Smarter Buildings, Stadiums, Campus and Cities

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Smarter Buildings Make for a Sustainable Future

Here in New York, people pay one of the highest energy rates in the country, which drives $15 billion of energy bills for our buildings every year.

More than 75 percent of CO2 emissions in New York come from heating, cooling and providing electricity to buildings. That's more than double the national average.

By

Florence Hudson, Contributor

IBM Energy and Environment Strategist and an expert on designing "smart buildings."


Source: https://www.huffpost.com/entry/smarter-buildings-make-fo_b_762656
Sustainable Buildings: What Are We Waiting For?

We can make incredible progress towards a more sustainable future using the tools we have and the inventions that already exist.

By Florence Hudson, IBM Energy and Environment Strategist and an expert on designing "smart buildings."

- The building sector is responsible for more electricity consumption than any other sector, 42 percent, and 15 percent of all greenhouse gas (GHG) Emissions.
- In the U.S., buildings represent 72% of all energy usage and 39% of GHG emissions. Yet, up to 50% of that electricity is wasted.
- In New York City, buildings account for *68% of carbon emissions in 2022 (80% in 2010).
- By 2025, buildings will be the single largest energy consumers and emitters of greenhouse gas on our planet.

Building a Smarter Planet

- Measuring, Monitoring, Modeling, and Managing

- Our world is becoming **INSTRUMENTED**
  - Sensing/Metering
  - Data Collection
  - Real Time Data Integration
  - Real Time + Historical Data
  - Data Modeling + Analytics
  - Visualization + Decisions

- Our world is becoming **INTERCONNECTED**
  - Feedback to user and data source, incentives and actions to change behavior

- Things are becoming more **INTELLIGENT**
  - Feedback to user and data source, incentives and actions to change behavior

Source: TEDxNJIT, April 2012, [https://www.youtube.com/watch?v=P44VaTEYBF0](https://www.youtube.com/watch?v=P44VaTEYBF0)
Smarter Buildings

Going from LEED to LEEP - Leadership in Energy and Environmental Design to...Performance to reduce costs and improve efficiency

What’s smarter?

• Sensors and meters to collect data
• Interconnected, holistic energy and water management
• Integration of energy, water and asset management to lower operating costs

Smarter Business Outcomes

10% to 40% improvements in
• Reduced energy usage
• Reduced water usage
• Operational efficiency
• Asset life
• Costs

Fact:

• Buildings consume 70% of U.S. energy, generate 38% of GHGs - 80% in NYC
• Buildings create more CO₂ than all cars
• Up to 50% of energy and water wasted

Source: TEDxNJIT, April 2021, https://www.youtube.com/watch?v=P44VaTEYBF0
One Bryant Park in NYC was the first LEED Platinum Certified commercial skyscraper. One Bryant Park represents a shift in thinking about modern building design, achieving at large scale many of the green building movement’s most transformative ideas for water and energy conservation, material efficiency, and indoor environmental quality.

Water-saving measures, including greywater recycling, rainwater harvesting systems, and waterless urinals, save millions of gallons of potable water and reduce the building’s water consumption by nearly 50%. With an under-floor air system and 95% filtration, fresh air delivered to offices can be individually controlled and is actually cleaner when it is exhausted from the building. Recognizing its impact in the heart of a dense metropolis, thermal ice-storage tanks in the building’s cellar produce ice at night to cool the building, reducing the building’s peak demand on the city’s over-taxed electric grid. In addition, an onsite 4.6-megawatt cogeneration plant provides a clean, efficient power source for nearly 70% of the building’s annual energy requirements.

https://cookfox.com/projects/one-bryant-park/
## 8.2. Product mapping of top 10 player

**FIGURE 10. PRODUCT MAPPING OF TOP 10 PLAYERS**

<table>
<thead>
<tr>
<th>Company</th>
<th>HVAC Control</th>
<th>Lighting Control</th>
<th>Security and Access Control</th>
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<td>Legrand</td>
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</table>

