POLITECNICO DI MILANO





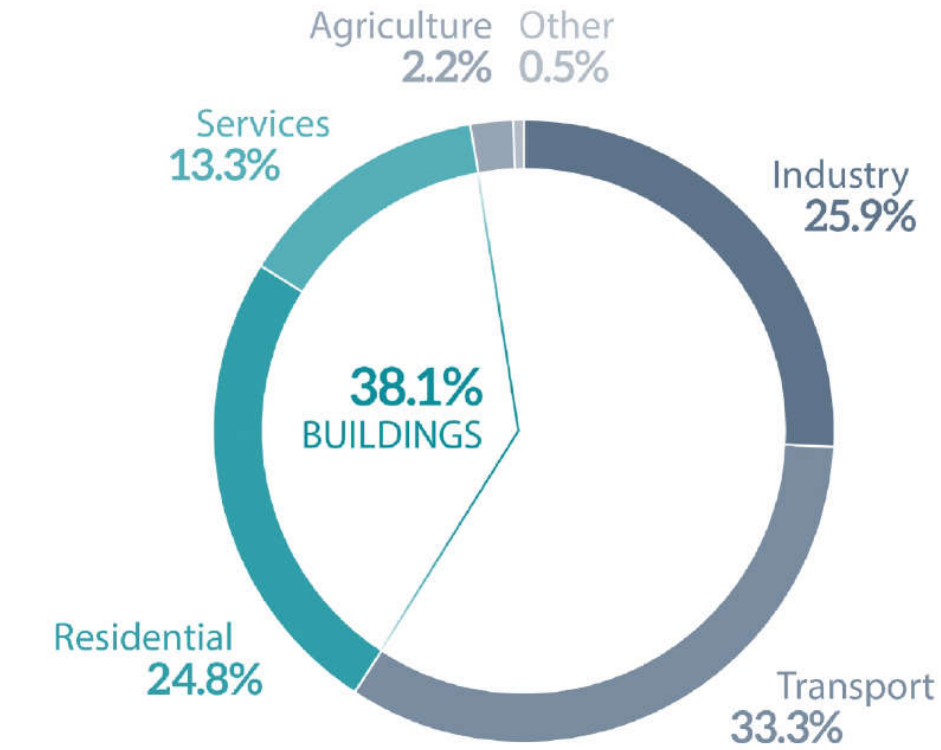
Energy and Environmental Technologies for Building Systems

