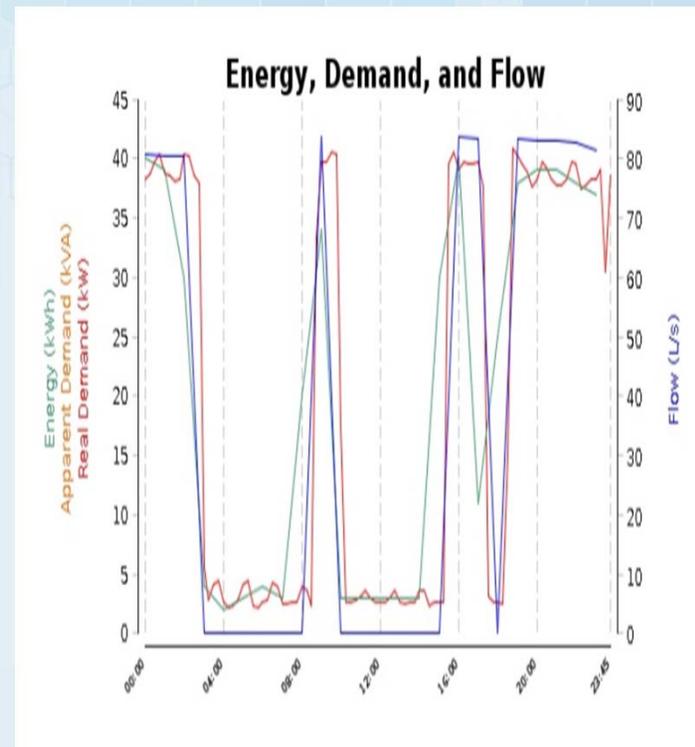
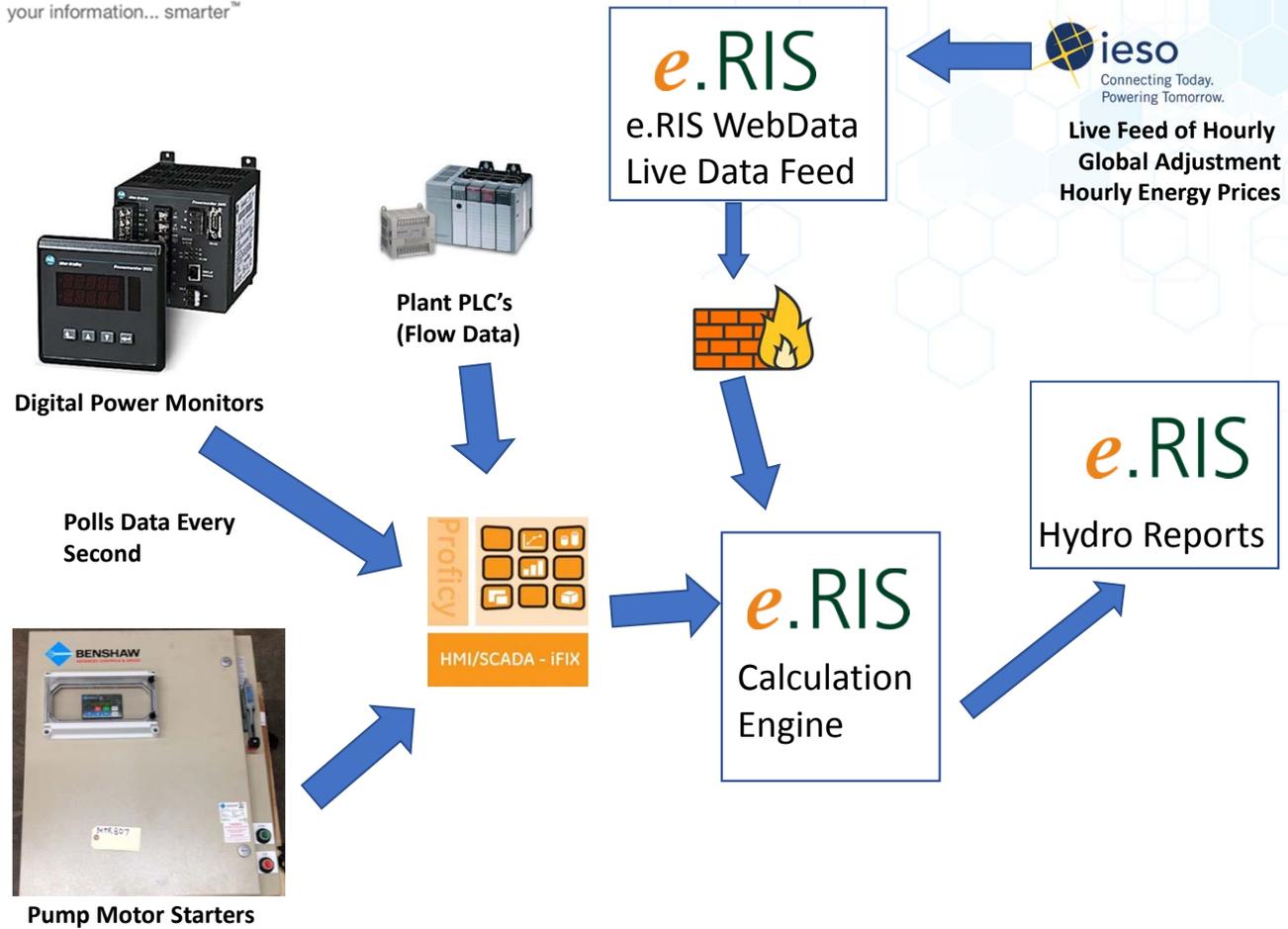
The five Hourly Energy Cost are then summed to get the total Hourly Energy Cost:

**Hourly Energy Cost_(Total) = Hourly Energy Cost_(First Rate) +
Hourly Energy Cost_(Remaining Rate) +
Hourly Energy Cost_(Non-adjusted) +
Hourly Energy Cost_(Adjusted) +
Hourly Energy Cost_(Difference)**

