Designing for Energy Codes and Standards

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Agenda

- Codes and Standards
- Metering Playbook

Focus will be on electrical monitoring and controls

Codes and Standards Overview

- Codes and Standards (ASHRAE, IECC, LEED, etc.)
- Adoption Status
- Considerations beyond code
- 90.1 versus IECC (other considerations)
- Validation of power monitoring
- Recommendations

Codes and Standards Overview

Codes and Standards

- IECC
- ASHRAE 90.1
- Other State Codes (WA/NY/CA)
- LEED
- Green Globes
- Guiding Principles
- SEC compliance

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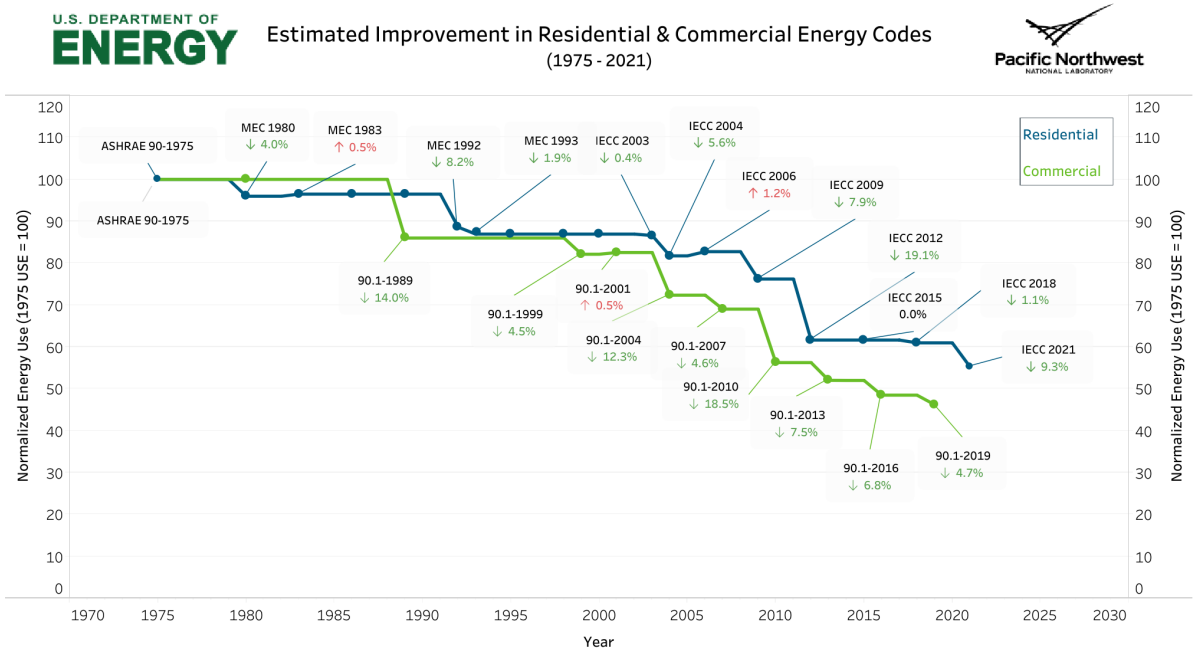
Codes and Standards – IECC and ASHRAE

- Model code cycle



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Codes and Standards – IECC – Metering

2018 IECC (Nashville **Residential** adopted code)

C405.5 Dwelling electrical meter (Mandatory).

Each dwelling unit located in a *Group R*-2 building shall have a separate electrical meter.

C ❖ People are more likely to conserve energy when provided with the means to track how much they are using. This requirement does not mandate that the units be billed separately for the electrical service; it simply helps people to understand how their use of the service and selection of equipment can affect energy consumption.

2018 IECC - **Commercial**

- No metering requirements in code.

2021 IECC

- Key changes to the 2021 IECC improve efficiency by 9.4% and reduce greenhouse gases by 8.7% over the 2018 IECC.

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Codes and Standards – IECC – Metering

Starting in 2021 IECC

C405.12 Energy monitoring.

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New buildings with a gross *conditioned floor area* of 25,000 square feet (2322 m^2) or larger shall be equipped to measure, monitor, record and report energy consumption data in compliance with Sections C405.12.1 through C405.12.5.

C405.6 Dwelling electrical meter.

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Each dwelling unit located in a Group R-2 (apartment) building shall have a separate electrical meter.

C405.12.1 Electrical energy metering.

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For all electrical energy supplied to the building and its associated site, including but not limited to site lighting, parking, recreational facilities and other areas that serve the building and its occupants, meters or other measurement devices shall be provided to collect energy consumption data for each end-use category required by Section C405.12.2.

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Codes and Standards – IECC - Metering

C405.12.2 End-use metering categories.

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Meters or other approved measurement devices shall be provided to collect energy use data for each end-use category indicated in Table C405.12.2. Where multiple meters are used to measure any end-use category, the data acquisition system shall total all of the energy used by that category. Not more than 5 percent of the measured load for each of the end-use categories indicated in Table C405.12.2 shall be permitted to be from a load that is not within that category.

Exceptions:

1.1. HVAC and water heating equipment serving only an individual dwelling unit shall not require end-use metering.

2.2. End-use metering shall not be required for fire pumps, stairwell pressurization fans or any system that operates only during testing or emergency.

3.3. End-use metering shall **not be required for an individual tenant space** having a floor area not greater than 2,500 square feet (232 m^2) where a dedicated source meter complying with Section C405.12.3 is provided.

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Codes and Standards – IECC - Metering

TABLE C405.12.2 - ENERGY USE CATEGORIES

LOAD CATEGORY	DESCRIPTION OF ENERGY USE
Total HVAC system	Heating, cooling and ventilation, including but not limited to fans, pumps, boilers, chillers and water heating.
Interior lighting	Lighting systems located within the building.
Exterior lighting	Lighting systems located on the building site but not within the building.
Plug loads	Devices, appliances and equipment connected to convenience receptacle outlets.
Process loads	Any single load that is not included in an HVAC, lighting or plug load category and that exceeds 5 percent of the peak connected load of the whole building, including but not limited to data centers, manufacturing equipment and commercial kitchens.
Building operations and other miscellaneous loads	The remaining loads not included elsewhere in this table, including but not limited to vertical transportation systems and automatic doors.

Codes and Standards – IECC - Metering

C405.12.3 Meters.

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Meters or other measurement devices required by this section shall be configured to automatically communicate energy consumption data to the data acquisition system required by Section C405.12.4. Source meters shall be allowed to be any digital-type meter. Lighting, HVAC or other building systems that can monitor their energy consumption shall be permitted instead of meters. Current sensors shall be permitted, provided that they have a tested accuracy of ±2 percent. Required metering systems and equipment shall have the capability to provide at least hourly data that is fully integrated into the data acquisition system and graphical energy report in accordance with Sections C405.12.4 and C405.12.5.

C405.12.4 Data acquisition system.

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A data acquisition system shall have the capability to store the data from the required meters and other sensing devices for a minimum of 36 months. The data acquisition system shall have the capability to store real-time energy consumption data and provide hourly, daily, monthly and yearly logged data for each end-use category required by Section C405.12.2.

Codes and Standards – IECC - Metering

C405.12.5 Graphical energy report.