Course Introduction

Piacenza Campus,1st Semester 2018-2019

B. Najafi

Importance of Building Energy Sector

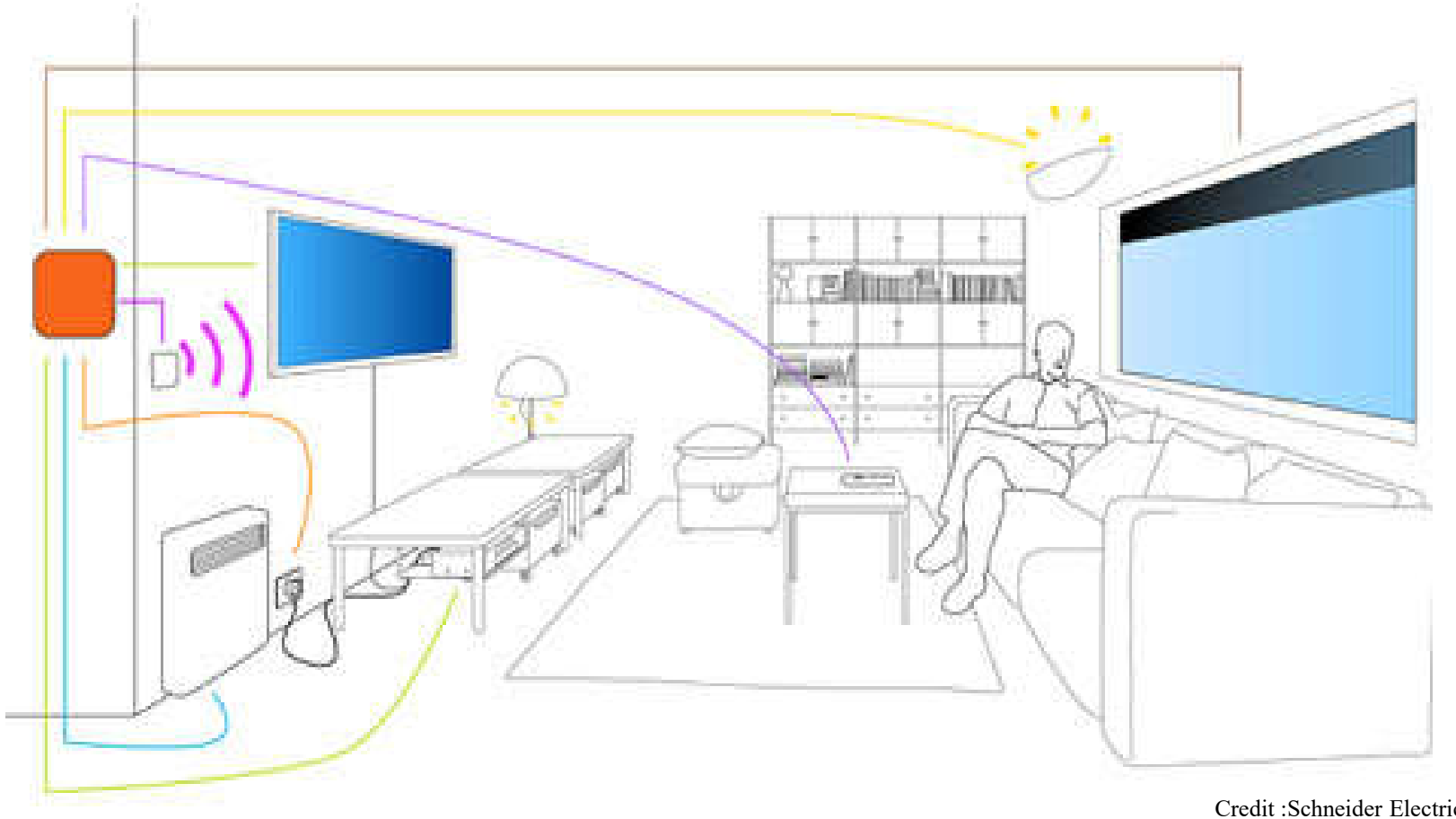


Data source: Eurostat, 2014.

