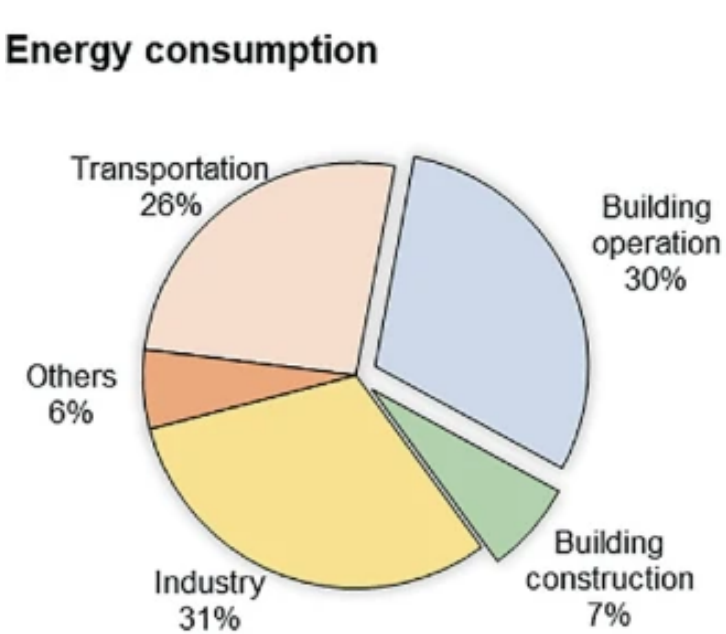
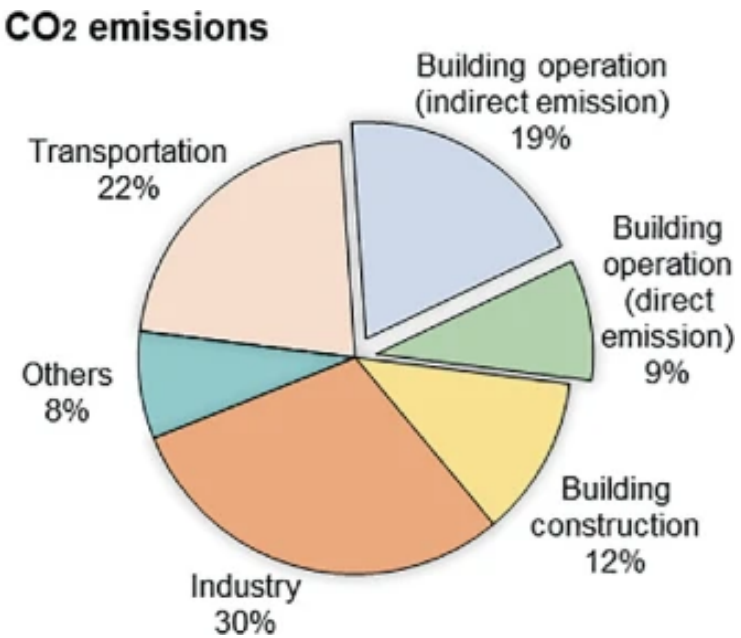
INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES LYON

Building Energy Simulation

Building Sector Worldwide





Why Energy Efficiency in Buildings?

- Economic incentive
- Return on investment?
- Global warming mitigation (GHGE)
- Life Cycle Analysis

Energy Efficient Design

- How to assess efficiency solutions?
- Buildings must be taken as a whole
- Performance driven design
- Need for modelling and simulations

Buildings as complex transient systems

- Conduction through building envelope
- Convective heat transfer at internal and external surfaces
- Solar heat gains
- Thermal radiation
- Air flows and humidity

Building Energy Modelling

- A building energy model may be viewed as a graph
- Observables (generally temperatures) are the nodes
- Fluxes between observables are the links

