



# 2026 ASHRAE WINTER CONFERENCE

## **Seminar 18, Modern AI Tooling for the ASHRAE Workforce**

### **Transforming Building Energy Modeling Processes with Large Language Models**

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# Learning Objectives

- Identify AI tools that are relevant to their profession
- Understand the correlation of various AI tools/methods
- Understand how generative AI, aggregation and contextualization can influence building intelligence
- Recognize how AI can be integrated into current practices to enhance output

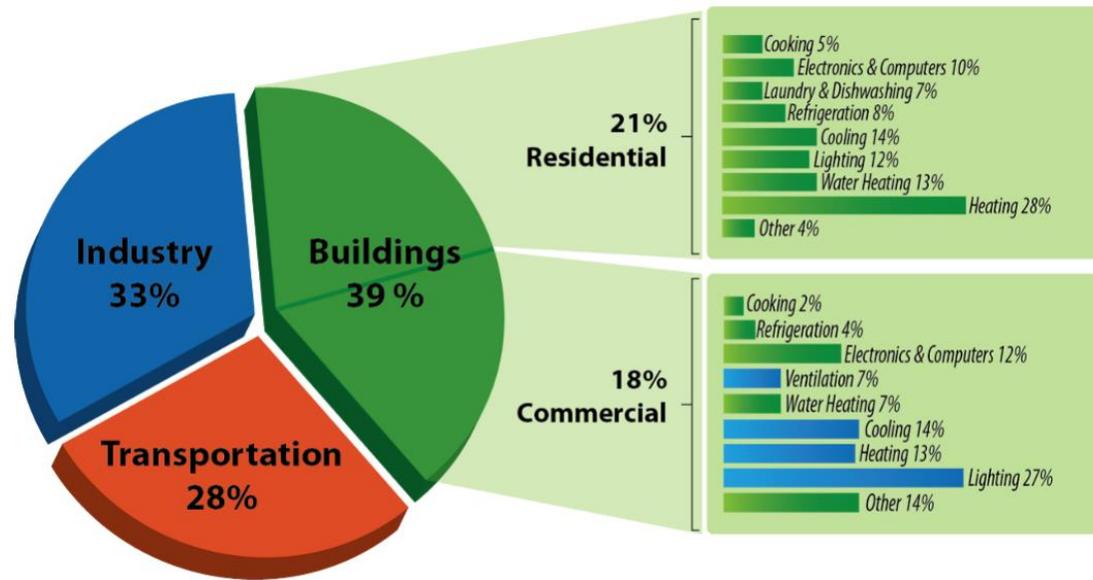
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# Agenda

- **Background and Motivation**
- **Challenges**
- **Solutions**
- **Conclusion**

# Background and Motivation



**Buildings account for 40% of global energy consumption and CO<sub>2</sub> emission**

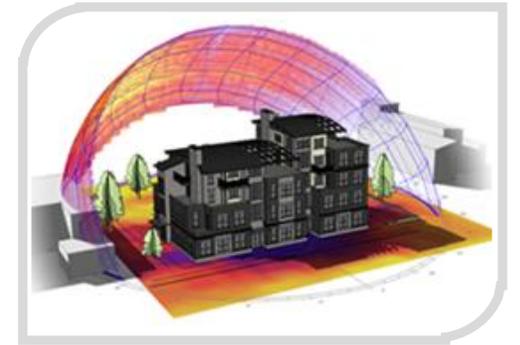


**Whole world energy efficiency, and decarbonization**

# Background and Motivation

*What is Building Energy Modeling (BEM)?*

- *A Physics- and math-based technique to construct a “Digital Twin”*
- *To predict building energy consumption/indoor environment*



*Support various applications:*

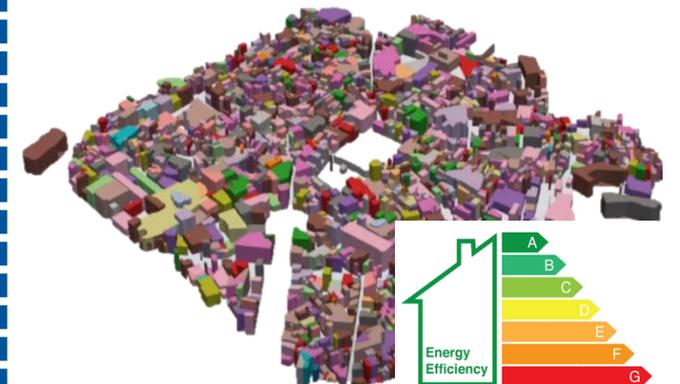
## Sustainable Design



## Smart Operation



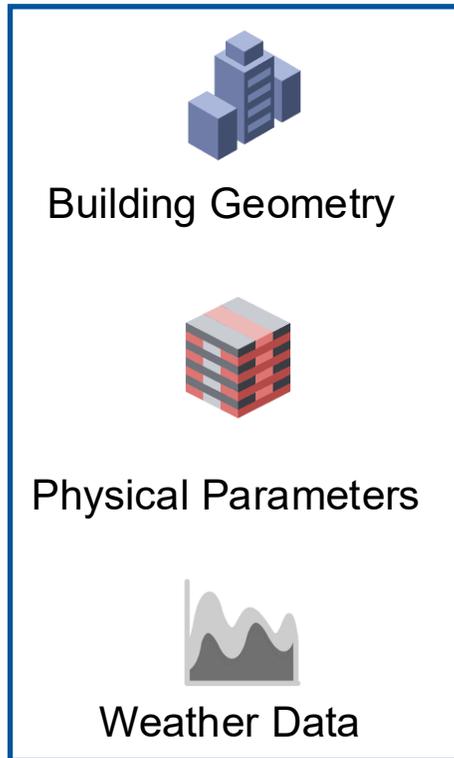
## Urban Analysis



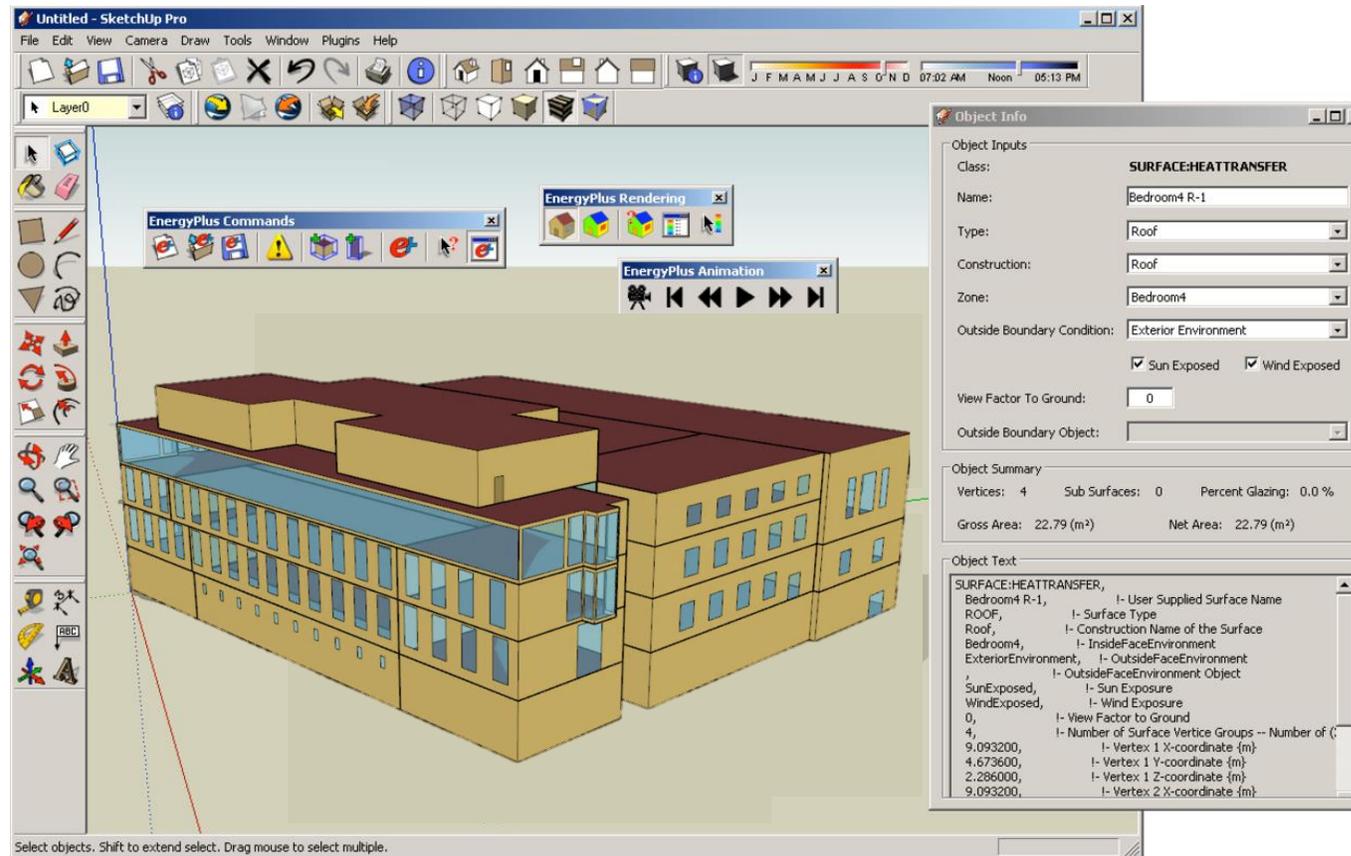
**Important tool for building sustainability and decarbonization**

# Traditional Building Energy Modeling Process

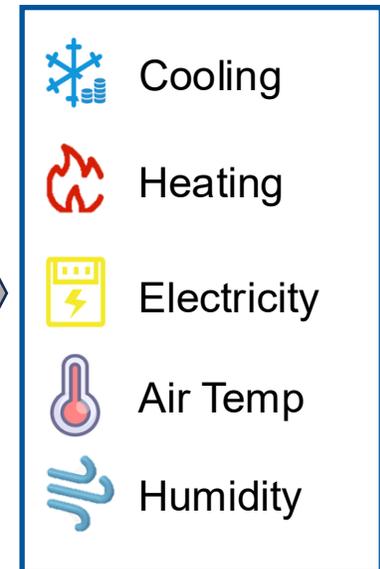
❖ Building energy modeling is **time consuming** and **labor intensive** !!