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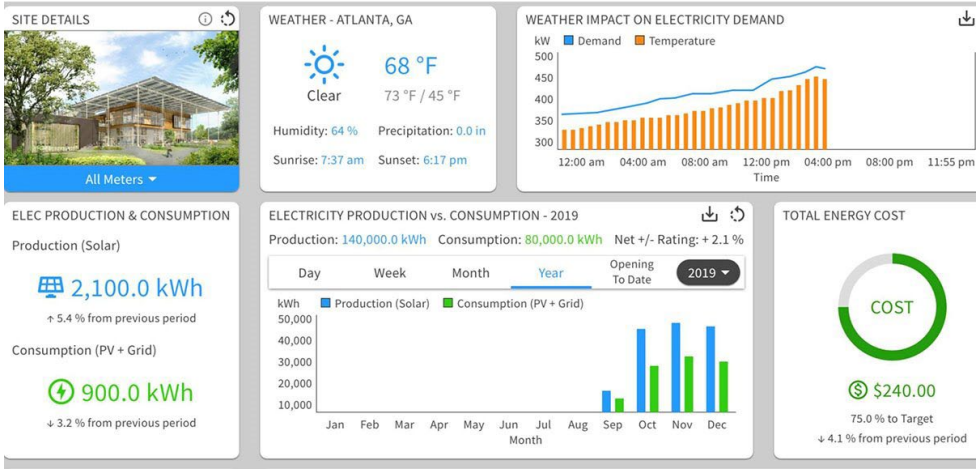
A permanent and readily accessible reporting mechanism shall be provided in the building that is accessible by building operation and management personnel. The reporting mechanism shall have the capability to graphically provide the energy consumption for each end-use category required by Section C405.12.2 at least every hour, day, month and year for the previous 36 months.



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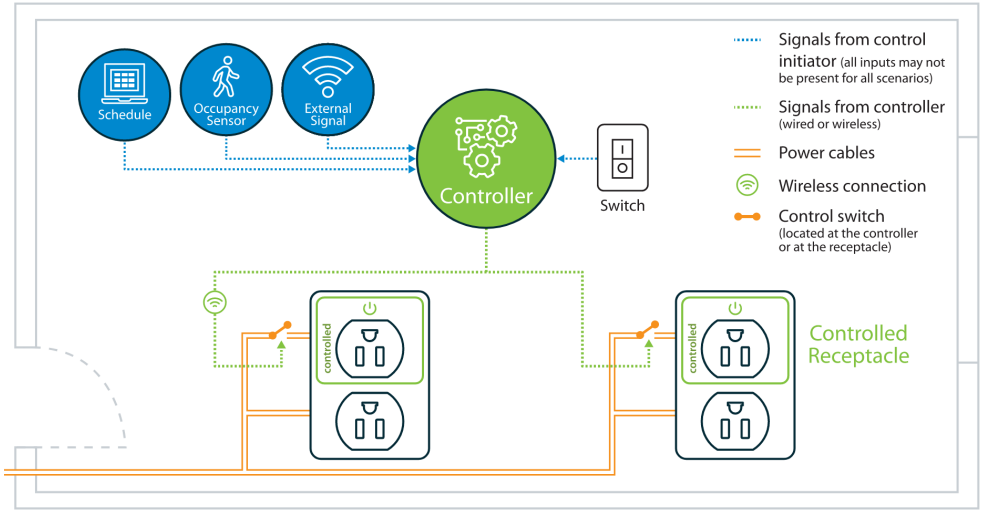
Codes and Standards – IECC and ASHRAE – Plug

- Automatic Receptacle Control
  (90.1-2010, 2021 IECC)
  - Time clock w/ occupant override
  - Occupant sensor
  - Other signal



Source: NREL

Codes and Standards – IECC and ASHRAE - Ltg

- Occupancy/Vacancy Sensors
  (all current versions)
  - Complexity has increased each code cycle

- Daylight Responsive Controls
  (90.1-2010, 2012 IECC)

Source: 2030 Palette

Codes and Standards – ASHRAE 90.1 – Metering

- Metering and Monitoring (2013 and later)

8.4.3.1 Monitoring. Measurement devices shall be installed in new buildings to monitor the electrical energy use for each of the following separately:
a. Total electrical energy
b. HVAC systems
c. Interior lighting
d. Exterior lighting
e. Receptacle circuits
f. Refrigeration systems (added in 2022)

For buildings with tenants, these systems shall be separately monitored for the total building and (excluding shared systems) for each individual tenant.

Exception: Up to 10% of the load for each of the categories (b) through (e) shall be allowed to be from other electrical loads. (2013, 2016, 2019)

(2022 Code) Exception to 8.4.3.1: Where the design load of any of the categories (b) through (f) are less than 10% of the whole-building load, these categories shall be allowed to be combined with other categories. (2022)

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Codes and Standards – 90.1 – Metering

8.4.3.2 Recording and Reporting. The electrical energy use for all loads specified in Section 8.4.3.1 shall be recorded a minimum of every 15 minutes and reported at least hourly, daily, monthly, and annually. The data for each tenant space shall be made available to that tenant. In buildings with a digital control system installed to comply with Section 6.4.3.10, the energy use data shall be transmitted to the digital control system and graphically displayed. The system shall be capable of maintaining all data collected for a minimum of 36 months.

Exceptions to 8.4.3.1 and 8.4.3.2:
1. Building less than 25,000 ft2.
2. Individual tenant spaces less than 10,000 ft2.
3. Dwelling units.
4. Residential buildings with less than 10,000 ft2 of common area.
5. Critical equipment and life-safety branches of NFPA 70, Article 517.

Codes and Standards – State Codes

- 2021 IECC with FL amendments

accordance with ASME A17.1/CSA B44 or applicable local code.

Exception: A variable voltage drive system that reduces operating voltage in response to light loading conditions is an alternative to the reduced speed function.

C405.8.2.1 Energy recovery (Mandatory).

Escalators shall be designed to recover electrical energy when resisting overspeed in the down direction.

C405.9 Lighting for plant growth and maintenance (Mandatory).

Not less than 95 percent of the permanently installed luminaires used for plant growth and maintenance shall have a photon efficiency of not less than 1.6 µmol/J as defined in accordance with ANSI/ASABE S640.

SECTION C406
ADDITIONAL EFFICIENCY PACKAGE OPTIONS

C405.12 Deleted

C406.1 Requirements.

Buildings shall comply with at least one of the following:

1. More efficient HVAC performance in accordance with Section C406.2.
2. Reduced lighting power density system in accordance with Section C406.3.
3. Enhanced lighting controls in accordance with Section C406.4.
4. On-site supply of renewable energy in accordance with Section C406.5.
5. Provision of a dedicated outdoor air system for certain HVAC equipment in accordance with Section C406.6.
6. High-efficiency service water heating in accordance with Section C406.7.

C406.1.1 Tenant spaces.

Tenant spaces shall comply with Section C406.2, C406.3, C406.4, C406.6 or C406.7. Alternatively, tenant spaces shall comply with Section C406.5 where the entire building is in compliance.

