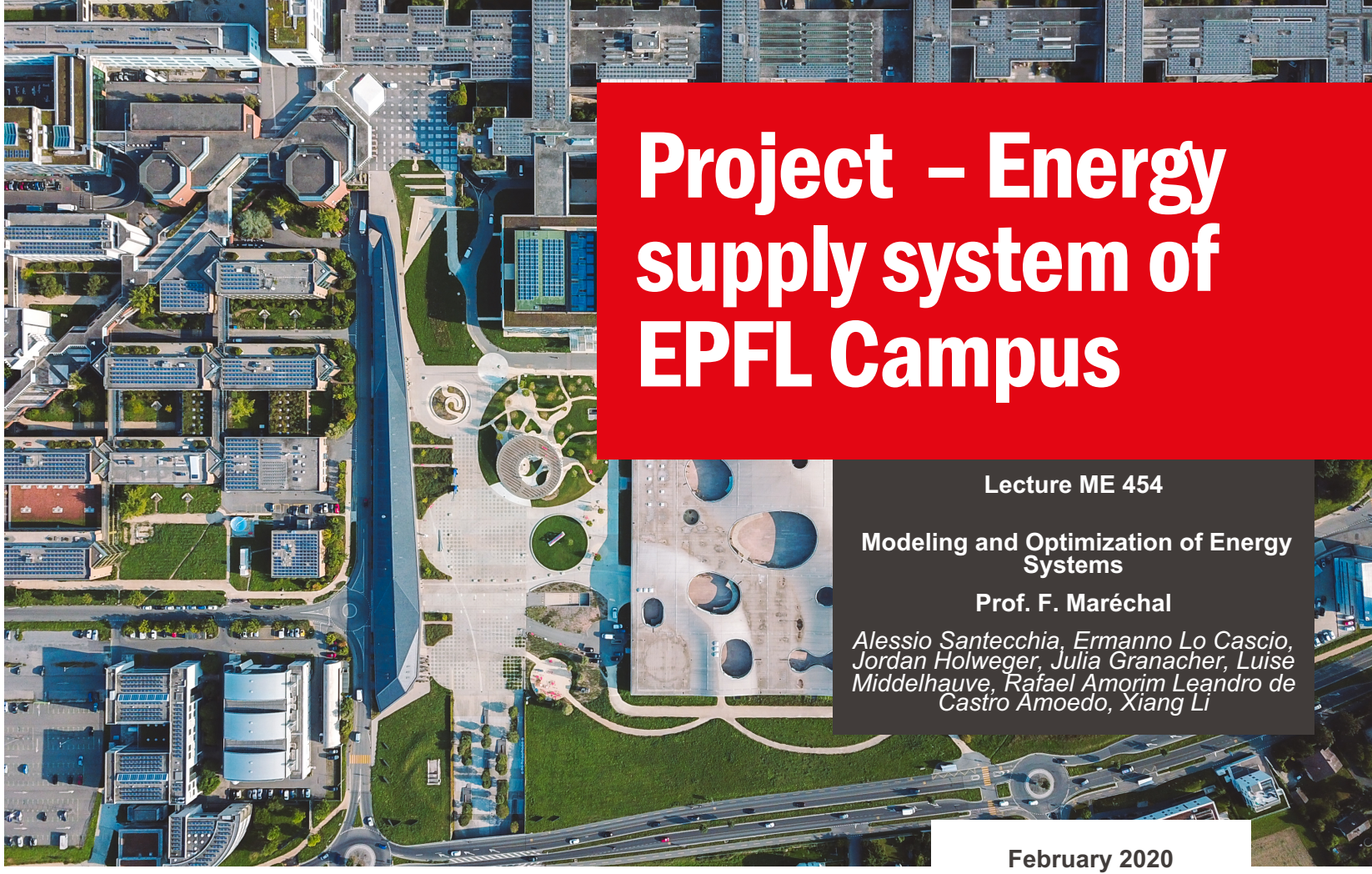


Project – Energy supply system of EPFL Campus

Lecture ME 454

Modeling and Optimization of Energy Systems

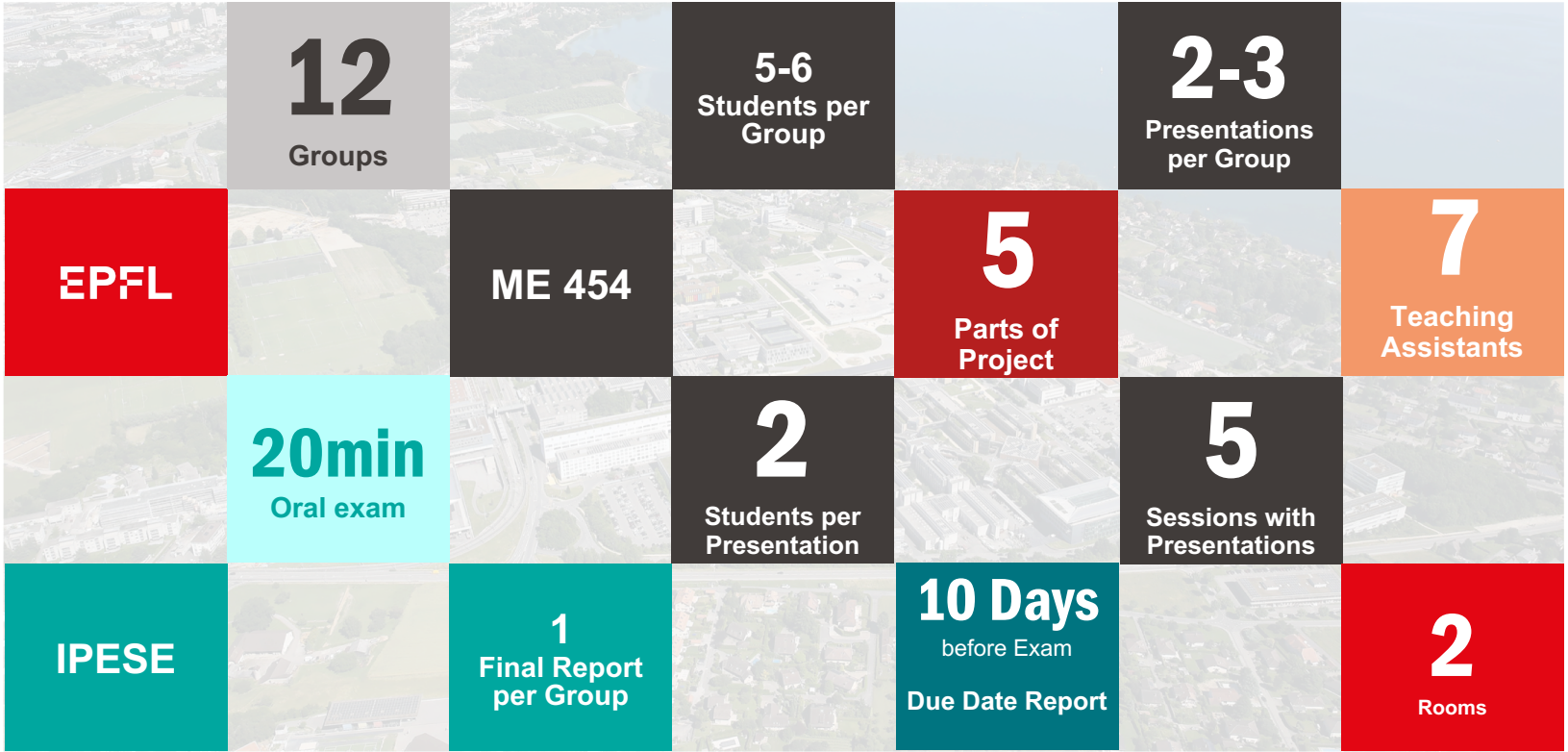
Prof. F. Maréchal

Alessio Santecchia, Ermanno Lo Cascio, Jordan Holweger, Julia Granacher, Luise Middelhauve, Rafael Amorim Leandro de Castro Amoedo, Xiang Li

February 2020

École polytechnique fédérale de Lausanne

General Overview



General Information

- Grading Method
  - Oral Exam *-- 20 Minutes*
  - Group Project *-- Presentation & Report*
- Group Project
  - Groups of 5- 6 Students
  - 5 Presentations during Class *– 2-3 per Group*
  - Final Report *-- Due Date 10 Days before Exam*
- Project Presentations
  - **Not** Graded
  - 2 -3 slides *-- 5 min + 10 min Discussion*
  - 2 Students for each Presentation
  - **Random** selection of Groups each Session
  - Upload slides on moodle *-- before Session*

Timeline

Week	Theory	Project	Deliverable
1	Course introduction	-	
2	Equations and Solving Methods	Part 1 - Building Demand	
3	-	Part 1 - Building Demand	
4	MILP problem statement	Part 2 – Integration Utilities	Students Presentation 1
5	Thermo-economic analysis	Part 2 – Integration Utilities	
6	Optimization approaches	Part 2 – Integration Utilities	
7	Solving optimization problems	Part 3 –NLP Heat Recovery	Students Presentation 2
8	Thermodynamic properties for process flowsheet models	Part 3 –NLP Heat Recovery	
9	EASTER BREAK		
10	Process unit, flowsheets & resolution sequence	Part 4 –Flow Sheeting	
11	Data Reconciliation	Part 4 –Flow Sheeting	
12	Heuristic methods & Multi Objective Optimisation	Part 5 - Scenarios	Students Presentation 3&4
13	-	Part 5 - Scenarios	
14	-	Part 5 - Scenarios	
15	Recap/ Questions	-	Students Presentation 5

