The Role of Energy Management Information Systems in Wisconsin's Focus on Energy Program

Final presentation

25 June 2021

slipstream

Agenda

- Intro and overview
- Product review
- Potential modeling
- Program review
- Program recommendations
- Discussion

Approach: We will perform research to create a foundation for Focus on Energy to begin ramping up EMIS offerings. The research will start with investigating best practices and best available products for EMIS-based efficiency and demand response around the country. We will then combine this with modeling, stakeholder discussions, and interviews focused on the Wisconsin context. The result will be program recommendations for Focus on Energy.

Introduction

- What is EMIS?
  - Software tools to manage building energy use
  - EIS (energy information systems) use whole-building data sets
  - AFDD (automated fault detection and diagnostics) use BAS and equipment-level data
  - ASO (automated system optimization) is an emerging area for real-time implementation of energy saving measures, demand management, etc.
- Project overview
  - September 2020 through June 2021
  - Reviewed available research and evaluation reports
  - Interviewed vendors, service providers, clients, and implementers
  - Developed EMIS load shapes and Wisconsin grid model
- Previous deliverables:
  - Program and product review memo (February)
  - Modeling results presentation (April)

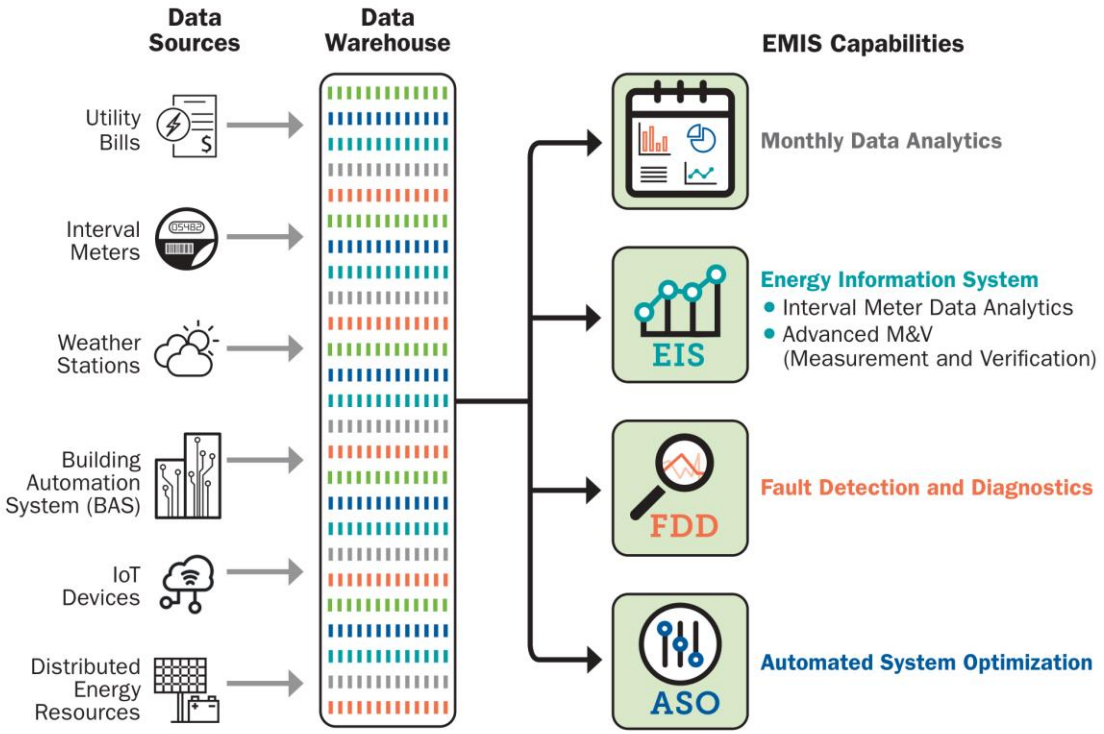
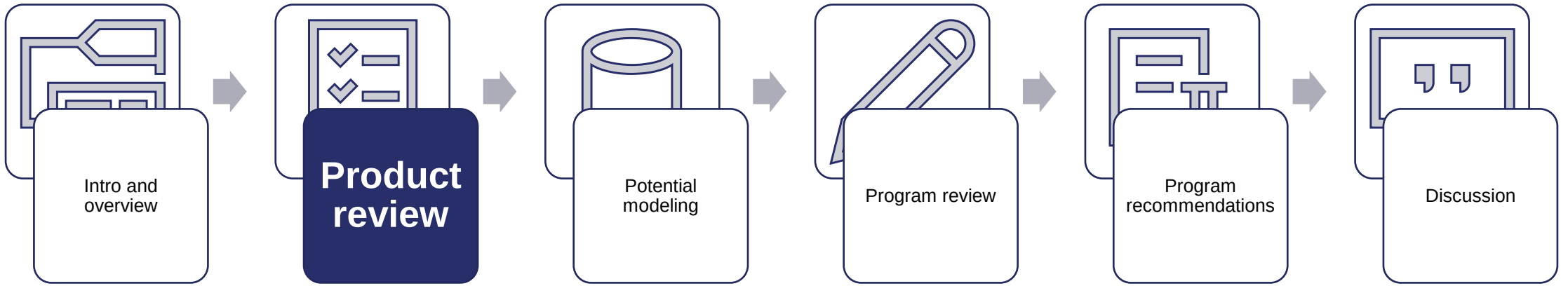


Image from Kramer et.al. "Proving The Business Case for Building Analytics". Lawrence Berkeley National Laboratory, October 2020.

A few EMIS vendors…

BrainBox	Carbon Lighthouse	Cimetrics (Analytika)	Clockworks Analytics
CopperTree Analytics (Kaizen)	InSite	Kinetic Buildings (Synapse)	Niagara (Tridium)
Prescriptive Data (Nantum OS)	SkyFoundry (SkySpark)	Switch Automation	Trane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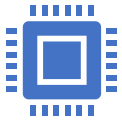
EMIS data sources

- BAS/BMS
- Utility meters
- Submeters
- Lighting systems
- Internet-connected data sources

Product lifecycle



Connect building's data sources to the EMIS platform

Hardware, software, or both

Learning and training period

Project Haystack/Brick Schema

Initial ECM recommendations within 4-6 weeks

Faults and upgrade opportunities ranked and tracked over time

Vendor integrations

Ticketing systems

RFP generation

Helpdesk

Typical costs and structure

Initial cost • Software • Hardware • Engineer time	$15k to $60k, or by sq ft
Annual fee • Software support • Engineer time	$0.04/ft^2 to $0.13/ft^2

Sales channels

Direct sales

- Portfolios
- Markets
- Market segments

Reseller programs

- Controls vendors
- Local engineering firms

Energy Savings Potential of EMIS

HOW EMIS SAVES ENERGY

- Energy Information Systems: compares energy performance of **multiple buildings to each other** and **an individual building to itself**
- Automated Fault Detection: **detects and reports** equipment failures, malfunctions, and suboptimal operation
- Savings tend to **increase** year to year