*Simulation Input*



**Simulation Engine: EnergyPlus with SU**

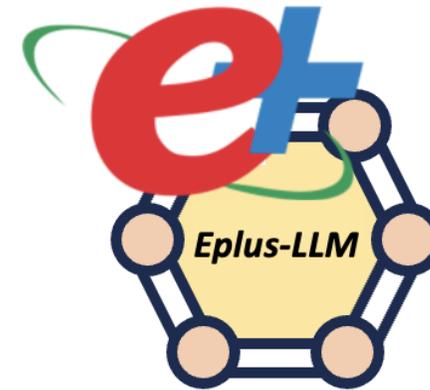
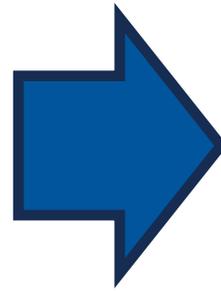


*Simulation Output*

# Transformed Building Energy Modeling Process



Large Language Model  
(Generative AI)

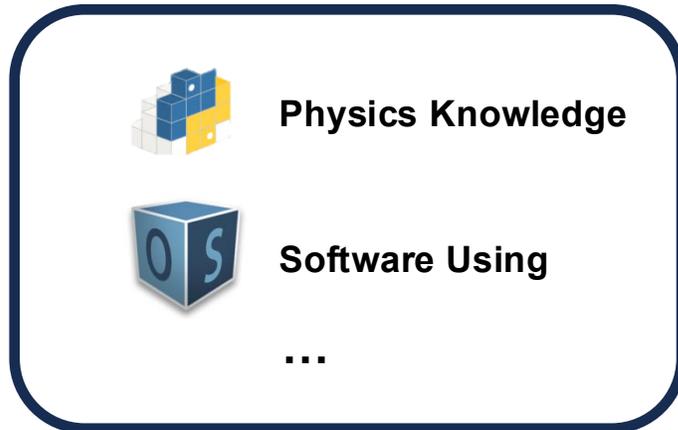
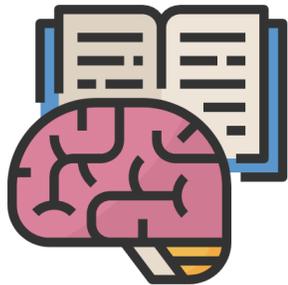


Building Energy Models  
(EnergyPlus)

Directly **translate** user modeling intents into desired building energy models

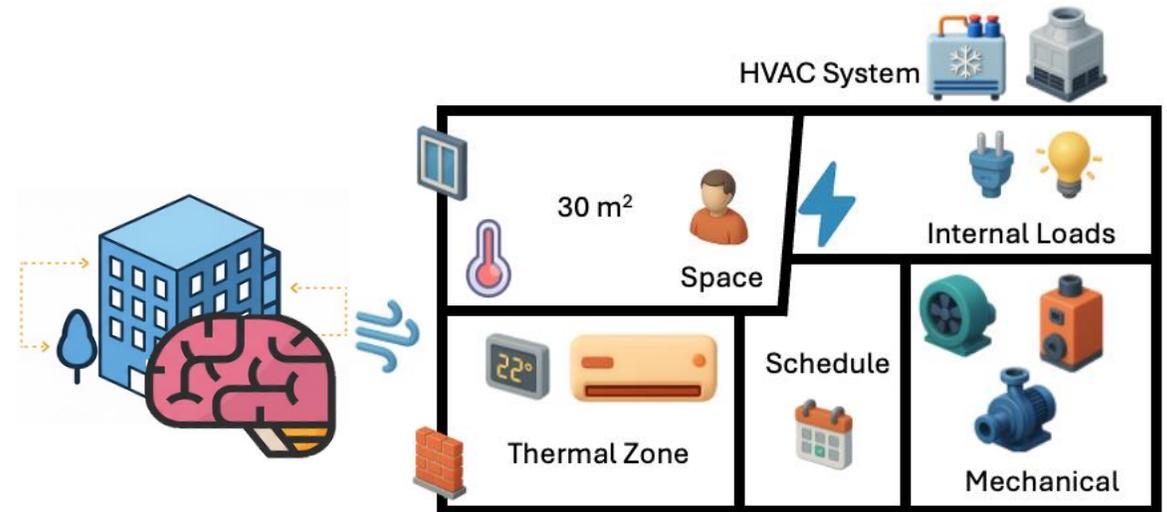
# Existing Challenges

**Lack expertise knowledge** in the specific building domain



Need customization for **domain-specific** and task-specific applications

**Modeling is complicated with high requirements**

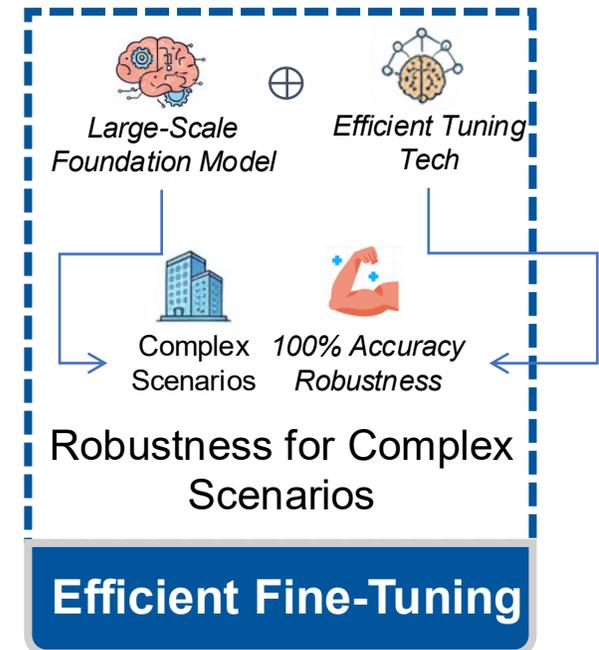
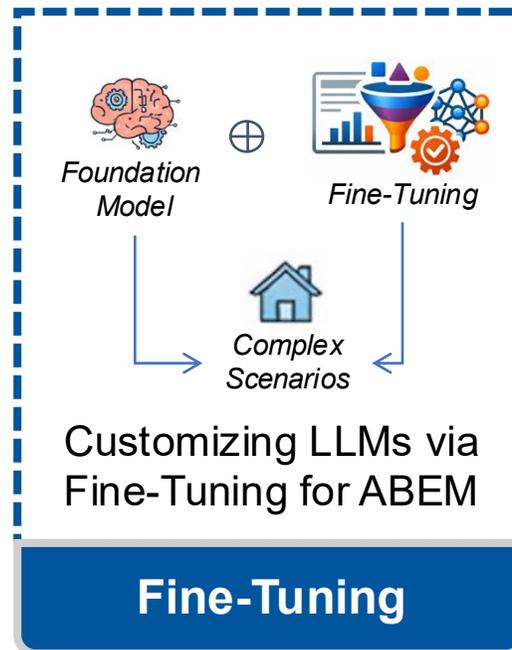
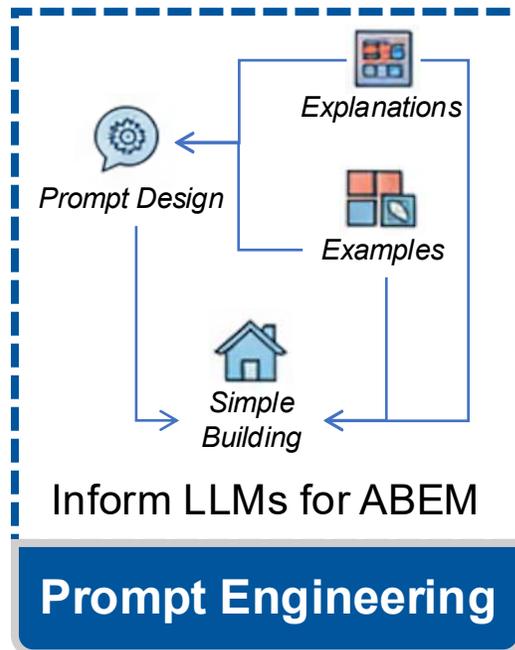


Buildings are diverse, while modeling of buildings requires **100% accurate model**

# Solutions

## ❖ Potential Solutions

Using Large Language Models (LLMs) to realize **Automated Building energy Modeling (ABEM)**



- 💡 RAG: Retrieval augmented generation on extra knowledge base
- 💡 MCP: Model context protocol, put your tools in context, let LLMs know how to apply tools (e.g., Python codes)
- 💡 Agentic pipe: Hybrid tricks, e.g., applied multi-LLMs and multi-techs

