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Heat energy saving solutions for modernization of heating &hot water systems in apartment houses

DANFOSS UAB

Kęstutis Paulavičius

Kestutis.paulaviciusv@danfoss.com

Content

- Energy measurement
- Renovation of heating and hot water systems
- Heating systems new build
- Substations

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Energy measurement

Danfoss is a pioneer in ultrasonic metering technology

- District heating systems were established in major cities and towns. The infrastructure was largely based on Soviet-era technology.
- The sector faced issues with efficiency and reliability, requiring significant modernization.

First ultrasonic flow meter

1978

First transit time ultrasonic meter

1991

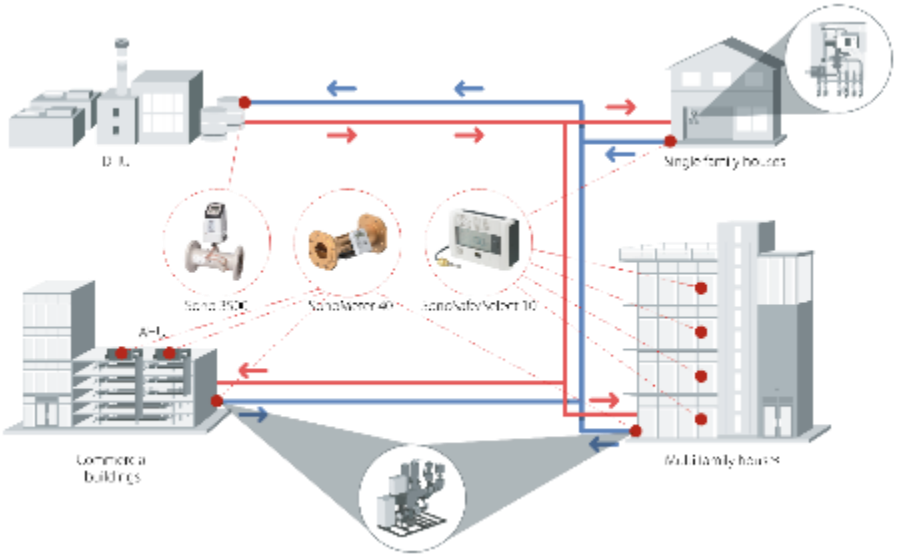
First meter configurable via App

2016

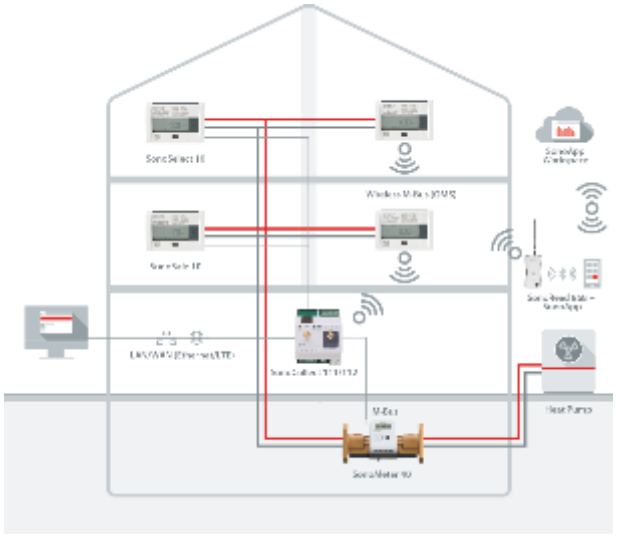
Energy metering applications

- Energy meters began to be installed in individual buildings to measure heat consumption accurately. This was part of the broader effort to modernize the district heating infrastructure.

District heating network



Multi-Family Building



The Measuring Instruments Directive (MID)

- EN1434 defines 3 accuracy classes refering to MID
- MID: MPE (maximum permissible error) applicable to complete thermal energy meters

Complete energy meter class 2

$$\boldsymbol{E = E_f + E_t + E_c}$$

E_f...*MPE flow sensor [%]*

E_t...*MPE temperature senor [%]*

E_c...*MPE energy calculator[%]*

Flow sensor class 2

$$E_f = \left(2 + 0{,}02\ \frac{q_p}{q_{ac}}\right), \textbf{ but no more than 5\%}$$

$q_p[m^3/s]$... ...*nominal flow*
$q_{ac}[m^3/s]$ ...*actual operating flow rate*

Temperature sensors class 2

$$E_t = \left(0{,}5 + 3\ \frac{\Delta\vartheta_{min}}{\Delta\vartheta}\right)$$, **where the error relates to the indicated value of the relationshop between temperature sensor pair output and temperature difference**

$\Delta\vartheta_{min}[K]$ ...*minimum temperature difference f or which the system is rated*

$\Delta\vartheta[K]$ ...*actual operating temperature difference*

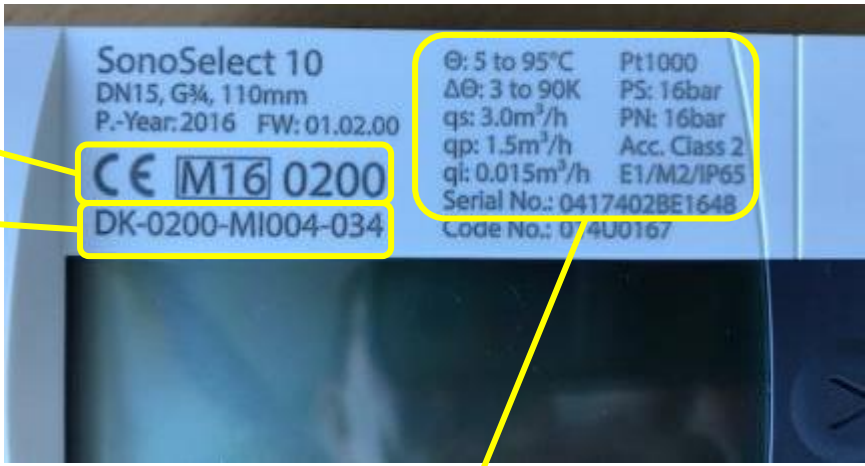
Energy calculator class 2

$$E_t = \left(0{,}5 + \frac{\Delta\vartheta_{min}}{\Delta\vartheta}\right)$$, **where the error relates to the value of the thermal energy indicated to the true value of thermal energy**

Approval and marking according to MID

Declaration of conformity
CE M[year] [code of notified body]

Type approval no.

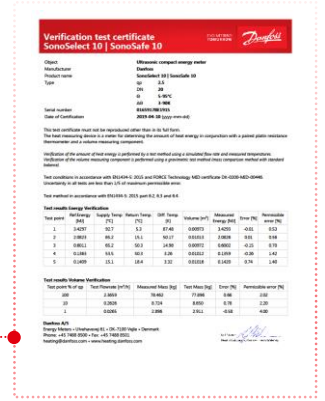


Metrologically required data about performance parameters and serial no.

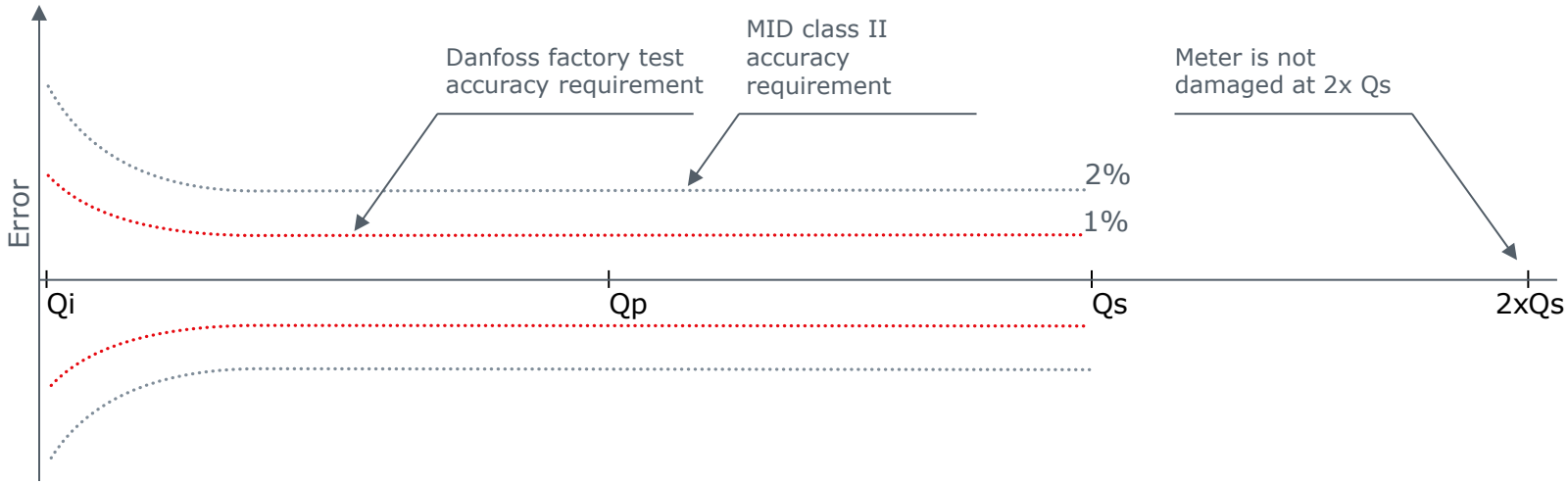
exception cooling meters:
A national approval or notification is necessary in DE, AT, CH, DK

High accuracy over product lifetime

- Each Danfoss Energy meter is designed and tested to fulfill and exceed MID class II requirements.
- Our products sustain 3x required durability tests as required by MID EN 1434-4 (12.000 cycles representing 15 years of operations).

