



Institute of Technology in Architecture
Faculty of Architecture / ETH Zurich

LowEx Building Symposium

Dual Zone Borehole and System Control: The Simultaneous Source and Store

Philippe Goffin

Chair of Building Systems

26. November 2010

ETH

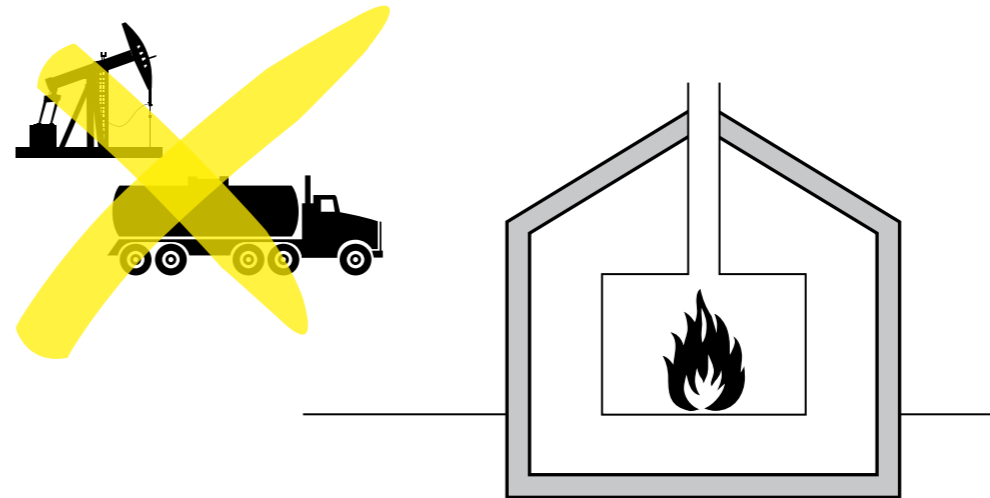
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Introduction

- **Future buildings will not be allowed to have any burning processes inside them. Therefore new components and new control systems are required.**

- **Content of this talk:**

- **Standard solution - As implemented up to now**
- **Future solution - B35**
- **Solutions for building automation**