Europe's Energy consumption by Sector

Correlation with Emerging Technologies

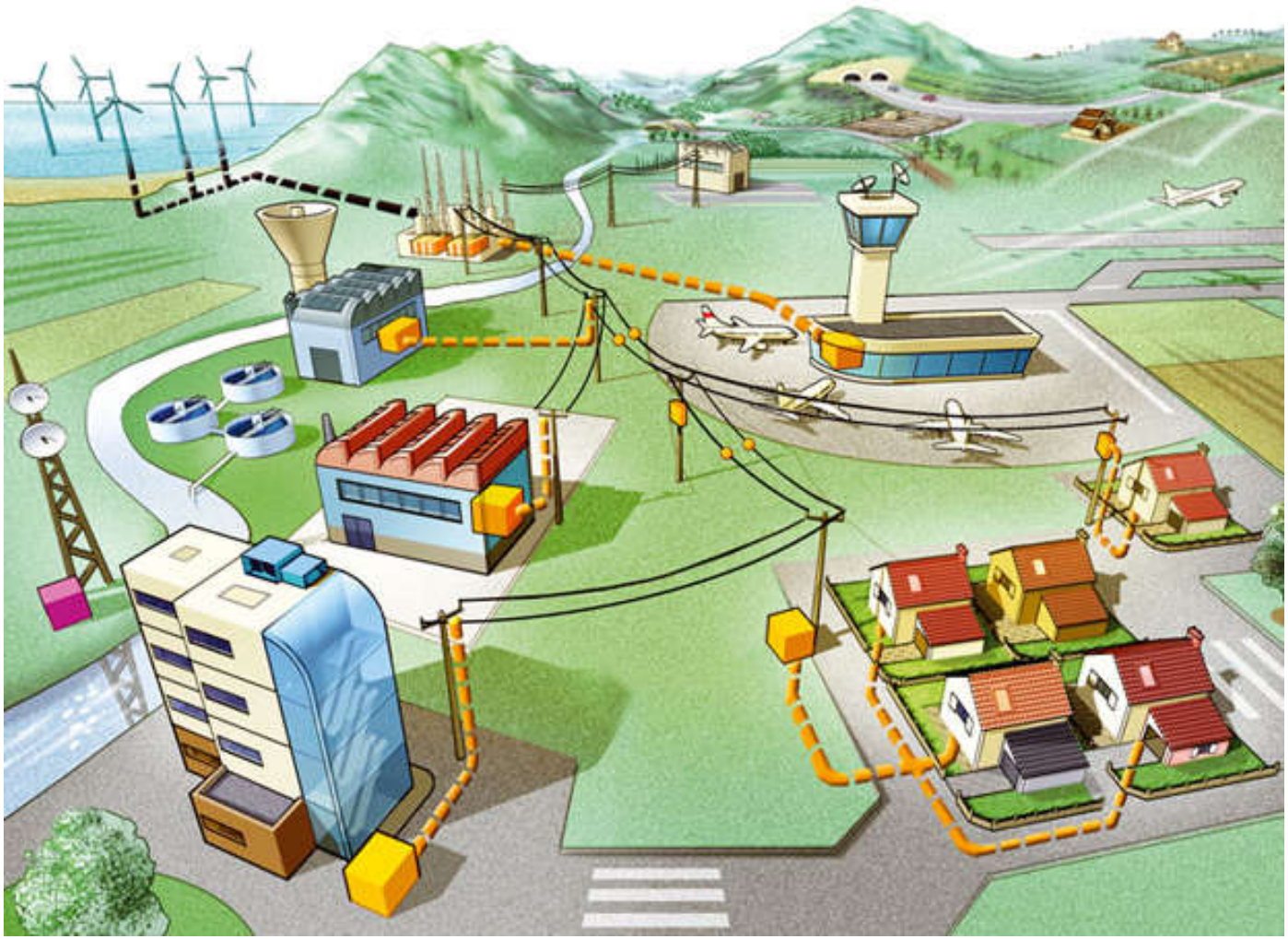
- Smart buildings can be a part of internet of things
  - ✓ Smart Homes