Exception: Previously occupied tenant spaces that comply with this code in accordance with Section C501. (EN8148)

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Codes and Standards – State Codes - WA

LOAD CATEGORY	DESCRIPTION OF ENERGY USE
HVAC system	Heating, cooling and ventilation, including but not limited to fans, pumps, boilers, chillers and water heating.
Lighting	Energy used for heating of domestic and service hot water.
Service Water Heating	Lighting systems located on the building site but not within the building.
Plug loads	Devices, appliances and equipment connected to convenience receptacle outlets.
Electric Vehicle Charging	This category shall include all energy used for electric vehicle charging.
Process loads	Energy used by any nonbuilding process load including, but not limited to, nonresidential refrigeration and cooking equipment, laundry equipment, industrial equipment, and stage lighting.
Full-floor tenant space	Multitenant building where more than 90 percent of the leasable area of a floor is occupied by a single tenant

Codes and Standards – State Codes – Title 24

TABLE 130.5-B MINIMUM REQUIREMENTS FOR SEPARATION OF ELECTRICAL LOAD

ELECTRICAL LOAD TYPE	ELECTRICAL SERVICES RATED 50 kVA OR LESS	ELECTRICAL SERVICES RATED MORE THAN 50 kVA AND LESS THAN OR EQUAL TO 250 kVA	ELECTRICAL SERVICES RATED MORE THAN 250 kVA AND LESS THAN OR EQUAL TO 1000 kVA	ELECTRICAL SERVICES RATED MORE THAN 1000 kVA
Lighting including exit and egress lighting and exterior lighting	Not required	All lighting in aggregate	All lighting disaggregated by floor, type or area	All lighting disaggregated by floor, type or area
HVAC systems and components including chillers, fans, heaters, furnaces, package units, cooling towers and circulation pumps associated with HVAC	Not required	All HVAC in aggregate	All HVAC in aggregate and each HVAC load rated at least 50 kVA	All HVAC in aggregate and each HVAC load rated at least 50 kVA
Domestic and service water system pumps and related systems and components	Not required	All loads in aggregate	All loads in aggregate	All loads in aggregate
Plug load including appliances rated less than 25 kVA	Not required	All plug load in aggregate Groups of plug loads exceeding 25 kVA connected load in an area less than 5000 sf	All plug load separated by floor, type or area Groups of plug loads exceeding 25 kVA connected load in an area less than 5000 sf	All plug load separated by floor, type or area All groups of plug loads exceeding 25 kVA connected load in an area less than 5000 sf
Elevators, escalators, moving walks and transit systems	Not required	All loads in aggregate	All loads in aggregate	All loads in aggregate
Other individual non-HVAC loads or appliances rated 25 kVA or greater	Not required	All loads in aggregate	All loads in aggregate	All loads in aggregate
Industrial and commercial load centers 25 kVA or greater, including theatrical lighting installations and commercial kitchens	Not required	All loads in aggregate	All loads in aggregate	All loads in aggregate
Renewable power source (net or total)	Each group	Each group	Each group	Each group
Loads associated with renewable power source	Not required	All loads in aggregate	All loads in aggregate	All loads in aggregate
Charging stations for electric vehicles	All loads in aggregate	All loads in aggregate	All loads in aggregate	All loads in aggregate

Codes and Standards – State Codes – Title 24

TABLE 130.5-AMINIMUM REQUIREMENTS FOR METERING OF ELECTRICAL LOAD

METERING FUNCTIONALITY	ELECTRICAL SERVICES RATED 50 kVA OR LESS	ELECTRICAL SERVICES RATED MORE THAN 50 kVA AND LESS THAN OR EQUAL TO 250 kVA	ELECTRICAL SERVICES RATED MORE THAN 250 kVA AND LESS THAN OR EQUAL TO 1000 kVA	ELECTRICAL SERVICES RATED MORE THAN 1000 kVA
Instantaneous (at the time) kW demand	Required	Required	Required	Required
Historical peak demand (kW)	Not required	Not required	Required	Required
Tracking kWh for a user-definable period	Required	Required	Required	Required
kWh per rate period	Not required	Not required	Not required	Required

Codes and Standards – LEED

- Leadership in Energy & Environmental Design
- v4, v4.1, v5 (out for public comment)

- Minimum Energy Performance (prerequisite)
  - ASHRAE 90.1-2010, 2013, 2016, 2019, 2022

- Monitoring-Based Commissioning (credit)

- Advanced Energy Metering (credit)

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Codes and Standards – LEED BD+C

Advanced Energy Metering v4, v4.1 (credit)

- All whole-building energy sources used by the building
- Any end uses that represent 10% or more of the total annual consumption
- Electricity meters must record both consumption and demand.
- Whole-building electricity meters should record the power factor.
- The system must be capable of storing all meter data for at least 36 months.
- The data must be remotely accessible.
- All meters must report hourly, daily, monthly, and annual energy use.
- Install tenant meters to capture every energy source to each tenant.

Codes and Standards – LEED BD+C

Energy Metering and Reporting v5 (prerequisite)

- Meet 90.1-2019 (90.1-2022 after 1/1/2028).
- Non-transient residential dwelling unit meters.
- Additional meters required beyond 90.1
  - On-site renewable energy
  - EV charging

Codes and Standards – Green Globes 2013, 2021

- All points are optional
  - Points for 1 to 4 Green Globes
- Minimum Energy Performance
- Advanced Energy Metering
- Interior Lighting

Codes and Standards – Green Globes

- ASHRAE 90.1-2010
- Building Level Energy Metering
- Multi-Unit Residential Building metering per unit

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Codes and Standards – Green Globes

Metering for Points

- Lighting zone (<20,000sf)
- Plug load zone (<20,000sf)
- HVAC (>5 HP)
- On-site renewables
- Chilled water
- Heating water/steam
- Specialty/process electrical equipment

Codes and Standards – Green Globes

- Monitoring Plan
- Verification using measured data
- FDD Lighting Systems
- Lighting Controls – dimming
- Lighting Controls – load shedding
- Plug load switching per 90.1-2010

Additional Points

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Codes and Standards – SEC Compliance

17 CFR 210, 229, 230, 232, 239, and 249

PwC – “But it will be critical for companies to start thinking now about the process for ESG data collection (completeness), data quality (accuracy), data transformation and reporting strategy”

Key takeaway is that data will be audited

Example Energy Code Project

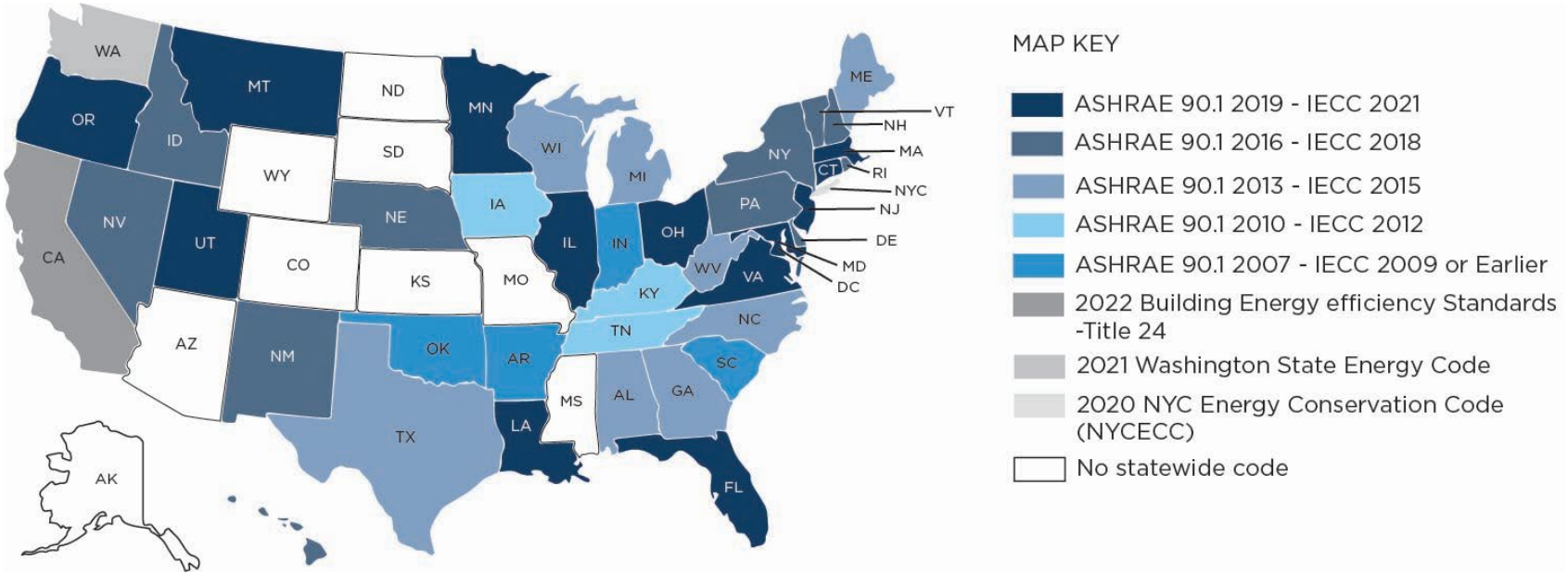
New Construction at Georgia Tech

- State Code – IECC 2015 (w/ GA amendments) or 90.1-2013
- LEED v4, v4.1 – 90.1-2010, 2013, 2016,
- Yellow Book – 90.1-2019 greatest extent possible

A single project may have three or more energy codes that are applicable.