Standard solution: The components

1. thermal collector

2. window: double or triple glazed

3. ventilation system

a. mechanical

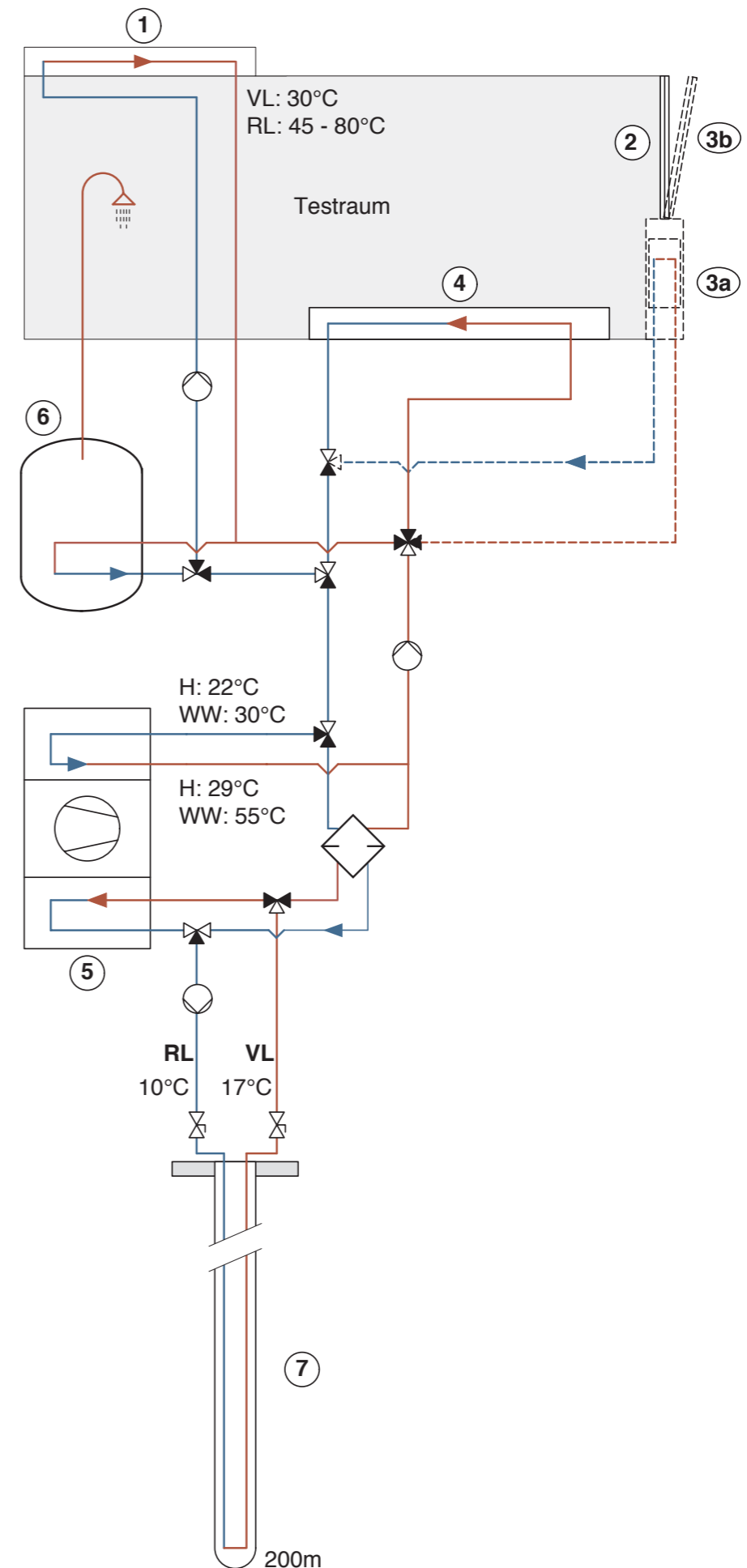
b. natural

4. floor heating system

5. heat pump

6. domestic hot water tank (DHW tank)