Important Platforms

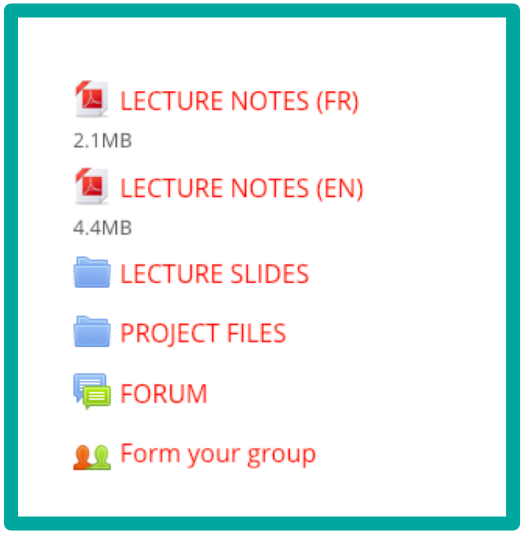
overleaf, moodle & mattermost

moodle

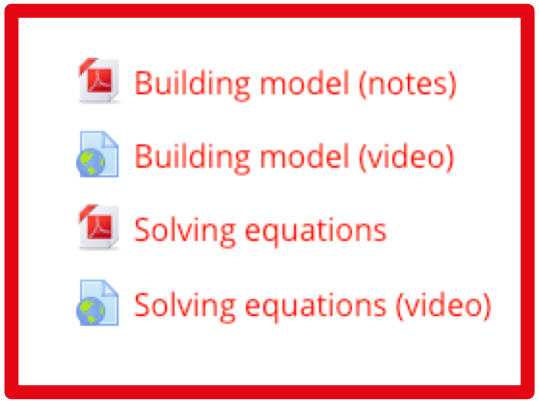
Moodle contains all **material** & **files** necessary for the course & project.

- Website

Main documents and folders:



Weekly notes and videos:



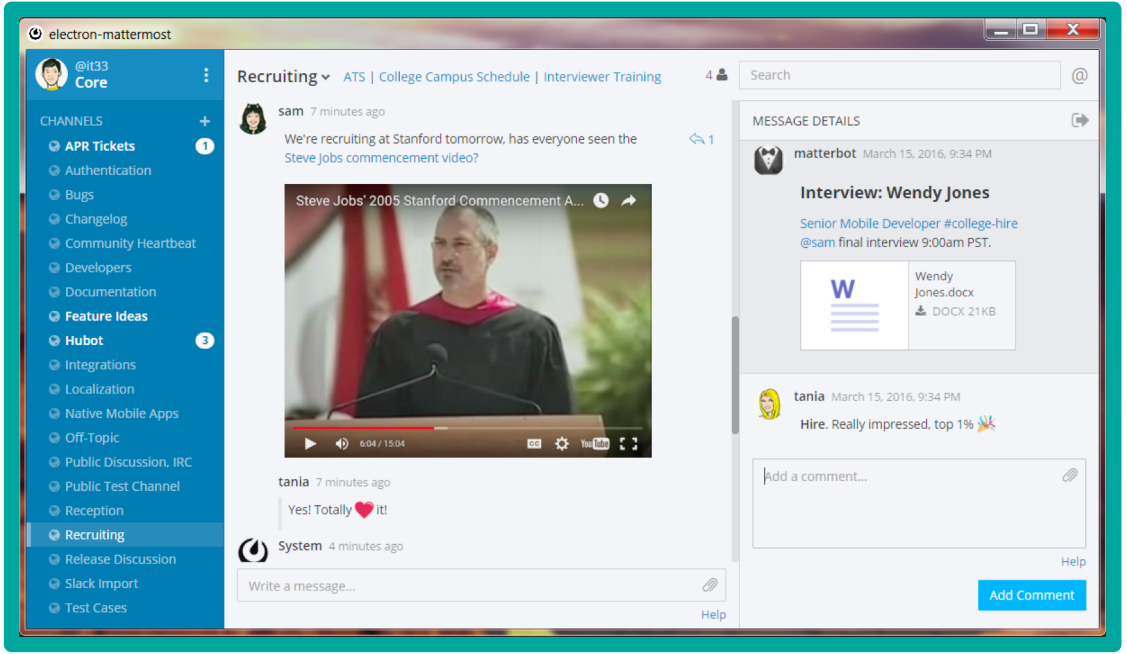
! Check before each class, updates may occur

Mattermost

Direct communication with assistants and your group members via chat.

