ACHIEVING NET ZERO:

Combining Integrated Design, Energy Modeling, and Post Occupancy Monitoring for a Successful Project

IMEG

The FUTURE. Built Smarter.

Introductions

Alex Zuro, Speaker

- Senior Building Performance Consultant, **IMEG**

Ted Dodas, Speaker

- Mechanical Project Engineer, **IMEG**

Agenda

Integrated Design

- About our Net Zero Case Study: District 26
- Owner Operation / Scheduling
- Architectural Impacts
- VRF System and Why

Energy Modeling

- Initial Modeling
- Modeling for Net Zero

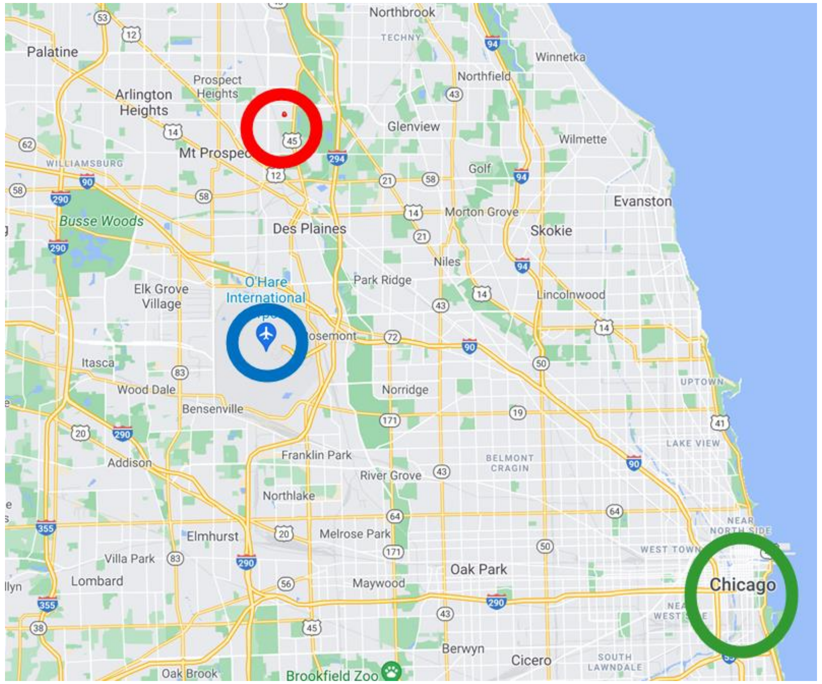
Post Occupancy Monitoring

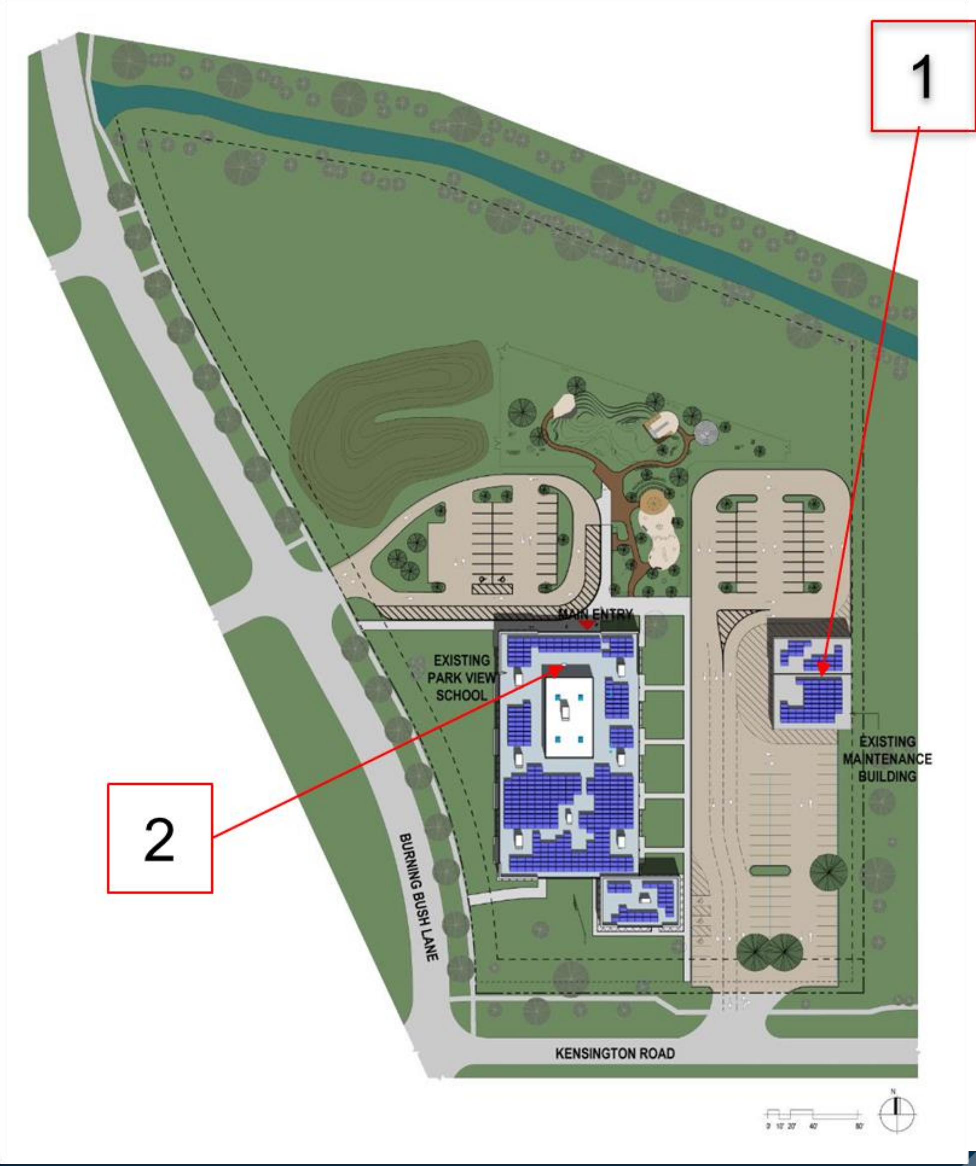
- Implementation
- Resolve Issues
- Net Zero Tracking

ABOUT DISTRICT 26 PRAIRIE TRAILS SCHOOL

Intro to project

- Elementary School & District Offices Building
- Building Area – Approximately 29,000sf





- Baseline ASHRAE 90.1 EUI — 75 kbtu/yr./sf
- Proposed EUI — 24-29 kbtu/yr./sf
- Baseline carbon footprint/year: — 174 metric tons
- Proposed carbon footprint/year: — -24 metric tons
- Carbon footprint reduction — 100+%
- Estimated annual energy savings to District 26: — +/- $30,000 /100% cost savings

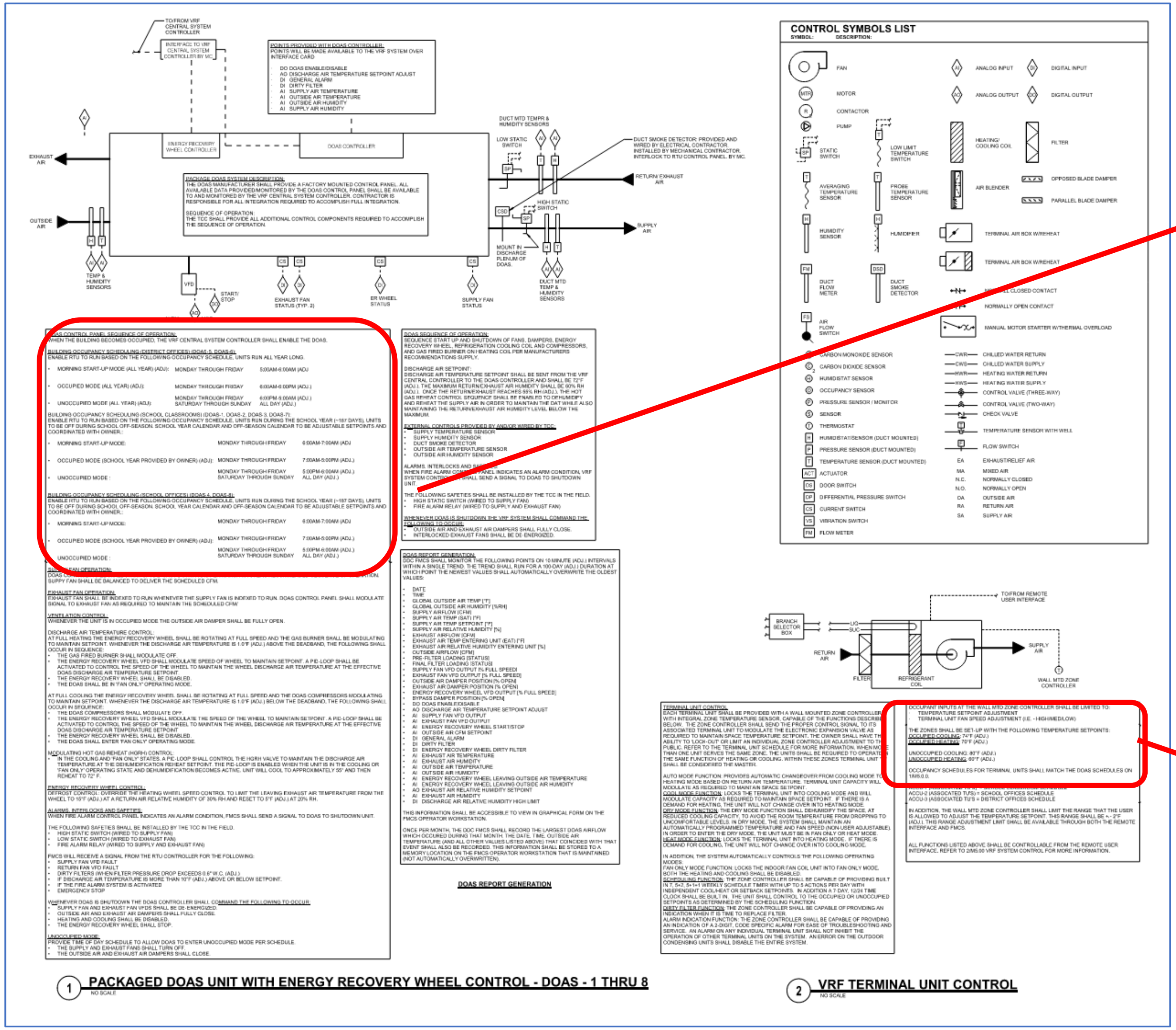
Project Goal

About District 26

INTEGRATED DESIGN

Owner Coordination

- Building Use
  - Yearly Schedule
- Staff Hours
  - Administration Hours
  - Teachers
  - Students
- Entrances and Exits to the Building
  - Flow of Students
- Room Temperature Setpoints
- Room Temperature Control Deadband



BUILDING OCCUPANCY SCHEDULING (DISTRICT OFFICES) (DOAS-5, DOAS-6):
ENABLE RTU TO RUN BASED ON THE FOLLOWING OCCUPANCY SCHEDULE, UNITS RUN ALL YEAR LONG.

• MORNING START-UP MODE (ALL YEAR) (ADJ):	MONDAY THROUGH FRIDAY	5:00AM-6:00AM (ADJ
• OCCUPIED MODE (ALL YEAR) (ADJ):	MONDAY THROUGH FRIDAY	6:00AM-6:00PM (ADJ.)
• UNOCCUPIED MODE (ALL YEAR) (ADJ):	MONDAY THROUGH FRIDAY SATURDAY THROUGH SUNDAY	6:00PM-5:00AM (ADJ.) ALL DAY (ADJ.)

BUILDING OCCUPANCY SCHEDULING (SCHOOL CLASSROOMS) (DOAS-1, DOAS-2, DOAS-3, DOAS-7):
ENABLE RTU TO RUN BASED ON THE FOLLOWING OCCUPANCY SCHEDULE, UNITS RUN DURING THE SCHOOL YEAR (~187 DAYS), UNITS TO BE OFF DURING SCHOOL OFF-SEASON. SCHOOL YEAR CALENDAR AND OFF-SEASON CALENDAR TO BE ADJUSTABLE SETPOINTS AND COORDINATED WITH OWNER.:

• MORNING START-UP MODE:	MONDAY THROUGH FRIDAY	6:00AM-7:00AM (ADJ
• OCCUPIED MODE (SCHOOL YEAR PROVIDED BY OWNER) (ADJ):	MONDAY THROUGH FRIDAY	7:00AM-5:00PM (ADJ.)
• UNOCCUPIED MODE :	MONDAY THROUGH FRIDAY SATURDAY THROUGH SUNDAY	5:00PM-6:00AM (ADJ.) ALL DAY (ADJ.)

BUILDING OCCUPANCY SCHEDULING (SCHOOL OFFICES) (DOAS-4, DOAS-8):
ENABLE RTU TO RUN BASED ON THE FOLLOWING OCCUPANCY SCHEDULE, UNITS RUN DURING THE SCHOOL YEAR (~187 DAYS), UNITS TO BE OFF DURING SCHOOL OFF-SEASON. SCHOOL YEAR CALENDAR AND OFF-SEASON CALENDAR TO BE ADJUSTABLE SETPOINTS AND COORDINATED WITH OWNER.:

• MORNING START-UP MODE:	MONDAY THROUGH FRIDAY	6:00AM-7:00AM (ADJ
• OCCUPIED MODE (SCHOOL YEAR PROVIDED BY OWNER) (ADJ):	MONDAY THROUGH FRIDAY	7:00AM-5:00PM (ADJ.)
• UNOCCUPIED MODE :	MONDAY THROUGH FRIDAY SATURDAY THROUGH SUNDAY	5:00PM-6:00AM (ADJ.) ALL DAY (ADJ.)

THE ZONES SHALL BE SET-UP WITH THE FOLLOWING TEMPERATURE SETPOINTS:
OCCUPIED COOLING: 74°F (ADJ.)
OCCUPIED HEATING: 70°F (ADJ.)

UNOCCUPIED COOLING: 80°F (ADJ.)
UNOCCUPIED HEATING: 60°F (ADJ.)

OCCUPANCY SCHEDULES FOR TERMINAL UNITS SHALL MATCH THE DOAS SCHEDULES ON 1/M5.0.0.

ACCU-1 (ASSOCIATED TU'S) = SCHOOL CLASSROOM SCHEDULE
ACCU-2 (ASSOCATED TU'S) = SCHOOL OFFICES SCHEDULE
ACCU-3 (ASSOCIATED TU'S = DISTRICT OFFICES SCHEDULE

IN ADDITION, THE WALL MTD ZONE CONTROLLER SHALL LIMIT THE RANGE THAT THE USER IS ALLOWED TO ADJUST THE TEMPERATURE SETPOINT. THIS RANGE SHALL BE +/- 2°F (ADJ.). THIS RANGE ADJUSTMENT LIMIT SHALL BE AVAILABLE THROUGH BOTH THE REMOTE INTERFACE AND FMCS.

