Better Buildings®
U.S. DEPARTMENT OF ENERGY

Better Buildings Residential Network
Peer Exchange Call Series

How is Artificial Intelligence's Use and Rapid Growth Impacting Energy Efficiency?

February 8, 2024

U.S. DEPARTMENT OF ENERGY

Agenda and Ground Rules

- Moderator
  - **Jonathan Cohen,** Better Buildings Residential Network, U.S. DOE Residential Buildings Integration Program (RBI)
- Agenda Review and Ground Rules
- Residential Network Overview and Upcoming Call Schedule
- Opening Poll
- Featured Speakers
  - **Ann Collier,** Smart Electric Power Alliance (SEPA)
  - **Micaela Christopher,** Uplight
- Open Discussion
- Closing Poll and Announcements

Ground Rules:

1. **Sales of services and commercial messages are not appropriate** during Peer Exchange Calls.
2. Calls are a safe place for discussion; **please do not attribute information to individuals** on the call.

The views expressed by speakers are their own, and do not reflect those of the Dept. of Energy.

Join the Network

Member Benefits:

- Recognition in media, social media and publications
- Speaking opportunities
- Updates on latest trends
- Voluntary member initiatives
- One-on-One brainstorming conversations

Commitment:

- Members only need to provide *one number*: their organization's number of residential energy upgrades per year, or equivalent.

Upcoming Calls (2nd & 4th Thursdays):

- *2/22: How to Encourage Households to Prioritize Energy Efficiency Given Competing Demands*
- *3/14: The Solar – Energy Efficiency Nexus Update*

Peer Exchange Call summaries are posted on the Better Buildings website a few weeks after the call

Ann Collier

SEPA

Smart Electric Power Alliance

How Is Artificial Intelligence's Use and Rapid Growth Impacting Energy Efficiency?

Ann Collier, Senior Manager – Emerging Technology

DOE Better Buildings Residential Network Peer Exchange: February 8, 2024

What SEPA Does

Smart Electric Power Alliance

SEPA is a **membership organization** comprised of 1,100+ utilities, industry partners, regulators and other stakeholders.

We Accelerate the Transformation to a Carbon Free Energy System through:

EDUCATION

Raise awareness of practical and actionable solutions

FACILITATION

Drive collaborative problem solving

CREATION

Develop and deliver strategies and guidance our members can use

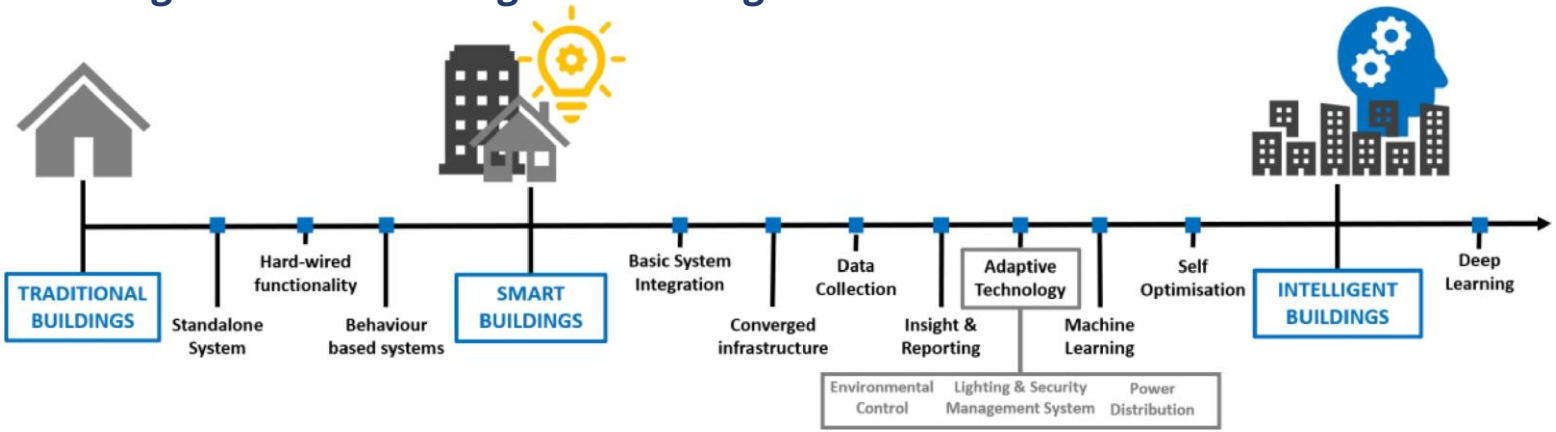
The Journey to Carbon-Free

Smart Electric Power Alliance

Ambitious Goals…

- Reduce U.S. greenhouse gas emissions 50-52% below 2005 levels in 2030
- Reach 100% carbon pollution-free electricity by 2035
- Achieve a net-zero emissions economy by 2050
- Deliver 40% of the benefits from federal climate/energy investments to disadvantaged communities

