BASICS OF HEAT ENERGY DEMAND

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CONTENT OF LECTURE

- Importance and EU legislation
- Energy labels of building
- Heat losses – U coeff.
- Energy demand for heating
- Technology examples

Importance of energy efficiency of buildings

Buildings are currently responsible for app. 40% of energy consumption in EU and 36% of CO2 emissions

35% of buildings: older than 50 years

Reasonable improvement of energy efficiency of buildings can save 5-6% of energy consumed by EU and similarly contribute to CO2 redution

Importance of energy efficiency of buildings 2

INTRODUCTION

Map

- Land area: 78867 km^2
- Population: 10,511 mil. (2013)
- Population density: 133/km^2
- GDP per capita: 388 771 CZK (nominal, 2013)
  (80% of EU28 GDP average, PP)
- Schengen area: yes

Key figures

- Heat sales (M€)
  - aggregated data not available, only data for individual companies and data for heat production and delivery
- Final heat consumption (TWh)
  - 39.8 TWh (total)
  - 11.6 TWh (residential)
  - 28.2 TWh (production and services)
  - 15.2 TWh (delivery to final consumers from DH systems)
- Average DH price to final consumers (c/kWh)
  - 7,56 (2011)
  - 7,91 (2012)
  - 7,87 (2013)
  - 7,93 (2014, estimation)
- Inhabitants using DH (million)
  - 4 mil.
  - 1.55 mil flats (households)
- Market share of DH (%)
  - 38 %

Key EU legislation

Directive 2010/31/EU on the energy performance of buildings

Directive 2012/27/EU on energy efficiency

Key measures:

- energy labels of buildings – to help customers decide, to create pressure for renovation
- inspection schemes for heating and air conditioning
- all new buildings must be nearly zero energy buildings by end of 2020
- energy efficient renovations to at least 3% of buildings owned and occupied by central government
- National Energy Efficiency Action Plans

Energy Label of Building

Based on thermal losses of building (specific heat consumption)

Consumption of energy by the premise

Industrial premises: typically individual consumption based, key driver is type of production and technology used (usually we concentrate to the utilization of waste heat or of waste products – so called secondary energy sources), key role of energy audit

Office buildings: consumption depends on quality of heat isolation (material used for walls, windows), way of heating and cooling, recuperation of energy, way of building utilization

Block of flats: design of the house, quality of heat isolation, efficiency of heating (and lighting) control, design of heating system, motivation of individual households to energy saving

Individual (family) houses: design of the house and heating system, quality of isolation material, possibility of heating (and lighting) management, individual preferences

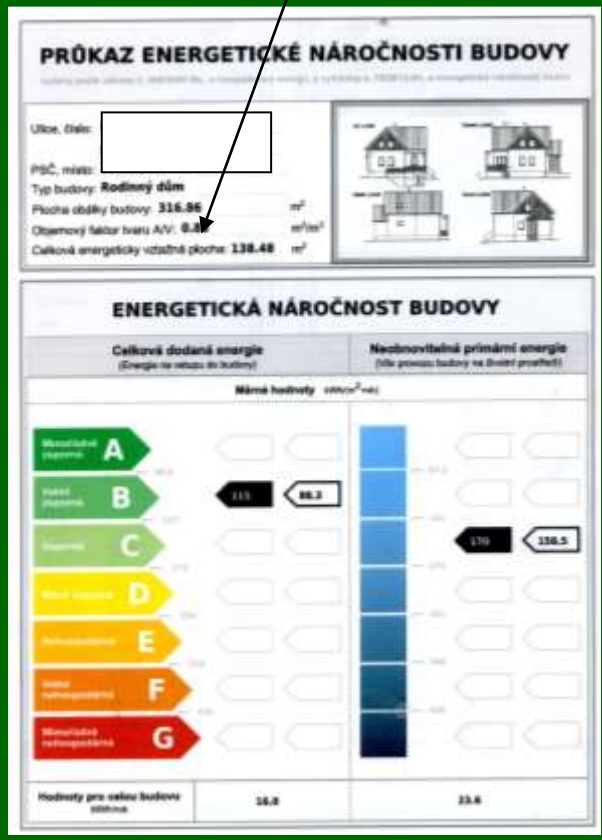
Energy for family house

Note: is similar to all other types of buildings

compactness: 0,2 to 1,2

ENERGY FOR:

- space heating
- hot water preparation
- lighting
- cooling
- air ventilation
- humidity management



Examples of U coefficients

Heat losses of the building depends on among other on its design and construction material used