Adoption Status

State Code Adoption



Considerations beyond code

Considerations Beyond Code

- Purpose of building
- Owner goals
- Owner sophistication
- BAS/BCS/EMS integration
- Div 25
- Other sustainability goals (net zero, performance-based)
- Panel and feeder layout (optimize with submetering in mind)
- Billing and tenants

IECC or 90.1

IECC or 90.1

- Design team can use either for compliance
- Differing requirements can tip the scales

IECC or 90.1 – Mandatory Requirement Differences

- IECC
  - Fan Power Limitation
  - Energy Recovery

- 90.1
  - Electric submetering
  - Daylighting
  - Switched Receptacles

Note: Later IECC versions incorporate 90.1 requirements, but many states omit these from adopted code.

Design Intent on Paper

Example of Design Intent – Basis of Design, Specs

Basis of Design

ELECTRICAL SYSTEMS **2.7**

3. Ground Fault Protection:

   a. Ground fault protection will be provided for 480 V services and feeders 1000 A and larger.

4. Duct Bank:

   a. Underground concrete-encased duct bank will be used for secondary feeder installation.

5. Meters:

   a. The main service switchboard and select panelboards will be provided with an electronic power monitor. The monitor will be a microprocessor-based device with the capability for future connection to a remote host computer. Metered values (true RMS) will include multiphase amperes and volts, watts, VARS, volt-amps, watt-hours and VAR-hours, amperes and watts demand, frequency, power factor, and harmonic distortion. Electrical system shall be provided with a power monitoring system submeters that monitors energy usage as required by ASHRAE-90.1 - 2019 for the buildings, HVAC systems, interior lighting, exterior lighting, and receptacle circuits. Information will be recorded and reported in the building automation system.

6. Panelboards:

   a. Branch circuit panelboards will be provided on each floor to serve the lighting and receptacles. on the same floor. Each laboratory will be provided with a dedicated panelboard.

LEED v4 for BD+C: Core and Shell
Project Checklist

Y	?	N			
1			Credit	Integrative Process	1
19	0	1		**Location and Transportation**	20
			Credit	LEED for Neighborhood Development Location	20
2			Credit	Sensitive Land Protection - Previously developed site	2
2		1	Credit	High Priority Site - 'Difficult Development Area'	3
6			Credit	Surrounding Density and Diverse Uses	6
6			Credit	Access to Quality Transit	6
1			Credit	Bicycle Facilities	1
1			Credit	Reduced Parking Footprint	1
1			Credit	Green Vehicles - CoA req 20% EV	1
6	3	2		**Sustainable Sites**	11
Y			Prereq	Construction Activity Pollution Prevention	Required
1			Credit	Site Assessment	1
		2	Credit	Site Development - Protect or Restore Habitat	2
	1		Credit	Open Space (30% of site area open of which 25% has plantings)	1
3			Credit	Rainwater Management	3
1	1		Credit	Heat Island Reduction	2
	1		Credit	Light Pollution Reduction (Need to verify)	1
1			Credit	Tenant Design and Construction Guidelines	1
9	0	4		**Water Efficiency**	11
Y			Prereq	Outdoor Water Use Reduction (30% redux WaterSense required)	Required
Y			Prereq	Indoor Water Use Reduction	Required
Y			Prereq	Building-Level Water Metering	Required
3			Credit	Outdoor Water Use Reduction (30% redux WaterSense; 100pct reclaim)	3
4		2	Credit	Indoor Water Use Reduction (40% = 4pt max CS; 50% 6pt BD&C)	4
1		2	Credit	Cooling Tower Water Use	3
1			Credit	Water Metering	1
23	9	3		**Energy and Atmosphere**	33
Y			Prereq	Fundamental Commissioning and Verification	Required
Y			Prereq	Minimum Energy Performance	Required
Y			Prereq	Building-Level Energy Metering	Required
Y			Prereq	Fundamental Refrigerant Management	Required
6			Credit	Enhanced Commissioning	6
14	3	1	Credit	Optimize Energy Performance (EUI 25; 32% below 90.1-2010 = 14 pts)	18
1			Credit	Advanced Energy Metering	1
1	1		Credit	Demand Response/Grid Harmonization/GridOptimal APC	2
	3	2	Credit	Renewable Energy Production (Alternate 5% onsite, 20% offsite)	3
1			Credit	Enhanced Refrigerant Management	1
	2		Credit	Green Power and Carbon Offsets (only v4; v4.1 merges Renew...)	2

LEED BUILDING RATING **2.17**

Prereq. Fundamental Commissioning –

Prereq. Minimum Energy Performance – The project design shall comply with mandatory provisions of ASHRAE 90.1-2010, with errata. Additionally, an energy simulation model will be developed to determine building energy performance and anticipated energy cost savings. Efficient building envelope design and equipment selections will be prioritized for initial savings and PV shall be maximized onsite to further offset the project's energy needs.

Prereq. Fundamental Refrigerant Management – No CFC-based refrigerants shall be used in any new equipment serving the project, including but not limited to HVAC, laboratory and commercial kitchen equipment.

Enhanced Commissioning –

Optimize Energy Performance – Refer to strategies outlined above in Prereq Minimum Energy Performance.

Advanced Energy Metering – Natural gas and electricity meters will be installed to track and report whole-building energy usage for the new research building and parking deck. Additionally, all end-uses that account for 10% or more of the anticipated project energy usage shall be metered to support energy management. This will be accomplished by including electrical metering to isolate receptable loads, installing gas meters at boilers to track demands and establishing BCS controls to track fan VFD consumption (kWh), fan VFD demands (kW) and chiller output (kW).