# Solution 1: Prompt Engineering

## ❖ Prompt Engineering to Inform LLMs for ABEM

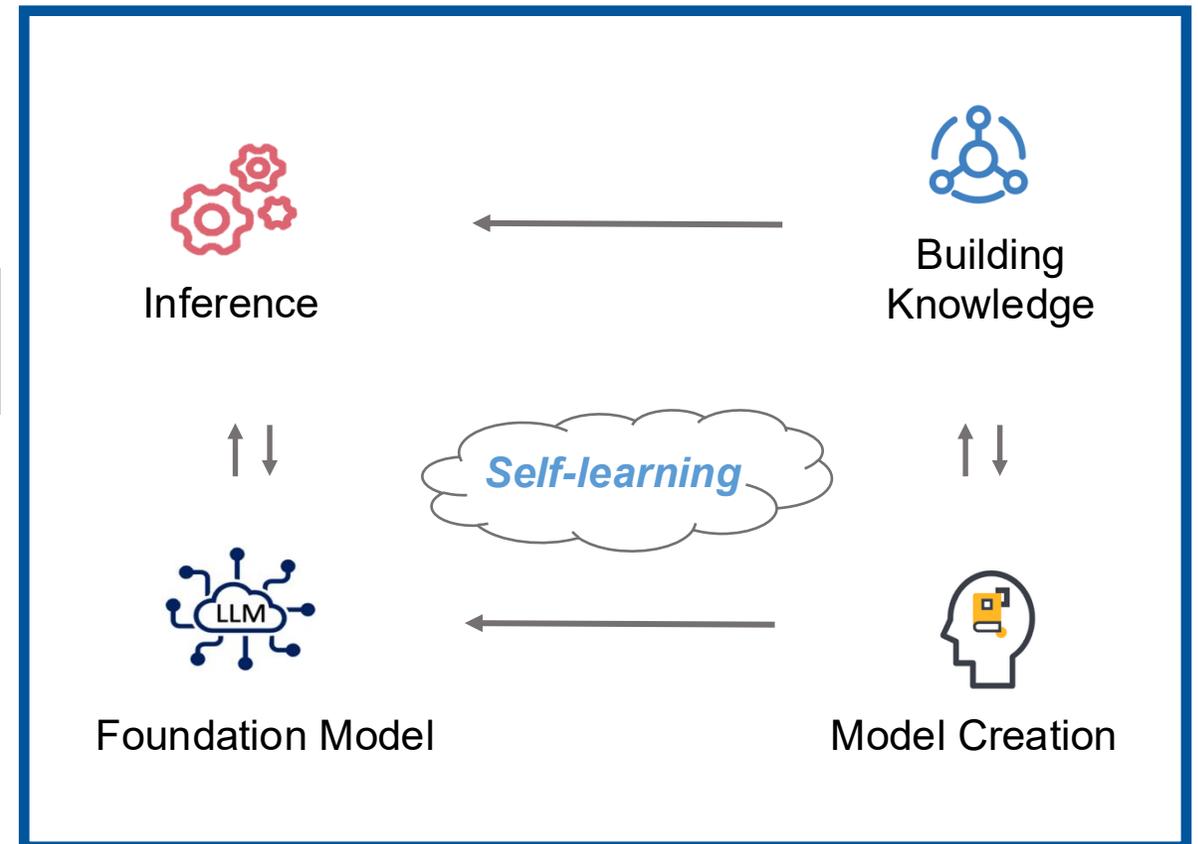
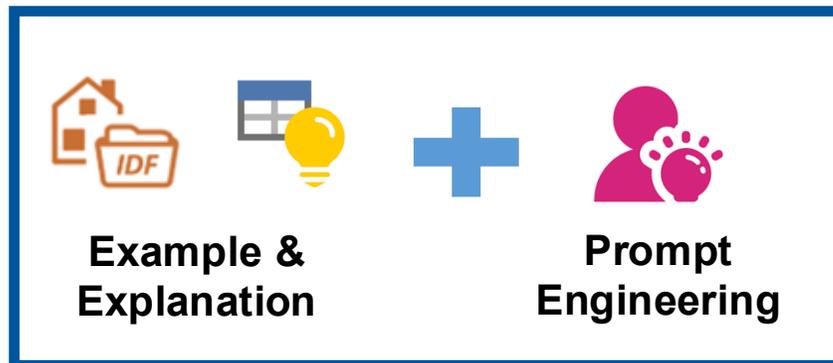
### Motivation

What is prompt engineering?

- *Designing inputs* to guide LLM outputs

Why using prompt engineering?

- *Simplest way to explore* (No tech and source required)

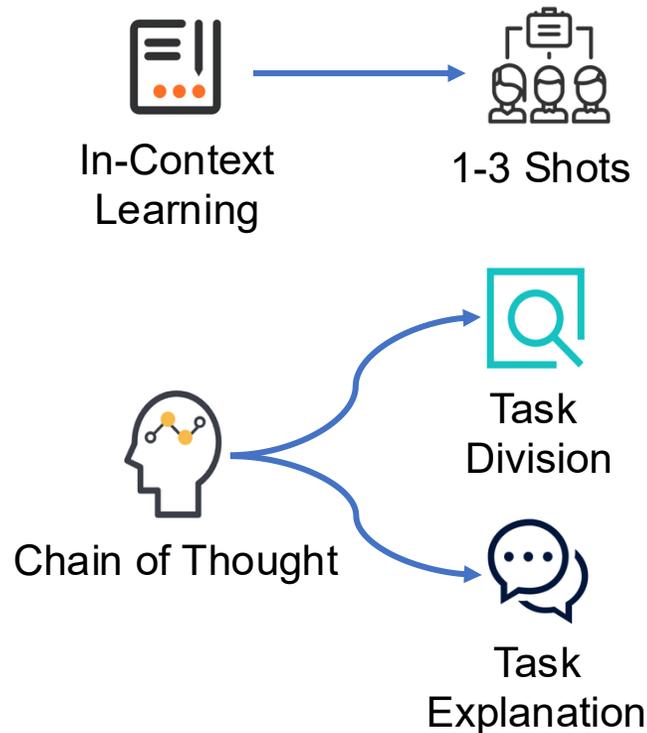


Prompt Engineering Workflow

# Prompt Engineering: Summary

## ❖ Summary of prompt engineering in ABEM

### Prompt Strategies



### State of The Art LLMs



T5



Llama



Mistral



Qwen



Solar



Vicuna

### ABEM Tasks



Simple Building



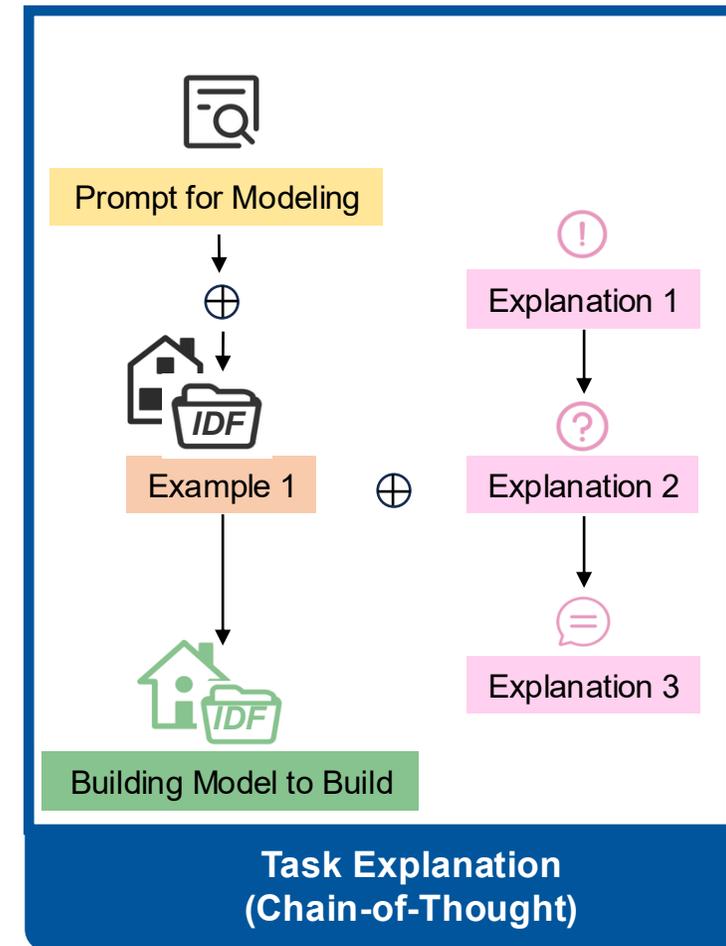
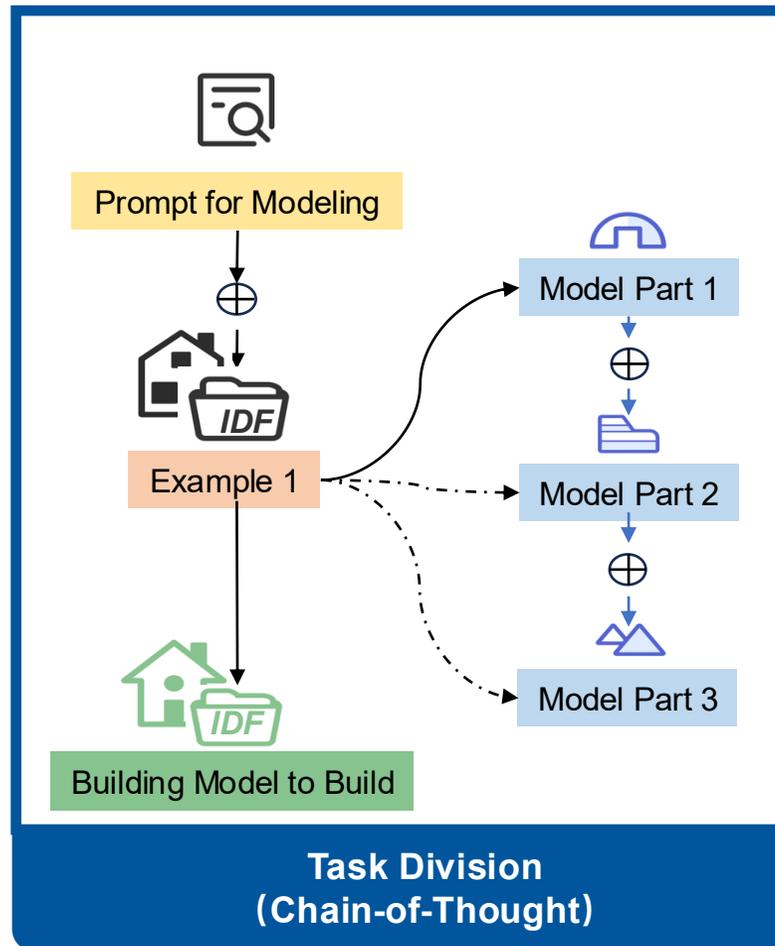
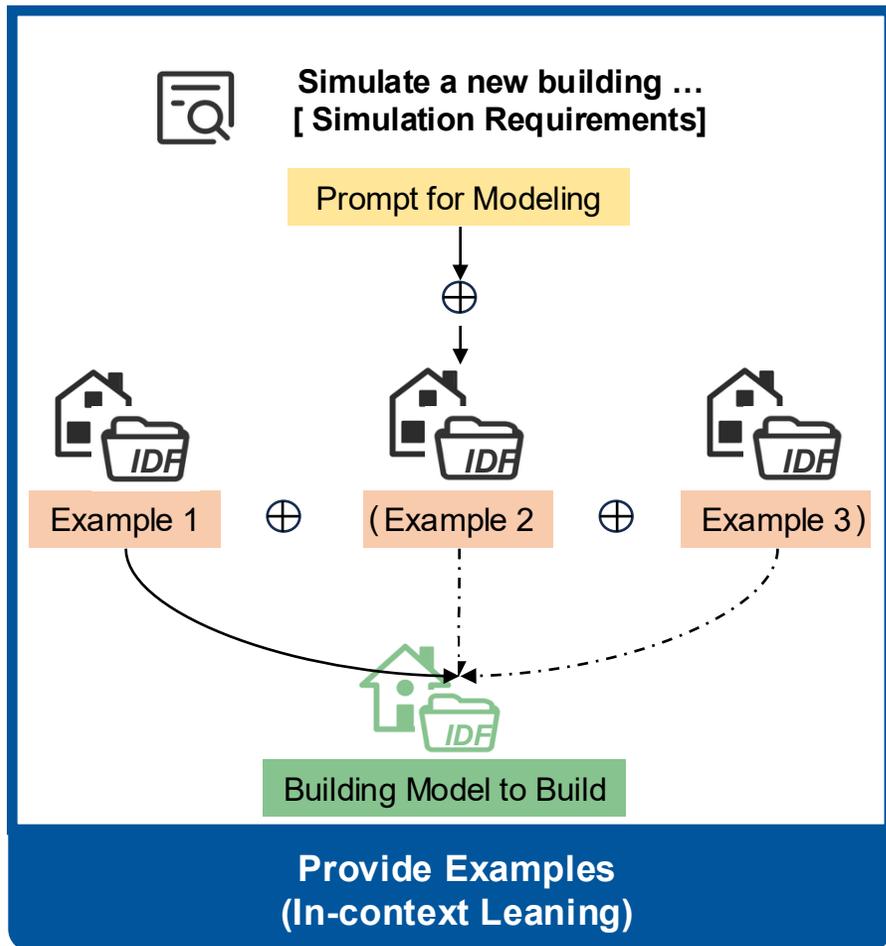
Typical Building



