Smarter Buildings, Stadiums, Campus and Cities

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HUFFPOST

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."

Oct. 14, 2010, 11:47 AM EDT | **Updated** May. 25, 2011

Source: https://www.huffpost.com/entry/smarter-buildings-make-fo_b_762656

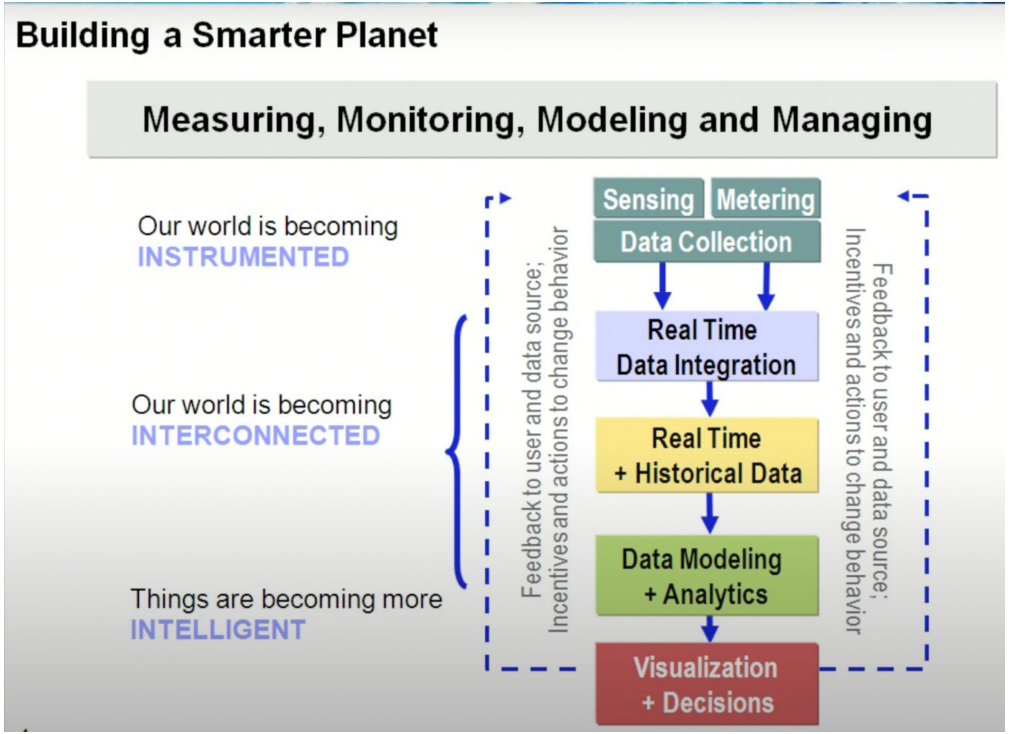
Sustainable Buildings: What Are We Waiting For?

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

Source: https://www.huffpost.com/entry/sustainable-buildings-wha_b_683190 , *Aug. 16, 2010 | **Updated** May. 25, 2011;*
**https://www1.nyc.gov/site/sustainability/codes/buildings.page*



Source: TEDxNJIT, April 2012, 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

Fact:
- Buildings consume 70% of U.S. energy, generate 38% of GHGs - 80% in NYC
- Buildings create more CO_2 than all cars
- Up to 50% of energy and water wasted

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

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

COOKFOX

https://cookfox.com/projects/one-bryant-park/

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.**

Allied Market Research

8.2. Product mapping of top 10 player

FIGURE 10. PRODUCT MAPPING OF TOP 10 PLAYERS

Company	Product Type		
	HVAC Control	Lighting Control	Security and Access Control
Beijer Electronics			
Honeywell International			
Schneider Electric			
Siemens AG			
General Electric			
ABB			
Johnson Controls			
Control4			
Lutron Electronics			
Legrand			

Source: Company Website, Annual Report, Secondary Research, and AMR Analysis

Global Building Automation and Controls Market

Opportunity Analysis and Industry Forecast, 2020-2027

A Smarter Planet is a System of Systems

Smarter Cities
- Improve efficiency
- Improve sustainability

Intelligent Transportation Systems
- Reduce traffic congestion
- Reduce CO_2 emissions
- Increase mass transit usage
- Improve environment

