

Building Design Optimisation

- A Few Key Concepts

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Today's Topics

1. Why do we need parametric analysis and optimisation
2. What is optimisation and its key components
3. Applications of optimisation

The challenges of energy modelling

The screenshot displays the EnSimS software interface, which is used for building energy simulation. The main window shows a schematic diagram of a building's HVAC system, including a chiller, condenser, and various piping loops. The interface is divided into several panes:

- Left Pane (Components):** Lists building levels and zones. The 'Building level' section includes:
 - 0F Ground floor
 - Ground floor East
 - Ground floor West
 - Zone 3
 - 1F First floor
 - First floor East
 - First floor West
 - Zone 2
 - Atrium Reception
 - Component block 10
 - Component block 5
 - Component block 7
 - Component block 8
 - Component block 9
 - Rooflight
 - Core rooftop => 1F First fl
 - Reception rooftop => Atri
- Top Right Pane (Generic Office Area):** Displays 'B1 Offices and Workshop businesses' and a value of '1'.
- Center Pane (Edit Chiller - Chiller):** A detailed configuration window for a chiller. It includes the following settings:
 - General:** Name: Chiller; Chiller template: EnergyPlus Indirect Absorption Chiller; Chiller type: 5-Indirect Absorption; Nominal capacity (W): Autosize; Nominal pumping power (W): 250,000; Chiller flow mode: 3-Not modulated; Sizing factor: 1.000.
 - Condenser:** Condenser type: 2-Water cooled.
 - Temperatures:** Reference entering condenser fluid temperature (°C): 35.000; Entering condenser water temperature limit (°C): 10.000; Leaving chilled water temperature limit (°C): 5.000; Temperature lower limit generator inlet (°C): 30.000.
 - Flow Rates:** Design chilled water flow rate (m³/s): Autosize; Design condenser water flow rate (m³/s): Autosize.
 - Part Load Settings:** Minimum part load ratio: 0.150; Maximum part load ratio: 1.000; Optimum part load ratio: 0.650.
 - Part Load Settings Curves:** Generator heat input function of part-load ratio curve: SteamUseFPLR; Pump electric input function of part-load ratio curve: PumpUseFPLR.
 - Correction Curves:** Checkboxes for Condenser temperature capacity correction, Chilled water temperature capacity correction, Condenser temperature heat input correction, and Chilled water temperature generator heat input correction.
 - Generator Hot Water Supply:** Checkboxes for Hot water plant connection and Generator temperature capacity correction.
- Right Pane (Data Report):** A 'Data Report (Not Editable)' window showing a 'General' section with 'SteamUseFPLR' as the Note, Source, and Category. It also includes a 'Curve Plot' for 'SteamUseFPLR' showing a linear relationship between Output and Input.

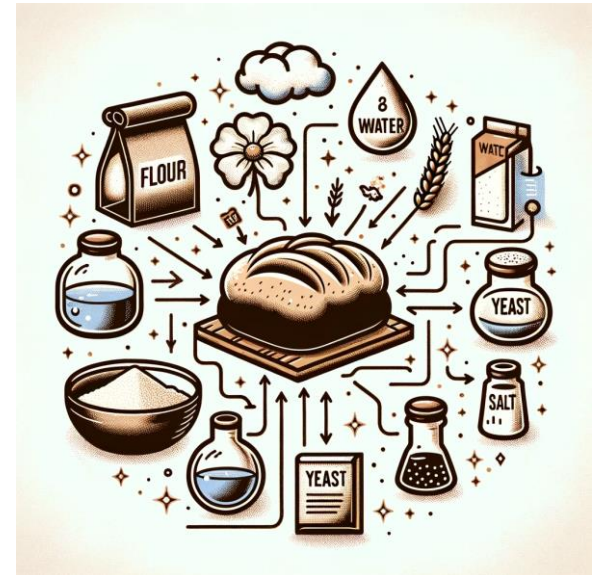
Let's first look at how to find the best building design

Please go to:

<https://app.ensims.com>

The key ingredients of optimisation

1. Optimisation variables – the search space
2. Optimisation criteria – **objectives** and **constraints**
3. An effective and **efficient** search strategy
4. Means to evaluate **many** solutions