Owner Driven Controls Input

Building Envelope

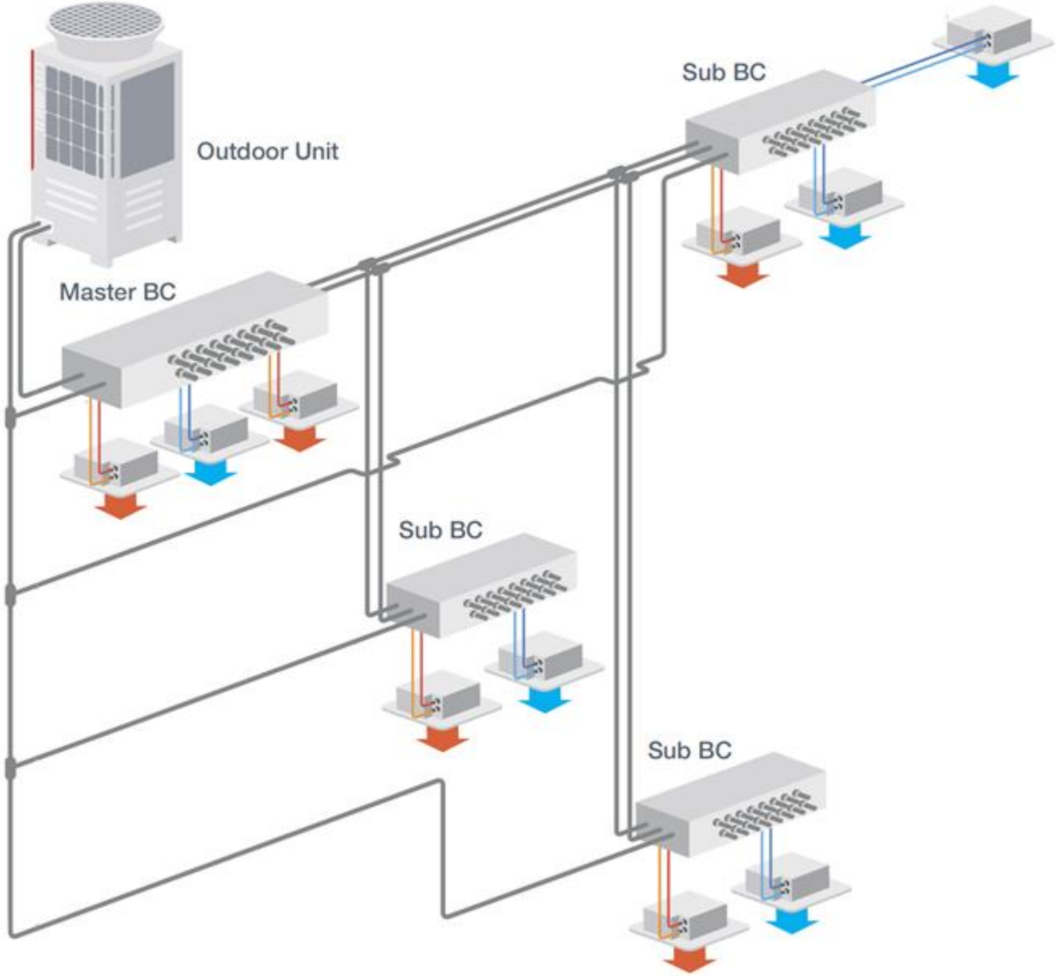
- Roof insulation performance value from R-13.2 (existing) to R-65 (average)
- Wall construction insulation performance value from R-6.0 to R-24.
- Window construction U-factor from 0.15 and SHGC of 0.41 to U-factor of 0.35.
- Building Air Tightness from 1.07 to 0.6 CFM/ft^2

System/Plant	EUI		Energy Cost	
	(kBtu/sqft/yr)	% Savings	($/yr)	% Savings
Baseline: 90.1-2013	75	-	$ 30,128	-
Single Pipe Hybrid Geothermal	20	74%	$ 21,854	27%
Single Pipe 100% Geothermal	20	74%	$ 21,682	28%
VRF Hybrid Geothermal	17	78%	$ 18,264	39%
VRF 100% Geothermal	16	78%	$ 18,026	40%
VRF Air Cooled	23	69%	$ 25,327	16%

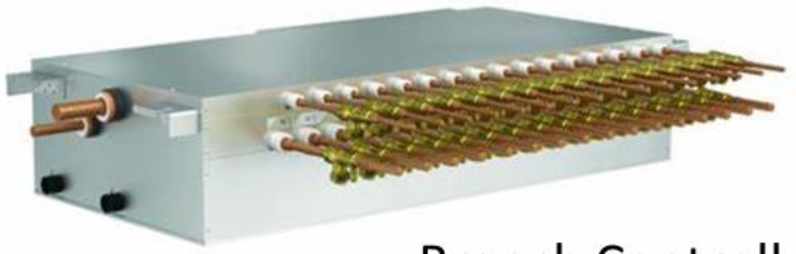
Energy Source	Utility Costs	
Electric	$0.086 per kWh	$0.025 per kBtu
Natural Gas	$0.386 per therm	$0.004 per kBtu

Envelope Assumptions	
Exterior Wall:	R-18 (U-0.055)
Roof:	U-0.032
Windows:	U-0.42 and SHGC: 0.40
Window to Wall Ratio:	35%

Early Modeling Options – Mechanical Systems



Air Source
Condensing Unit



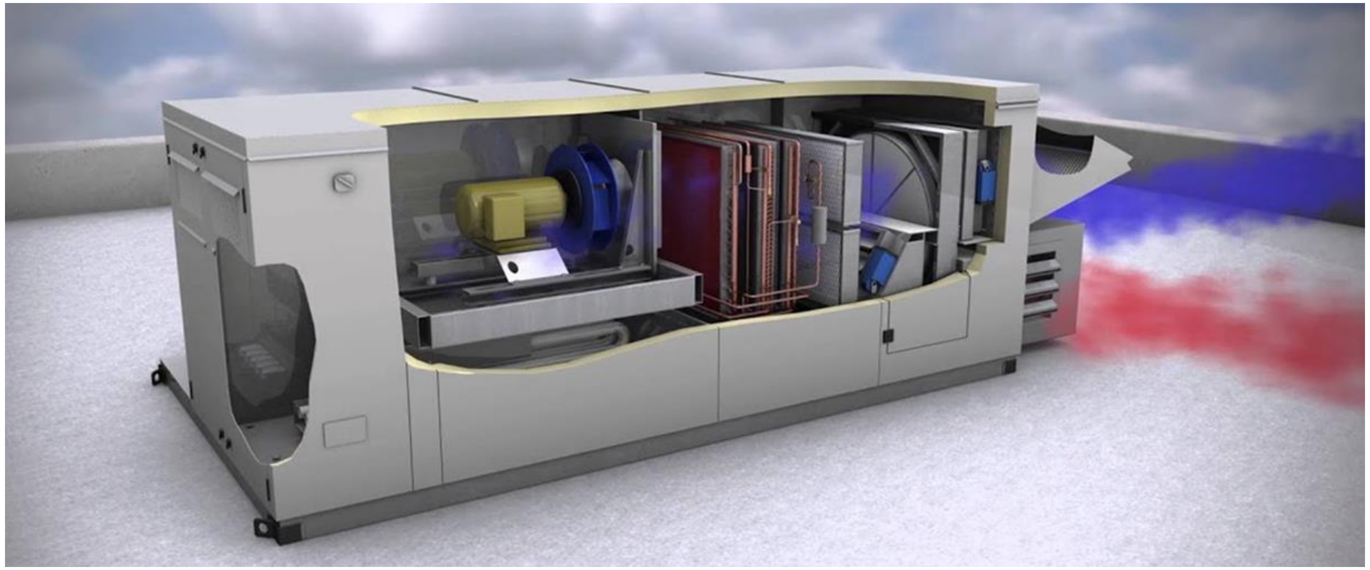
Branch Controller

DOAS Coupled with VRF System

- **Mechanical system**
  - The existing hot water boiler system coupled with unit ventilators was replaced with a new electric variable refrigerant flow (VRF) system with heat recovery. The VRF system is coupled with dedicated outside air units with energy recovery wheels for fresh air delivery. New temperature controls
  - Building Automation System load-specific electrical monitoring, including plug loads, lighting loads, HVAC loads, **and** energy generation **from** the PV panels.
- **New rooftop photovoltaic system to generate on-site renewable energy.**
- **The annual production target is currently 239.5 MWh, which includes a 22.7% buffer**

DOAS Coupled with VRF System

- **DOAS Components:**
- **ECM Motor Fan**
  - Electronically Commutated Motor
- **Energy Recovery Wheel**
  - All building exhaust is recovered
- **Digital Scroll Compressors**
- **Heat Pump Heating**
  - Coefficient of Performance of 2.3
  - **Operates in heating down to 0°F**



Dedicated Outside Air System (DOAS)

AHRI CERTIFIED®
www.ahridirectory.org

Certificate of Product Ratings

AHRI Certified Reference Number : 518128 Date : 11-20-2019 Model Status : Active

Old AHRI Reference Number :

Brand Name : Airxchange

Product Type : Wheel

Model Number : ERC-3014C

Selection Software Name :

Selection Software Version :

Rated as follows in accordance with the latest edition of ANSI/AHRI 1060 (I-P) Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment and subject to rating accuracy by AHRI-sponsored, independent, third party testing:

Nominal Air Flow (scfm) : 1400
Pressure Drop (at nominal airflow, in. H2O) : 1.00

Leakage Ratings	PressureDiff	EATR(%)	OACF	PurgeAngle
Test 1 :	0	2.4	1.04	N/A
Test 2 :	0.5	0.8	1.08	2
Test 3 :	1	0.9	1.10	1

	Sensible(%)	Latent(%)	Total(%)
100% Air Flow Heating :	76	70	74
75 % Air Flow Heating :	80	75	78
100% Air Flow Cooling :	76	70	72
75% Air Flow Cooling :	80	75	77

	Net Sensible(%)	Net Latent(%)	Net Total(%)
100% Air Flow Heating :	76	70	74
75 % Air Flow Heating :	80	75	78
100% Air Flow Cooling :	74	69	72
75% Air Flow Cooling :	80	74	77

†"Active" Model Status are those that an AHRI Certification Program Participant is currently producing AND selling or offering for sale; OR new models that are being marketed but are not yet being produced."Production Stopped" Model Status are those that an AHRI Certification Program Participant is no longer producing BUT is still selling or offering for sale.
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CERTIFICATE NO.: 132187591191029440

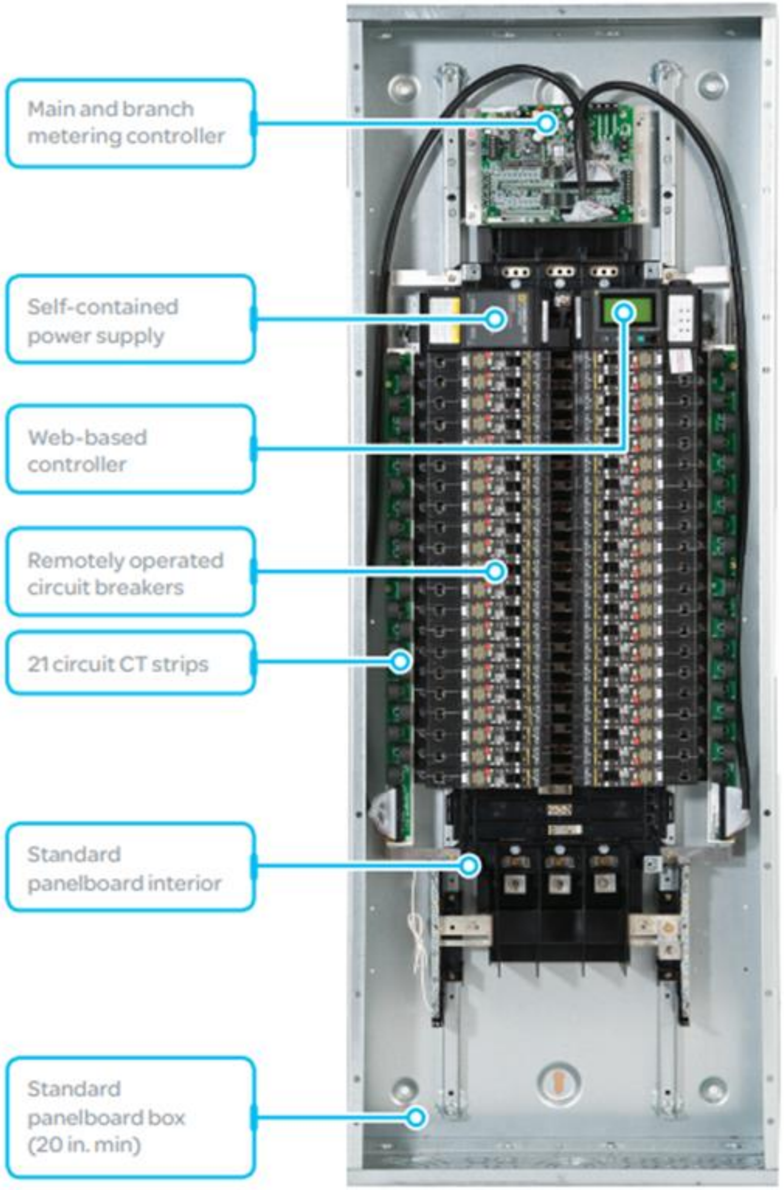
AHRI ERV performance extrapolation - straight line method

WUFI Inputs		Total Design Airflow
Sensible Recovery Efficiency	0.81	10,435
Humidity Recovery Efficiency	0.75	

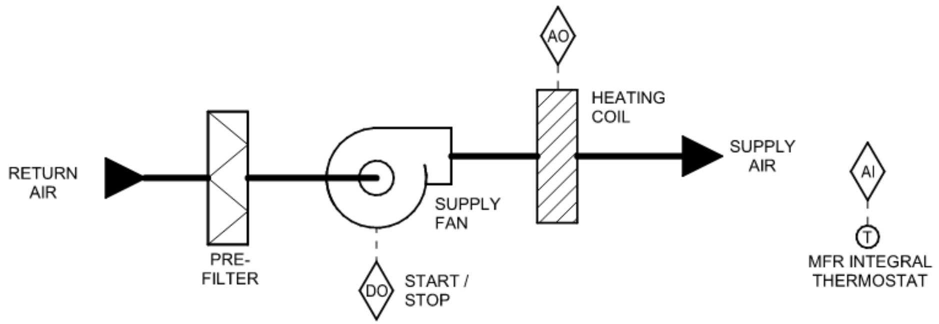
Model	Units	CFM	Net Sensible (%)		Net Latent (%)		Weighted Sensible Recovery	Weighted Humidity Recovery	Net Sensible Slope		Net Latent Slope	
			Heating	Cooling	Heating	Cooling			Heating	Cooling	Heating	Cooling
DOAS-1	100% AHRI Rated Airflow	1,400	76	74	70	69			0.0114	0.0171	0.0143	0.0143
	75% AHRI Rated Airflow	1,050	80	80	75	74						
	Design airflow	980	80.8	81.2	76.0	75.0	0.0759	0.0714				
DOAS-2	100% AHRI Rated Airflow	1,400	76	74	70	69			0.0114	0.0171	0.0143	0.0143
	75% AHRI Rated Airflow	1,050	80	80	75	74						
	Design airflow	1,570	74.1	71.1	67.6	66.6	0.1114	0.1017				
DOAS-3	100% AHRI Rated Airflow	1,400	76	74	70	69			0.0114	0.0171	0.0143	0.0143
	75% AHRI Rated Airflow	1,050	80	80	75	74						
	Design airflow	930	81.4	82.1	76.7	75.7	0.0725	0.0684				
DOAS-4	100% AHRI Rated Airflow	1,400	76	74	70	69			0.0114	0.0171	0.0143	0.0143
	75% AHRI Rated Airflow	1,050	80	80	75	74						
	Design airflow	990	80.7	81.0	75.9	74.9	0.0765	0.0720				
DOAS-5	100% AHRI Rated Airflow	1,400	76	74	70	69			0.0114	0.0171	0.0143	0.0143
	75% AHRI Rated Airflow	1,050	80	80	75	74						
	Design airflow	910	81.6	82.4	77.0	76.0	0.0712	0.0671				
DOAS-6	100% AHRI Rated Airflow	1,400	76	74	70	69			0.0114	0.0171	0.0143	0.0143
	75% AHRI Rated Airflow	1,050	80	80	75	74						
	Design airflow	700	84.0	86.0	80.0	79.0	0.0563	0.0537				
DOAS-7	100% AHRI Rated Airflow	1,400	76	74	70	69			0.0114	0.0171	0.0143	0.0143
	75% AHRI Rated Airflow	1,050	80	80	75	74						
	Design airflow	1,565	74.1	71.2	67.6	66.6	0.1112	0.1014				
DOAS-8	100% AHRI Rated Airflow	1,400	76	74	70	69			0.0114	0.0171	0.0143	0.0143
	75% AHRI Rated Airflow	1,050	80	80	75	74						
	Design airflow	950	81.1	81.7	76.4	75.4	0.0739	0.0696				
RTU-1	100% AHRI Rated Airflow	3,200	65	64	61	60			0.0200	0.0143	0.0143	0.0143
	75% AHRI Rated Airflow	2,400	72	69	66	65						
	Design airflow	1,840	92.2	83.4	80.4	79.4	0.1626	0.1418				
	100% AHRI Rated Airflow								0.0000	0.0000	0.0000	0.0000
	75% AHRI Rated Airflow	0										
	Design airflow		0.0	0.0	0.0	0.0	0.0000	0.0000				
	100% AHRI Rated Airflow								0.0000	0.0000	0.0000	0.0000
	75% AHRI Rated Airflow	0										
	Design airflow		0.0	0.0	0.0	0.0	0.0000	0.0000				
	100% AHRI Rated Airflow								0.0000	0.0000	0.0000	0.0000
	75% AHRI Rated Airflow	0										
	Design airflow		0.0	0.0	0.0	0.0	0.0000	0.0000				
	100% AHRI Rated Airflow								0.0000	0.0000	0.0000	0.0000
	75% AHRI Rated Airflow	0										
	Design airflow		0.0	0.0	0.0	0.0	0.0000	0.0000				

Ventilation w/ Heat/Energy Recovery

- All LED Lighting
- All lighting on vacancy sensor or occupancy sensor where possible
- DHW loop on thermostat-controlled "on demand" system
- Measurement and verification electrical panels for energy monitoring



Energy Efficient Lighting and DHW



SEQUENCE OF OPERATION:

THE CABINET HEATER SHALL BE FURNISHED WITH A UNIT MOUNTED FAN SPEED SELECTOR SWITCH (OFF-HIGH-MED-LOW). THE UNIT SHALL MAINTAIN A SPACE TEMPERATURE OF NO MORE THAN 70°F.