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Example of Design Intent – Drawing

Electrical Detail – Project A

METERS:

M1: MSB MAIN BREAKER (TOTAL ENERGY)
M2: BH1 MAIN BREAKER (LIGHTING)
M3: BDPL1 MAIN BREAKER (RECEPTACLE)
M4: BH2 MAIN BREAKER (LIGHTING)
M5: 1H1 MAIN BREAKER (LIGHTING)
M6: 1DPL1 MAIN BREAKER (RECEPTACLE)
M7: 1DPL2 MAIN BREAKER (RECEPTACLE)
M8: 1H2 MAIN BREAKER (LIGHTING)
M9: 2H1 MAIN BREAKER (LIGHTING)
M10: 2DPL1 MAIN BREAKER (RECEPTACLE)
M11: 2DPL2 MAIN BREAKER (RECEPTACLE)
M12: 2H2 MAIN BREAKER (LIGHTING)
M13: 3H1 MAIN BREAKER (LIGHTING)
M14: 3DPL1 MAIN BREAKER (RECEPTACLE)
M15: 3DPL2 MAIN BREAKER (RECEPTACLE)
M16: 3H2 MAIN BREAKER (LIGHTING)
M17: 4H1 MAIN BREAKER (LIGHTING)
M18: 4DPL1 MAIN BREAKER (RECEPTACLE)
M19: 4DPL2 MAIN BREAKER (RECEPTACLE)
M20: 4H2 MAIN BREAKER (LIGHTING)
M21: NEW MS-A MAIN BREAKER (MARL)
M22: MSB:12 SUBMETER (CC-1)
M23: BDPMH1 MAIN BREAKER (EQUIPMENT)
M24: PDPMH1 MAIN BREAKER (EQUIPMENT)
M25: PDPMH2 MAIN BREAKER (EQUIPMENT)
M26: OS2TL1 MAIN BREAKER (RECEPTACLE)
M27: OS2TL2 MAIN BREAKER (RECEPTACLE)
M28: OS3LB1 MAIN BREAKER (RECEPTACLE)
M29: OS2DPL2 MAIN BREAKER (RECEPTACLE)
M30: OS4DPL1 MAIN BREAKER (RECEPTACLE)
M31: OS4DPL2 MAIN BREAKER (RECEPTACLE)
M32: OSBDPL1 MAIN BREAKER (RECEPTACLE)
M33: EMBH1 MAIN BREAKER (LIGHTING)
M34: EMBH1:1 SUBMETER (LIGHTING)
M35: EMBH1:3 SUBMETER (LIGHTING)
M36: EMBH1:5 SUBMETER (LIGHTING)
M37: OSBDPMH1 MAIN BREAKER (EQUIPMENT)

METER CALCULATIONS:

BASEMENT RECEPTACLES AND LIGHTING = M2+M3+M4+M32
FIRST FLOOR RECEPTACLES AND LIGHTING = M5+M6+M7+M8
SECOND FLOOR RECEPTACLES AND LIGHTING = M9+M10+M11+M12+M26+M27
THIRD FLOOR RECEPTACLES AND LIGHTING = M13+M14+M15+M16+M28+(M29-M27)
FOURTH FLOOR RECEPTACLES AND LIGHTING = M17+M18+M19+M20+M30+M31
MARL = M21
HVAC/PLUMBING SYSTEMS = M22+M23+M24+M25+M37
INTERIOR LIGHTING = M2+M4+M5+M8+M9+M12+M13+M16+M17+M20+M33-M34-M35-M36
EXTERIOR LIGHTING = M34+M35+M36
RECEPTACLE CIRCUITS = M3+M6+M7+M10+M11+M14+M15+M18+M19+M26+M27+M28+M29+M30+M31+M32
TOTAL ENERGY = M1

METERING NOTES:

1. REFER TO SPECIFICATION SECTION 260913 FOR ADDITIONAL INFORMATION REGARDING METERING REQUIREMENTS.
2. PROVIDE CONTROL WIRING, CURRENT TRANSFORMERS, AND OTHER COMPONENTS BETWEEN METERS AS REQUIRED TO MEET THE DESIGN INTENT. COORDINATE ADDITIONAL REQUIREMENTS WITH THE OWNER.

4 ELECTRICAL METERING DETAIL
SCALE: 1/8" = 1'-0"

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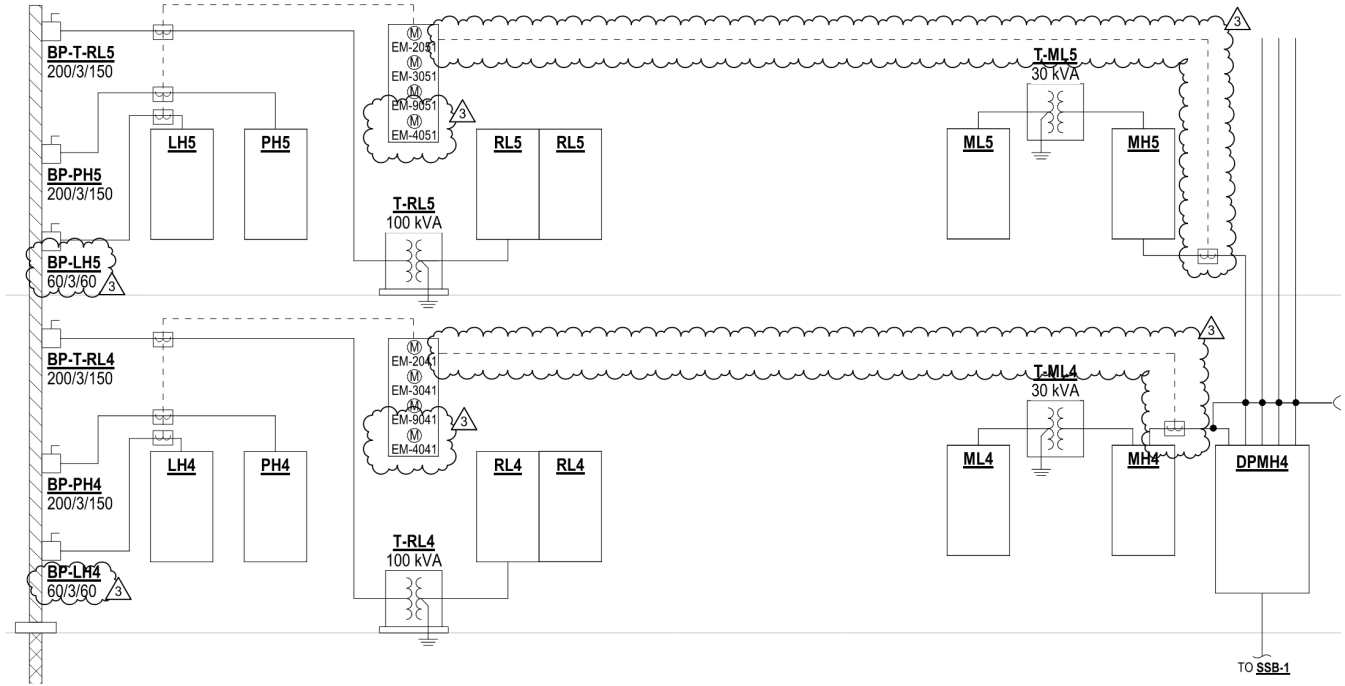
Example of Design Intent – Drawing

HVAC Controls – Project A

BCS PANEL INPUT/OUTPUT SUMMARY MISCELLANEOUS	OUTPUTS										INPUTS												SOFTWARE																	
	DIGITAL					ANALOG					DIGITAL					ANALOG							ALARM			BCS		ENERGY MGMT.												
	SYSTEM GRAPHIC DISPLAY	START/STOP	ENABLE/DISABLE	OPEN/CLOSE	ACTIVATE/DEACTIVATE	SETPOINT ADJUST	BCS CONTROL				CURRENT SENSING RELAY	DIFFERENTIAL PRESSURE SWITCH	AUXILIARY CONTACT	ALARM CONTACT	PULSE CONTACT	TEMPERATURE	FLOW	PRESSURE	DEWPOINT	CARBON DIOXIDE	KILOWATT-HOURS	STATUS/INTERLOCK	HIGH/LOW LIMIT	RUN TIME TOTALIZATION	PROPORTIONAL	PROPORTIONAL + INTEGRAL	TIME SCHEDULE START/STOP	OPTIMUM START/STOP	DAY/NIGHT SETBACK	ECONOMIZER	ENERGY METERING	ENERGY TOTALIZATION	BAS TREND	CALCULATED POINT			FAILURE MODE (NOTES 1 AND 2)		NOTES
OUTSIDE AIR TEMPERATURE	X															X																	X					
OUTSIDE AIR DEWPOINT	X																		X														X					
OUTSIDE AIR CARBON DIOXIDE	X																			X													X					
ELECTRICAL METER	X																																						
MAIN ELECTRICAL SWITCHBOARD																					X												X					6
ELECTRICAL SUB METER (36)																					X												X					8
NATURAL GAS METER	X																X																X					

