Illinois Energy Efficiency Stakeholder Advisory Group
Large Group Meetings
Tuesday March 10 and Wednesday March 11, 2020

Utility Responses to Follow-Up Items

See red text below for utility responses.

March 10-11 SAG Utility Presentations:

- ComEd Portfolio Overview
  - See pages 1-2 below for ComEd responses to questions.
- Peoples Gas & North Shore Gas 2019 Program Review Presentation
  - See pages 2-6 below for Peoples Gas & North Shore Gas responses to questions.
- Nicor Gas Portfolio Overview
  - See page 7 below for Nicor Gas responses to questions.
- Ameren Illinois PY2019 Results Overview
  - See pages 8-9 below for Ameren IL responses to questions.
- Attendee List and Notes from March 10-11 SAG Meetings

Tuesday, March 10 (Day 1 Meeting)

ComEd Responses:

1. Streetlighting Program
   a. What share of Streetlighting is from Chicago?
      - In 2019, Chicago was the largest participant with 77% of the energy savings (80,388 fixtures and 58,037 MWh)

   b. Is there any [lighting system] redesign being done? Or is it just pole for pole swap?
      - Nearly all work is fixture swap with very little falling in the category of lighting system redesign
2. Multi-family Weatherization through Community Action Agencies – is this offered by all CAAs in ComEd's service territory or only certain Agencies?
   - CEDA is the only agency that braids MF projects (meaning that they also do IHWAP-only MF projects). No other agencies in ComEd territory complete MF projects for IHWAP.
   - Lake, Will, McHenry, and Kendall-Grundy agencies have completed MF projects for the utilities (utility-only projects)
   - The remaining agencies in ComEd's territory do not do MF projects. They can if they want to pursue it, but ComEd has seen little interest from the agencies.
3. C&I Programs
   a. On compressed air – are you providing education process to detect leaks, etc.? Interested in additional information.
      - ComEd has offered in the past and will again this year both in-person and webinar training classes on how to identify opportunities for compressed air systems including leak detection. All industrial customers receive an email invite to attend the classes. In addition, there is training available to any contractor for how to use the Fix it Now workbook calculations and to perform/install leak detection/repairs, high efficiency air nozzles, no loss condensate drains and VFD compressors.

b. Describe virtual commissioning vs. retro-commissioning.
   - Both retro-commissioning (RCx) and virtual commissioning (VCx) help customers make operational improvements to their major building systems, especially HVAC. Typical measures implemented include equipment scheduling, adjustment of setpoints, and optimization of outside air use. The main difference between RCx and VCx is how measures are identified and verified.
   - In RCx, an engineering service provider (SP) goes to the customer's site and collects information directly from building systems and from the building automation system. That data is analyzed and recommendations for operational improvements are developed.
   - In VCx, all work is done remotely. Operational improvement opportunities are identified by the SP using analysis of smart meter interval usage data instead of through direct system-level measurement, and then confirmed through a phone conversation with the customer.
   - In both RCx and VCx, the customer selects measures to implement, and then the SP verifies the savings. In RCx, this is done on-site through system-level/BAS data. In VCx, it's done remotely using smart meter data.

c. What % of top 100 and top 500 customers are participating?
   - Approx. 50% of the top 100 customers C&I customers between 1-10 MW have "participated" in programs between the years 2018-2020.
   - Approx. 40% of the top 500 C&I customers between 1-10 MW have "participated" in programs between the years 2018-2020.

4. Electric New Homes – is there a report available on the 2019 research?
   - A public-facing report was not produced following the 2019 research. However, we can share general pilot info and marketing materials. See SAG website March meeting page:
     - ComEd Electric Homes New Construction Overview
     - ComEd Electric Homes New Construction Pre-Application Worksheet

Peoples Gas/North Shore Gas Responses:

1. Public Sector Customers – how is public customer defined? The presentation showed 43 customers in Peoples Gas service territory, which seemed high. What type of entity is included in that number?

   A: The customer values represent buildings instead of a unique public sector entity. We reported a total of 43 individual customers in the PGL territory and 12 in NSG. These include several Chicago Public School sites (high schools, elementary schools), projects at Navy Pier, the City of Chicago, and several RCx tune-up projects at Noble Network charter schools. A breakdown by program path is below.