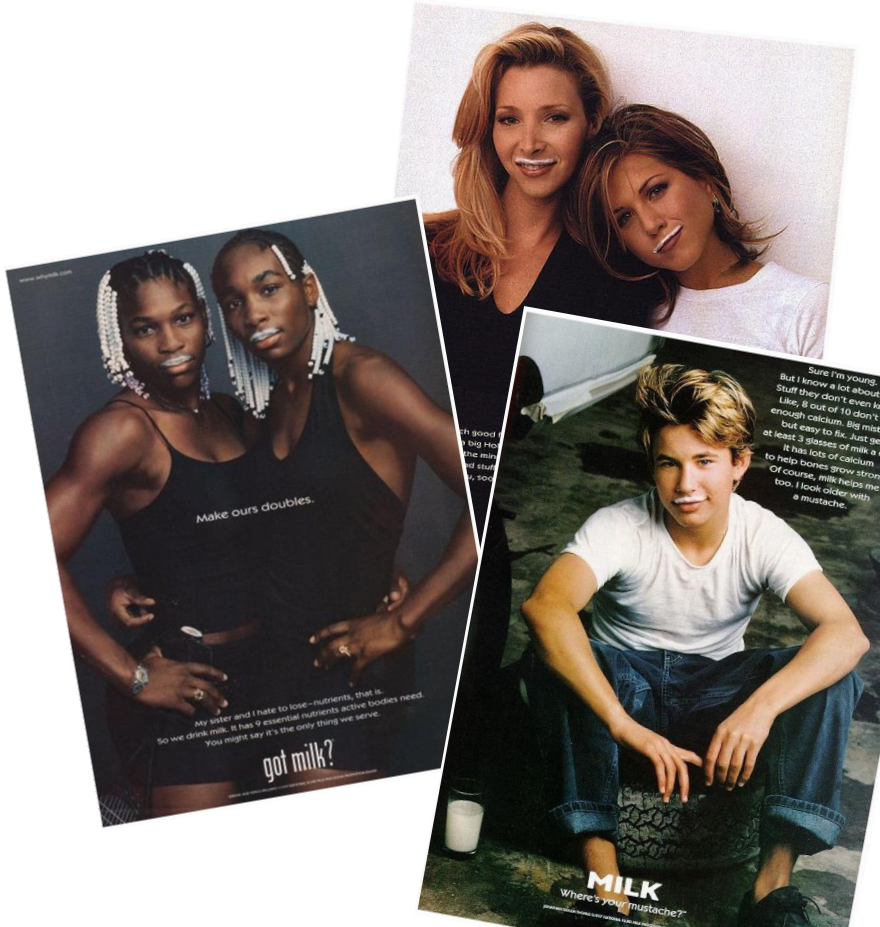
… and a Progression to "Intelligent" Buildings



Sources: U.S. White House Tien et al., 2022

Got AI?

- AI: computer algorithms solving “difficult tasks through experience and observations”
- Why now?
  - Years of investment to improve models
  - Vast digital data + new sensors
  - Computing power
  - Lower-cost remote (cloud) computing
- AI is most valuable when there is
  - Access to plentiful digital data
  - Value in automation
  - A need to wring insight from complexity
- AI advancements come at a time when energy systems & social systems are also changing



Data-Enabled Carbon Reduction

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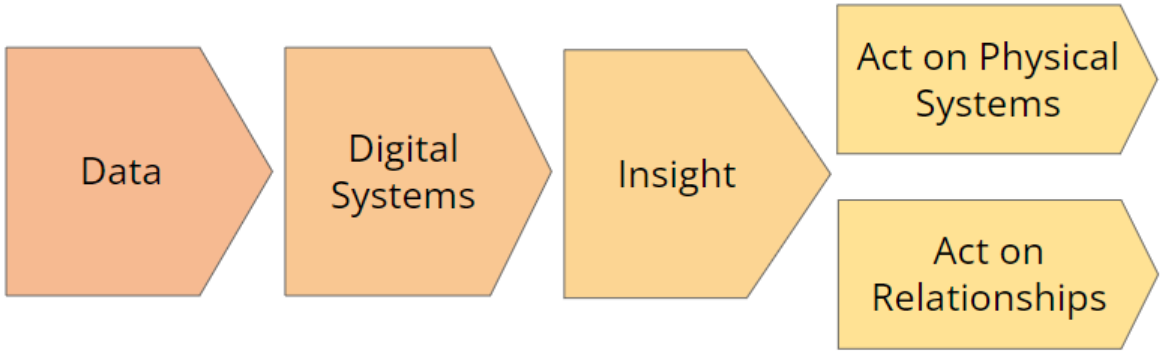
- What information would lead to more progress?
- How do we obtain that information?