WHEN THE OUTDOOR AIR TEMPERATURE IS ABOVE 45°F, HEATING SHALL BE DISABLED.

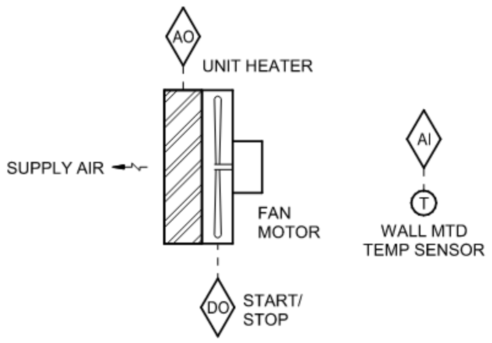
WHEN THE OUTDOOR AIR TEMPERATURE IS BELOW 45°F, HEATING SHALL BE ENABLED AND THE FAN SHALL RUN CONTINUOUSLY.

ALARMS, INTERLOCKS & SAFETIES:

- SEND AN ALARM TO THE FMCS OPERATOR INTERFACE IF SPACE TEMPERATURE FALLS 10°F (ADJ.) BELOW SETPOINT.

2 CABINET HEATER CONTROL - ELECTRIC

NO SCALE



SEQUENCE OF OPERATION:

WHEN THE OUTDOOR AIR TEMPERATURE IS ABOVE 40°F (ADJ.), TEMPERATURE SENSOR SHALL ENERGIZE FAN AND MODULATE THE ELECTRIC COIL TO MAINTAIN A SPACE TEMPERATURE OF 70°F (ADJ.). WHEN SPACE TEMPERATURE IS SATISFIED THE FAN SHALL TURN OFF.

WHEN THE OUTDOOR AIR TEMPERATURE IS BELOW 40°F (ADJ.), TEMPERATURE SENSOR SHALL MODULATE THE ELECTRIC COIL TO MAINTAIN A SPACE TEMPERATURE OF 70°F (ADJ.) AND THE UNIT FAN SHALL RUN CONTINUOUSLY.

ALARMS, INTERLOCKS & SAFETIES:

SEND AN ALARM TO THE FMCS OPERATOR INTERFACE IF SPACE TEMPERATURE FALLS 10°F (ADJ.) BELOW SETPOINT.

3 UNIT HEATER CONTROL - ELECTRIC

NO SCALE

Energy Efficient Controls Sequence


PRAIRIE TRAILS
SCHOOL

ENERGY MODELING

Early Energy Modeling

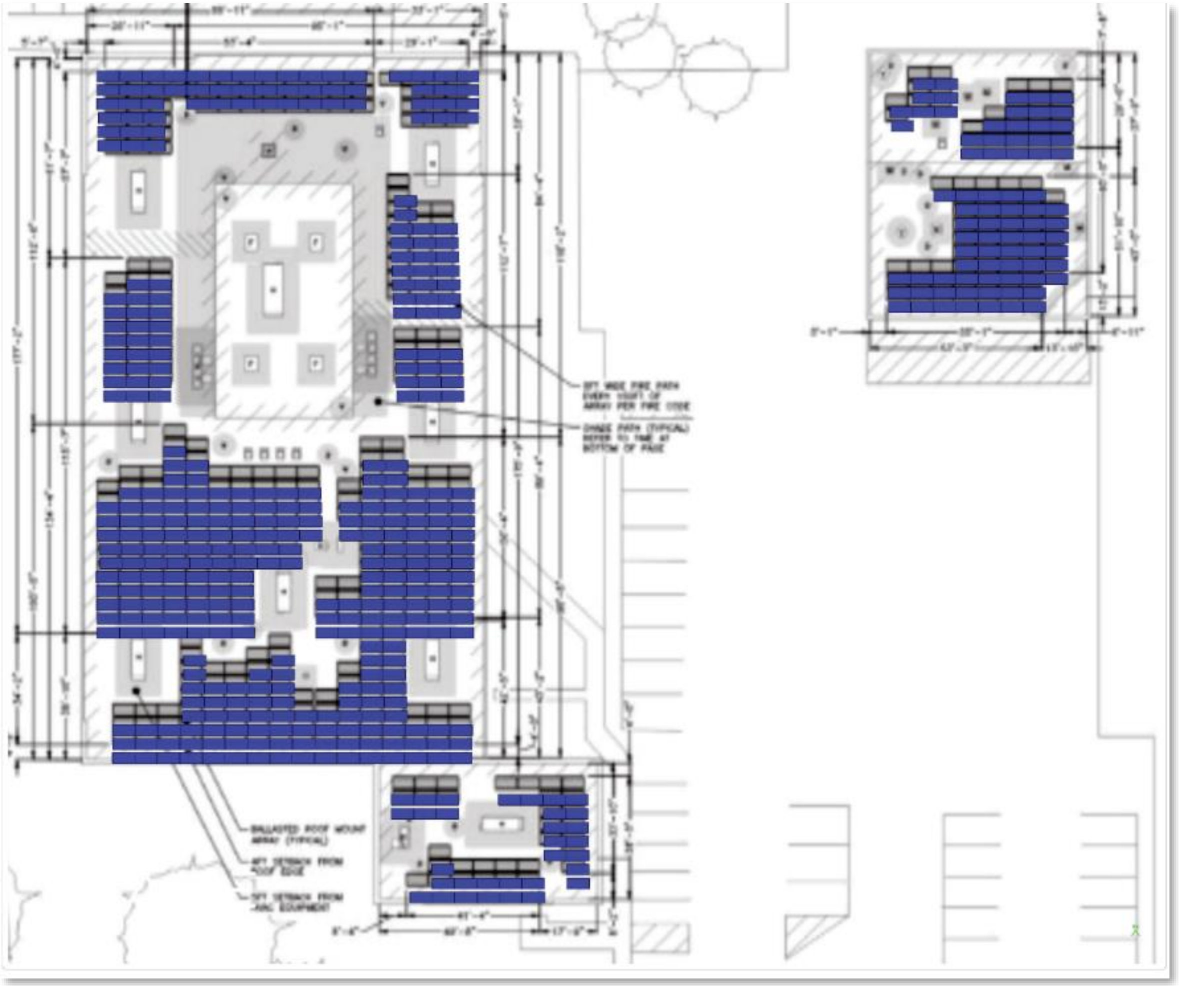
- **Energy modeling started in concept/schematic phase**
- **Choices:**
  - Geothermal (hybrid and 100%)
  - Geothermal with Water Cooled VRF (hybrid and 100%)
  - Air Cooled VRF
- **Compared systems against ASHRAE 90.1-2013**

RESULTS

224,209 kWh/Year*

System output may range from 214,636 to 233,604 kWh per year near this location.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)
January	2.67	11,977
February	3.56	14,298
March	4.65	20,011
April	5.46	21,774
May	6.01	23,983
June	6.60	24,749
July	6.67	25,041
August	6.08	23,261
September	5.38	20,496
October	3.92	15,901
November	2.87	11,915
December	2.40	10,802
Annual	**4.69**	**224,208**



DD Modeling/PV Sizing

Offices - Weekdays

January to June and September to December			July and August		
Start	End	% Occupied	Start	End	% Occupied
Midnight	6 a.m.	0	Midnight	6 a.m.	0
6 a.m.	7 a.m.	25	6 a.m.	7 a.m.	25
7 a.m.	8 a.m.	75	7 a.m.	8 a.m.	75
8 a.m.	9 a.m.	100	8 a.m.	9 a.m.	75
9 a.m.	10 a.m.	100	9 a.m.	10 a.m.	100
10 a.m.	11 a.m.	100	10 a.m.	11 a.m.	100
11 a.m.	Noon	75	11 a.m.	Noon	75
Noon	1 p.m.	90	Noon	1 p.m.	90
1 p.m.	2 p.m.	90	1 p.m.	2 p.m.	90
2 p.m.	3 p.m.	90	2 p.m.	3 p.m.	90
3 p.m.	4 p.m.	90	3 p.m.	4 p.m.	90
4 p.m.	5 p.m.	75	4 p.m.	5 p.m.	75
5 p.m.	6 p.m.	10	5 p.m.	6 p.m.	10
6 p.m.	7 p.m.	0	6 p.m.	7 p.m.	0
7 p.m.	8 p.m.	0	7 p.m.	8 p.m.	0
8 p.m.	9 p.m.	0	8 p.m.	9 p.m.	0
9 p.m.	10 p.m.	0	9 p.m.	10 p.m.	0
10 p.m.	11 p.m.	0	10 p.m.	11 p.m.	0
11 p.m.	Midnight	0	11 p.m.	Midnight	0

Classrooms - Weekdays

January to June and September to December			July and August		
Start	End	% Occupied	Start	End	% Occupied
Midnight	6 a.m.	0	Midnight	6 a.m.	0
6 a.m.	7 a.m.	0	6 a.m.	7 a.m.	0
7 a.m.	8 a.m.	75	7 a.m.	8 a.m.	0
8 a.m.	9 a.m.	90	8 a.m.	9 a.m.	15
9 a.m.	10 a.m.	100	9 a.m.	10 a.m.	25
10 a.m.	11 a.m.	100	10 a.m.	11 a.m.	25
11 a.m.	Noon	100	11 a.m.	Noon	25
Noon	1 p.m.	90	Noon	1 p.m.	25
1 p.m.	2 p.m.	90	1 p.m.	2 p.m.	25
2 p.m.	3 p.m.	90	2 p.m.	3 p.m.	25
3 p.m.	4 p.m.	90	3 p.m.	4 p.m.	25
4 p.m.	5 p.m.	75	4 p.m.	5 p.m.	0
5 p.m.	6 p.m.	0	5 p.m.	6 p.m.	0
6 p.m.	7 p.m.	0	6 p.m.	7 p.m.	0
7 p.m.	8 p.m.	0	7 p.m.	8 p.m.	0
8 p.m.	9 p.m.	0	8 p.m.	9 p.m.	0
9 p.m.	10 p.m.	0	9 p.m.	10 p.m.	0
10 p.m.	11 p.m.	0	10 p.m.	11 p.m.	0
11 p.m.	Midnight	0	11 p.m.	Midnight	0

WUFI®
25 years

Occupancy Summary for WUFI	Occupant Type	Occupancy	Start Time	End Time	Hours	Days/Year
School Year						
Educational						
Classrooms	Children (age 0-10)	250	7:00 AM	5:00 PM	10.00	185
Classrooms	Adult Standing or Light Work	22	7:00 AM	5:00 PM	10.00	185
Offices	Adult Standing or Light Work	26	6:00 AM	5:00 PM	11.00	185
					0.00	
Extracuricular School Use						
Multipurpose Room	Adult Standing or Light Work	223	6:00 PM	10:00 PM	4.00	9
					0.00	
Public Use						
Multipurpose (Adult) - AM Child Care	Adult Standing or Light Work	3	6:00 AM	7:00 AM	1.00	185
Multipurpose (Adult) - PM Child Care	Adult Standing or Light Work	3	5:00 PM	6:30 PM	1.00	185
Multipurpose (Children) - AM Child Care	Children (age 0-10)	15	6:00 AM	7:00 AM	1.00	185
Multipurpose (Children) - PM Child Care	Children (age 0-10)	15	5:00 PM	6:30 PM	1.00	185
Classroom (Public Use)	Adults	20	7:00 PM	9:00 PM	2.00	3
					0.00	
Off Season						
Educational						
Classrooms	Children (age 0-10)	50	8:00 AM	12:00 PM	4.00	58
Offices	Adult Standing or Light Work	20	6:00 AM	5:00 PM	11.00	58
					0.00	
Extracuricular					0.00	
Classrooms	Children (age 0-10)	0			0.00	
					0.00	
Public						
Multipurpose (Children) - Camp	Children (age 0-10)	25	8:00 AM	4:00 PM	8.00	58
Multipurpose (Adult) - Camp	Adult Standing or Light Work	2	8:00 AM	4:00 PM	8.00	58
Multipurpose (Children) - PM	Children (age 0-10)	30	7:00 PM	9:00 PM	2.00	24

Collaborative Modeling

Model Results

Net Zero Targets:

- Total Energy Usage of 25 EUI
- Solar Generated of 29 EUI

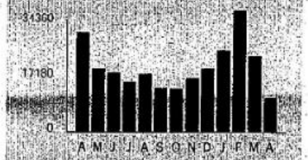
POST OCCUPANCY MONITORING

Comparing Modeled and Actual Data

ComEd
An Exelon Company

Visit ComEd.com
Customer Service / Power Outage
English
1.877.4COMED1 (1.877.426.6331)
Español
1.800.95.LUCES (1.800.955.8237)
Hearing/Speech Impaired
1-800.572.5789 (TTY)

Your Usage Profile
13-Month Usage (Total kWh)



Electric Usage

Month	kWh
Apr-21	28067
May-21	18374
Jun-21	16953
Jul-21	14401
Aug-21	16708
Sep-21	12754
Oct-21	12545
Nov-21	15406
Dec-21	18092
Jan-22	23284
Feb-22	34358
Mar-22	21816
Apr-22	10005

Month Billed	Average Daily kWh	Temp
Last Year	905.4	48
Last Month	703.7	31
Current Month	345.0	43

Page 1 of 2
Account Number
Name
Service Location

Phone Number

Bill Summary	
Previous Balance	$3,138.42
Total Payments - Thank You	$3,138.42
Amount Due on April 27, 2022	**$1,155.18**

Issue Date April 12, 2022

Meter Information

Read Dates	Meter Number	Load Type	Reading Type	Previous	Meter Reading Present	Difference	Multiplier X	Usage
3/14-4/12	230282563	I/O w/ Flow Thru	kWh From Grid	Actual	Actual			10005
3/14-4/12	230282563	I/O w/ Flow Thru	kWh To Grid	Actual	Actual			8566
3/14-4/12	230282563	I/O w/ Flow Thru	On Pk kW	Actual	Actual			73.44

Service from 3/14/2022 to 4/12/2022 - 29 Days **Commercial Demand - 100 to 400 kW**

Electricity Supply Services				**$230.88**
Electricity Supply Charge	10,005 kWh	X	0.06522	652.53
Transmission Services Charge	10,005 kWh	X	0.01353	135.37
Purchased Electricity Adjustment				11.51
Net Metering Credit - Supply	8,566 kWh	X	-0.06637	-568.53
Delivery Services - ComEd				**$673.27**
Customer Charge				26.75
Standard Metering Charge				9.77
Distribution Facilities Charge	73.44 kW	X	8.50000	624.24
IL Electricity Distribution Charge	10,005 kWh	X	0.00125	12.51
Taxes and Other				**$203.95**
Environmental Cost Recovery Adj	10,005 kWh	X	0.00046	4.60
Renewable Portfolio Standard	10,005 kWh	X	0.00502	50.23
Zero Emission Standard	10,005 kWh	X	0.00195	19.51
Energy Efficiency Programs	10,005 kWh	X	0.00363	36.32