SIMPLE PAYBACK

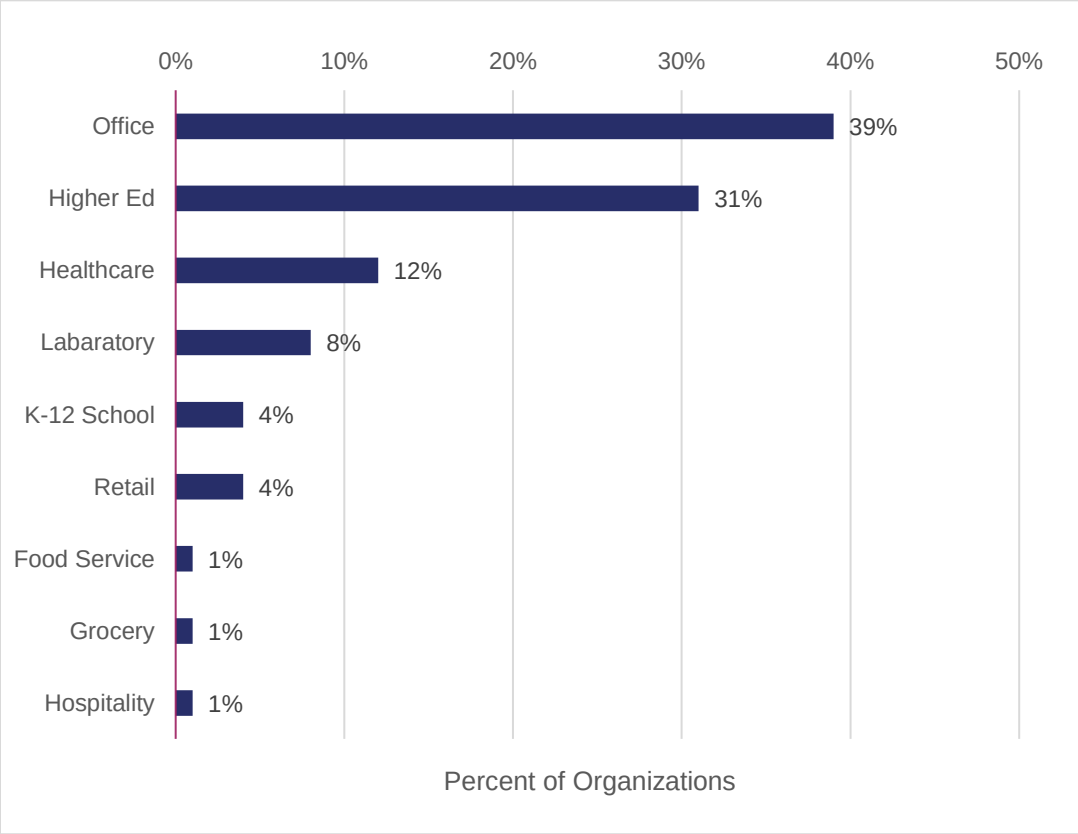
Median simple payback of 2 years*

Source	Annual Energy Savings Potential
Kramer et. al. (2020)	3% median ($0.03/sq ft) (EIS only) 9% median ($0.24/sq ft) (EIS + AFDD) (Whole building level, all fuels)
Granderson and Lin (2016)	Ranges from 10-26% Average 18.4%
Meiman et. al. (2012)	8% energy savings / 4 yr simple payback
Mills and Matthew (2009)	$0.25 cost savings/sq. ft./year, median 2.5 yr. simple payback

*Kramer et.al. “Proving The Business Case for Building Analytics”. Lawrence Berkeley National Laboratory, October 2020.

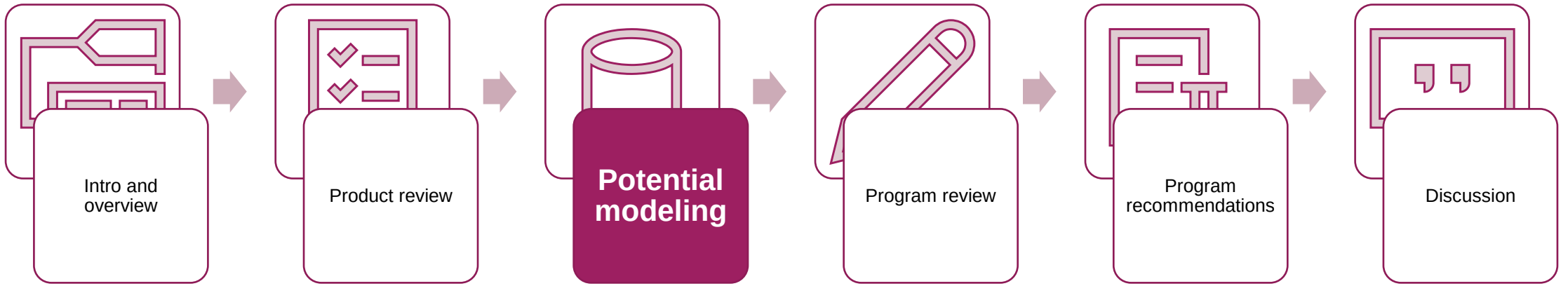
EMIS market characterization

LBL's Smart Energy Analytics Campaign



SPECTRUM data on applications (4/2014 to 3/2021)

Building type	Quantity in Wisconsin	SEM and/or RCx participants	EMIS measure participants	Modeled participation rate
Medium Office	1406	19	30	3%
Large Office	96			3%
Hospital	123	58	14	59%
Outpatient Healthcare	510	28	11	8%
Secondary School	822	88	163	31%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Modeling Approach

measures that represent EMIS

measures to building stock and achievable potential

impact of measures statewide

cost and emissions data for 2020 and 2030

Measure development

Based on DOE prototype building models

NREL's ComStock (beta)

- State-by-state building stock based on CBECS
- Measure data from across the U.S.
- Calibrated modeling through EnergyPlus with hourly outputs

eQuest modeling

- Additional measures not available from ComStock
- Baselines from prior Slipstream research and ComEd RCx persistence studies

Selected measures

NREL's ComStock

- RTU VFD and controls improvements
- Upgrade RTU DX air conditioner
- Upgrade boiler
- Add heat recovery
- Demand controlled ventilation
- Adjust thermostat setpoints
- Daylighting controls
- ~~Predictive thermostats~~
- ~~Lighting occupancy controls~~

eQuest modeling

- Add economizer
- Reset chilled water supply temperature
- Reset hot water temperature
- Reset supply air temperature