Mattermost Docs Features Apps & Integrations Blog Contribute Enterprise Download

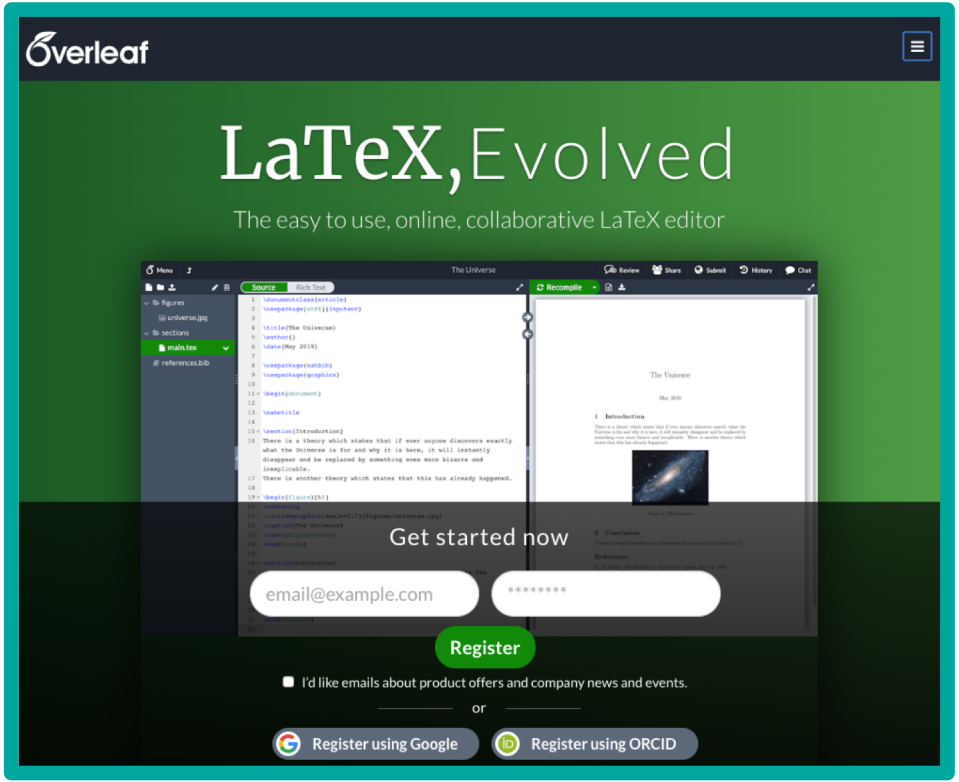
- **Sign up** in a group on moodle
- **Accept** the invitation to our server (email)
- **Install** the software from the Website



Overleaf

Collaborative LaTeX editor to write reports together

- **Sign up** with epfl email
- **Create** new project
- **Share** with your group



Website

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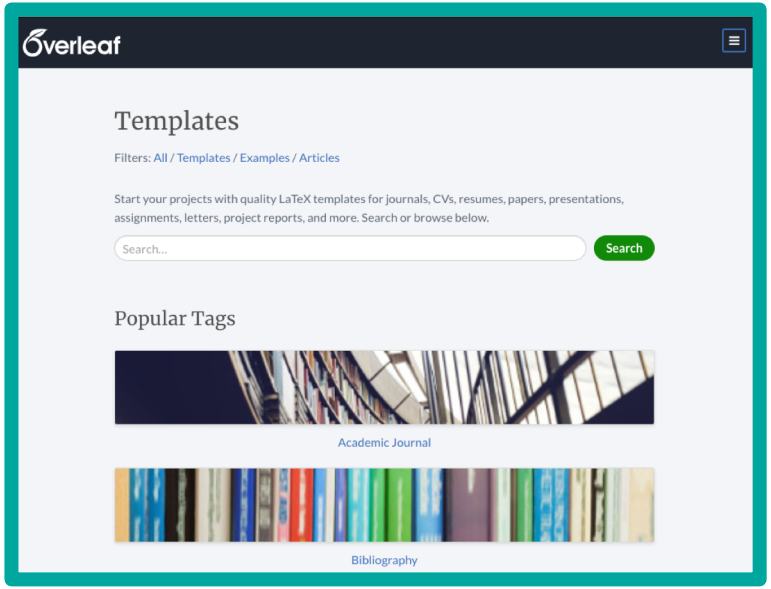
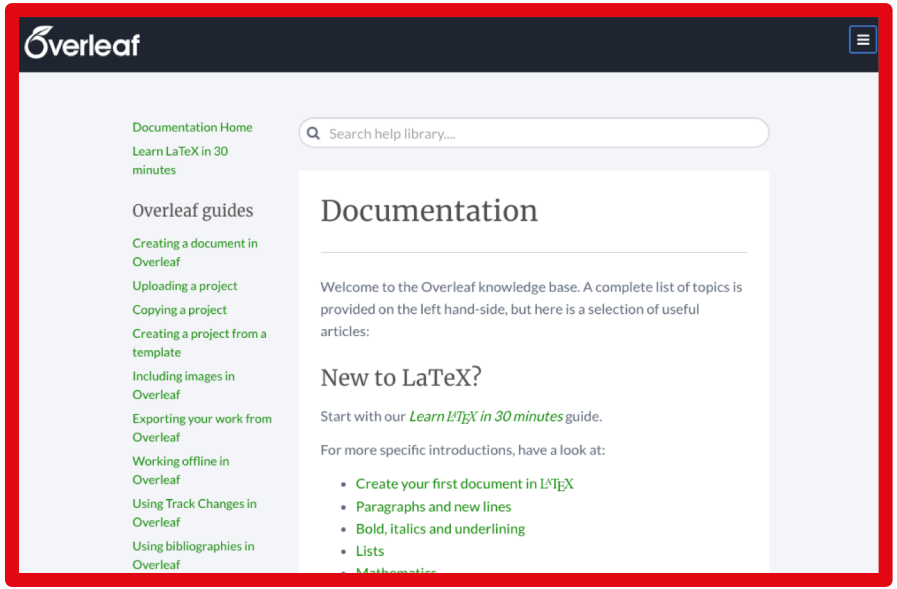