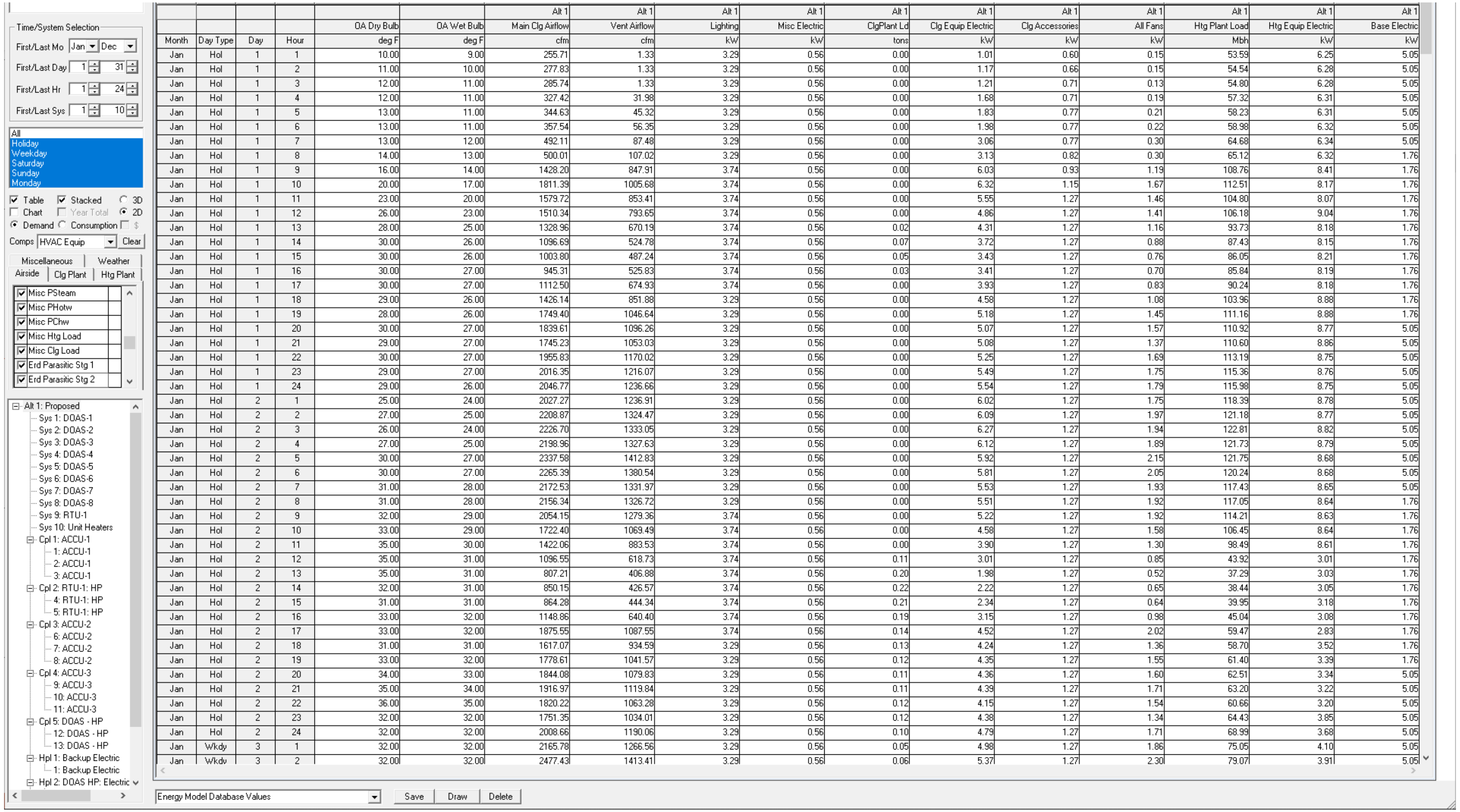
For Electric Supply Choices visit pluginillinois.org

(continued on next page)

- **Monthly bills don’t tell the whole story**

Energy model provides modeled data

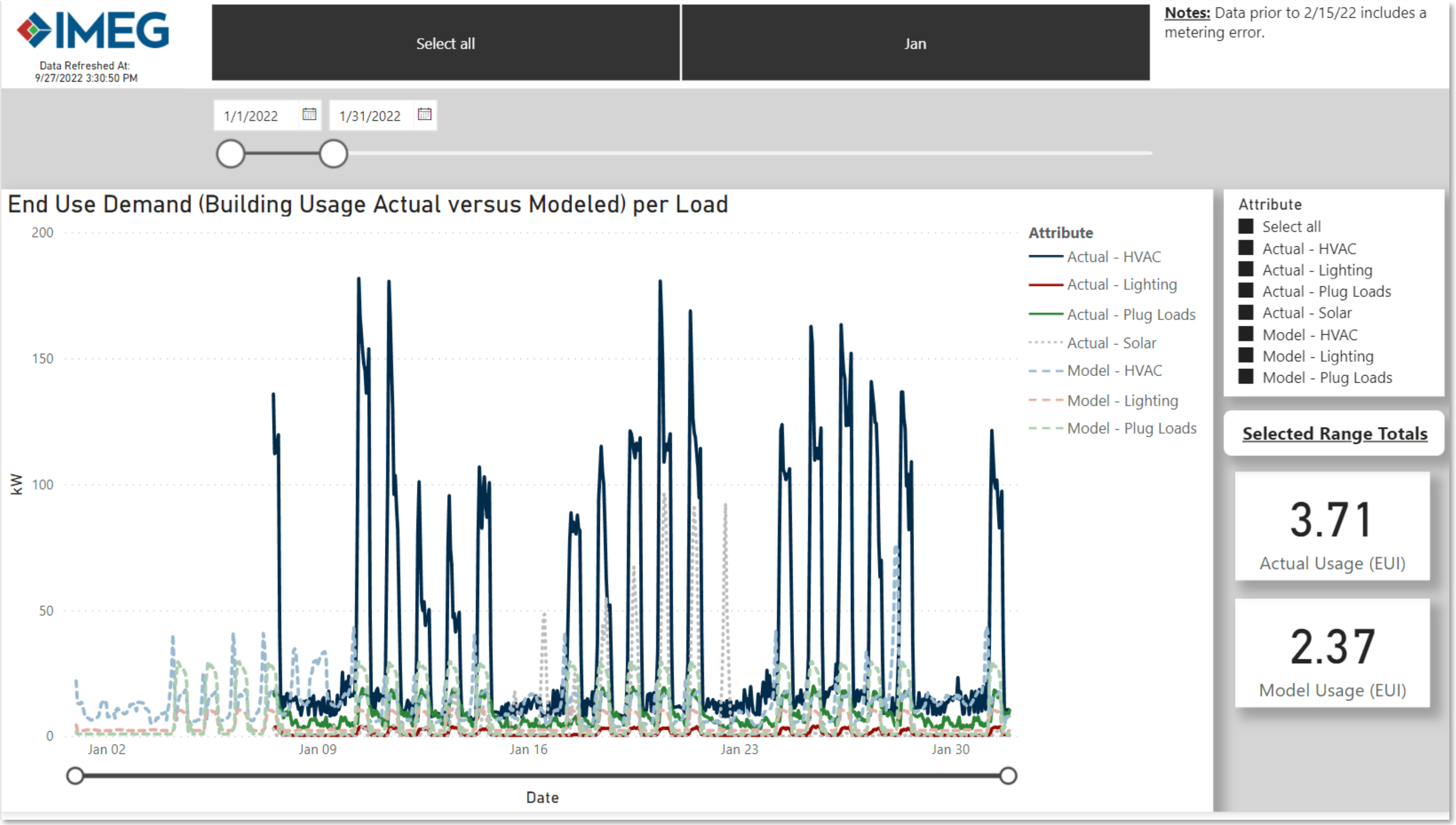
BAS provides actual values



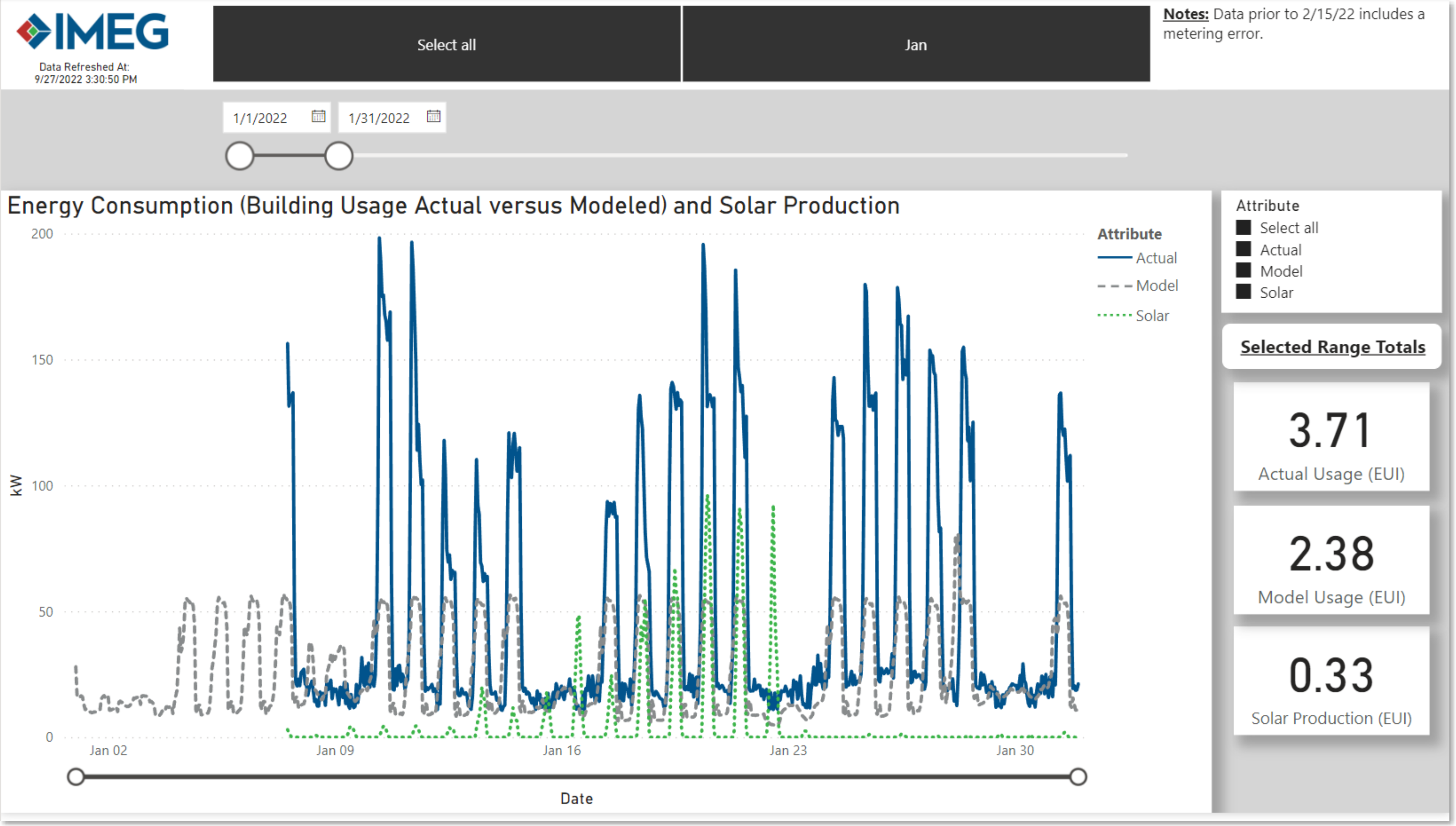
						Alt 1	Alt 1	Alt 1	Alt 1	Alt 1	Alt 1	Alt 1	Alt 1	Alt 1	Alt 1	Alt 1
				OA Dry Bulb	OA Wet Bulb	Main Clg Airflow	Vent Airflow	Lighting	Misc Electric	ClgPlant Ld	Clg Equip Electric	Clg Accessories	All Fans	Htg Plant Load	Htg Equip Electric	Base Electric
Month	Day Type	Day	Hour	deg F	deg F	cfm	cfm	kW	kW	tons	kW	kW	kW	Mbh	kW	kW
Jan	Hol	1	1	10.00	9.00	255.71	1.33	3.29	0.56	0.00	1.01	0.60	0.15	53.59	6.25	5.05
Jan	Hol	1	2	11.00	10.00	277.83	1.33	3.29	0.56	0.00	1.17	0.66	0.15	54.54	6.28	5.05
Jan	Hol	1	3	12.00	11.00	285.74	1.33	3.29	0.56	0.00	1.21	0.71	0.13	54.80	6.28	5.05
Jan	Hol	1	4	12.00	11.00	327.42	31.98	3.29	0.56	0.00	1.68	0.71	0.19	57.32	6.31	5.05
Jan	Hol	1	5	13.00	11.00	344.63	45.32	3.29	0.56	0.00	1.83	0.77	0.21	58.23	6.31	5.05
Jan	Hol	1	6	13.00	11.00	357.54	56.35	3.29	0.56	0.00	1.98	0.77	0.22	58.98	6.32	5.05
Jan	Hol	1	7	13.00	12.00	492.11	87.48	3.29	0.56	0.00	3.06	0.77	0.30	64.68	6.34	5.05
Jan	Hol	1	8	14.00	13.00	500.01	107.02	3.29	0.56	0.00	3.13	0.82	0.30	65.12	6.32	1.76
Jan	Hol	1	9	16.00	14.00	1428.20	847.91	3.74	0.56	0.00	6.03	0.93	1.19	108.76	8.41	1.76
Jan	Hol	1	10	20.00	17.00	1811.39	1005.68	3.74	0.56	0.00	6.32	1.15	1.67	112.51	8.17	1.76
Jan	Hol	1	11	23.00	20.00	1579.72	853.41	3.74	0.56	0.00	5.55	1.27	1.46	104.80	8.07	1.76
Jan	Hol	1	12	26.00	23.00	1510.34	793.65	3.74	0.56	0.00	4.86	1.27	1.41	106.18	9.04	1.76
Jan	Hol	1	13	28.00	25.00	1328.96	670.19	3.74	0.56	0.02	4.31	1.27	1.16	93.73	8.18	1.76
Jan	Hol	1	14	30.00	26.00	1096.69	524.78	3.74	0.56	0.07	3.72	1.27	0.88	87.43	8.15	1.76
Jan	Hol	1	15	30.00	26.00	1003.80	487.24	3.74	0.56	0.05	3.43	1.27	0.76	86.05	8.21	1.76
Jan	Hol	1	16	30.00	27.00	945.31	525.83	3.74	0.56	0.03	3.41	1.27	0.70	85.84	8.19	1.76
Jan	Hol	1	17	30.00	27.00	1112.50	674.93	3.74	0.56	0.00	3.93	1.27	0.83	90.24	8.18	1.76
Jan	Hol	1	18	29.00	26.00	1426.14	851.88	3.29	0.56	0.00	4.58	1.27	1.08	103.96	8.88	1.76
Jan	Hol	1	19	28.00	26.00	1749.40	1046.64	3.29	0.56	0.00	5.18	1.27	1.45	111.16	8.88	1.76
Jan	Hol	1	20	30.00	27.00	1839.61	1096.26	3.29	0.56	0.00	5.07	1.27	1.57	110.92	8.77	5.05
Jan	Hol	1	21	29.00	27.00	1745.23	1053.03	3.29	0.56	0.00	5.08	1.27	1.37	110.60	8.86	5.05
Jan	Hol	1	22	30.00	27.00	1955.83	1170.02	3.29	0.56	0.00	5.25	1.27	1.69	113.19	8.75	5.05
Jan	Hol	1	23	29.00	27.00	2016.35	1216.07	3.29	0.56	0.00	5.49	1.27	1.75	115.36	8.76	5.05
Jan	Hol	1	24	29.00	26.00	2046.77	1236.66	3.29	0.56	0.00	5.54	1.27	1.79	115.98	8.75	5.05
Jan	Hol	2	1	25.00	24.00	2027.27	1236.91	3.29	0.56	0.00	6.02	1.27	1.75	118.39	8.78	5.05
Jan	Hol	2	2	27.00	25.00	2208.87	1324.47	3.29	0.56	0.00	6.09	1.27	1.97	121.18	8.77	5.05
Jan	Hol	2	3	26.00	24.00	2226.70	1333.05	3.29	0.56	0.00	6.27	1.27	1.94	122.81	8.82	5.05
Jan	Hol	2	4	27.00	25.00	2198.96	1327.63	3.29	0.56	0.00	6.12	1.27	1.89	121.73	8.79	5.05
Jan	Hol	2	5	30.00	27.00	2337.58	1412.83	3.29	0.56	0.00	5.92	1.27	2.15	121.75	8.68	5.05
Jan	Hol	2	6	30.00	27.00	2265.39	1380.54	3.29	0.56	0.00	5.81	1.27	2.05	120.24	8.68	5.05
Jan	Hol	2	7	31.00	28.00	2172.53	1331.97	3.29	0.56	0.00	5.53	1.27	1.93	117.43	8.65	5.05
Jan	Hol	2	8	31.00	28.00	2156.34	1326.72	3.29	0.56	0.00	5.51	1.27	1.92	117.05	8.64	1.76
Jan	Hol	2	9	32.00	29.00	2054.15	1279.36	3.74	0.56	0.00	5.22	1.27	1.92	114.21	8.63	1.76
Jan	Hol	2	10	33.00	29.00	1722.40	1069.49	3.74	0.56	0.00	4.58	1.27	1.58	106.45	8.64	1.76
Jan	Hol	2	11	35.00	30.00	1422.06	883.53	3.74	0.56	0.00	3.90	1.27	1.30	98.49	8.61	1.76
Jan	Hol	2	12	35.00	31.00	1096.55	618.73	3.74	0.56	0.11	3.01	1.27	0.85	43.92	3.01	1.76
Jan	Hol	2	13	35.00	31.00	807.21	406.88	3.74	0.56	0.20	1.98	1.27	0.52	37.29	3.03	1.76
Jan	Hol	2	14	32.00	31.00	850.15	426.57	3.74	0.56	0.22	2.22	1.27	0.65	38.44	3.05	1.76
Jan	Hol	2	15	31.00	31.00	864.28	444.34	3.74	0.56	0.21	2.34	1.27	0.64	39.95	3.18	1.76
Jan	Hol	2	16	33.00	32.00	1148.86	640.40	3.74	0.56	0.19	3.15	1.27	0.98	45.04	3.08	1.76
Jan	Hol	2	17	33.00	32.00	1875.55	1087.55	3.74	0.56	0.14	4.52	1.27	2.02	59.47	2.83	1.76
Jan	Hol	2	18	31.00	31.00	1617.07	934.59	3.29	0.56	0.13	4.24	1.27	1.36	58.70	3.52	1.76
Jan	Hol	2	19	33.00	32.00	1778.61	1041.57	3.29	0.56	0.12	4.35	1.27	1.55	61.40	3.39	1.76
Jan	Hol	2	20	34.00	33.00	1844.08	1079.83	3.29	0.56	0.11	4.36	1.27	1.60	62.51	3.34	5.05
Jan	Hol	2	21	35.00	34.00	1916.97	1119.84	3.29	0.56	0.11	4.39	1.27	1.71	63.20	3.22	5.05
Jan	Hol	2	22	36.00	35.00	1820.22	1063.28	3.29	0.56	0.12	4.15	1.27	1.54	60.66	3.20	5.05
Jan	Hol	2	23	32.00	32.00	1751.35	1034.01	3.29	0.56	0.12	4.38	1.27	1.34	64.43	3.85	5.05
Jan	Hol	2	24	32.00	32.00	2008.66	1190.06	3.29	0.56	0.10	4.79	1.27	1.71	68.99	3.68	5.05
Jan	Wkdy	3	1	32.00	32.00	2165.78	1266.56	3.29	0.56	0.05	4.98	1.27	1.86	75.05	4.10	5.05
Jan	Wkdy	3	2	32.00	32.00	2477.43	1413.41	3.29	0.56	0.06	5.37	1.27	2.30	79.07	3.91	5.05