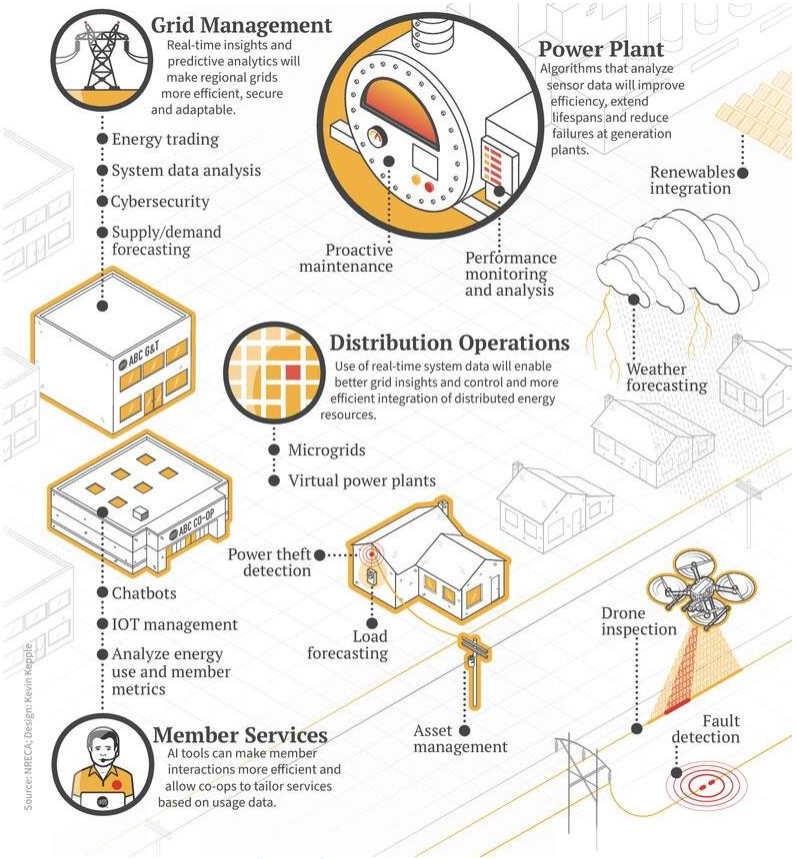


Target Outcome:
A carbon-free energy system that is safe, affordable, reliable, resilient and equitable

Work backwards from the target outcome
Also consider drivers (ex: complexity, speed, scarcity)

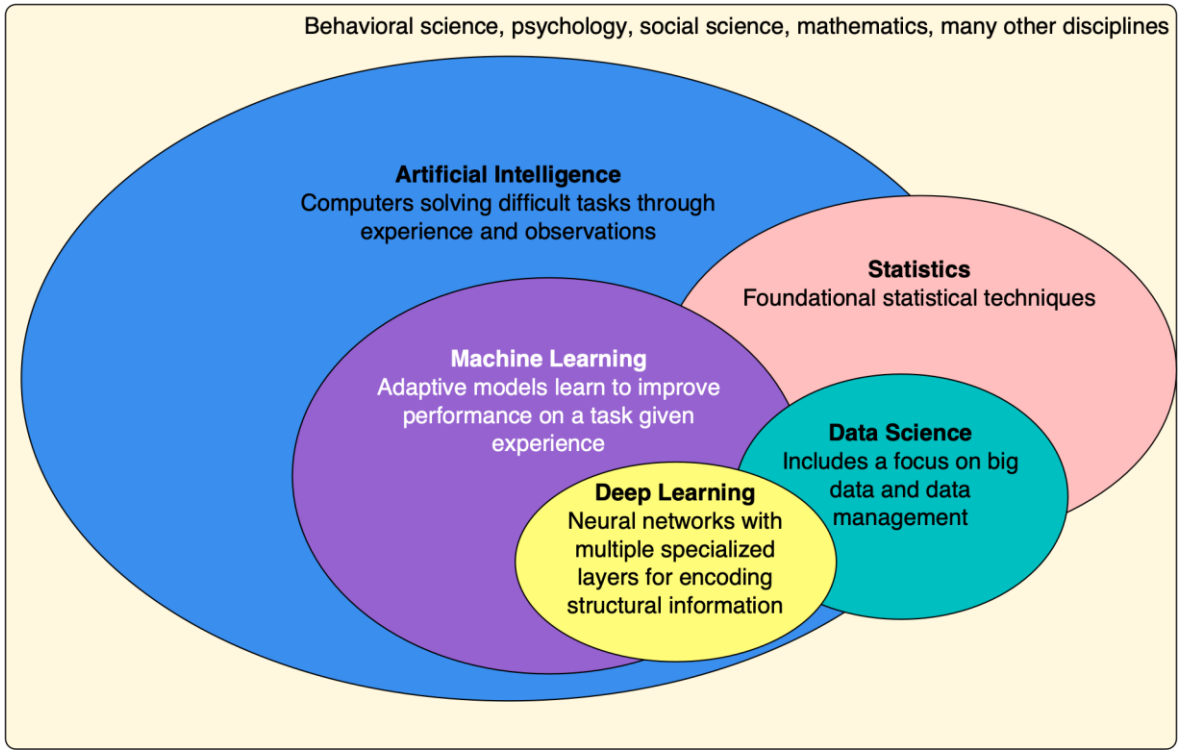
Opportunities for Advanced Analytics

- Forecasting and managing **load growth** is an increasing challenge– *How to make better predictions?*
- **Grid-interactive efficient buildings, smart communities**, **VPPs**, and **microgrids** require optimization– *How to best communicate & automate?*
- We are asking **customers** to embark on an increasingly-complex journey– *Can we simplify it?*
- Equitable solutions require **equitable participation**– *Is there a role for big data in community processes?*
- Digitally-immersed society – *How to manage effects of AI and digitization on **data center** consumption?*
- Few energy efficiency programs are "well positioned to **scale** to meet climate targets" (ACEEE, 2022)– *Can we do more with our data to accelerate progress?*
- And more…



Source: NRECA (2024)

