ENERGY AND BUILDINGS

Michele De Carli

Sara Bordignon

Enrico Prataviera

Persons in charge of the course:

Michele De Carli

Enrico Prataviera

Sara Bordignon

Topics:

- Climatic conditions
- Buildings' Envelope: thermal bridges and surface and interstitial condensation
- IEQ (Indoor Environmental Quality)
- Glass components and natural lighting
- Energy balance of a room
- Analysis of building consumptions for heating and cooling
- Analysis of Domestic Hot Water (DHW) consumption
- Analysis of building consumptions for electricity
- Energy and Environmental Certification
- Examples of multi-energy systems
- ZEB (Zero Emission Buildings) and PEH (Plus Energy Houses)
- The concept of neighborhoods and district solutions

Calculation codes :

These codes will be learnt and used by students and are mandatory for the final exam:

- FEMM 4.0 (thermal bridges)
- ENERGYPLUS (dynamic simulation of buildings and systems)
- SKETCHUP (tool for drawing 3-D building models)

Other tools to be used :

- WORD, EXCEL

Report on your own house energy consumption including:

- a thermal bridge of your house: define the heat loss and the possible surface condensation problem
- analysis of interstitial condensation problems of your house
- the electric and heating consumptions based on bills
- determination of the net energy demand for heating/cooling the building by means of the commercial dynamic simulation tool ENERGYPLUS
- dynamic simulation with cooling plant switched off and evaluation of the indoor temperatures drift in summer
- evaluation of the efficiency of the current plant
- comparison between results of calculations and energy bills
- final editing of the report

Students have to deliver the report based on the calculations. There are two possible deadlines to present the report:

- one deadline in January for the students who want to take the exam in the winter period (January-February)
- one deadline in June for the students who want to take the exam in the summer period (June-July)
- one deadline in September for the students who want to take the exam in autumn period (September)

The report has to be uploaded in moodle.

The 3 dates for the exam are:

- 19 January 2022 9.00 am Room M5
- 8 February 2022 9.00 am Room M5
- 22 January 2022 9.00 am Room M6

EXAMINATION

- Report: 15 points to be delivered via moodle
- One open written question (20 minutes): 7.5 points
- One open oral question: 7.5 points

- Overall: report (15 points) + written question (7.5 points) + oral question (7.5 points)

Organization of lectures

Front lectures:

– Classroom-taught/web
– via web at least 19/10 and 26/10 (officially 1 hour taught corresponds to 0.5 h on-line taught)

Web lectures will be recorded

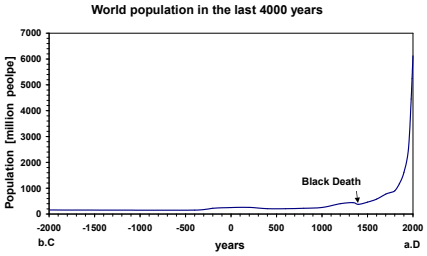
Laboratory

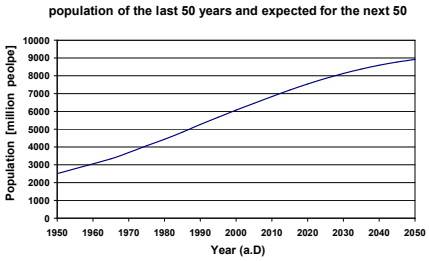
– Classroom-taught or via web
– Thermal bridges & Condensation (end of October)
– Dynamic simulation of the building (end-November/beginning-December)

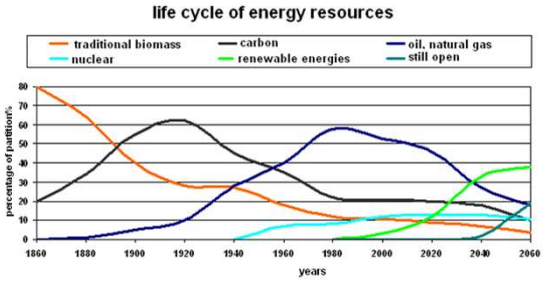
Web lectures for the laboratory may be done via Zoom

Student reception (usually from November) will be defined depending on the future rules

The well known energy problem







- **Population increase**
- **Energy consumption increase**
- **Need to invest in RES**