Energy, Demand, and Flow



Power Calculations – IESO Data Feed



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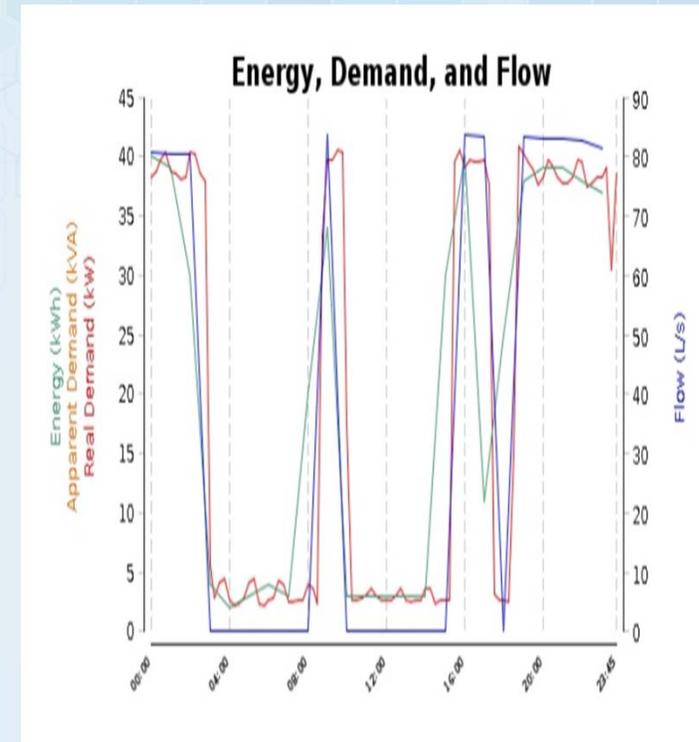
Power Calculations – e.RIS Configuration

Constant Editor

[Add New Constant](#) Reload

Show entries Search:

Name	Value	Description	
GHEGLFSM1RMI	1.0260 \$	Total Loss Factor - Secondary Metered 5000k	Edit
GHEGSC1DDRMI	0.0070 \$ 0.007 (2015-10-01 – 2016-10-31)	Debt Retirement Charge 0-50kW	Edit
GHEGSC1FPRMI	0.087 \$ 0.077 (2015-10-01 – 2016-10-31) 0.065 (2017-05-01 – 2017-10-31)	Off-peak rate 0-50kW	Edit
GHEGSC1LFRMI	1.026	Time Of Use Loss Factor - Hydro Cost Calculation	Edit
GHEGSC1LLRMI	0.026	Time Of Use Line Loss Factor - Hydro Cost Calculation	Edit
GHEGSC1MPRMI	0.132 \$ 0.114 (2015-10-01 – 2016-10-31) 0.095 (2017-05-01 – 2017-10-31)	Mid-peak rate 0-50kW	Edit
GHEGSC1MSRMI	0.562666 \$/day	Time Of Use Monthly Service Charge - Hydro Cost Calculation	Edit
GHEGSC1OEPRMI	0.0011	Time Of Use OEP Charge - Hydro Cost Calculation	Edit
GHEGSC1OPRMI	0.180 0.135 (2015-10-01 – 2016-10-31) 0.132 (2017-05-01 – 2017-10-31)	ON-Peak rate 0-50kWh	Edit
GHEGSC1RRRMI	0.0013	Time Of Use Rural Rate Assistance - Hydro Cost Calculation	Edit



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Power Calculations – e.RIS Configuration

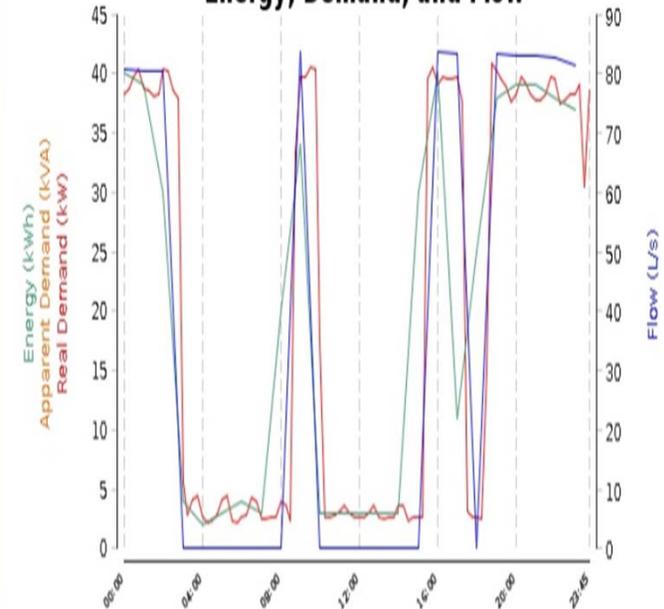
Edit: TOU kWh Daily Cost - 2017 DF

Save Save & Close Close Add Version Constants Add Input Add Output

General Settings & Versions Variables View (V1)