Example of Design Intent – Drawing

Electrical Riser – Project B



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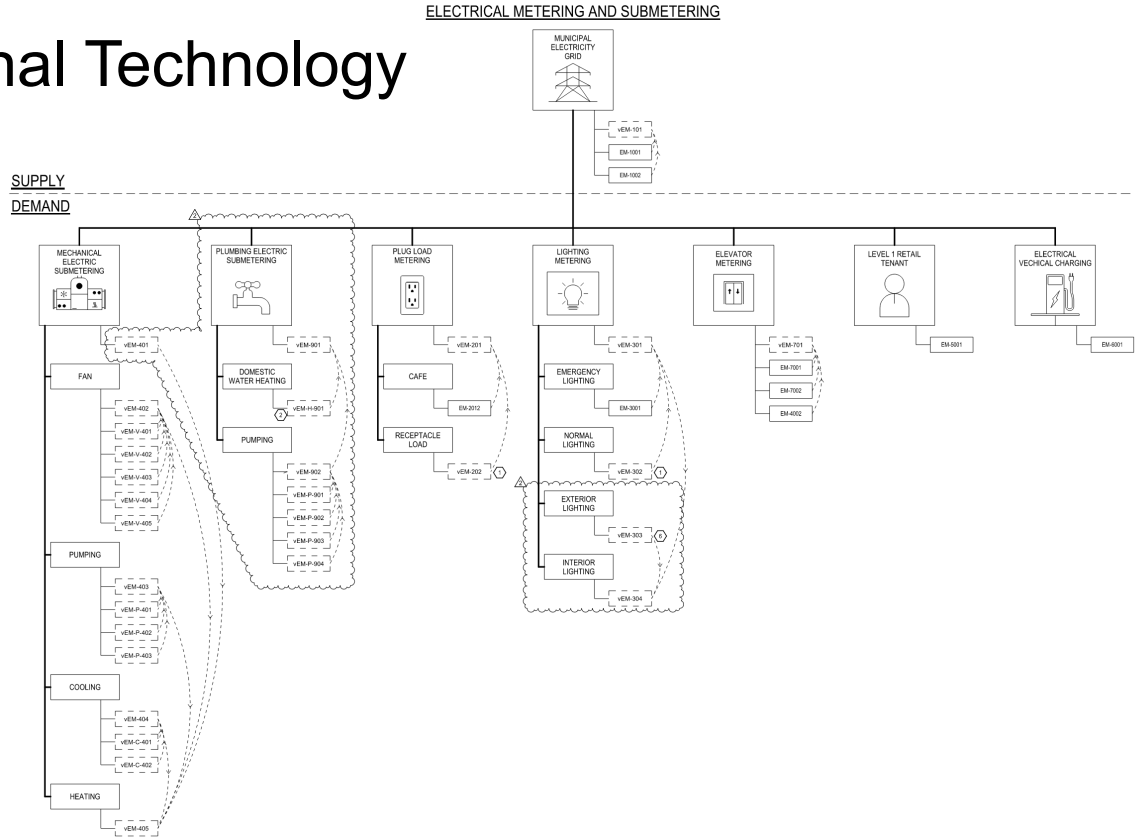
Example of Design Intent – Drawing

Operational Technology

Project B



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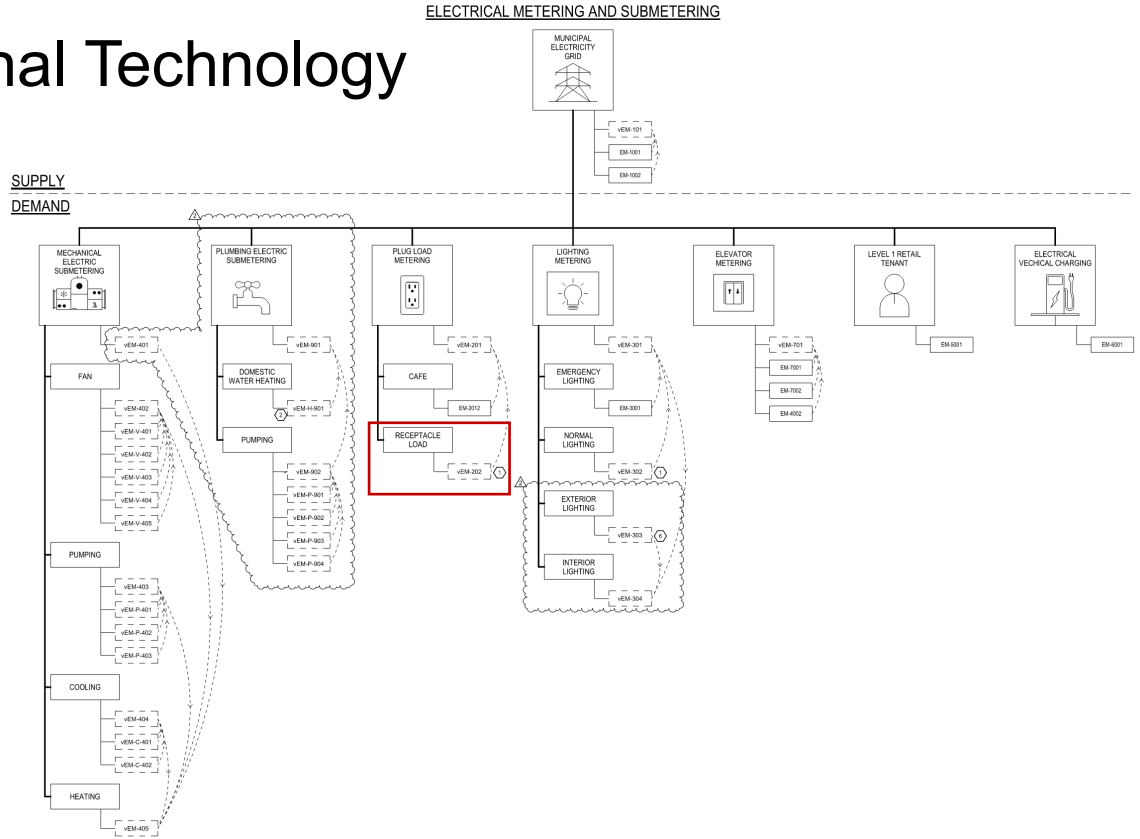
Example of Design Intent – Drawing

Operational Technology

Project B



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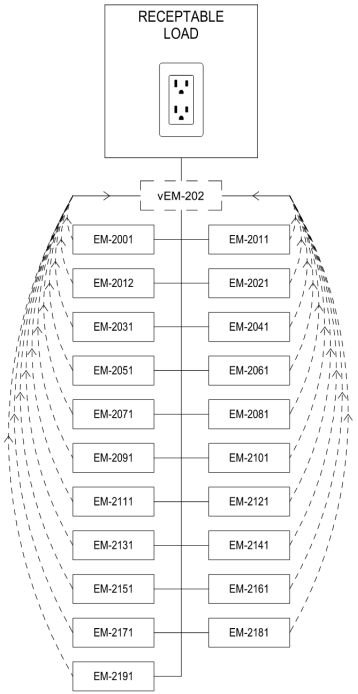
Example of Design Intent - Drawing