TRANE®

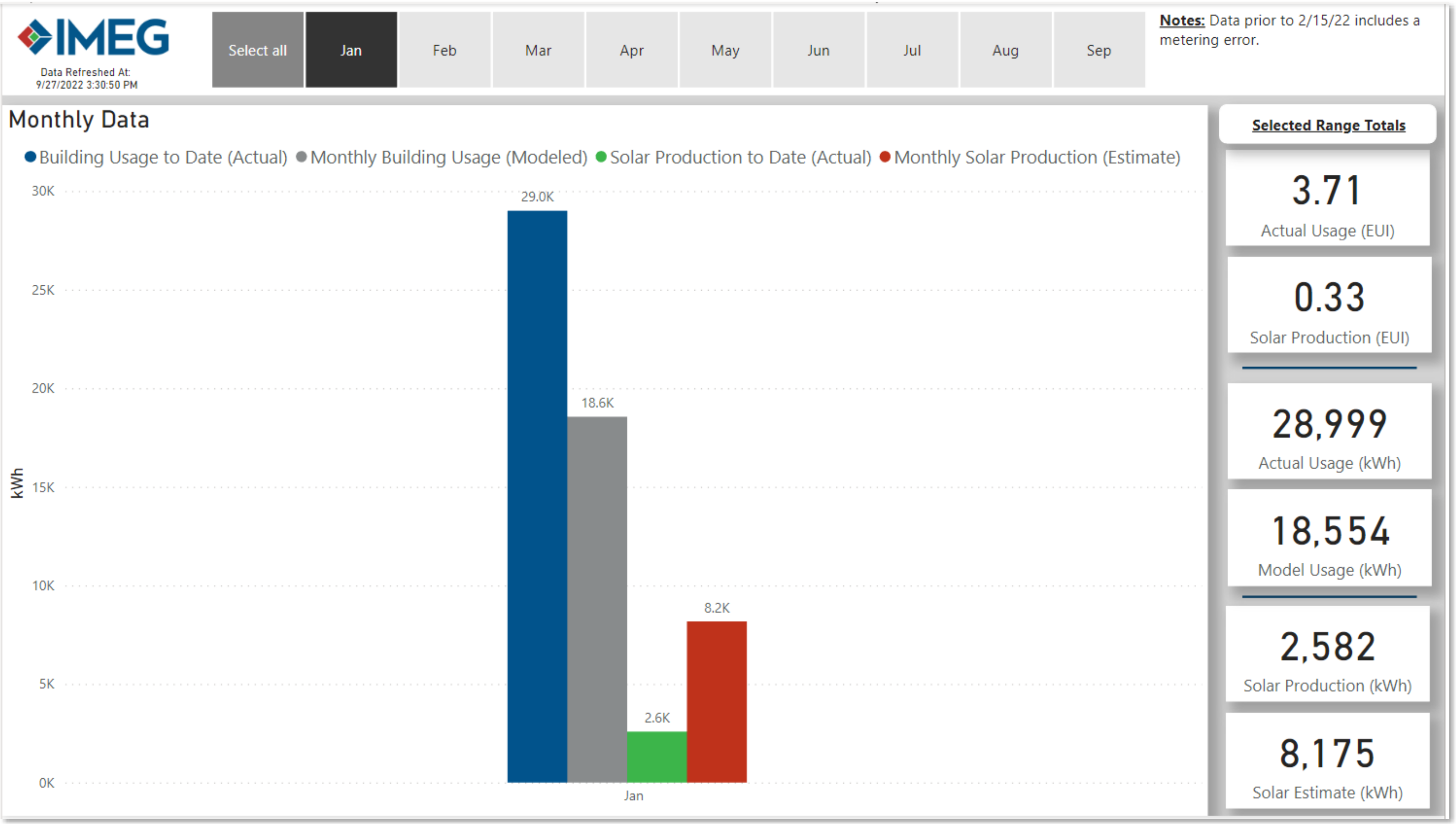
Comparing Modeled and Actual Data



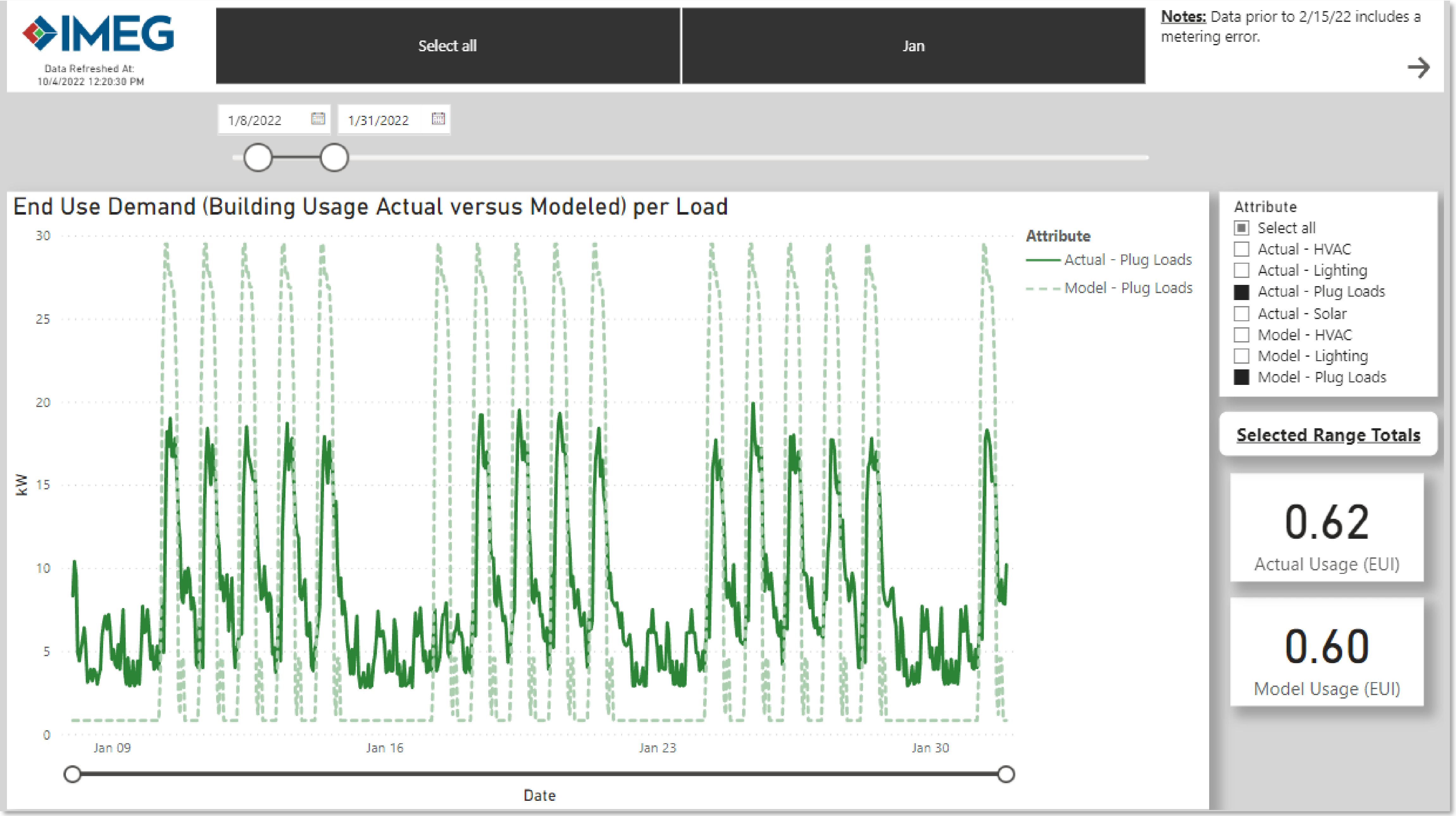
End Use Comparison



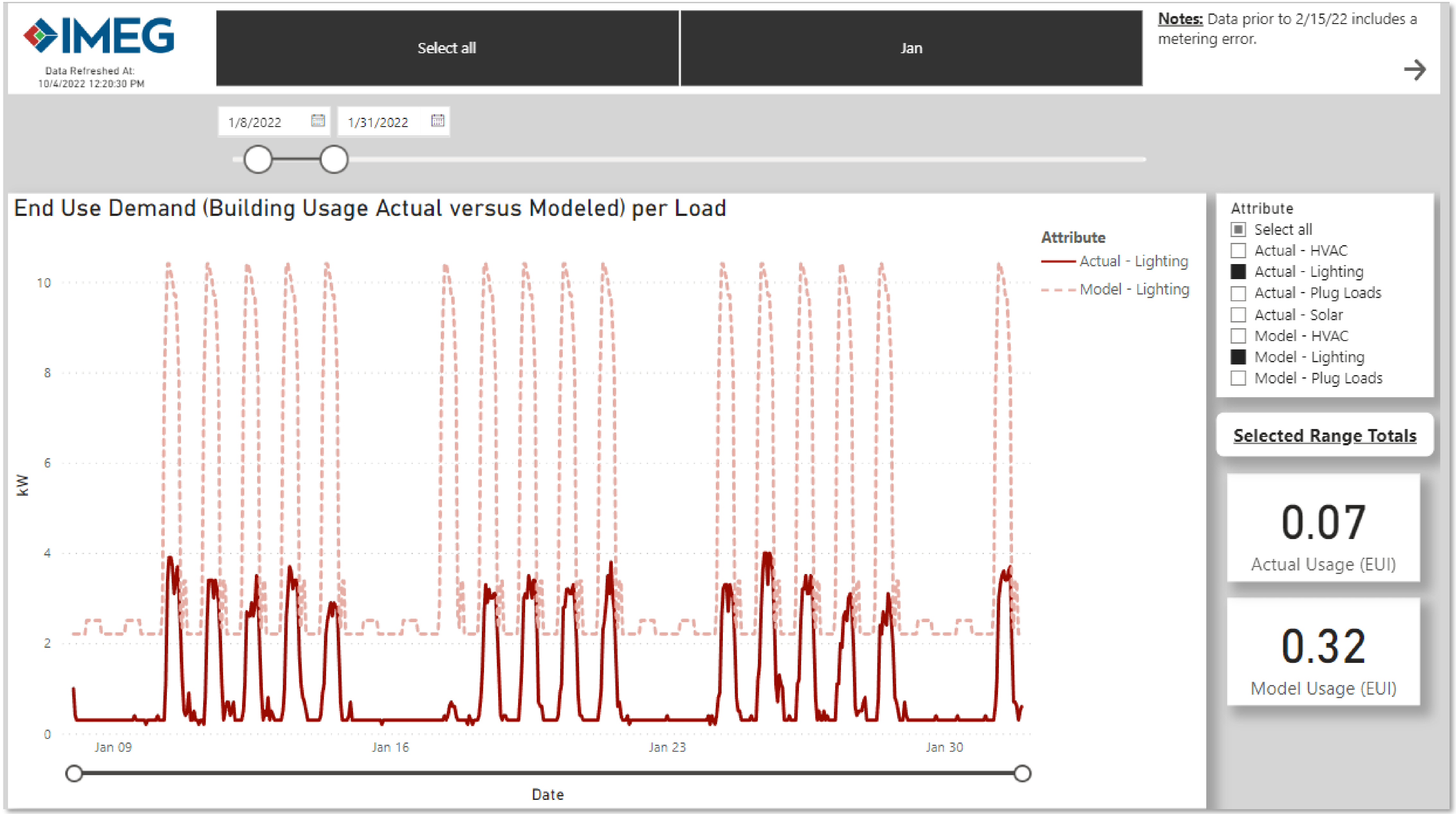
Total Usage and Solar Production



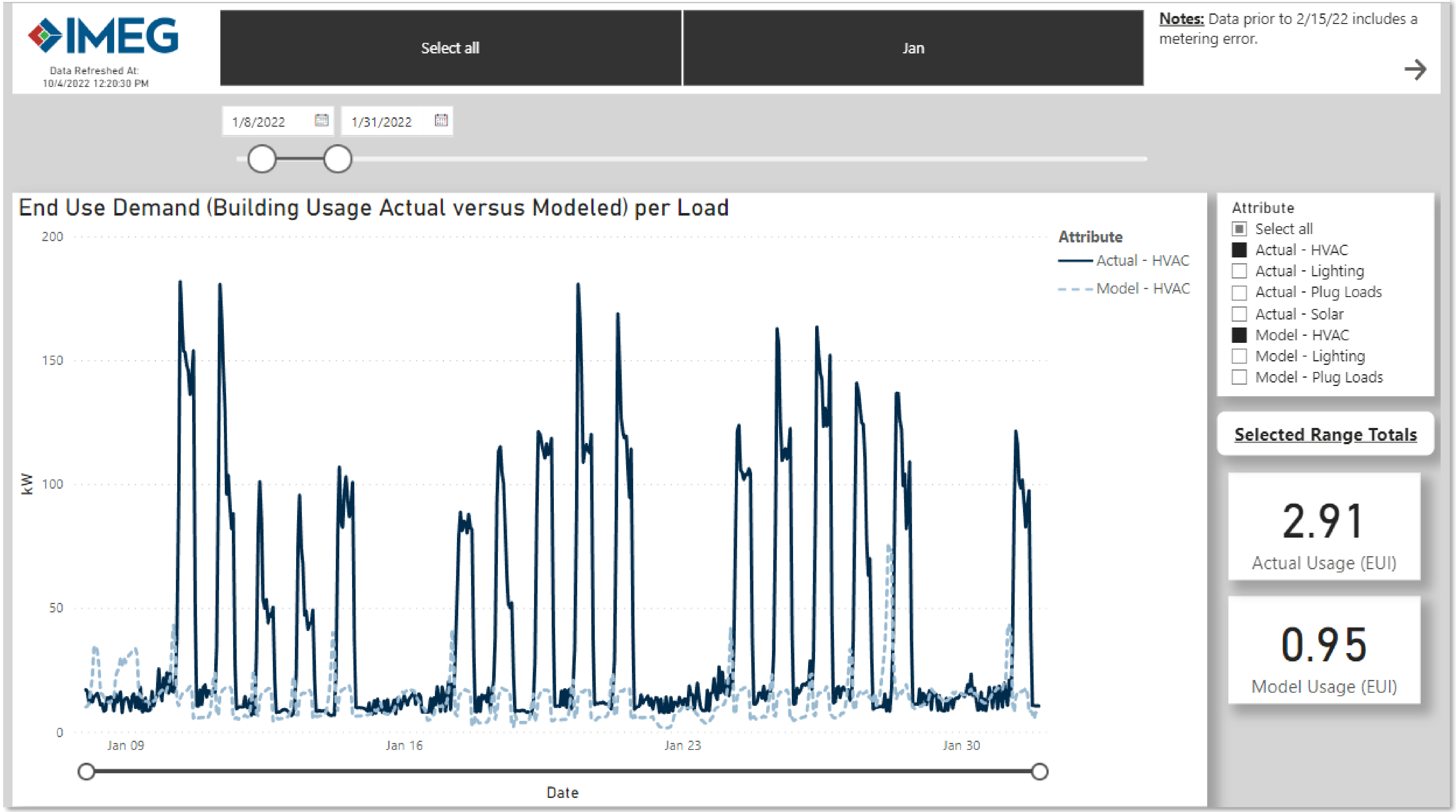
Month-to-Month Comparison



Receptacles


IMEG
Data Refreshed At:
10/4/2022 12:20:30 PM
Select all
Jan
Notes: Data prior to 2/15/22 includes a metering error.
1/8/2022
1/31/2022
End Use Demand (Building Usage Actual versus Modeled) per Load
Attribute
Actual - Lighting
Model - Lighting
kW
10
8
6
4
2
0
Jan 09
Jan 16
Jan 23
Jan 30
Date
Attribute
Select all
Actual - HVAC
Actual - Lighting
Actual - Plug Loads
Actual - Solar
Model - HVAC
Model - Lighting
Model - Plug Loads
Selected Range Totals
0.07
Actual Usage (EUI)
0.32
Model Usage (EUI)