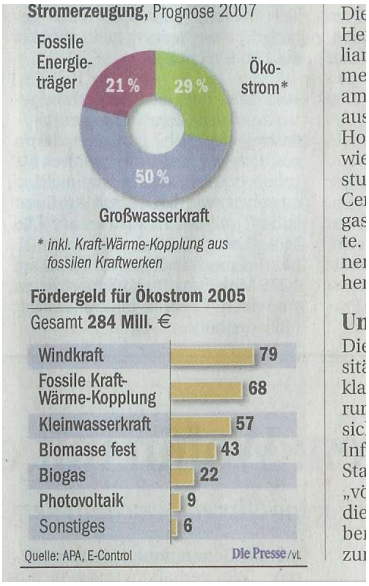
Kunden zahlen Zeche für Ökostrom

ENERGIE. *Regulator: Strom durch erneuerbare Energie um zehn Prozent teurer.*

STROM: Grün, aber teuer

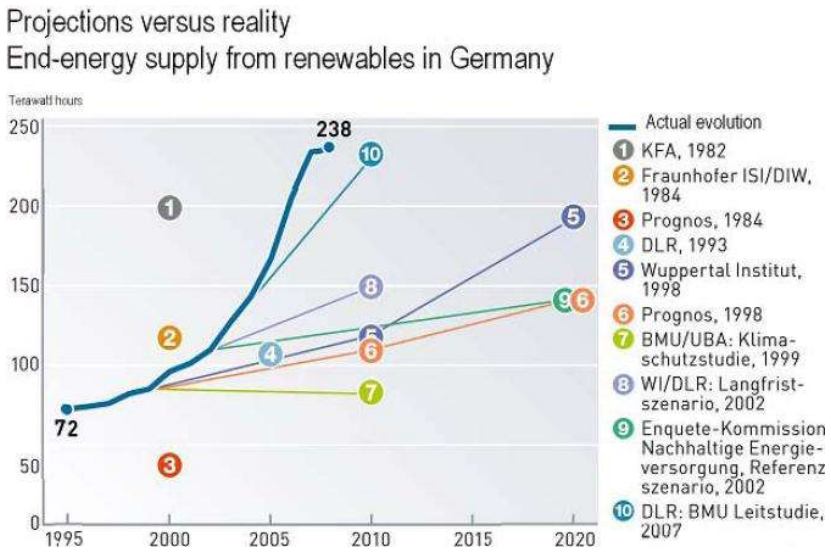
Im Ökostromgesetz ist festgehalten, dass erneuerbare Energie bis zum Jahr 2008 einen Anteil von vier Prozent am gesamten Stromverbrauch haben soll. Aufgrund der bereits erfolgten zahlreichen Genehmigungen für Ökostromanlagen – vor allem Windkraft nimmt stark zu – dürfte der Anteil allerdings bei acht Prozent liegen. Für den Stromregulator ist das problematisch: Ökostrom sei hierzulande zu teuer, die Stromkunden müssten letztendlich die Subventionen berappen.

