



**16th IBPSA**  
INTERNATIONAL  
**CONFERENCE**  
AND EXHIBITION



# Updated OpenStudio Small and Medium Office Prototype Models

Speaker:

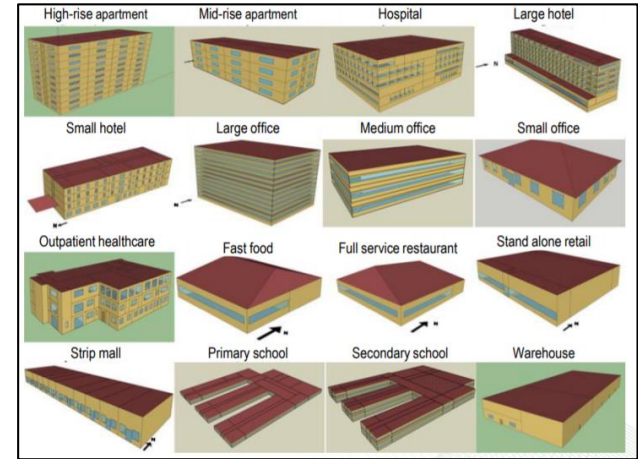
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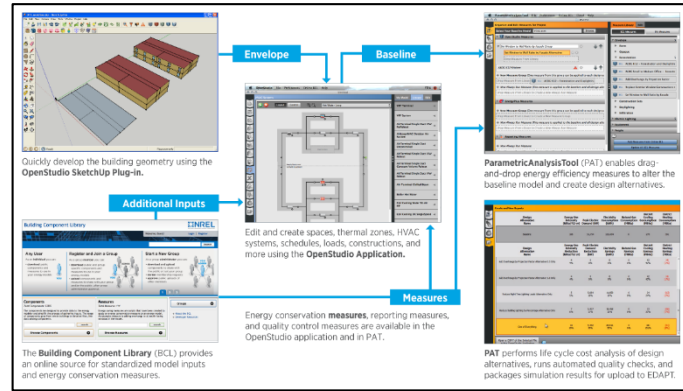
# Introduction/Background

- **Prototype Building Models**
  - DOE's support for ANSI/ASHRAE/IES Standard 90.1 and International Energy Conservation Code (IECC)
  - 80% of the commercial building floor area
- **Office buildings** (small, medium, and large): the most common types
  - **Simplified space type** in current set of prototype building model suites
  - Could not be easily used to properly assess changes



# Introduction/Background

- Advantages of redefining as OpenStudio models
  - Measure-based modification of buildings
  - ASHRAE 90.1-compliant baseline models, analysis of retrofit options, cloud-based computation, and reporting of energy-based analysis
  - **OpenStudio Standards** is a collection of measures and resources

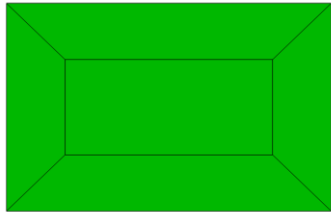
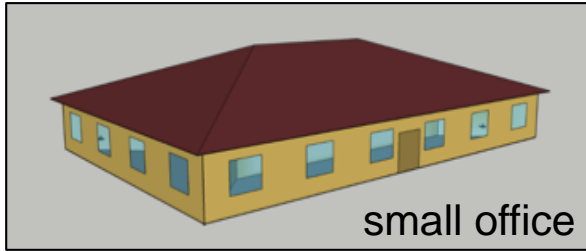


# Intended Use Cases

- Space type
  - Gain greater specificity over building attributes.
- Measures
  - Accurately quantify energy, demand, or water savings opportunities
- HVAC control
  - Allow customizable control over HVAC control algorithms
- Demand response
  - Provide more specific details related to occupancy and equipment to provide demand response services to the grid

# Methodology

- Original small and medium office prototype

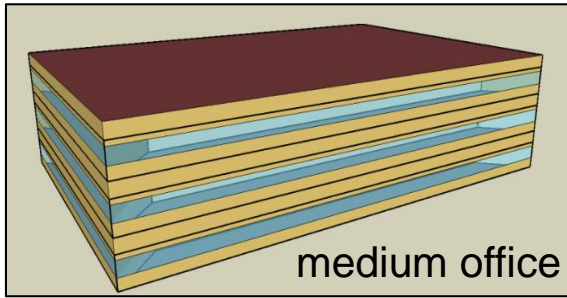


Office

- 1-story building, 511 m<sup>2</sup>
- Four perimeter zones and one core zone
- Window wall ratio
  - 24.4% for South and 19.8% for others
- Wood-frame construction, unheated slab-on-grade
- Air source heat pump systems with gas furnace as back up
- Constant volume single zone system
- Setpoint temperature: 23.9°C (C), 21.1°C (H)
- Setback setpoint: 29.4°C(C), 15.6°C(H)