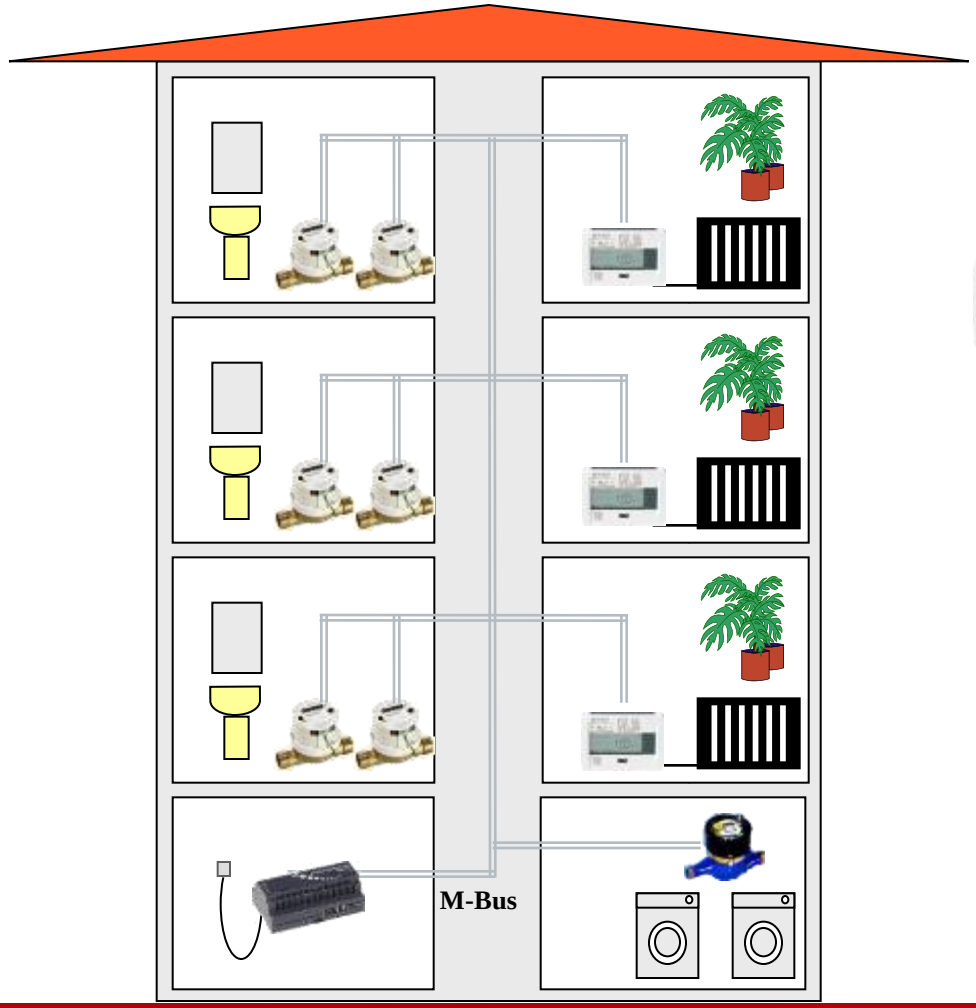

Verification test certificate
SonoSelect 10 | SonoSafe 10

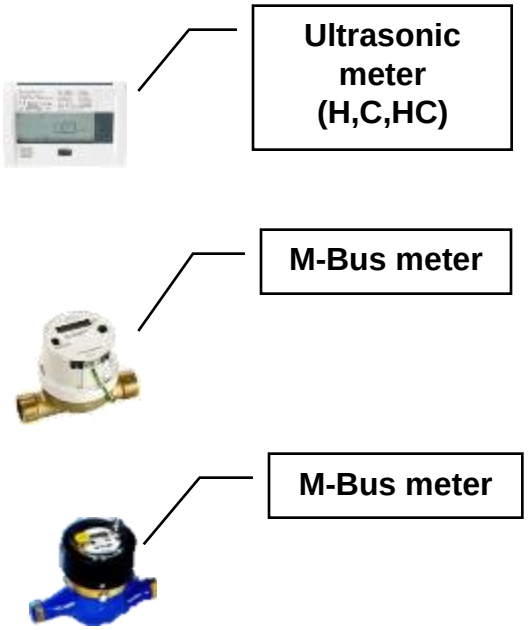
Verification test certificate for every meter



Consumption monitoring

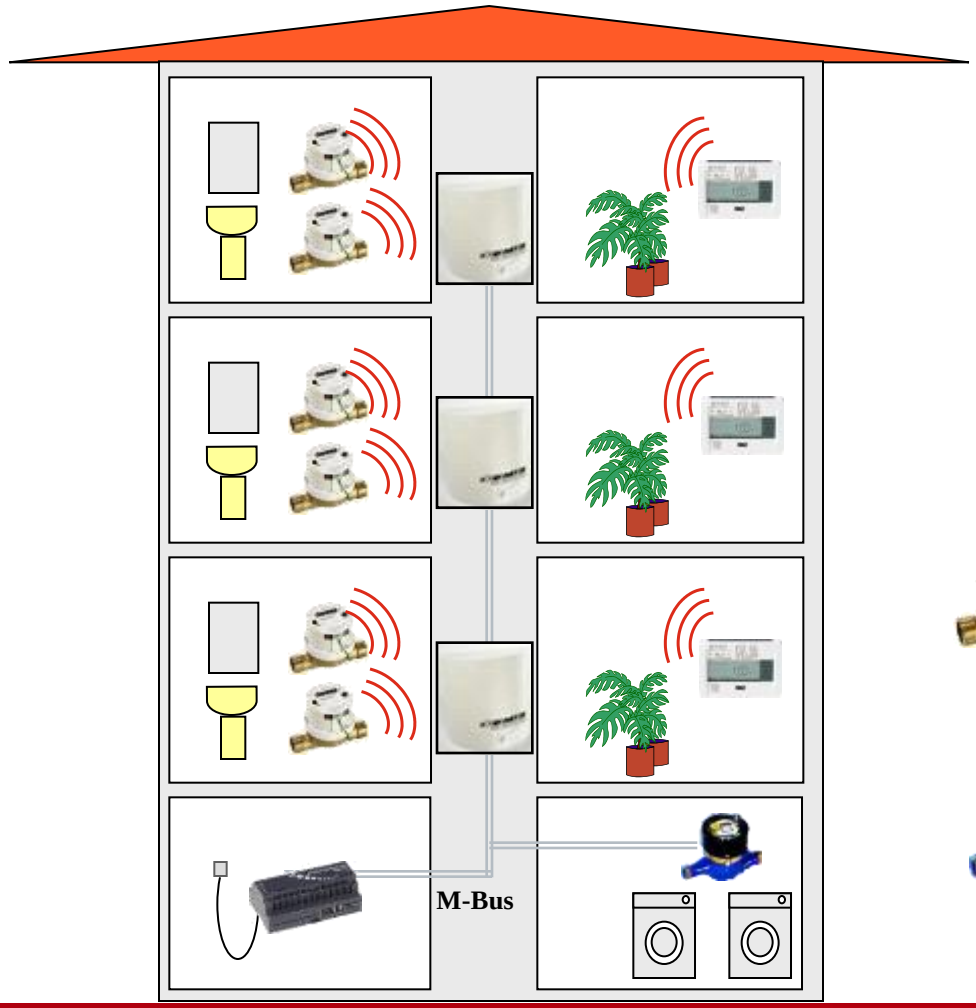
- Wired M-Bus network. Cable work is needed

