Summary of Work

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1 Summary of Work

The whole thesis was divided into three sections, which are, namely,

- DesignBuilder Building Modeling
- Initial EnergyPlus Building Simulation
- SIA Building Energy Calculation
- Building Envelope and Weather Condition Calibration
- Building Parameters Variation
- Heat Island Effect and Global Warming Effect

2 Building Modeling

This project focuses on 2 existing uninsulated buildings. One is office building (Sumatrastrasse 10) and the other is residential building (Honggerstrasse 23).

- Residential Building and Office Building
  - Re-generate building plan from pdf reports
  - Check SIA382 model for detailed building material and building part sizes
  - Generate the building model using DesignBuilder
- Weather Data
  - Obtain standard weather data in Zurich
  - Obtain weather data (hourly) in year 2015 in Zurich from *IDAWEB-MeteoSwiss*
    - Temperature (Dry/Wet bulb)
    - Relative humidity
    - Wind direction
    - Wind speed
    - (Didn't change radiation)
  - Generate Zurich year 2015 *.epw* weather file

3 Initial EnergyPlus Building Simulation

After the DesignBuilder model is completed, the file is then converted to *.idf* file and being further processed. Firstly the standard simulation, then the dynamic simulation is performed

- Standard Schedule Simulation
  - Export to *.idf* files and apply SIA standard *nominal schedules* in EnergyPlus
    - Occupancy
    - Appliance
    - Electricity
    - Lighting
    - Ventilation
    - Heating/Cooling
  - Undergo simulation using both *2015 weather file* and *standard weather file*
- Dynamic Schedule Simulation
  - Occupancy

  - Appliance
  - Electricity
  - Lighting
  - Ventilation
  - Heating/Cooling
  - Air Infiltration
- Compare Standard/Dynamic Results

4 SIA180 Building Energy Calculation

Recalculate the 2 buildings' energy demand using SIA180 method.

- Obtain standard Zurich Meteostation weather data
  - Average monthly temperature
  - Heating degree days
  - Heating days
  - Solar Radiation onto east/west/south/north/horizontal surface
- Obtain 2015 weather data by using *Rhino/Grasshopper*
  - Average monthly temperature
  - Heating degree days
  - Heating days
  - Solar Radiation onto east/west/south/north/horizontal surface
- Obtain Building Parameters
  - Wall and roof properties
  - Window properties
  - Convection Coefficient
- Calculate Energy Gains
  - Solar Gain
  - Internal Gain (from appliances)
- Calculate Energy Loses
  - Transmission Loss
  - Ventilation Loss
- Obtain Key Assumptions

5 Building Envelope and Weather Condition Calibration

Take 10-15 days in June or September and compare the historical indoor/outdoor temperature vs. simulation indoor/weather temperatue.

5.1 Honggerstrasse Building Calibration

- Date: 1 June - 10 June
- Compare weather file outdoor temperature with recorded site temperature
- Calibrate indoor temperature
  - Modify appliance level and appliance schedule
  - Modify air infiltration level
  - Apply Shading schedule
- Compare recorded annual consumption vs. calibrated annual consumption

5.2 Sumatrastrasse Building Calibration

- Date: 1 September - 15 September
- Calibrate indoor temperature
  - Apply Shading schedule
  - Modify air infiltration level
  - Fix air ventilation setting

- Compare recorded annual consumption vs. calibrated annual consumption

6 Building Parameters Variation

The final part of the research is to determine the key parameters that make significant influence to the simulation reslut.

6.1 jE-Plus Dynamic Analysis

Program *je-Plus* is used to assign different values to the targeted parameters. These targeted parameters include:

- Schedule and occupancy of different areas and facilities
  - People activities
  - Lighting
  - Appliances
  - Outdoor air supply (ventilation)
  - Domestic hot water
- Building envelope properties
  - Air tightness (Infiltration)
  - Heat convection coefficient
  - Outside layer solar absorptance
- Heating and cooling setpoint temperature

6.2 Correlation Matrix

Correlation matrix is produced to compare the influence of all parameters.

7 Urban Heat Island Effect and Global Warming Effect

Take local temperature (in winter) and compare it with the station temperature. Then discover a pattern and apply it onto the station weather file and generate an ”urban heat island weather file”
Draw a box plot and a histrogram to compare the effects of global warming and urban heat island effect.