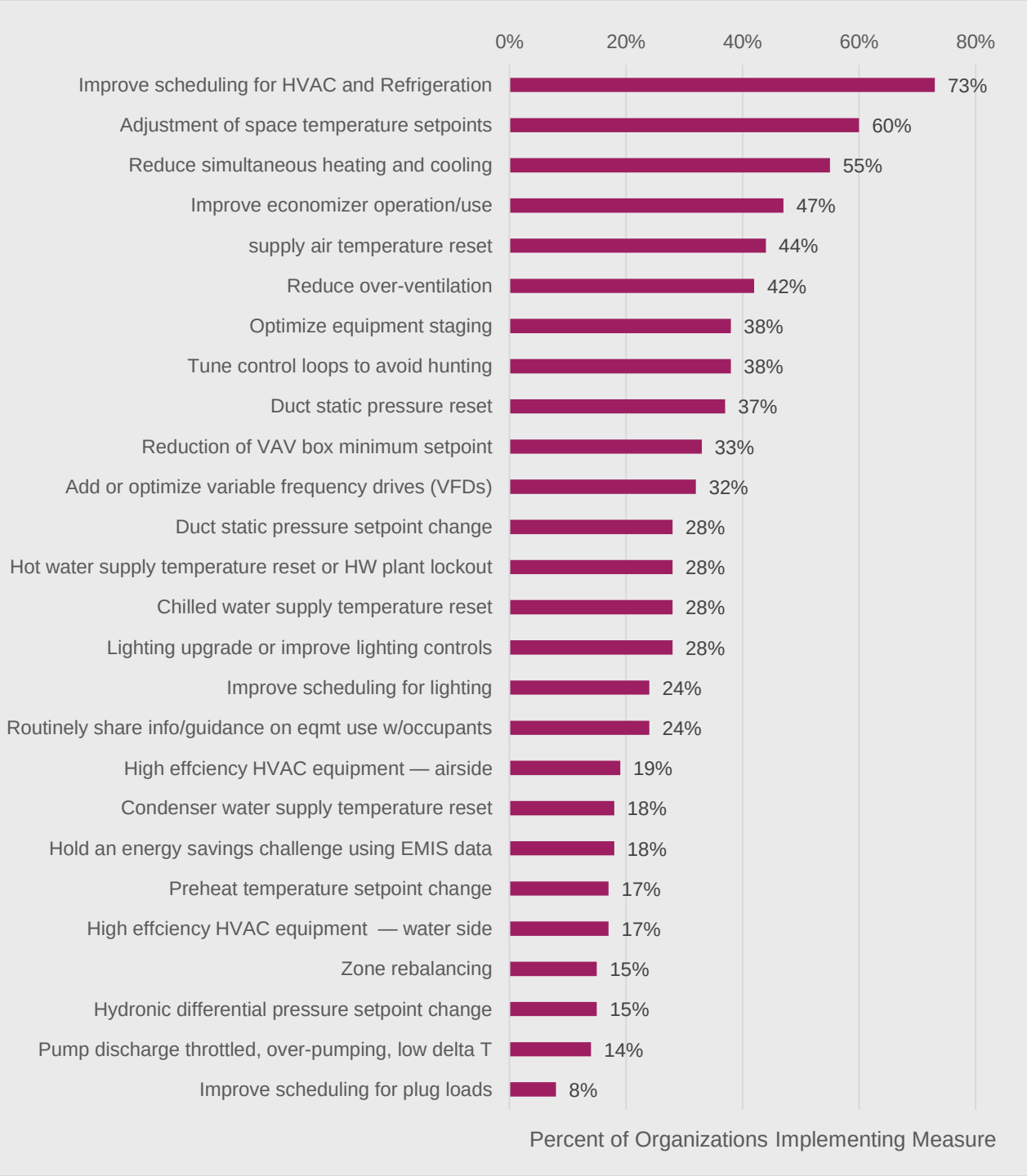
Scaling Measures

LBL's Smart Energy Analytics Campaign

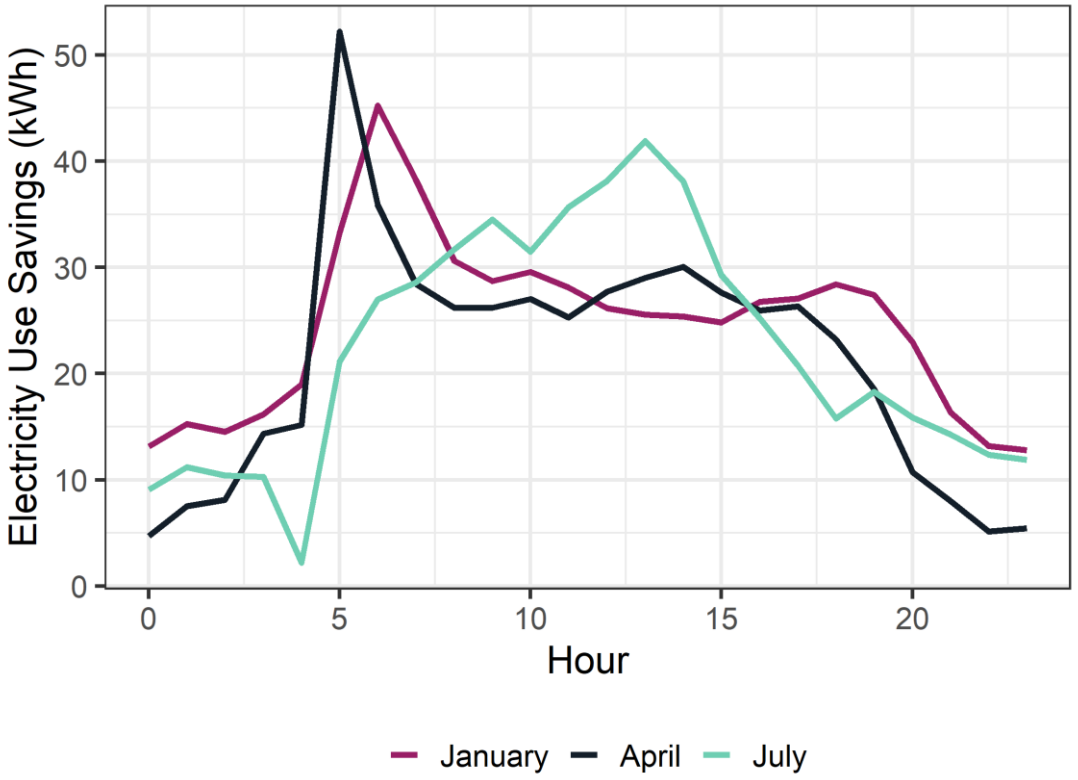
- 104 organizations, with 6,500 buildings covering over half a billion square feet of combined floor area
- Measures selected and scaled based on frequency
- *Source:* Kramer, Hannah, Guanjing Lin, Claire Curtin, Eliot Crowe, and Jessica Granderson. 2020. "Proving the Business Case for Building Analytics." https://doi.org/10.20357/B7G022