Credit :Schneider Electric

Correlation with Emerging Technologies

- Smart buildings can be a part of Smart grids

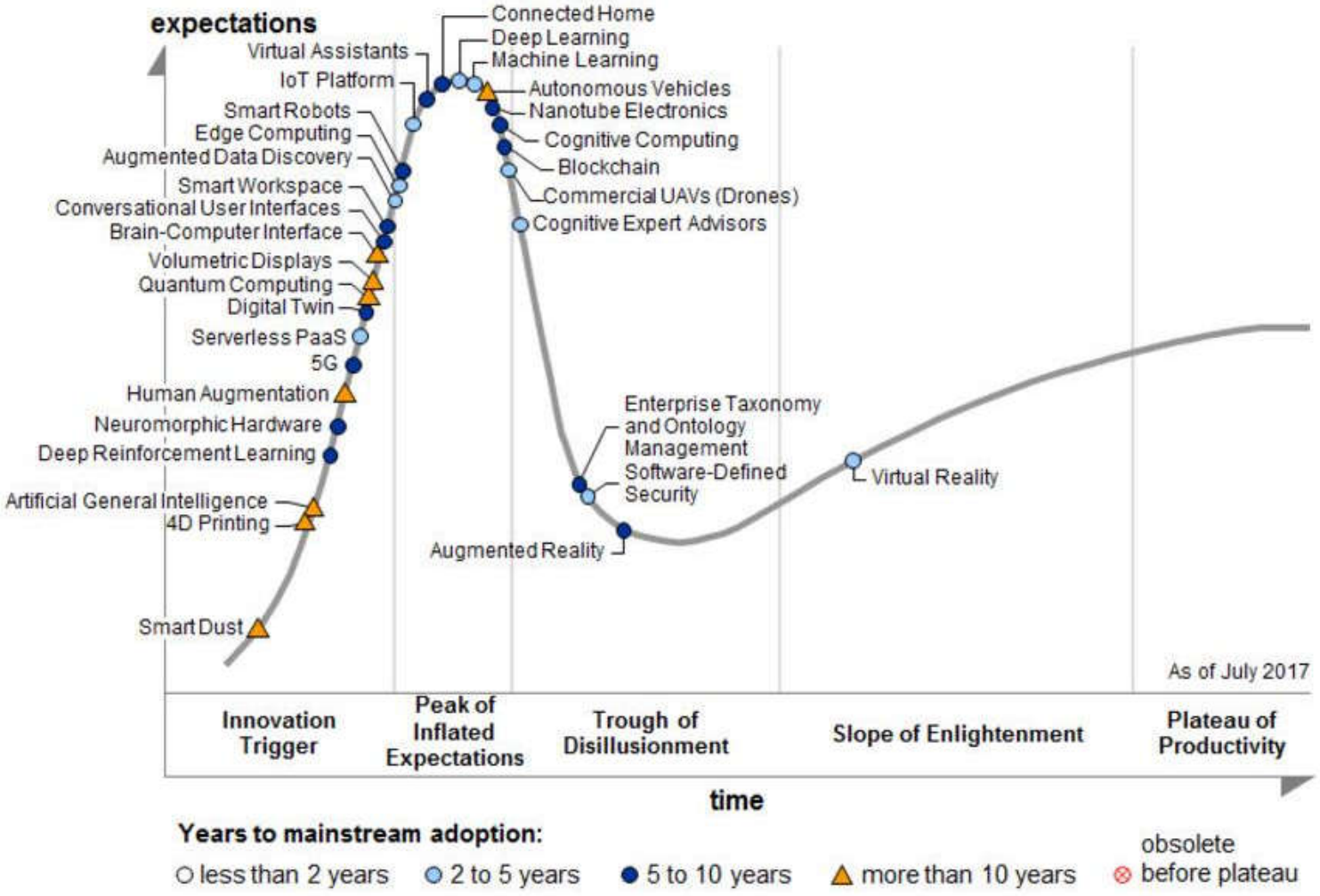


Credit :Schneider Electric

Correlation with Emerging Technologies

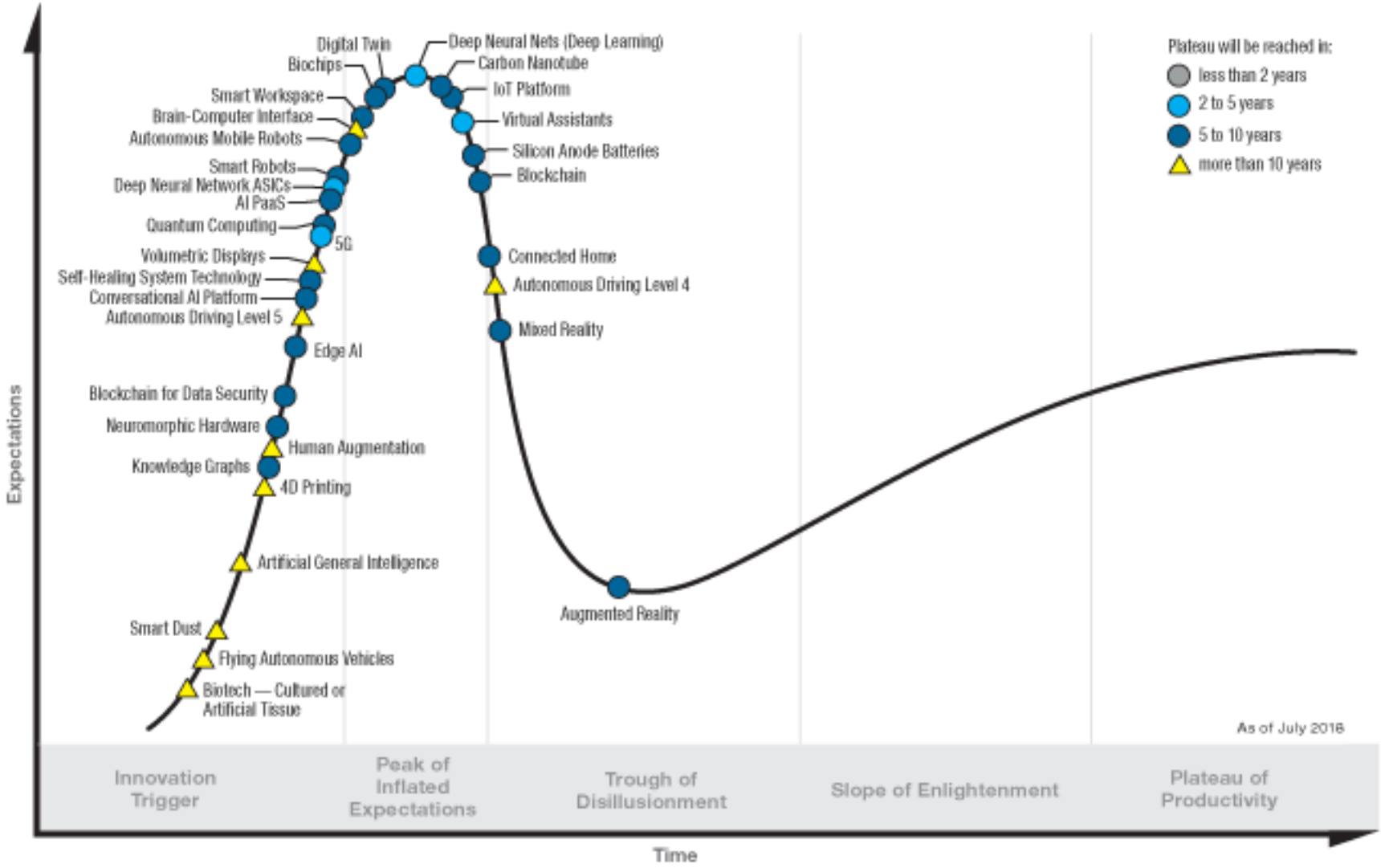
Gartner's diagram of emerging technologies, July 2016

