OAK RIDGE National Laboratory | BUILDING TECHNOLOGIES RESEARCH INTEGRATION CENTER

# Virtual Electric Power Board of Chattanooga, TN (EPB)

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Creating a digital twin of 178,368 buildings in the service area for the Electric Power Board of Chattanooga, Tennessee, with comparison to 15-minute electricity data

## Automatic Detection and Building Energy Model Creation (AutoBEM)

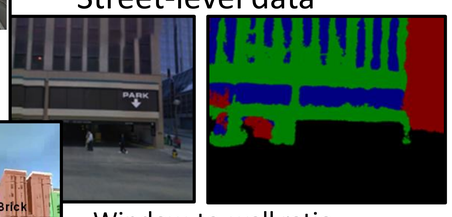
### Data Sources

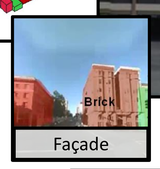
- Imagery (satellite, aerial)
- Street-level imagery
- Cartographic layers
  - Elevation, GIS
- Tax assessors
- Ranking of descriptors EE and Demand impacts (281–4,617 per building type)

Data comparison matrix

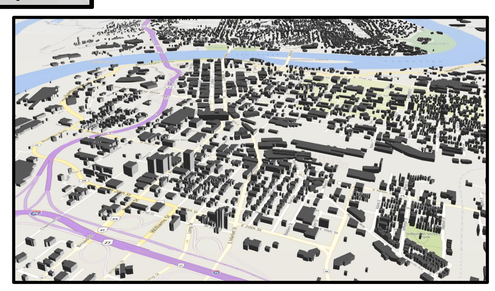
| | Short Title |
|---|---|
| Summary | Satellite imagery, including panchromatic and multispectral images |
| Data type | Image |
| Company | |
| Website | |
| Temporal resolution | Cities - 3-11 times per week |
| Spatial resolution | 0.3 m |
| Measure accuracy | |
| Cost | $11 per sq. km |
| Format | GeoTiff |
| Mapping to building input variables | Building footprints |
| Mapping to area properties | Vegetated areas, road surface, buildings, parking lots |
| Mapping to material properties | Road pavement materials (e.g., concrete, asphalt), parking lots (e.g., gravel, soil) |
| Coverage of US | Over 10 million km² of coverage of the contiguous US |
| Orientation | Aerial |
| Existing internal software | N/A |
| Existing expertise | Remote sensing data analysis tool |
| Restrictions | N/A |


Street-level data



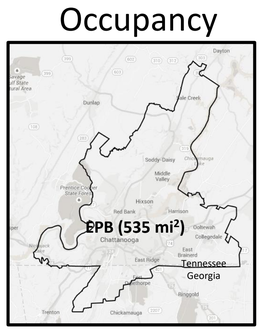




Window-to-wall ratio

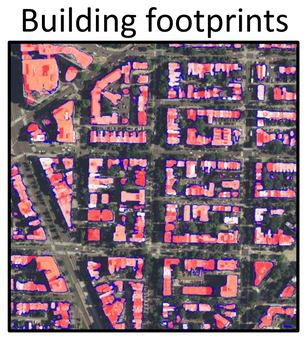


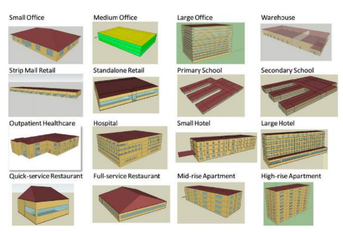
| Class | Object | Field | Default | Minimum | Maximum | Distribution | Type | Group | Constraint |
|---|---|---|---|---|---|---|---|---|---|
| Sizing:Parameters | | Heating Sizing Factor | 1.33 | 0.931 | 1.729 | uniform | float | | |
| Sizing:Parameters | | Cooling Sizing Factor | 1.33 | 0.931 | 1.729 | uniform | float | | |
| Lights | Core_bottom_Lights | Watts per Zone Floor Area | 10.76 | 7.532 | 13.988 | uniform | float | G0001 | |
| Lights | Core_mid_Lights | Watts per Zone Floor Area | 10.76 | 7.532 | 13.988 | uniform | float | G0001 | |
| Lights | Core_top_Lights | Watts per Zone Floor Area | 10.76 | 7.532 | 13.988 | uniform | float | G0001 | |
| … | … | Watts per Zone Floor Area | 10.76 | 7.532 | 13.988 | uniform | float | G0001 | |
| Lights | Perimeter_top_ZN_4_Lights | Watts per Zone Floor Area | 10.76 | 7.532 | 13.988 | uniform | float | G0001 | |
| ElectricEquipment | Core_bottom_PlugMisc_Equip | Watts per Zone Floor Area | 10.76 | 7.532 | 13.988 | uniform | float | G0002 | |
| … | … | Watts per Zone Floor Area | 10.76 | 7.532 | 13.988 | uniform | float | G0002 | |
| ElectricEquipment | Core_bottom_Elevators_Equip | Design Level | 32109.89011 | 22476.92 | 41742.86 | uniform | float | | |
| Exterior:Lights | Exterior Facade Lighting | Design Level | 14804 | 10362.8 | 19245.2 | uniform | float | | |
| ZoneInfiltration:DesignFlowRate | FirstFloor_Plenum_Infiltration | Flow per Exterior Surface Area | 0.000302 | 0.000211 | 0.000393 | uniform | float | G0003 | |
| … | … | Flow per Exterior Surface Area | 0.000302 | 0.000211 | 0.000393 | uniform | float | G0003 | |
| ZoneInfiltration:DesignFlowRate | TopFloor_Plenum_Infiltration | Flow per Exterior Surface Area | 0.000302 | 0.000211 | 0.000393 | uniform | float | G0003 | |