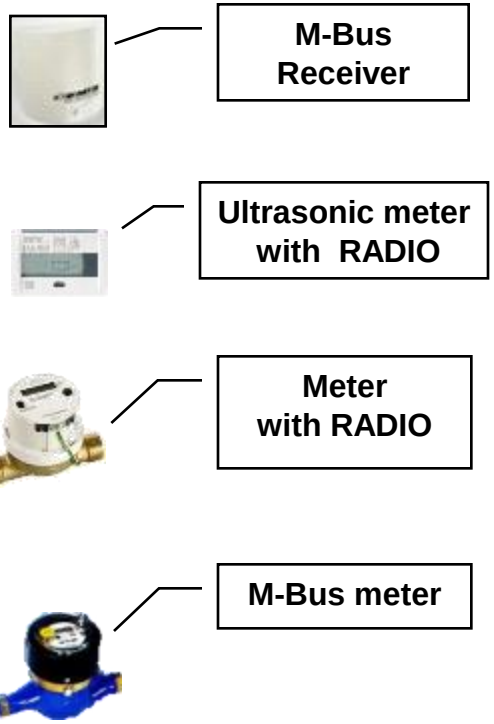




Consumption monitoring

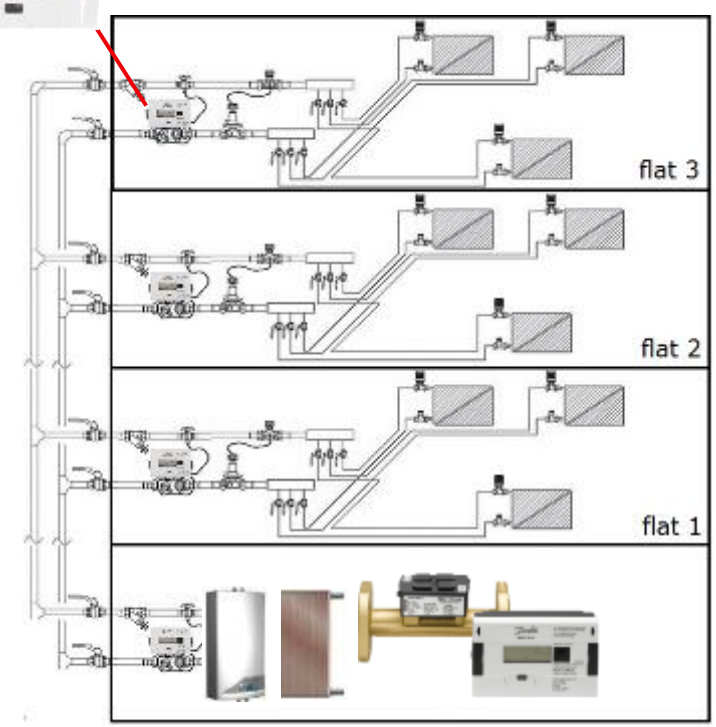
- Wireless M-Bus network. M-Bus receivers are needed



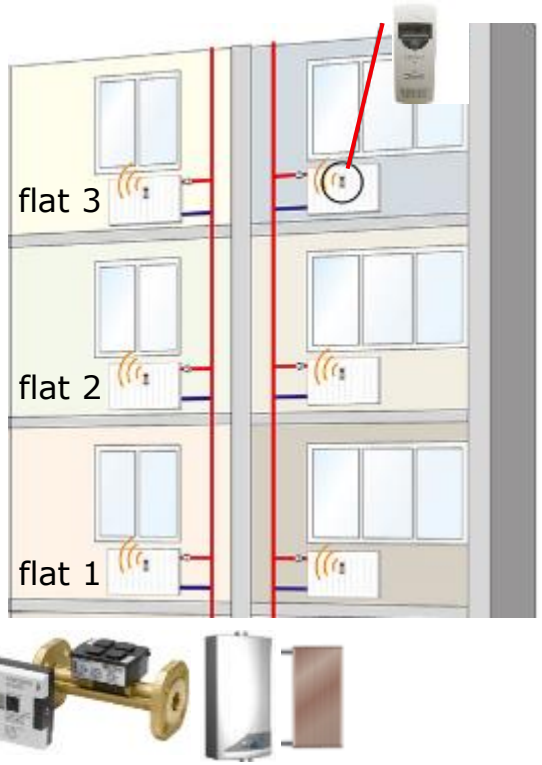


Horizontal vs vertical heating system

- Thermal energy meters

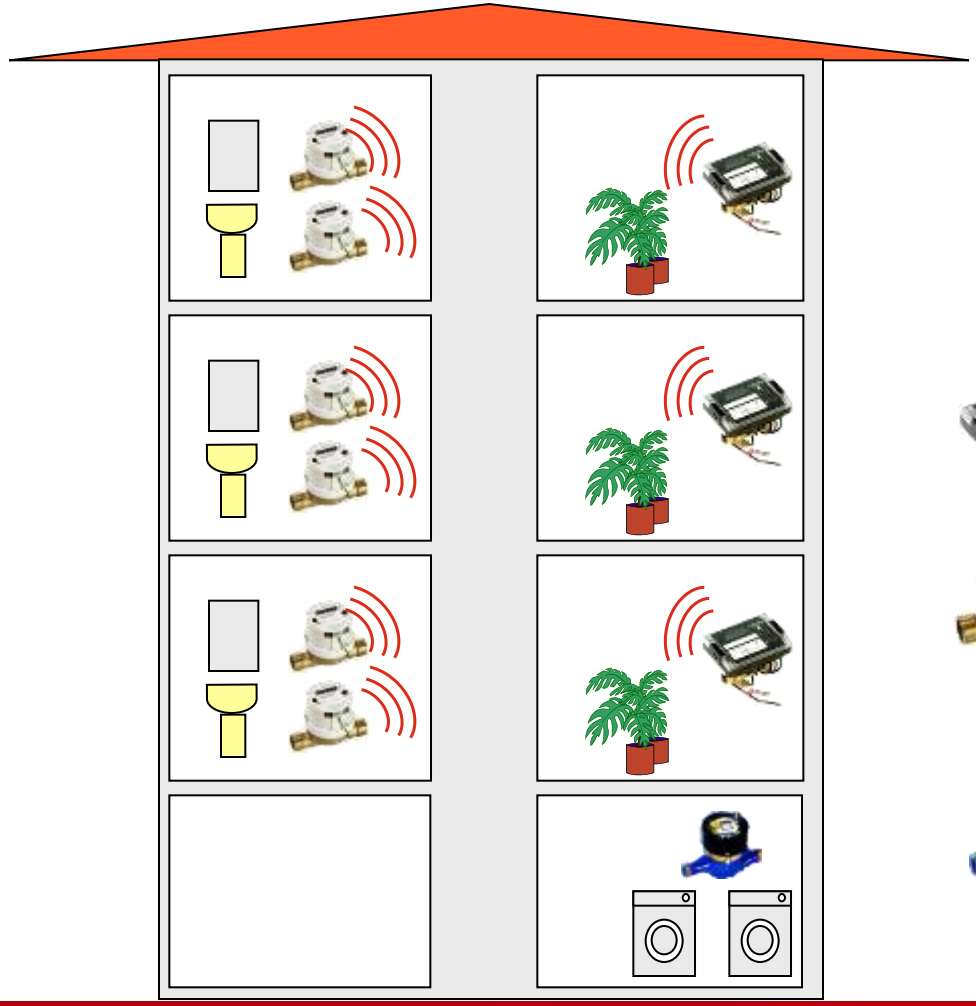


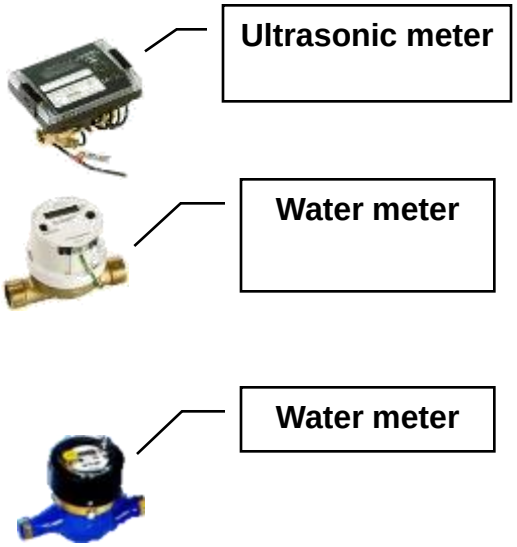
- Heat cost allocators. Mainly renovation.