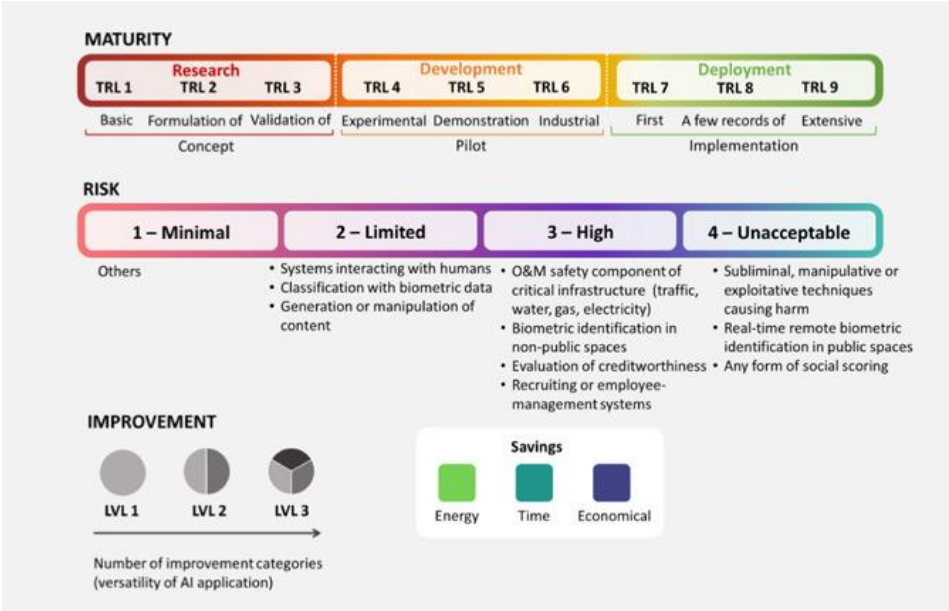
Advanced Analytics— A Family Tree

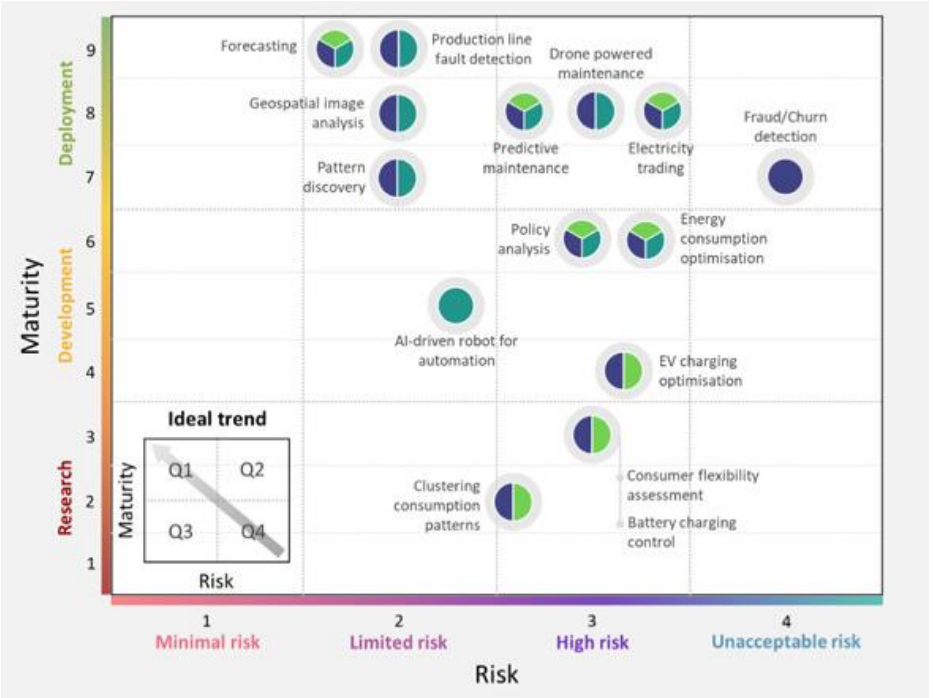


Source: Dr Amy McGovern – University of Oklahoma

Technology Evaluation

- Suitability and acceptability are multi-dimensional
- Frameworks can help clarify the big picture



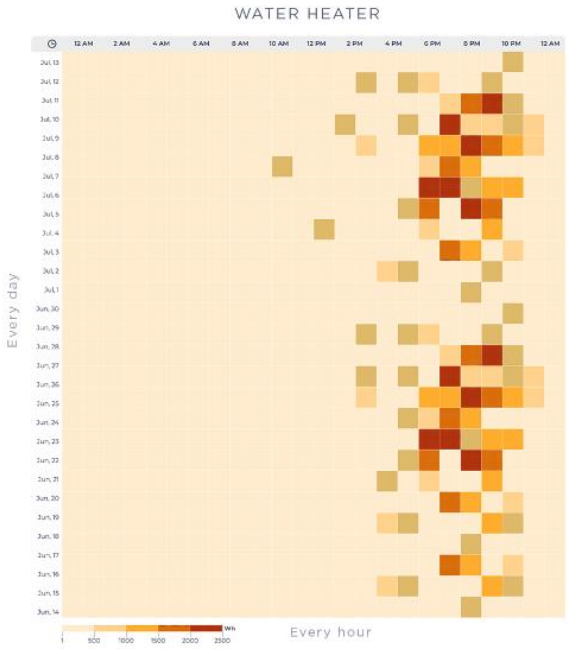


Source: Quest, et. al. (2022)