U - Heat transfer coefficients: W/(m^2,K):

• lower is U value of given material, the more slowly heat is able to transmit through it (given material is better heat insulator)

Examples:

• concrete 20 cm: 3.3

• brick 30 cm: 1.7

• polystyrene: 0.12

Windows:

Old windows: up to 2.7

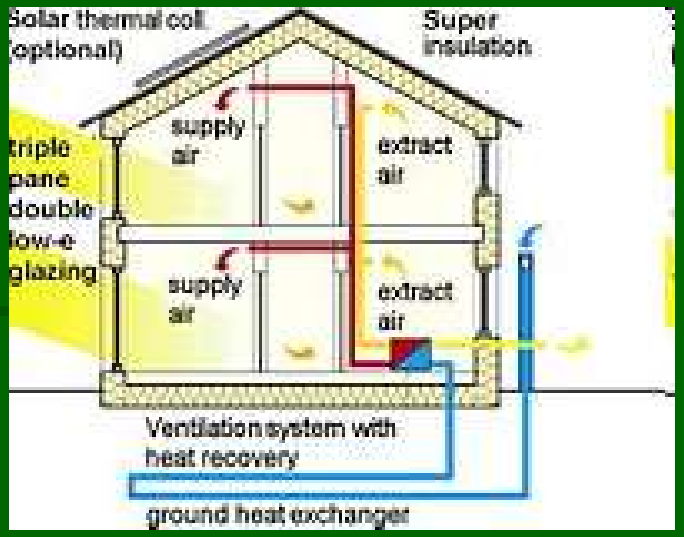
Double insulated glazing 24 mm with argon filling: 1.1

Triple insulated glazing 36 mm with argon filling: 0.7

Energy demand for heating

Total energy losses of the building: sum of individual contributions (walls, windows, roof, etc.)

Total value expressed in kW (depends also on size of building) for given reference temperature



Classification of the building

- low energy house: 15-50 kWh/m2,a
- passive house: less than 15 kWh/m^2,a

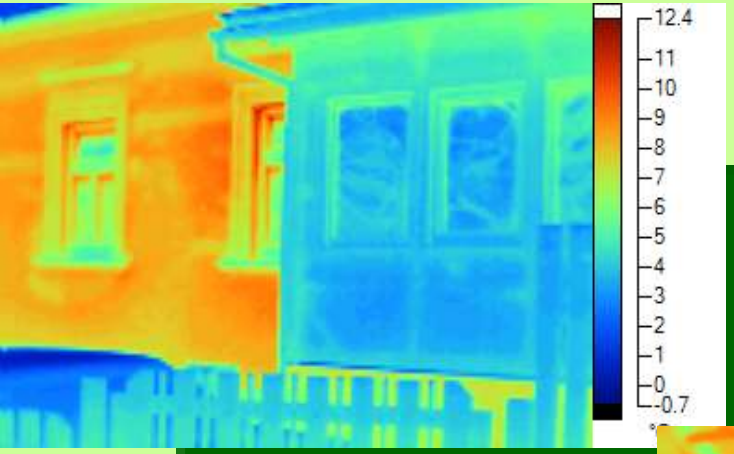
and total consumption of energies in the building

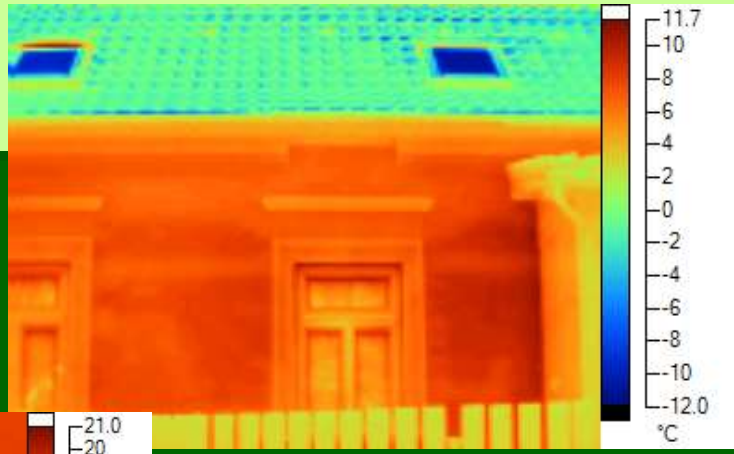
Incl. home appliances less than 120 kWh/m^{2}a