EV

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

Smarter Buildings
- Reduce energy and water usage / cost
- Reduce CO_2 emissions
- Integrate renewable energy

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

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

Source: TEDxNJIT, April 2021, https://www.youtube.com/watch?v=P44VaTEYBF0

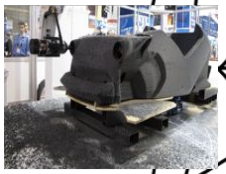
Smarter cities will be an interconnected “system of systems“ leveraging data to improve city operations, energy use, efficiency, safety, quality of life, the environment and the citizen experience

Mesh Networks

V2V, V2I, V2H, V2P

Smart Grid & MicroGrid

Smarter Transportation



Smart Homes & Buildings

Industrial IoT

Connected Healthcare

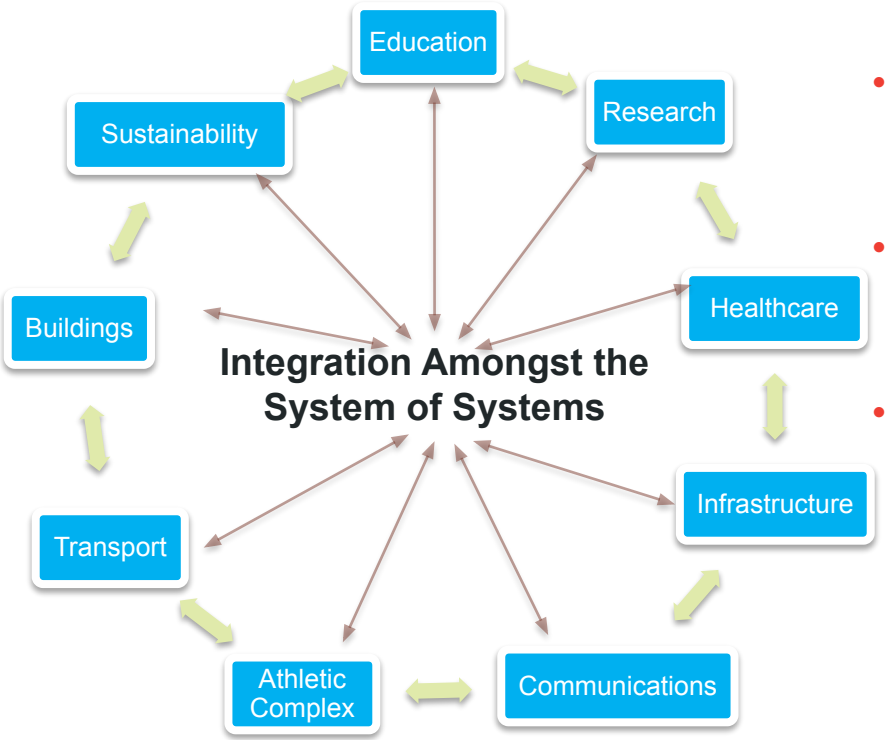
TIPPSS

(Trust, Identity, Privacy, Protection, Safety, Security)

Connected Citizens

Source: Florence D. Hudson, updated from NSF Future Wireless Cities Workshop, The Washington Campus, Washington, D.C., Feb 2016

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
  - Central IT
  - Campus Security
  - Administration
  - Research Community
  - Faculty & Students