Traditional solution: invest in central large plants

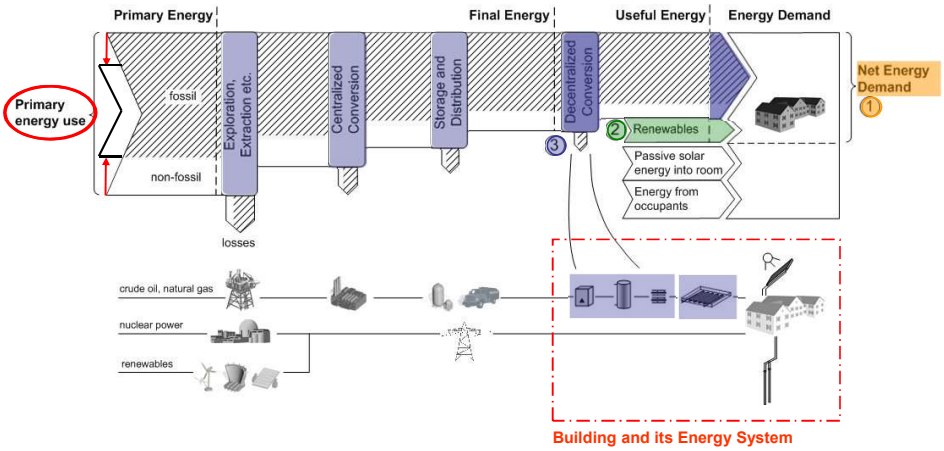


RENEWABLE ENERGY IN GERMANY

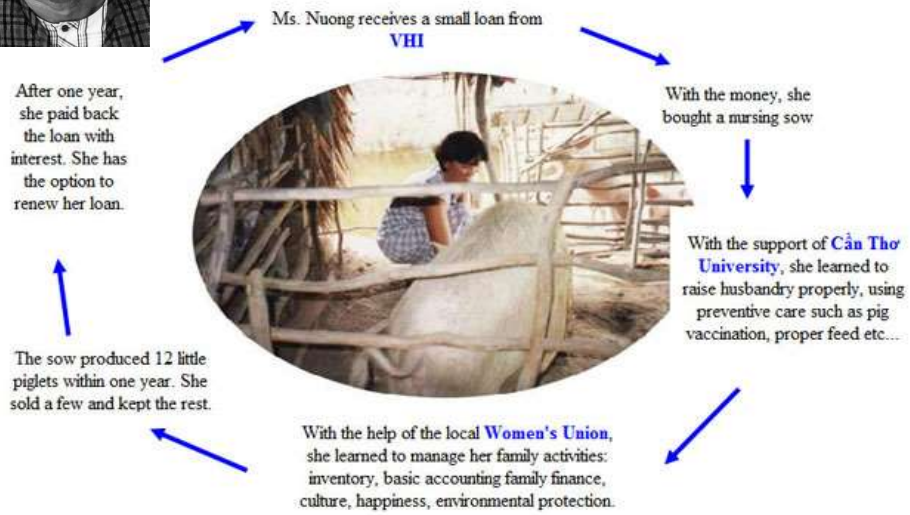
The trend has been been underestimated!



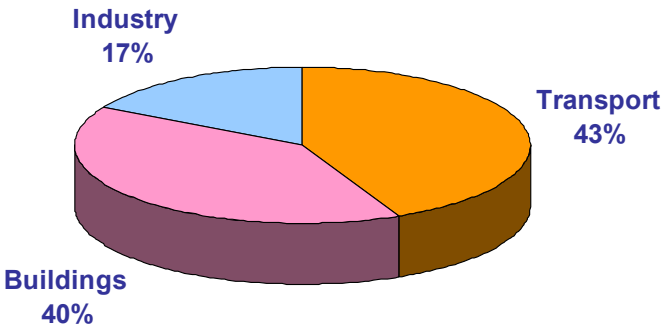
Three Ways to Reduce Primary Energy Use in Buildings



Yunus Muhammad
He invented microcredits

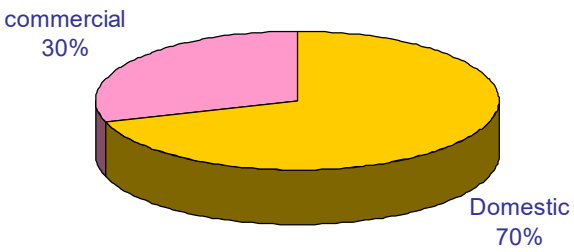


Energy use by sector in EU



Buildings are responsible for 40% of the emission of carbon dioxide

Energy use according to the type of building



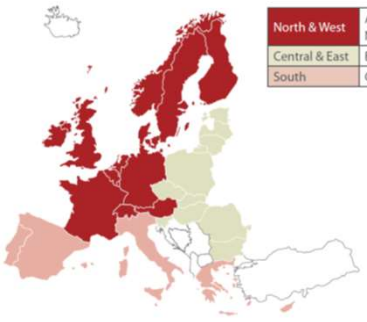
40% of overall emissions in buildings

Residential buildings are responsible for 28% of CO_2 emissions

Commercial buildings are responsible for 12% of CO_2 emissions

How many buildings in Europe?

