CSCI 622

Brock Gion

Electricity Consumption Explorer

Main Project Goals

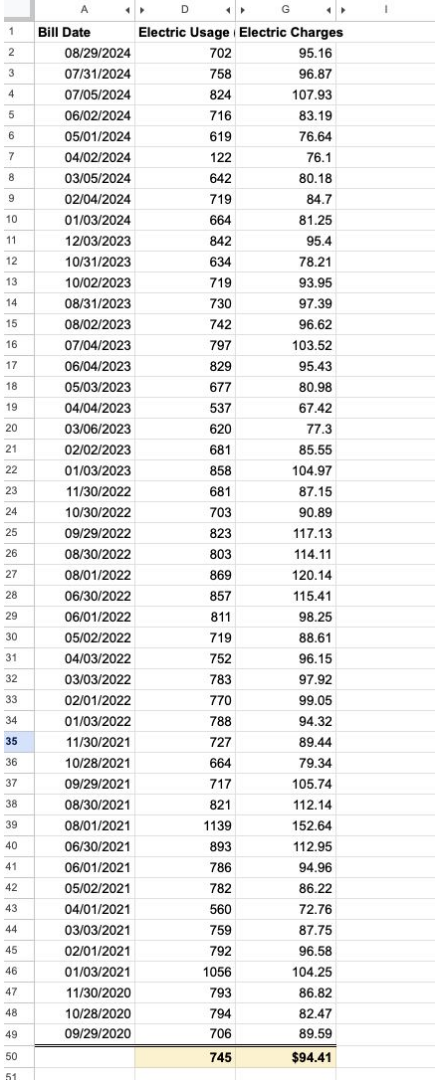
Use data to…

1. Understand my electricity consumption patterns at home

On average, over the last 4 years my **monthly electric usage is ~745kwh/month**. That's the only metric I know going into this project

2. Reduce carbon footprint

While I'd like to use more renewable sources of energy (i. solar/wind), options are limited in North Dakota. So, step 1, looking to become more efficient with my energy usage, then use this data to size a solar pv system FY2025.



	A	D	G	I
1	Bill Date	Electric Usage	Electric Charges	
2	08/29/2024	702	95.16	
3	07/31/2024	758	96.87	
4	07/05/2024	824	107.93	
5	06/02/2024	716	83.19	
6	05/01/2024	619	76.64	
7	04/02/2024	122	76.1	
8	03/05/2024	642	80.18	
9	02/04/2024	719	84.7	
10	01/03/2024	664	81.25	
11	12/03/2023	842	95.4	
12	10/31/2023	634	78.21	
13	10/02/2023	719	93.95	
14	08/31/2023	730	97.39	
15	08/02/2023	742	96.62	
16	07/04/2023	797	103.52	
17	06/04/2023	829	95.43	
18	05/03/2023	677	80.98	
19	04/04/2023	537	67.42	
20	03/06/2023	620	77.3	
21	02/02/2023	681	85.55	
22	01/03/2023	858	104.97	
23	11/30/2022	681	87.15	
24	10/30/2022	703	90.89	
25	09/29/2022	823	117.13	
26	08/30/2022	803	114.11	
27	08/01/2022	869	120.14	
28	06/30/2022	857	115.41	
29	06/01/2022	811	98.25	
30	05/02/2022	719	88.61	
31	04/03/2022	752	96.15	
32	03/03/2022	783	97.92	
33	02/01/2022	770	99.05	
34	01/03/2022	788	94.32	
35	11/30/2021	727	89.44	
36	10/28/2021	664	79.34	
37	09/29/2021	717	105.74	
38	08/30/2021	821	112.14	
39	08/01/2021	1139	152.64	
40	06/30/2021	893	112.95	
41	06/01/2021	786	94.96	
42	05/02/2021	782	86.22	
43	04/01/2021	560	72.76	
44	03/03/2021	759	87.75	
45	02/01/2021	792	96.58	
46	01/03/2021	1056	104.25	
47	11/30/2020	793	86.82	
48	10/28/2020	794	82.47	
49	09/29/2020	706	89.59	
50		745	$94.41	
51				

Main Project Goals

1. Understand my electricity consumption patterns at home

On average, over the last 4 years my **monthly electric usage is ~745kwh/month**.
That's the only metric I know going into this project

RESULT: Yes! Using data now beginning to understand usage patterns of appliances

*TBD: Still have unknowns, prefer detailed breakout of "office/livingroom" electronics

	total monthly electric usage in kwh -->	656.56		204.76	
		november	***november %***	**december**	**december %**
appliances	dishwasher	16.53	*2.5%*	2.43	*1.2%*
	microwave	2.41	*0.4%*	0.58	*0.3%*
	fridge basement	45.05	*6.9%*	14.33	*7.0%*
	fridge kitchen	14.35	*2.2%*	4.33	*2.1%*
	garage freezer	22.02	*3.4%*	6.19	*3.0%*
	boiler (natural gas)	5.98	*0.9%*	0.84	*0.4%*
		106.32	16%	28.70	14%
consumer electronics	office / livingroom	80.70	*12.3%*	32.41	*15.8%*
	computer/monitors ??				
	TV ??				
	lights ??				

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Basement Fridge = Power Hog

- On average, this appliance is ~7% of total monthly electric usage
- Compared to the kitchen fridge, using almost 3x the energy!!

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Boiler = Efficient

- Brand new boiler was installed 2022 (less than 2 years old)
- This is a “natural gas” boiler, so electrical usage is very minimal
- Data shows it’s relatively low at under < 6kwh/month (less than ~1% of total monthly electric usage)

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	TV ??				
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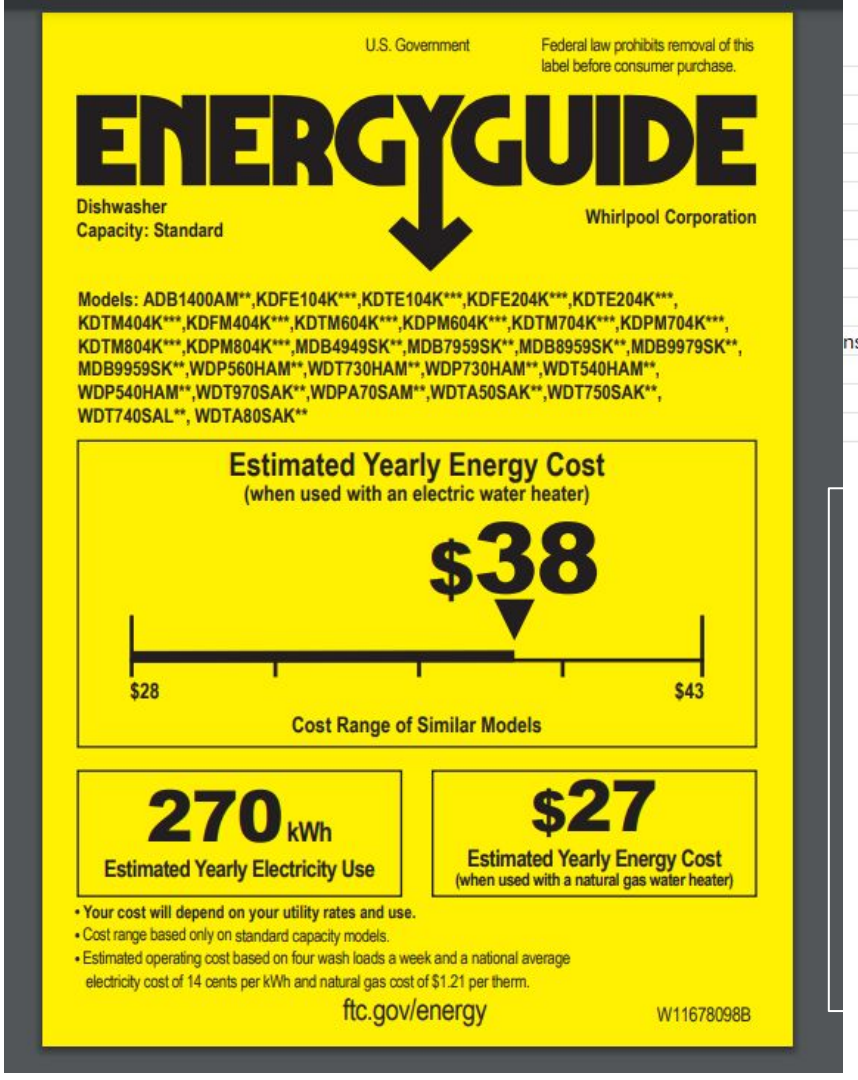
Dishwasher = Defunct

- 10+ year old dishwasher just went kaput, pump is worn out. Repair or replace?
- Key consideration: what's the electrical usage? How will it compare to a new dishwasher?
- Based on ~1 month of data, shows avg. usage 16.53 kWh/mo



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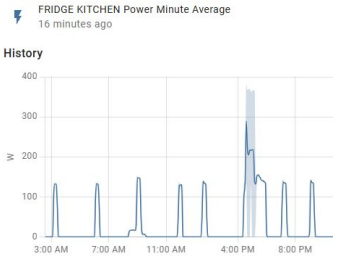
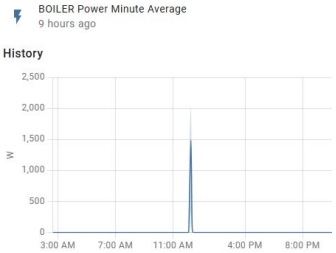
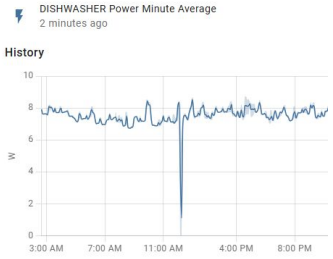
Energy Guide Ratings