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

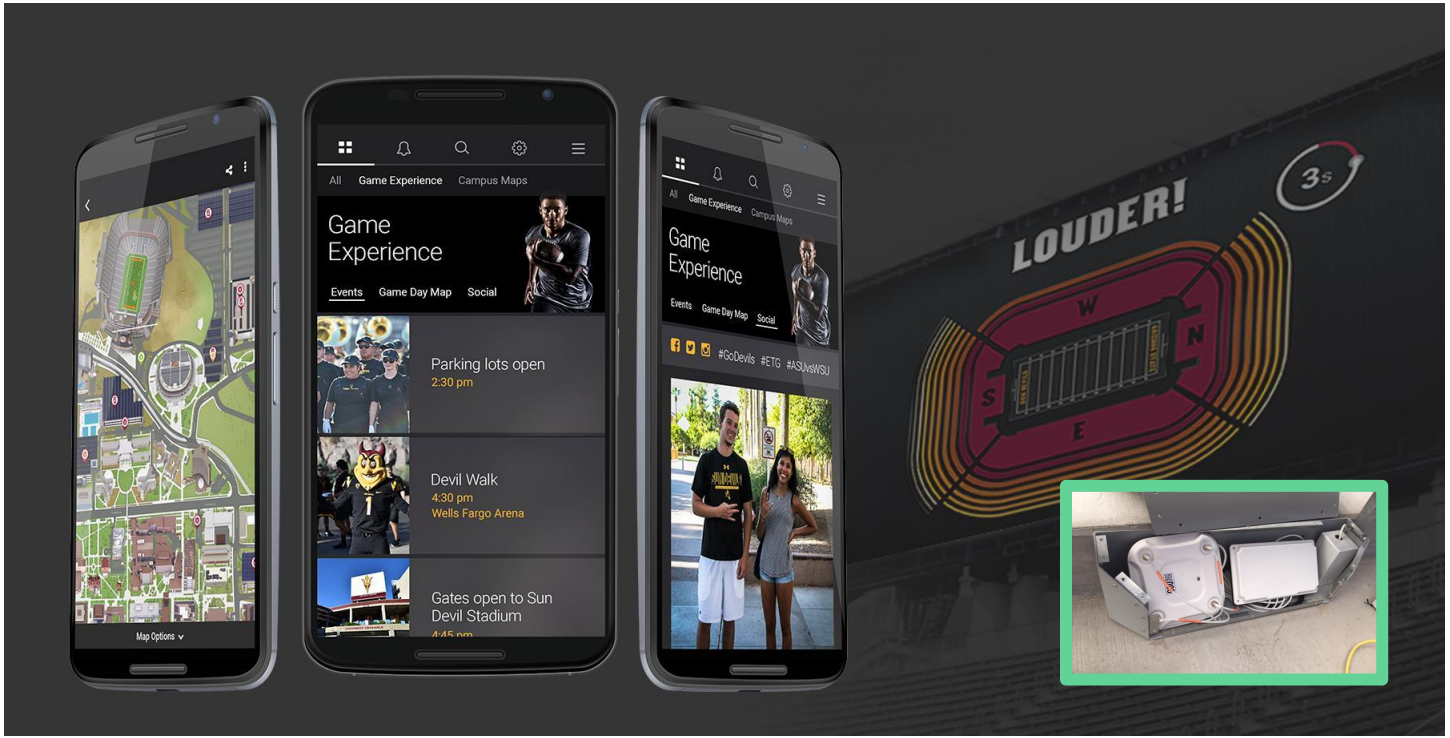
Select Use Cases

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

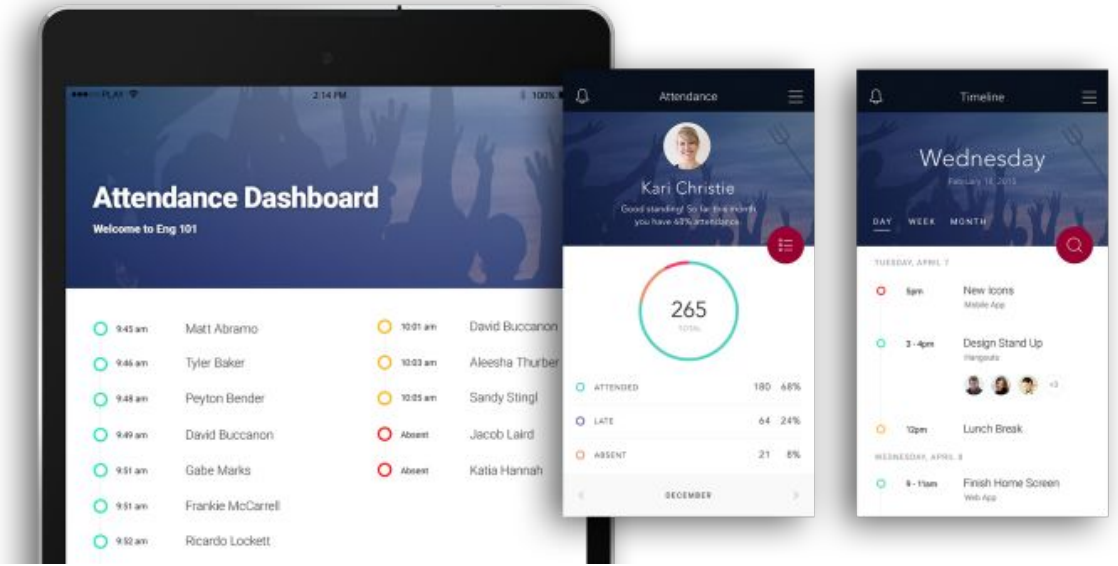
Queue Time (Hardware Solution)