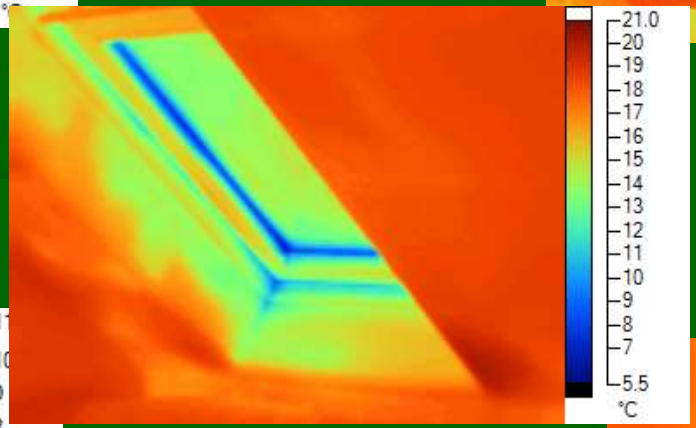
- older houses (e.g. from 70ies): >200 kWh/m^2,a
- current standard houses: 80-120 kWh/m^2,a

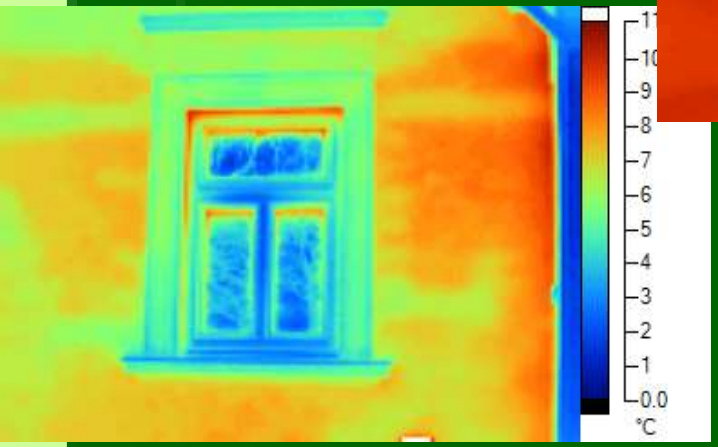
(we can calculate total heat demand in GJ using physical equivalent)

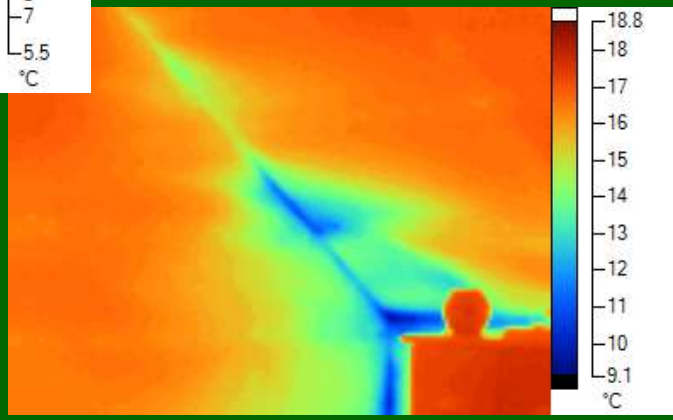
Energy demand for heating











Energy for heating

Heating degree days – HDD

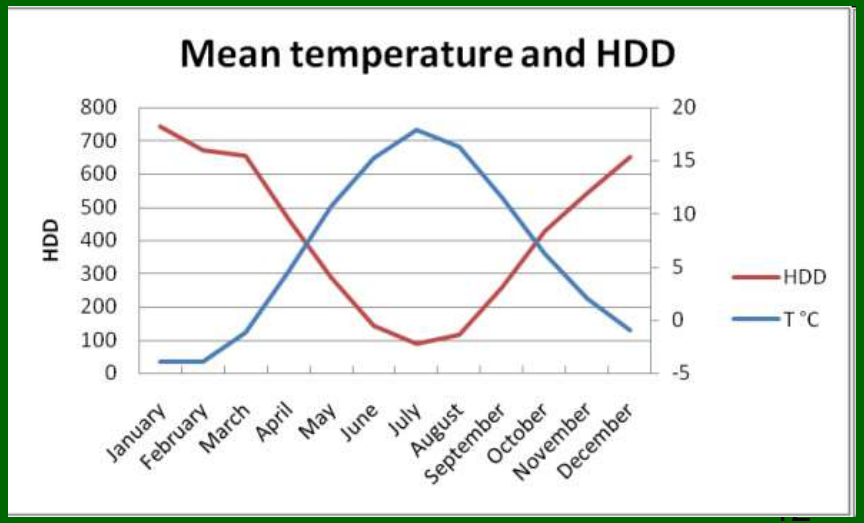
• heat demand also depends on inside (e.g. 18 C) and outside temperature, HDD is used as a proxy / heating requirements for a given building at a specific location are considered to be directly proportional to the number of HDD at that location