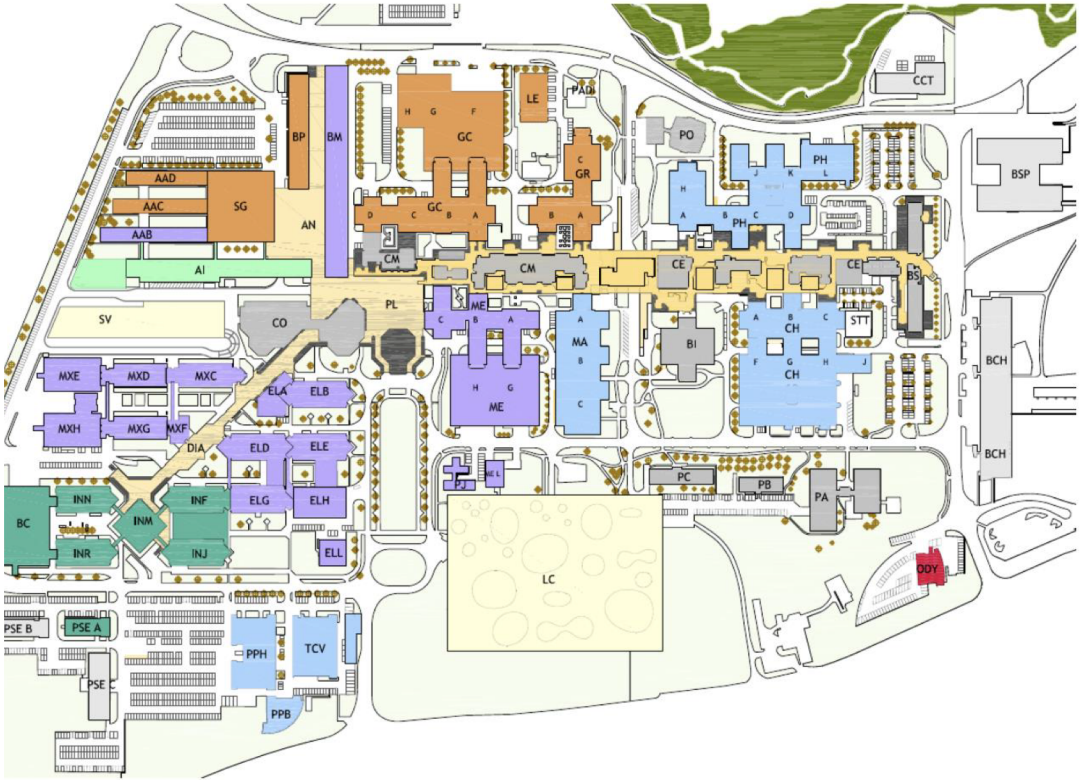


Templates

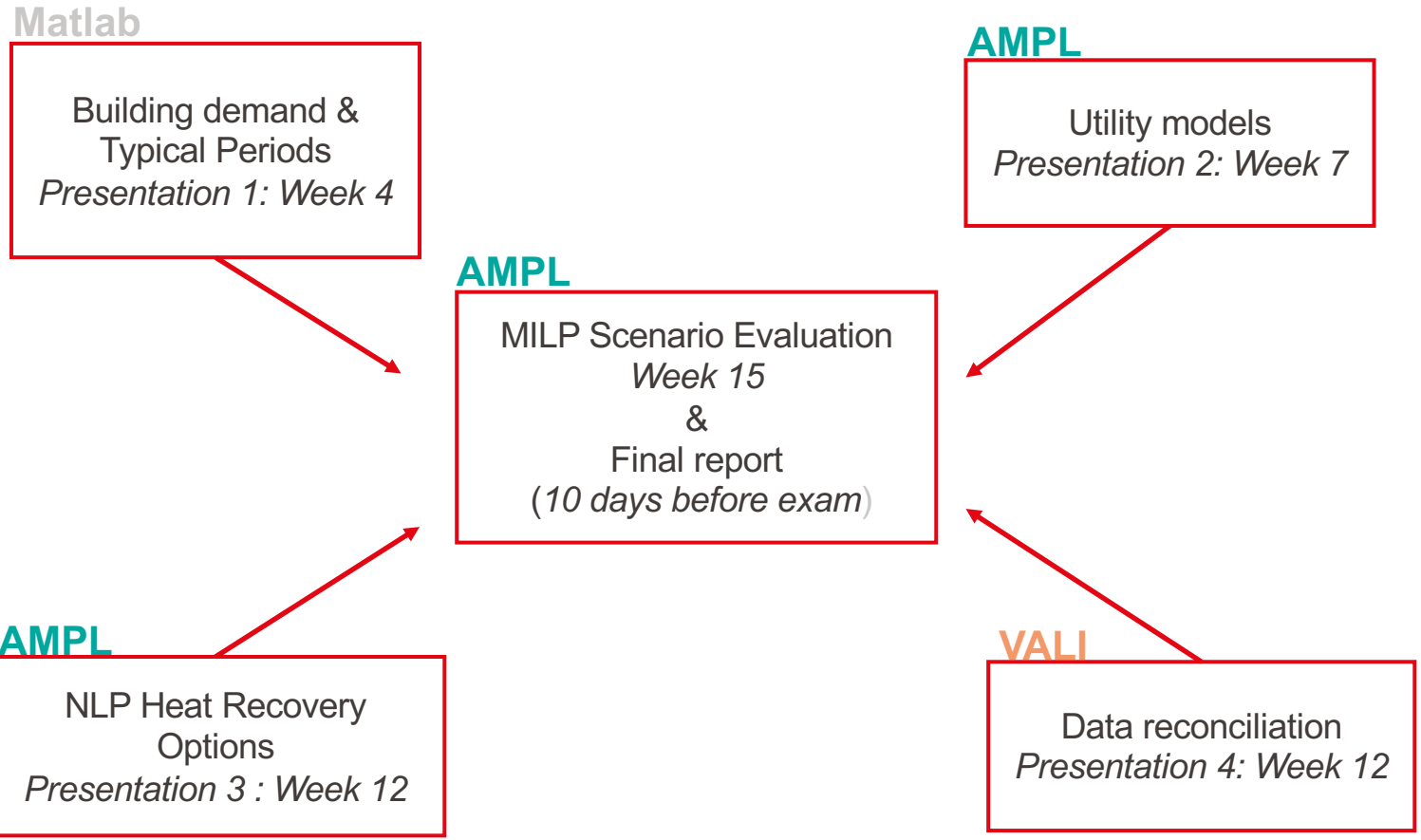
Documentation

Project Overview

- The **energy system of EPFL** supplies heating, cooling and electricity.