Input	Query	Start Offset	Duration	UseCache	Used In	
KWH_1H_CB	PH.WDSCADA.CBSPM01PMQKW.F_CV:periodTotal:PT1H	P1D	P1D	false	1	Rename
KWH_1H_CFH	PH.WDSCADA.CWSPM01PMQKW.F_CV:periodTotal:PT1H	P1D	P1D	false	1	Rename
KWH_1H_CW	PH.WDSCADA.CABPM01PMQKW.F_CV:periodTotal:PT1H	P1D	P1D	false	1	Rename
KWH_1H_DW	PH.WDSCADA.DEBPM01PMQKW.F_CV:periodTotal:PT1H	P1D	P1D	false	1	Rename
KWH_1H_HT	PH.WDSCADA.HEBPM01PMQKW.F_CV:periodTotal:PT1H	P1D	P1D	false	1	Rename
KWH_1H_QW	PH.WDSCADA.QUBPM01PMQKW.F_CV:periodTotal:PT1H	P1D	P1D	false	1	Rename
KWH_1H_RB	PH.WDSCADA.ROBPM01PMQKW.F_CV:periodTotal:PT1H	P1D	P1D	false	1	Rename
Constant	Value	Description				
GHEGSC1OPRMI	0.180	ON-Peak rate 0-50kWh				
	0.135 (2015-10-01T00:00:00–2016-10-31T00:00:00)					
	0.132 (2017-05-01T00:00:00–2017-10-31T00:00:00)					
GHEGSC1MPRMI	0.132 \$	Mid-peak rate 0-50kW				
	0.114 (2015-10-01T00:00:00–2016-10-31T00:00:00)					
	0.095 (2017-05-01T00:00:00–2017-10-31T00:00:00)					
GHEGSC1FPRMI	0.087 \$	Off-peak rate 0-50kW				
	0.077 (2015-10-01T00:00:00–2016-10-31T00:00:00)					
	0.065 (2017-05-01T00:00:00–2017-10-31T00:00:00)					
GHEGSC1VCRM1	0.0133 \$	Distribution Volumetric Rate 0-50kW				
	0.0128 (2015-10-01T00:00:00–2016-10-31T00:00:00)					
	0.0116 (2017-01-01T00:00:00–2018-01-01T00:00:00)					
GHEGSC1TCRM1	0.0051 \$	Transmission Connection 0-50kW				
	0.0047 (2015-10-01T00:00:00–2016-10-31T00:00:00)					
	0.004 (2017-01-01T00:00:00–2018-01-01T00:00:00)					
GHEGSC1TRMI	0.0068 \$	Transmission Network 0-50kW				
	0.0066 (2015-10-01T00:00:00–2016-10-31T00:00:00)					
	0.0052 (2017-01-01T00:00:00–2018-01-01T00:00:00)					
GHEGSC1DDRM1	0.0070 \$	Debt Retirement Charge 0-50kW				
	0.007 (2015-10-01T00:00:00–2016-10-31T00:00:00)					
GHEGSC1WMRMI	0.0060 \$	Wholesale Market 0-50kW				
	0.0057 (2015-10-01T00:00:00–2016-10-31T00:00:00)					
	0.0036 (2017-01-01T00:00:00–2018-01-01T00:00:00)					
GHEGSC1MSRMI	0.562666 \$/day	Time Of Use Monthly Service Charge - Hydro Cost Calculation				
GHEGSC1LLRMI	0.026	Time Of Use Line Loss Factor - Hydro Cost Calculation				

Energy, Demand, and Flow



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Calculated Tags

Edit: TOU kWh Daily Cost - 2017 DF

Save Save & Close Close Add Version Constants Add Input Add Output

General Settings & Versions Variables View (V1)

Name	ID	Type	Enabled
TOU kWh Daily Cost - 2017 DF	ef1553df-bca8-4ee5-857d-05e0ea99ea8	automatic	<input checked="" type="checkbox"/>

Description

Time Of Use Hydro Cost Calculation

Schedule will run at 1:00, every day

Months Every month

Days Every day of the month

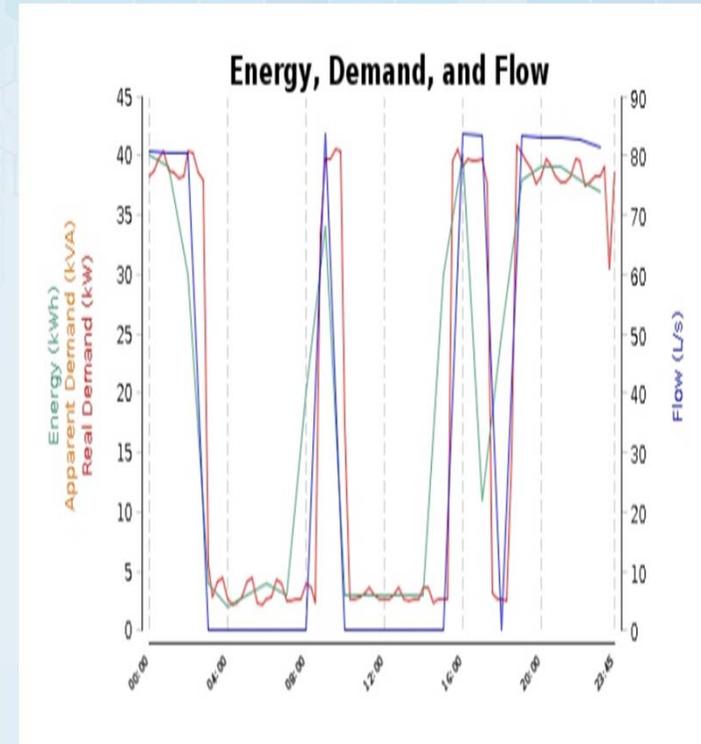
Weekdays Every day of the week:

Hours

Minutes

Last Run 2019-10-04 01:00:00 Update 2019-10-04 01:00:00

Version	Effective	Expires	Published (Enabled)
1	2017-01-01		in use



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Power Calculations – e.RIS Configuration

Edit: TOU kWh Daily Cost - 2017 DF

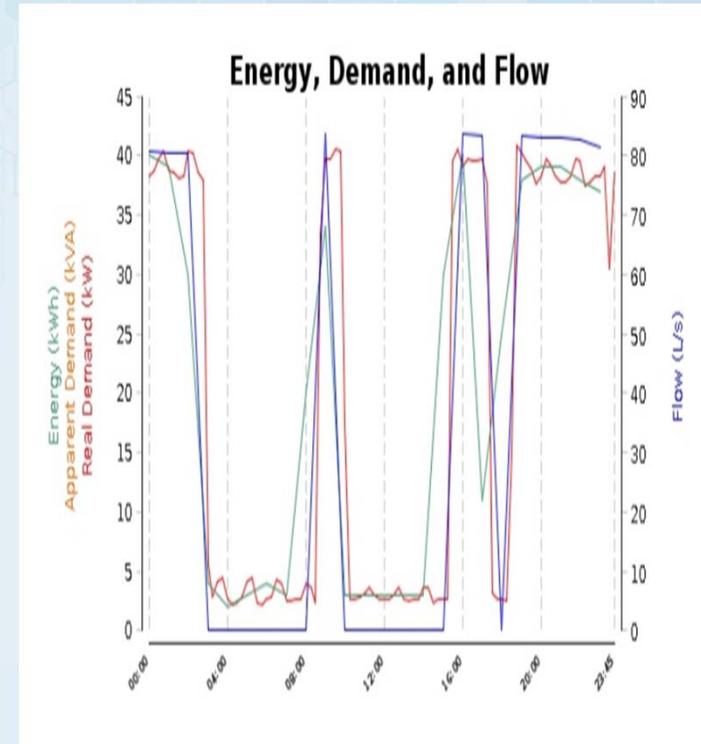
Save Save & Close Close Add Version Constants Add Input Add Output