- Looking at a new dishwasher, est. usage is ~22 kwh/mo (270/12 = 22.5)
- ftc.gov/energy
  - The EnergyGuide label lets you know how much energy an appliance uses and see how it compares to the energy use of similar appliances.
- Appliance energy labeling mandated in 1980 (by the Energy Policy and Conservation Act)

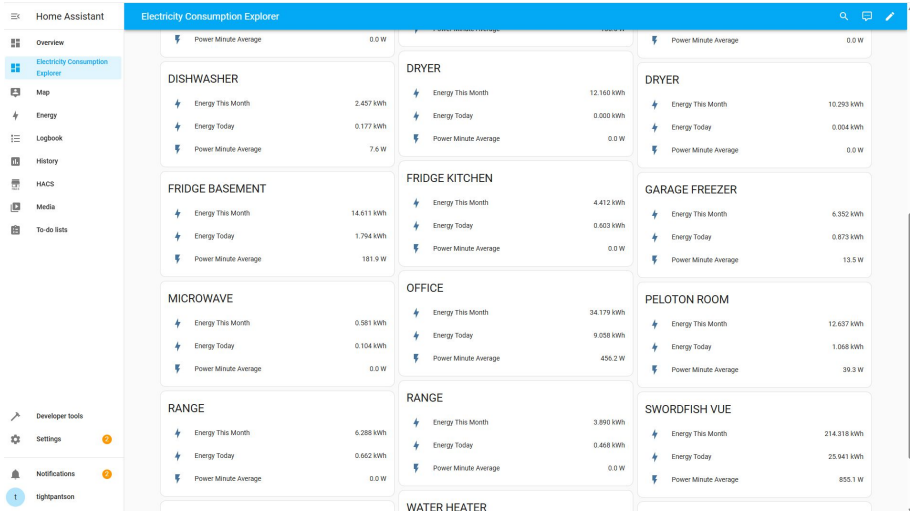
“Energy Signatures” for each major appliance







- In a household, each appliance has a unique “energy signature”
- Key takeaway so far? Focus on the major appliances, then drill down into finer level detail of other electronics
- **Data-wise, now able to capture ALL the readings of all devices at household** pulling electrical power. Display in a dashboard through Home Assistant



Main Project Goals

Use data to…

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While I'd like to use more renewable sources of energy (i. solar/wind), options are limited in North Dakota. So, step 1, looking to become more efficient with my energy usage, then use this data to size a solar pv system FY2025.

RESULT: Yes! Trending in right direction (latest 3 month avg. is **708kwh/month**).
Estimated yearly electricity usage FY2025? ~8,000 kWh/year

*These results are preliminary at this point, gives confidence it's possible to improve

	A	D	G	I	J	K	L	M
1	**Bill Date**	**Electric Usage**	**Electric Charges**					
2	12/01/2024	736	87.56					
3	10/29/2024	591	72.39					
4	09/30/2024	799	102.6	708.67	<-- trailing ~3 month average, monhtly kwh usage (sep, oct, nov)			
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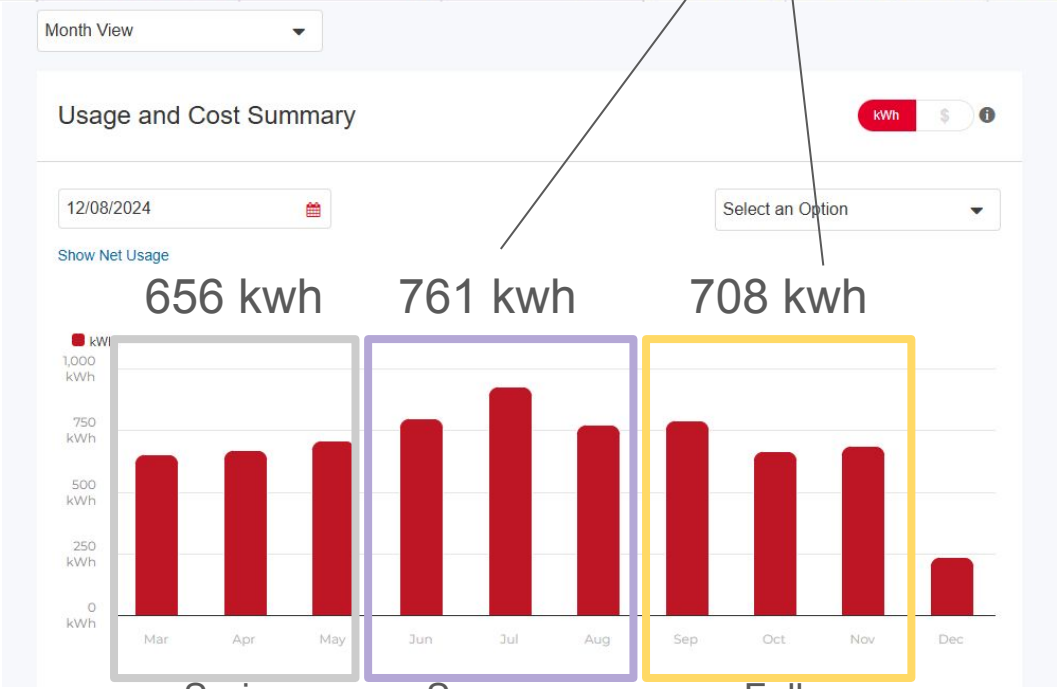
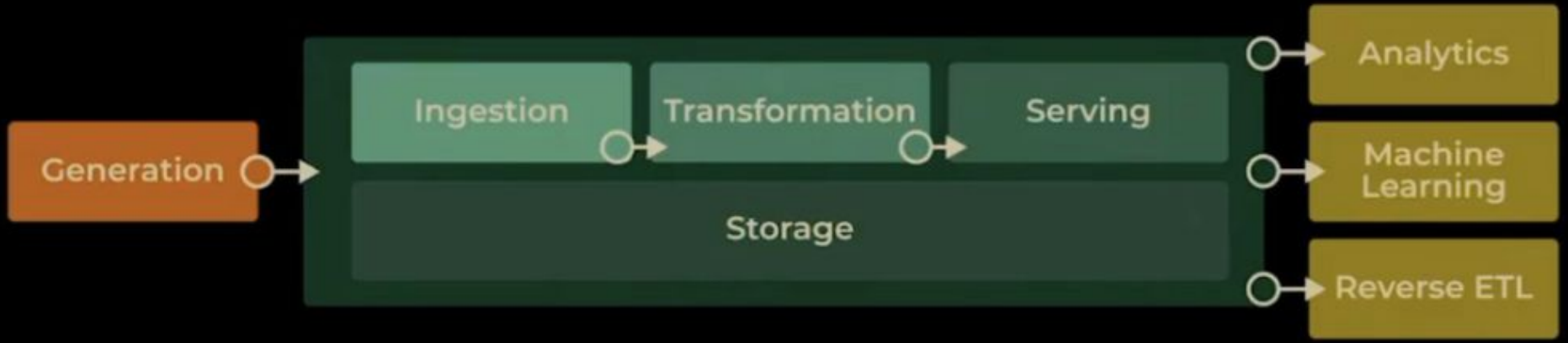


- Reduction from ~761kwh to ~708kwh
- In last 3 months reduced average monthly electric usage by **~6.91%**

DATA ENGINEERING LIFECYCLE



UNDERCURRENTS

Security | Data Management | DataOps | Data Architecture | Orchestration | Software Engineering

DATA ENGINEERING LIFECYCLE

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DATA ENGINEERING LIFECYCLE

Transformation

Serving

Storage

Analytics

Machine Learning

Reverse ETL

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Data Architecture

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Software Engineering

DATA

CYCLE

- Analytics
- Machine Learning
- Reverse ETL

Security

Software Engineering

DATA ENGINEERING LIFECYCLE

Generation

Step 1

Ingestion

Step 2

Transformation

Step 3

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Step 4

Machine Learning

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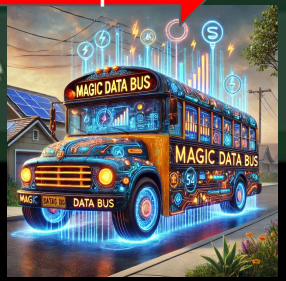
Storage

Step 3



Analytics

Step 4

Machine Learning

Reverse ETL

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DATA ENGINEERING LIFECYCLE

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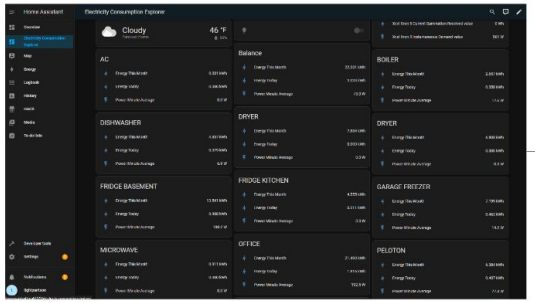
Step 1:
DATA GENERATION

2 data sources:

- Itronmeter
- Emporia circuit monitoring

itron meter

emporia
(home energy
monitoring system)



Home Assistant
(local server: homeassistant.local)

API Access

itron meter (1)

emporia sensors (16)

sensor.ac_power_minute_average
sensor.office_power_minute_average
sensor.dryer_power_minute_average
sensor.dryer_power_minute_average_2
sensor.water_heater_power_minute_average
sensor.watwr_heater_power_minute_average
sensor.garage_freezer_power_minute_average
sensor.peloton_power_minute_average
sensor.washer_power_minute_average
sensor.boiler_power_minute_average
sensor.fridge_basement_power_minute_average
sensor.fridge_kitchen_power_minute_average
sensor.microwave_power_minute_average
sensor.dishwasher_power_minute_average
sensor.range_power_minute_average
sensor.range_power_minute_average_2