7. vertical borehole



Standard solution: The automation part

1. heating

a. borehole - heat pump - floor heating system

2. cooling

a. floor heating system - borehole

b. passive cooling

3. fresh air supply

a. mechanical, air tempered through heating loop

b. natural ventilation

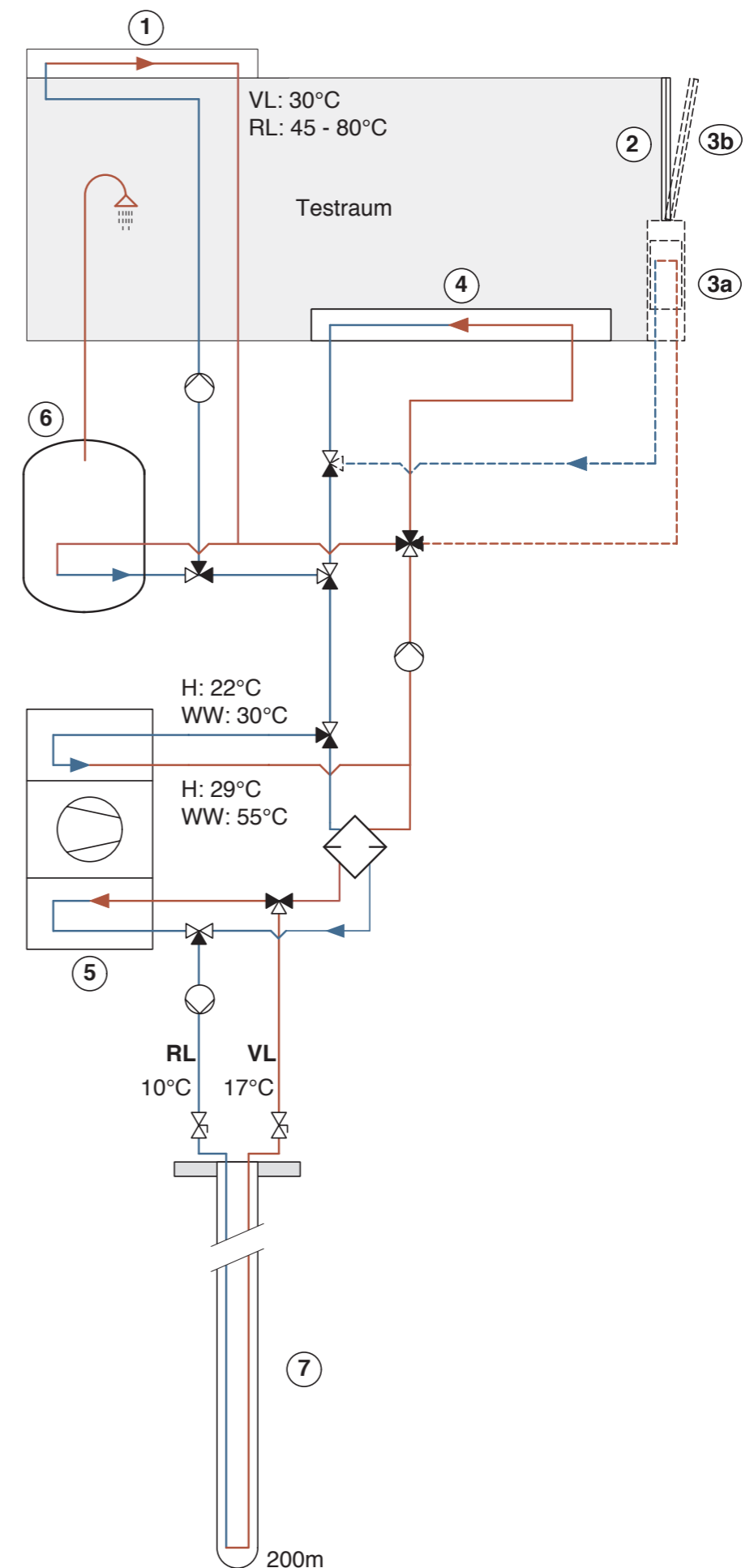
4. domestic hot water preparation

a. borehole - heat pump - DHW tank

b. thermal collector - DHW tank