Real-World Building

# Strategies

## ❖ Overview of the designed prompt strategies

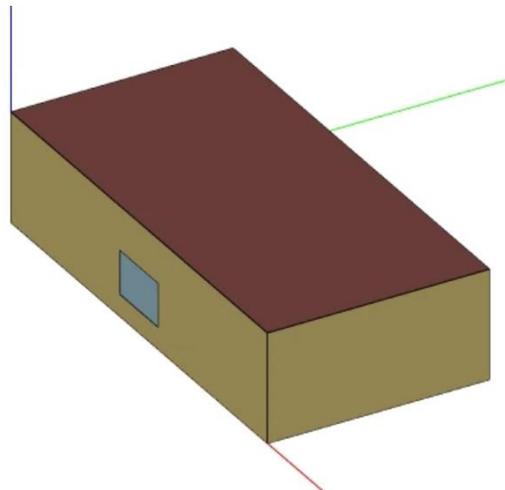


# Task Definition

## ❖ Overview of ABEM tasks

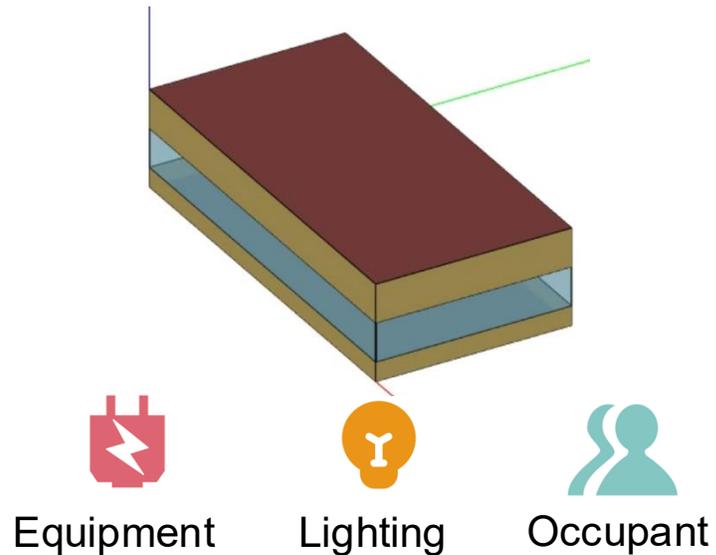
### Task 1 - Simple Building

Geometry box,  
No internal gain,  
single window



### Task 2 - Typical Building

Regular building with  
Internal gain



### Task 3 - Real Building

iUnit in National Renewable Energy  
Lab



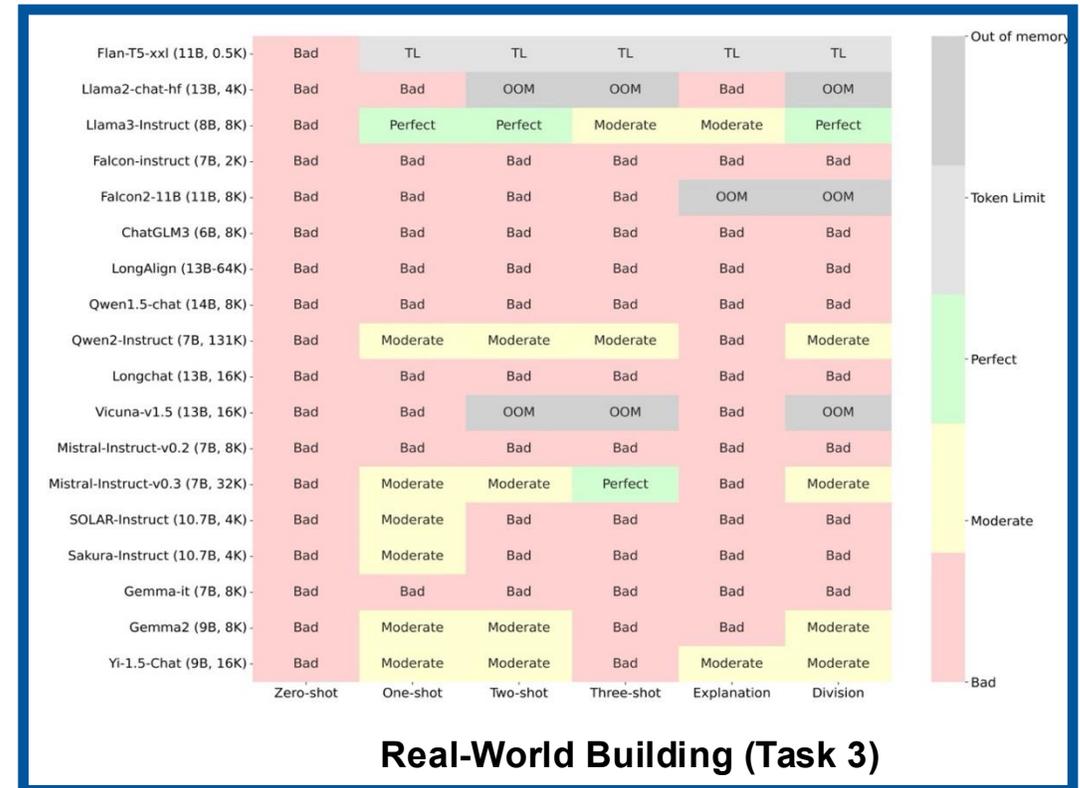
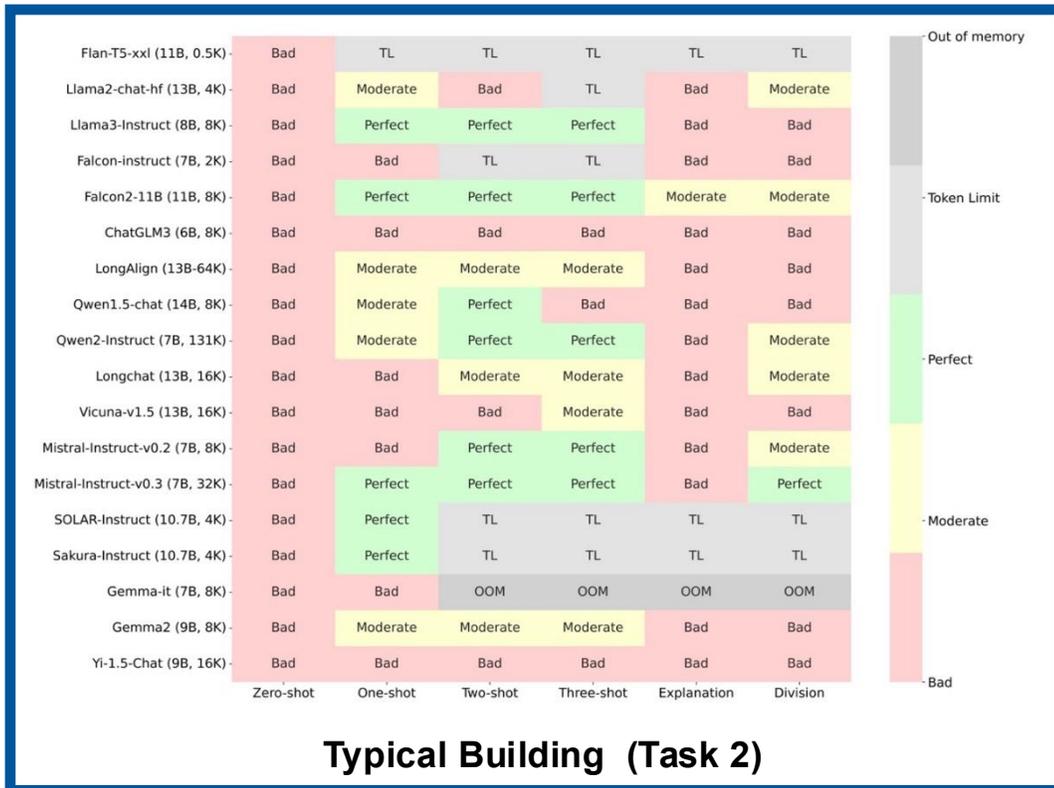
# LLM Selection

❖ **18 state of the art LLMs**  
**(on leaderboard)**

❖ **Light-weight LLMs**  
**(7-14B parameters)**

Instruction model	Foundation model	Model size (parameters)	Context window (tokens)
Flan-T5-xxl	T5	11B	512
Llama2-chat-hf-13B	Llama	13B	4K
Llama3-8B-Instruct	Llama	8B	8K
Falcon-7B-instruct	Falcon	7B	2K
Falcon2-11B	Falcon	11B	8K
ChatGLM3-6B	ChatGLM3-Base	6B	8K
LongAlign-13B-64K	LongAlign-Base	13B	64K
Qwen1.5-14B-Chat	Qwen	14B	8K
Qwen2-7B-Instruct	Qwen	7B	131K
Longchat-13B-16K	Llama	13B	16K
Vicuna-13B-V1.5-16k	Llama	13B	16K
Mistral-7B-Instruct-v0.2	Mistral	7B	8K
Mistral-7B-Instruct-v0.3	Mistral	7B	32K
SOLAR-10.7B-Instruct-v1.0	SOLAR	10.7B	4K
Sakura-Solar-Instruct	SOLAR	10.7B	4K
Gemma-7b-it	Gemini	7B	8K
Gemma-2-9b-it	Gemini	9B	8K
Yi-1.5-9B-Chat-16K	Yi	9B	16K

# Results



- ❖ For simple task (e.g., Task 2, Typical Building), providing just one model example (one-shot learning) is enough for the LLM to complete building model generation.
- ❖ In context learning and chain-of-thought strategies are effective ways to customize model generation and can improve accuracy and success rates.