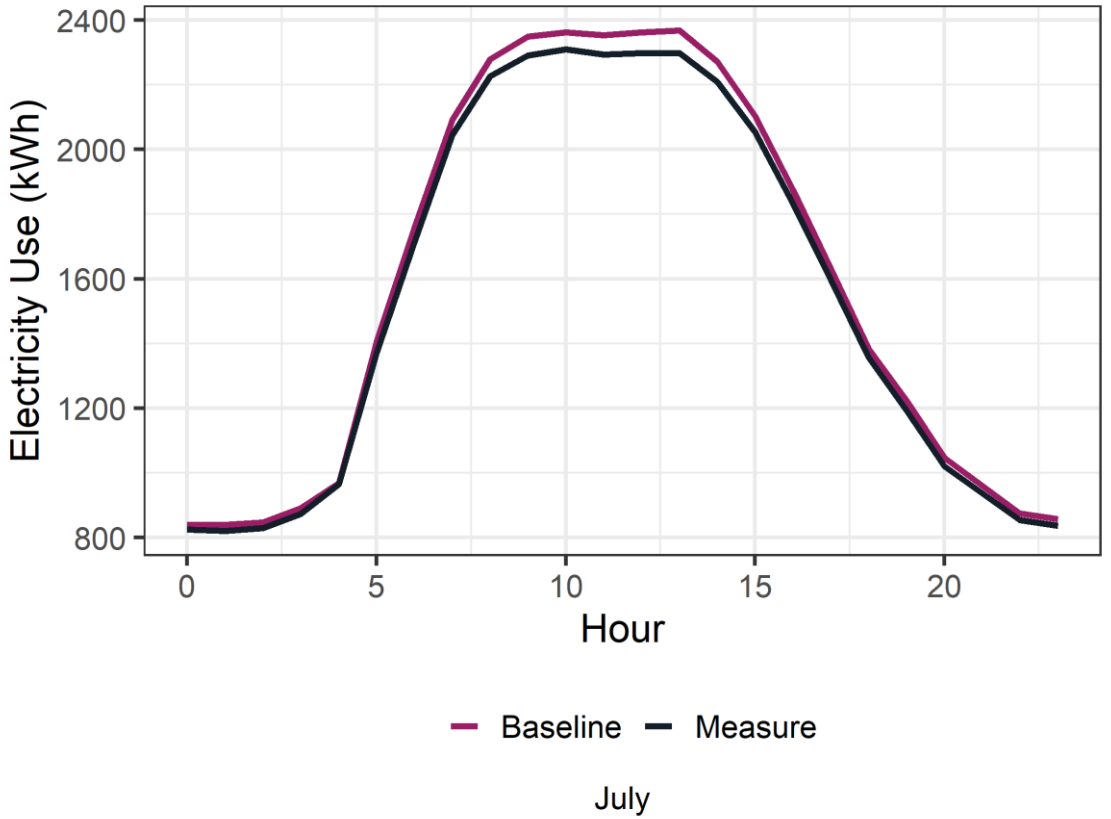
Vendor interviews

- Verified based on Slipstream's interviews of EMIS vendors and installers

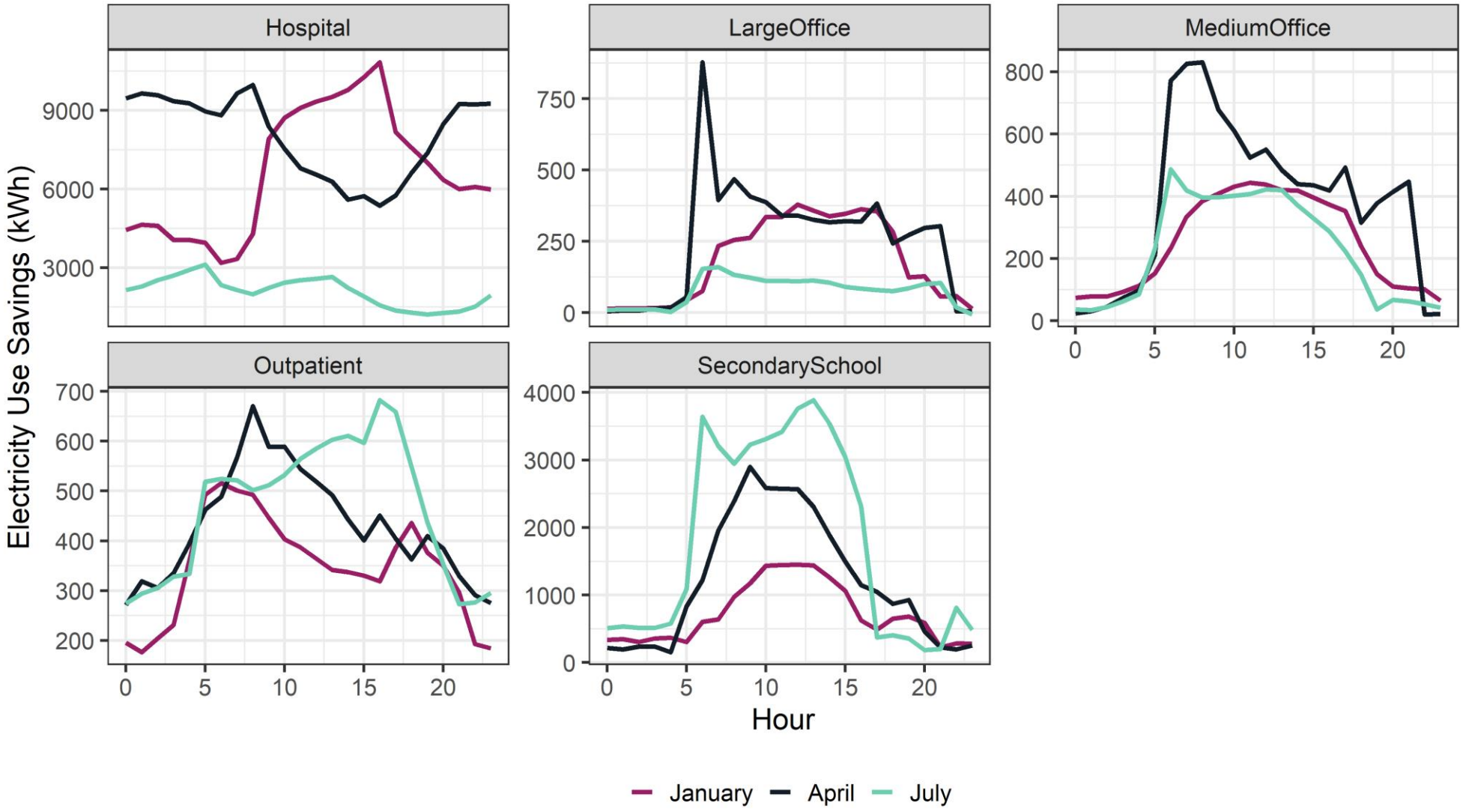


Large Office – Thermostat Setpoints

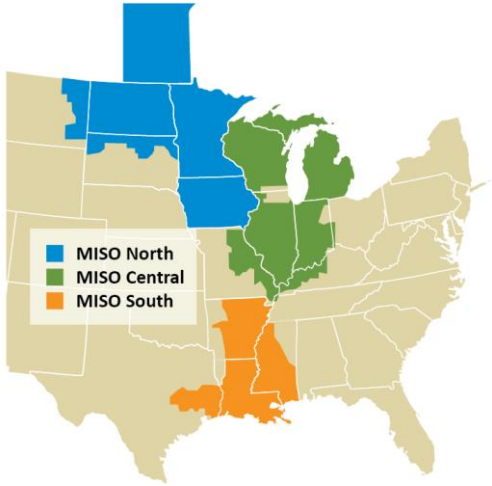


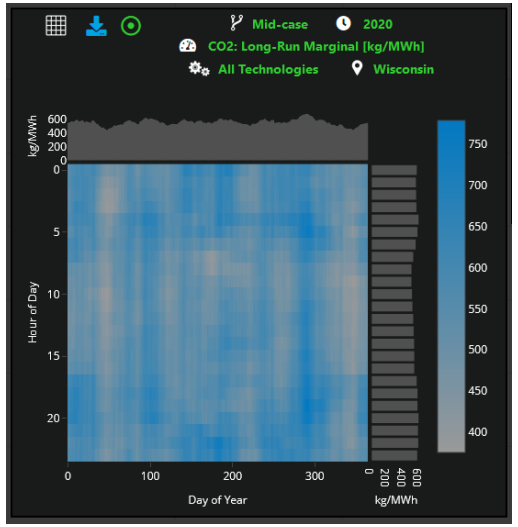


Total Electricity Savings by Building Type



Cost and Emissions Data Sources





Wholesale market data

Current and forecasted wholesale and capacity prices

Grid dispatch data

Current and forecasted marginal emissions

Cambium Mid-case scenario

Statewide utility rates

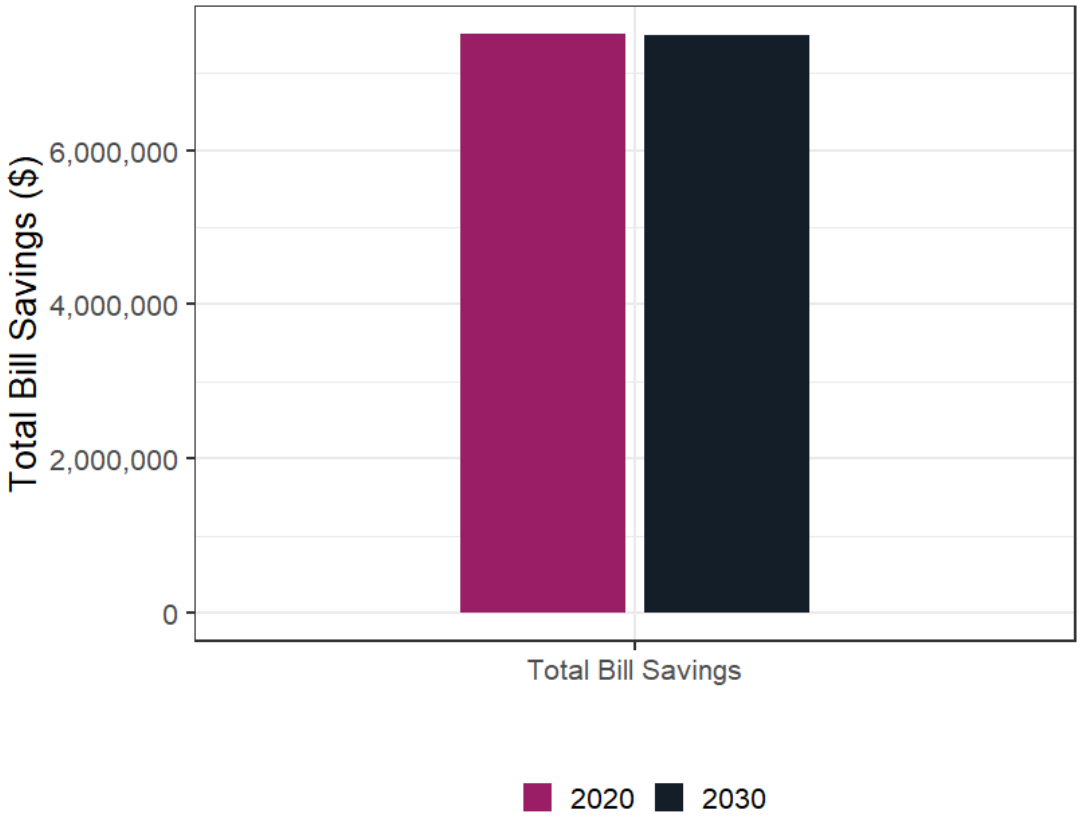
Current statewide average utility rates (weighted average of approved commercial TOU rates from IOUs) and forecasted 2030 utility rates