A Few Applications for EE/DR+ Program Design

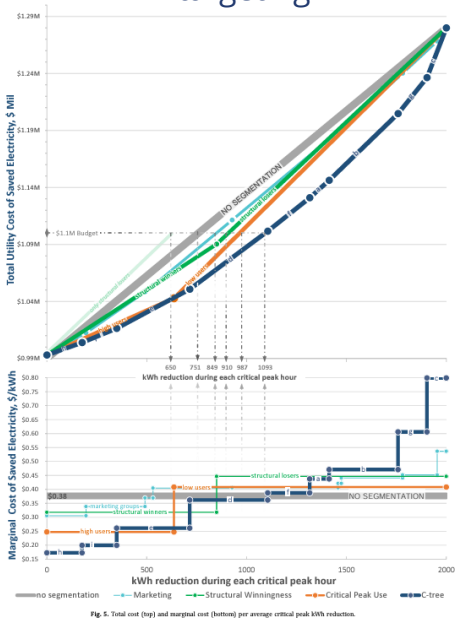
Smart Electric Power Alliance

Detecting appliances and usage at scale, via AMI data



Source: Bidgely

Improved customer segmentation & demand response program targeting



Source: LBNL (2020)

Operator-centric grid-interactive efficient building controls

Source: Community Energy Labs

Are Program Participants AI Literate?

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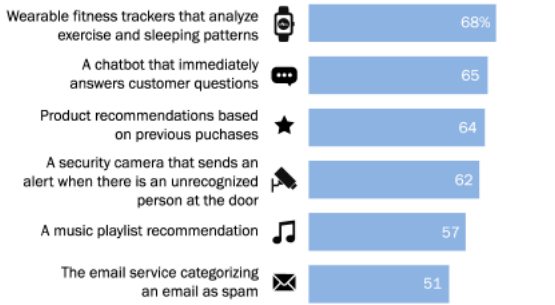
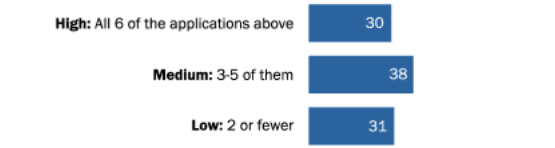
"The ability to understand, use, monitor, and critically reflect on AI applications– without necessarily being able to develop AI models." Laupichler et al. (2022)

Half of Americans or more aware of common uses of AI, but fewer can identify AI's role in all six examples

% of U.S. adults who identify that the following use artificial intelligence in multiple choice questions



% of U.S. adults who correctly identify ___ as using AI



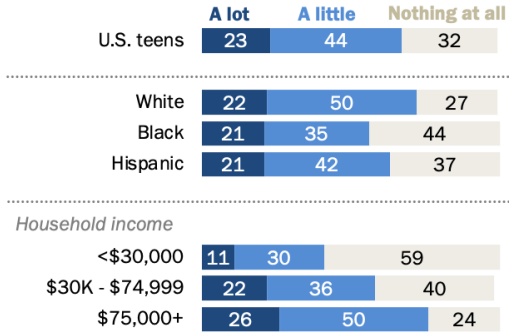
Note: All questions are multiple choice; for full question wording, see topline.
Source: Survey conducted Dec. 12-18, 2022.
"Public Awareness of Artificial Intelligence in Everyday Activities"

PEW RESEARCH CENTER

Source

Most teens have heard of ChatGPT, but awareness varies by race and ethnicity, household income

% of U.S. teens ages 13 to 17 who say they have heard ___ about ChatGPT, an artificial intelligence (AI) program used to create text



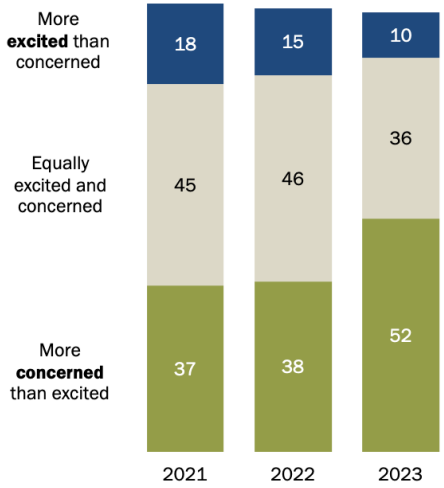
Note: White and Black teens include those who report being only one race and are not Hispanic. Hispanic teens are of any race. There were not enough Asian American teens in the sample to analyze responses separately. Those who did not give an answer are not shown.
Source: Survey of U.S. teens ages 13 to 17 conducted Sept. 26-Oct. 23, 2023.

PEW RESEARCH CENTER

Source

Concern about artificial intelligence in daily life far outweighs excitement

% of U.S. adults who say the increased use of artificial intelligence in daily life makes them feel ...



Note: Respondents who did not give an answer are not shown.
Source: Survey conducted July 31-Aug. 6, 2023.