*Source: Company Website, Annual Report, Secondary Research, and AMR Analysis*
A Smarter Planet is a System of Systems

**Smarter Cities**
- Improve efficiency
- Improve sustainability

**Intelligent Transportation Systems**
- Reduce traffic congestion
- Reduce CO₂ emissions
- Increase mass transit usage
- Improve environment

**Smarter Grids**
- Improve grid management, reduce outages
- Reduce energy usage / cost
- Incorporate renewable energy

**Smarter Buildings**
- Reduce energy and water usage / cost
- Reduce CO₂ emissions
- Integrate renewable energy

**Advanced Water Management**
- Flood risk management
- Reduce water and energy usage

**Alternative Energy Research**
- Energy storage
  - Thin films, advanced materials
  - Nanomembranes for desalination

Source: TEDxNJIT, April 2021, [https://www.youtube.com/watch?v=P44VqTEYBF0](https://www.youtube.com/watch?v=P44VqTEYBF0)
Smarter cities will be an interconnected “system of systems“ leveraging data to improve city operations, energy use, efficiency, safety, quality of life, the environment and the citizen experience.

Defining a Smart Campus

A Smart Campus leverages data to **improve student success, the student experience and campus operations**

Requires integration of Information Technology and Operational Technology to **better inform decision making** in each domain and across the campus

Achieving a Smart Campus will involve cross-campus collaboration with multiple stakeholder partnerships. These partnerships will include, but are not be limited to:

- Facilities
- Administration
- Central IT
- Research Community
- Campus Security
- Faculty & Students
THE VISION FOR A CONNECTED CAMPUS AT ASU

- Anomaly Detection
- Space Utilization
- Seamless Messaging Tools
- In-Seat Ordering
- EstimatedWait Times
- Smart Lighting
- Targeted Promotions
- Automated Attendance Tracking
- Classmate Collaboration
- Campus Wayfinding
- Predictive Building Maintenance
- Driverless Shuttles
- Crowd Monitoring
- Targeted Emergency Notifications

Connecting devices campus-wide to make more informed decisions and offer a more personalized experience.
Wearables for Access Control and Commerce –
enter classroom, dorm, stadium; track attendance; pay for food, books
ASU/Intel research collaboration in Sun Devil Stadium/Croke Park Stadium

- Crowd motion studies/facial expression recognition
- Environmental monitoring/feedback (fan control)
- Queue wait time estimation (concessions, restrooms)
- Noise monitoring/feedback (Victory Cheer game)
- Athlete performance monitoring/feedback (wearables)
- Real time parking density feedback/wayfinding
- Pitch/playing surface health
- Groundwater monitoring
Select Use Cases

**Student Ticketing**
- Complement Paciolan
- Equal access to seats for students on all campuses
- Simplify wristbanding process
- Promote attendance

**Game Day Navigation**
- Traffic, parking real-time info
- Campus walking directions
- Bus/shuttle schedules
- Custom event maps
Select Use Cases

In Seat Experience
- Digital signage integration
- Personal/group messaging using beacon / Wi-Fi data
- Polling, Gaming, Stats
- In seat ordering

Pre-Post Event
- Event-based posts/feeds
- Social media integration
- Location sharing
- Targeted coupons
Get Loud - Stadium Noise Meter
Attendance

People Counting
Queue Time (Hardware Solution)
Queue Time (Software Solution)
Device Development and Testing
Blue Tooth Bracelet
Cisco CMX for Wifi based identification
Real Time Parking

Live parking data is displayed on the ASU’s interactive map layer with color-coded polygons:

- red lots are full;
- yellow lots are almost full;
- green lots have plenty of capacity.
Campus Bird (Maps/Wayfinding)

- Custom event maps
  - Only relevant POIs
  - Custom POI information for events
  - Time-boxed availability
- Geo-fence definitions
- Ads / coupons associated with map categories or POIs
- Internal building maps
Graduation

- Devils on Campus App
  - Beacon
  - Tracking of attendance metrics
- Automated Push Campaigns based on location
- Push Notifications
- Trained stake holders to send push notifications.
Smart Campus Focus Areas