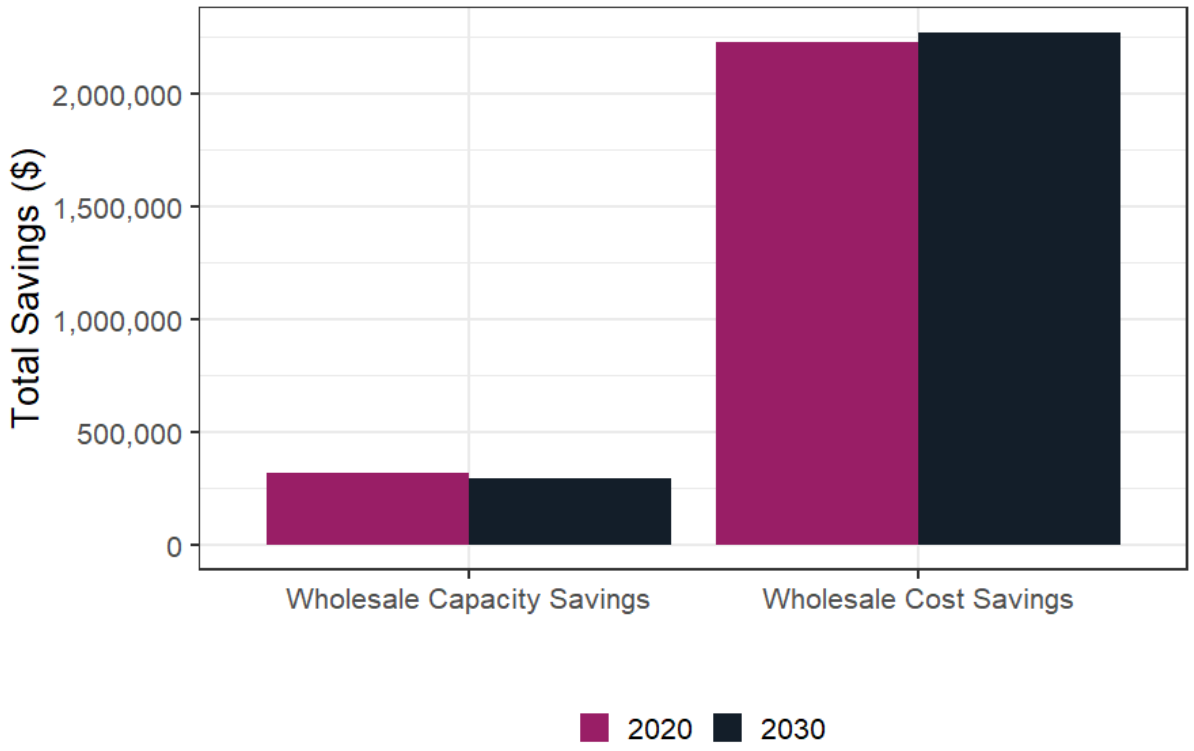
2020 Savings Results

Building Level

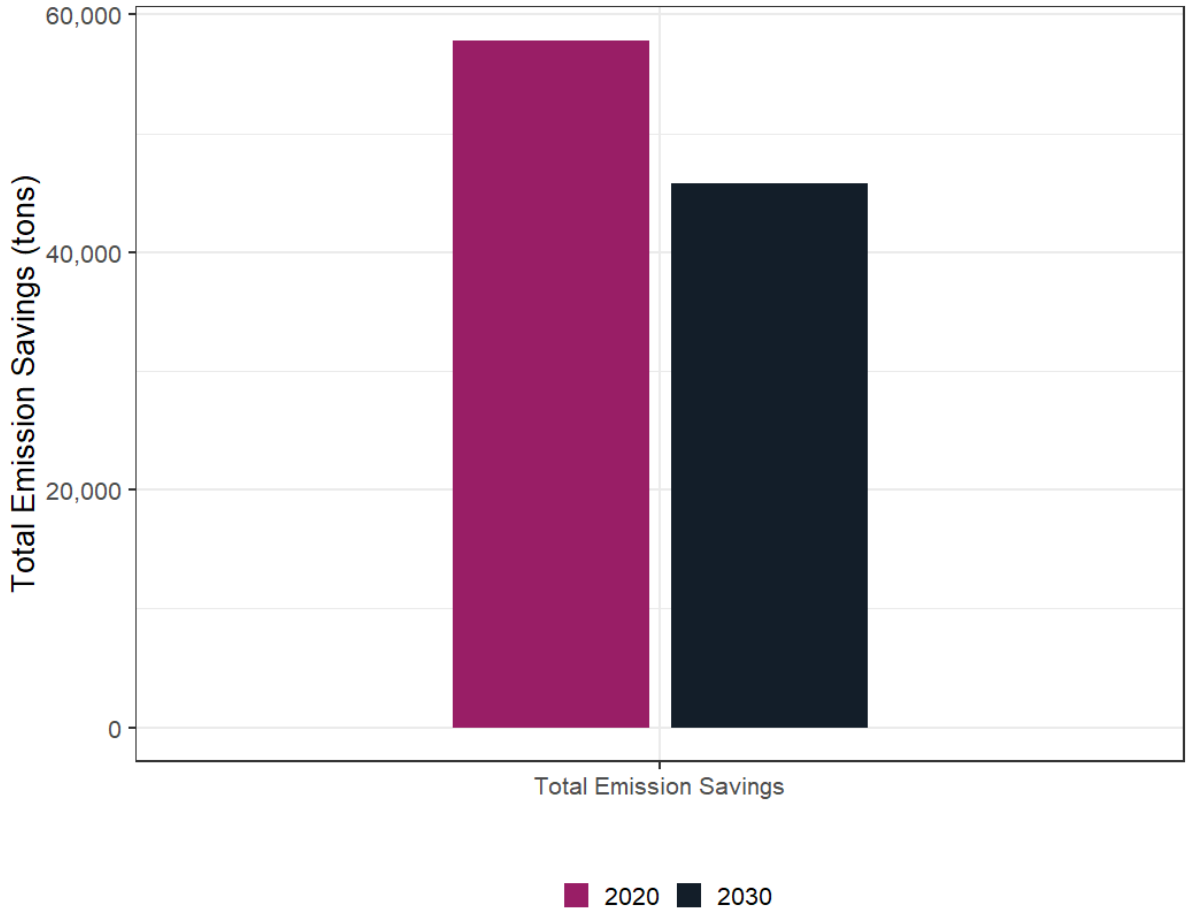
Building Type	kWh Savings	Therm Savings	kBtu Savings	Percent kBTU Savings	kBtu savings per sq ft	Utility Bill Consumption Savings	Demand Charge Savings	Total Bill Savings	Bill savings per sq ft
Hospital	716,960	14,532	1,663,288	19%	5.9	$57,820	$8,075	$65,985	$0.23
Large Office	517,368	7,569	908,533	14%	2.6	$41,995	$4,605	$46,600	$0.13
Medium Office	53,493	1,752	190,927	17%	2.8	$4,800	$930	$5,730	$0.08
Outpatient	95,605	2,897	317,739	13%	3.4	$8,275	$1,685	$9,960	$0.11
Secondary School	46,760	4,877	501,417	17%	5.2	$5,985	$1,780	$7,760	$0.08
Total (full building stock)	**71,260,040**	**2,492,000**	**270,085,320**	**17%**	**5.1**	**$6,349,540**	**$1,152,290**	**$7,501,830**	**$0.12**

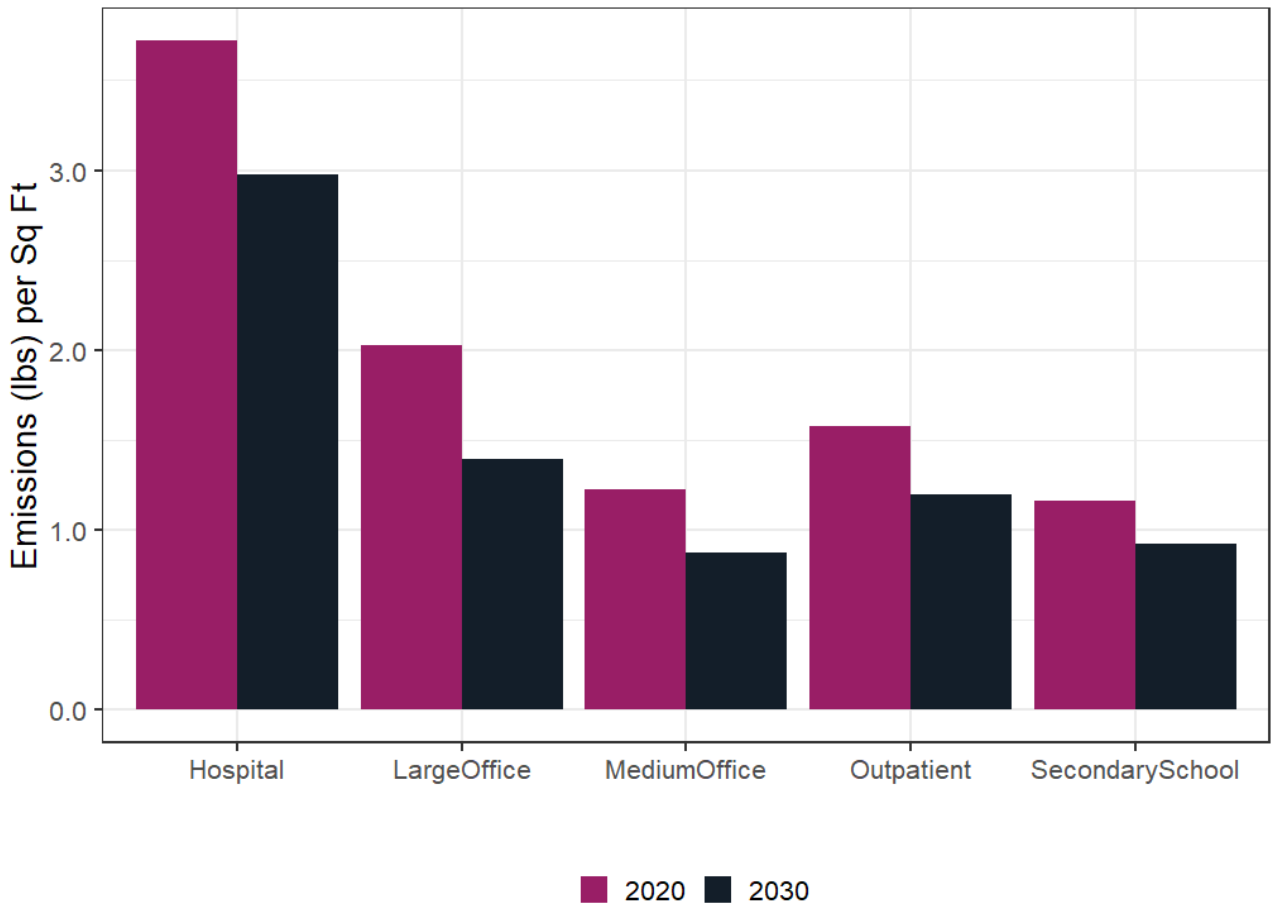
Statewide cost savings

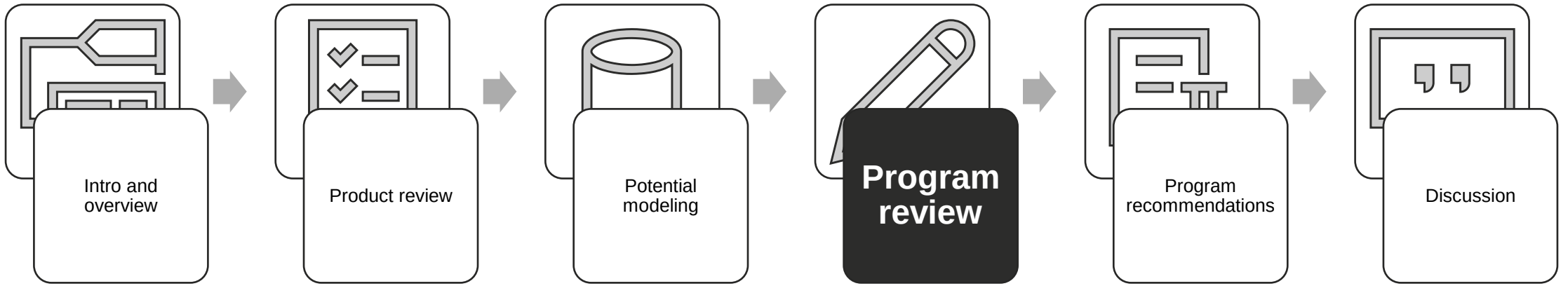




Statewide emission savings



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Current related Focus on Energy offerings