PEW RESEARCH CENTER

Source

U.S. Blueprint for an AI Bill of Rights

Smart Electric Power Alliance

 **Safe and Effective Systems**	You should be protected from unsafe or ineffective systems.
 **Algorithmic Discrimination Protections**	You should not face discrimination by algorithms and systems should be used and designed in an equitable way.
 **Data Privacy**	You should be protected from abusive data practices via built-in protections, and you should have agency over how data about you is used.
 **Notice and Explanation**	You should know that an automated system is being used and understand how and why it contributes to outcomes that impact you.
 **Human Alternatives, Consideration, and Fallback**	You should be able to opt out, where appropriate, and have access to a person who can quickly consider and remedy problems you encounter.

Source: White House Office of Science and Technology Policy. “Blueprint for an AI Bill of Rights” October 2022

Contact Us

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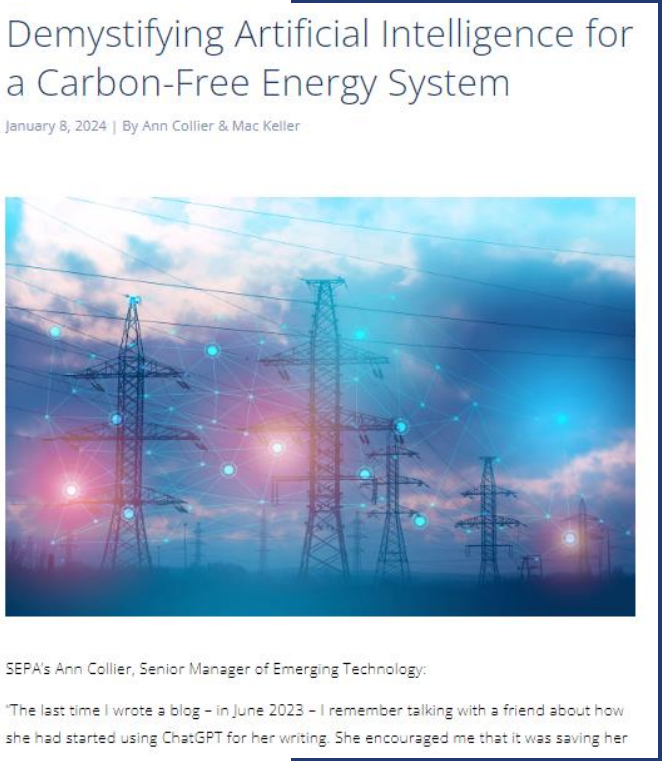

Blog

Micaela Christopher

Uplight


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Harnessing the Power of AI for Energy Efficiency

How Increasingly Complex Data has Impacted Uplight's Adoption of AI Technologies

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Who Am I?

Micaela Christopher

- PhD in Cognitive Psychology from the University of Colorado at Boulder
- Started at Tendril in March 2016 as a Data Scientist
- Director of Data Science and Engineering over our four Platform Analytics teams
  - Hypothesis: Bringing together software devs, data engineers, and data scientists drives quicker ML development and establishes robust processes/templates for other teams to utilize

Outline

Outline

- A Brief Introduction to Uplight
- How Uplight Approached Energy Efficiency in 2016
- The Impact of AMI Data
- The Impact of Smart Device Data
- The Connected Customer Journey
- Next Phase of Uplight AI
- Focusing on Customers' Rights and Access
- A Note about Training Data
- Wrapping Up

A Brief Introduction to Uplight

Our Impact

IDENTIFY & ENGAGE

REACHING
TWO THIRDS OF
U.S. ENERGY
CUSTOMERS

110
MILLION
HOMES &
BUSINESSES

TRANSACT & ENROLL

$286M

IN ENERGY BILL
SAVINGS IN 2022

INTELLIGENT ORCHESTRATION

ENROLLING
ENERGY CUSTOMERS AT
THE RATE TO ADD

200MW

OF FLEXIBLE LOAD
ANNUALLY

840
THOUSAND TONS
OF CO_2e

ABATED IN 2022

How Uplight Approached Energy Efficiency in 2016

2016

Main types of data

- Monthly utility bills
- Demographics
- Weather

Main products

- Home Energy Reports (HERs)
  - Goal: up to 2% energy savings across many households
    - Over 7 TWh of energy savings
  - Opt-out design
- Tendril Building Model
  - Physics-based disaggregation

AI used for

- Determining eligibility for HER program
- Similar Home Comparisons
- Energy Disaggregation
- Measurement of energy savings

Small pilot for smart thermostat control

uplight

The Impact of Advanced Metering Infrastructure (AMI) Data

The Impact of AMI Data

Quantity of Data Increased

1 data point/household/month to ~3k data points/household/month

Unlocked New Models

- Propensity
  - Solar, EV, TOU, etc.
- Detection
  - EV, HVAC Fuel type, etc.
- Usage insights
  - Mid-cycle updates
  - High bill alerts
  - Better disaggregation (Physics + ML)

Improved EE Performance

- Goal similar as before: Demystify energy use for end users
- Better able to target programs to those households most likely to save
- Increase believability of results
- Allow households to adjust during a billing cycle, not just retroactively

The Impact of Smart Device Data

Smart Device Data

Smart Devices

- Internet of Things (IoT) devices connect and exchange data over the internet.
  - Includes smart thermostats, EV chargers, and electric hot water heaters
- Uplight not only collects data from devices, but can also communicate and control devices (opt-in only)
- Similar coverage to AMI data (i.e., sub-hourly resolution)