Run Powershell scripts
to get data from API for
for itron & emporia

Azure Storage

Step 1:
DATA GENERATION

Itronmeter

	A	B	C
1	entity_id	state	last_changed
2	sensor.xcel_itron_5_insta	534	2024-10-01T05:00:00.000Z
3	sensor.xcel_itron_5_insta	532	2024-10-01T05:00:11.292Z
4	sensor.xcel_itron_5_insta	533	2024-10-01T05:00:17.023Z
5	sensor.xcel_itron_5_insta	534	2024-10-01T05:00:22.851Z
6	sensor.xcel_itron_5_insta	535	2024-10-01T05:00:28.507Z
7	sensor.xcel_itron_5_insta	534	2024-10-01T05:00:34.317Z
8	sensor.xcel_itron_5_insta	533	2024-10-01T05:00:40.033Z
9	sensor.xcel_itron_5_insta	535	2024-10-01T05:00:57.545Z
10	sensor.xcel_itron_5_insta	534	2024-10-01T05:01:03.312Z
11	sensor.xcel_itron_5_insta	537	2024-10-01T05:01:20.319Z
12	sensor.xcel_itron_5_insta	536	2024-10-01T05:01:25.911Z
13	sensor.xcel_itron_5_insta	535	2024-10-01T05:01:31.643Z
14	sensor.xcel_itron_5_insta	534	2024-10-01T05:01:37.286Z
15	sensor.xcel_itron_5_insta	536	2024-10-01T05:01:48.748Z
16	sensor.xcel_itron_5_insta	534	2024-10-01T05:01:54.479Z
17	sensor.xcel_itron_5_insta	535	2024-10-01T05:02:00.302Z
18	sensor.xcel_itron_5_insta	533	2024-10-01T05:02:17.358Z
19	sensor.xcel_itron_5_insta	535	2024-10-01T05:02:23.050Z
20	sensor.xcel_itron_5_insta	534	2024-10-01T05:02:34.619Z
21	sensor.xcel_itron_5_insta	537	2024-10-01T05:02:51.925Z
22	sensor.xcel_itron_5_insta	536	2024-10-01T05:02:58.069Z
23	sensor.xcel_itron_5_insta	537	2024-10-01T05:03:03.803Z
24	sensor.xcel_itron_5_insta	536	2024-10-01T05:03:09.435Z
25	sensor.xcel_itron_5_insta	535	2024-10-01T05:03:15.274Z
26	sensor.xcel_itron_5_insta	536	2024-10-01T05:03:26.641Z
27	sensor.xcel_itron_5_insta	535	2024-10-01T05:03:32.289Z
28	sensor.xcel_itron_5_insta	537	2024-10-01T05:03:38.039Z
29	sensor.xcel_itron_5_insta	536	2024-10-01T05:03:49.375Z
30	sensor.xcel_itron_5_insta	538	2024-10-01T05:04:00.737Z
31	sensor.xcel_itron_5_insta	534	2024-10-01T05:04:06.780Z
32	sensor.xcel_itron_5_insta	536	2024-10-01T05:04:12.616Z
33	sensor.xcel_itron_5_insta	535	2024-10-01T05:04:18.269Z
34	sensor.xcel_itron_5_insta	538	2024-10-01T05:04:29.974Z
35	sensor.xcel_itron_5_insta	535	2024-10-01T05:04:35.861Z
36	sensor.xcel_itron_5_insta	534	2024-10-01T05:04:47.740Z
37	sensor.xcel_itron_5_insta	536	2024-10-01T05:04:53.507Z
38	sensor.xcel_itron_5_insta	538	2024-10-01T05:04:59.352Z
39	sensor.xcel_itron_5_insta	536	2024-10-01T05:05:04.984Z
40	sensor.xcel_itron_5_insta	535	2024-10-01T05:05:10.678Z
41	sensor.xcel_itron_5_insta	534	2024-10-01T05:05:22.454Z
42	sensor.xcel_itron_5_insta	535	2024-10-01T05:05:34.434Z
43	sensor.xcel_itron_5_insta	533	2024-10-01T05:05:46.007Z

2024-10-01_sensor.xcel_itron_5_

- **“instantaneous_demand_value”** dimension
  - **3 fields**
    - **Entity_id**
      - constant for all values
    - **State**
      - express in raw Watts
    - **Last_changed**
      - timestamp

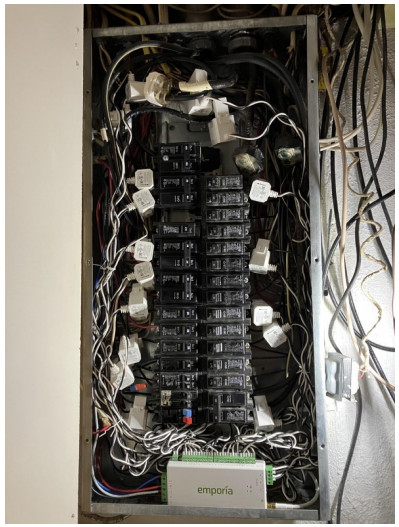
- Typical daily file contains ~10K rows

- Filename example:

2024-11-30_sensor.xcel_itron_5_instantaneous_demand_value.csv

Step 1:
DATA GENERATION

Emporia circuits



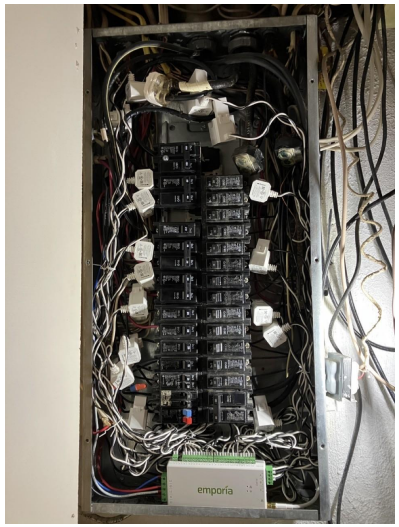
	A	B	C
1	entity_id	state	last_changed
2	sensor.fridge	178.0326594	2024-11-30T00:00:00+00:00
3	sensor.fridge	177.490139	2024-11-30T00:01:23.335181+00:00
4	sensor.fridge	177.3737078	2024-11-30T00:03:23.311463+00:00
5	sensor.fridge	175.8437327	2024-11-30T00:05:23.322256+00:00
6	sensor.fridge	442.2252558	2024-11-30T00:07:23.301722+00:00
7	sensor.fridge	437.4649719	2024-11-30T00:08:23.274399+00:00
8	sensor.fridge	433.9307877	2024-11-30T00:10:23.318716+00:00
9	sensor.fridge	441.2823853	2024-11-30T00:12:23.274809+00:00
10	sensor.fridge	439.2026306	2024-11-30T00:14:23.302450+00:00
11	sensor.fridge	439.1166336	2024-11-30T00:16:23.292365+00:00
12	sensor.fridge	439.9620454	2024-11-30T00:18:23.250608+00:00
13	sensor.fridge	0	2024-11-30T00:20:23.334914+00:00
14	sensor.fridge	125.2476552	2024-11-30T00:45:23.345435+00:00
15	sensor.fridge	184.6873288	2024-11-30T00:47:23.268778+00:00
16	sensor.fridge	177.3083458	2024-11-30T00:49:23.257504+00:00
17	sensor.fridge	181.4390071	2024-11-30T00:51:23.327221+00:00
18	sensor.fridge	183.3081863	2024-11-30T00:53:23.289982+00:00
19	sensor.fridge	184.5748632	2024-11-30T00:54:23.273509+00:00
20	sensor.fridge	186.44223	2024-11-30T00:56:23.263174+00:00
21	sensor.fridge	187.7982132	2024-11-30T00:58:23.291337+00:00
22	sensor.fridge	189.2905632	2024-11-30T01:00:23.323283+00:00
23	sensor.fridge	189.7634816	2024-11-30T01:02:23.311581+00:00
24	sensor.fridge	189.3888064	2024-11-30T01:04:23.321184+00:00
25	sensor.fridge	189.2544736	2024-11-30T01:06:23.265118+00:00
26	sensor.fridge	188.3599164	2024-11-30T01:08:23.274888+00:00
27	sensor.fridge	187.9107101	2024-11-30T01:09:23.314393+00:00
28	sensor.fridge	186.8989825	2024-11-30T01:11:23.314559+00:00
29	sensor.fridge	186.0318344	2024-11-30T01:13:23.284544+00:00
30	sensor.fridge	182.306059	2024-11-30T01:15:23.285112+00:00
31	sensor.fridge	184.9601967	2024-11-30T01:17:23.288956+00:00
32	sensor.fridge	184.2817646	2024-11-30T01:19:23.341377+00:00
33	sensor.fridge	182.7784465	2024-11-30T01:21:23.315120+00:00
34	sensor.fridge	181.8428772	2024-11-30T01:23:23.344660+00:00
35	sensor.fridge	181.4086617	2024-11-30T01:25:23.270393+00:00
36	sensor.fridge	180.7264476	2024-11-30T01:27:23.261530+00:00
37	sensor.fridge	180.5448616	2024-11-30T01:29:23.328624+00:00
38	sensor.fridge	180.6258036	2024-11-30T01:31:23.271032+00:00
39	sensor.fridge	179.7921249	2024-11-30T01:33:23.287632+00:00
40	sensor.fridge	179.2163302	2024-11-30T01:35:23.272305+00:00
41	sensor.fridge	178.3731059	2024-11-30T01:37:23.307034+00:00
42	sensor.fridge	177.699367	2024-11-30T01:39:23.275699+00:00
43	sensor.fridge	177.0991007	2024-11-30T01:41:23.256905+00:00
44	sensor.fridge	177.1598831	2024-11-30T01:43:23.288004+00:00
45	sensor.fridge	177.5597557	2024-11-30T01:45:23.314539+00:00