General Settings & Versions Variables View (V1)

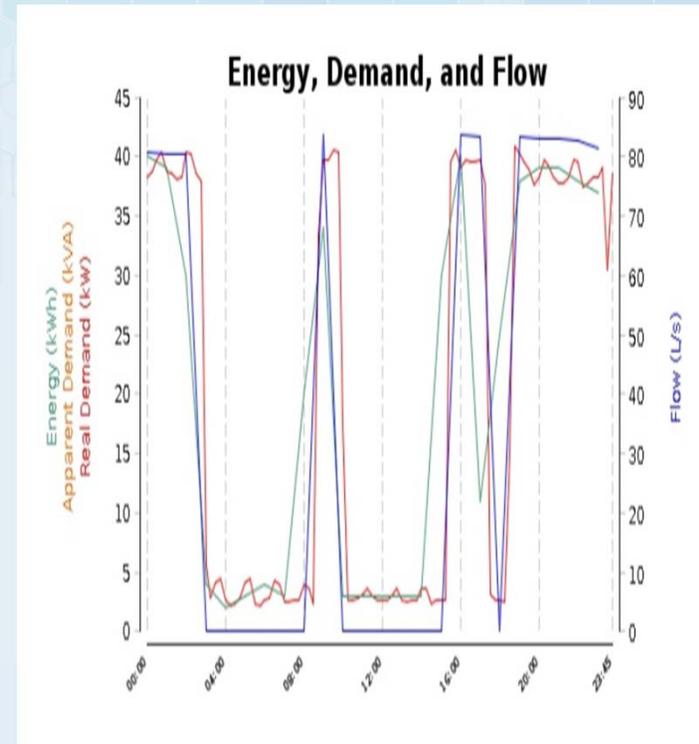
```

1 BigDecimal kWhRate = 0;
2 BigDecimal kWhCost = 0;
3 BigDecimal Delivery = 0;
4 BigDecimal LineLoss = 0;
5 BigDecimal Regs = 0;
6 BigDecimal Flat = 0;
7 BigDecimal Debt = 0;
8 def eCostFunction(KWH_1H, GHEGSC1OPRMI, GHEGSC1MPRMI, GHEGSC1FPRMI, GHEGSC1VCRM,
9 GHEGSC1TCRMI, GHEGSC1TNRMI, GHEGSC1DDRMI, GHEGSC1WRRMI, ECOST_TDAY)
10 {
11 ECOST_TDAY.value = 0;
12 BigDecimal kWhCost = 0;
13 if(!KWH_1H.empty){
14 for(Data d : KWH_1H.array){
15 //Summer Rate Months
16 if(d.getMonth() >= 5 && d.getMonth() <= 10 ){
17 //find if date is weekday
18 if(d.getDayOfWeek() >= 2 && d.getDayOfWeek() <= 6){
19 //Calculate off-peak from 7pm to 7am
20 if((d.getHour() >= 0 && d.getHour() < 7) || (d.getHour() >= 19 && d.getHour() <= 23)){
21 kWhRate = GHEGSC1FPRMI.value;
22 }
23 //calculate Mid-Peak
24 if((d.getHour() >= 7 && d.getHour() < 11) || (d.getHour() >= 17 && d.getHour() < 19)){
25 kWhRate = GHEGSC1MPRMI.value;
26 }
27 //calculate On-Peak
28 if(d.getHour() >= 11 && d.getHour() < 17){
29 kWhRate = GHEGSC1OPRMI.value;
30 }
31 }
32 //find if date is a weekend
33 //calculate for off-peak
34 if(d.getDayOfWeek() == 1 || d.getDayOfWeek() == 7){
35 kWhRate = GHEGSC1FPRMI.value;
36 }
37 }

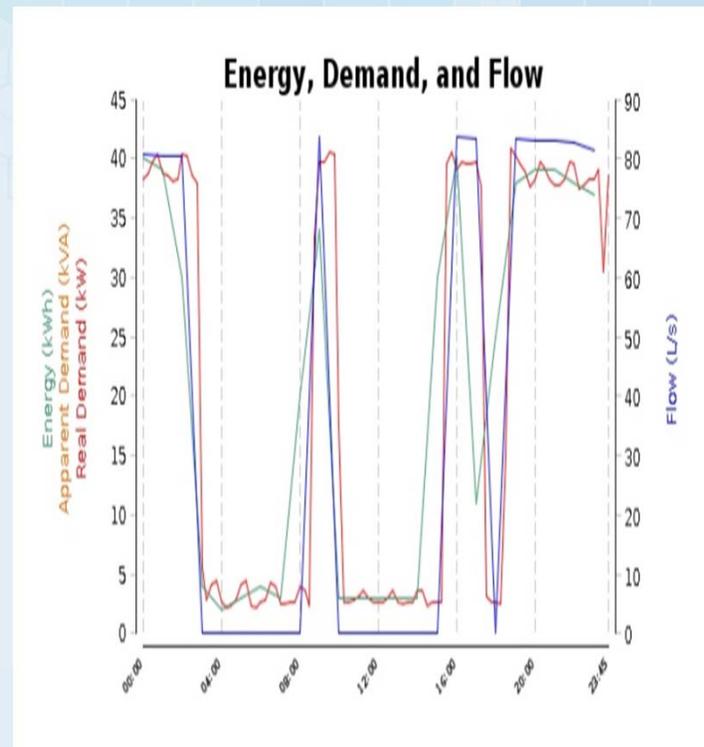
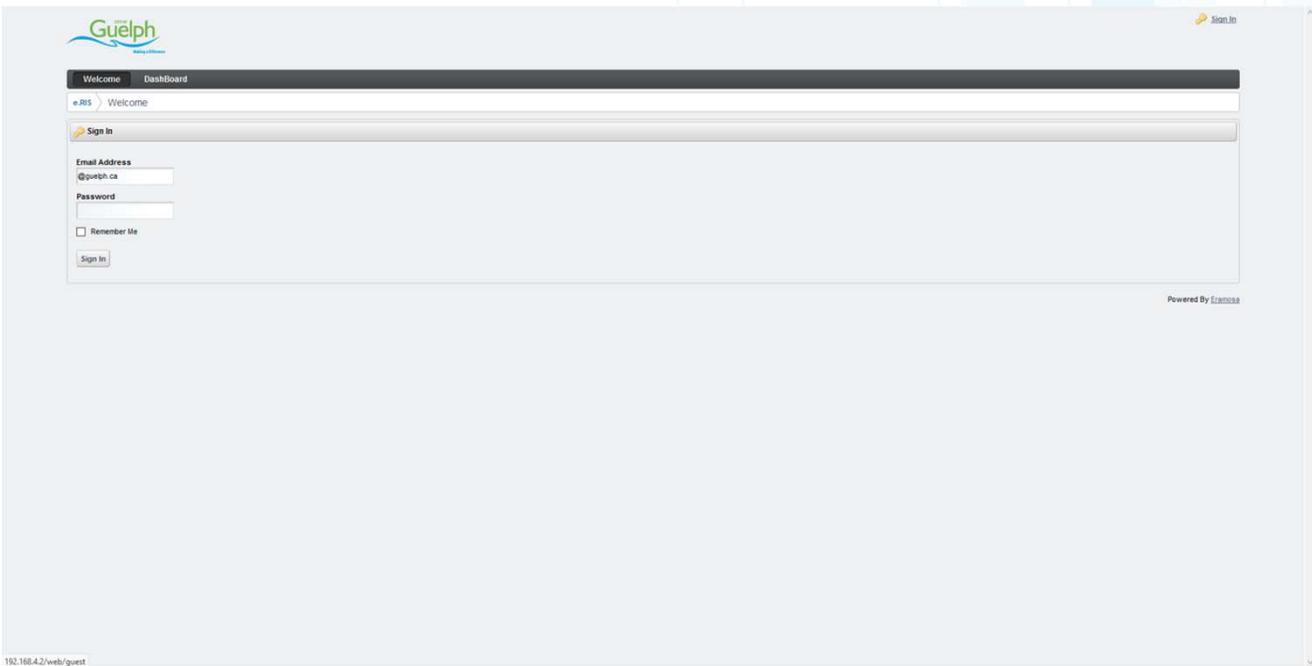
```