- Student experience & success
- Facilities/Buildings: lighting, HVAC…
- Smart stadiums: fan experience & revenues
- Define infrastructure standards
- Security: physical, data, holistic view
- Connected vehicles
- Identify adoption roadblocks
- Anticipating future needs

Smart Campus Challenges

- Managing the data
- Standards
- Ethics
- Infrastructure management
  - Power supply: batteries, PoE
  - Enterprise risk management
  - Privacy & security

Source: Florence D. Hudson, Internet2 Chief Innovation Office
Smart Cities, Campuses, & Communities will be built on a foundation of Internet of Things technologies.

**SMART CITY CONCEPTS**

- Smart Governance and Smart Education
- Smart Citizen
- Smart Energy
- Smart Technology
- Smart Infrastructure
- Smart Mobility
- Smart Building
- Smart Healthcare

Smart Grids are a key step in the development of Smart Cities/Campuses, and require end to end trust and security.

Smart Grid value is transformational and positively impacts:

- Transmission and network optimization
- Optimized renewables integration
- Distribution automation
- Advanced metering infrastructure
- Analytics for pattern recognition & optimization
- Cybersecurity for threat avoidance, identification and analysis

DOE Invests $61 Million for Smart Buildings that Accelerate Renewable Energy Adoption and Grid Resilience

OCTOBER 13, 2021

Ten “Connected Communities” Will Equip More than 7,000 Buildings with Smart Controls, Sensors, and Analytics to Reduce Energy Use, Costs, and Emissions

“These Connected Communities can interact with the electrical grid to optimize their energy consumption which will substantially decrease their carbon emissions and cut energy costs.”

GEBs - grid-interactive efficient buildings

Ten “Connected Communities” funded by DOE

• Electric Power Research Institute, Inc. (New York City, Seattle, San Diego) will transform multi-family buildings in affordable housing developments into GEBs that will demonstrate different ways to decarbonize buildings, make them more resilient, and reduce utility bills. (Award: $5.27M)

• IBACOS, Inc. (NC) for 1,000 new and existing homes (Award: $6.65M)

• Open Market ESCO LLC (MA) 20 low-income apartments (Award: $6.65M)

• PacifiCorp (UT) solar photovoltaic, batteries, electric vehicle charging. (Award: $6.42M)

• Portland General Electric (OR) will renovate over 500 buildings (Award: $6.65M)

• Post Road Foundation (ME, NH) Transactive Energy Services in rural communities. (Award: $6.65M)

• Slipstream Group Inc. (WI) 15 facilities in Madison, Wisconsin and EV charging (Award: $5.18M)

• Spokane Edo LLC (WA) Opportunity Zones of vulnerable populations. (Award: $6.65M)

• SunPower Corporation (CA) all-electric homes in Menifee, California with and community-scale battery storage. (Award: $6.65M)

• The Ohio State University (OH) will investigate the capacity of Ohio State’s existing on-campus connected community to provide essential but overlooked ancillary grid services from a diverse range of grid-interactive technologies in a cyber- and data-secure environment. (Award amount: $4.2M)
Columbia University Smart Cities and Buildings Initiatives

COLUMBIA ICSL

INTELLIGENT AND CONNECTED SYSTEMS LAB

Implementation

Building Energy Optimization Projects include:

- **ePrints**: a real-time and scalable system for fair apportionment and tracking of personal energy footprints in commercial buildings; Wei, Chen, Vega, Xia, Chandrasekaran, Jiang; ACM Systems for Energy-Efficient Built Environments (BuildSys 2017)

- **RecEnergy**: A Deep Reinforcement Learning Based Recommender System for Occupant-Driven Energy Optimization in Commercial Buildings; Wei, Xia, Chen, Qian, Li, Jiang; IEEE IOT Journal

Research Coordination Network (RCN): Sustainable Cities, People and Infrastructures at the Water-Energy-Climate Nexus
Questions & Answers…

Thank You

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