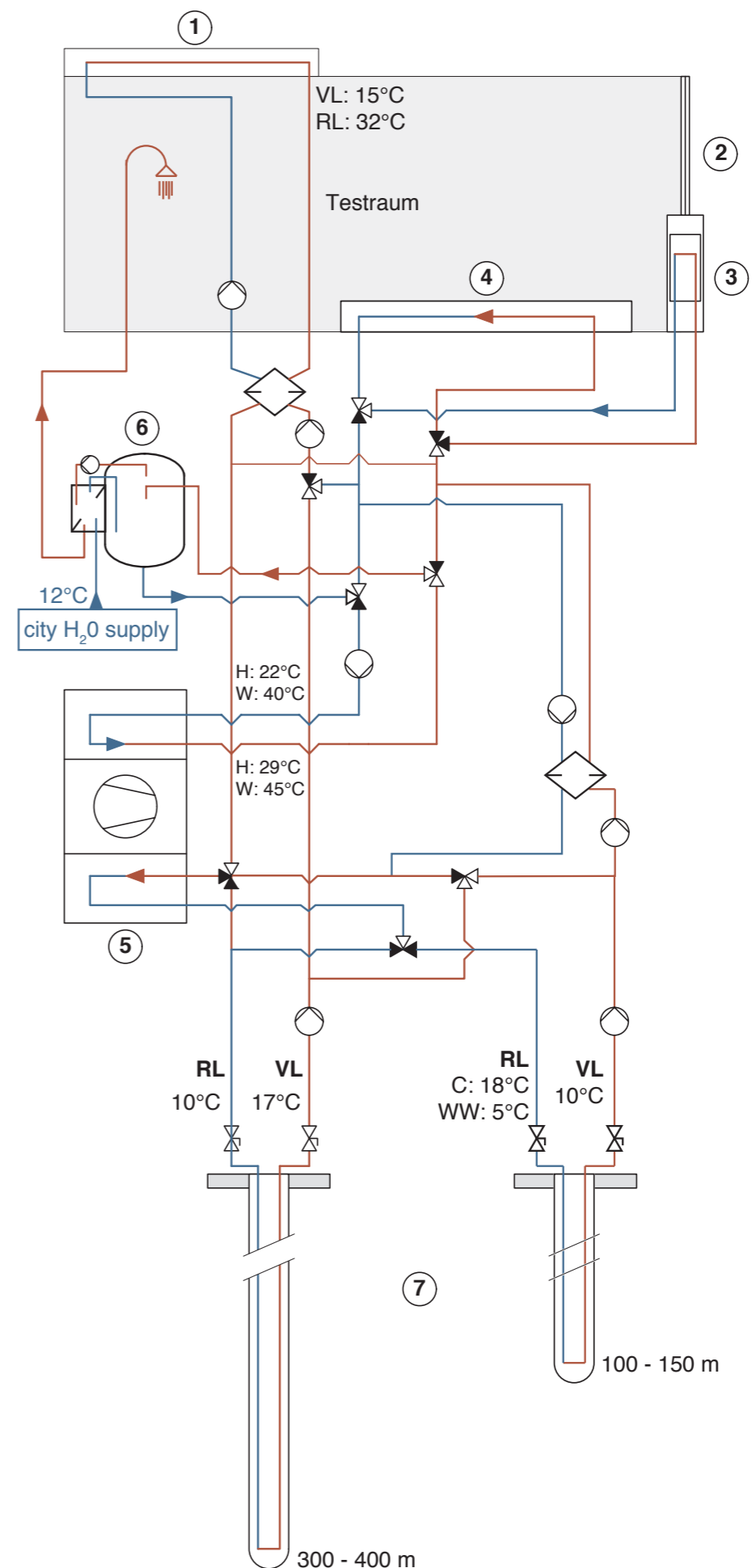
5. borehole regeneration

a. floor heating system - borehole, e.g. room cooling



B35 solution: The components

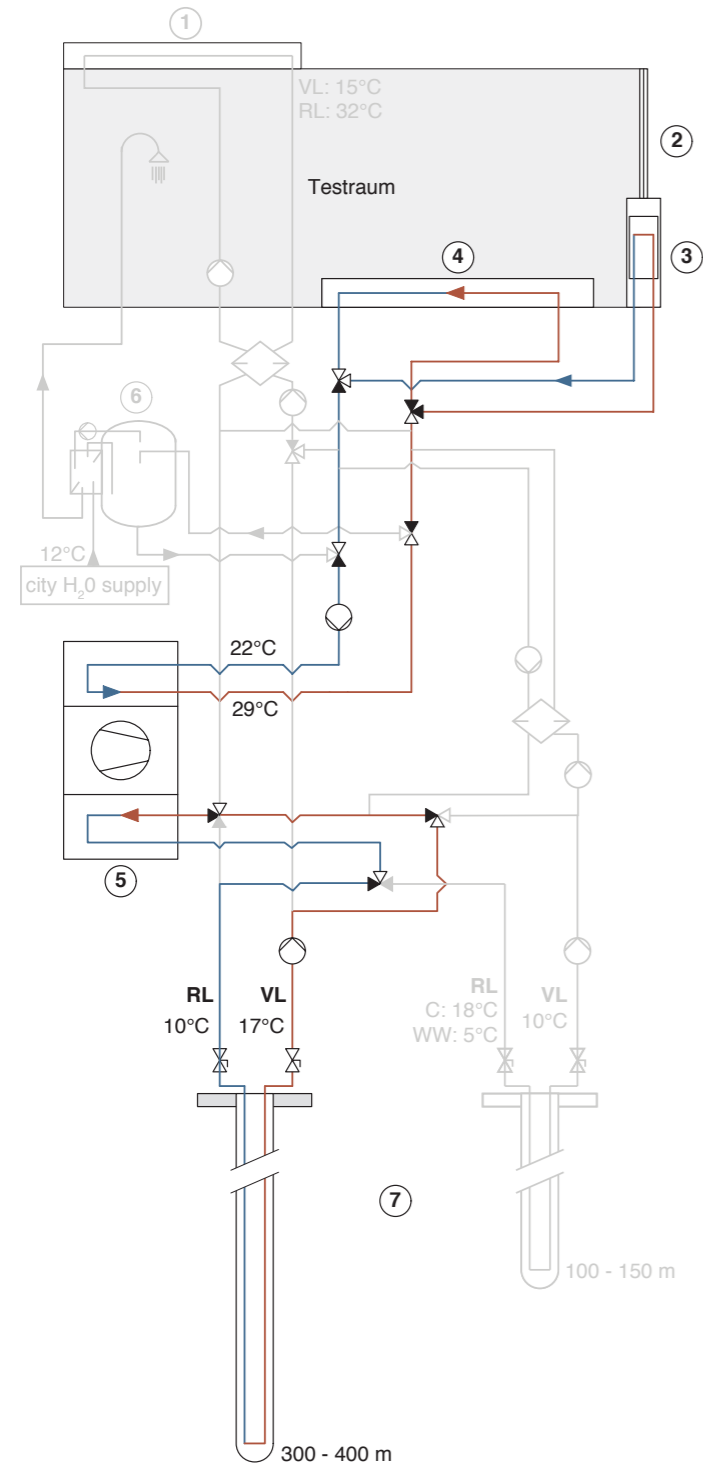
1. hybrid PV-Thermal collector
2. window: double glazed and M-Glass
3. decentralized ventilation system
 - a. mechanical
4. floor heating system
5. heat pump
6. hot water tank with heat exchanger (HWwHX tank)
7. dual zone vertical borehole