- The **heating system** is about to reach the end of its lifetime.
- The management board is searching for **replacement** of the existing system.

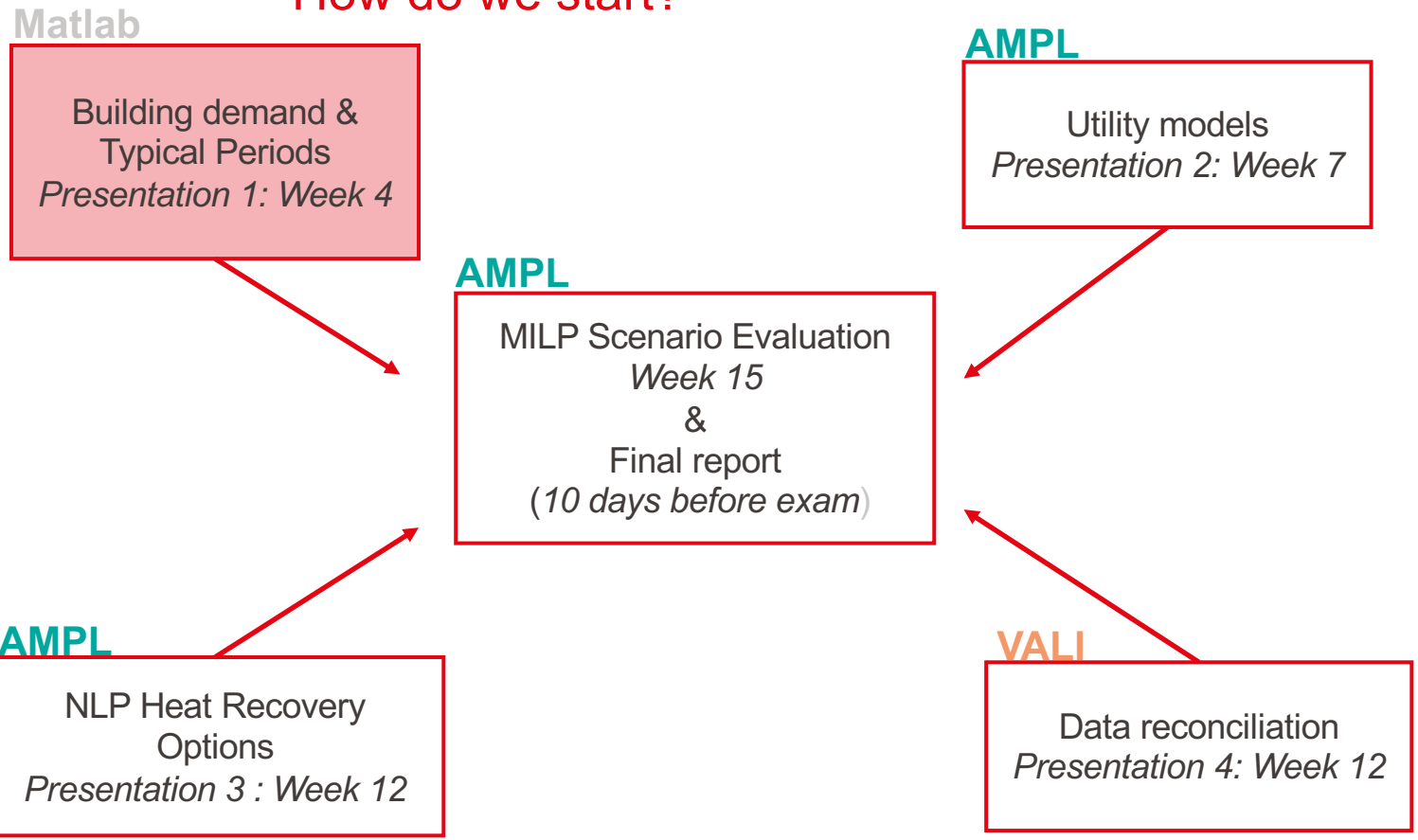


Project Overview



Project Overview

How do we start?