Consumption monitoring

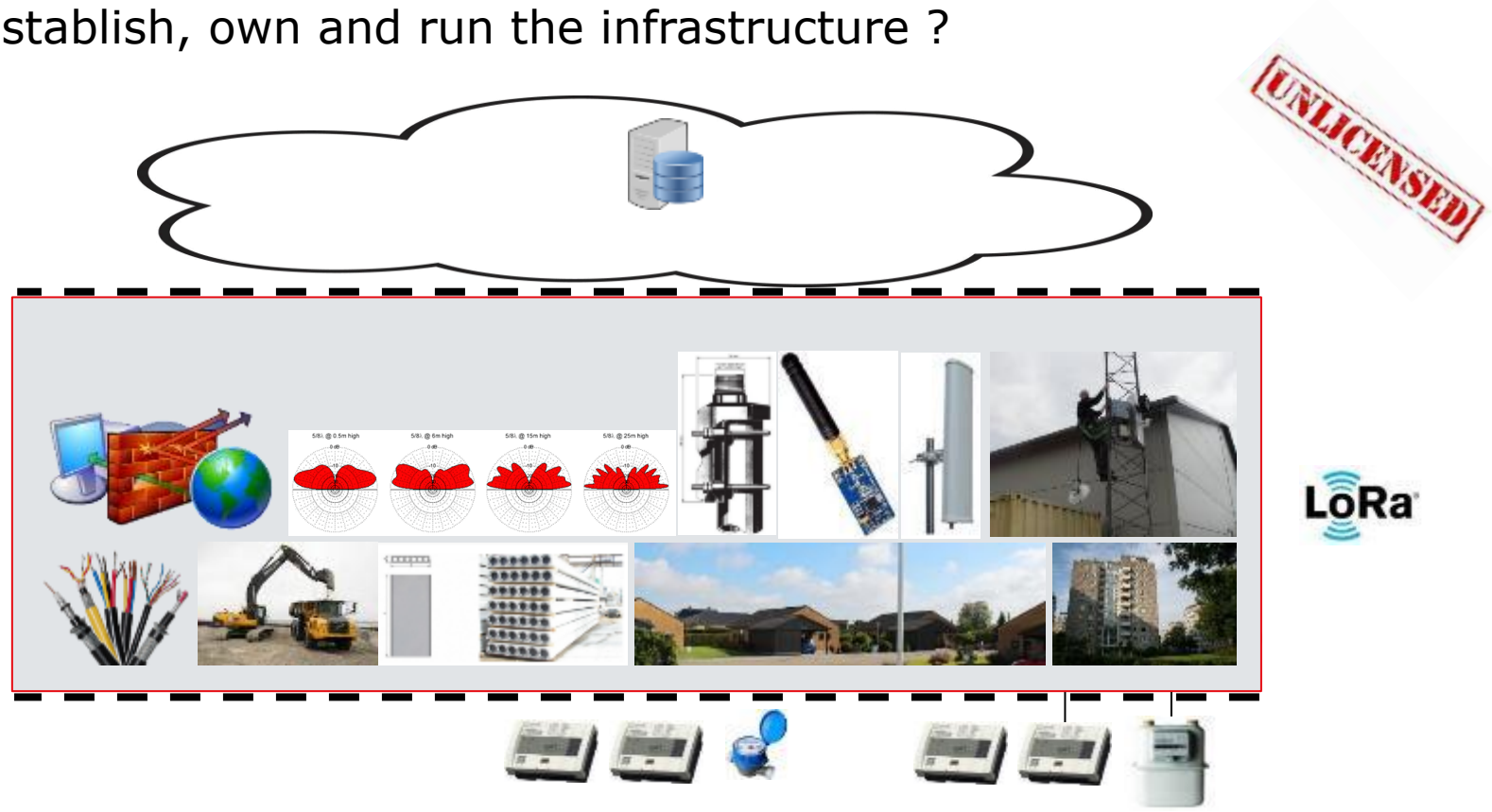
- LoRa or NB-IoT network





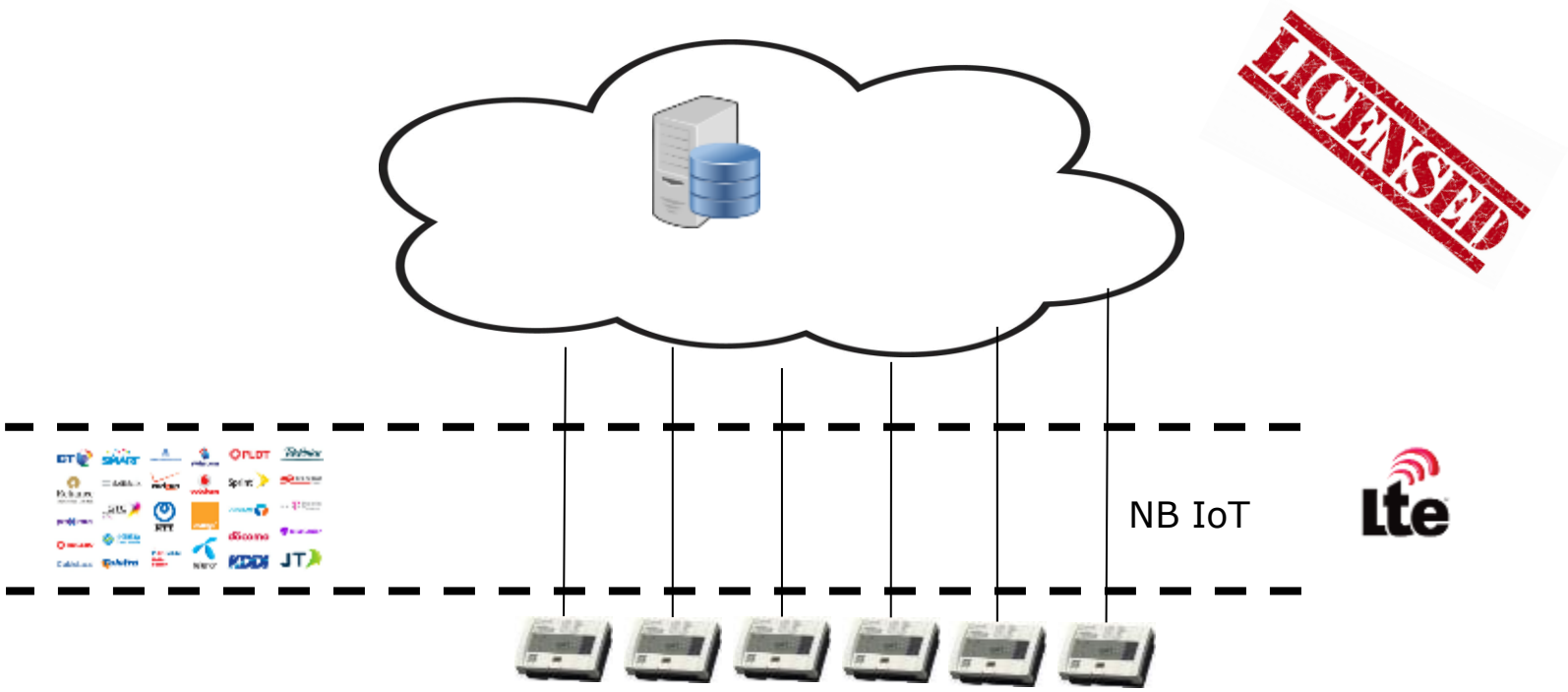
LoRa

- Who establish, own and run the infrastructure ?



NB-IoT

- No need for infrastructure, which is already there



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Renovation

European legislation

EED (Energy Efficiency Directive)

- Mandatory metering for end-user billing
- Meters must be remotely readable devices
- Read at least monthly since 1.1.2022
- Existing non remotely readable meters to be replaced by 1.1.2027
- Smart meter to be installed in every apartment

European legislation

EPBD (Energy Performance of Buildings Directive)

- Individual room control + dynamic balancing (Art. 8/14)
- Mandatory to install BACS (Building Automation and Control System) with continuous energy monitoring of technical building system in non-residential buildings by 2025 with output above 290kW (Art. 14/15)
- Regular inspections of residential buildings with output above 70kW OR install BACS with continuous energy monitoring of technical building system (Art. 14/15)
- Smart meters to be installed in heat pumps, chillers, AHUs...

