

# 10 key elements of Energy Simulation

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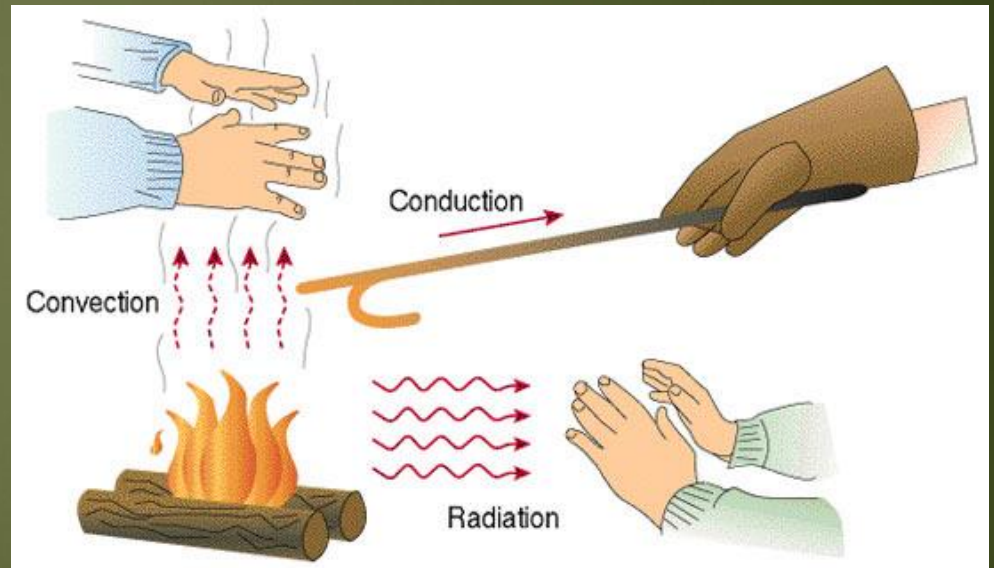
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# Energy Simulation is Complex!

- ▶ GIGO
  - ▶ Garbage In = Garbage Out
- ▶ Bad News:
  - ▶ Thousands of numbers to get right.
  - ▶ Input mistakes are guaranteed!
- ▶ Good News:
  - ▶ Thousands of numbers.
  - ▶ Making mistakes in a few numbers is usually not that disastrous.

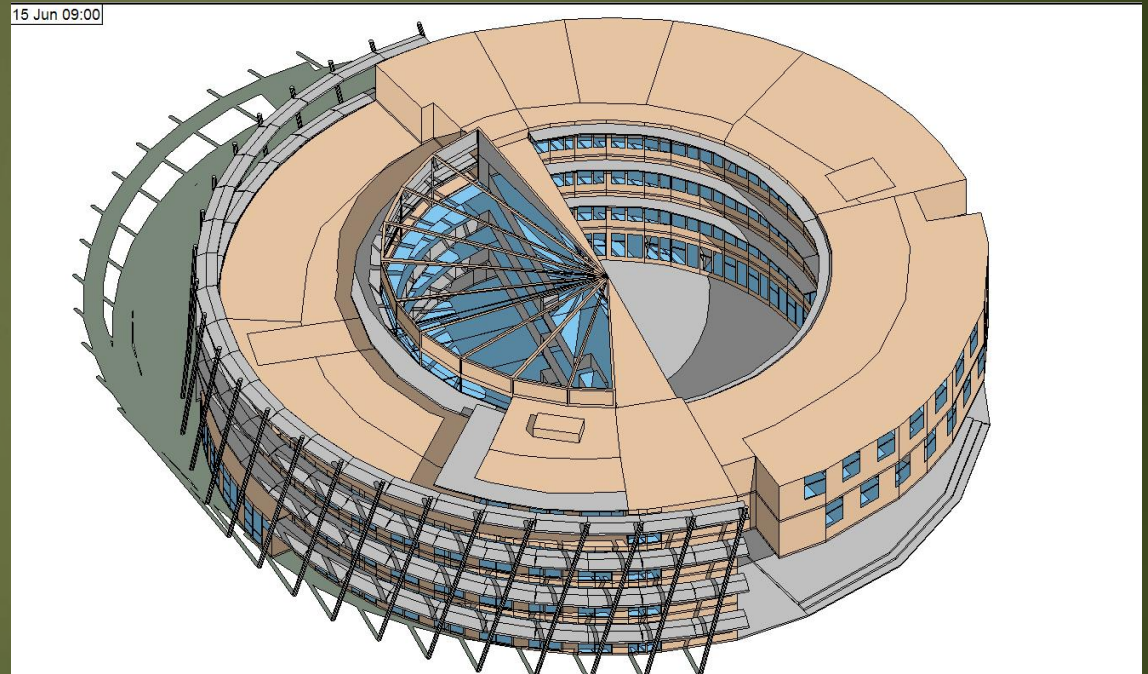
# 1. Computational Engine

1. 1<sup>ST</sup> Law of thermodynamic - balance of energy transfer
2. Conduction
3. Convection
4. Radiation
5. Evaporation
6. Ashrae 140 Bestest
7. DOE-2, EnergyPlus, Apache, Trnsys, TAS