SEM

RCx

HVAC

- Upgrades: A/C, ASHP, boiler, chiller, DHW, etc.
- Implementation: Economizers, connected thermostats, heat recovery
- Controls: Temperature resets, demand controlled ventilation
- Motors/drives: VSD, VFD, ECM

Controller upgrades

- Advanced RTU controller, GREM

Lighting controls

- Bi-level, connected/networked lighting systems

Focus on Energy programs

RCx

- Focus on EUI and MMBtu
- Streamlined process for clients
- Improved cost effectiveness

SEM

- Success in industrial sector
- Long-term engagement typical

Controls

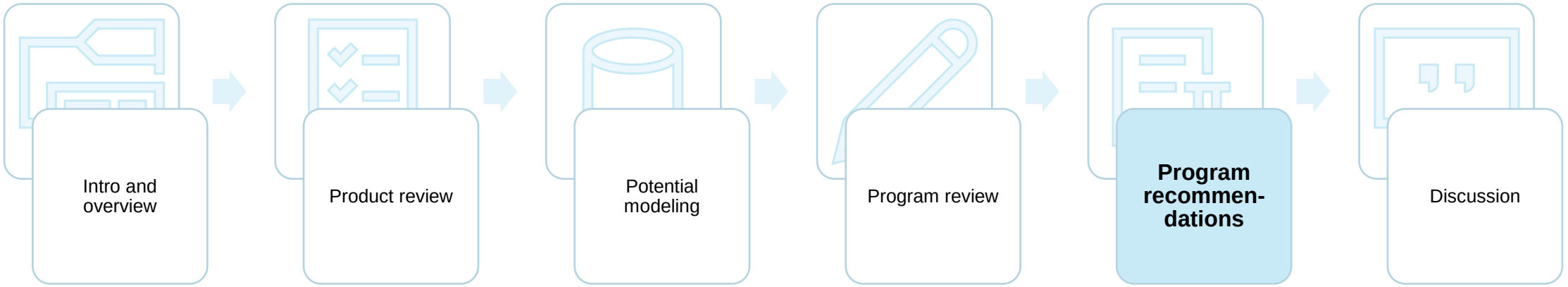
- Success in refrigeration, RTU, and DCV
- Less overlap with EMIS markets

EMIS enabled measures (outside of SEM or RCx)

Building Type	Lighting controls	All other controls	Other	Total
	Sites with at least one such measure			
Agriculture	0	1	442	**443**
Education	19	48	513	**580**
Food sales and service	0	204	247	**451**
Healthcare	4	1	87	**92**
Housing and lodging	1	18	90	**109**
Manufacturing	35	62	751	**848**
Office	5	20	67	**92**
Public assembly and religious worship	4	19	101	**124**
Public order and safety	1	10	66	**77**
Retail	14	80	110	**204**
Warehouse	8	2	34	**44**
Other	8	15	274	**297**
Total	**99**	**480**	**2,782**	**3,361**

Programs outside of Wisconsin

Program type	Structure	Risks and benefits	Examples
Real time energy management (RTEM)	• Cost offset based on spec, building size • ECMs incentivized elsewhere	• Does not directly incentivize savings • Strong growth sector	• NYSERDA – 30% of cost, 5 year contract • BC Hydro – $0.05 to $0.10/ft^2
Monitoring-based commissioning (MBCx)	• Cost offset based on spec, building size • Some restriction on ECM incentives	• Improved savings and persistence vs RCx • High realization rate	• ComEd – $0.10 to $0.25/ft^2, tiered (previously based on kWh saved)
Pay for performance (P4P)	• Not specific to EMIS, but a good fit • Targets buildings implementing suites of interactive measures • Incentive estimated up-front based on engineering calcs • Final incentive calculated after observation	• Final incentive calculated/paid after M&V period • Capture savings that would be hard to track elsewhere	• DCSEU – pilot stage currently. Incentives range from $0.03/kWh saved up to $100,000 per site depending on total pilot budget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Program pathways for Focus on Energy

Program type	Benefits	Risks	Solutions
Real time energy management (RTEM)	• Clear incentive structure enables robust vendor outreach • Broad appeal across sectors • Enables creative use of EMIS	• Up-front incentive could lead to attrition • Less guarantee of robust savings	• Require evidence of multi-year contract with vendor with application
Monitoring-based commissioning (MBCx)	• Can build on success and active development of RCx program • Increase savings and persistence of RCx	• May not reach client types outside of traditional RCx programs	• Offer an “RCx lite” pathway, perhaps using EIS
Pay for performance (P4P)	• Capture highly-specific and interactive measures that are hard to track elsewhere • Verified savings	• Unknown incentive amount • Incentive paid after M&V period	• Provide a portion of incentive up-front • Verify some savings seasonally rather than annually

Additional options

Tie-in to SEM

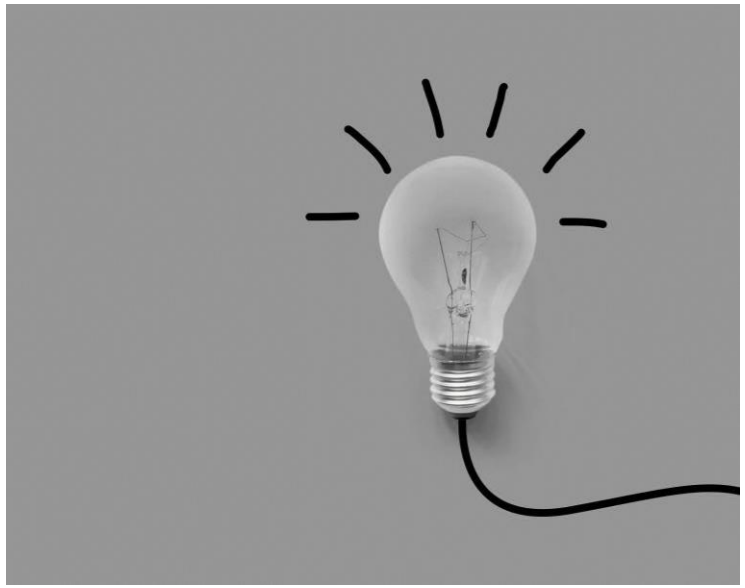
- Hand-off from SEM to EMIS
- EMIS reports for SEM follow-up

Energy Information Systems

- Lower cost, lower savings entry point
- Use utilities' own data to identify candidates
- Could also be a part of SEM

Demand response

- Demand charge savings of $1.2M
- Total demand reduction of 8.1 MW
- Reduction of 7.1 MW during 61 system peak hours



Key question

What benefit would there be to Focus on Energy in developing an EMIS program, in addition to continuing to run the existing programs that already offer support and incentives for the measures that EMIS enables?

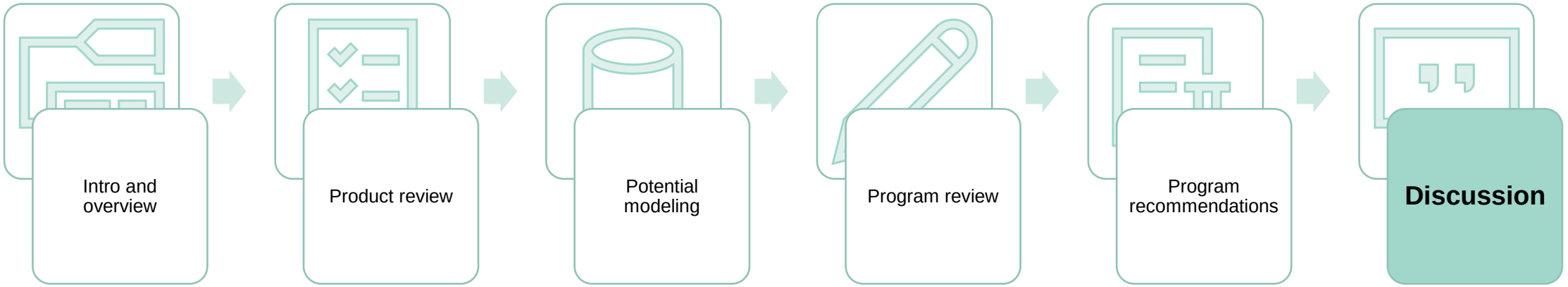
Key take-aways

Challenges

- EMIS is proven tech, but still new
- Upfront costs and unpredictable incentives limit adoption
- Client engagement required for long-term success