Certifying the sustainability of buildings

BREEAM

- Building Research Establishment - sustainability of buildings
- Energy management brings points
- Outstanding rating for 85+ points
- UK origin

LEED

- Leadership in Energy and Environmental Design
- Building energy monitoring is mandatory
- Advanced energy management needed for highest ratings
- Platinum rating for 80+ points
- US origin

Y	?	N			
0	0	0	**Energy and Atmosphere**		**33**
Y			Prereq	Fundamental Commissioning and Verification	Required
Y			Prereq	Minimum Energy Performance	Required
Y			Prereq	Building-Level Energy Metering	Required
Y			Prereq	Fundamental Refrigerant Management	Required
			Credit	Enhanced Commissioning	6
			Credit	Optimize Energy Performance	18
			Credit	Advanced Energy Metering	1
			Credit	Demand Response	2
			Credit	Renewable Energy Production	3
			Credit	Enhanced Refrigerant Management	1
			Credit	Green Power and Carbon Offsets	2

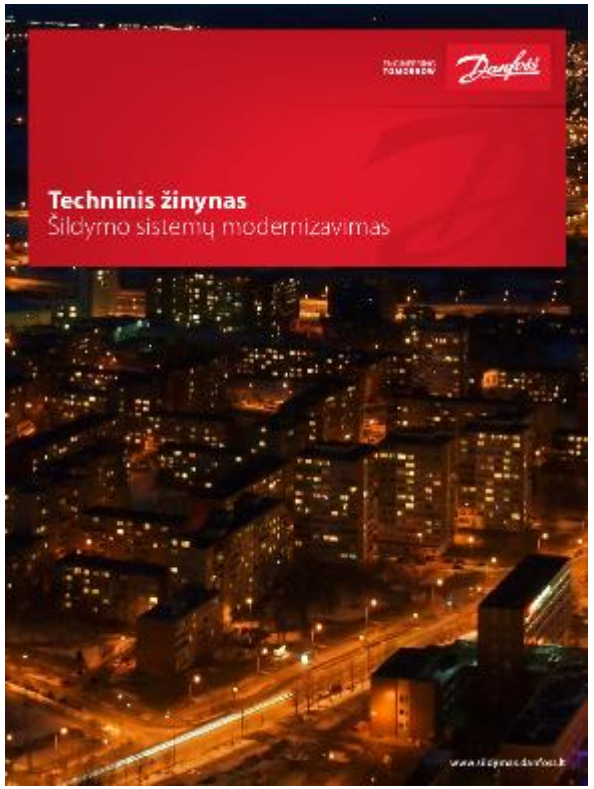
Renovation

Projects

- Projects and savings were illustrated.

Technical manual

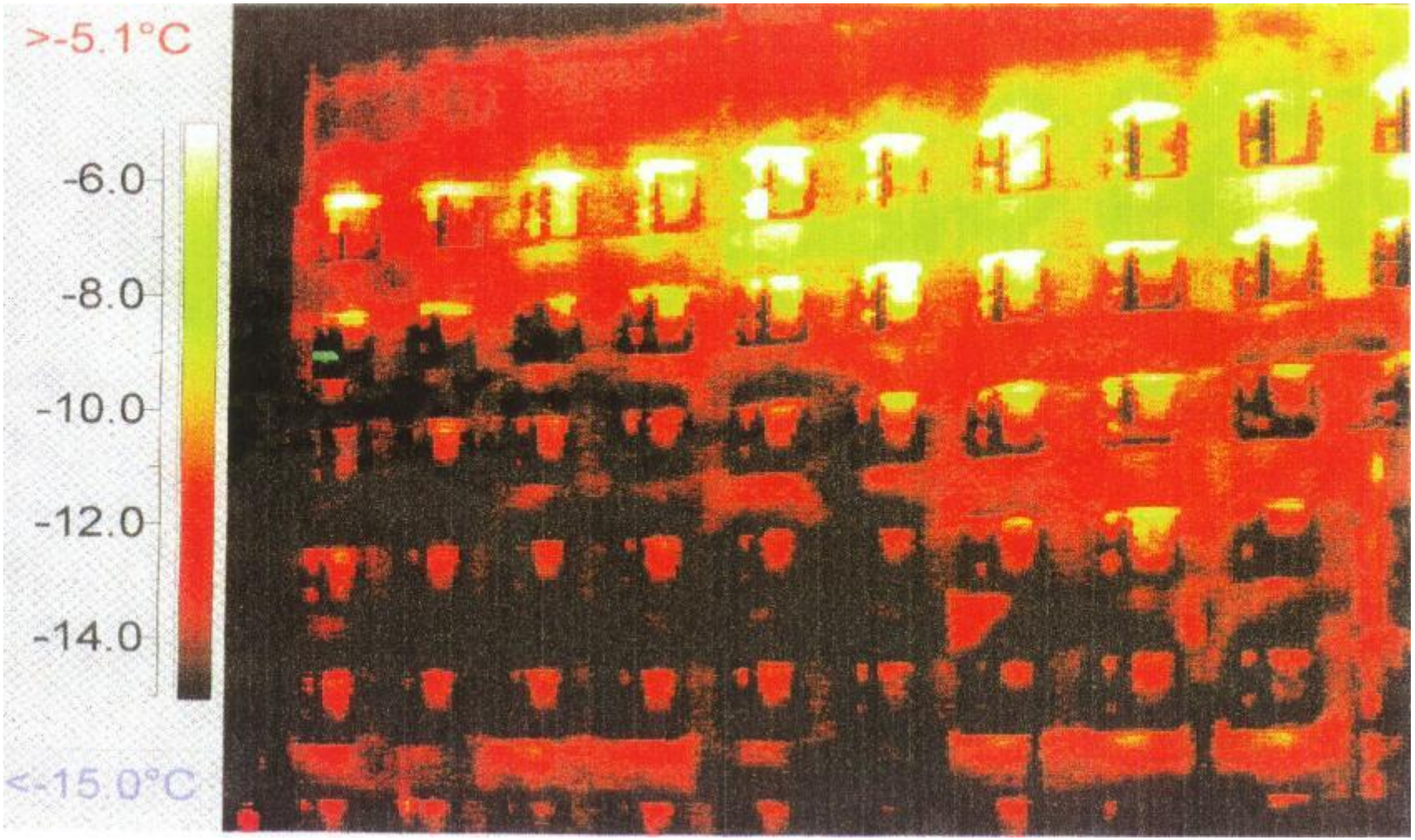
- There focus was on how to do.



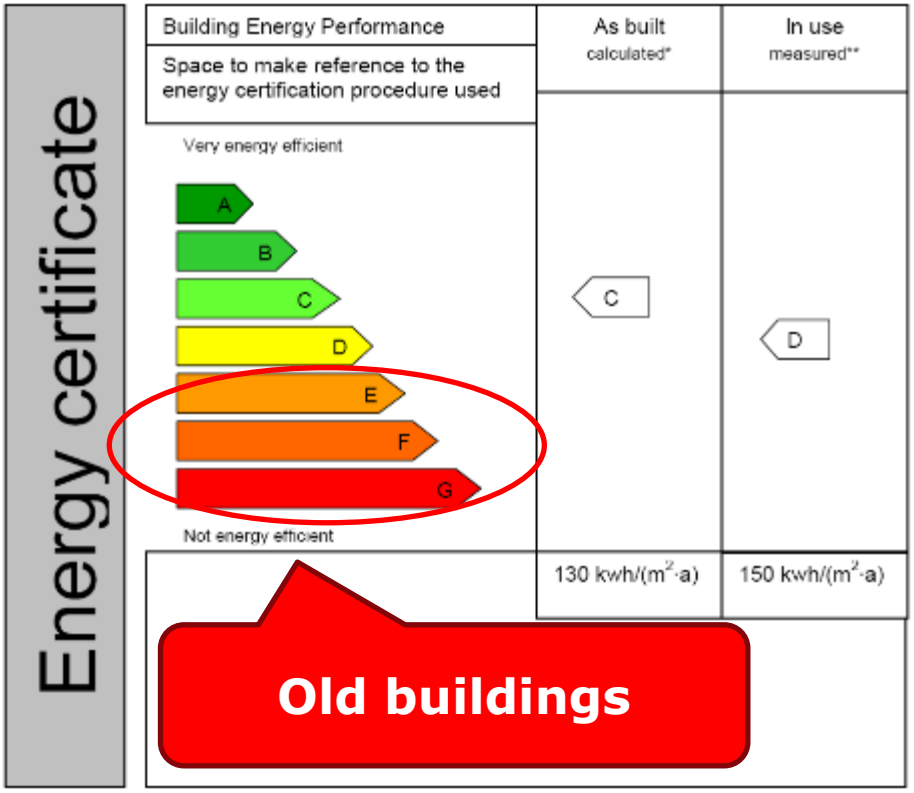
Outcome of projects

	One pipe	Two pipe. Vertical	Two pipe. Horizontal	Flat station
Investment	~10 EUR/m^2	~23 - 35 EUR/m^2	~35 - 40m^2	2900 - 4400 m^2
Return on investment	2 – 4 years	5 – 8 years	7 – 10 years	10 – 12 years
Efficiency	Up to 20%	Up to 20%	Up to 20%	Up to 20%
Installation per room	1 – 3 h	3 – 8 h	3 – 8 h	8 – 20 h
Hot Water make up	No	No	No	Yes
Heat cost allocators	Yes	Yes	Yes	Yes (not relevant)
Energy meter	No	No	Yes	Yes