# Methodology

- Original small and medium office prototype



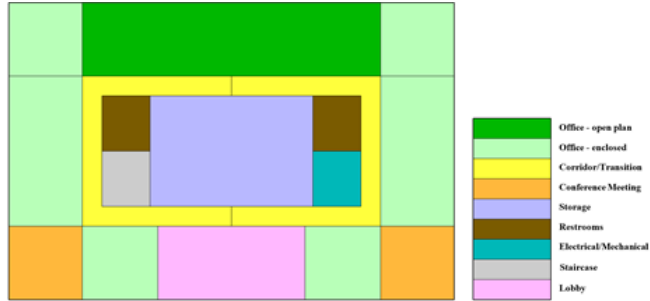
Office

- 3-story building, 4,978.6 m<sup>2</sup>
- Four perimeter zones and one core zone
- Window wall ratio: 33%
  - Steel-frame construction, unheated slab-on-grade
- Packaged DX air conditioning unit with gas furnace
- VAV terminal box with electric reheating coil
- Setpoint temperature: 23.9°C (C), 21.1°C (H)
- Setback setpoint: 29.4°C(C), 15.6°C(H)

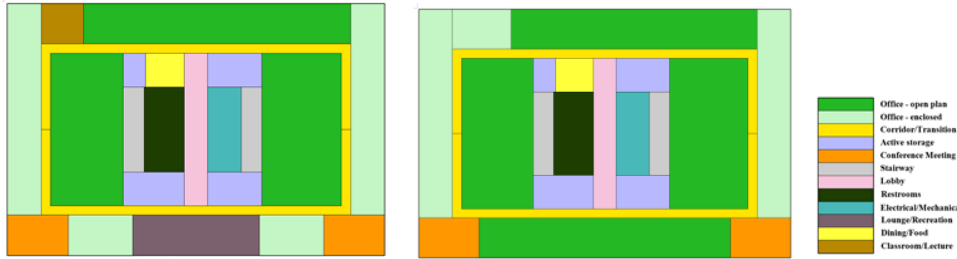
# Methodology

- Update for Space Types: 16 climate locations and 4 building standards
  - Building envelope thermal properties and HVAC system type
    - Original small/medium office prototype building models
  - The HVAC system capacity: auto-sized
    - Can be different from the original models
  - One VAV box for each space
    - Increased total number of VAV boxes
  - The number of AirLoopHVAC: one for each floor
  - Internal gain: space type as defined in ASHRAE Standard 90.1 and 62.1

# Methodology



New small office prototype model layout



New medium office prototype model layout  
(ground floor and mid/top floor)

Space	Area Fraction	
	Small Office (511 m <sup>2</sup> )	Medium Office (4,979.6 m <sup>2</sup> )
Office - open plan	15%	42.4%
Office - enclosed	29%	18.7%
Corridor/Transition	12%	9.1%
Conference Meeting/ Multipurpose	8%	5.2%
Stairway	3%	3.7%
Lobby	6%	3.7%
Restrooms	4%	3.6%
Electrical/Mechanical	2%	3.0%
Active storage <50 & >1000 ft <sup>2</sup>	14%	5.2%
Active storage 50-1000 ft <sup>2</sup>		1.9%
Lounge/Recreation	2%	1.8%
Dining Area	-	0.9%
Classroom/Lecture/Training	-	0.6%
Food Preparation <sup>1</sup>	-	0.4%

<sup>1</sup> Combined with dining area



# Results: Input comparison

Lighting, ventilation, occupancy, and elec. equipment per area for ASHRAE 90.1-2004

Prototype	Space Type	Lighting per Area (W/m <sup>2</sup> )	Ventilation per Area (L/s*m <sup>2</sup> )	Ventilation per Person (L/s*person)	Occupancy per Area (people/m <sup>2</sup> )	Electric Equipment per Area (W/m <sup>2</sup> )
Original	WholeBuilding - Md Office	10.76	0.51	-	0.05	8.07
Original	WholeBuilding - Small Office	10.76	0.51	-	0.06	6.78
Updated	Storage	8.61	0.76	-	-	-
	Stair	6.46	0.25	-	-	-
	Restroom	9.69	0.25	-	-	2.91
	OpenOffice	11.84	0.00	9.44	0.06	10.33
	Lobby <sup>3</sup>	13.99	0.00	7.08	0.11	2.91
	Elec/MechRoom	16.15	0.76	-	-	2.91
	Corridor	5.38	0.25	-	-	3.12
	Conference	13.99	0.00	9.44	0.54	10.76
	ClosedOffice	11.84	0.00	9.44	0.05	9.36
	Dining	9.69	0.00	7.08	0.11	10.76
	Classroom	15.07	0.00	8.00	0.38	10.00
	Weighted Average - Md Office	11.09	0.91	-	0.07	7.64
	Weighted Average - Small Office	10.87	1.07	-	0.08	6.46
	Percentage Increase- Md Office [%]	3	80		33	-5
	Percentage Increase- Sm Office [%]	1	110		31	-5