Unlocking Energy Efficiency

- Per the DOE, air conditioning accounts for ~6% of all electricity produced in the United States
  - Cost of $29 billion
  - 117 million metric tons of carbon dioxide
- Uplight uses smart device data + weather to model and optimize HVAC run schedules alongside internal temperature
  - Demand Response
  - Continuous Demand Management (e.g., TOU rates)
- Ended 2023 with 400k+ smart thermostats and EV chargers under management

The Connected Customer Journey

Energy Efficiency through Connection

- Uplight formed in 2019
  - Tendril, Simple Energy, First Fuel, Energy Savvy, Ecotagious, and eeMe
  - Agentis and AutoGrid added in 2022 and 2024
- New data and models!
  - Business customer data and associated models
  - Marketplace product
- Full complement of products for the energy consumer
  - Education around consumption and rates
    - Aide in monitoring changes in consumption
  - Personalized actions and offers based on the location + account
  - Track purchases of energy efficient products
  - Actively optimize smart devices

Next Phase of Uplight AI

AutoGrid Acquisition

More Data! New Models!	Deeper Connection to the Grid	Globalization
Established Virtual Power Plant (VPP) and Distributed Energy Resource Management System (DERMS) provider Additional classes of smart devices (water heaters, HVAC systems, solar, and grid-scale storage)	Adding 8 GW of load under management Greatly expands upon our existing smart device product offerings	Working with utilities and businesses in North America, Europe, and Asia

Appreciate that risks around AI are becoming even higher with increased integration with the grid + international presence

Focusing on Customers’ Rights and Access

Take Data Protections Seriously

DPA Updated Regularly	Data Processing Addendum (DPA) kept in compliance with changing privacy laws. Legal and Compliance work closely with Security, Product, and Engineering to balance successful outcomes with policy
Allow Opt-Outs	Products with direct control over devices *always* opt-in at start and allow for opt-outs. All other products also allow opt-outs.
Data Lineage + Governance	We continually iterate and improve upon our architecture to track data through our systems and models, while limiting access
Partner with Clients	Utility clients take their customer protection very seriously and we partner with them on every contract
Look for Ways to Improve	The world is going to constantly change. Staying ahead and adapting will take effort.

Focus on Inclusion of Diverse Communities

Because our main clients are utilities, we have data on the entire customer base

However we are aware of limitations to eligibility and benefiting from our products. For example:

- Low-to-Moderate Income (LMI) customers may not always provide the largest energy efficiency savings
- Renters limited in what changes they can make to their homes/apartments
- Smart Device programs require good, solid internet connections

Uplight Product Managers look to find and close gaps in the customer base with alternative solutions

- For example, LMI customers can receive specific offers and messaging to help them find opportunities for energy cost savings

A Note about Training Data

Training Data

Source of Many AI Problems

Bad data + Any Model = Bad Results

Data can be bad for quantity as well as quality

Finding, vetting, and cleaning data is a skill that takes training and time

PSA: If you do not know and trust the data used to train a model, be skeptical of any result from that model

Never Good Enough

Product will never run out of ideas, but we can not develop a solution unless our training data supports that use case

Source data from utilities, third parties, and end users

Always looking for new and better data for our models

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Wrapping Up

AI-enabled Energy Efficiency is key to Uplight's success

My experience at Uplight over the last 8 years shows how increasing quality and quantity of energy data has unlocked new types of models

I find it super rewarding to put my skills towards helping folks use less energy

Acknowledgement that increased data complexity comes with increased responsibilities towards the safeguarding and use of that data