Thermograph of typical old construction living house



Improved energy performance



Указания по определению класса энергоэффективности здания и форме его представления (тепловая оболочка + системы отопления, охлаждения, вентиляции, кондиционирования, затенения, освещения, гвс)

АВТОМАТИЗАЦИЯ СИСТЕМ ОТОПЛЕНИЯ

B

C

РАДИАТОРНЫЕ ТЕРМО-РЕГУЛЯТОРЫ

АВТОМАТИЧЕСКИЕ БАЛАНСИРОВОЧНЫЕ КЛАПАНЫ СТОЯКОВ

ТЕПЛО-ПУНКТЫ

D

E

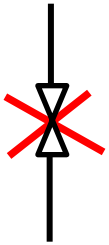
F

G

ШАРОВЫЕ КРАНЫ, ПРОБКОВЫЕ КРАНЫ, НЕРЕГУЛИРОВАННЫЕ

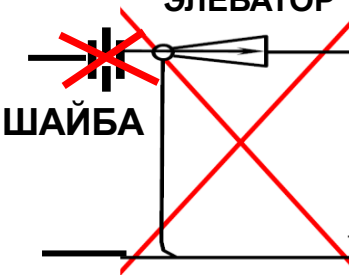
ШАЙБА

РУЧНОЙ ВЕНТИЛЬ



ЭЛЕВАТОР

ШАЙБА

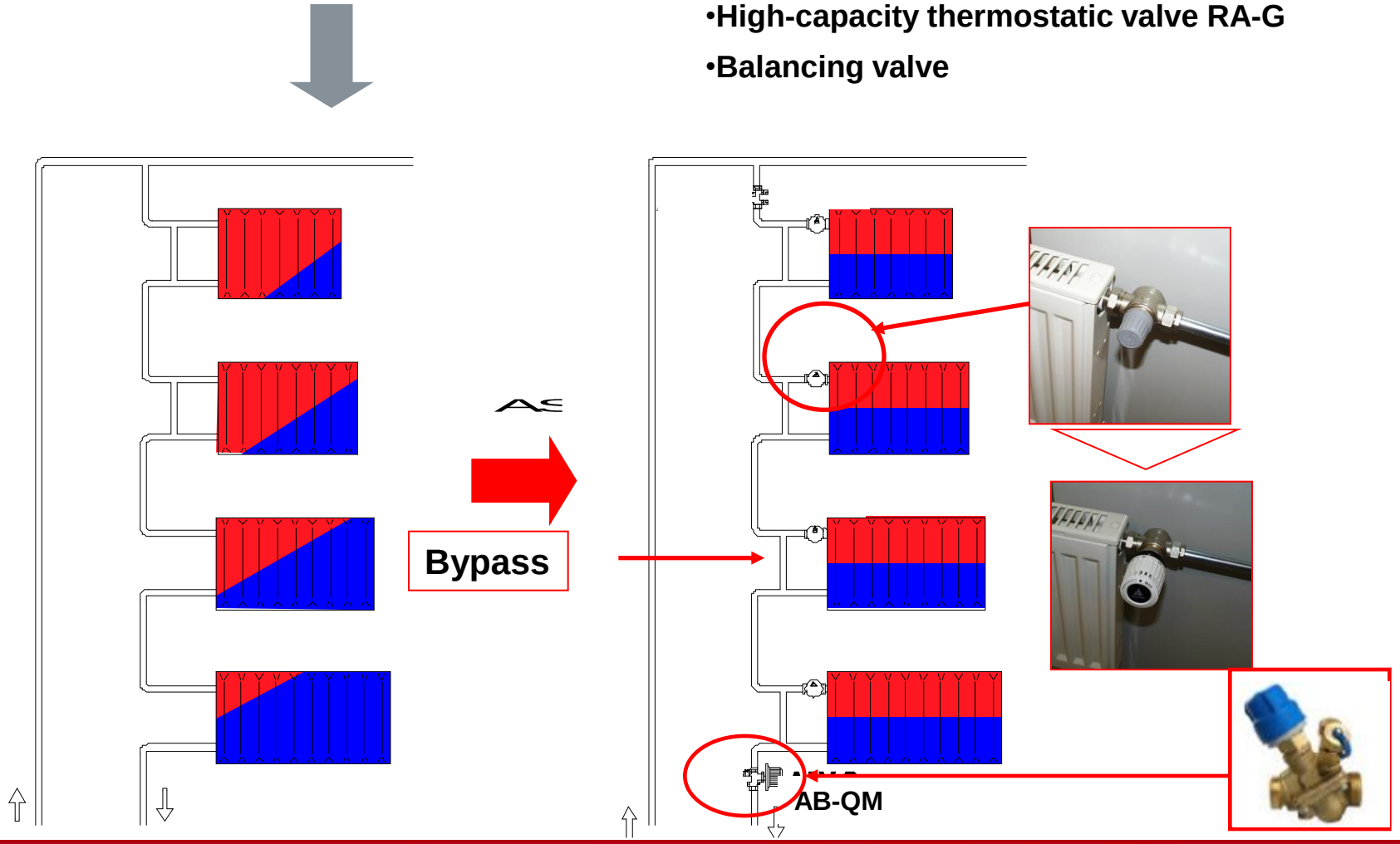


One pipe system

Before

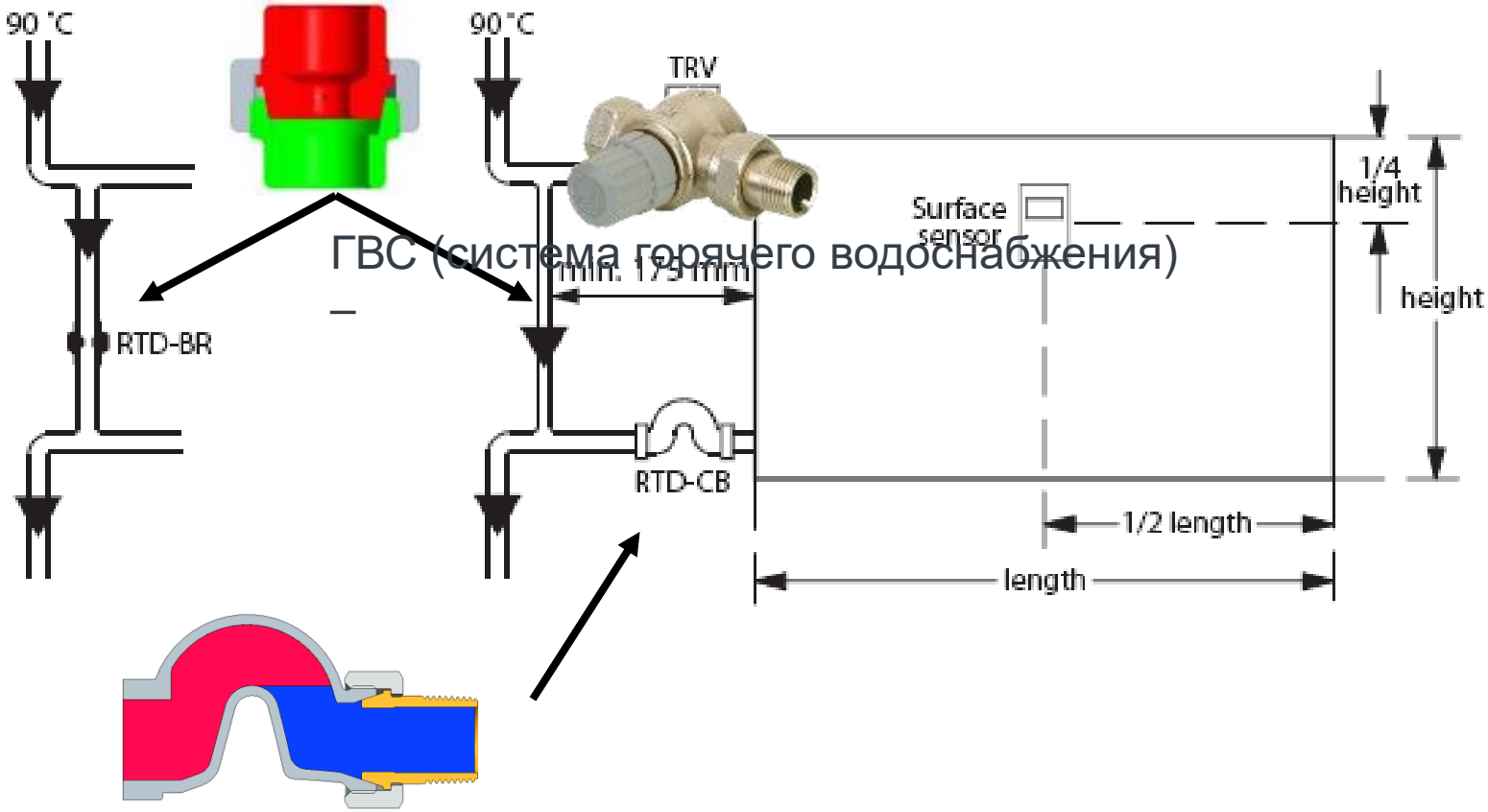
After

- Bypass
- High-capacity thermostatic valve RA-G
- Balancing valve



Radiator valve installation

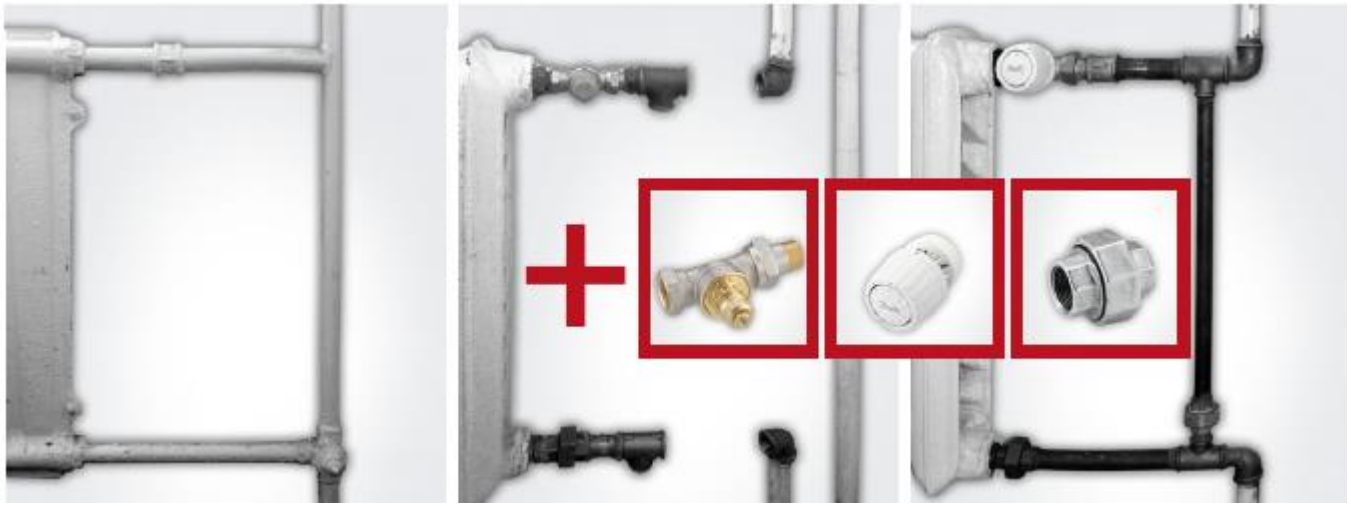
- RTD-BR – bypass flow restrictor.
- RTD-CB – backflow preventer for high supply temperature systems.



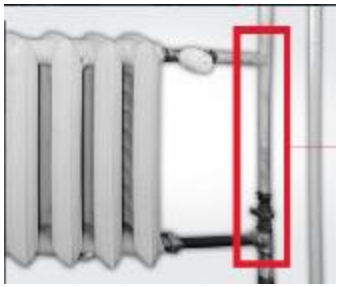
ГВС (система горячего водоснабжения)

Radiator valve installation

- We explained installation step by step.