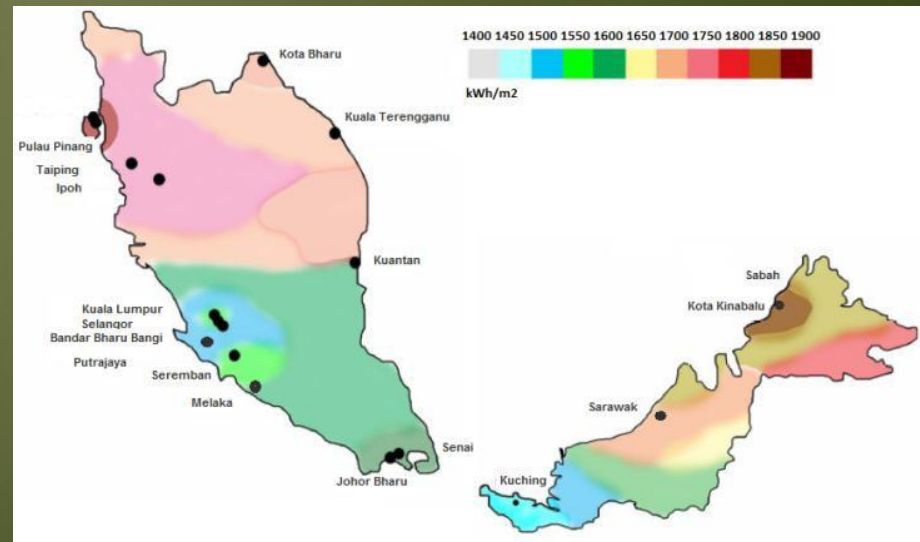
# 2. Building Modelling

- ▶ 3D modelling
- ▶ Orientation



# 3. Weather data

- ▶ Location setting
- ▶ Weather data allocation
- ▶ Weather data dependable?



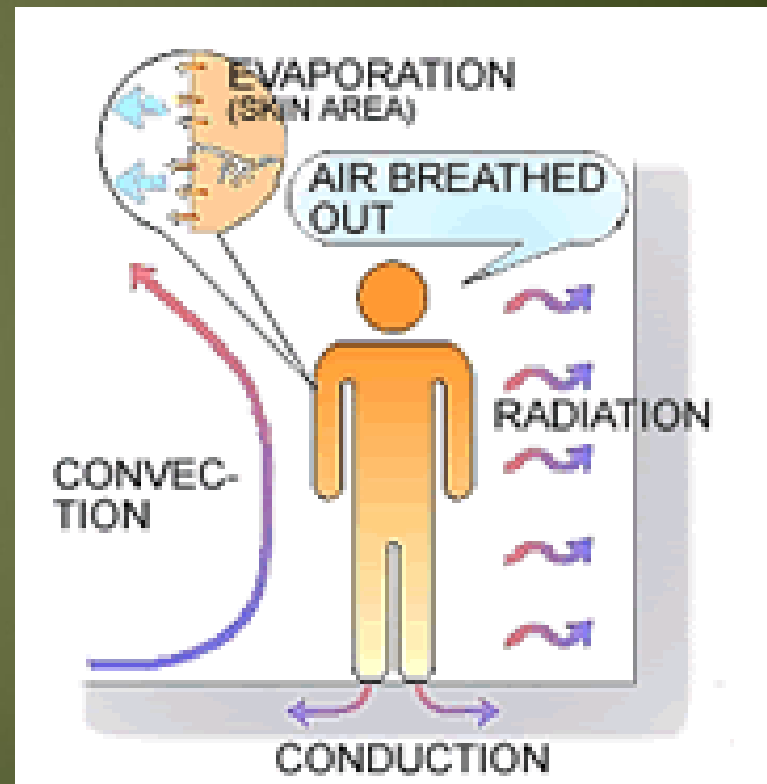
# 4. Building envelope properties

- ▶ Brick wall Layers
- ▶ Concrete wall Layers
- ▶ Roof layers
- ▶ Floor layers
- ▶ Solar absorption
- ▶ Emissivity
- ▶ K-value
- ▶ Thermal capacity



# 5. Comfort Requirement

- ▶ Air temperature
- ▶ Relative humidity
- ▶ Moisture content
- ▶ Mean radiant temperature
- ▶ Operative temperature
- ▶ PPD
- ▶ PMV



# 6. Internal heat gains

- ▶ People Sensible/Latent Heat
- ▶ Lighting Power Density
- ▶ Equipment (small power/plug load)
- ▶ Server Power?
- ▶ Misc.
  - ▶ Pantry?
  - ▶ Security Access?
  - ▶ Keluar sign?
  - ▶ Printers?
  - ▶ Base/Phantom Load?



# 7. Schedule/profiles

- ▶ What time/day people are in office?
  - ▶ Fixed?
  - ▶ Flexible?
- ▶ What time/day air-conditioning is on?
  - ▶ Precooling?
  - ▶ Maximum demand management?
- ▶ What time/day lighting is on?
  - ▶ Daylight harvested?
- ▶ What time/day equipment are using power?

# 8. Mechanical fresh air vent.


- ▶ How much fresh air is provided?
- ▶ Ashrae 62.1

# 9. Infiltration of fresh air

- ▶ Air leakages in buildings

# 10. air-conditioning system

- ▶ Simple or Detailed Modeling?
- ▶ System coefficient of performance (cop)
- ▶ Split-unit?
- ▶ VRV system?
- ▶ Chiller system with chilled water?
  - ▶ Air Cooled?
  - ▶ Water cooled?
  - ▶ CAV/VAV?
  - ▶ Constant/primary-secondary/primary variable
  - ▶ Radiant Cooling/Heating?
  - ▶ Displacement Ventilation?
- ▶ Capacity and Efficiency of equipment?



How do you ensure  
your building is  
performing as  
simulated?

# Tracking Efficiency

- ▶ Simulation
- ▶ Detail design
- ▶ Tender specification
- ▶ Tender award
- ▶ Contractor purchases
- ▶ Contractor installation
- ▶ Commissioning
- ▶ Fine-tuning during operation
- ▶ Continuous improvements