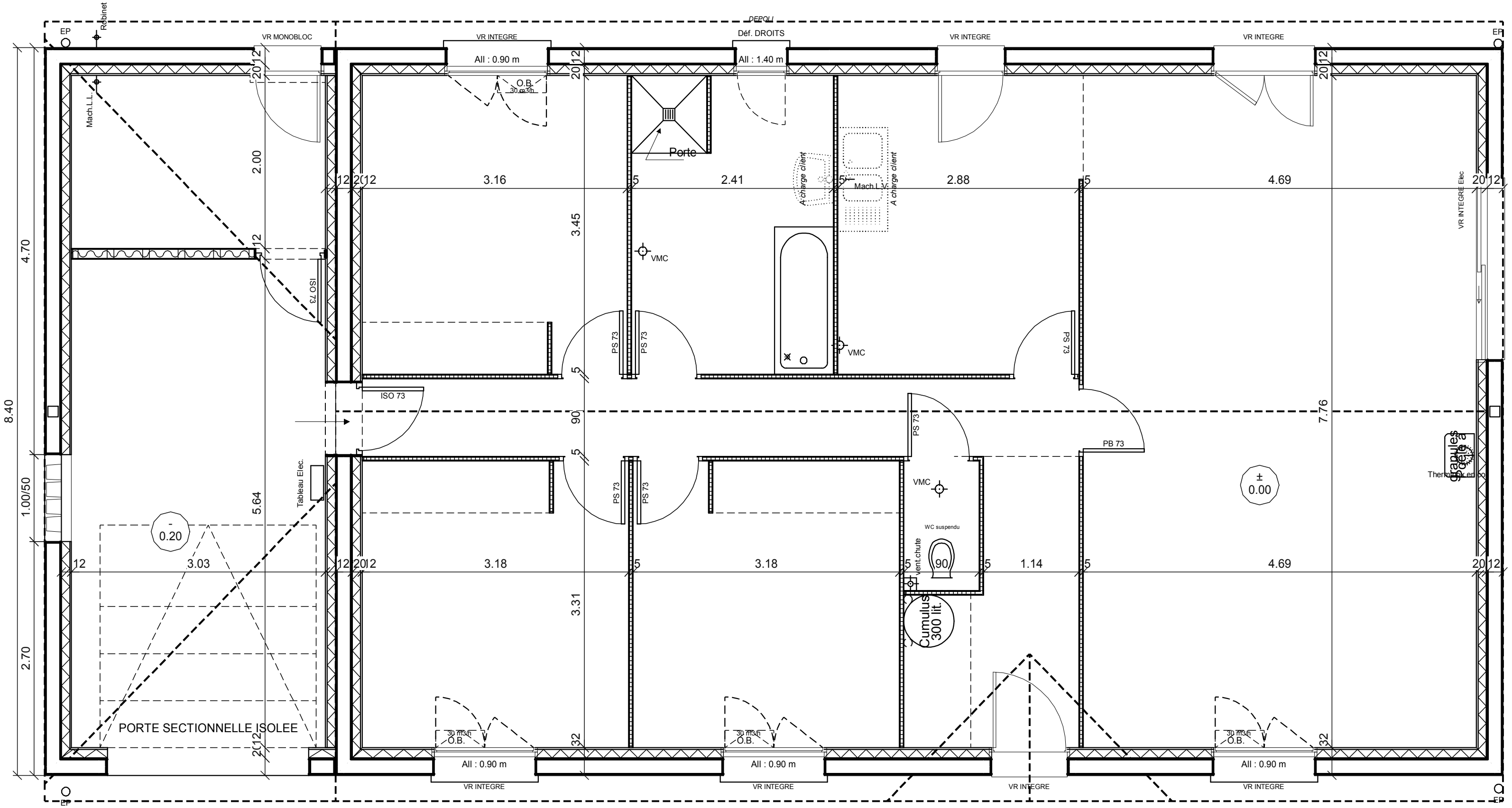
Common Modelling Practices

- Thermal zones (i.e. one or several rooms) have uniform temperatures
- Conduction is one-dimensional (FVM or lumped capacitance)
- Internal radiative balance is averaged
- Use of air change rate per thermal zone

Aspects Seldom Taken into Account

- Stratification
- Thermal bridges
- Humidity
- Behaviour of appliances and systems
- Air flows

Case Study



VR MONOBLOC
VR INTEGRE
Déf. DROITS
All : 0.90 m
All : 1.40 m
Porte
VMC
ISO 73
PS 73
PB 73
Mach.L.L.
Mach.L.V.
A charge client
Tableau Elec.
WC suspendu
Cumulus 300 lit.
PORTE SECTIONNELLE ISOLEE
O.B.
EP
Robinet
3.16
2.41
2.88
4.69
3.03
3.18
1.14
3.45
3.31
2.00
4.70
8.40
2.70
1.00/50
5.64
7.76
0.20
± 0.00

Building Characteristics

Height 2.5 m
External walls 20 cm lightweight concrete blocs, 12 cm mineral wool
Internal walls 2 × 13 mm plasterboard, 24 mm gap
Windows 4 mm double glazing, 16 mm gap
Floor 15 cm concrete slab, 10 cm insulation, 5 cm screed
Ceiling 2 cm plasterboard, 14 cm mineral wool
Heating setpoint temperature 19 °C
Garage no insulation, no ceiling, height 2.2 m

Objectives

- Model the house using the DesignBuilder software
- Assert the obtained model with steady state calculations
- Evaluate energy consumption and thermal comfort
- Evaluate the impact of some configurations or modifications
- Propose an improved version of the house

Impact studies

- External insulation and thermal mass
- Setback temperature and recovery time
- Air conditioning and night-time ventilation
- Solar protection and orientation
- Global warming