**However, for complex building, prompt engineering is **not sufficient** to achieve ABEM!**

# Solution 2: Fine-Tuning

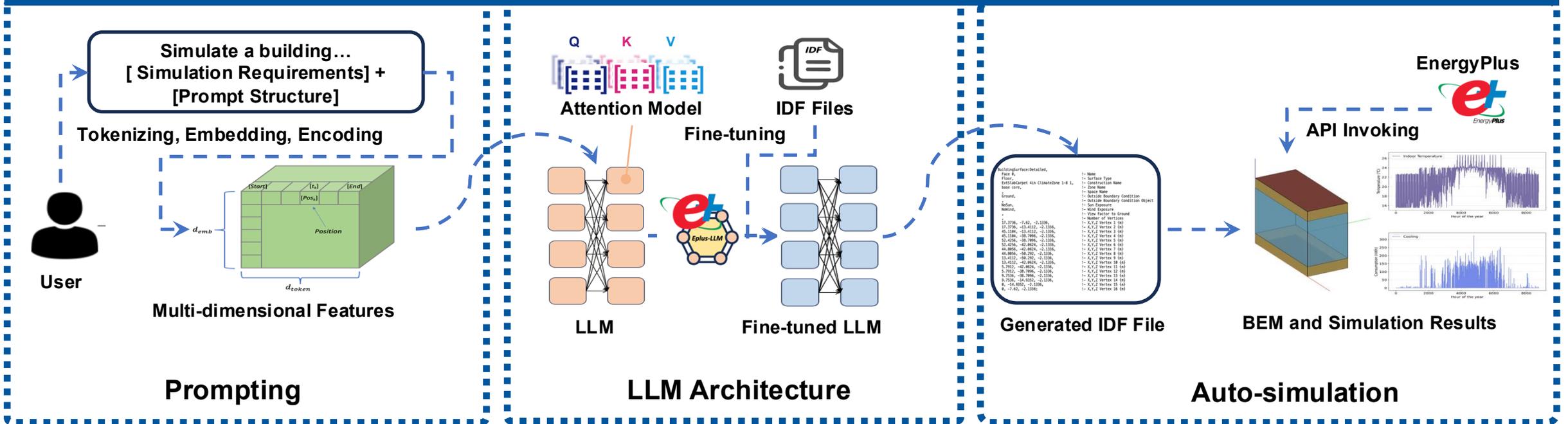
## ❖ Fine-Tuning to customize LLMs for ABEM

### Motivation

Prompt engineering is not sufficient!

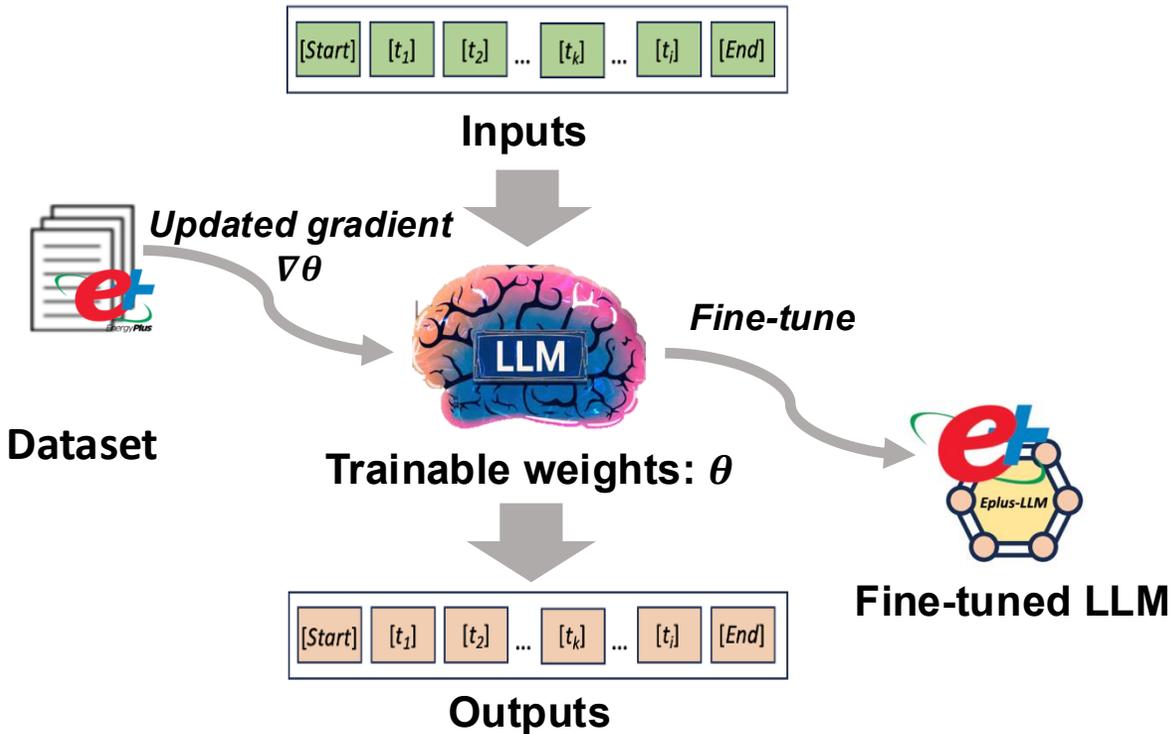
– Fine-tuning to further *improve the ability* of LLMs for ABEM, e.g., cover more *complex scenarios, high accuracy, strong robustness*.