Simplified calculation of HDD: as (18 °C - Tmean) if Tmean is lower than 18 °C (heating threshold, may be different) and zero if Tmean is greater than or equal 18 °C; Tmean is the mean daily outdoor temperature, calculated as Tmean = (Tmin + Tmax / 2)

individual for each country and

region (calculation e.g.

at http://www.degreedays.net/)

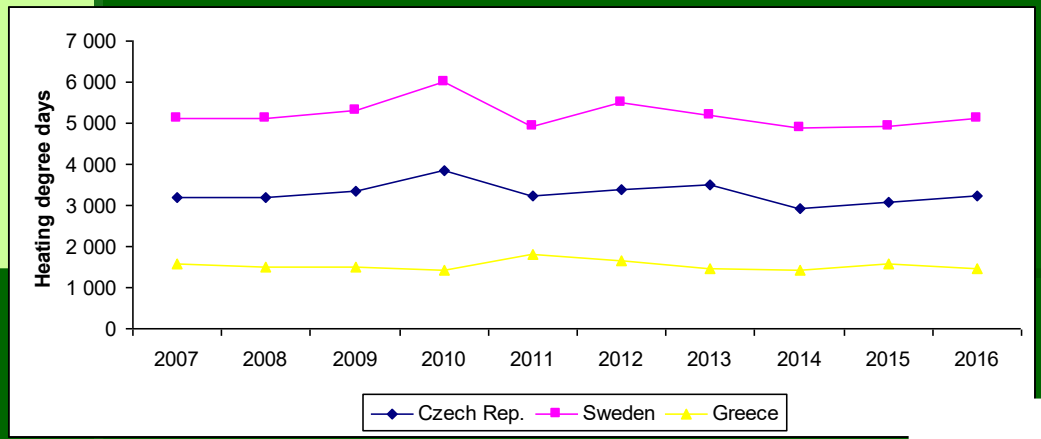


Energy for heating 2

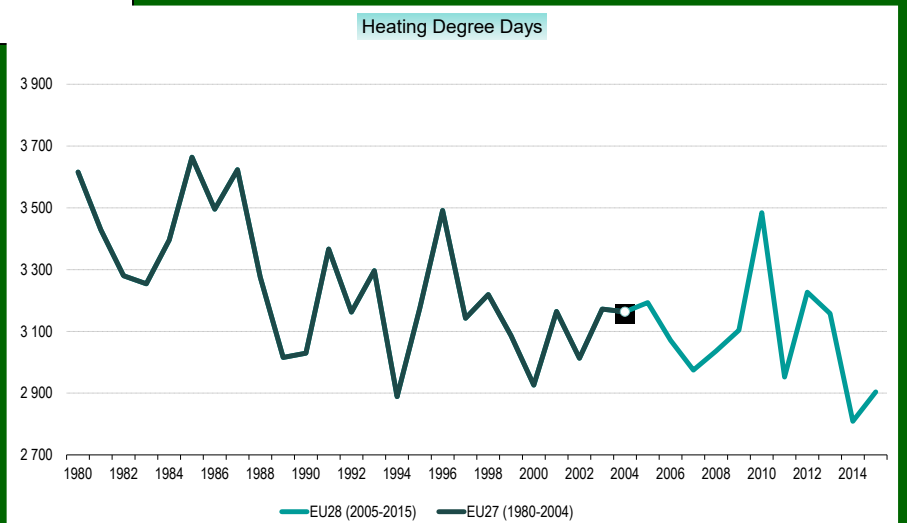
Heating degree days – HDD

Example for three different climate regions and EU

(see http://ec.europa.eu/eurostat/data/database?node_code=nrg_chdd_a)



See also http://www.degreedays.net/introduction



Energy for hot water preparation

Typically between 20-25% of total energy consumption of household

- depends of behavior, number of persons, etc.
- hot water: 55 C
- hot water preparation:
  - individual system: accumulation boiler or water flow heaters (gas or electricity
  - system for heating and hot water preparation

Heating a house

Heating from District heating system:

- central source of heat
  - heating plant
  - cogeneration plant (back pressure turbine, condensing turbine)
  - hot water or steam pipelines
- advantages:
  - higher utilization of primary energy and lower CO^2 emissions
  - lower conventional emissions (e.g. desulphurization units)
  - easy to use at consumption point
- disadvantages:
  - high investment cost and higher portion of fix cost – mortal spiral when energy savings are massively introduced at consumers side in existing DHS

Heating a house

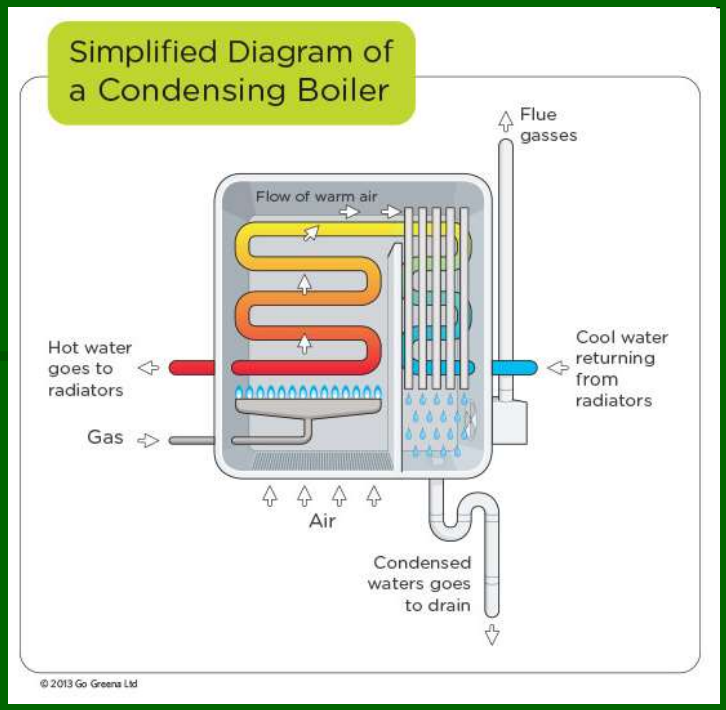
Central boiler for building (family house) – efficiency of typical heating devices

- natural gas
  - conventional: up to 90%, but old one can have only 65-75%
  - condensing: up to 105%

waste heat in flue gases to pre-heat cold water entering the boiler.

Lower temperatures of heating water

Outflow of condensate water



Heating a house

Central boiler for building (family house) – efficiency of typical heating devices

- coal boiler
  - conventional (old): 66% (sometimes misused for waste burning)
  - modern: regulation of efficiency: 73%, since 2018: 82% (automatic delivery of cola into boiler)
- pellets boiler: 92% (also advantage in very low amount of ash)
- electric boiler
  - with or without accumulation
  - accumulation can cover energy requirement when boilers is switched of in period of low tariff (if available)
- wood boiler: 75-85% (depends on class)
  - HV of wood depends of moisture content, dry wood needed

Heating a house

Heat pums

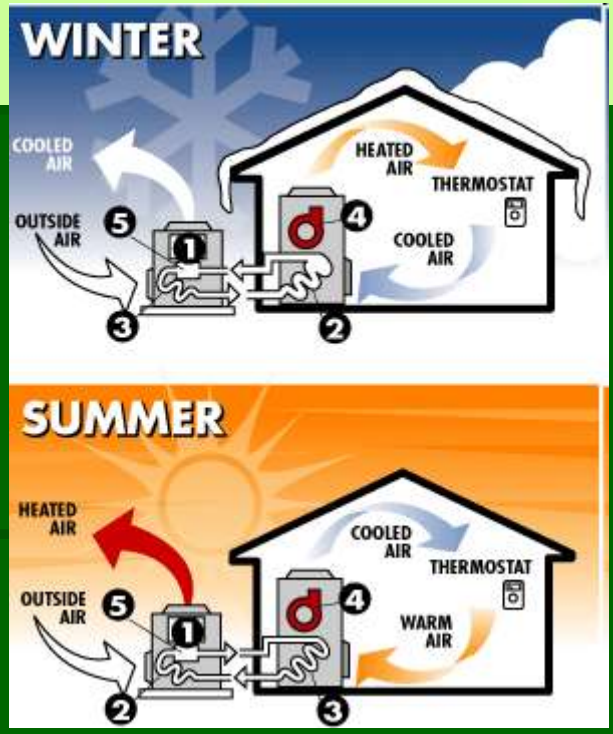
- air – water type
- water - water type
- ground – water type
- installed power in kWth to cover