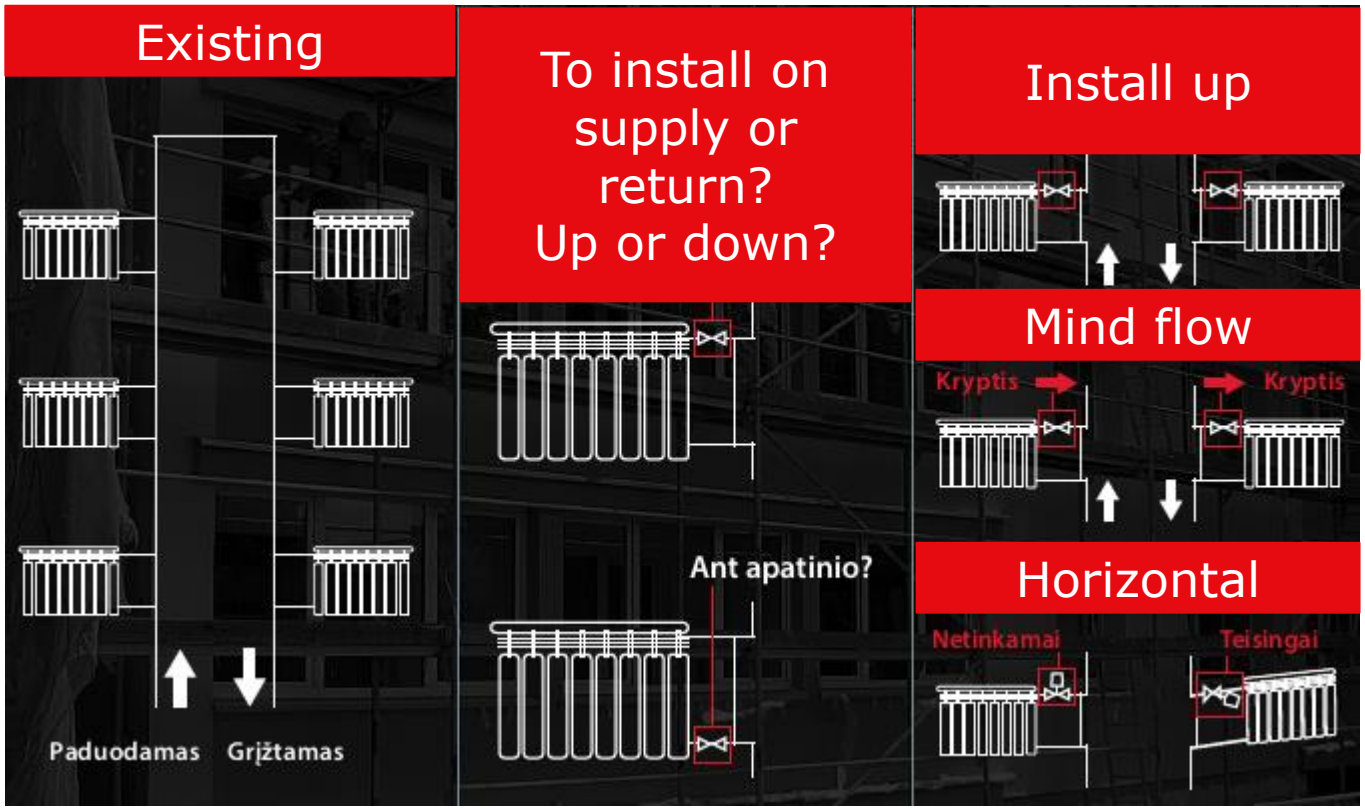


- Highlighted errors

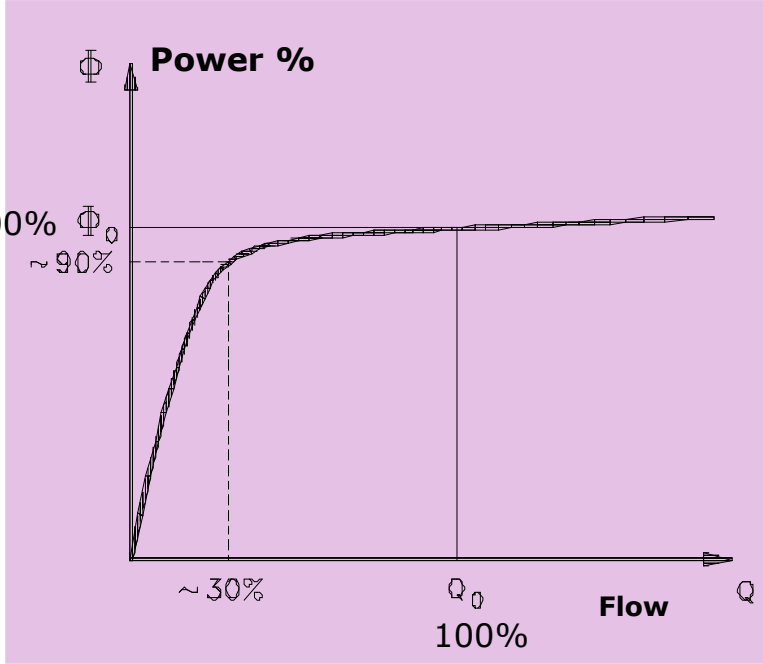


Radiator valve installation

- Explained complicated scenarios

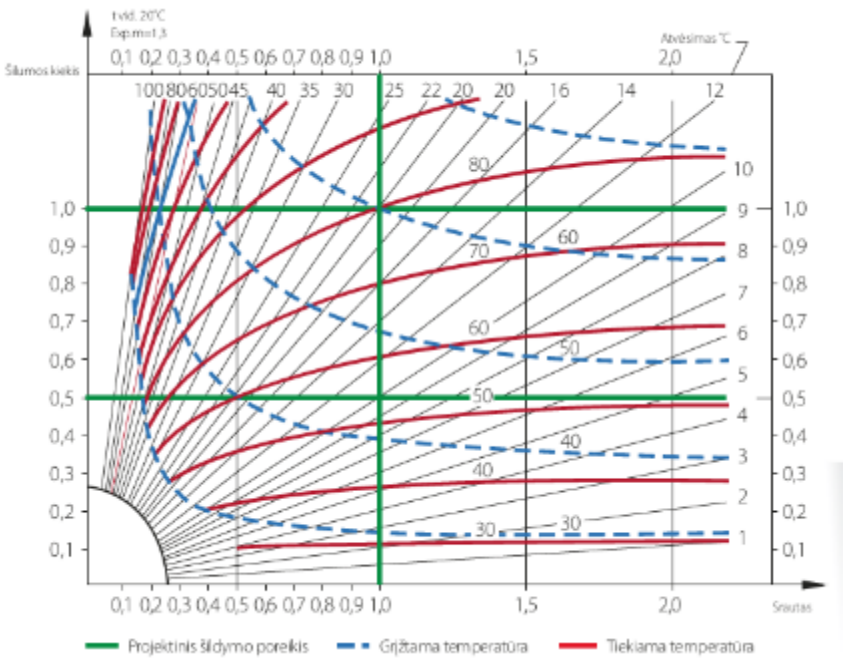


Radiator valve installation



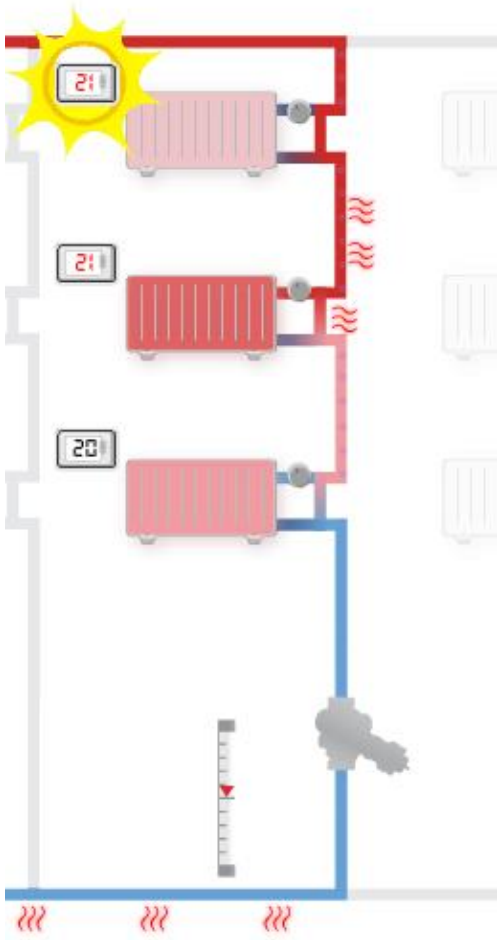
- Special high flow capacity radiator thermostatic valve to be installed
- Bypass should be installed of size smaller than main riser pipe size or flow restrictor should be installed.
- Flow to radiator decrease result in radiator emission decrease.
- Phenomena compensated by slight temperature increase.