ELECTRICAL PLUG LOAD SUBMETERING



Operational Technology – Project B

ELECTRICAL SUBMETERING AND MONITORING SCHEDULE

METER ID	METERED PANEL	METER LOCATION	LOAD DESCRIPTION	UNIT 1	UNIT 1 INTERVAL	UNIT 2	UNIT 2 INTERVAL	METER PROGRAM
EM-2001	T-RLB	B002	PLUG LOAD	KW	5 MIN	KWH	15 MIN	CODE
EM-2011	T-RL1	B002	PLUG LOAD	KW	5 MIN	KWH	15 MIN	CODE
EM-2021	T-RL2	B002	PLUG LOAD	KW	5 MIN	KWH	15 MIN	CODE
EM-2031	T-RL3	B002	PLUG LOAD	KW	5 MIN	KWH	15 MIN	CODE
EM-2041	T-RL4	0429	PLUG LOAD	KW	5 MIN	KWH	15 MIN	CODE
EM-2051	T-RL5	0529	PLUG LOAD	KW	5 MIN	KWH	15 MIN	CODE
EM-2061	T-RL6	0629	PLUG LOAD	KW	5 MIN	KWH	15 MIN	CODE
EM-2071	T-RL7	0729	PLUG LOAD	KW	5 MIN	KWH	15 MIN	CODE
EM-2081	T-RL8	0829	PLUG LOAD	KW	5 MIN	KWH	15 MIN	CODE
EM-2091	T-RL9	0929	PLUG LOAD	KW	5 MIN	KWH	15 MIN	CODE
EM-2101	T-RL10	1029	PLUG LOAD	KW	5 MIN	KWH	15 MIN	CODE
EM-2111	T-RL11	1129	PLUG LOAD	KW	5 MIN	KWH	15 MIN	CODE
EM-2121	T-RL12	1229	PLUG LOAD	KW	5 MIN	KWH	15 MIN	CODE
EM-2131	T-RL13	1329	PLUG LOAD	KW	5 MIN	KWH	15 MIN	CODE
EM-2141	T-RL14	1429	PLUG LOAD	KW	5 MIN	KWH	15 MIN	CODE
EM-2151	T-RL15	1529	PLUG LOAD	KW	5 MIN	KWH	15 MIN	CODE
EM-2161	T-RL16	1629	PLUG LOAD	KW	5 MIN	KWH	15 MIN	CODE
EM-2171	T-RL17	1729	PLUG LOAD	KW	5 MIN	KWH	15 MIN	CODE
EM-2181	T-RL18	1829	PLUB LOAD	KW	5 MIN	KWH	15 MIN	CODE
EM-2191	T-RLR	1929	PLUG LOAD	KW	5 MIN	KWH	15 MIN	CODE

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Validation of Power Monitoring

Validation of Power Monitoring – Why?

- Garbage in garbage out
- Actionable information
- Where and how is data seen?
- Trending

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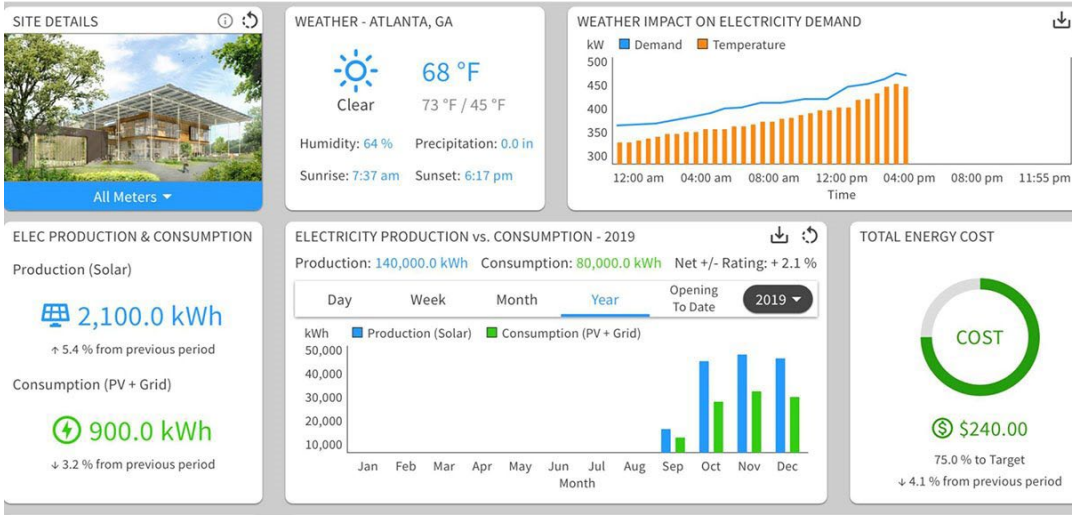
Validation of Power Monitoring – Who?

- Manufacturer
- Electrical Contractor
- Controls Contractor
- Integration Contractor
- GC/CM
- Commissioning Agent
- Consulting Engineer
- Facilities Staff

Validation of Power Monitoring – What?

- Installed
- Integrated
- Organized
- Trending
- Meters read positive values
- Meters show up on a screen that the owner will see



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Recommendations

Recommendations

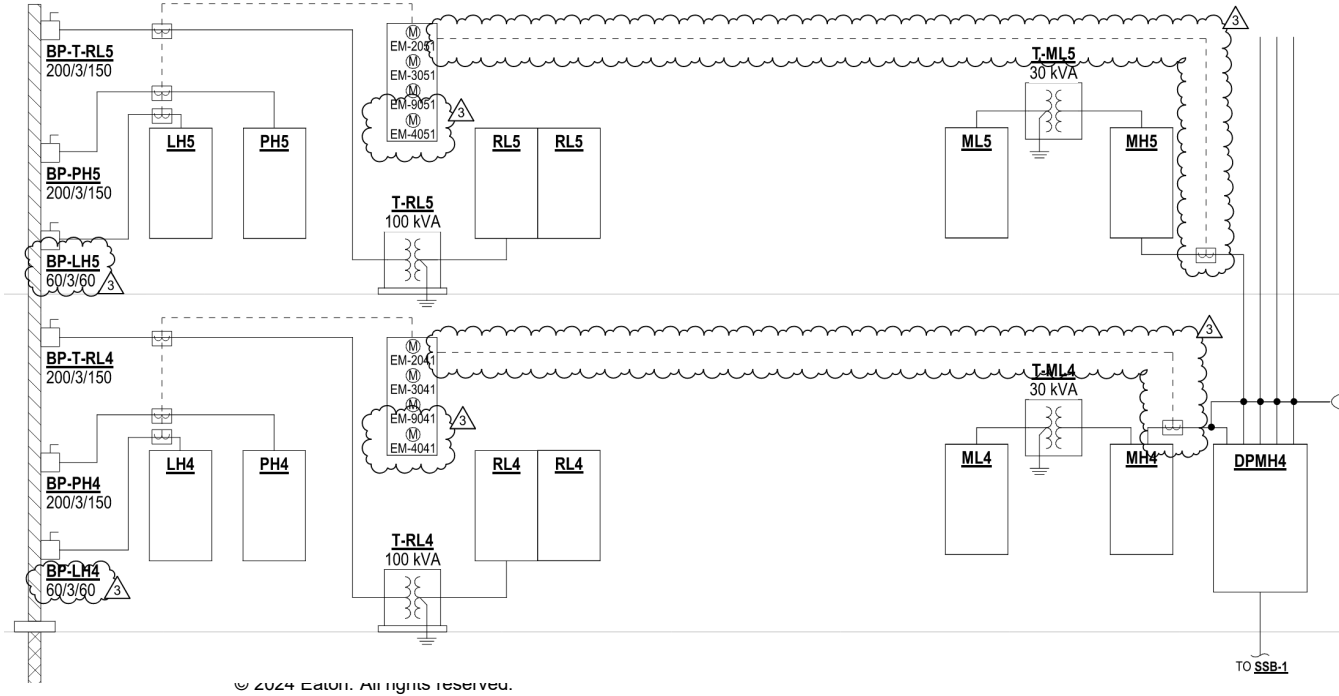
How can Eaton support these types of designs. How can Eaton better support the consultant?