## Workflow of LLM Fine Tuning and Building Model Generation

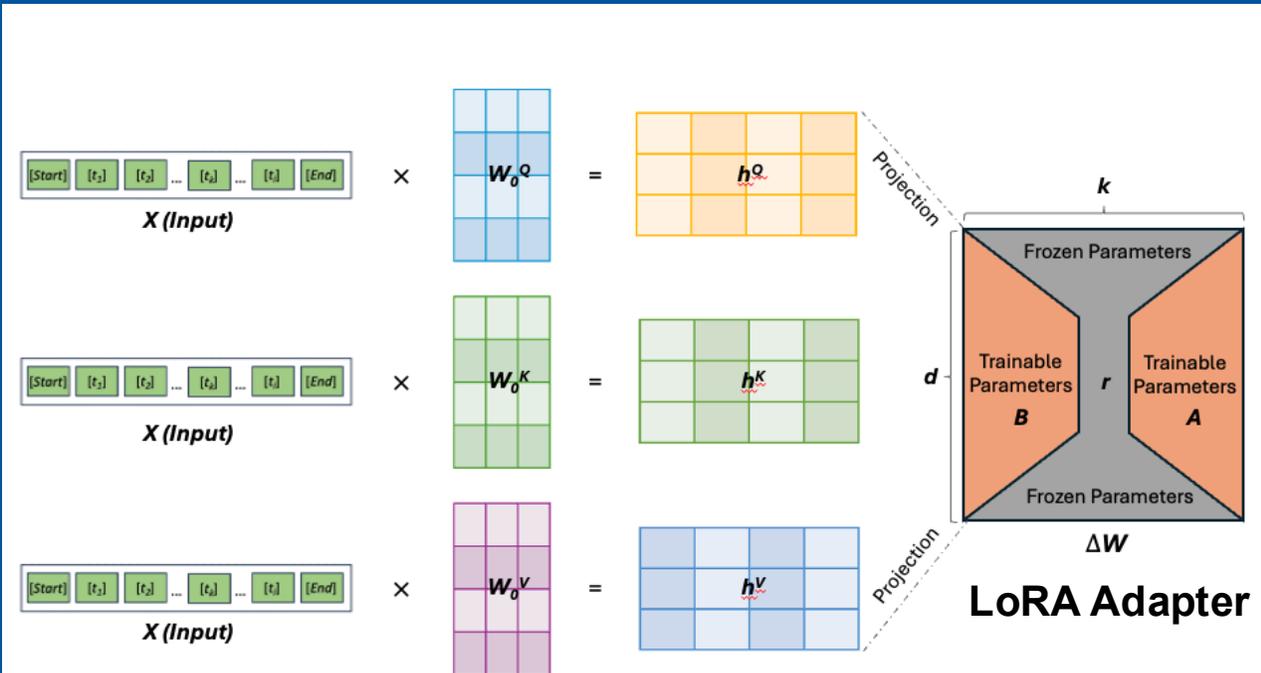


# Solution 3: Efficient Fine-Tuning

## Full Parameter Fine-Tuning

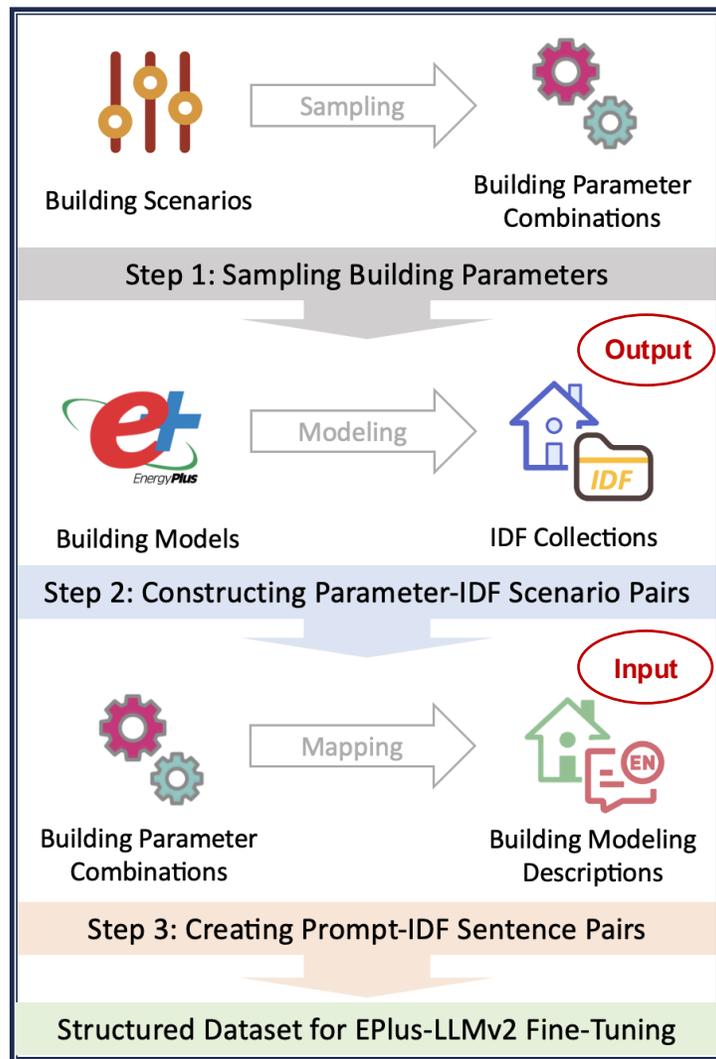


## Parameter-Efficient Fine-Tuning

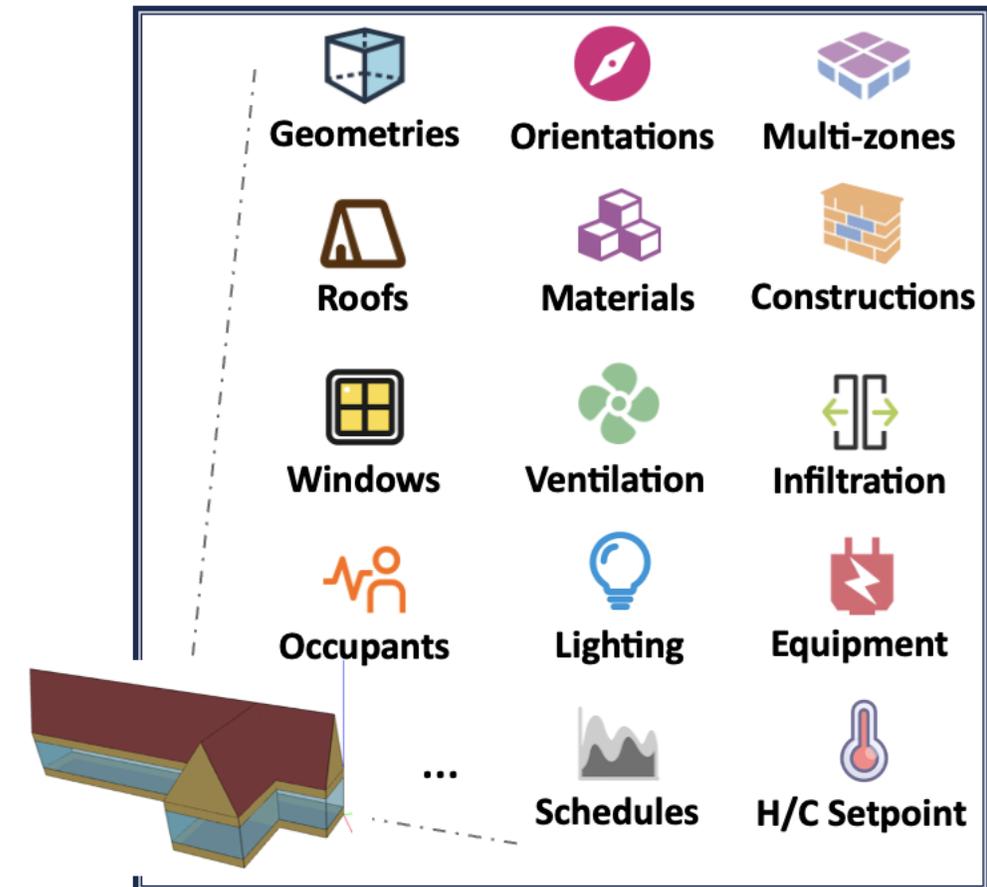


Fine-Tuning: 100% Accuracy, Robustness, No example needed, Free prompt design

# Data Preparation and Scenarios



Data Pipeline



EPlus-LLM: 70k building energy models  
EPlus-LLMv2: 490k building energy models

Covered Scenarios

# Input-Output in Training Dataset



**Prompt of building scenario:**  
**Hip roof, multi-thermal zones, etc.**

Simulate a building that is 417.04 meters long, 306.59 meters wide, and 264.75 meters high, with a hip roof. The distance of roof peak to the length and width side of building is 153.29 meters and 208.52 meters, respectively. The attic height is 73.45 meters. The building orientation is 44 degrees to the north. The building has 5 thermal zones with 1 core thermal zone and 4 exterior thermal zones in each orientation. The depth of exterior thermal zone is 22.99 meters. The window-to-wall ratio is 0.19. The windowsill height is 107.22 meters, the window height is 157.53 meters, and the window jamb width is 1.94 meters.

The window U-factor is 1.3 W/m2K and the SHGC is 0.35. The wall is made of wood, with a thickness of 0.42 meters and the wall insulation is RSI 1.6 m2K/W (U-factor 0.63 W/m2K). The roof is made of gypsum, with a thickness of 0.29 meters and the roof insulation is RSI 4.3 m2K/W (U-factor 0.23 W/m2K ). The floor is made of concrete, covered with carpet.

The ventilation rate is 2.3 ach. The infiltration rate is 0.49 ach.

The people density is 26.02 m2/person, the light density is 5.80 W/m2, and the electric equipment density is 23.67 W/m2. Occupancy starts at 8:00 and ends at 17:00. The occupancy rate is 0.82. The unoccupancy rate is 0.48.

The heating setpoint is 21.44 Celsius in occupancy period and 13.76 Celsius in unoccupancy period. The cooling setpoint is 23.74 Celsius in occupancy period and 27.58 Celsius in unoccupancy period.

## Generated Building Energy Model

**Building Geometry:**  
 building size, orientation, roof setting, thermal zone settings, and window configurations



**Constructions and Materials:**  
 Window, wall, roof, and floor information



**Air flow:**  
 Ventilation, and infiltration



**Internal loads and schedules:**  
 People, lighting, equipment, and occupancy



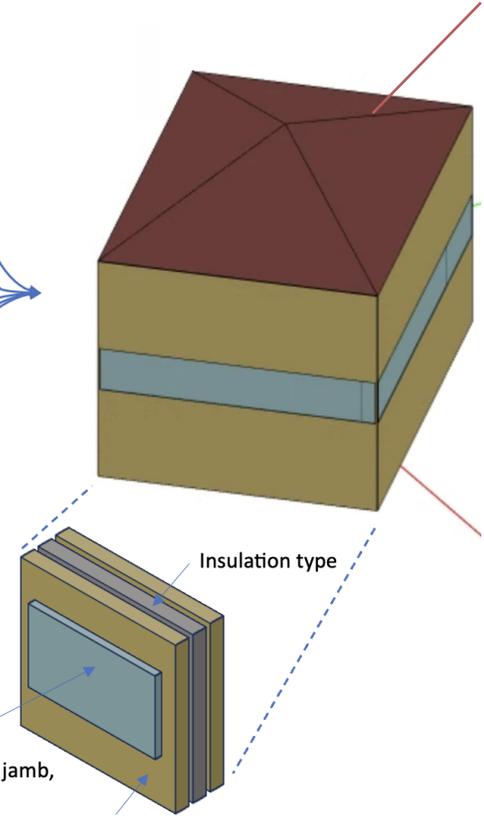
**Setpoints:**  
 Cooling, and heating



Window: WWR, sill, jamb, U-factor, and SHGC

Construction material and thickness

Insulation type



```

BuildingSurface:Detailed,
Face 2,
Wall,
ASHRAE 189.1-2009 ExtWall Mass ClimateZone 4, !- Construction Name
Thermal Zone 1,
,
Wall simulation setting
Outdoors,
,
SunExposed,
WindExposed,
,
,
0, 0, 3,
0, 10, 3,
0, 10, 0,
0, 0, 0;
Wall geometry information, described by coordinates
!- Name
!- Surface Type
!- Construction Name
!- Zone Name
!- Space Name
!- Outside Boundary Condition
!- Outside Boundary Condition Object
!- Sun Exposure
!- Wind Exposure
!- View Factor to Ground
!- Number of Vertices
!- X,Y,Z Vertex 1 {m}
!- X,Y,Z Vertex 2 {m}
!- X,Y,Z Vertex 3 {m}
!- X,Y,Z Vertex 4 {m}

PenetrationSurface:Detailed,
Face 3,
Window,
ASHRAE 189.1-2009 ExtWindow ClimateZone 4-5, !- Construction Name
Face 2,
,
Window simulation setting
,
,
,
!- Name
!- Surface Type
!- Building Surface Name
!- Outside Boundary Condition Object
!- View Factor to Ground
!- Frame and Divider Name
!- Multiplier
!- Number of Vertices
!- X,Y,Z Vertex 1 {m}
!- X,Y,Z Vertex 2 {m}
!- X,Y,Z Vertex 3 {m}
!- X,Y,Z Vertex 4 {m}
Window geometry information, described by coordinates
0, 9.9, 1.95,
0, 9.9, 1.05,
0, 0.1, 1.05,
0, 0.1, 1.95;

ElectricEquipment,
Electric Equipment 1,
Thermal Zone 1,
Medium Office Bldg Equip,
Watts/Area,
,
Equipment simulation setting and configuration
5,
,
,
,
General;
!- Name
!- Zone or ZoneList or Space or SpaceList Name
!- Schedule Name
!- Design Level Calculation Method
!- Design Level {W}
!- Watts per Zone Floor Area {W/m2}
!- Watts per Person {W/person}
!- Fraction Latent
!- Fraction Radiant
!- Fraction Lost
!- End-Use Subcategory
    
```

**Input**  
 (Building Description from Users)

**Output**  
 (Building Model in IDF Format)

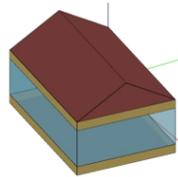
# Validation

## ❖ Accuracy

**402** validation cases, **100%** accuracy

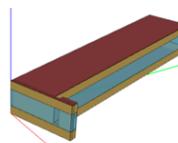
### Example 1: Square shaped, residential, single thermal zone, gable roof, etc.