- 16 circuits being monitored

16circuits	Emporia Device Name	Home Assistant Name
CT-1	AC	sensor.ac_power_minute_average
CT-2	OFFICE	sensor.office_power_minute_average
CT-3	DRYER	sensor.dryer_power_minute_average
CT-4	DRYER	sensor.dryer_power_minute_average_2
CT-5	WATER HEATER	sensor.water_heater_power_minute_average
CT-6	WATWR HEATER	sensor.watwr_heater_power_minute_average
CT-7	GARAGE FREEZER	sensor.garage_freezer_power_minute_average
CT-8	PELOTON ROOM	sensor.peloton_power_minute_average
CT-9	WASHER	sensor.washer_power_minute_average
CT-10	BOILER	sensor.boiler_power_minute_average
CT-11	FRIDGE BASEMENT	sensor.fridge_basement_power_minute_average
CT-12	FRIDGE KITCHEN	sensor.fridge_kitchen_power_minute_average
CT-13	MICROWAVE	sensor.microwave_power_minute_average
CT-14	DISHWASHER	sensor.dishwasher_power_minute_average
CT-15	RANGE	sensor.range_power_minute_average
CT-16	RANGE	sensor.range_power_minute_average_2

Step 1:
DATA GENERATION

Emporia circuits



	A	B	C
1	entity_id	state	last_changed
2	sensor.fridge	178.0326594	2024-11-30T00:00:00+00:00
3	sensor.fridge	177.490139	2024-11-30T00:01:23.335181+00:00
4	sensor.fridge	177.3737078	2024-11-30T00:03:23.311463+00:00
5	sensor.fridge	175.8437327	2024-11-30T00:05:23.322256+00:00
6	sensor.fridge	442.2252558	2024-11-30T00:07:23.301722+00:00
7	sensor.fridge	437.4649719	2024-11-30T00:08:23.274399+00:00
8	sensor.fridge	433.9307877	2024-11-30T00:10:23.318716+00:00
9	sensor.fridge	441.2823853	2024-11-30T00:12:23.274809+00:00
10	sensor.fridge	439.2026306	2024-11-30T00:14:23.302450+00:00
11	sensor.fridge	439.1166336	2024-11-30T00:16:23.292365+00:00
12	sensor.fridge	439.9620454	2024-11-30T00:18:23.250608+00:00
13	sensor.fridge	0	2024-11-30T00:20:23.334914+00:00
14	sensor.fridge	125.2476552	2024-11-30T00:45:23.345435+00:00
15	sensor.fridge	184.6873288	2024-11-30T00:47:23.268778+00:00
16	sensor.fridge	177.3083458	2024-11-30T00:49:23.257504+00:00
17	sensor.fridge	181.4390071	2024-11-30T00:51:23.327221+00:00
18	sensor.fridge	183.3081863	2024-11-30T00:53:23.289982+00:00
19	sensor.fridge	184.5748632	2024-11-30T00:54:23.273509+00:00
20	sensor.fridge	186.44223	2024-11-30T00:56:23.263174+00:00
21	sensor.fridge	187.7982132	2024-11-30T00:58:23.291337+00:00
22	sensor.fridge	189.2905632	2024-11-30T01:00:23.323283+00:00
23	sensor.fridge	189.7634816	2024-11-30T01:02:23.311581+00:00
24	sensor.fridge	189.3888064	2024-11-30T01:04:23.321184+00:00
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45	sensor.fridge	177.5597557	2024-11-30T01:45:23.314539+00:00

- For each circuit can see power usage by the minute
- **“power minute average”** dimension
  - **3 fields**
    - **entity_id**
    - **state**
    - **last_changed**
- Typical file much smaller volume, < 500 rows
- Filename examples:

*2024-11-30_**dishwasher**_power_minute_average.csv*

*2024-11-30_**fridge_basement**_power_minute_average.csv*

*2024-11-30_**boiler**_power_minute_average.csv*

Electricity Consumption Explorer

Energy distribution today

GO TO THE ENERGY DASHBOARD

Cloudy

Forecast Home

38 °F
84%

AC

Energy This Month	0.218 kWh
Energy Today	0.000 kWh
Power Minute Average	0.0 W

DISHWASHER

Energy This Month	2.473 kWh
Energy Today	0.012 kWh
Power Minute Average	7.6 W

FRIDGE BASEMENT

Energy This Month	14.751 kWh
Energy Today	0.071 kWh
Power Minute Average	184.5 W

Outlet 2 Right	
Porch	

tightpantson	Away

Light

Balance

Energy This Month	39.678 kWh
Energy Today	0.280 kWh
Power Minute Average	156.5 W

DRYER

Energy This Month	12.160 kWh
Energy Today	0.000 kWh
Power Minute Average	0.0 W

FRIDGE KITCHEN

Energy This Month	4.447 kWh
Energy Today	0.000 kWh
Power Minute Average	0.0 W

Xcel Itron 5 Current Summation Delivered timePeriodduration	1
Xcel Itron 5 Current Summation Delivered time...	6 seconds ago
Xcel Itron 5 Current Summation Delivered value	6,086,904 Wh
Xcel Itron 5 Current Summation Received timePeriodduration	1
Xcel Itron 5 Current Summation Received time...	6 seconds ago
Xcel Itron 5 Current Summation Received value	0 Wh
Xcel Itron 5 Instantaneous Demand value	864 W

BOILER

Energy This Month	0.844 kWh
Energy Today	0.000 kWh
Power Minute Average	0.0 W

DRYER

Energy This Month	10.293 kWh
Energy Today	0.000 kWh
Power Minute Average	0.0 W

GARAGE FREEZER

Energy This Month	6.419 kWh
Energy Today	0.078 kWh
Power Minute Average	13.4 W

Electricity Consumption Explorer

Energy distribution today

1.1 kWh Grid — 1.1 kWh Home

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1%	0.0 W

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DATA ENGINEERING LIFECYCLE

Generation

Step 1

Step 2

Ingestion

Transformation

Step 3

Serving

Storage

Analytics

Step 4

Machine Learning

Reverse ETL

UNDERCURRENTS

Security

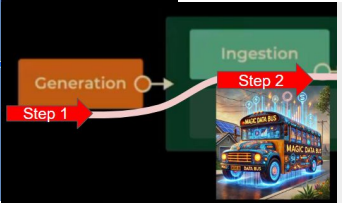
Data Management

DataOps

Data Architecture

Orchestration

Software Engineering



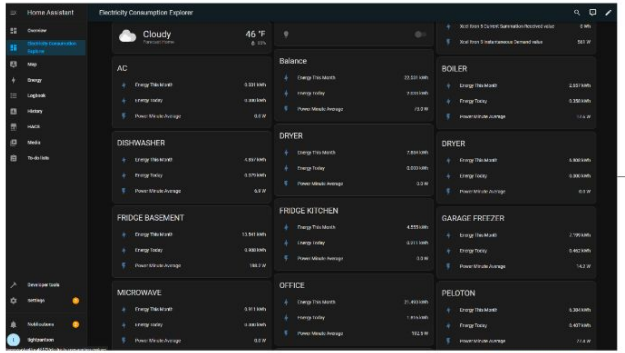
Step 2:
DATA INGESTION

2 Powershell scripts for data ingestion:

- *get_emporiacircuits_data.ps1*
- *get_itronmeter_data.ps1*

itron meter

emporia
(home energy
monitoring system)



Home Assistant
(local server: homeassistant.local)

API Access

itron meter (1)

sensor.xcel_itron_5_instantaneous_demand_value

emporia sensors (16)

sensor.ac_power_minute_average
sensor.office_power_minute_average
sensor.dryer_power_minute_average
sensor.dryer_power_minute_average_2
sensor.water_heater_power_minute_average
sensor.water_heater_power_minute_average
sensor.garage_freezer_power_minute_average
sensor.peloton_power_minute_average
sensor.washer_power_minute_average
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sensor.fridge_basement_power_minute_average
sensor.fridge_kitchen_power_minute_average
sensor.microwave_power_minute_average
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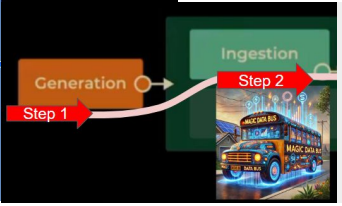
sensor.range_power_minute_average
sensor.range_power_minute_average_2

