Potential Impact of IoT Loads

Emerging Connectivity on the Grid

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IoT and Connected Devices

- IoT (Internet of Things) is a high level term for a device that connects to networks and transmits device status / operational data.
- IoT connectivity opens a potential means of utility & consumer (RCI) partnerships including -
  - DR, Load Shifting, Monitoring, & Management.
- IoT devices combine to create “smart” applications like smart homes, smart buildings, smart industries, and smart cities.
- Smart applications allow for a centralized means of access and control -
  - Data is largely proprietary or inaccessible to utilities / aggregators.
Energy Efficiency Continues to Evolve: “The 4 Waves”

1st Wave (~1970s)
- DOE codes and standards
- Energy Star program

2nd Wave (~1990s)
- Utility energy efficiency programs
- ~$6B per year to accelerate adoption

3rd Wave (~2006)
- Micro efficiency leading to macro efficiency
- Example – iPhone LED/OLED screen leads to hyper-efficient large-screen TVs

4th Wave (Now)
- Connected systems (Internet of Things)
- Machine learning/AI energy management
New Opportunities

- IoT connectivity delivers a range of new opportunities, consumer options, data streams, and potential municipal/utility services
Example IoT / Connected Devices and Applications

- TVs and projectors
- Washers / Dryers
- Refrigerators
- Dish washers
- Water heaters
- Heat pumps
- Air conditioning
- Wearables
- Speakers
- Thermostats
- Interior lighting

- Sensors / Meters
- Security systems
- Robots
- Smart poles / Streetlighting
- Autonomous / Smart vehicles
- Smart parking
- Ranges / Ovens
- Locks
- Security Cameras
- Retail / Interactive Kiosks
- ..... More and more daily .....
IoT Market by Application

Source – Statista / Grand View Research

Consumer Electronics
Estimated to be $180 Billion by 2022

Transportation
Estimated to be $140 Billion by 2022
IoT Infrastructure Market Size By Application

- **Market size in billion U.S. dollars**
  - **2016**
    - Smart cities: $3.05 Billion
    - Smart buildings: $7.35 Billion
    - Smart homes: $4.55 Billion
  - **2024**
    - Total Market: $33.15 Billion
    - Smart cities: $4.55 Billion
    - Smart buildings: $21.25 Billion
    - Smart homes: $4.55 Billion

**Source** – Statista/Global Market Insights
Connected technologies comprise the majority of end use devices currently targeted for evaluation by EPRI end use technology researchers.

- IoT and connected devices have been the focus of EPRI’s recent CES reports.
- All EPRI programs and sectors are evaluating how IoT will impact their areas of research.
- EPRI’s recently launched AI initiative is focused on using IoT device data for utility and consumer benefit.
IoT Connectivity

- IoT devices provide data, and enhanced levels of information, to consumers, manufacturers, installers, equipment owner/operators, municipalities, utilities and others.
- Data from connected IoT devices are the foundation of smart homes, smart buildings, autonomous vehicles, interactive marketing, real time information displays, and other applications that provide the infrastructure for smart cities and a connected grid.
Connectivity Options and Flexibility

- There are a range of protocols
- Their use varies by application
- Consumers want seamless experiences

- Embedded computing drives functionality
- Data storage and communication are the backbone to smart devices
  - Data centers will be impacted
  - Data security is critical
Ecosystems and Protocols
5G and Connectivity

5G Connectivity Node

Equipment for IoT services in the 5G era. Integrated with WiFi, Bluetooth, and other communication technology modules to serve as a bridge between various IoT devices and 5G network.
Connected Televisions

8K

Google Assistant

SMART

androidtv

OLED

cocao tv

8K

Chiq Smart TV

Alexa

Chiq Smart TV 6 Series

Netflix

Prime Video

androidtv

Cinema+
Connected Washer / Dryer / Dish Washing

Haier Smart Washing Machine

Whirlpool All-In-One Washer & Dryer is compatible with Apple Watch®
Connected Closet
Smart Kitchens
Connected Lighting
Smart Thermal

Voice Control & Body Sense

Honeywell Home
T6 Pro Z-Wave Thermostat

Turn the AC to 78 fahrenheit

Dim the table lamp.
Smart Air and Water Purification

Automated filter replacement through Amazon’s Dash Replenishment Service
Smart Mirrors
Non Traditional IoT Loads

Meet Phyn, your smart water assistant.

- **Leak Alerts**
  Mobile alerts as soon as Phyn detects a leak.