Simulate a building that is 429.55 meters long, 634.04 meters wide, and 243.27 meters high, with a gable roof. The roof ridge is 214.78 meters to the width side of the building. The attic height is 128.54 meters. The building orientation is 95 degrees to the north. The window-to-wall ratio is 0.68. The windowsill height is 38.92 meters, the window height is 204.35 meters, and the window jamb width is 0.01 meters. The window U-factor is 6.81 W/m<sup>2</sup>K and the SHGC is 0.22. The wall is made of brick, with a thickness of 0.28 meters and the wall insulation is RSI 1.8 m<sup>2</sup>K/W (U-factor 0.56 W/m<sup>2</sup>K). The roof is made of wood, with a thickness of 0.16 meters and the roof insulation is RSI 3.6 m<sup>2</sup>K/W (U-factor 0.29 W/m<sup>2</sup>K). The floor is made of concrete, covered with carpet. The ventilation rate is 1.65 ach. The infiltration rate is 1.0 ach. The people density is 3.01 m<sup>2</sup>/person, the light density is 28.53 W/m<sup>2</sup>, and the electric equipment density is 6.54 W/m<sup>2</sup>. Occupancy starts at 10:00 and ends at 20:00. The occupancy rate is 0.45. The unoccupancy rate is 0.76. The heating setpoint is 20.33 Celsius in occupancy period and 16.22 Celsius in unoccupancy period. The cooling setpoint is 24.83 Celsius in occupancy period and 27.02 Celsius in unoccupancy period.



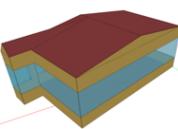
### Example 2: U-shaped, commercial, multi-zones, flat roof, etc.

Simulate a U-shaped building that is 69.15 meters high. The horizontal segment is 139.12 meters long and 5.38 meters wide. The left vertical segment is 97.38 meters long and 483.01 meters wide. The right vertical segment is 30.73 meters long and 14 meters wide. The building orientation is 343 degrees to the north. The building has 3 thermal zones with each segment as one thermal zone. The window-to-wall ratio is 0.50. The window height is 17.29 meters, the window height is 51.86 meters, and the window jamb width is 0.01 meters. The window U-factor is 2.48 W/m<sup>2</sup>K and the SHGC is 0.28. The wall is made of gypsum, with a thickness of 0.36 meters and the wall insulation is RSI 1.6 m<sup>2</sup>K/W (U-factor 0.63 W/m<sup>2</sup>K). The roof is made of metal, with a thickness of 0.49 meters and the roof insulation is RSI 2.1 m<sup>2</sup>K/W (U-factor 0.48 W/m<sup>2</sup>K). The floor is made of concrete, covered with carpet. The ventilation rate is 5.88 ach. The infiltration rate is 0.58 ach. The people density is 2.45 m<sup>2</sup>/person, the light density is 8.95 W/m<sup>2</sup>, and the electric equipment density is 20.95 W/m<sup>2</sup>. Occupancy starts at 9:00 and ends at 16:00. The occupancy rate is 0.24. The unoccupancy rate is 0.57. The heating setpoint is 21.11 Celsius in occupancy period and 15.64 Celsius in unoccupancy period. The cooling setpoint is 22.93 Celsius in occupancy period and 27.55 Celsius in unoccupancy period.



### Example 3: T-shaped, residential, multi-zones, gable roof, etc.

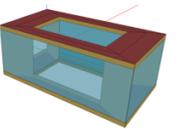
Simulate a T-shaped building that is 231.15 meters high, with a gable roof. The horizontal segment is 376.82 meters long and 645.76 meters wide. The vertical segment is 64.06 meters long and 733.82 meters wide. The vertical segment is 284.24 meters to the edge of the horizontal segment. The roof ridge is 322.88 meters to the length side of the horizontal segment, and 32.03 meters to the width side of the vertical segment. The attic height is 45.46 meters. The building orientation is 74 degrees to the north. The building has 2 thermal zones with each segment as one thermal zone. The window-to-wall ratio is 0.50. The window height is 57.79 meters, the window height is 173.36 meters, and the window jamb width is 0.01 meters. The window U-factor is 1.38 W/m<sup>2</sup>K and the SHGC is 0.5. The wall is made of metal, with a thickness of 0.07 meters and the wall insulation is RSI 2.1 m<sup>2</sup>K/W (U-factor 0.48 W/m<sup>2</sup>K). The roof is made of brick, with a thickness of 0.14 meters and the roof insulation is RSI 2.1 m<sup>2</sup>K/W (U-factor 0.48 W/m<sup>2</sup>K). The floor is made of concrete, covered with carpet. The ventilation rate is 5.91 ach. The infiltration rate is 0.71 ach. The people density is 6.34 m<sup>2</sup>/person, the light density is 2.14 W/m<sup>2</sup>, and the electric equipment density is 27.59 W/m<sup>2</sup>. Occupancy starts at 6:00 and ends at 14:00. The occupancy rate is 0.99. The unoccupancy rate is 0.35. The heating setpoint is 20.97 Celsius in occupancy period and 12.96 Celsius in unoccupancy period. The cooling setpoint is 24.19 Celsius in occupancy period and 27.47 Celsius in unoccupancy period.



- Geometry
- Building Use Scenario
- Construction Configuration
- .....

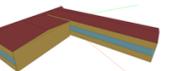
### Example 4: Hollow square-shaped, commercial, multi-zones, gable roof, etc.

Simulate a hollow square building that is 150.51 meters high, with a gable roof. The horizontal segments are 204.39 meters long and 80.20 meters wide. The vertical segments are 41.08 meters long and 371.28 meters wide. The roof ridges are 40.10 meters to the length side of the horizontal segments, and 20.54 meters to the width side of the vertical segments, respectively. The attic height is 0.52 meters. The building orientation is 179 degrees to the north. The building has 4 thermal zones in each orientation. The window-to-wall ratio is 0.85. The window height is 11.29 meters, the window height is 139.22 meters, and the window jamb width is 0.01 meters. The window U-factor is 4.76 W/m<sup>2</sup>K and the SHGC is 0.42. The wall is made of rammed earth, with a thickness of 0.48 meters and the wall insulation is RSI 1.6 m<sup>2</sup>K/W (U-factor 0.63 W/m<sup>2</sup>K). The roof is made of gypsum, with a thickness of 0.36 meters and the roof insulation is RSI 1.6 m<sup>2</sup>K/W (U-factor 0.63 W/m<sup>2</sup>K). The floor is made of concrete, covered with carpet. The ventilation rate is 6.05 ach. The infiltration rate is 0.9 ach. The people density is 8.57 m<sup>2</sup>/person, the light density is 14.85 W/m<sup>2</sup>, and the electric equipment density is 25.69 W/m<sup>2</sup>. Occupancy starts at 7:00 and ends at 17:00. The occupancy rate is 0.63. The unoccupancy rate is 0.4. The heating setpoint is 19.17 Celsius in occupancy period and 16.56 Celsius in unoccupancy period. The cooling setpoint is 24.71 Celsius in occupancy period and 26.22 Celsius in unoccupancy period.



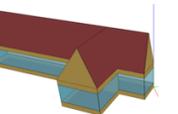
### Example 5: U-shaped, residential, multi-zones, gable roof, single window, etc.

Simulate a U-shaped building that is 97.55 meters high, with a gable roof. The horizontal segment is 543.63 meters long and 34.61 meters wide. The left vertical segment is 173.96 meters long and 653.57 meters wide. The right vertical segment is 360.84 meters long and 228 meters wide. The roof ridge is 17.30 meters to the length side of the horizontal segment, and 86.98 meters, 180.42 meters to the width side of the vertical segments, respectively. The attic height is 14.90 meters. The building orientation is 63 degrees to the north. The building has 3 thermal zones with each segment as one thermal zone. There is a window on the east wall. The window-to-wall ratio is 0.33. The window height is 32.68 meters, the window height is 64.87 meters, and the window jamb width is 0.01 meters. The window U-factor is 2.62 W/m<sup>2</sup>K and the SHGC is 0.65. The wall is made of concrete, with a thickness of 0.07 meters and the wall insulation is RSI 2.6 m<sup>2</sup>K/W (U-factor 0.39 W/m<sup>2</sup>K). The roof is made of wood, with a thickness of 0.46 meters and the roof insulation is RSI 5.4 m<sup>2</sup>K/W (U-factor 0.19 W/m<sup>2</sup>K). The floor is made of concrete, covered with carpet. The ventilation rate is 0.92 ach. The infiltration rate is 0.25 ach. The people density is 1.14 m<sup>2</sup>/person, the light density is 24.66 W/m<sup>2</sup>, and the electric equipment density is 13.18 W/m<sup>2</sup>. Occupancy starts at 9:00 and ends at 22:00. The occupancy rate is 0.12. The unoccupancy rate is 0.29. The heating setpoint is 18.01 Celsius in occupancy period and 16.18 Celsius in unoccupancy period. The cooling setpoint is 24.25 Celsius in occupancy period and 26.16 Celsius in unoccupancy period.



### Example 6: T-shaped, commercial, multi-zones, gable roof, etc.

Simulate a T-shaped building that is 94.13 meters high, with a gable roof. The horizontal segment is 623.58 meters long and 78.8 meters wide. The vertical segment is 93.54 meters long and 202.06 meters wide. The vertical segment is 89.55 meters to the edge of the horizontal segment. The roof ridge is 39.40 meters to the length side of the horizontal segment, and 46.77 meters to the width side of the vertical segment. The attic height is 114.93 meters. The building orientation is 126 degrees to the north. The building has 2 thermal zones with each segment as one thermal zone. The window-to-wall ratio is 0.64. The window height is 16.94 meters, the window height is 77.19 meters, and the window jamb width is 0.01 meters. The window U-factor is 3.32 W/m<sup>2</sup>K and the SHGC is 0.51. The wall is made of metal, with a thickness of 0.34 meters and the wall insulation is RSI 1.6 m<sup>2</sup>K/W (U-factor 0.63 W/m<sup>2</sup>K). The roof is made of brick, with a thickness of 0.49 meters and the roof insulation is RSI 5.4 m<sup>2</sup>K/W (U-factor 0.19 W/m<sup>2</sup>K). The floor is made of concrete, covered with carpet. The ventilation rate is 7.95 ach. The infiltration rate is 0.32 ach. The people density is 3.44 m<sup>2</sup>/person, the light density is 4.71 W/m<sup>2</sup>, and the electric equipment density is 20.25 W/m<sup>2</sup>. Occupancy starts at 10:00 and ends at 18:00. The occupancy rate is 0.94. The unoccupancy rate is 0.67. The heating setpoint is 18.09 Celsius in occupancy period and 16.45 Celsius in unoccupancy period. The cooling setpoint is 25.17 Celsius in occupancy period and 27.72 Celsius in unoccupancy period.