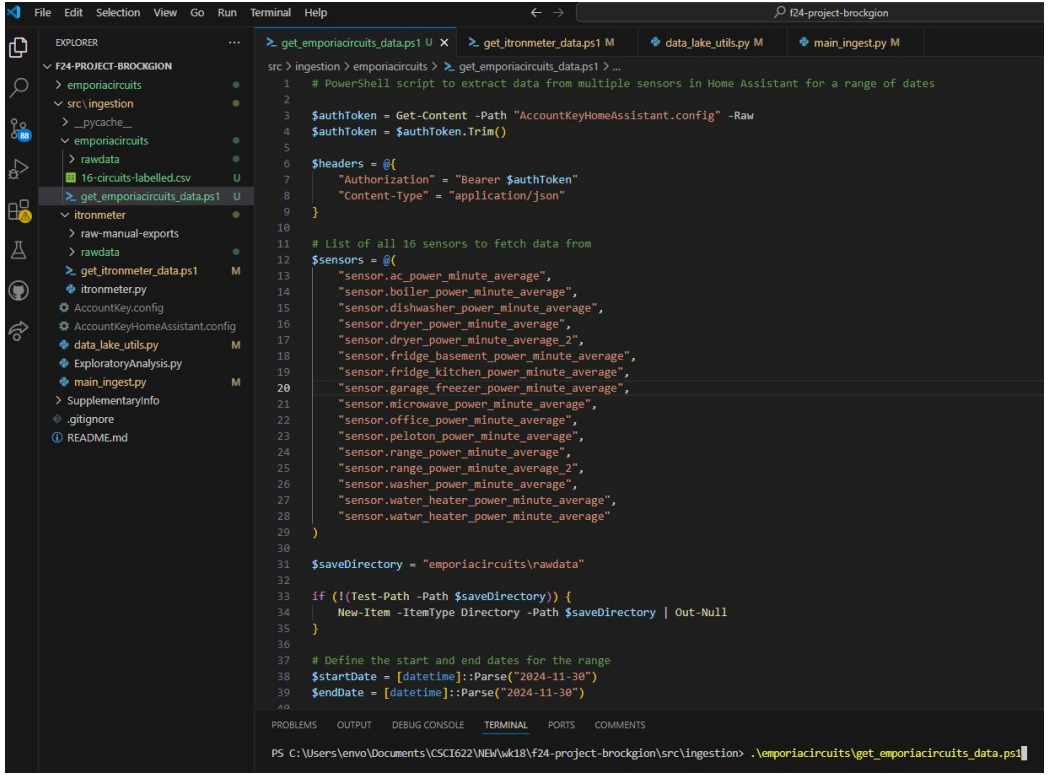
Run Powershell scripts
to get data from API for
for itron & emporia

Azure Storage



Step 2:
DATA INGESTION

get_emporiacircuits_data.ps1



- **Manually mapped all 16 sensors as hardcoded list**
  - Although this list could change, don't expect it to occur often
- **Single script gets all data for 16 sensors, and uploads to Azure blob storage container**
  - Key parameter is date range

```
# Define the start and end dates for the range
$startDate = [datetime]::Parse("2024-11-30")
$endDate = [datetime]::Parse("2024-11-30")
```

DATA ENGINEERING LIFECYCLE

Generation

Step 1

Step 2

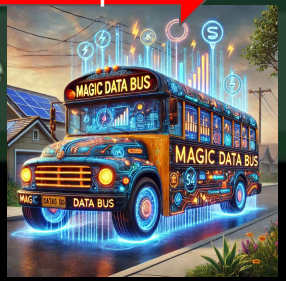
Ingestion

Transformation

Serving

Storage

Step 3



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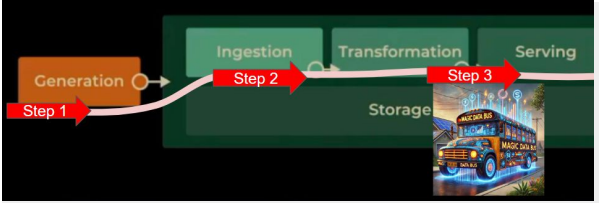
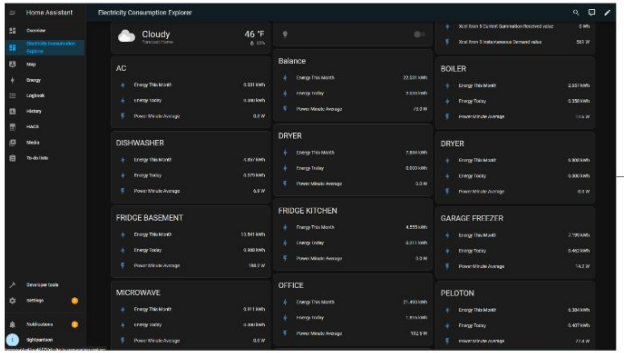


Step 3:
DATA STORAGE

Cloud storage:
- Azure Blob container

itron meter

emporia
(home energy
monitoring system)



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(local server: homeassistant.local)

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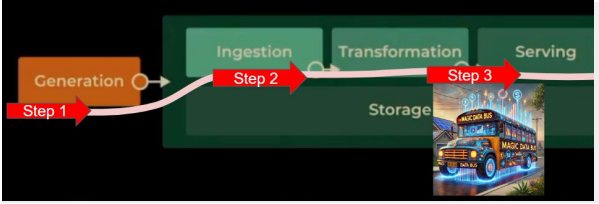


Step 3:
DATA STORAGE

https://portal.azure.com/#view/Microsoft_Azure_Storage/ContainerMenuBlade/~/

Microsoft Azure

Home > azdbrickstorage | Containers >

electric-meter-data
Container

Search

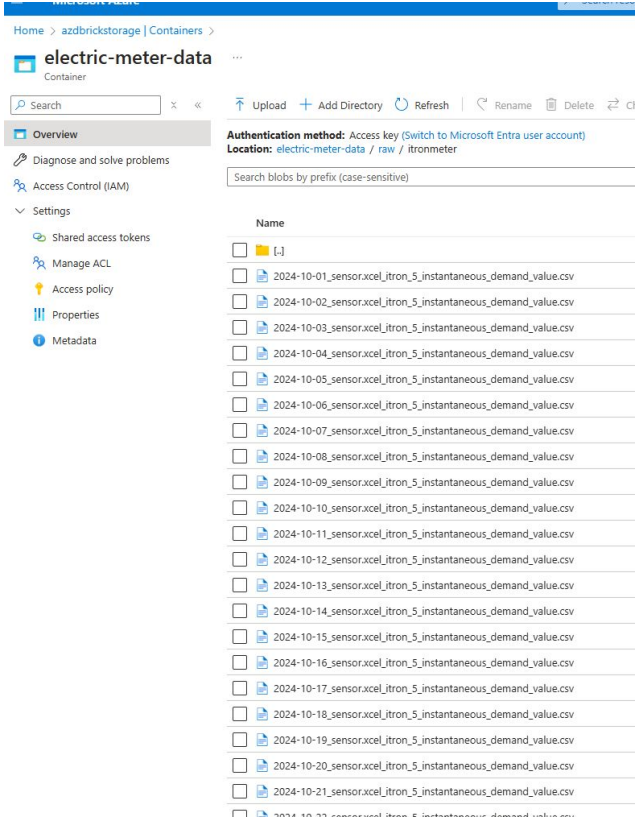
Overview
Diagnose and solve problems
Access Control (IAM)
Settings
Shared access tokens
Manage ACL
Access policy
Properties
Metadata

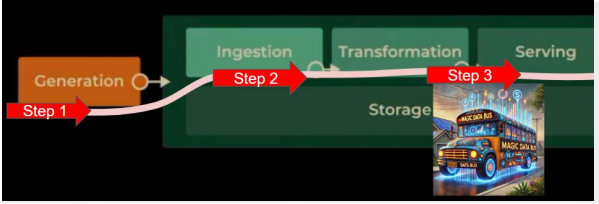
Upload | Add Directory | Refresh | Renar

Authentication method: Access key (Switch to Microsoft Entra
Location: electric-meter-data / raw

Search blobs by prefix (case-sensitive)

Name
[..]
emporiacircuits
itronmeter





Step 3:
DATA TRANSFORMATION - Azure Databricks

Microsoft Azure | databricks

Search data, notebooks, recents, and more... CTRL + P

New

Workspace
Recents
Catalog
Workflows
Compute

SQL
SQL Editor
Queries
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Data Engineering
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Delta Live Tables

Machine Learning
Playground
Experiments
Features
Models
Serving

Marketplace
Partner Connect

Exploratory Analysis Electricity Consumption | main | Python

File Edit View Run Help Last edit was 24 days ago

Connect to Azure Storage

Waiting | Waiting for compute to start 2

```
# Add imports, read in data to analyze
import json
import matplotlib.pyplot as plt
from pyspark.sql.functions import sum, desc, isnull, col, avg, count, when, from_json, to_timestamp, window
from pyspark.sql.types import StructType, StructField, IntegerType, StringType

storage_account_name = "azdbrickstorage"  # Your storage account name
my_scope = "azdbrick-scope"  # The secret scope you created
my_key = "electricSecret"  # The secret key name in your vault

# Configure Spark to use the storage account key from your secret scope
spark.conf.set(
    f"fs.azure.account.key.{storage_account_name}.dfs.core.windows.net",
    dbutils.secrets.get(scope=my_scope, key=my_key)
)

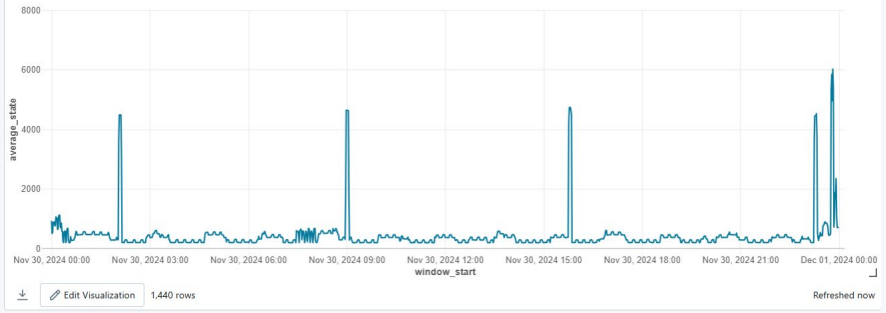
# Define the URI for accessing the data
uri = f"abfss://electric-meter-data@{storage_account_name}.dfs.core.windows.net/"

# itron
itron_df = spark.read.csv(uri+"raw-input/xcel_itron_5_instantaneous_demand_value-2024-11-13.csv", header=True)

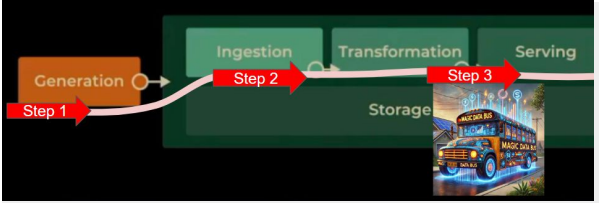
# emporia sensors
sensors = [
    "ac_power_minute_average",
    "office_power_minute_average",
    "dryer_power_minute_average",
    "dryer_power_minute_average_2",
    "water_heater_power_minute_average",
    "watwr_heater_power_minute_average",
    "garage_freezer_power_minute_average",
    "peloton_power_minute_average",
    "washer_power_minute_average",
    "boiler_power_minute_average",
    "fridge_basement_power_minute_average"
```

aggregated_data: pyspark.sql.dataframe.DataFrame = [window_start: timestamp, average_state: double]
data_to_plot: pyspark.sql.dataframe.DataFrame = [last_changed: timestamp, state: string]
df: pyspark.sql.dataframe.DataFrame = [entity_id: string, state: string ... 2 more fields]