- **Auto Shutoff**
  Mitigate damage in event of a leak.

- **Remote Shutoff**
  Control your home’s water shutoff from anywhere.

- **Plumbing Check**
  Daily diagnostic tests find pinhole leaks.

- **Water Use**
  See your water use monthly, weekly, daily and hourly.

- **Water Use Plus**
  Insights on your home’s water use by fixture type.

- **Multi-Property**
  Monitor and manage up to six properties.

- **Frozen Pipe Detection**
  Early warning alerts before a pipe freezes.

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KOHLER Konnect. smart products have the ability to transform your bathroom using light, sound, color and water. And with built-in voice control, it all happens seamlessly. From exotic to energizing, and every feeling in between, your bathroom can finally do what no other can—create an experience as unique as you.
Smart Homes

Smart Living

Somfy - The most complete Smart Home Experience

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Consumer IoT Impact

- Climate control
- Lighting fixture and level control
- Personalization
- Energy management
- Window / Door / Security monitoring
- Camera integration and monitoring
- Geo fencing
- SMS / Text device notification
- Energy management

- New devices to acquire and control
- Phone / App level device monitoring
- Centralized / Curated remote or cloud based control
- Increased opportunities to shift / schedule device operation
- Easy access to historic usage data
- Potential ability to engage in manual and/or automated EE and DR events
- Consumer empowerment
Connected Retail
Smart Agriculture

WORKING SMART

Worldwide, John Deere machines are recording up to 15M sensor measurements every second. At 8 bytes per measurement, this is upwards of 100 MB per second into our cloud-based data platform. All of this data powers highly-automated Deere machines.

WHERE AUTONOMOUS TECHNOLOGY DELIVERS EXTRAORDINARY EFFICIENCY

BY USING AI TO PRECISELY MANAGE EACH PLANT
Smart Buildings
Smart Industry
Smart Cities

- Smart City concepts entail a myriad of IoT (the Internet of Things) technologies that combine to deliver enhanced experiences and benefits to residents.
Smart Cities
Autonomous Connected Shuttles
Autonomous Connected Service Vehicles
Smart Regions

Connect your world with SmartThings
Integrated Grid
Connecting Central Generation and DER with Customers
that’s More Adaptive, Predictive, Dynamic and Flexible
Further Expansion of the Connected Energy Network

A Digitally Connected Grid
Sensors, Information, Communication, Analytics + Artificial Intelligence
Community / Utility IoT Impact

- Cumulative and device level IoT data can be used to provide new services and benefits including:
  - Smart asset tracking
  - Centralized real time event monitoring
  - Traffic / Parking optimization
  - Trash can detection
  - Automated operational status / state logging
  - Targeted maintenance, scheduling and planning

- DERMS and VPP functionality - similar but different options

- **DERMS (Distributed energy resource management system)** – software solution that uses IoT data to allow for grid voltage management, optimization of power flow, and local / smart grid management

- **VPP (Virtual Power Plant)** - software solution that uses IoT data to allow for grid frequency stabilization, energy trading, portfolio management, and peak load/demand management
### IoT Risk Example - Grid Security of Connected Devices

- **As end-use devices are become more connected, the risk of a coordinated cyber-attack using internet connected appliances and loads increases**

- Several demand response are currently online and controlling end-use loads for peak shaving and load balancing.
  - Example Mosaic Power advertises that they control approximately 15,000 water heaters for frequency regulation.
  - If a single platform controlled 1,000,000 water heaters (1% of total US water heaters), it would have the capacity to instantly change demand on the order of 4,500 MW
    - That is larger than the largest nuclear power plant in the U.S.
  - Shifting this much power could disrupt the electrical grid in various ways: 1) Cause Frequency Disturbance, 2) Cascading Line Failures, 3) Increase Operating Cost.
Summary

- The IoT market is rapidly expanding both in offerings and in revenue.
- IoT devices provide data and enhanced levels of information to consumers, manufacturers, installers, equipment operators, municipalities, utilities and others.
- IoT devices within smart homes, smart buildings, smart industrial processes, smart communities, autonomous vehicles, and other connected devices deliver the data that creates smart cities / smart regions and a connected grid.
- IoT devices depend on reliable communication and centralized storage / analysis.
- IoT devices and their data create opportunities for consumers, cities and utilities.
- As end-use devices become more connected, the risk of sporadic and/or coordinated cyber-attacks increases, so planning and consistent monitoring are vital.
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