So what did this get us....

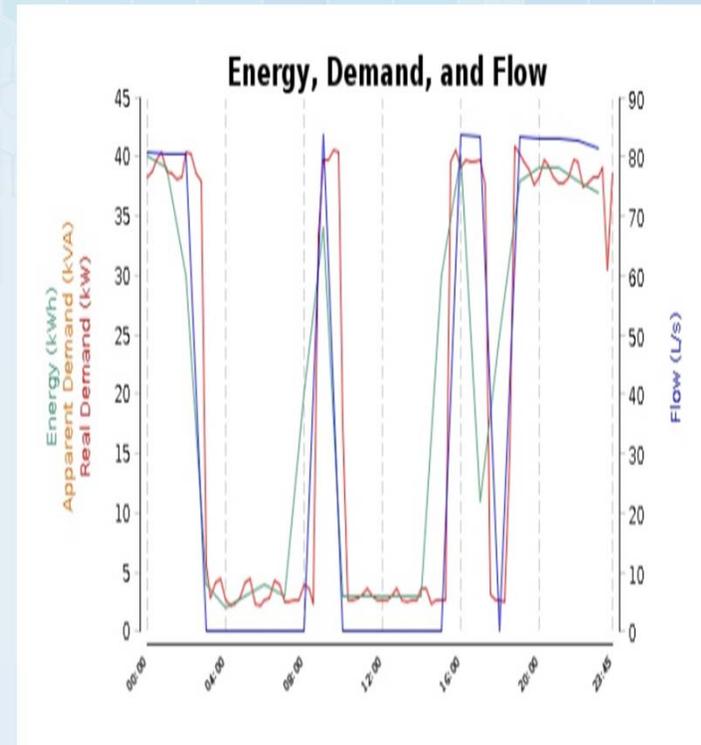
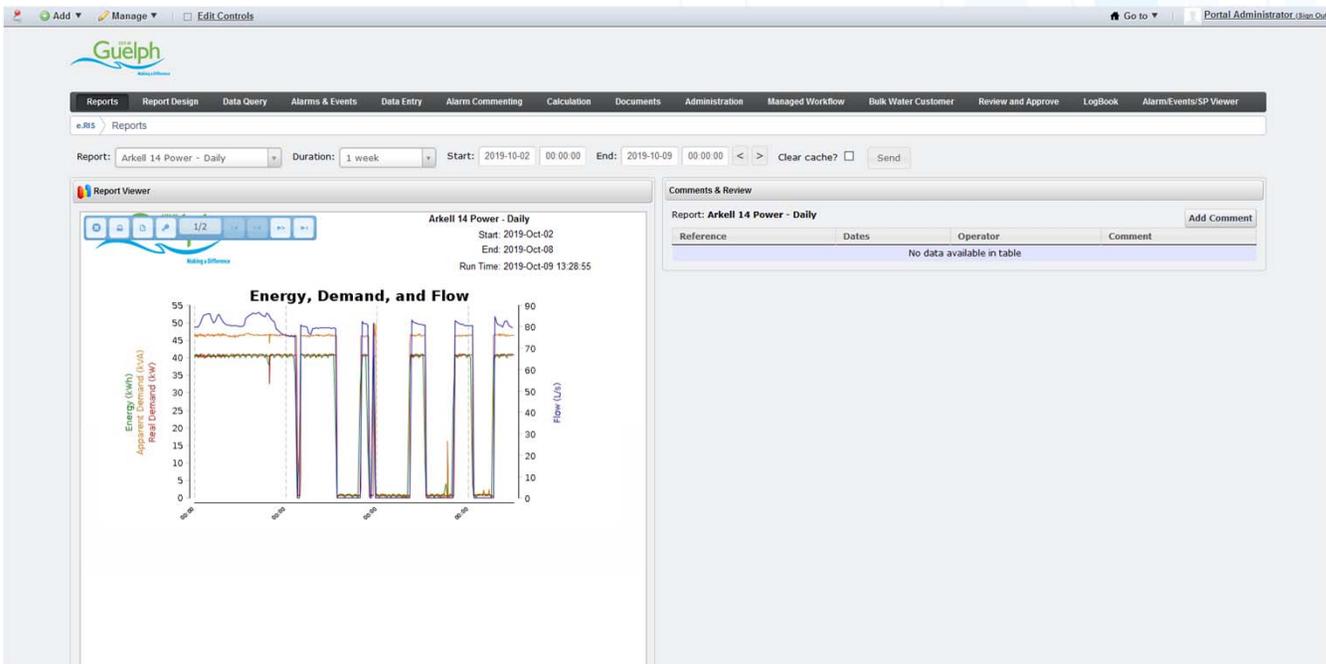