# Validation

## ❖ Robustness

Algorithm: Generate Diverse U-Shaped Multi-Gable Building Prompts

Input: K → number of samples to generate  
Output: S → list of (Prompt, Command) pairs

Initialize empty list S

For k = 1 to K do:

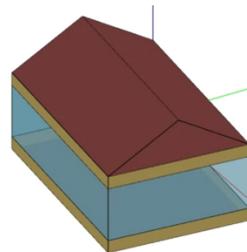
1. Sample number of stories n
2. Partition n stories into several height groups  
// introduces vertical geometry variation
3. For each height group:  
sample a height and expand into vector c\_values
4. Sample building parameters:
  - orientation angle  $\theta$
  - window-to-wall ratios for four facades
  - U-shape dimensions:
    - horizontal wing: (h\_a, h\_b)
    - left vertical wing: (v1\_a, v1\_b)
    - right vertical wing: (v2\_a, v2\_b)
  - attic height a\_t// ensures diverse building geometry
5. Generate natural-language description P\_k summarizing all sampled parameters
6. Construct geometry command C\_k using the parametric generator
7. Append (P\_k, C\_k) to dataset S

End For

Save S as a JSON file

Return S

Algorithm: Training Data Preparation



Error-Free Identification of the Building Model with Noised Prompts

### Spelling mistakes

Simuate a builing that is 429.55 metrs long, 634.04 metrs wide, and 243.27 metrs high, with a gable rof. The rof ridge is 214.78 meters to the widh side of the builing. The attic hight is 128.54 metrs. The builing orintation is 95 degress to the norh. The window-to-wall ratio is 0.68. The windwsill hight is 38.92 meters, the window hight is 204.35 meters, and the window jamb widh is 0.01 meters. The window U-factor is 6.81 W/m2K and the SHGC is 0.22. The wal is made of brick, with a thickess of 0.28 meters and the wall insulation is RSI 1.3 m2K/W. The rof is made of wood, with a thickess of 0.16 meters and the rof insulation is RSI 5.4 m2K/W. The flor is made of concret, covered with carpet. The ventiation rate is 1.65 ach. The infiltration rate is 1.0 ach. The people densiv is 3.01 m2/person, the light densiv is 28.53 W/m2, and the electric equipment densiv is 6.54 W/m2. Occupancy starts at 10:00 and ends at 20:00. The occpancy rate is 0.45. The unoccupancy rate is 0.76. The heating setpoint is 20.33 Celcius in occpancy period and 16.22 Celcius in unoccupancy period. The cooling setpoint is 24.83 Celcius in occpancy period and 27.02 Celcius in unoccupancy period.

Highlights are various spelling mistakes, e.g., simuate (simulate), metrs (meters), and rof (roof), etc.

### Tone styles

Simulate a building is measured with 429.55 meters in length, 634.04 meters in width, and 243.27 meters in height, featuring a gable roof. The roof ridge is positioned 214.78 meters along the width side of the building, and the attic height is 128.54 meters. The building is oriented 95 degrees to the true north. The window-to-wall ratio is 0.68, with a windowsill height of 38.92 meters, window height of 204.35 meters, and a jamb width of 0.01 meters. The window has a U-value of 6.81 W/m2K and a Solar Heat Gain Coefficient (SHGC) of 0.22. The wall is made of brick, with a thickness of 0.28 meters and insulated to an R-value of RSI 1.3 m2K/W. The roof is constructed from wood, with a thickness of 0.16 meters and insulation rated at RSI 5.4 m2K/W. The floor is made of concrete covered with carpeting. Ventilation is provided at a rate of 1.65 air changes per hour (ach), while infiltration is set at 1.0 ach. The occupant density is 3.01 square meters per person, lighting power density is 28.53 W/m<sup>2</sup>, and electrical equipment power density is 6.54 W/m<sup>2</sup>. The building is occupied between 10:00 and 20:00, with an occupancy rate of 0.45 and an unoccupancy rate of 0.76. During occupied hours, the heating setpoint is 20.33 Celsius, and during unoccupied hours, it is 16.22 Celsius. The cooling setpoint is 24.83 Celsius during occupied hours and 27.02 Celsius during unoccupied hours.

Highlights are different description styles, e.g., is measured with (that is), featuring (with), and is oriented (orientation is), etc.

### Omitted words

(Simulate a building that) is 429.55 meters long, 634.04 meters wide, and 243.27 meters high, (with a) gable roof. The roof ridge is 214.78 meters to the width (side of the building). The attic height is 128.54 meters. (The building orientation) is 95 degrees to the north. The window-to-wall ratio is 0.68. The windowsill (height is) 38.92 meters, the window height is 204.35 meters, and the window jamb width is 0.01 meters. The (window) U-factor is 6.81 W/m2K and the SHGC is 0.22. The wall is (made of) brick, (with a thickness of) 0.28 meters (and the) wall insulation is RSI 1.3 m2K/W. The roof is (made of) wood, (with a thickness of) 0.16 meters (and the roof) insulation is RSI 5.4 m2K/W. (The floor is made of concrete, covered with carpet.) The ventilation (rate is) 1.65 ach. The infiltration (rate is) 1.0 ach. The people (density is) 3.01 m2/person, the light (density is) 28.53 W/m2, and the electric equipment (density is) 6.54 W/m2. Occupancy starts (at) 10:00 (and) ends (at) 20:00. The occupancy rate is 0.45. The unoccupancy rate is 0.76. The heating setpoint is 20.33 (Celsius in) occupancy (period and) 16.22 (Celsius in) unoccupancy period. The cooling setpoint is 24.83 Celsius in occupancy (period and) 27.02 Celsius in unoccupancy (period).

Highlights are omitted words, e.g., omitting the object (the building orientation), the adjunct (side of the building), and the verb (is), etc.

- ❖ Unseen descriptions
- ❖ Omissions
- ❖ Spelling mistakes
- ❖ Different description styles

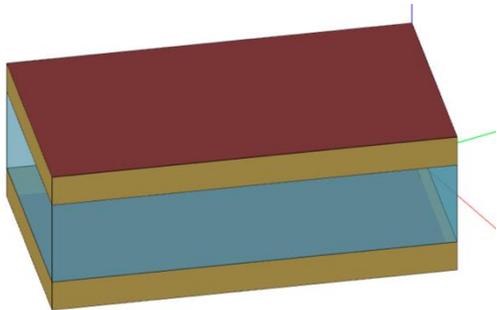
# Validation

## ❖ Modeling Effort

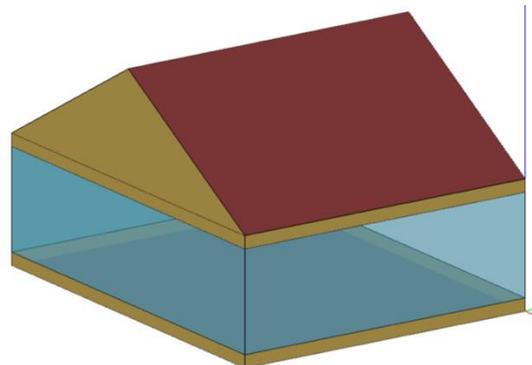
		EnergyPlus	OpenStudio	EPlus-LLMv2
Single zone	Flat roof	3 h	2 h	3 min
	Gable/hip roof	3.2 h	2.5 h (with SketchUp)	3.1 min
Multi-zone	Flat roof	8 h	2.5 h	3.3 min
	Gable/hip roof	8.5 h	3 h (with SketchUp)	3.4 min

*\*Expert simulation time*

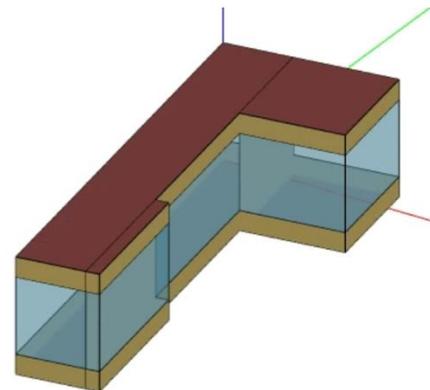
Single zone, flat roof



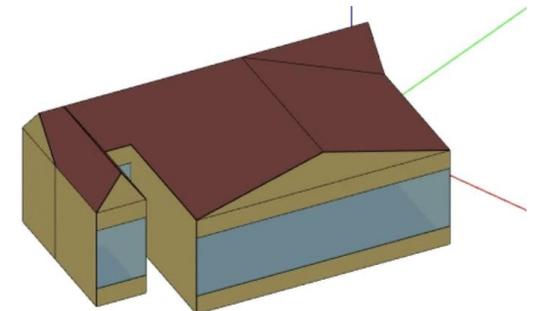
Single zone, gable roof



Multi zone, flat roof



Multi zone, gable roof



# Video Demo



## *EPlus-LLMv2: Fine-Tuning a Large Language Model for Auto-Building Energy Modeling in Complex Building Scenarios*

### BEMs Auto-Generation

#### User Prompt

This is an example: Simulate a building that is 417.04 meters long, 306.59 meters wide, and 264.75 meters high, with a hip roof. The distance of roof peak to the length and width side of building is 153.29 meters and 208.52 meters, respectively. The attic height is 73.45 meters. The building orientation is 44 degrees to the north. The building has 5 thermal zones with 1 core thermal zone and 4 exterior thermal zones in each orientation. The depth of exterior thermal zone is 22.99 meters. The window-to-wall ratio is 0.19. The window sill height is 107.22 meters, the window height is 157.53 meters, and the window jamb width is 1.94 meters. The window U-factor is 6.3 W/m<sup>2</sup>K and the SHGC is 0.55. The wall is made of wood, with a thickness of 0.42 meters and the wall insulation is R37. The roof is made of gypsum, with a thickness of 0.29 meters and the roof insulation is R21. The floor is made of concrete, covered with carpet. The ventilation rate is 2.3 a<sub>ch</sub>. The infiltration rate is 0.49 a<sub>ch</sub>. The people density is 26.02 m<sup>2</sup>/person, the light density is 5.80 W/m<sup>2</sup>, and the electric equipment density is 23.67 W/m<sup>2</sup>. Occupancy starts at 8:00 and ends at 17:00. The occupancy rate is 0.82. The unoccupancy rate is 0.48. The heating setpoint is 21.44 Celsius in occupancy

Auto-Generate

Download Generated IDF File

### Upload Weather & Run Simulation

Upload Weather File

Download Simulation Output File

# Conclusion

Techniques	Constraints	Opportunities
Prompt Engineering	Domain-Specific Tasks	More Tasks
Fine-Tuning	Computing Resources/Costs	More Accuracy
Parameter-Efficient Fine-Tuning	Complex Scenarios	More Efficient/Automated
RAG	Requirement for Robustness	More Robust
MCP	Requirement for Scalability	More Scalable
Hybrid Pipeline	High Technical Difficulty	More Flexible Pipelines

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# Questions



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