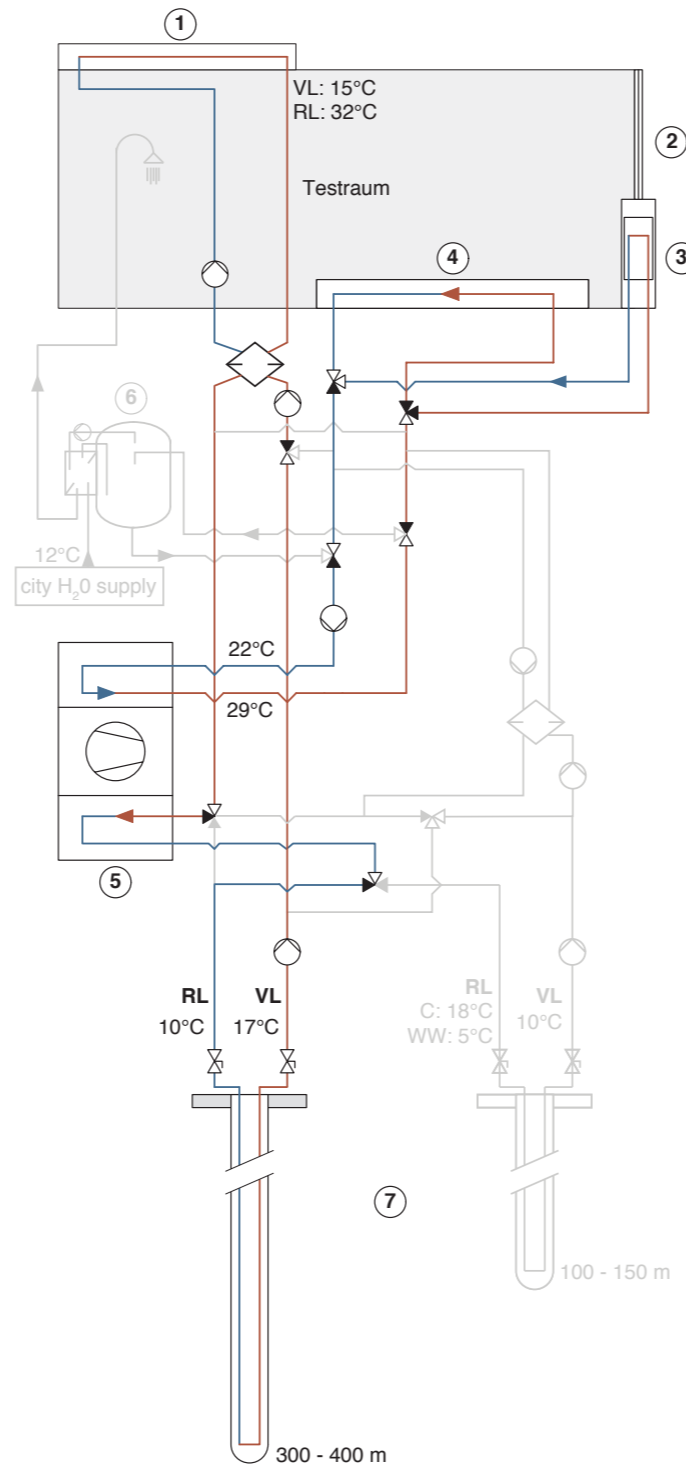
B35 solution: The automation part - Heating