Lighting, ventilation, occupancy, and elec. equipment per area for ASHRAE 90.1-2007

Prototype	Space Type	Lighting per Area (W/m <sup>2</sup> )	Ventilation per Area (L/s*m <sup>2</sup> )	Ventilation per Person (L/s*person)	Occupancy per Area (people/m <sup>2</sup> )	Electric Equipment per Area (W/m <sup>2</sup> )
Original	WholeBuilding - Md Office	10.76	0.46	-	0.05	8.07
Original	WholeBuilding - Sm Office	10.76	0.51	-	0.06	6.78
Updated	Storage	8.61	0.61	-	-	-
	Stair	6.46	0.30	-	-	-
	Restroom	9.69	0.30	-	-	2.91
	OpenOffice	11.84	0.30	2.36	0.06	10.33
	Lobby	13.99	0.30	2.36	0.11	2.91
	Elec/MechRoom	16.15	0.61	-	-	2.91
	Corridor	5.38	0.30	-	-	3.12
	Conference	13.99	0.30	2.36	0.54	10.76
	ClosedOffice	11.84	0.30	2.36	0.05	9.36
	Dining	9.69	0.30	2.36	0.11	10.76
	Classroom	15.07	0.61	4.72	0.38	10.00
	Weighted Average - Md Office	11.09	0.51	-	0.07	7.64
	Weighted Average - Small Office	10.87	0.56	-	0.08	6.46
	Percentage Increase- Md Office [%]	3	11		33	-5
	Percentage Increase- Sm Office [%]	1	10		31	-5

# Results: Input comparison

Lighting, ventilation, occupancy, and elec. equipment per area for ASHRAE 90.1-2010

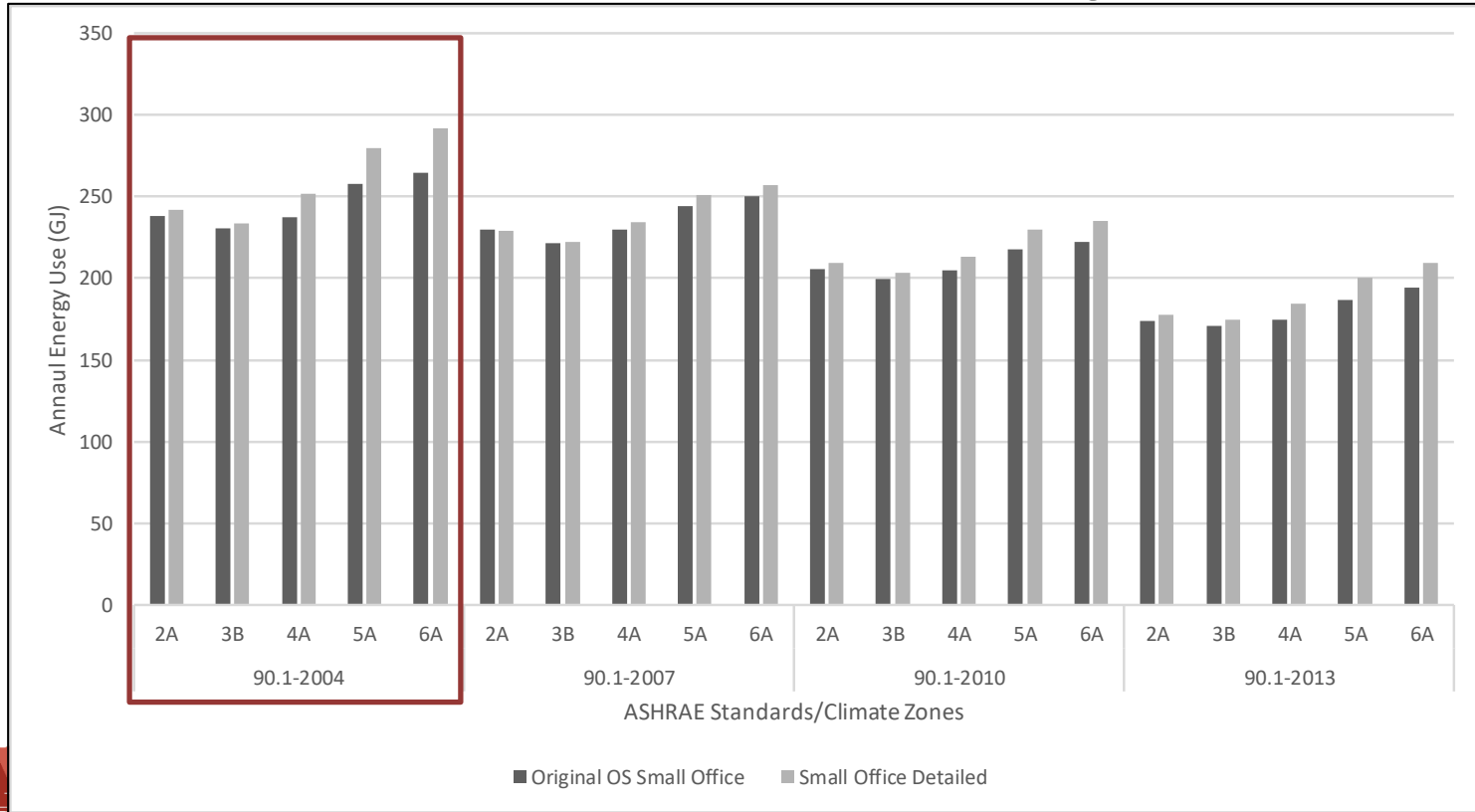
Lighting, ventilation, occupancy, and elec. equipment per area for ASHRAE 90.1-2013