Queue Time (Software Solution)

Device Development and Testing

Blue Tooth Bracelet

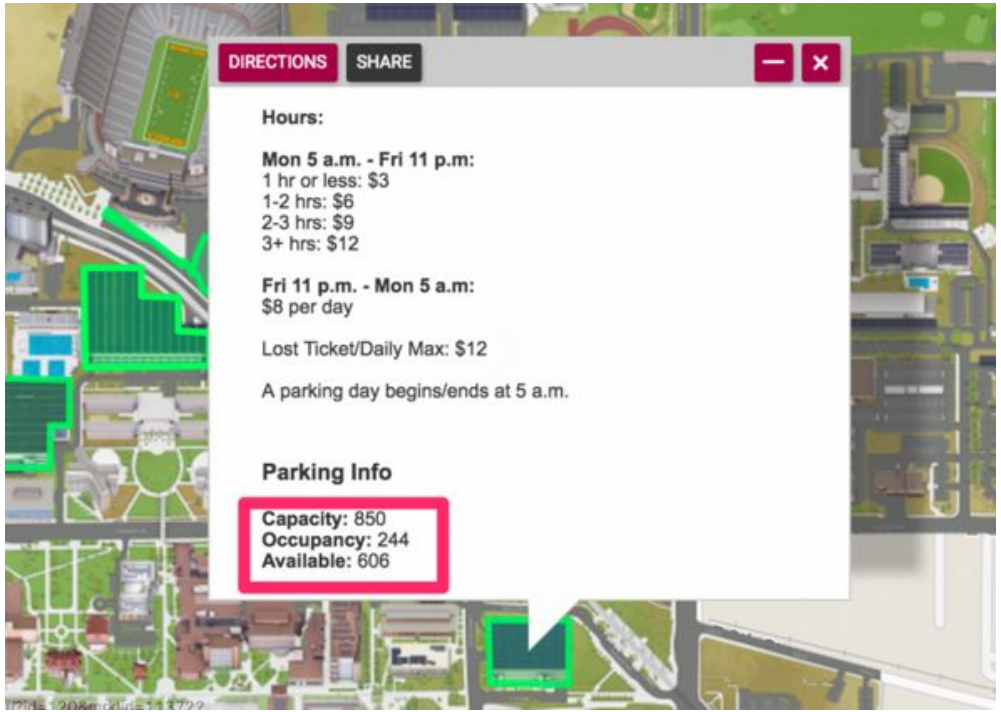
Cisco CMX for Wifi based identification



Real Time Parking

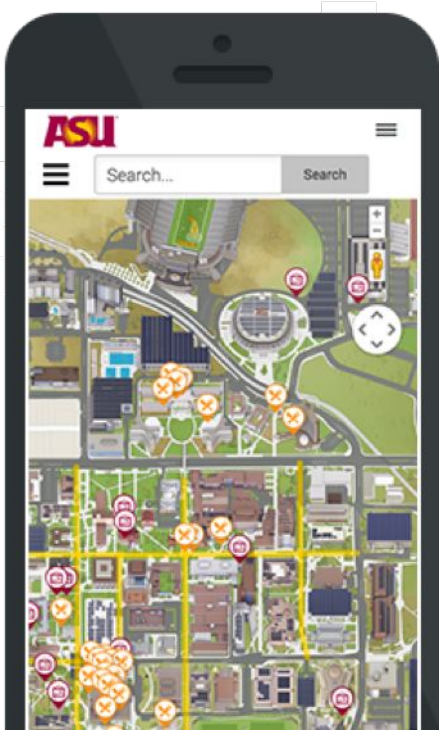
Live parking data is displayed on the ASU's interactive map layer with color-coded polygons:

- red lots are full;
- yellow lots are almost full;
- green lots have plenty of capacity.