► more degrees of freedom, e.g. 3 possible scenarios vs. 1 for standard solution

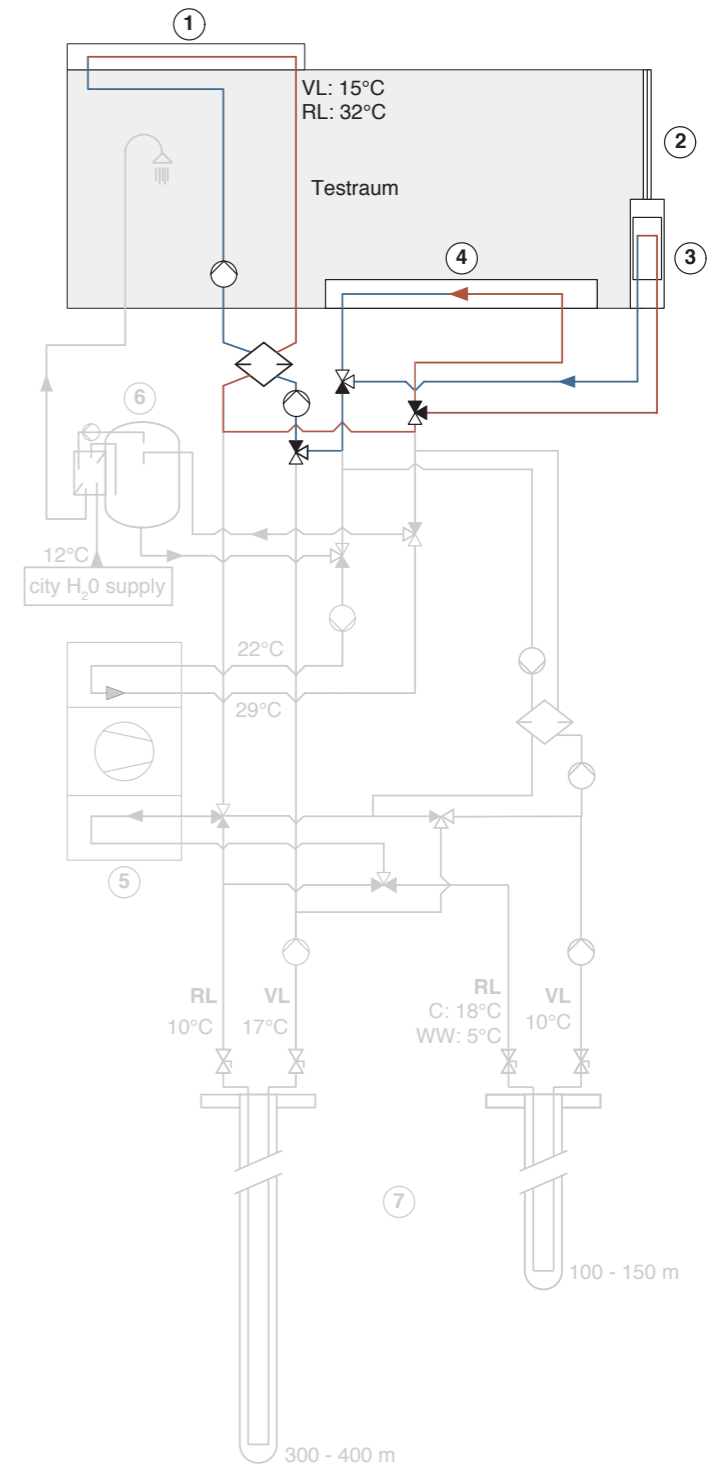
a. standard heating over HP



b. standard heating with solar assistance



c. direct "solar" heating



/ ITA

Institute of Technology in Architecture / Faculty of Architecture / ETH Zurich

Chair for Building Systems [BS] / Prof. Hansjürg Leibundgut

LowEx Building Symposium / 26.11.10 / 6 von 11

B35 solution: The automation part (cont.)

1. heating

- a. standard heating over heat pump
- b. standard heating with solar assistance
- c. direct "solar" assistance

2. cooling

- a. direct active cooling, e.g. floor to ground zone 1
- b. inverse solar collector function