- Keep us out of trouble
- Keep us informed on what is common and what is becoming standard
- Let us know of drawbacks

Recommendations

How can Eaton support these types of designs. How can Eaton better support the consultant?

Cost!!! – how can our designs be planned as the most overall cost effective



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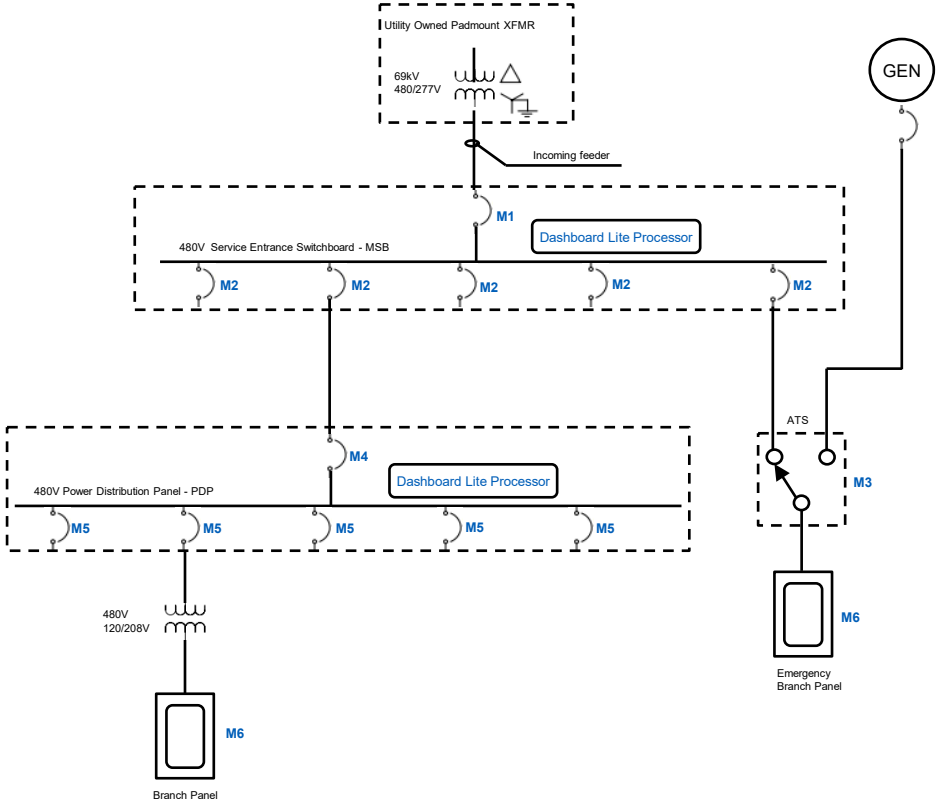
Metering Playbook - Commercial BLDG Example

Eaton Energy Code Meter Playbook
Commercial Buildings

Energy Code for Commercial Buildings Metering Schedule (ASHRAE 90.1, LEED, etc.)				
ID	**Meter Application**	**Meter Type**	**Description**	**Comments**
M1	Switchboard Main	Eaton PXM1000	Multi-function power meter	
M2	Switchboard Feeders	Eaton PXR25	Circuit breaker with energy metering trip unit	Requires serial to Ethernet converter (e.g. PX Dashboard Lite, PXG, etc.)
M3	Transfer Switches	Eaton PXM1000	Multi-function power meter	Not required if already metering ATS normal and emergency feeders
M4	Distribution Panel Main	Eaton PXM1000	Multi-function power meter	
M5	Distribution Panel Feeders	Eaton PXR25	Circuit breaker with energy metering trip unit	Requires serial to Ethernet converter (e.g. PX Dashboard Lite, PXG, etc.)
M6	Branch Panel Main + Feeders	Eaton PXBCM	Panelboard monitoring multipoint meter	
Note: Interface to Building Management System (BMS) shall be ethernet-based utilizing BACnet/IP protocol. (If alternate protocol is desired, additional components may be required.)				



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GS/Commercial Market Needs & Solutions

Market Segmentation

- Education
- Healthcare
- Commercial/Retail (Offices)
- Airports
- Government
- WWT

Market Needs & Wants

- Continuity of Business operations (Reliability & Resiliency)
- Operational Efficiency to maximize ROI, comfort over building lifecycle
- Deliver sustainability goals
- Keep people, assets and data within the building safe and secure
- Managing to current and future regulatory changes

Digital Offerings & Solutions

Power Distribution Monitoring & Control

Cybersecurity services

Meters and monitoring

Architecture design, build and planning

Remote monitoring

EPMS

Brightlayer software suite

Project Management

Digital Integration Services

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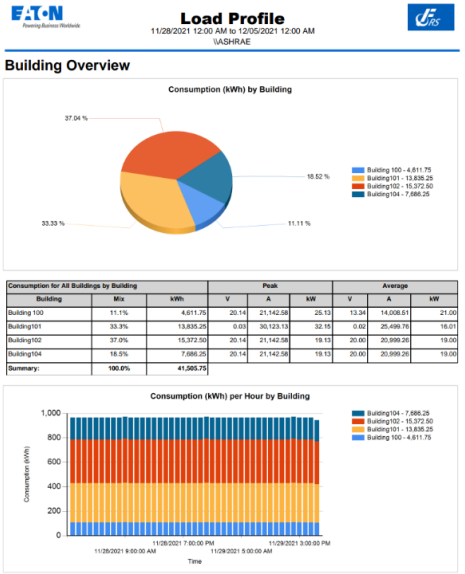
Codes/Compliance: ASHRAE/LEED/IgCC

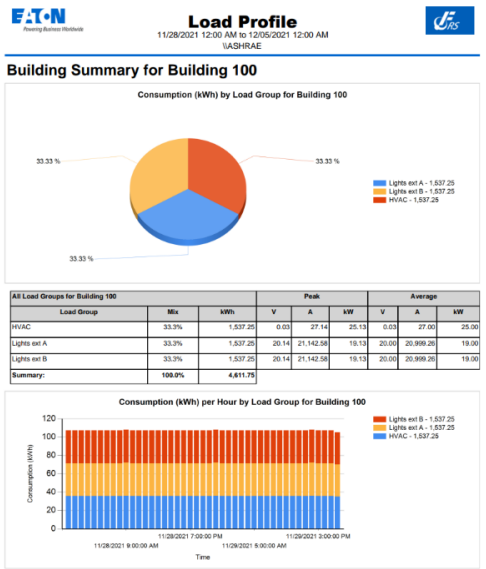
Comply with local energy codes. Track and progress to internal sustainability goals.

IECC (International Energy Conservation Code)
Establishes minimum requirements for energy efficient buildings using prescriptive and performance-related provisions. Section C405.12 specifically focuses on energy monitoring and reporting through a centralized energy management system

ASHRAE 90.1 is a parallel standard to IECC

"Beginning in April 2023, all new buildings and major retrofits constructed by the Federal government must comply with the 2021 IECC and the 2019 ASHRAE 90.1 building energy codes.





Digital Solution

- ✓ PDMC and/or EPMS
- ✓ Metering/Gateways
- ✓ Digital Integration Services

Applicable Sub-segments

- ✓ Education
- ✓ Healthcare
- ✓ Airports
- ✓ Commercial Buildings
- ✓ Government

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Comments & Questions?

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