Opportunities

- Realize increased savings from controls-based measures
- Capture additional measures
- Empower clients to discover and implement measures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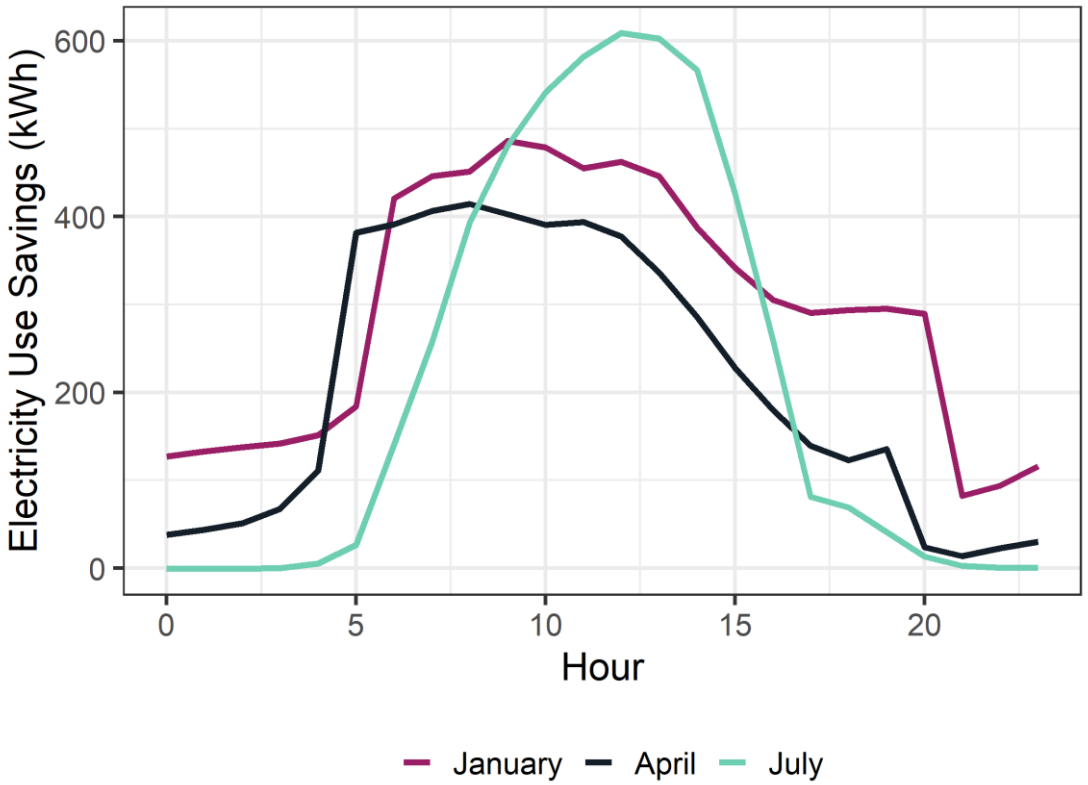
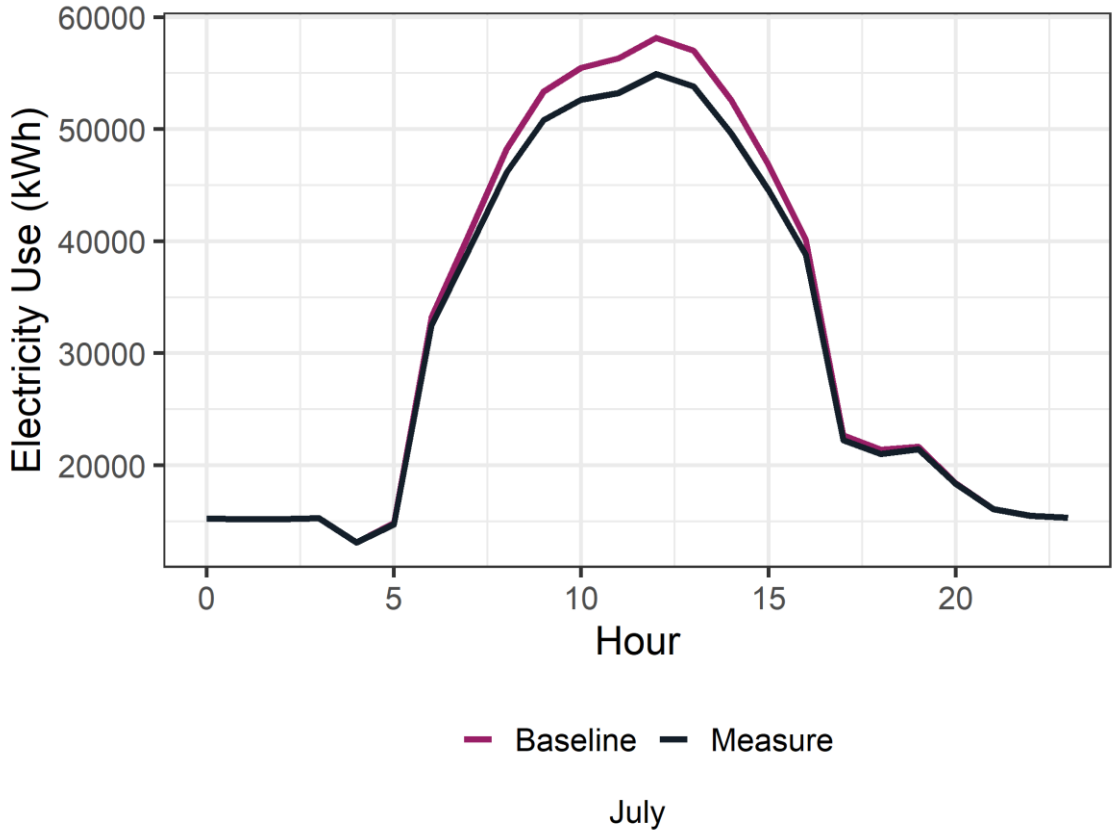
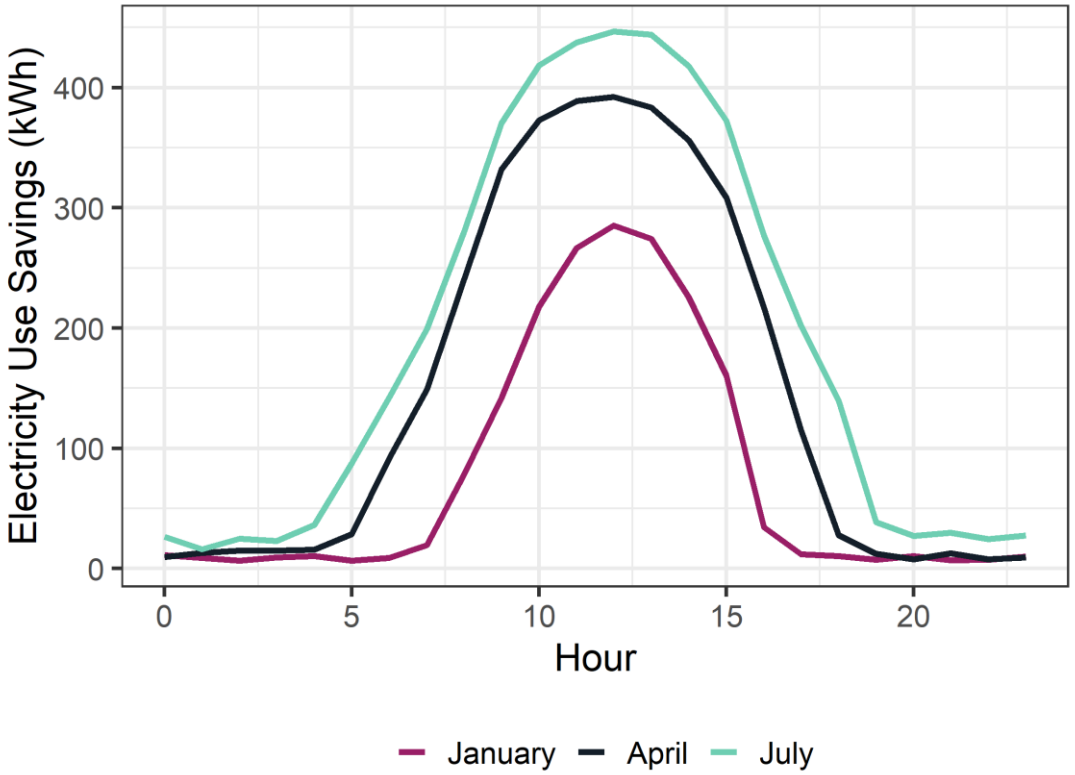
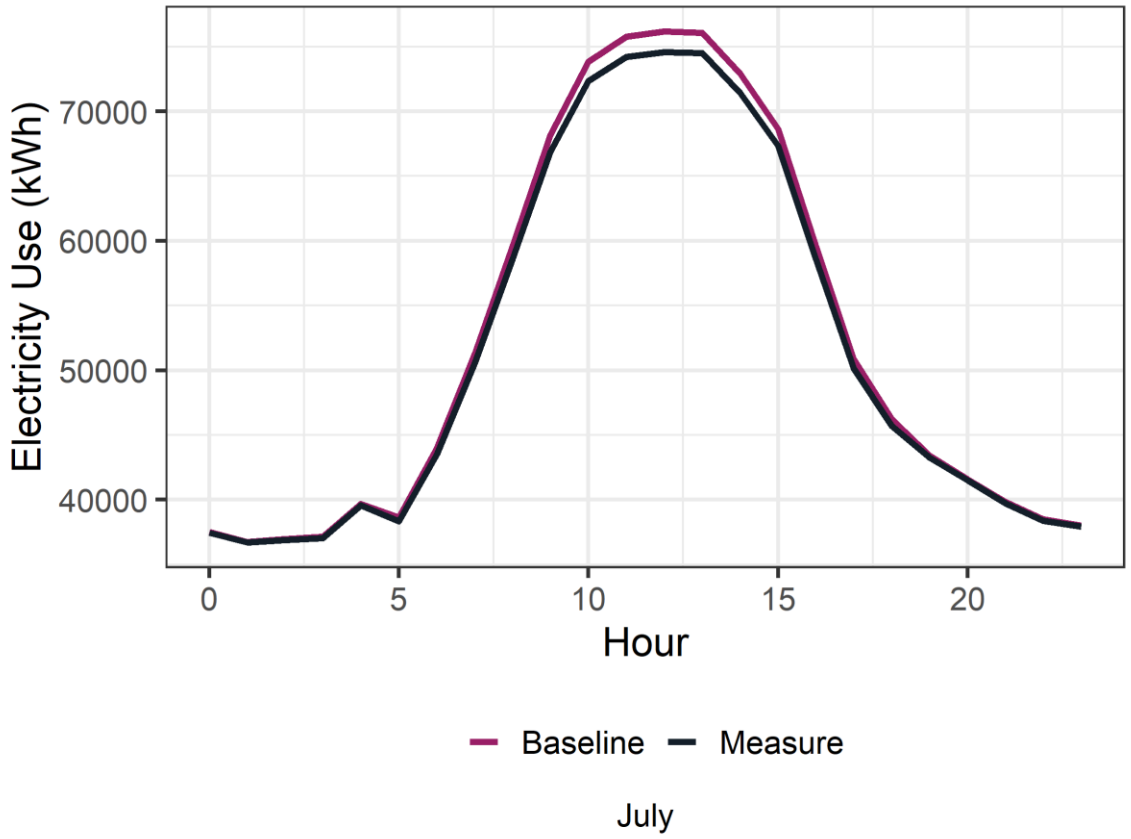
Secondary School – High efficiency RTU with VSD