Accessing the web-based e.RIS Reports



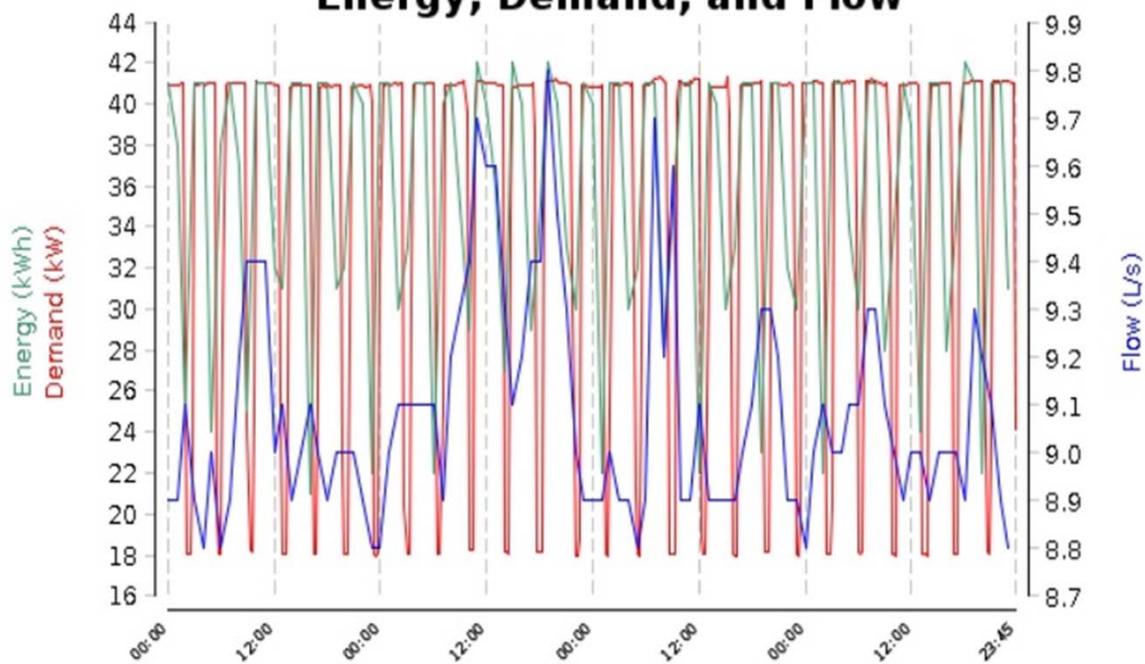
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Accessing the web-based e.RIS Reports