3. fresh air supply

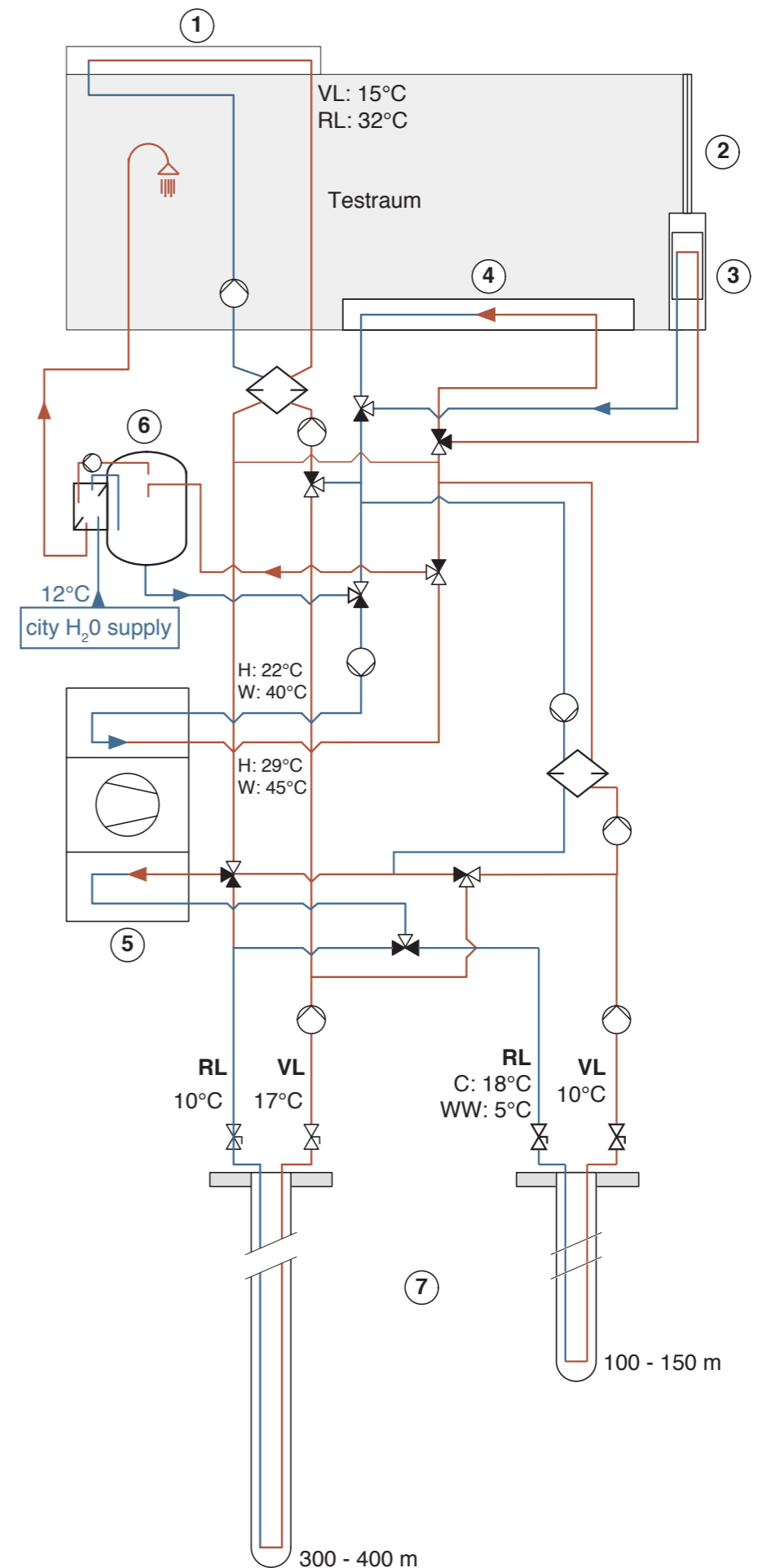
- a. mechanical, air tempered through heating loop
- b. through open windows

4. domestic hot water preparation

- a. ground zone 1 - heat pump - HW tank - HX
- b. ground zone 1 - solar HX - heat pump - HW tank - HX
- c. ground zone 1 - cool HX - solar HX - HP - HW tank - HX

5. borehole regeneration

- a. hybrid solar collector - ground zone 2



B35 solution: The advantages, the drawbacks

+

- More scenarios and parallel processes are possible
 - For example in Summer: Room cooling + domestic hot water preparation + regeneration of the ground zone 2
- Regeneration of the ground zone 2 occurs at a higher temperature level, e.g. 30°C
- higher efficiency of the PV panel, through active cooling

-

- more hardware means more complex, computation intensive algorithms for control
- risk of hardware, software malfunction can lead to “uncomfortable” states

But

- no risk no reward

Building automation solutions

- **Standard commercial automation solutions:**

- 1. Rule based control:**

- a. if “condition 1 true” then “do action 1”
- b. if “condition 2 true” then “do action 2”
- c. ...
- d. else “do action n”