Table | Visualization 1



Edit Visualization | 1,440 rows | Refreshed now



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Exploratory Analysis Electricity Consumption | main | Python

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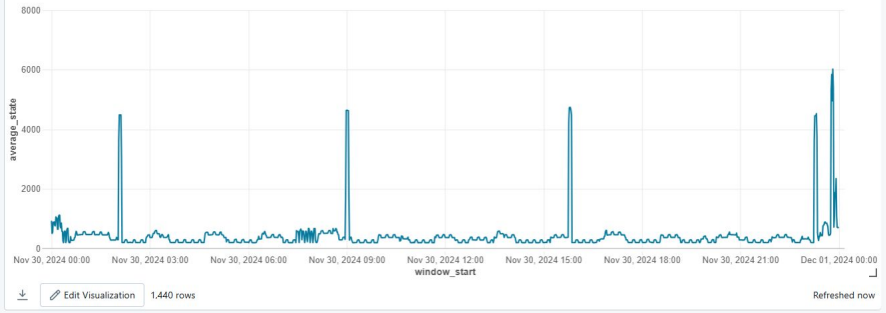
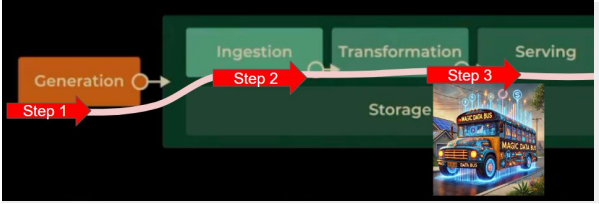
    "dryer_power_minute_average",
    "dryer_power_minute_average_2",
    "water_heater_power_minute_average",
    "watwr_heater_power_minute_average",
    "garage_freezer_power_minute_average",
    "peloton_power_minute_average",
    "washer_power_minute_average",
    "boiler_power_minute_average",
    "fridge_basement_power_minute_average"
```

aggregated_data: pyspark.sql.dataframe.DataFrame = [window_start: timestamp, average_state: double]
data_to_plot: pyspark.sql.dataframe.DataFrame = [last_changed: timestamp, state: string]
df: pyspark.sql.dataframe.DataFrame = [entity_id: string, state: string ... 2 more fields]

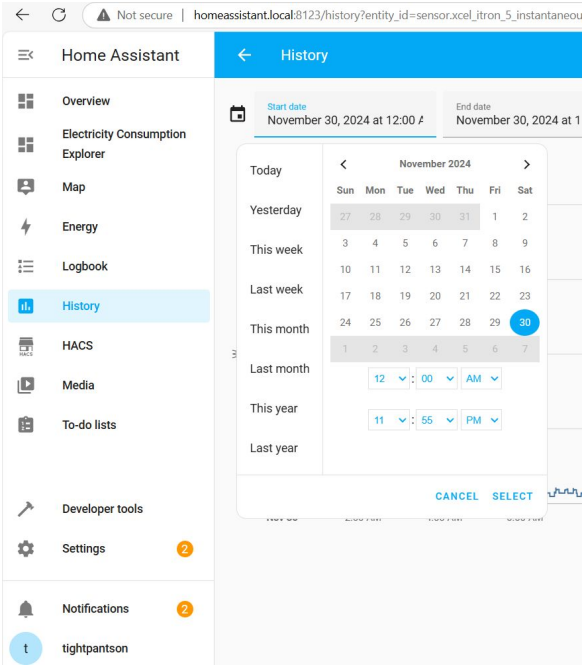
Table | Visualization 1



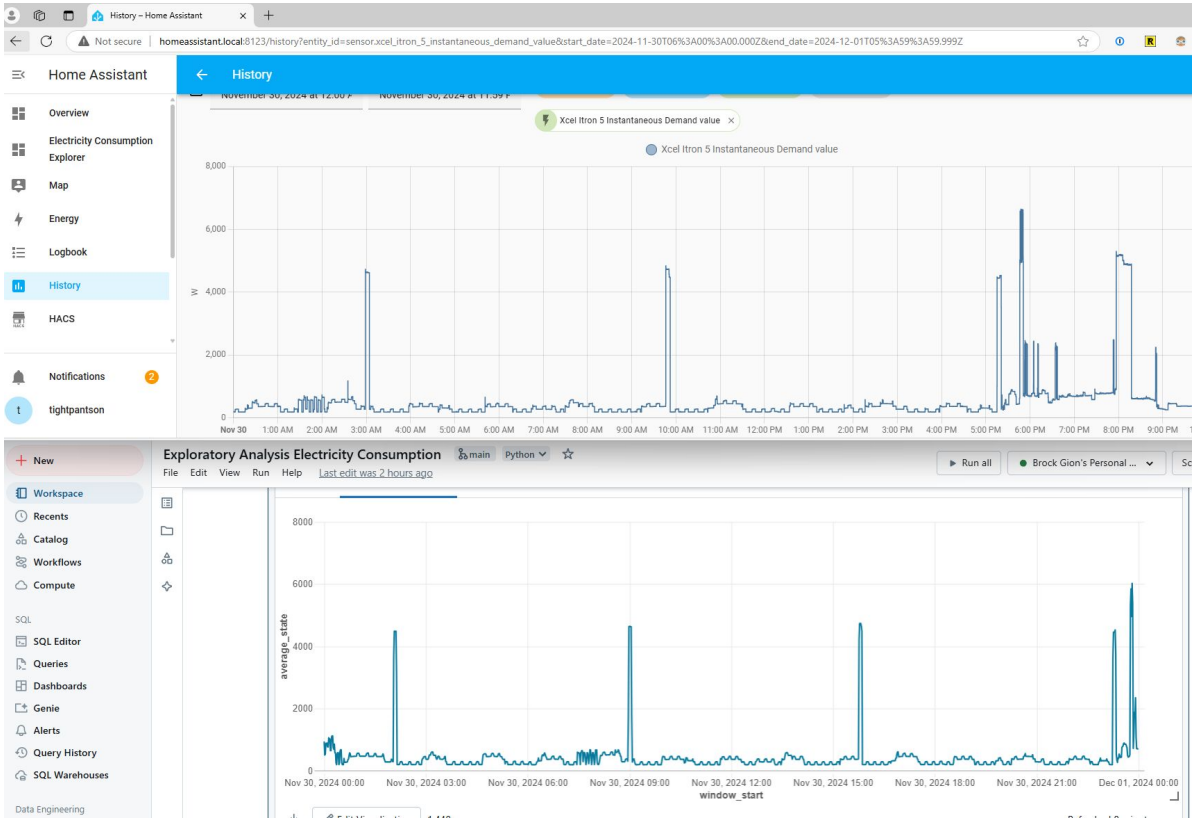
Edit Visualization | 1,440 rows | Refreshed now

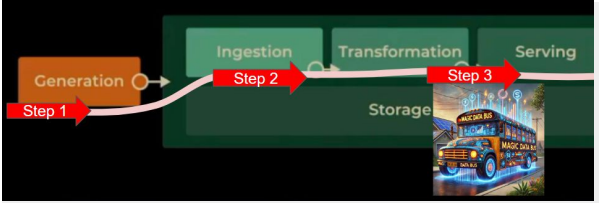


Step 3:
DATA TRANSFORMATION - Azure Databricks



Start Date: November 30, 2024 12:00 AM
End Date: November 30, 2024 11:59 PM





Step 3:
DATA TRANSFORMATION - Azure Databricks

databricks

Search data, notebooks, recents, and more... CTRL +

Electricity Consumption Explorer - Data Transformations main Python

File Edit View Run Help Last edit was 2 hours ago

itron (meter data)

Add "date" field

03:25 AM (1s) 4