Occupancy




Building footprints






### Software Tools

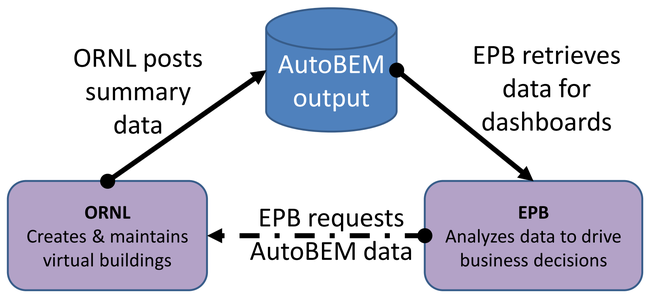
- Occupancy (every 90m)
- Aerial - best footprints
- Street - height, type, WWR
- LiDAR - geometry
- GIS - database API
- Building type
- Model generator
- Fastest buildings simulator
- Web-based visual analytics

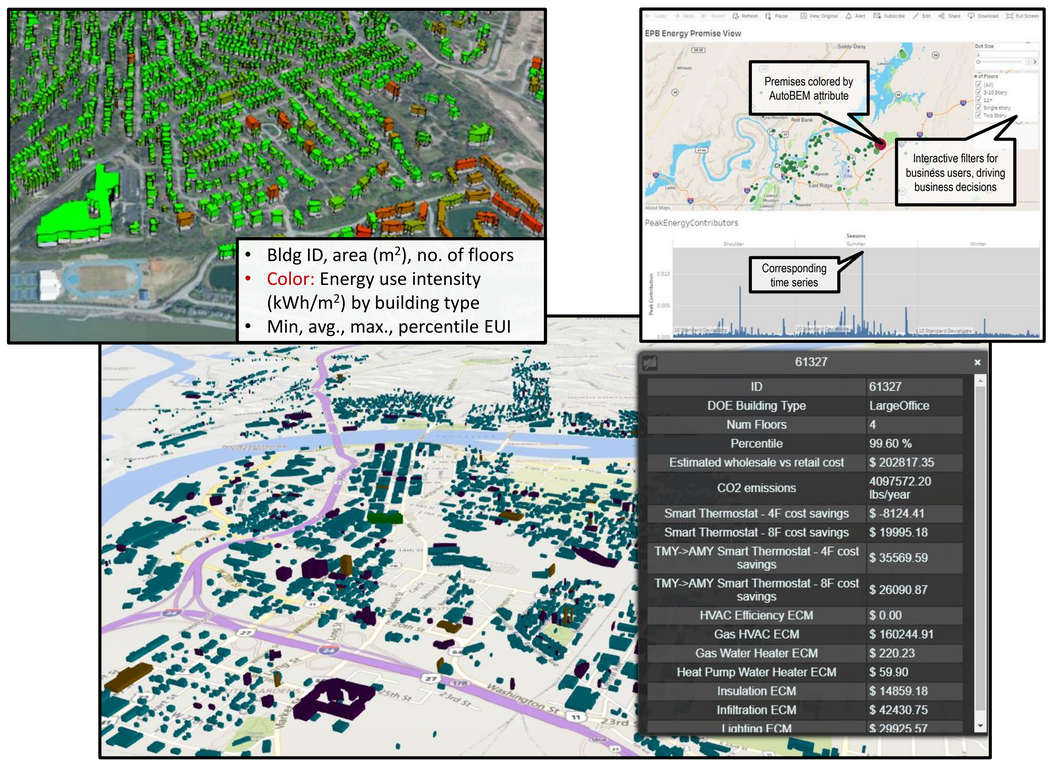
Result: Simulated buildings for any area of interest that match 15-minute electrical data more accurately than most manually created models

## Operational Use of BEM Simulations

### Use Cases

- Peak rate structure
- Demand-side mgmt
- Emissions
- Energy efficiency
- Customer education




### Measures

- Lighting, HVAC COP, infiltration, insulation
- Smart thermostats
- Water heaters
- PV/solar
- EV charging
- Future weather
- Dual-fuel HVAC
- Microgrids

Result: $11–35 million/year in potential savings identified via simulation-informed data and valuation for *energy, demand, emissions, and cost impact* to EPB and each customer for each building under five use cases covering nine monetization scenarios