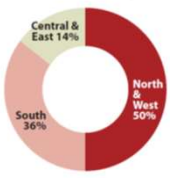
24 billion m² of gross floor area



North & West	AT, BE, CH, DE, DK, FI, FR, IE, LU, NL, NO, SE, UK	Population: 281 million
Central & East	BG, CZ, EE, HU, LT, LV, PL, RO, SI, SK	Population: 102 million
South	CY, GR, ES, IT, MT, PT	Population: 129 million

Floor space distribution

Source: BPIE survey



Source BPIE

Europe's buildings under the microscope

The first requirements

- Protection against weather

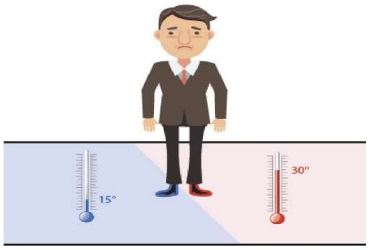
- Security

…. later

- Provide adequately accommodation to the various activities

- To show wealth or power

Only recently other needs have been considered, particularly those relating to thermal comfort



…. today

- complex multidisciplinary problem
- performance requirements

The evolution of the building envelopes

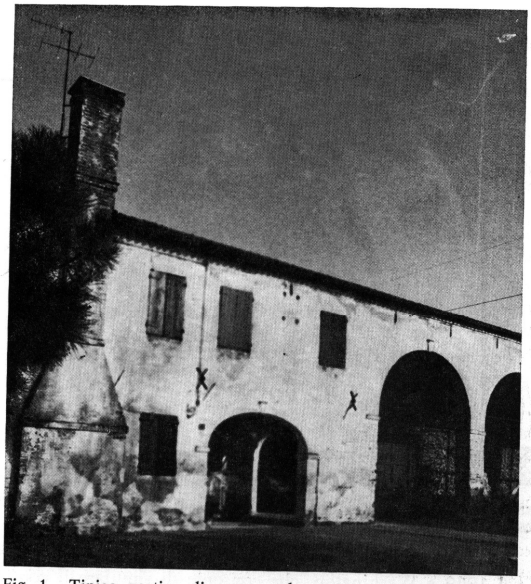
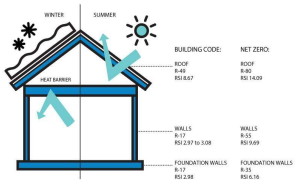


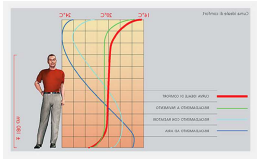
Fig. 1 - Tipico portico di casa rurale veneta con diverse altezze per la parte rustica e abitativa. (Foto E. Pagello)

Steps for a good design:

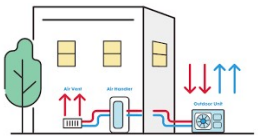
1. Building envelope



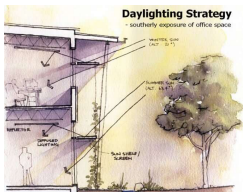
2. Terminals/emission units



3. Generation of heating/cooling
   + RES



4. Efficient lighting



0. Which is the bulding quality? ⇨ aesthetics

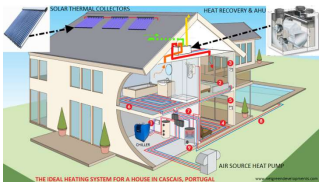
- Thermal comfort
- Indoor Air Quality (IAQ)
- Noise Control
- Light Control

Source; Shutterstock

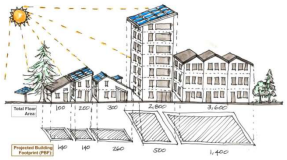
⇩

Health, comfort and productivity of people (IEQ, Indoor Environmental Quality)