In the context of building design & operation

Optimisation variables

- Dimensions, orientations, constructions, values, parameters, coefficients, ...
- Operational schemes, schedules and setpoints, custom control strategies ...
- Alternative designs, system configurations, equipment selection...
- And possibly a lot more

In the context of building design/operation

Optimisation criteria

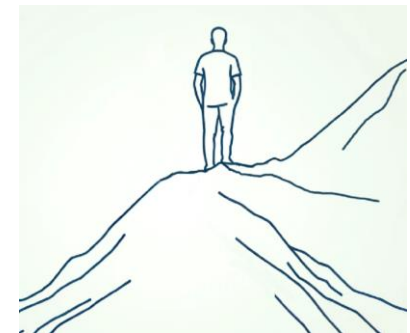
- ***Objectives*** are for chasing the **best** options

Performance and cost metrics such as:

- Energy
- Carbon
- Cost
- Comfort
- ...

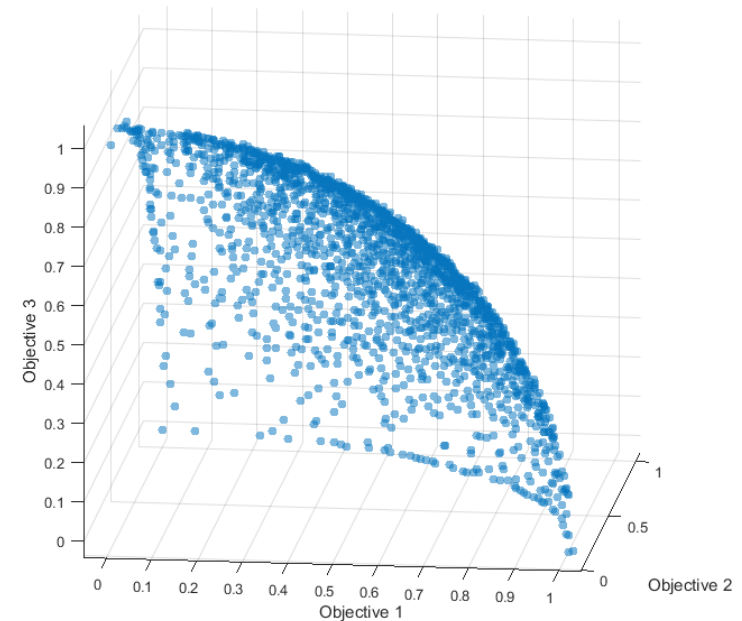
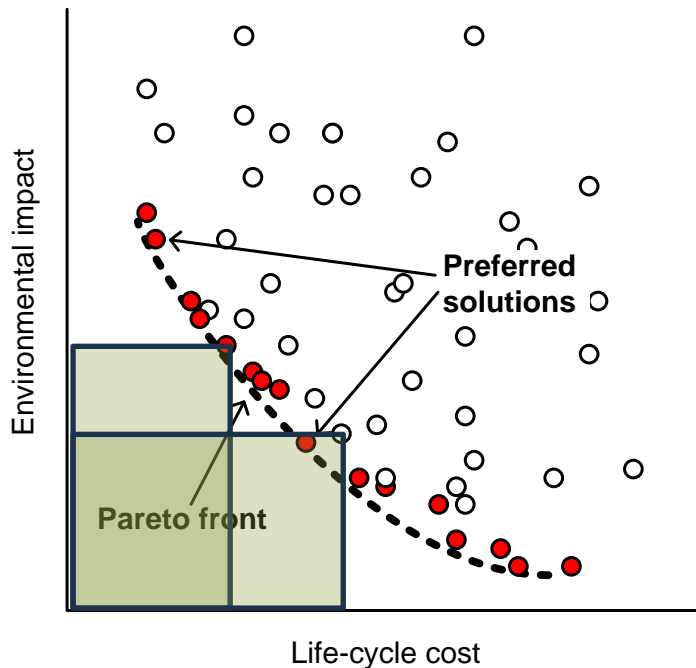
- ***Constraints*** are for seeking the **acceptable** options

- Energy
- Carbon
- Cost
- Comfort
- ...
- Availability, preference, and physics



Multi-objective optimisation

- Should I choose a single or multi-objective approach?
- How to handle 'many' (more than 2) objectives?



Genetic and Evolutionary Algorithms

 [Belyaev's Farm Fox Experiment](#)