Schools & Government	**55**
NSG Public Custom 2019	4
NSG Public Prescriptive 2019	8
PG Public Custom 2019	1
PG Public Prescriptive 2019	27
PG Public RCx 2019	15

2. C&I Program – why is the cost per therm so different for Peoples Gas vs. North Shore Gas?

   A: C&I programs are cost-effective in both PGL and NSG. In 2019, NSG had one large project that came in at $0.50/therm. As the NSG territory and goals are smaller, this single project affected the overall cost effectiveness for NSG and caused the two territories to look different in $/therm.

3. SEM – what is the measure life for these savings?

   A: SEM low-cost/no-cost measures typically have a measure life of under one year; capital projects will have a range. Currently, the TRM does not have a measure life quantified for SEM projects.

4. Home Energy Jumpstart – for what % of customer participants was an envelope measure identified and what % of customers followed through with a project (for both Peoples Gas and North Shore Gas).

   A: We recommend weatherization to 40-50% of customers. There is a very low percentage of projects that convert from a HEJ recommendation. Nearly all of Wx volume comes from trade allies.

5. The % of savings from Home Energy Reports, split for Peoples Gas and North Shore Gas.

   A: For PGL, Home Energy Reports were 7% of portfolio savings and for NSG, Home Energy Reports were 23% of portfolio savings.

6. Additional information about open source building sensors.

   A: Below is an overview on development of open source building sensors and controls.

Open Source Wireless Building Sensors and Controls: Room-level sensing and steam valve control in Alumni Hall at Illinois Institute of Technology

Building Automation Systems (BAS) are widely used to control building systems to deliver energy efficiency and manage demand flexibility across building loads. However, the use of BAS remains limited across the existing building stock, particularly in older residential and commercial buildings that lack the ability for multi-zone sensing and control without expensive add-ons, or for which there may be no commercially available products at all. Older buildings remain a challenge and require technology innovations to convert their many manual controls to digital-based controls so their systems can be integrated with modern BAS. Without innovations to encourage conversion to digital functionality, these buildings will not be able to shift to intelligent management practices where energy efficiency, peak demand, and thermal comfort can be optimized, and faults can be diagnosed quickly and effectively.

To this end, a research team recently developed a custom 3D-printed room-level steam radiator valve control and wireless sensor platform and deployed it in an existing building on the campus of Illinois Institute of Technology (Alumni Hall, built-in 1946). The automatic individual radiator controls consist of a custom 3D-

printed clamp-on device powered by a servo motor (i.e. it attaches on top of the existing manual control), which is controlled by logic programmed on a Raspberry Pi Zero control board to automatically adjust the original manual control valve setting, and thus controlling radiator temperature setpoint and steam flow rate. Total parts costs for the control node is currently under $60/node and can go much lower at scale. The control sequence is informed by custom low-cost wireless sensor nodes in each zone to monitor operating conditions (~$15 parts cost per sensor), built on an Arduino microcontroller platform previously developed by the project team called Open Source Building Science Sensors (http://osbss.com). Sensors measure temperature, relative humidity, mean radiant temperature, temperature on radiator surface (to understand usage), the temperature of steam supply and condensate pipes, room occupancy (via PIR and CO_2), and light intensity. Sensor nodes transmit data wirelessly to a base station and the data are stored in a database with a GUI portal built on open source Grafana software. The same data are also sent to the controller node to perform an action (in this case, valve adjustment via servo motor specifically matched to the existing manual control) based on the computed output signal control logic.