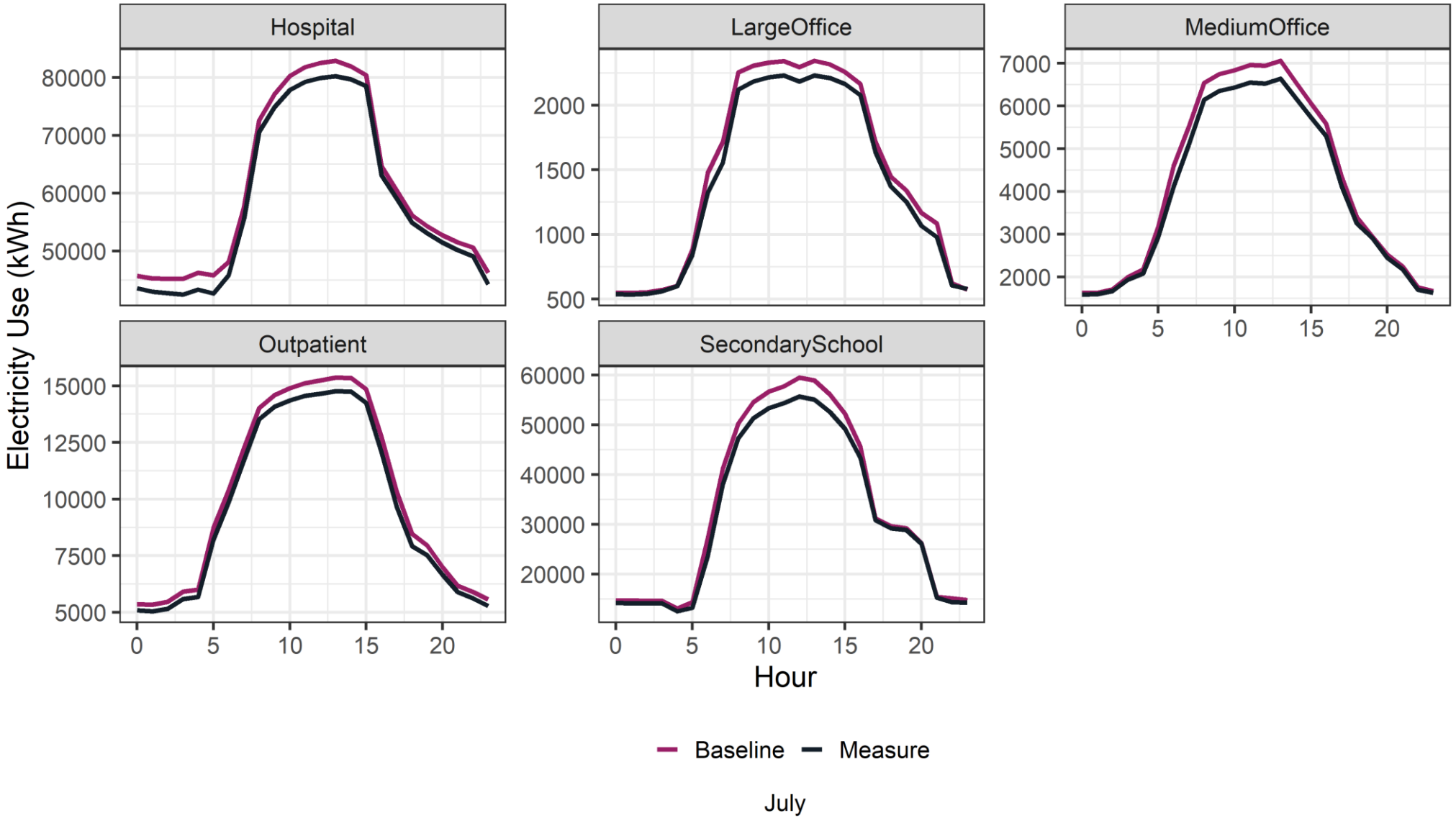


Hospital – Daylighting Controls





Baseline vs EMIS Electricity Use by Building Type



2020 Electric Rates

Bill element	Off-peak	Winter/Spring (January-May)			Summer (Jun-Sep)			Fall (Oct-Dec)			Average
		Morning	*Afternoon*	*Evening*	*Morning*	*Afternoon*	*Evening*	*Morning*	*Afternoon*	*Evening*	
Demand ($/kW)	3.47	9.22	8.66	10.14	10.59	11.51	9.14	9.22	8.66	10.14	**9.08**
Energy ($/kWh)	0.06	0.09	0.08	0.09	0.09	0.09	0.08	0.09	0.08	0.09	**0.08**

2020 Savings Results

Building Statistics

Summary statistics	Statewide sq ft	Statewide count	Avg sq ft	Modeled building rate	Modeled qty	Modeled sq ft
Medium Office	96,787,500	1,406	68,839	3%	49	3,373,110
Hospital	34,600,000	123	281,301	59%	72	20,253,670
Large Office	33,600,000	96	350,000	3%	3	1,050,000
Outpatient	48,262,500	510	94,632	8%	39	3,690,650
Secondary School	79,992,500	822	97,314	31%	251	24,425,815
Total	**293,242,500**	**2,957**	**892,087**	**14%**	**414**	**52,793,245**

2020 and 2030 Savings Results

Grid Level

2020

Building Type	Wholesale Cost Savings	Whole Capacity Cost Savings	Long-term Electricity Emission Savings (tons)	Natural Gas Emission Savings (tons)	Total Emission Savings
Hospital	$1,574,531	$127,695	31,547	6,121	37,668
Large Office	$50,485	$4,674	932	133	1,065
Medium Office	$86,194	$22,780	1,567	502	2,069
Outpatient	$120,140	$30,754	2,249	661	2,910
Secondary School	$394,358	$178,879	6,977	7,161	14,139
Total	**$2,225,708**	**$364,782**	**43,273**	**14,578**	**57,851**

2030

Building Type	Wholesale Cost Savings	Whole Capacity Cost Savings	Long-term Electricity Emission Savings (tons)	Natural Gas Emission Savings	Total Emission Savings
Hospital	$1,632,166	$121,550	24,047	6,121	30,168
Large Office	$49,744	$4,822	597	133	730
Medium Office	$84,264	$17,658	969	502	1,471
Outpatient	$123,809	$32,510	1,551	661	2,212
Secondary School	$383,097	$115,357	4,098	7,161	11,259
Total	**$2,273,079**	**$291,897**	**31,262**	**14,578**	**45,841**