Prototype	Space Type	Lighting per Area (W/m <sup>2</sup> )	Ventilation per Area (L/s*m <sup>2</sup> )	Ventilation per Person (L/s*person)	Occupancy per Area (people/m <sup>2</sup> )	Electric Equipment per Area (W/m <sup>2</sup> )
Original	WholeBuilding - Md Office	9.69	0.46	-	0.05	8.07
Original	WholeBuilding - Sm Office	9.69	0.43	-	0.06	6.78
Updated	Storage	6.78	0.61	-	-	-
	Stair	7.43	0.30	-	-	-
	Restroom	10.55	0.30	-	-	2.91
	OpenOffice	10.55	0.30	2.36	0.06	10.33
	Lobby	9.69	0.30	2.36	0.11	2.91
	Elec/MechRoom	10.23	0.61	-	-	2.91
	Corridor	7.10	0.30	-	-	3.12
	Conference	13.24	0.30	2.36	0.54	10.76
	ClosedOffice	11.95	0.30	2.36	0.05	9.36
	Dining	7.00	0.30	2.36	0.11	10.76
	Classroom	13.35	0.61	4.72	0.38	10.00
	Weighted Average - Md Office	10.23	0.51	-	0.07	7.64
	Weighted Average - Small Office	10.12	0.56	-	0.08	6.46
	Percentage Increase- Md Office [%]	6	11		33	-5
	Percentage Increase- Sm Office [%]	4	29		31	-5

Prototype	Space Type	Lighting per Area (W/m <sup>2</sup> )	Ventilation per Area (L/s*m <sup>2</sup> )	Ventilation per Person (L/s*person)	Occupancy per Area (people/m <sup>2</sup> )	Electric Equipment per Area (W/m <sup>2</sup> )
Original	WholeBuilding - Sm Office	8.83	0.43	-	0.06	6.78
Original	WholeBuilding - Md Office	8.83	0.46	-	0.05	8.07
Updated	Storage	6.78	0.61	-	-	-
	Stair	7.43	0.30	-	-	-
	Restroom	10.55	0.30	-	-	2.91
	OpenOffice	10.55	0.30	2.36	0.06	10.33
	Lobby	9.69	0.30	2.36	0.11	2.91
	Elec/MechRoom	4.52	0.61	-	-	2.91
	Corridor	7.10	0.30	-	-	3.12
	Conference	13.24	0.30	2.36	0.54	10.76
	ClosedOffice	11.95	0.30	2.36	0.05	9.36
	Dining	7.00	0.30	2.36	0.11	10.76
	Classroom	13.35	0.61	4.72	0.38	10.00
	Weighted Average - Md Office	10.01	0.51	-	0.07	7.64
	Weighted Average - Small Office	10.01	0.56	-	0.08	6.46
	Percentage Increase- Md Office [%]	13	18		19	13
	Percentage Increase- Sm Office [%]	13	22		47	-20