What is our Goal?

Project Overview

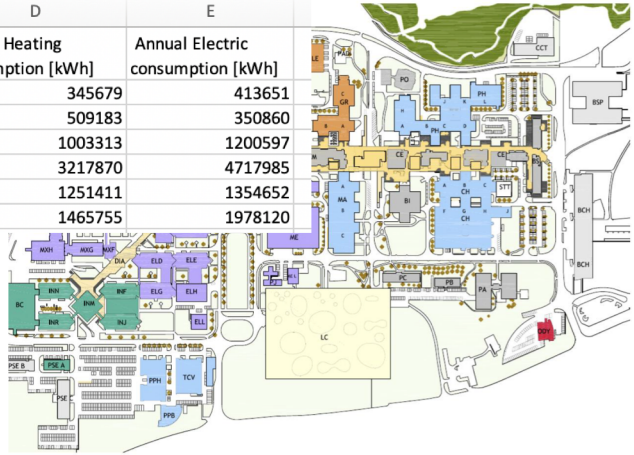
- The **energy system of EPFL** supplies heating, cooling and electricity.
- The **heating system** is about to reach the end of its lifetime.
- The management board is searching for **replacement** of the existing system.

What do we have?

Available Data

- Building Data
  P1_buildingdata.csv

	A	B	C	D	E
1	Building	Construction	Heated ground surface [m2]	Annual Heating consumption [kWh]	Annual Electric consumption [kWh]
2	BI	1	4496	345679	413651
3	BS	1	10267	509183	350860
4	CE	1	16655	1003313	1200597
5	CH	1	28986	3217870	4717985
6	CM	1	18663	1251411	1354652
7	GC	1	26586	1465755	1978120



- Weather Data
  P1_weatherdata.csv

	A	B
1	T amb [∞C]	Irr [W/m2]
2	9.1	0
3	9.3	0
4	9.1	0
5	9	0
6	8.8	0
7	8.7	0
8	8.7	0
9	8.6	0
10	8.7	2
11	9.4	41
12	10.1	76
13	10.7	104

- 2 “prepared” Matlab files
  Buildings.m & All_Buildings.m

- Project Description
  Project_description.pdf

What is missing?

Available Data

- Building Data
  P1_buildingdata.csv

	A	B	C	D	E
1	Building	Construction	Heated ground surface [m2]	Annual Heating consumption [kWh]	Annual Electric consumption [kWh]
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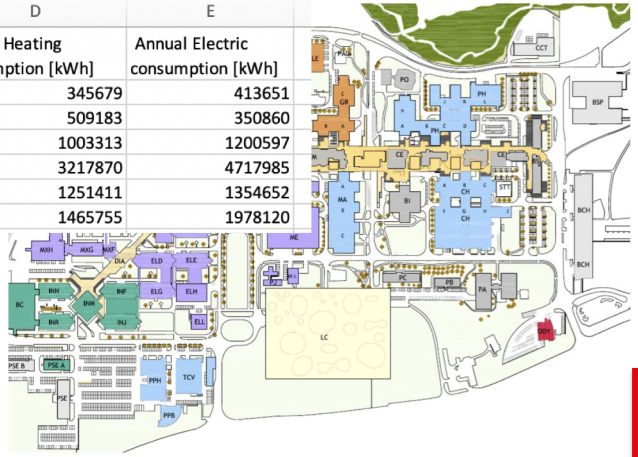

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Demand profiles?