Lighting


IMEG
Data Refreshed At:
10/4/2022 12:20:30 PM
Select all
Jan
Notes: Data prior to 2/15/22 includes a metering error.
1/8/2022
1/31/2022
End Use Demand (Building Usage Actual versus Modeled) per Load
200
150
100
50
0
kW
Jan 09
Jan 16
Jan 23
Jan 30
Date
Attribute
Actual - HVAC
Model - HVAC
Attribute
Select all
Actual - HVAC
Actual - Lighting
Actual - Plug Loads
Actual - Solar
Model - HVAC
Model - Lighting
Model - Plug Loads
Selected Range Totals
2.91
Actual Usage (EUI)
0.95
Model Usage (EUI)

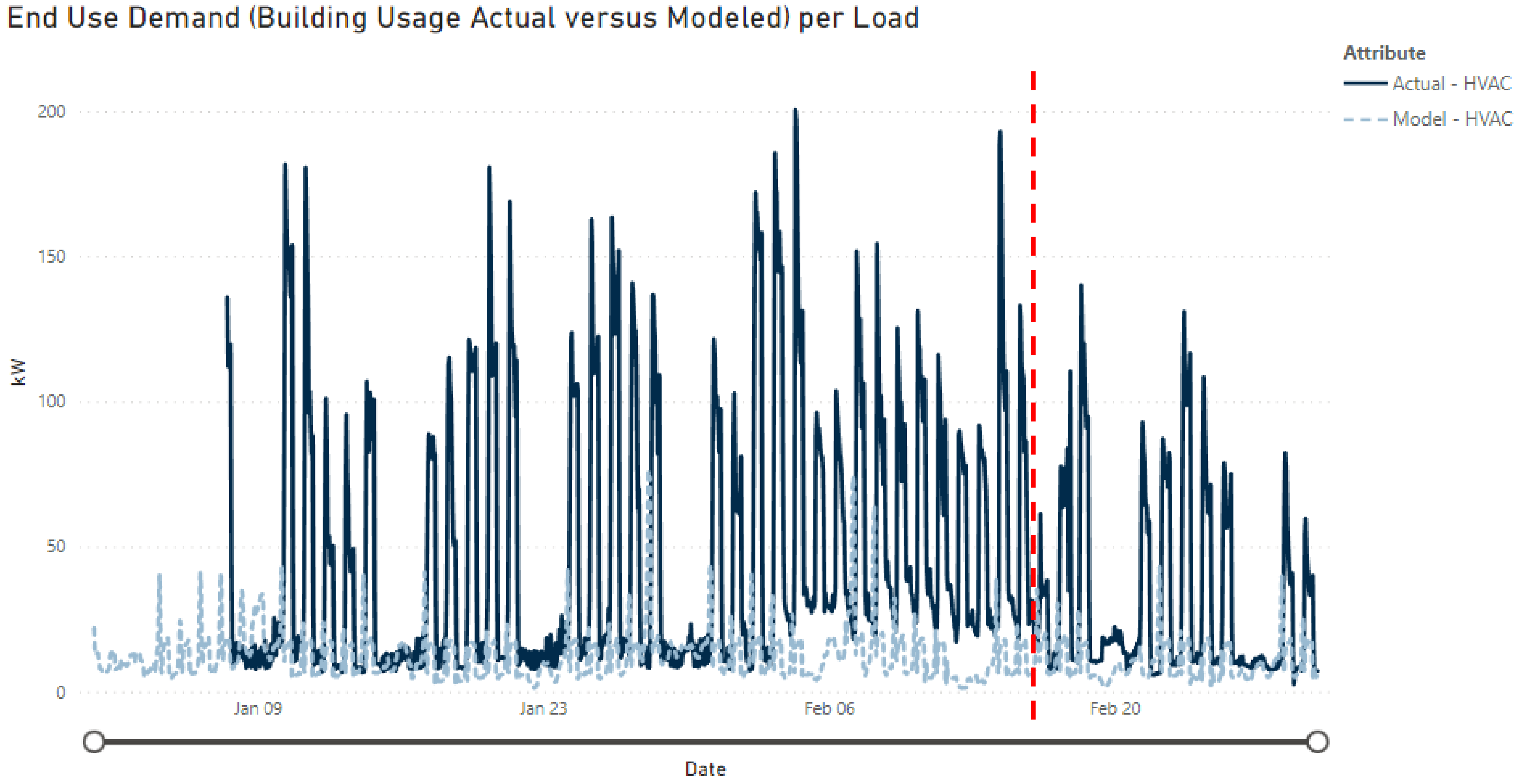
HVAC

Data Refreshed At:
10/3/2022 12:19:37 PM

Select all | Jan | Feb | Mar

Notes: Data prior to 2/15/22 includes a metering error.

1/1/2022 3/1/2022



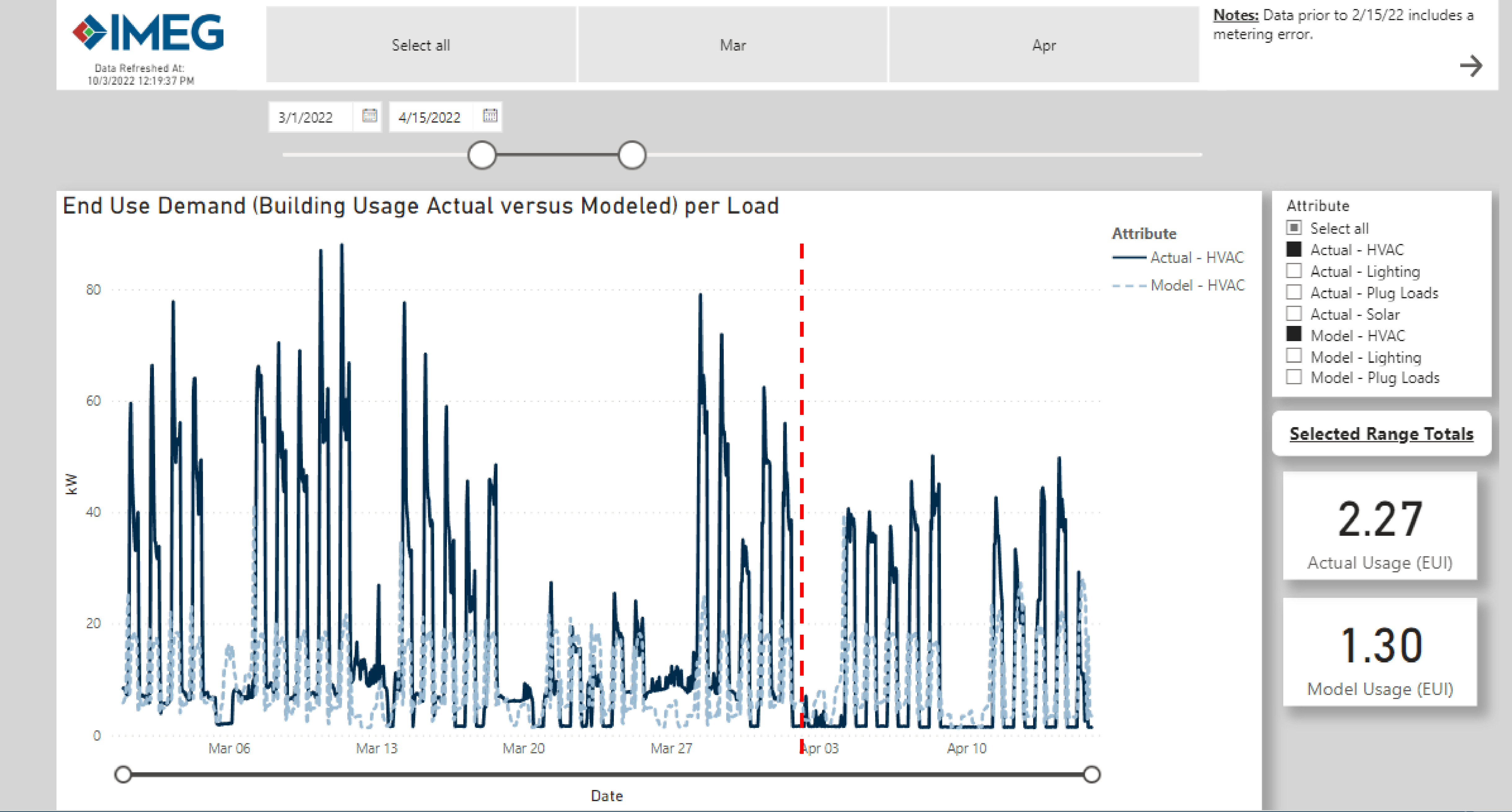
Attribute
- Select all
- Actual - HVAC
- Actual - Lighting
- Actual - Plug Loads
- Actual - Solar
- Model - HVAC
- Model - Lighting
- Model - Plug Loads

Selected Range Totals

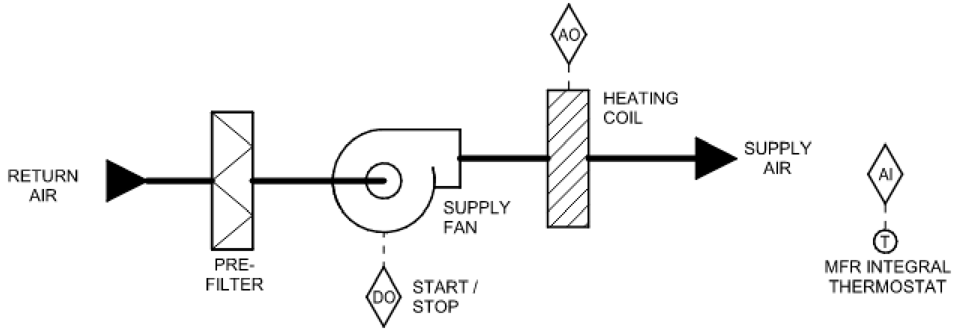
7.02
Actual Usage (EUI)

2.23
Model Usage (EUI)

January Through March



March to April



<u>SEQUENCE OF OPERATION</u>:

THE CABINET HEATER SHALL BE FURNISHED WITH A UNIT MOUNTED FAN SPEED SELECTOR SWITCH (OFF-HIGH-MED-LOW). THE UNIT SHALL MAINTAIN A SPACE TEMPERATURE OF NO MORE THAN 70°F.

WHEN THE OUTDOOR AIR TEMPERATURE IS ABOVE ~~45°F~~, HEATING SHALL BE DISABLED.

WHEN THE OUTDOOR AIR TEMPERATURE IS BELOW ~~45°F~~, HEATING SHALL BE ENABLED AND THE FAN SHALL RUN CONTINUOUSLY.

<u>ALARMS, INTERLOCKS & SAFETIES</u>:

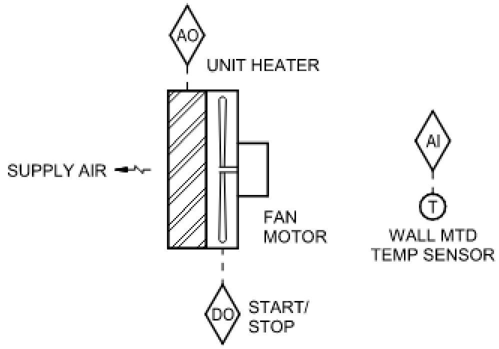
- SEND AN ALARM TO THE FMCS OPERATOR INTERFACE IF SPACE TEMPERATURE FALLS 10°F (ADJ.) BELOW SETPOINT.

50°F

40°F

2 CABINET HEATER CONTROL - ELECTRIC

NO SCALE



<u>SEQUENCE OF OPERATION</u>:

WHEN THE OUTDOOR AIR TEMPERATURE IS ABOVE 40°F (ADJ.), TEMPERATURE SENSOR SHALL ENERGIZE FAN AND MODULATE THE ELECTRIC COIL TO MAINTAIN A SPACE TEMPERATURE OF 70°F (ADJ.). WHEN SPACE TEMPERATURE IS SATISFIED THE FAN SHALL TURN OFF.

WHEN THE OUTDOOR AIR TEMPERATURE IS BELOW 40°F (ADJ.), TEMPERATURE SENSOR SHALL MODULATE THE ELECTRIC COIL TO MAINTAIN A SPACE TEMPERATURE OF 70°F (ADJ.) AND THE UNIT FAN SHALL RUN CONTINUOUSLY.

<u>ALARMS, INTERLOCKS & SAFETIES</u>:

SEND AN ALARM TO THE FMCS OPERATOR INTERFACE IF SPACE TEMPERATURE FALLS 10°F (ADJ.) BELOW SETPOINT.