Last year, the project team recently completed a 9-week experimental campaign with sensors and controls deployed in 15 radiator locations during the 2018-2019 heating season in Alumni Hall. The campaign included: 3 weeks of 'manual' operation (i.e., with the automatic control installed but no automatic control logic enforced; users could adjust the setpoint via up/down buttons on the control); 3 weeks of 'enforced schedule (ES)' in which the radiator setpoint was set back outside of working hours (i.e., 8 am to 5 pm); and 3 weeks of 'motion (M)' based control logic in which the radiator setpoint was set back any time motion was not detected for 15 minutes, presenting a form of occupancy-based control. The average radiator on-time was reduced from ~61% with manual controls (occupant controls) to ~44% with enforced schedule (common BAS controls); and to only ~23% with occupancy (motion) based control (advanced controls) of radiator setpoints, with only small changes in perceived occupant comfort. In other words, heating savings of up to 60% was achieved with occupancy-based control compared to manual control with only minor changes in thermal comfort. Given that steam accounts for about 80% of Alumni Hall's energy consumption, with a steam energy utilization index of 65.1 kBtu/ft2, substantial savings are possible through this novel sensing and control system. Refinements to the technology are now underway including battery powered operations. Expanded application with eventual commercialization is the goal.

7. **Art Institute Dehumidification Project – will follow-up if a whitepaper is made available.**

A: Below is a summary of the Art Institute Dehumidification Project.

Machine Learning Aided HVAC Optimization at the Art Institute of Chicago

The Opportunity
According to the ASHRAE Handbook—HVAC Applications, humidity presents the most severe threat, behind light damage, to museum, gallery, and library

archives. The mechanical properties of many materials, as well as human comfort, depend on the temperature of the surrounding air and the amount of water vapor contained in it. Either very low or fluctuating relative humidity can lead to mechanical damage within the artifacts. Historically, concerns over mechanical damage have led to extremely narrow specifications, such as 50 +/- 3% relative humidity and 21 +/- 1 o C (LaFontaine 1979). These specifications still form the basis of many museum and archive conservation guidelines. The conventional approach to humidity control is to cool the supply air down to a temperature that corresponds to a known humidity level suitable for all spaces, then reheat the air to meet the temperature needs of each individual zone. This is done to create a fixed starting point for the HVAC controls. However, it also generates energy waste by overcooling and subsequently reheating the air.

At the Art Institute of Chicago, 34 constant air volume (CAV) air handling units (AHUs) supply a combined total of 760,000 cubic feet per minute (CFM) of conditioned air to critical art gallery spaces. Each air handler is set to maintain gallery temperatures at 68 o F or 72 o F and gallery relative humidity between 50 and 55%. These air handlers are set to continuously cool supply air to 58 o F unless there is a call for dehumidification. When a gallery relative humidity reading hits 53% RH, it triggers a call to dehumidify, whereby the supply air temperature drops to 52 o F. Gallery air handlers operate 24 hours a day, every day, there is a significant amount of time when the supply air is cooled and reheated unnecessarily.

Humidity control can be optimized by identifying supply air temperature setpoints that minimize simultaneous cooling and heating. Anticipating setpoints and managing air handler controls for optimal performance is not trivial. However, machine learning algorithms are uniquely suited to accomplish this task.

Machine Learning-Optimized Air Handler

The objective of this project was to construct a machine learning model that:

- Responds to real-time conditions
- Minimizes energy waste
- Maintains gallery temperature and humidity requirements.

The Peoples Gas and North Shore Gas Energy Efficiency Research and Development Program partnered with systems integrator Mobiliya (now a QuEST Global company) to accomplish this task. Mobiliya's Energy Management Solution product formed the foundation on which the air handler optimization solution was built. A diagram of the IoT system architecture deployed at the Art Institute is included below in Figure 1.

Every 15 minutes, a total of 39 sensor readings (per AHU) are sent to the cloud and fed through the machine learning algorithm. The algorithm returns a single output: optimized supply air temperature. If the gallery relative humidity is below 53%, then the building automation system implements the supply air temperature.