Envelope



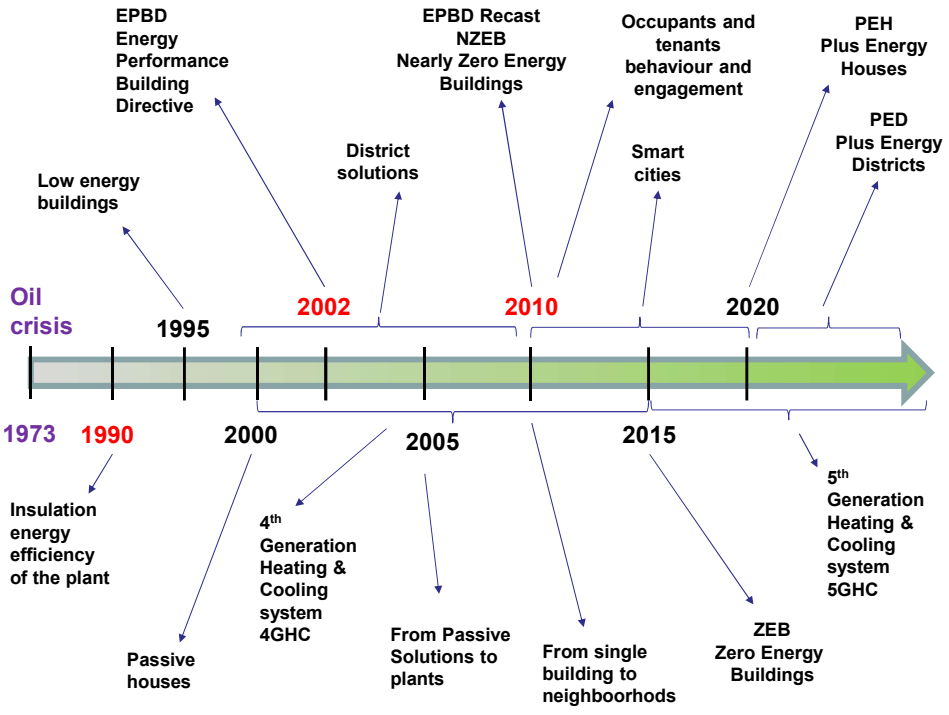
HVAC



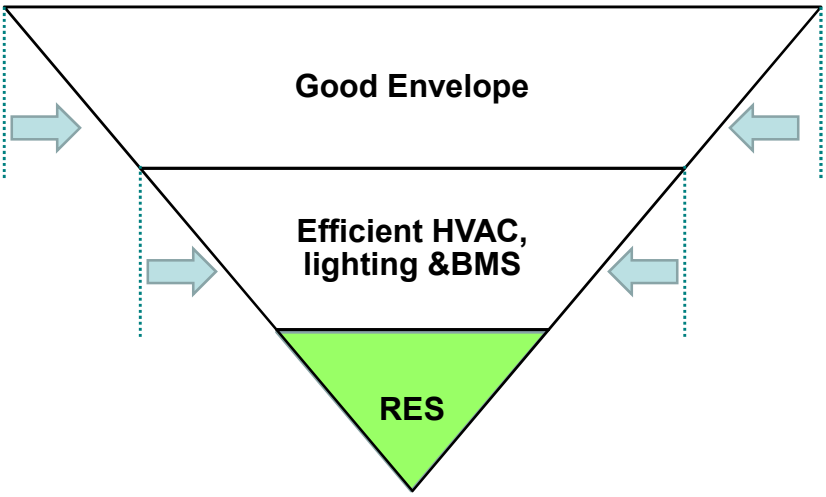
RES

Centralised District

Decentralised Solutions (prosumers)



Hierarchy of solutions:

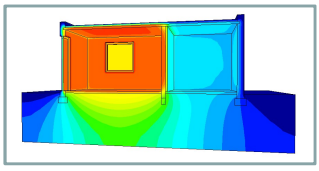


Increasing complexity of the building

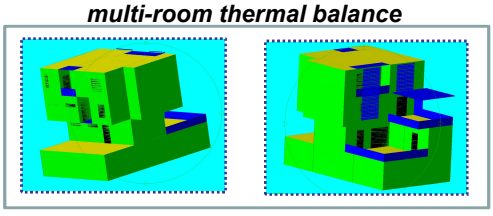
Increasing burden of calculations

How complicate should be a model?

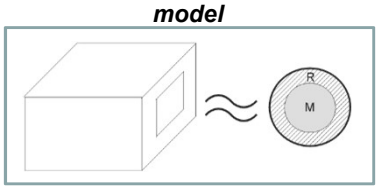
Detailed 3-D conduction problem

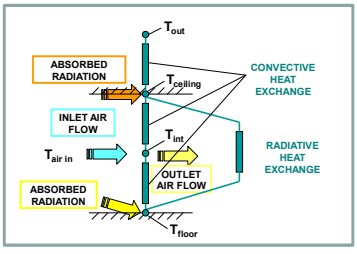


Detailed 3-D geometry: dynamin multi-room thermal balance



Lumped resistance-capacity model





Simplified resistance model

Master theses:

- Indoor Environmental Quality (Core Care laboratory)
- GSHPs and Multi-source RES in buildings
- Neutral loops for heating and cooling buildings (thermal smart grids)
- Urban models
- UNIZEB: Zero Energy Laboratory of UNIPD
- Research group infos available on the site

  https://research.dii.unipd.it/betalab/