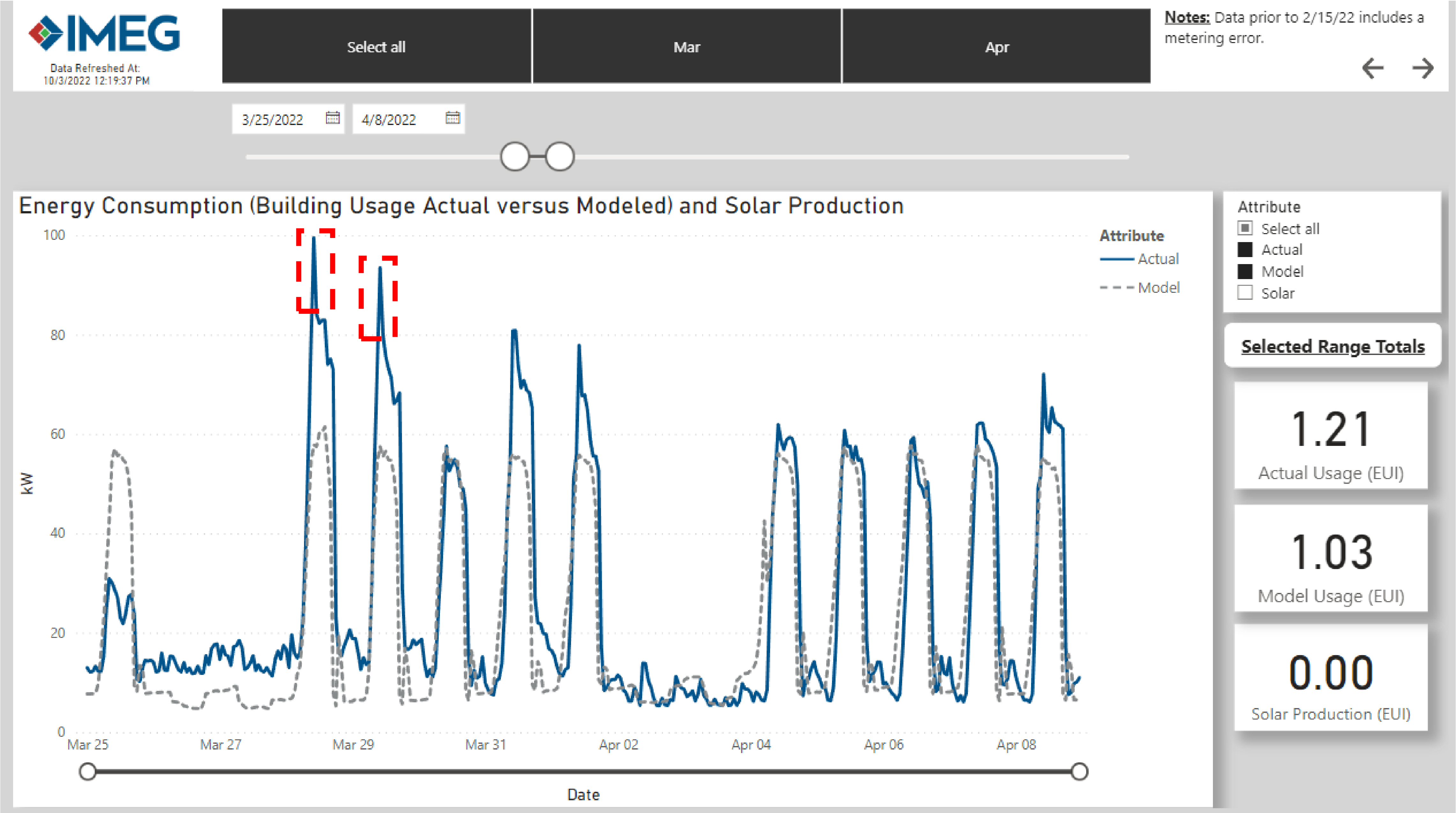
50°F

50°F

3 UNIT HEATER CONTROL - ELECTRIC

NO SCALE

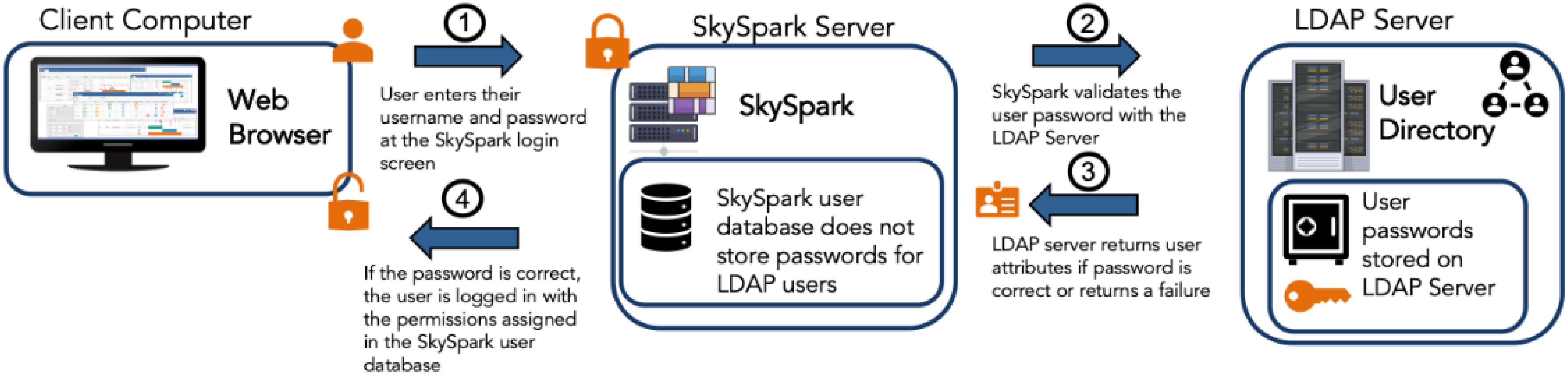
March Controls Reprogramming



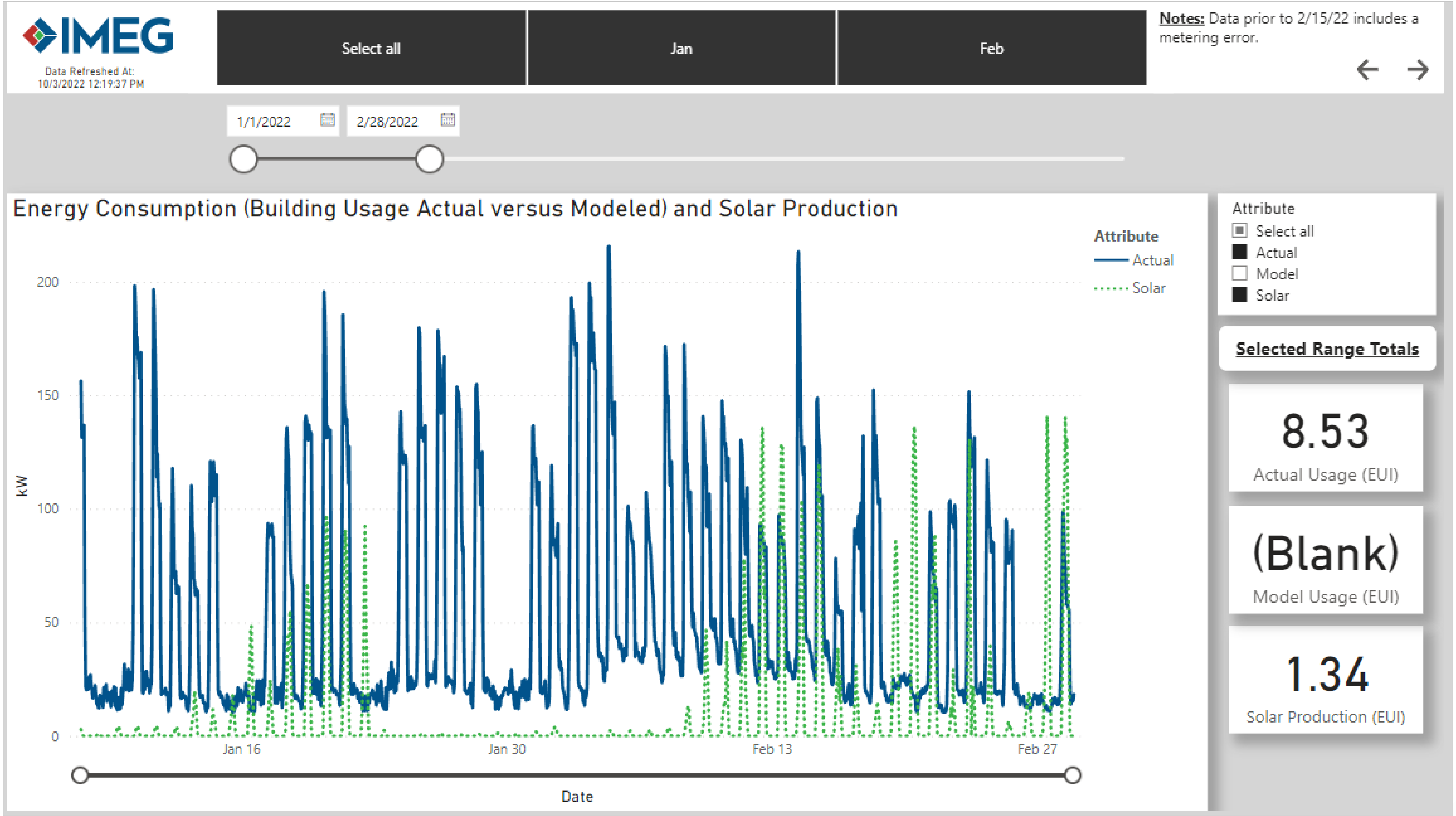
March to April

Next Steps

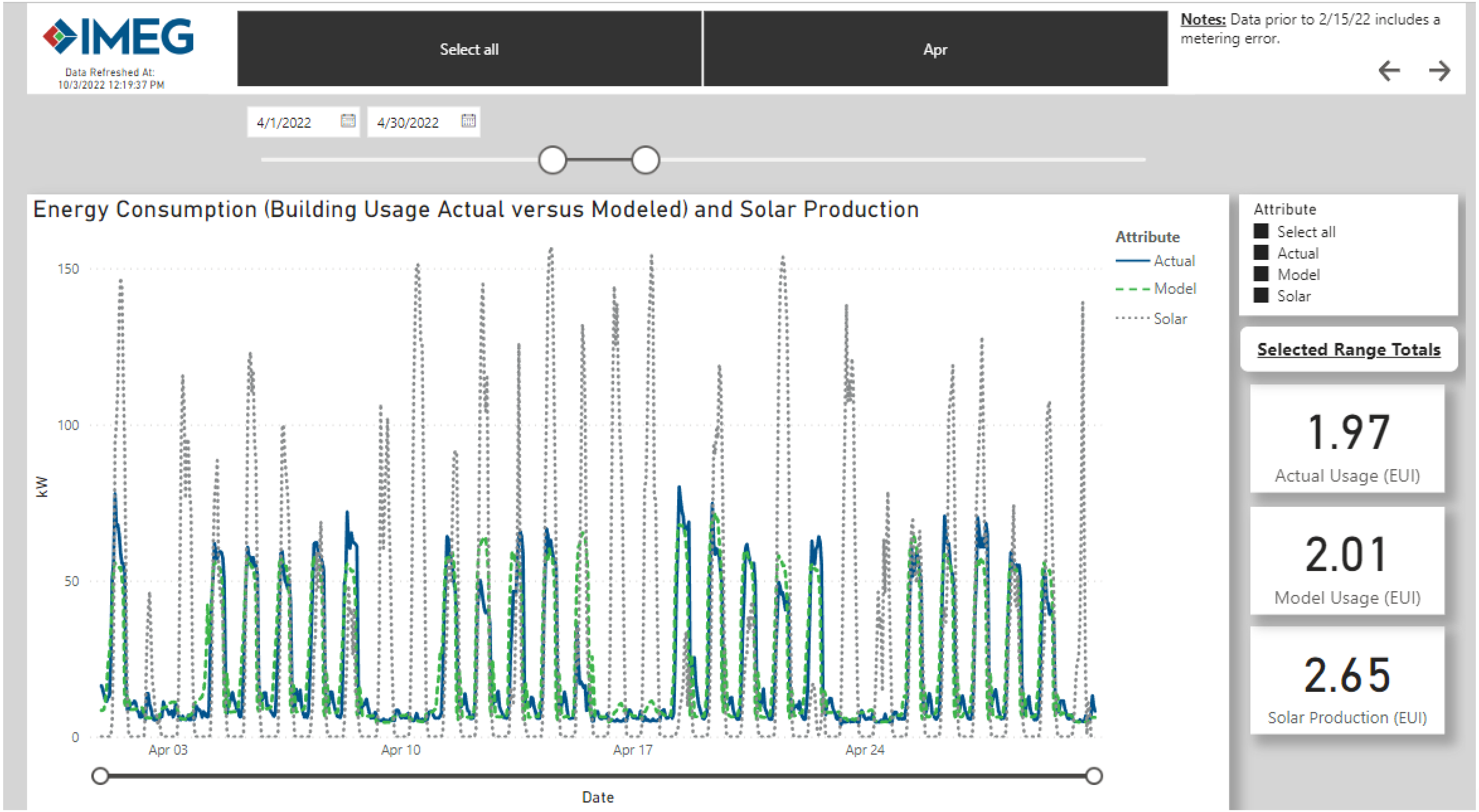
- Trending better after issues were addressed...
- ...But process to get actual data was still manual



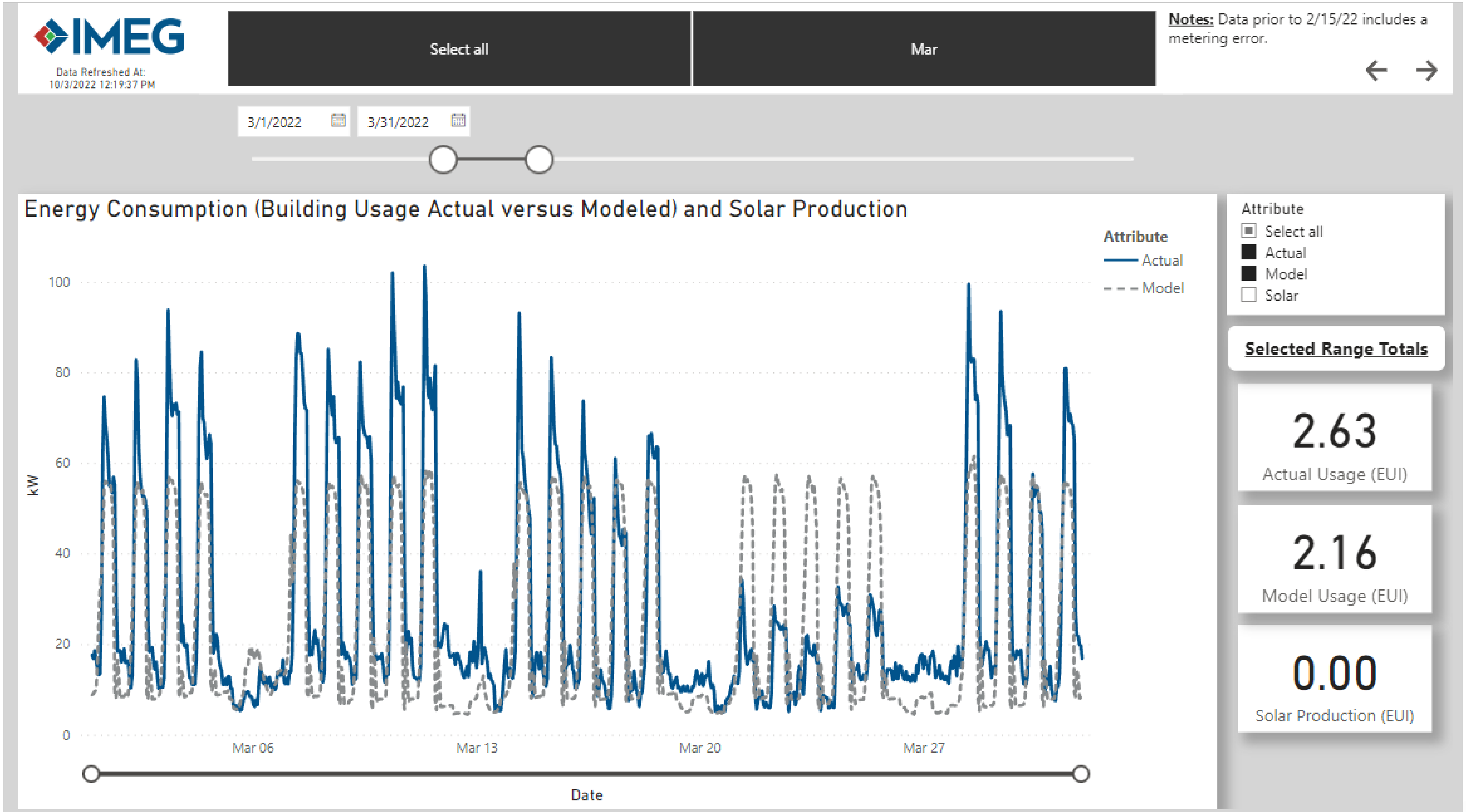
Automated Process


IMEG
Data Refreshed At:
10/3/2022 12:19:37 PM
Select all
Jan
Feb
Notes: Data prior to 2/15/22 includes a metering error.
1/1/2022
2/28/2022
Energy Consumption (Building Usage Actual versus Modeled) and Solar Production
Attribute
Actual
Solar
kW
200
150
100
50
0
Jan 16
Jan 30
Feb 13
Feb 27
Date
Attribute
Select all
Actual
Model
Solar
Selected Range Totals
8.53
Actual Usage (EUI)
(Blank)
Model Usage (EUI)
1.34
Solar Production (EUI)