Ongoing efforts by a cross-functional team is required

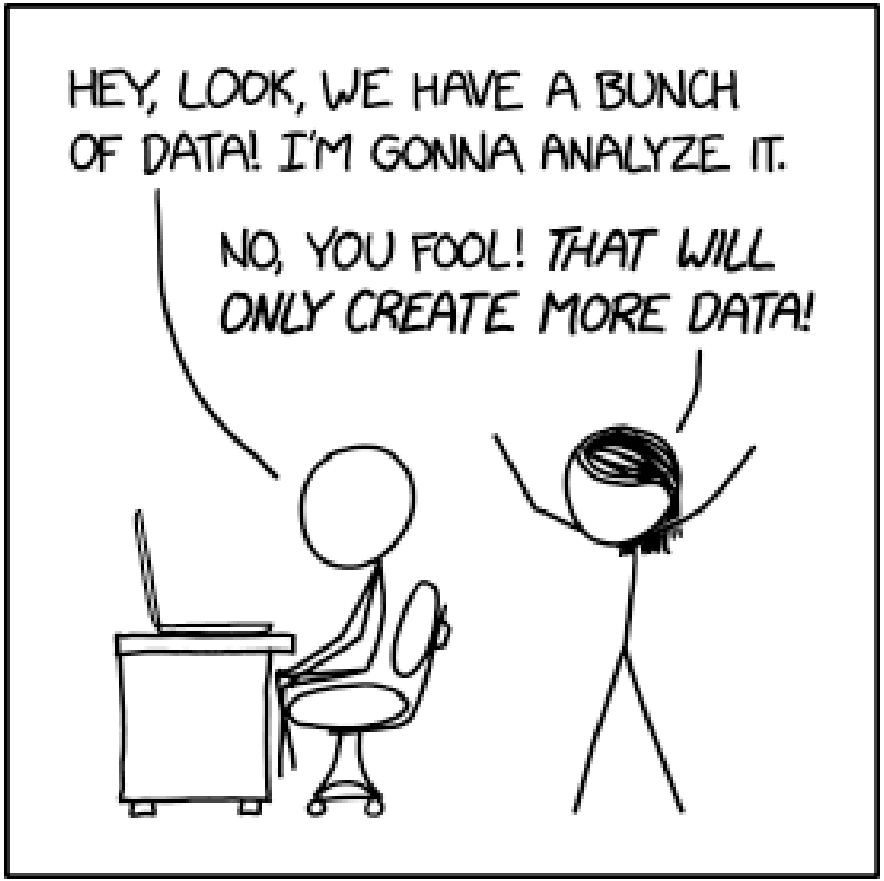

Image taken from https://xkcd.com/2582/

A Subset of Helpful Folks at Uplight

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Announcement:
Building America Retrofit Solutions Teams!

Team Leads and Locations:

Team Lead: Frontier Energy – Building Research and Consulting Business Unit
Location: Southwestern U.S.

Team Lead: Center for Energy & Environment
Location: Midwest U.S.

Team Lead: Enterprise Community Partners Inc.
Location: Western and Central U.S.

Team Lead: Steven Winter Associates
Location: Northeastern U.S.

Team Lead: EXP
Location: Eastern U.S.

Team Lead: Cycle Architecture, PLLC
Location: Northeastern U.S.

Team Lead: Syracuse Center of Excellence in Environmental & Energy Systems
Location: Northeastern U.S.

Team Lead: Earth Advantage
Location: Pacific Northwest U.S.

Team Lead: Southeast Energy Efficiency Alliance
Location: Southeastern U.S.

Building America Retrofit Solutions Teams

A portfolio of field demonstration projects leading to de-risked, equitable, and scalable technical retrofit solutions in the existing U.S. housing stock

Building America
U.S. DEPARTMENT OF ENERGY

Nine Multi-Disciplinary Teams Each Consisting Of:

Scan QR code to learn more about the teams!

Key Objectives:

- **Reduce risk** of retrofits to end-user, utilities, contractors, financiers.
- **Improve value proposition** of retrofit improvements to end-user, utilities, regulators.
- **Develop, disseminate, and promote** use of best retrofit practices.
- **Inform** technology development to meet end-user/contractor needs.

Teams will engage directly with communities to identify retrofit needs and develop best practice guidance for broader, scalable retrofit implementation (timeline: 1–3-year projects)

Smart Tools for Efficient HVAC Performance (STEP) Campaign

Pacific Northwest NATIONAL LABORATORY

STEP CAMPAIGN

Scan this QR code to visit our website

Contact: christian.valoria@pnnl.gov

The STEP Campaign aims to increase adoption of smart diagnostic tools to streamline HVAC system performance testing and troubleshooting, reducing energy-wasting faults and improving occupant comfort.

To join the STEP Campaign, visit: bit.ly/3DFmEaE

HVAC Contractors and Technicians

- Reduce callbacks, improve consistency and quality, streamline processes
- Find out where to get training on smart diagnostic tools
- Be recognized for successful adoption of smart diagnostic tools!

Utilities and Program Implementers

- Streamline quality installation and quality maintenance programs
- Improve engagement with your contractors
- Be recognized for programs that utilize smart diagnostic tools!

HVAC Training Organizations

- Offer qualified training on System Performance with smart diagnostic tools
- Promote your training events
- Be recognized for providing training!

Weatherization Organizations

- Ensure your ASHP/CAC installations are operating at optimized efficiency
- Develop pilot with PNNL team
- Be recognized!

ORGANIZING PARTNERS

ACCA · BUILDING PERFORMANCE ASSOCIATION · CEE Working Together, Advancing Efficiency · HVAC Excellence · NATE · neea · U.S. DEPARTMENT OF ENERGY

Explore the Residential Program Guide

Resources to help improve your program and reach energy efficiency targets:

- Handbooks - explain *why* and *how* to implement specific stages of a program.
- Quick Answers - provide answers and resources for common questions.
- Proven Practices posts - include lessons learned, examples, and helpful tips from successful programs.
- Technology Solutions NEW! - present resources on advanced technologies, **HVAC** & **Heat Pump Water Heaters**, including installation guidance, marketing strategies, & potential savings.
- Health + Home Performance Infographic – spark homeowner conversations.

https://rpsc.energy.gov

Health + Home Performance Infographic

DOE's Health + Home Performance Infographic reveals the link between efficiency and health – something everyone cares about. Efficiency programs and contractors can use the question-and-answer format to discover a homeowner's needs.

The infographic is ideal for the "kitchen table" conversations where people decide what to do – and who they want to do it. It also has links for homeowners to find a qualified contractor if they do not already have one.

Download this infographic from DOE's Better Buildings Residential Network.

Looking for photos to help tell your energy efficiency story? Visit our image libraries: https://www.energy.gov/eere/better-buildings-residential-network/articles/image-libraries

Thank You!

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Please send any follow-up questions or future call topic ideas to:
bbresidentialnetwork@ee.doe.gov