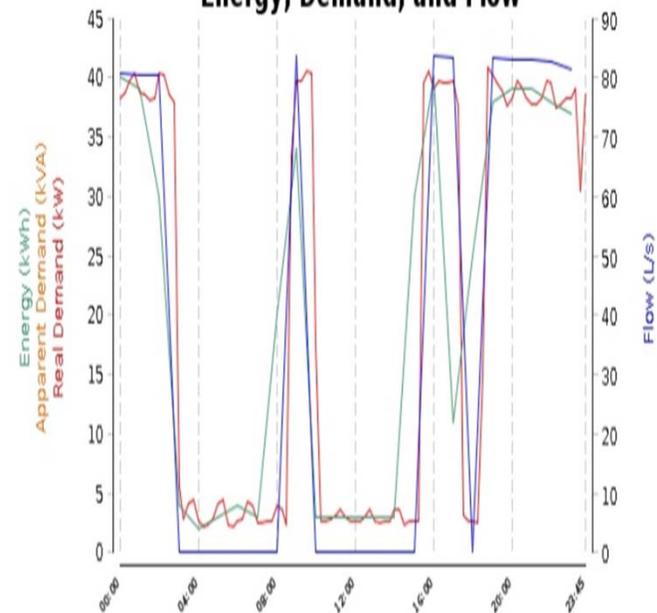


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Energy, Demand, and Flow



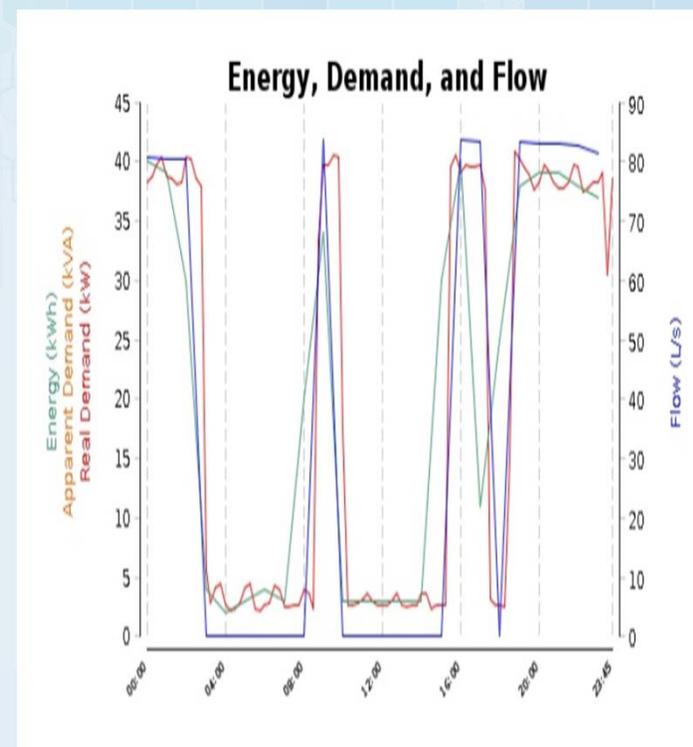
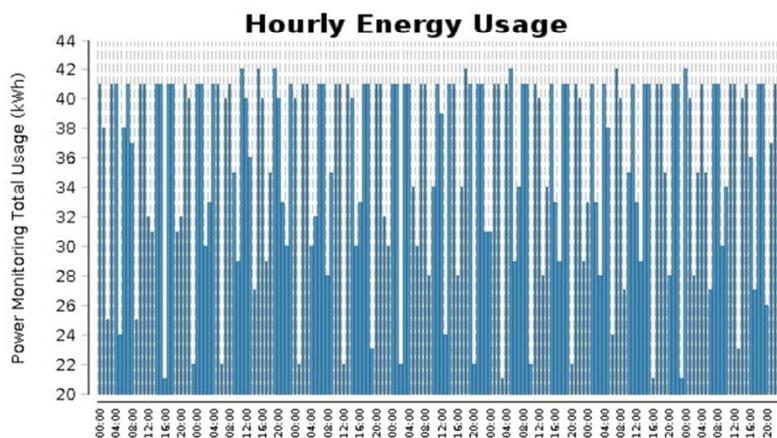
Energy, Demand, and Flow



e.RIS Hydro Reports - Results

Time	Max Demand (kW)	Max Demand Timestamp	Energy Use (kWh)	Booster Pump Flow Volume (m³)	Energy Per m3 (kWh/m3) Calculation	Energy Cost Est. Today (\$)	Cents Per m3 (¢/m3) Calculation
2019-Sep-01	41.429	09:41	847	764.0	1.109	111.01	14.53
2019-Sep-02	41.580	18:30	871	784.0	1.111	145.45	18.55
2019-Sep-03	41.925	15:09	848	768.0	1.104	141.37	18.41
2019-Sep-04	41.510	18:32	860	769.0	1.118	143.28	18.63
2019-Sep-05	41.609	07:32	844	753.0	1.121	140.93	18.72
2019-Sep-06	41.384	18:45	836	748.0	1.118	139.67	18.67
2019-Sep-07	41.461	11:59	862	764.0	1.128	112.97	14.79