Aim Part 1

Identification of typical heat and electricity demand per building

Outline Part 1

Identification of typical heat and electricity demand per building

Task 1: Estimation of heat gains

Task 2: Calculation of building envelope properties

Task 3: Calculation of the hourly demand

Task 4: Clustering of typical days

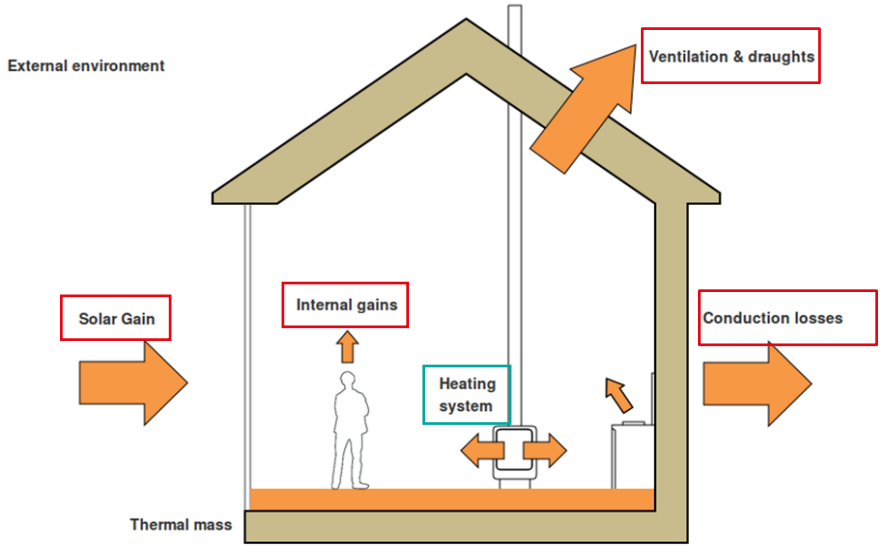
Outline Part 1

Identification of typical heat and electricity demand per building

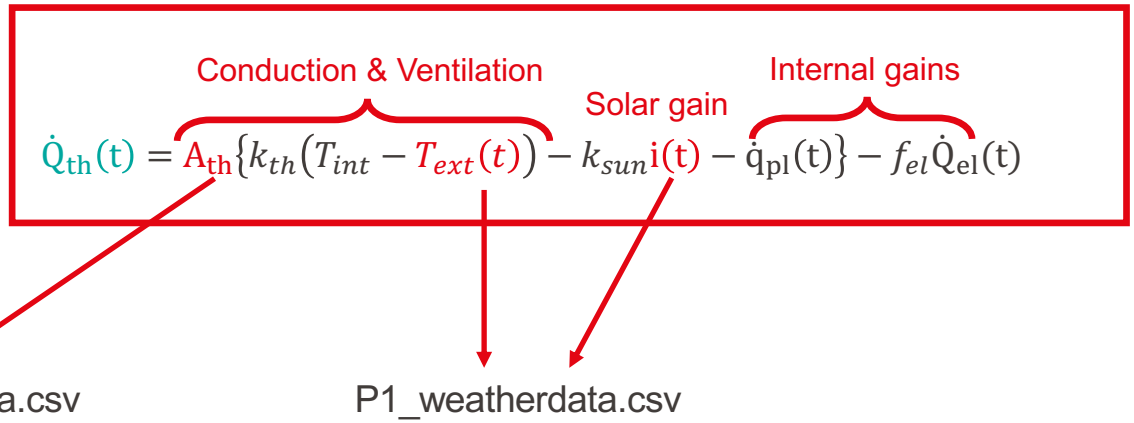
- Task 1: Estimation of heat gains
- Task 2: Calculation of building envelope properties
- Task 3: Calculation of the hourly demand
- Task 4: Clustering of typical days

Estimation of Heat Gains

$$\dot{Q}_{th}(t) = \overbrace{A_{th}\{k_{th}(T_{int} - T_{ext}(t))}^{\text{Conduction \& Ventilation}} - \overbrace{k_{sun} i(t)}^{\text{Solar gain}} - \overbrace{\dot{q}_{pl}(t)\}}^{\text{Internal gains}} - f_{el}\dot{Q}_{el}(t)$$



Estimation of Heat Gains



Estimation of Heat Gains

Conduction & Ventilation

Solar gain

Internal gains

$$\dot{Q}_{th}(t) = A_{th}\{k_{th}(T_{int} - T_{ext}(t)) - k_{sun}i(t) - \dot{q}_{pl}(t)\} - f_{el}\dot{Q}_{el}(t)$$

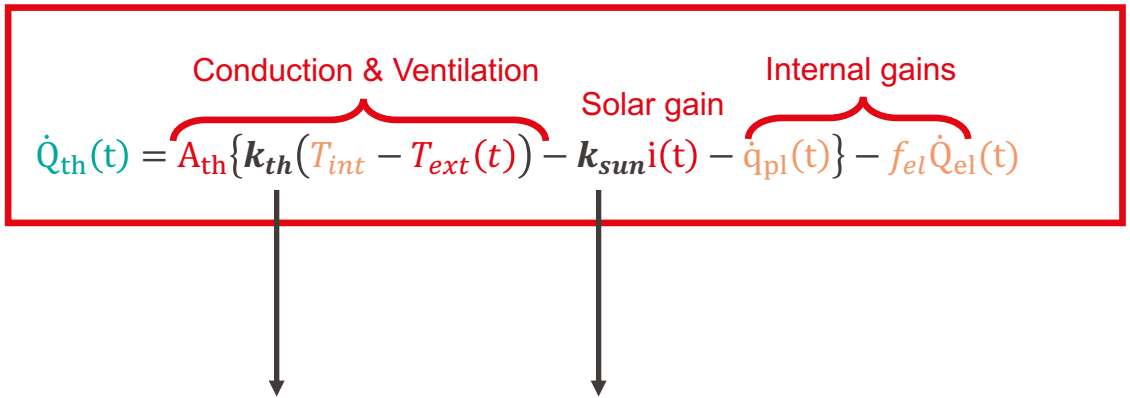
21 °C

- P1_buildingdata.csv
- Project description: Figure 1.1 & Table 1.2

80%

- P1_buildingdata.csv
- Unified Distribution
- Mo – Fr; 7AM – 9PM

Estimation of Heat Gains



→ Task 2 of part 1

Outline Part 1

Identification of typical heat and electricity demand per building

Task 1: Estimation of heat gains

Task 2: Calculation of building envelope properties

Task 3: Calculation of the hourly demand

Task 4: Clustering of typical days

Your TODOs

- ✓ Form a Group (moodle)
- ✓ Set up Tools (Matlab, Mattermost, Overleaf)
- ✓ Download Project files - **Project description**
- ✓ Get started with Part 1 Task 1
- ✓ Look forward to next Wednesday ☺

Questions?