Correlation with Emerging Technologies



Gartner's diagram of emerging technologies, July 2017

Correlation with Emerging Technologies



Gartner's diagram of emerging technologies, July 2018

Career Opportunities

- Current Trends
  - ✓ Energy manager
  - ✓ HVAC specialist
  - ✓ Energy audit expert and consultant in energy sector

- Estimated Future Trends:
  - ✓ Home automation expert in space conditioning sector
  - ✓ Energy analyst, Energy data analyst and energy data scientist

Covered Topics

Topic 1: Fundamentals of building physics

1.1: Review of conductive and convective heat transfer

1.2: Review of radiation heat transfer

1.3. Solar radiation

1.4 Heat transfer through walls and windows, simplifications

1.5. Psychrometric fundamentals

1.6. Basement heat transfer

1.7. Thermal Comfort

1.8. Heat gains and infiltration

1.9. Residential heating and cooling load calculation, ASHRAE RLF method

1.10. Non- Residential heating and cooling load calculation, ASHRAE Heat balance methods

Topic 2: Data-driven Building simulation

Topic 3: Heating, cooling and air-conditioning systems

3.1 centralized heating, ventilating and air conditioning (HVAC) systems

3.2 decentralized heating, ventilating and air conditioning (HVAC) systems

Topic 4: Solar thermal systems

4.1 Solar thermal unit configurations

4.2 Solar thermal collectors, Storage units for solar thermal systems

4.3 Applications of solar thermal systems and corresponding sizing procedure

Simulation Tools

- Python general-purpose programming language employed for:
  - ✓Simplified physical modelling
  - ✓Implementing load calculation procedure
  - ✓Data driven simulation

- GIT: Employed both for version control and code sharing

- EnergyPlus:
  - ✓Open-Souce tool developed by the Department of Energy, US
  - ✓Employed for simulating both Building performance and HVAC system
  - ✓OpenStudio interface is employed in this course

References

❑Reference Books and Handbooks:

❖Building Physics

✓ Handbooks

- ➢2013 ASHRAE Handbook—Fundamentals
- ➢2015 ASHRAE Handbook—HVAC Applications

✓ Text Books

- ➢H. Hens, Building Physics – Heat, Air and Moisture – Fundamentals and Engineering Methods with Examples and Exercises,Ernst & Sohn
- ➢H. Hens, Applied Building Physics – Boundary Conditions, Building Performance and Material Properties, Ernst & Sohn

❖Solar Thermal systems:

- ➢J. A. Duffie, W. A. Beckman, Solar Engineering of Thermal Processes, 4th Edition, Wiley 2013

❖Heat transfer and thermodynamics fundamentals:

- ➢Çengel, Y. A., & Boles, M. A. (2001). Thermodynamics: An engineering approach. Boston: McGraw-Hill.
- ➢Cengel Y. & Ghajar A., Heat and Mass Transfer: Fundamentals and Applications,5th edition , 2015, McGraw-Hill.

Course Evaluation

- Course Evalaution:
  1. Mid-term written Exam - 25%
  2. Final written Exam (second mid-term)- 25%
  3. Continous evaluation (submissions) - 25%
  4. Final Project - 25%

- Important Points:
  - The student should pass the written exam parts (18/30) in order to have the next parts considered.
  - The continous evaluation and the project are determined in a final oral examiantion in which the students are evaluated both based on the submissions and project and their knowledge about the correlated underlying theory.