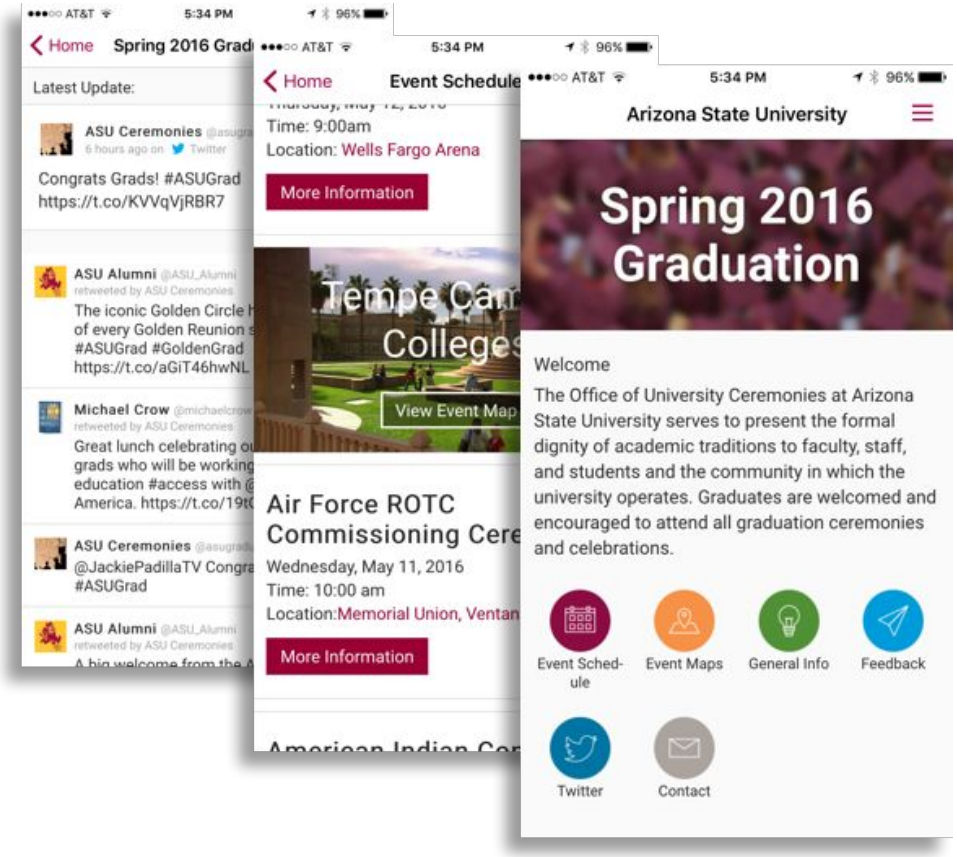
Campus Bird (Maps/Wayfinding)

- 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.