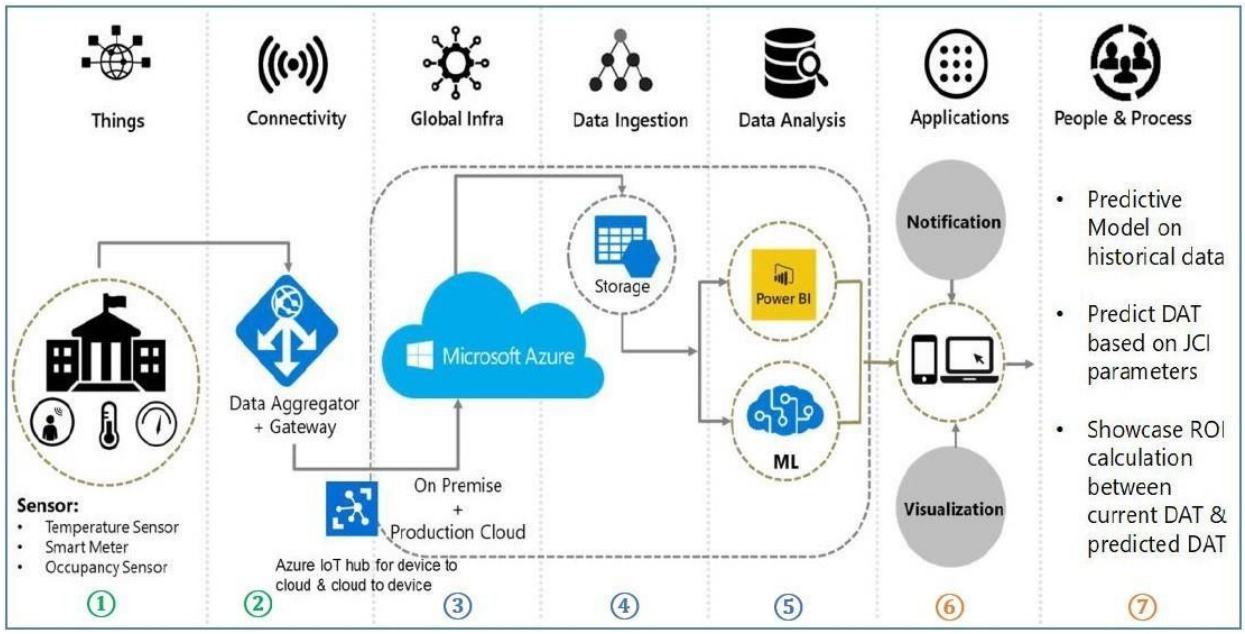

Figure 1: Optimized air handler system architecture. Green (1-2) represents layers located on-site at the Art Institute. Blue (3-5) represents layers located in the Azure Cloud, and orange (6-7) represents the user-facing layers accessible via the internet.

Results

Actual Savings from Optimized Air Handler	
Supply fan CFM	7,145 CFM
Annual natural gas savings	1,900 therms
Annual kWh savings	11,700 kWh
Combined energy cost savings	$1,850

Projected Savings from Optimizing All Gallery Air Handlers	
Supply fan CFM	760,000 CFM
Annual natural gas savings	205,200 therms
Annual kWh savings	1,250,000 kWh
Combined energy cost savings	$196,250

Future Applications

Many industrial processes must adhere to strict temperature and humidity requirements to ensure product quality. A non-exhaustive list of some such processes is included below.

Manufacturing and product warehousing applications

- Semiconductors
- Printed circuit boards
- Humidistats
- Thermostats
- Electric grid equipment
- Gum
- Leather
- Batteries
- Plastics
- Rubber-dipped goods
- Matches
- Plywood

Non-manufacturing/warehousing applications

- Hospitals
- Assisted living facilities
- Data centers
- Clean room environments
- Museums/libraries/archives
- Other healthcare facilities

Project Contacts: Allen Dusault adusault@franklinenergy.com and Thomas Manjarres, tmanjarres@franklinenergy.com

Wednesday, March 11 (Day 2 Meeting)

Nicor Gas Responses:

1. Of 10k homes served over 2 years in the Home Energy Savings Program, what % received a recommendation for insulation/air sealing? What % followed through with a project?
    a. Attached is the HES Process Review Evaluation completed last year by Navigant that provides the details to this question for weatherization participation (see slide 6 through 9): Nicor Gas PY6 Home Energy Savings Process Evaluation Results
2. For the IQ initiative, how many homes have participated for SF and MF?
    a. See chart below
3. Is it possible to separate out IQ initiative participation by kits, single family, multifamily, etc.? Also separate out the number of housing units that were served with weatherization, split by SF/MF.
    a. See chart below
4. Can you provide an update on coordination with ComEd on weatherization initiatives?
    a. ComEd may provide funding from their R&D budget to assist in the Urban Efficiency Group Ecosystem Pilot in the amount of $500K
    b. Nicor Gas would then take the $500K that we would have utilized within the Urban Efficiency Group Ecosystem and reallocates the funds to explore the Bungalow Association Weatherization Efforts
    c. Nicor Gas has inquired with ComEd if they would be interested in partnering with our diverse vendors Urban Efficiency and Anura
    d. We currently coordinate and partner with ComEd on all IHWAP weatherization projects
    e. ComEd partners with us on Home Energy Assessments where customers receive joint measures (i.e. lightbulbs, thermostats etc.); this no longer includes air sealing and insulation
    f. Nicor Gas has inquired with ComEd on IQ joint kits

Income Qualified Program Offerings	Customer Accounts	Units Served
IQ Energy Savings Kits	4,787	5,655
Single Family Weatherization	1,288	1,288
Multi-Family Weatherization	204	3,093
Public Housing Authority	30	2,008
Affordable Housing New Construction	9	258
	6,318	12,302

Ameren Illinois Responses:

1. Income Qualified Program Ally Weatherization vs. IHWAP-braided – can Ameren IL provide a list that compares the measures offered?

A.

IHWAP braided measures	IQ program ally measures
Ameren Illinois & CAA funded	**Ameren Illinois funded only**
Air sealing	Air Sealing
Insulation	Insulation
Aerators	Aerators
Showerheads	Showerheads
LEDs	LEDs
Pipe insulation	Pipe insulation
Smart stats	Smart Stats
ASHRAE exhaust fans	ASHRAE exhaust fans
Health & safety measures	Health & safety measures
Duct sealing	Duct sealing
Window/door repairs	Gas furnace or boiler
Window replacement*	BPM blower motors
Central AC or ASHP*	Central AC or ASHP
Gas furnace or boiler*	
Replacement doors*	
Refrigerator/freezer* replacement	

* Ameren program does not cover costs for these measures but customers are still eligible to receive these measures through the CAA.

2. The MWh savings per house for braided is 2500 kWh per home, while the Trade Ally channel is 4000 – much higher. Any specific reasons why? Are there more electric heated homes?

   The savings per house is basically the same for the two channels. AIC does not contribute funding for HVAC and window/door measures, thus does not claim those savings.

   The difference average is ~1200 kWh and ~100 Therms per home.
   - ACs account for ~1000+ kWh
   - Furnaces account for ~100+ Therms

3. Multi-Family Building Envelope Work (air sealing & insulation) – 400 therms per building seems small, Ameren IL to verify numbers?

   The program insulated 88,607 SF of Attic and reduced CFM by 17,240 in Electric properties, while insulating only 56,325 SF of Attic and reducing CFM by 13,723 in Duel

Fuel properties. Additionally, the average CFM reduction on Duel Fuel properties was 381 CFM vs. 1141 CFM in Electric properties.

4. Through prescriptive or another channel, what is the uptake on demand control ventilation?

   The savings numbers originally provided were gross values instead of net values. The table below provides net values and further information on uptake. The numbers for 2020 are pipeline projects at this point in the year. Implementation Plan values are at the end.

Program Year	# Projects	Electric Incentive	Net kWh	Calculated kWh savings (Gross)
10	5	$9,849.61	26,933.58	48,354.72
18	11	$16,834.60	77,181.15	138,565.79
19	18	$52,282.40	170,201.39	305,568.02
20	12	$16,048.77	63,548.62	93,043.37
Total	**46**	**$95,015.38**	**327,652.98**	**585,531.91**
20 Implementation Plan	19	$35,886.81	118,924.16	174,120.30

5. Resistance Heat Replacement with ASHP: stakeholders are interested in additional information?

   The AIC innovation team gathered kWh usage data for approximately 900,000 residential accounts. A regression analysis was used to identify about 350,000 accounts with statistically significant positive correlations between kWh usage and heating degree days. Additional analysis is being used to further isolate potential electric resistance heat candidates by focusing on total kWh and the ratio of winter to total kWh. This effort has been slowed by a shift in resources responding to the COVID-19 crisis.