majority of heating season

- collection of energy from outer space
- coefficient of performance
  - depends on type
  - depends on outer temperature

    and temperature of produced heat

    3 to 5



Solar energy for heating and hot water

Usually hybrid system

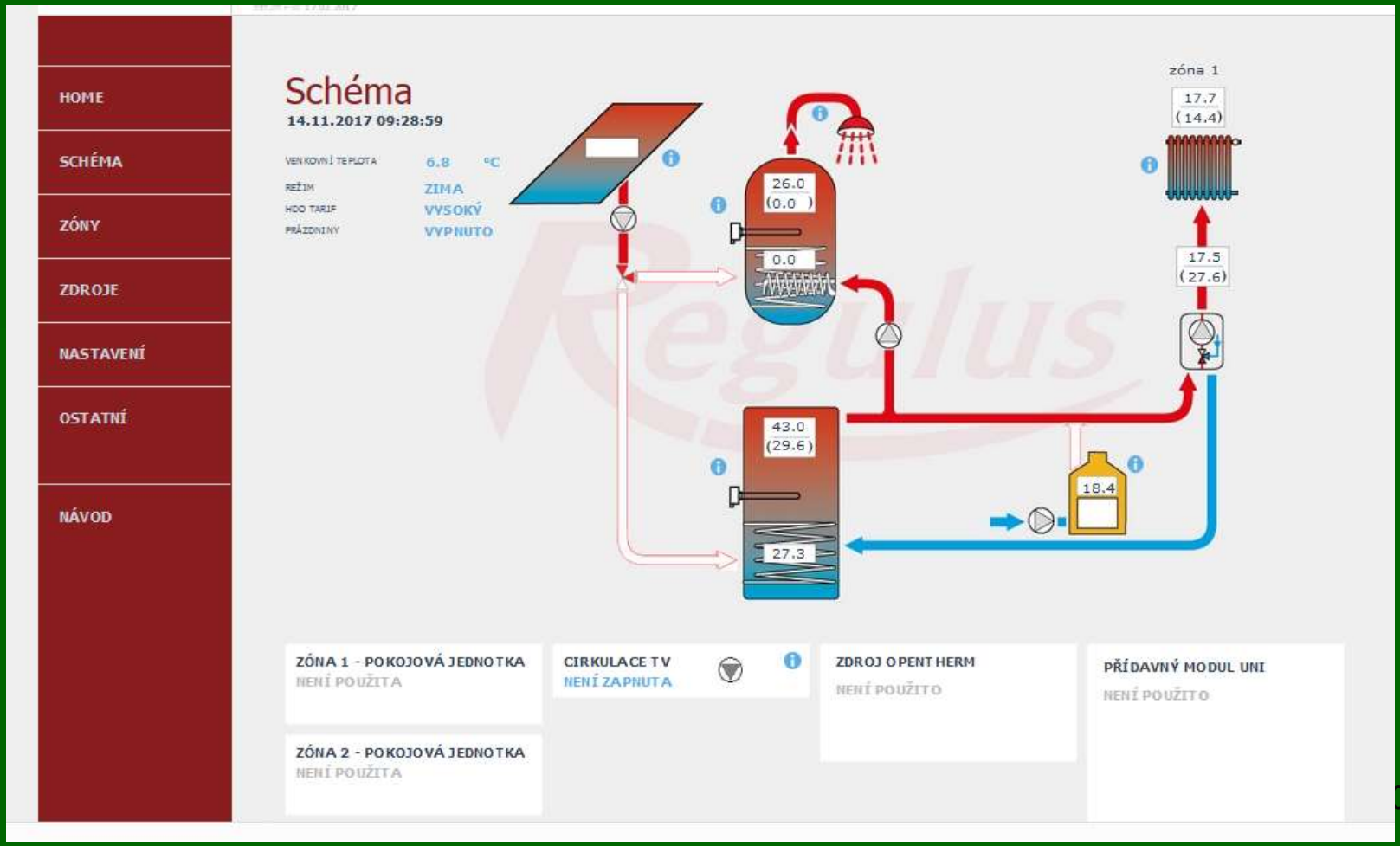
• design to cover all energy requirement of house would lead to extremely ineffective economic solutions

• PV for hot water has advantages in no effect to power grid

• solar thermal collector – effective way but troubles with heat consumption in summer period (e.g. to cool by pool or special design is needed)

Hybrid system for heating and hot water

Example of hybrid system combining biomass biomass stove with accumulation into water and electric heating



Thank you for attention