```
itron_df = itron_df.withColumn("date", col("last_changed").substr(1, 10))
display(itron_df)
```

(1) Spark Jobs

itron_df: pyspark.sql.dataframe.DataFrame = [entity_id: string, state: string ... 2 more fields]

Table +

	entity_id	state	last_changed	date
63	sensor.xcel_itron_5_instantaneous_demand_val...	756	2024-11-30T00:07:02.979113+00:...	2024-11-30
64	sensor.xcel_itron_5_instantaneous_demand_val...	754	2024-11-30T00:07:08.916010+00:...	2024-11-30
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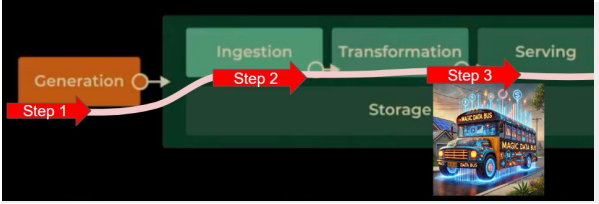
68	sensor.xcel_itron_5_instantaneous_demand_val...	757	2024-11-30T00:07:37.588677+00:...	2024-11-30
69	sensor.xcel_itron_5_instantaneous_demand_val...	753	2024-11-30T00:07:43.426128+00:...	2024-11-30
70	sensor.xcel_itron_5_instantaneous_demand_val...	755	2024-11-30T00:07:49.163928+00:...	2024-11-30
71	sensor.xcel_itron_5_instantaneous_demand_val...	756	2024-11-30T00:07:55.023884+00:...	2024-11-30
72	sensor.xcel_itron_5_instantaneous_demand_val...	1146	2024-11-30T00:08:00.835993+00:...	2024-11-30
73	sensor.xcel_itron_5_instantaneous_demand_val...	1145	2024-11-30T00:08:06.579026+00:...	2024-11-30
74	sensor.xcel_itron_5_instantaneous_demand_val...	1144	2024-11-30T00:08:12.355705+00:...	2024-11-30
75	sensor.xcel_itron_5_instantaneous_demand_val...	1021	2024-11-30T00:08:17.935158+00:...	2024-11-30
76	sensor.xcel_itron_5_instantaneous_demand_val...	1017	2024-11-30T00:08:23.623596+00:...	2024-11-30
77	sensor.xcel_itron_5_instantaneous_demand_val...	1015	2024-11-30T00:08:29.227205+00:...	2024-11-30

10,000+ rows | Truncated data | 1.11 seconds runtime

- **Adding a simple “date” field, very easy and useful**
- Example: extracting YYYY-MM-DD from “last_changed”
  - last_changed:
    - 2024-11-30T00:00:20.677Z
  - date:
    - 2024-11-30



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DATA TRANSFORMATION - Azure Databricks

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77	sensor.xcel_itron_5_instantaneous_demand_val...	1015	2024-11-30T00:08:29.227205+00:...	2024-11-30

10,000+ rows | Truncated data | 1.11 seconds runtime

- **Saving transformed data in a single coalesced "parquet" format**

- This allows for easier analytics using PowerBI

```
directory_path = "transformed/itronmeter"

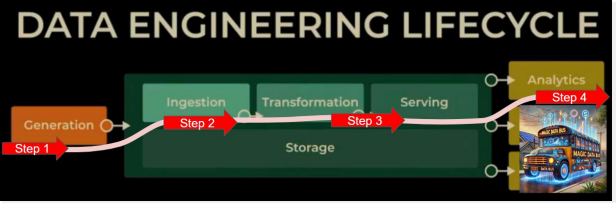
output_path = f"{uri}{directory_path}/"