Low Solar



Net Zero Month



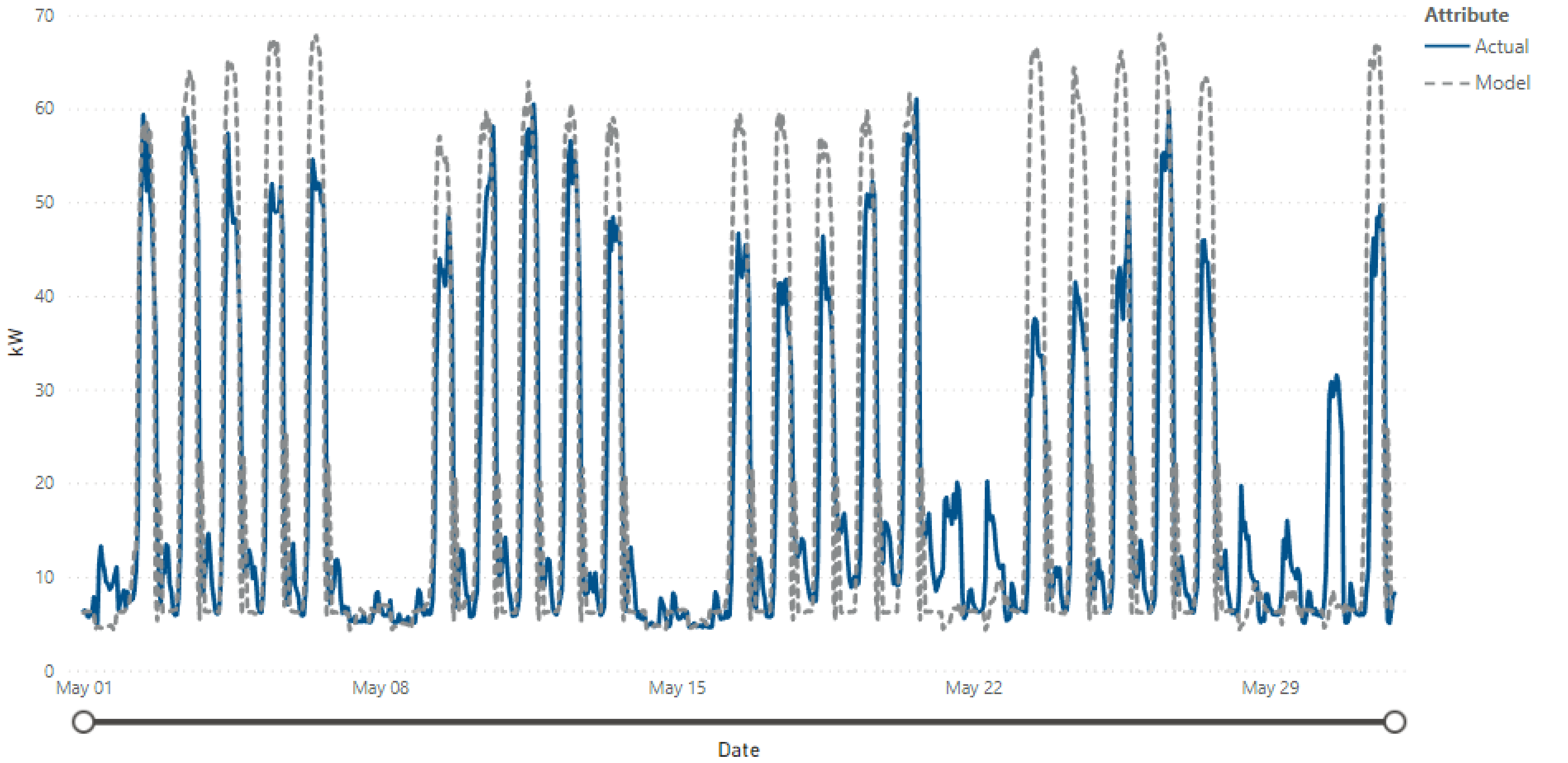
Before Issues Fixed

IMEG
Data Refreshed At:
10/3/2022 12:19:37 PM

Select all | May

Notes: Data prior to 2/15/22 includes a metering error.

5/1/2022 | 5/31/2022



Attribute
- Select all
- Actual
- Model
- Solar

Selected Range Totals

1.79
Actual Usage (EUI)

2.03
Model Usage (EUI)

0.00
Solar Production (EUI)

After Issues Fixed

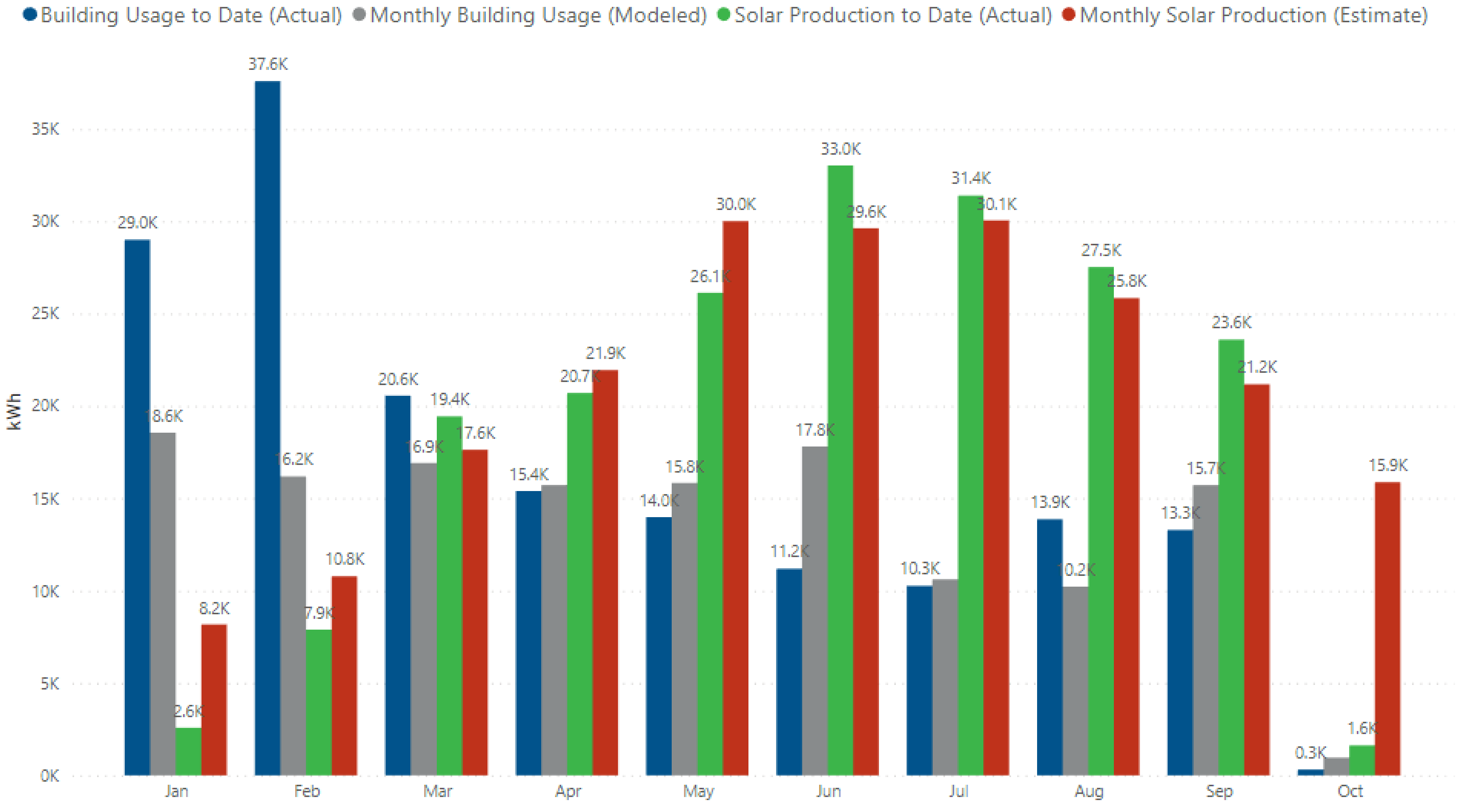
IMEG

Data Refreshed At:
10/3/2022 12:19:37 PM

Select all | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct

Notes: Data prior to 2/15/22 includes a metering error.

Monthly Data



Selected Range Totals

21.18
Actual Usage (EUI)

24.83
Solar Production (EUI)

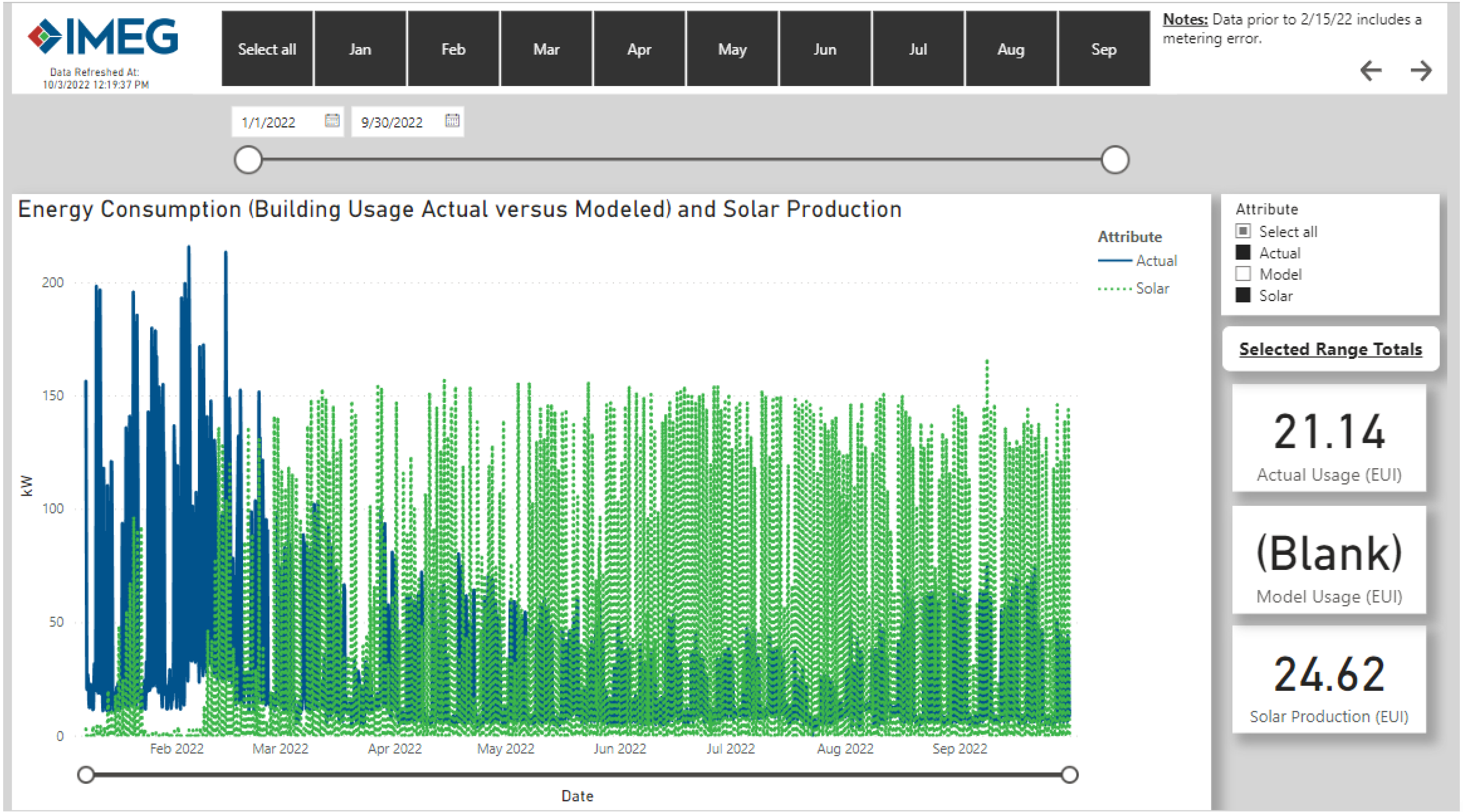
165,413
Actual Usage (kWh)

138,485
Model Usage (kWh)

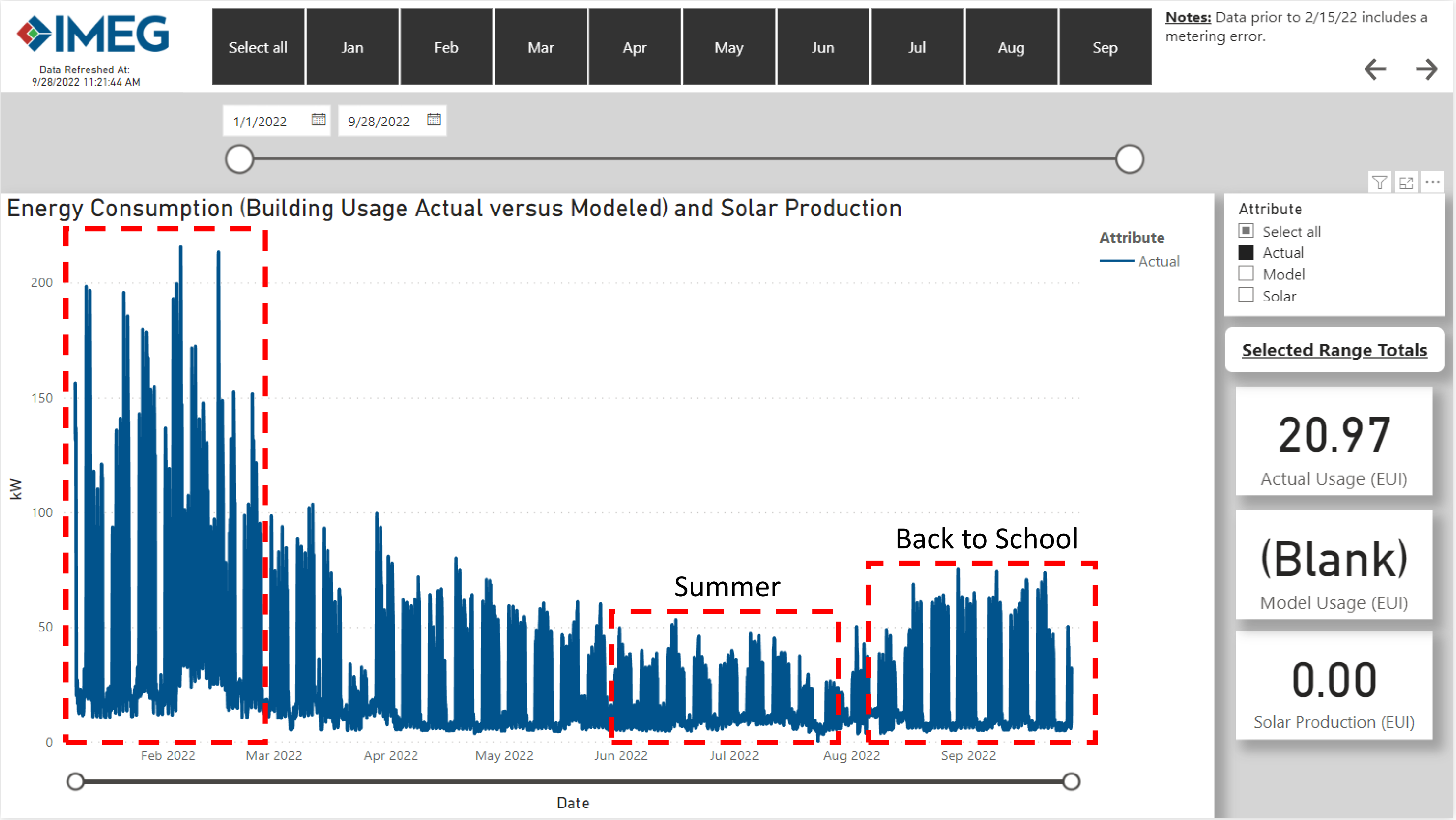
193,914
Solar Production (kWh)

211,095
Solar Estimate (kWh)

Month by Month Data



Total Usage/Generation to Date



Year Highlights

Integrated Design

- Occupancy discussion
  - Keep Challenging the Owner to maintain their intended scheduling and occupancy practices.
- Mechanical Systems
  - Keep commissioning your system and modifying controls sequences on a regular basis

Energy Modeling

- Energy Modeling for System Selection
- Collaboration with Client

Post Occupancy

- Be patient if you start in winter
- Energy Usage can help find issues
- Energy modeling can be a tool to predict Net Zero
- Importance of sub-metering individual loads and hourly trending data

What did we learn

QUESTIONS