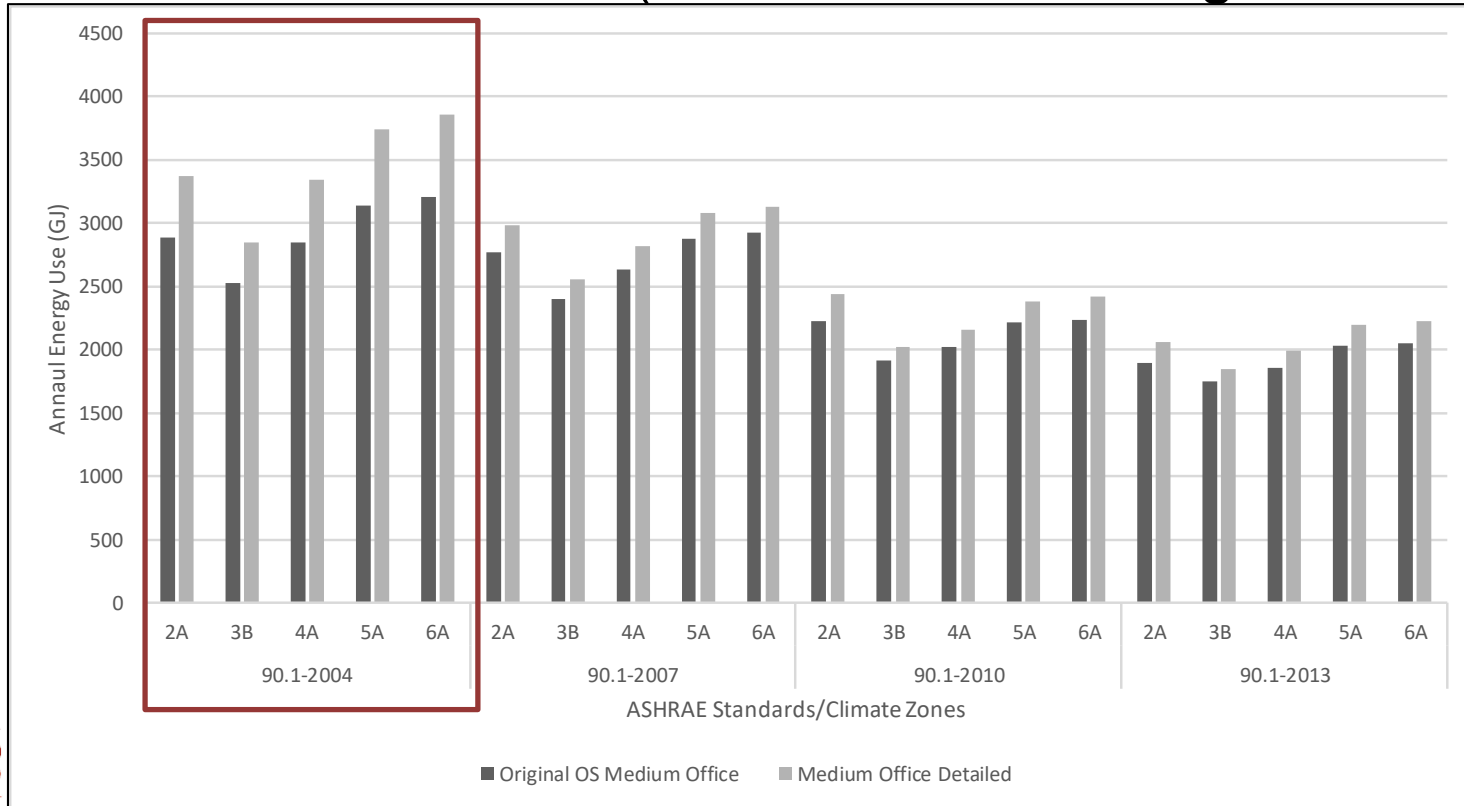
# Results: Annual energy use comparison

- Small office: 0-10% (0-8% if 2004 vintage is excluded)



# Results: Annual energy use comparison

- Medium office: 5-20% (5-10% if 2004 vintage is excluded)



# Discussion

- No attempt to match the energy use
  - More space type and associated space attributes
- Performed an energy use comparison analysis
  - To ensure reasonable trends and patterns
- **Discrepancies in energy use** are due to
  - space types and associated space specific lighting, plug load, ventilation rates and increased the number of HVAC system units and VAV boxes
- Developed based on US typical building for modelling flexibility

# Conclusion

- Discussed the updated the small and medium office prototype models
  - new space types based on existing standards
- Showed relatively close agreements for the simulated energy use
- All three office models will be provided in OpenStudio as measures



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## Updated OpenStudio Small and Medium Office Prototype Models

### Questions and Comments

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