CIO Smart Campus Advisory Council Interview Results

Smart Campus Focus Areas

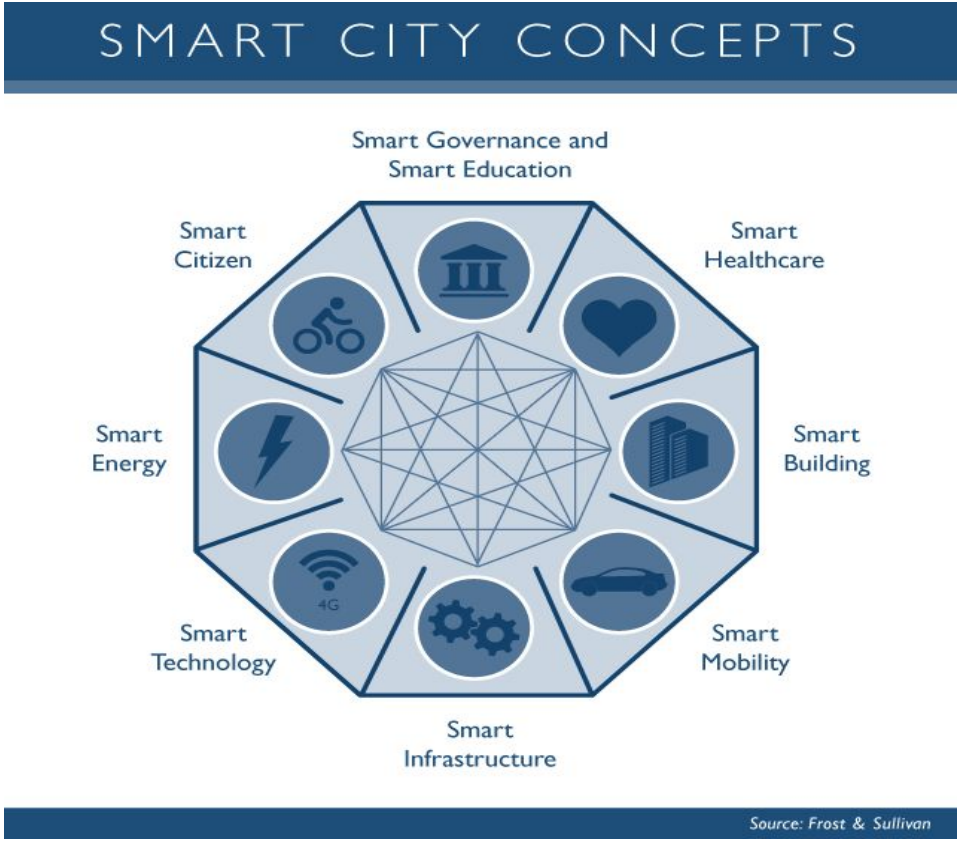
- Student experience & success
- Facilities/Buildings: lighting, HVAC…
- Smart stadiums: fan experience & revenues
- Define infrastructure standards
- Security: physical, data, holistic view
- Connected vehicles
- Identify adoption roadblocks
- Anticipating future needs

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.



Sources: Consultantcy.uk, "Smart City Market Revenues to Grow to 2 Trillion by 2020." 27 August 2015; Forbes, "Smart Cities – A $1.5 Trillion Market Opportunity." 19 June 2014; ACUPCC Reporting System; The White House, "FACT Sheet: Administration Announces New 'Smart Cities' Initiative to Help Communities Tackle Local Challenges and Improve City Services." September 2015.

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

Source: GreenTechMedia, “Smart Grid Market to Surpass $400 Billion Worldwide by 2020.” 13 August 2013.

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

https://www.energy.gov/articles/doe-invests-61-million-smart-buildings-accelerate-renewable-energy-adoption-and-grid

Ten "Connected Communities" funded by DOE

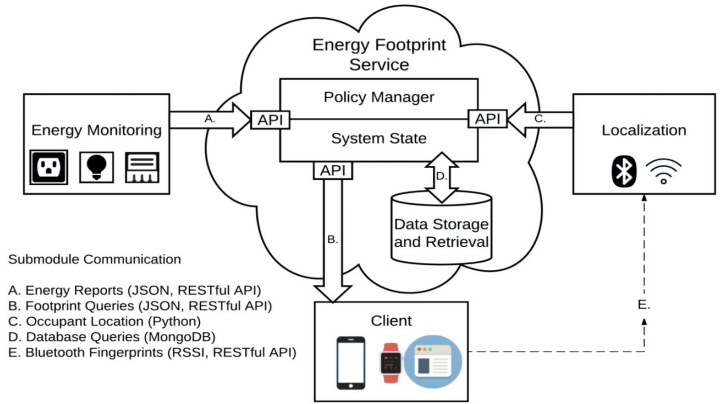
- **Electric Power Research Institute, Inc. (New York City, Seattle, San Diego) will transform multi-family buildings in affordable housing developments into GEBs that will demonstrate different ways to decarbonize buildings, make them more resilient, and reduce utility bills. (Award: $5.27M)**
- **IBACOS,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

RCN : SUSTAINABLE CITIES

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

Questions & Answers…

Thank You

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