- 2. predictive modules based on weather conditions**

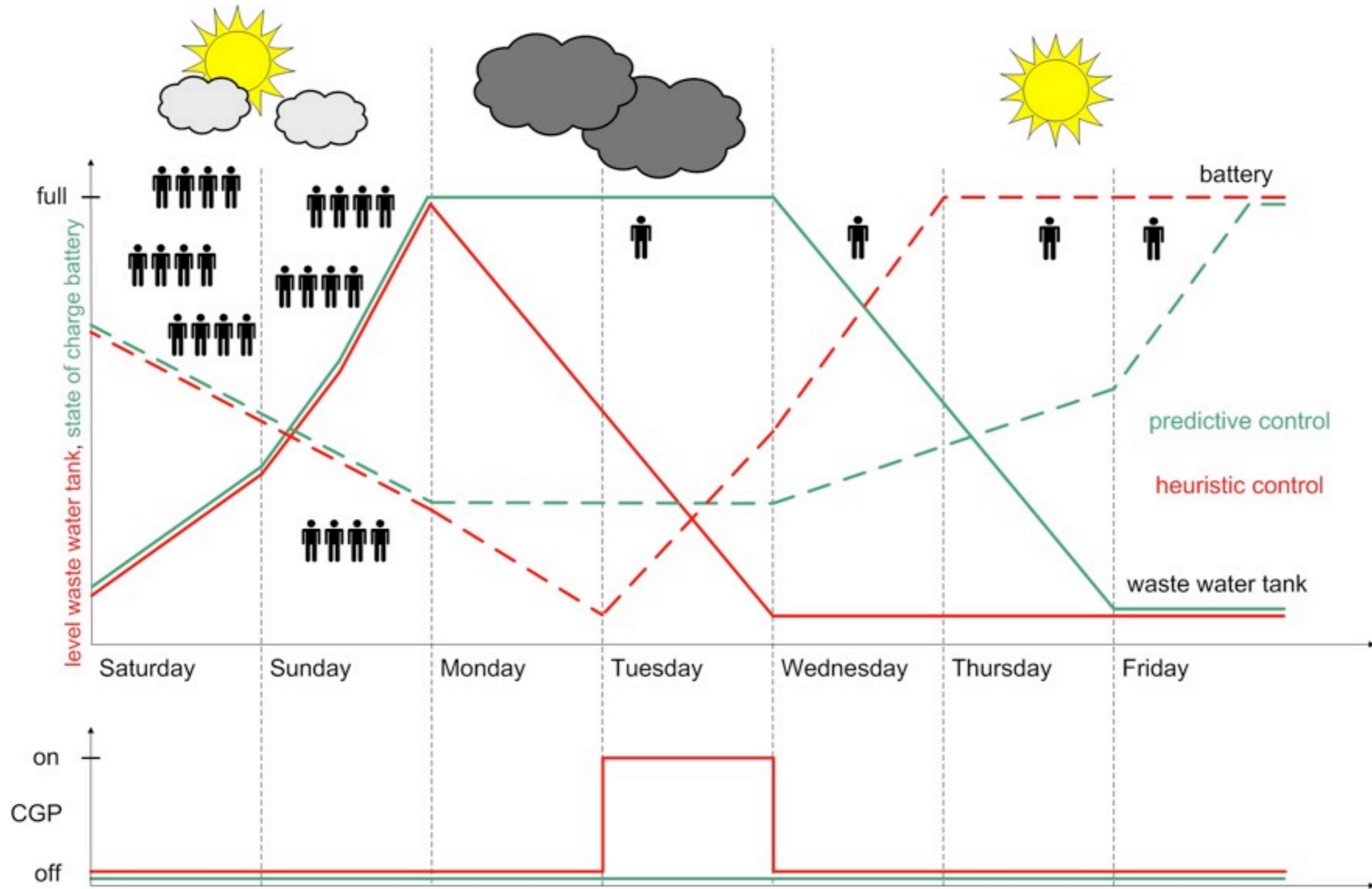
- **Automation solutions in research:**

- 1. Model based predictive control**

- a. a mathematical model of the building and its systems
- b. prediction of future states, e.g. weather, energy cost, occupancy, ...
- c. an optimization function

- 2. Adaptive control**

Model predictive control



© image courtesy of Samuel Fux, IDSC, ETH Zurich

B35 and HPZ automation: KTI Project

- Partnership with Siemens Building Systems, funded by the Swiss federal government
- Project aim:
 - Develop new control algorithms for low exergy building systems
 - Siemens: Predictive rule based control algorithms
 - ETH: Model predictive control algorithm
 - Compare both solutions based on their
 - efficiency
 - implementability
 - economics
 - robustness
 - Develop a final product for future low Ex buildings