# Save the aggregated data back to the desired path (overwrite original file)
aggregated_data.write.format("parquet").mode("overwrite").save(output_path)
```

DATA ENGINEERING LIFECYCLE

UNDERCURRENTS

Security | Data Management | DataOps | Data Architecture | Orchestration | Software Engineering

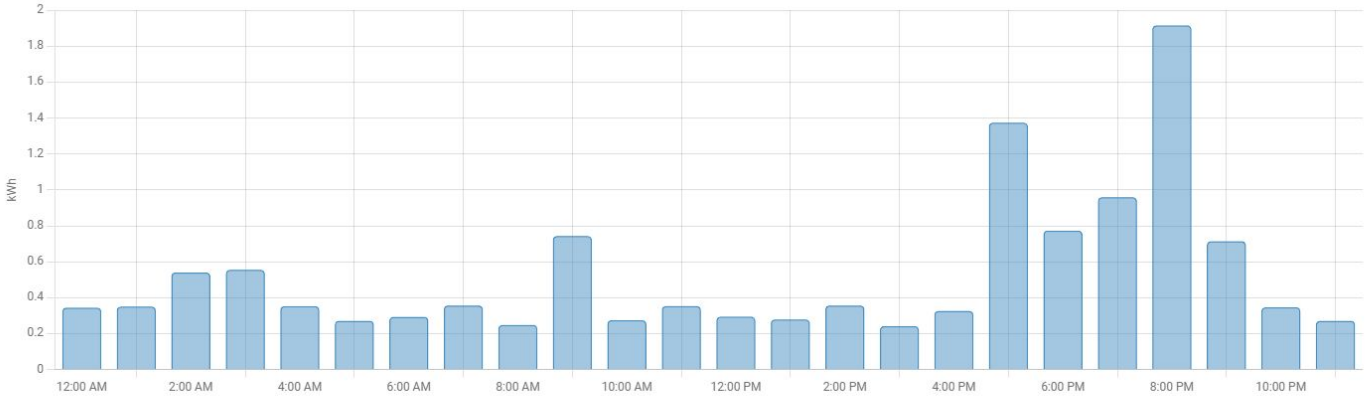


Step 4:
DATA ANALYTICS - Home Assistant

Energy

November 30, 2024 NOW

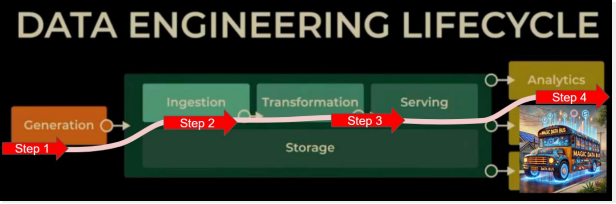
Energy usage



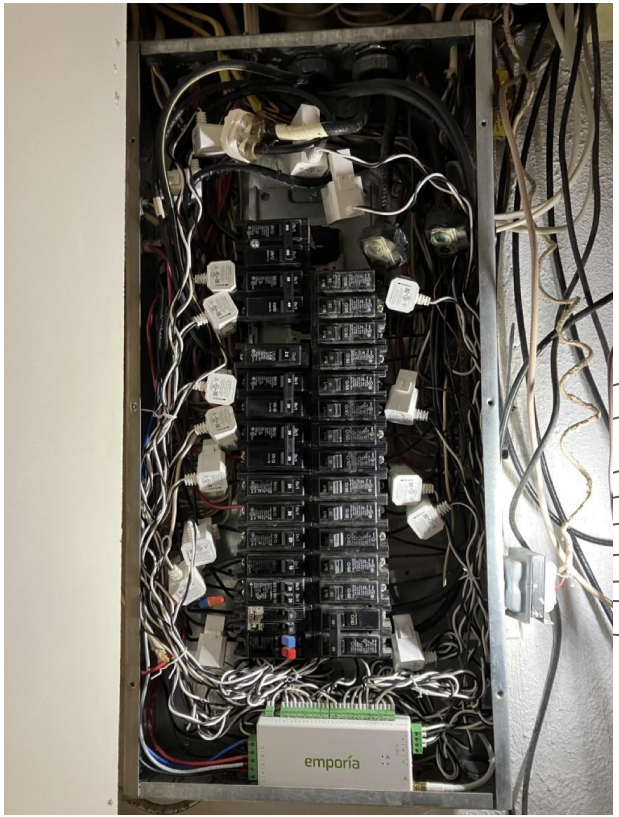
Energy distribution

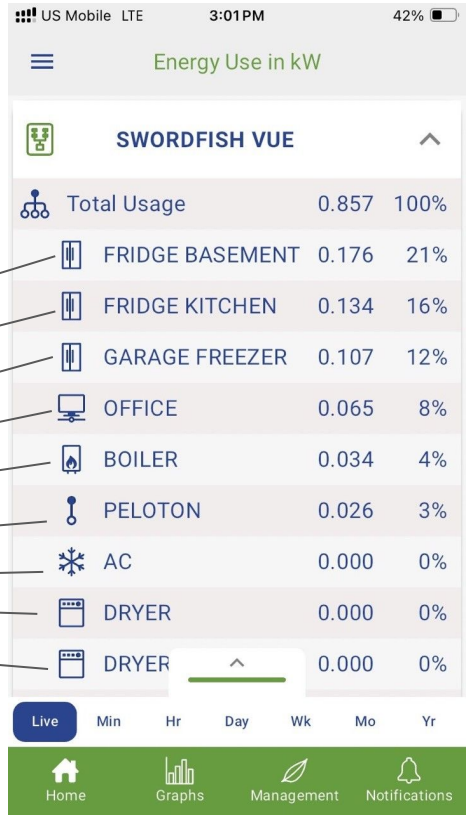
Sources

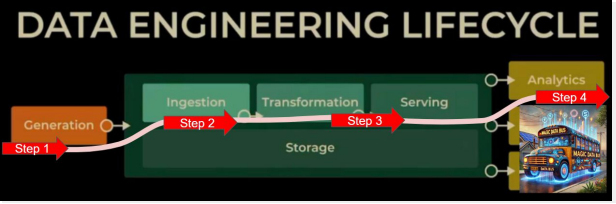
Source	Energy
Xcel Itron 5 Current Summation Delivered value	12.55 kWh
Grid total	**12.55 kWh**



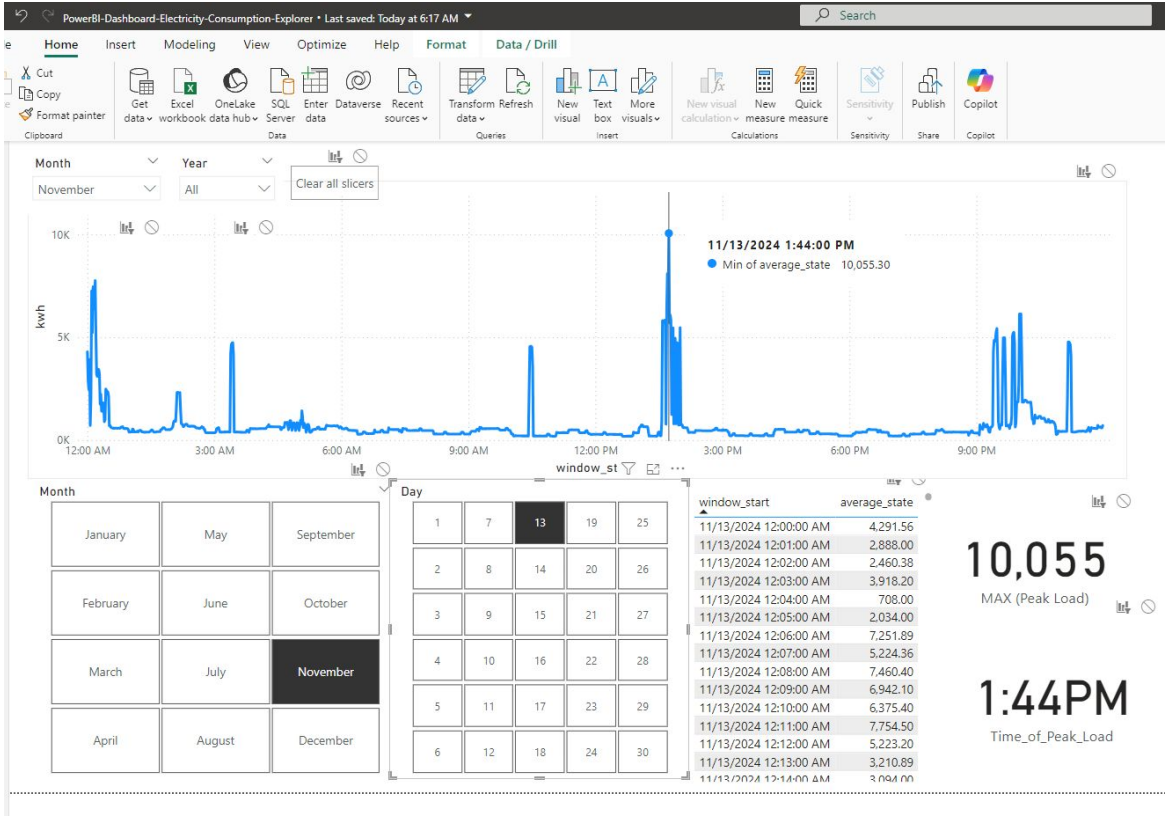
Step 4:
DATA ANALYTICS - Emporia Mobile App







Step 4:
DATA ANALYTICS - PowerBI Desktop



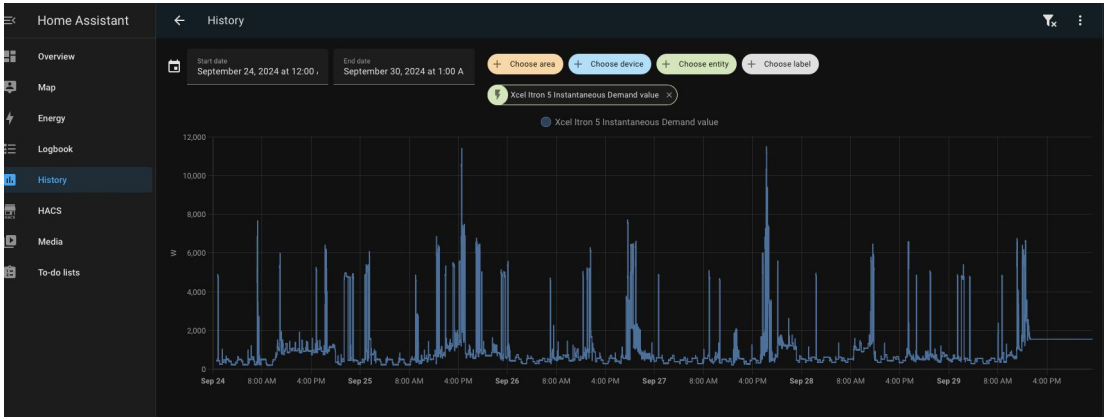
- **All data is synced to PowerBI - great visuals!**
- Easy to refresh the dashboard
- Everything accessed through a single coalesced “parquet” file saved in Azure Blob

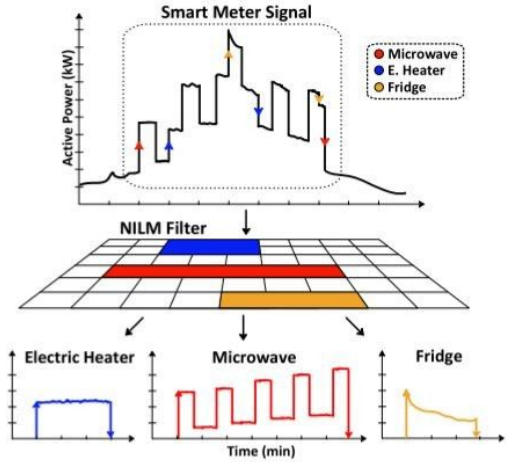
Other “Data-Centric” Goals

Expand on the data to…

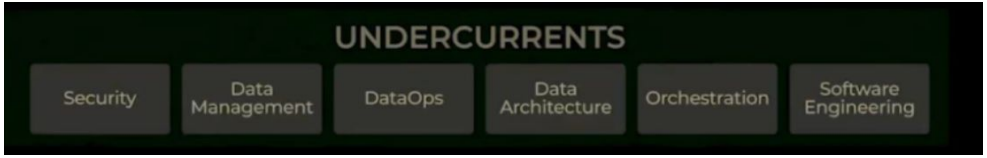
Create a dataset suitable for Machine Learning

Learn what it takes to engineer a system that’s appropriate for Machine Learning to detect patterns in my data. Ideally, want the ability to perform “**non-intrusive load monitoring**”.
https://en.wikipedia.org/wiki/Nonintrusive_load_monitoring





Undercurrent considerations



Security

- Setup isolated home network to keep all communication on own network (Mtr-Rdr2G).
- Principle of least privilege - only I have access

Data Management

- Capturing key metadata events.
  - **Manually annotate data when power outages occur** (no easy workaround)
- Standard units of measurement
  - Define all data in either:

    1) Watts

    2) kWh (kilowatt hours)

DataOps

- What can be automated?
  - Scripts are manual, need to have process automated in Home Assitant
- Any need for CI/CD?
  - Not yet
- How are repos tied into this?
  - Continue using Git as private repo, share with selective access

Data Architecture

- How does this solution scale? If interval readings are happening every 15 seconds, what's the benefit of capturing every 5 seconds?
  - **Capture ALL data at finest level of granularity, down to the second**

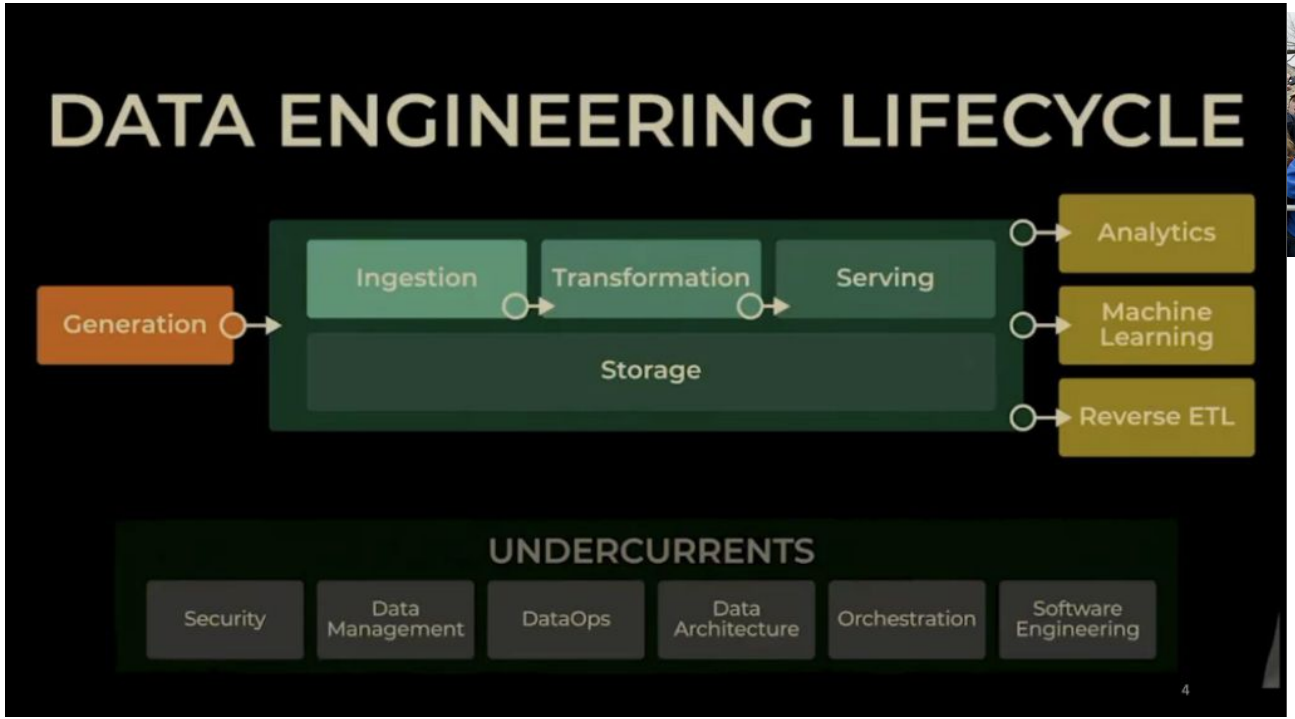
Orchestration

- Any daily/weekly/quarterly "batch" processes for analyzing the data?
  - Script files can cover daily/weekly batches. Wouldn't do quarterly

Software engineering

- What code will be used? Any plans to implement code as infrastructure?
  - Mix of basic powershell scripts, python, and home assistant YAML files
- How is data quality quality assurance performed?
  - Manually inspected, home assistant provide anomaly detection

Conclusion



- This project is a kickoff to a larger effort for an “energy home makeover” going into 2025
- Main focus of this semester was to solve for data ingestion, and confident that is working well!
- Next year plan to use this data more extensively…incorporate “time of use” billing, peak load factors, demand response, etc.