Time	Total Energy Usage (kWh)	Total Hydro Cost Est. (\$)
Sep 2019	5,968	934.68



Helmar Power - Daily

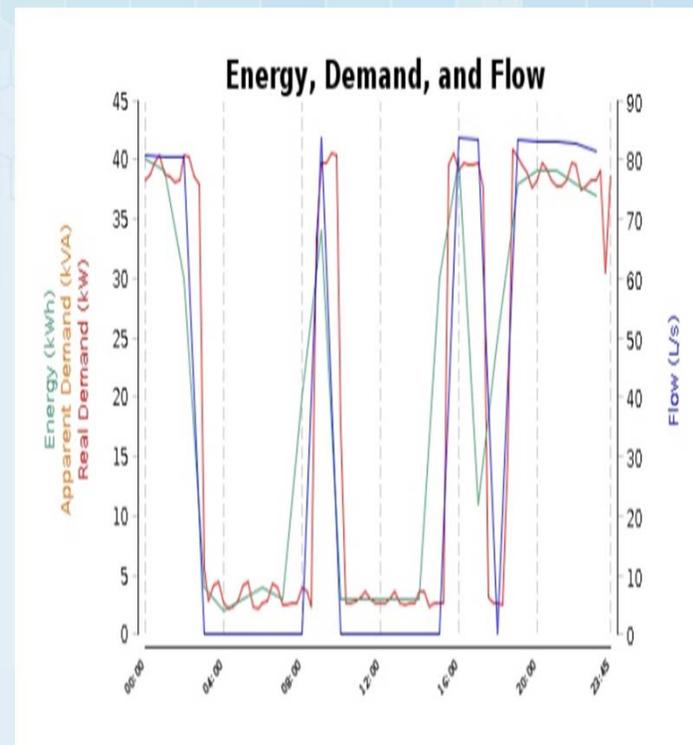
Start: 2019-Sep-01

End: 2019-Sep-30

Run Time: 2019-Oct-04 07:12:03

Time	Max Demand (kW)	Max Demand Timestamp	Energy USe (kWh)	Booster Pump Flow Volume (m ³)	Energy Per m3 (kWh/m3) Calculation	Energy Cost Est. Today (\$)	Cents Per m3 (¢/m3) Calculation
2019-Sep-01	41.429	09:41	847	764.0	1.109	111.01	14.53
2019-Sep-02	41.580	18:30	871	784.0	1.111	145.45	18.55
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2019-Sep-04	41.510	18:32	860	769.0	1.118	143.28	18.63
2019-Sep-05	41.609	07:32	844	753.0	1.121	140.93	18.72
2019-Sep-06	41.384	18:45	836	748.0	1.118	139.67	18.67
2019-Sep-07	41.461	11:59	862	764.0	1.128	112.97	14.79
2019-Sep-08	41.600	19:16	858	775.0	1.107	112.45	14.51
2019-Sep-09	41.523	11:44	847	760.0	1.114	141.24	18.58
2019-Sep-10	42.008	12:05	854	764.0	1.118	142.16	18.61
2019-Sep-11	41.558	07:23	852	756.0	1.127	142.19	18.81
2019-Sep-12	41.952	12:15	860	759.0	1.133	143.40	18.89
2019-Sep-13	42.841	00:49	831	743.0	1.118	138.91	18.70
2019-Sep-14	41.681	07:29	845	750.0	1.127	110.75	14.77
2019-Sep-15	41.497	18:10	866	768.0	1.128	113.49	14.78
2019-Sep-16	41.735	10:06	849	759.0	1.119	140.62	18.53
2019-Sep-17	41.606	11:04	849	758.0	1.120	141.32	18.64
2019-Sep-18	41.483	18:31	853	764.0	1.116	142.07	18.60
2019-Sep-19	41.477	22:19	862	757.0	1.139	143.80	19.00
2019-Sep-20	42.908	09:36	785	708.0	1.109	128.23	18.11
2019-Sep-21	41.492	09:05	854	759.0	1.125	111.92	14.75
2019-Sep-22	41.326	09:08	860	760.0	1.132	112.71	14.83
2019-Sep-23	41.419	12:39	847	755.0	1.122	140.51	18.61
2019-Sep-24	41.428	20:14	847	753.0	1.125	140.50	18.66
2019-Sep-25	41.408	18:02	847	754.0	1.123	141.24	18.73
2019-Sep-26	46.926	12:13	844	749.0	1.127	140.28	18.73
2019-Sep-27	43.096	06:50	864	754.0	1.146	144.16	19.12
2019-Sep-28	41.307	08:49	846	753.0	1.124	110.88	14.73
2019-Sep-29	41.403	04:12	849	759.0	1.119	111.27	14.66
2019-Sep-30	41.433	09:44	849	754.0	1.126	141.50	18.77

Time	Total Energy Usage (kWh)	Total Hydro Cost Est. (\$)
Sep 2019	25,486	3,970.28



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e.RIS Hydro Reports - Results



Helmar Power - Daily

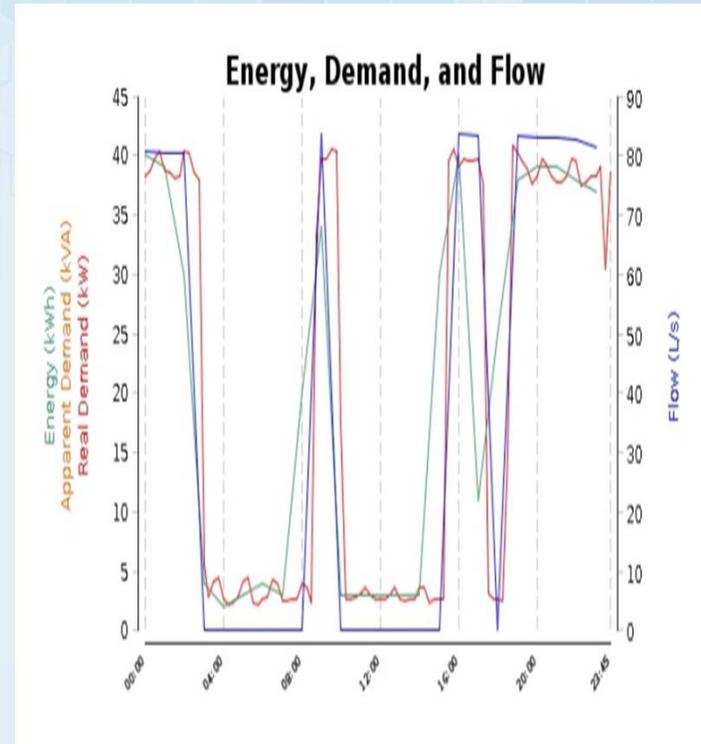
Start: 2019-Sep-01

End: 2019-Sep-30

Run Time: 2019-Oct-04 07:12:03

Time	Max Demand (kW)	Max Demand Timestamp	Energy USe (kWh)	Booster Pump Flow Volume (m³)	Energy Per m3 (kWh/m3) Calculation	Energy Cost Est. Today (\$)	Cents Per m3 (¢/m3) Calculation
2019-Sep-01	41.429	09:41	847	764.0	1.109	111.01	14.53
2019-Sep-02	41.580	18:30	871	784.0	1.111	145.45	18.55
2019-Sep-03	41.925	15:09	848	768.0	1.104	141.37	18.41
2019-Sep-04	41.510	18:32	860	769.0	1.118	143.28	18.63
2019-Sep-05	41.606						
2019-Sep-06	41.384						
2019-Sep-07	41.461						
2019-Sep-08	41.600						
2019-Sep-09	41.523						
2019-Sep-10	42.008		764.0	1.109	111.01	14.53	
2019-Sep-11	41.558		784.0	1.111	145.45	18.55	
2019-Sep-12	41.952		768.0	1.104	141.37	18.41	
2019-Sep-13	42.841		769.0	1.118	143.28	18.63	
2019-Sep-14	41.681		753.0	1.121	140.93	18.72	
2019-Sep-15	41.497		748.0	1.118	139.67	18.67	
2019-Sep-16	41.736		764.0	1.128	112.97	14.79	
2019-Sep-17	41.606		775.0	1.107	112.45	14.51	
2019-Sep-18	41.483		760.0	1.114	141.24	18.58	
2019-Sep-19	41.477						
2019-Sep-20	42.908		847	753.0	1.125	140.50	18.66
2019-Sep-21	41.492		847	754.0	1.123	141.24	18.73
2019-Sep-22	41.326		844	749.0	1.127	140.28	18.73
2019-Sep-23	41.419		864	754.0	1.146	144.16	19.12
2019-Sep-24	41.428	20:14	847	753.0	1.124	110.88	14.73
2019-Sep-25	41.408	18:02	847	754.0	1.123	141.24	18.73
2019-Sep-26	46.926	12:13	844	749.0	1.127	140.28	18.73
2019-Sep-27	43.096	06:50	864	754.0	1.146	144.16	19.12
2019-Sep-28	41.307	08:49	846	753.0	1.124	110.88	14.73
2019-Sep-29	41.403	04:12	849	759.0	1.119	111.27	14.66
2019-Sep-30	41.433	09:44	849	754.0	1.126	141.50	18.77

Time	Total Energy Usage (kWh)	Total Hydro Cost Est. (\$)
Sep 2019	25,486	3,970.28



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Any Questions?

* Not a High Performance SCADA System

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