Supply, return temperatures



- There is a need to adjust temperature schedule after building is renovated, considering increased insulation of construction and reduced demand for energy.

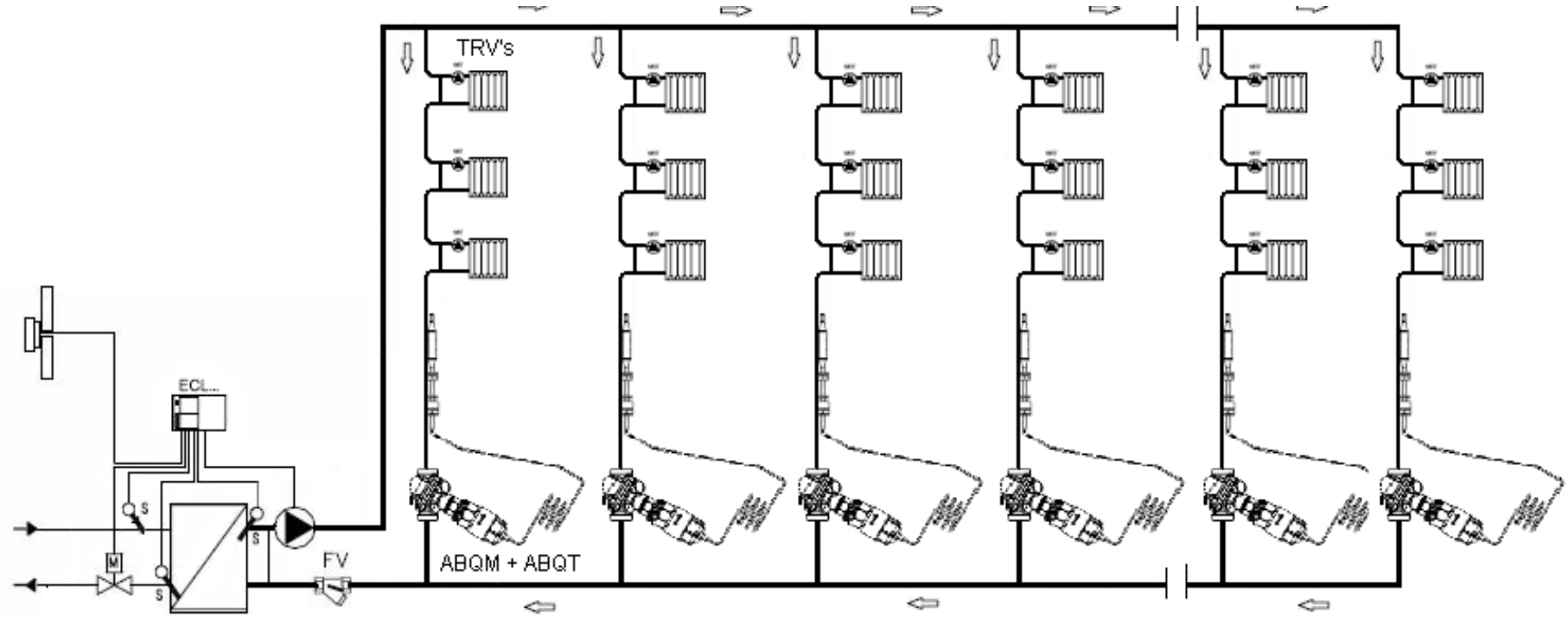
Riser heating



- When TRV is closed because of room temperature rise, water flows through a by-pass instead through a radiator.
- So, the water is not subject to cooling – which leads to a rise of return temperature!
- Balancing valve can be equipped with thermostat or electronic control system.

One-pipe renovation+ solution portfolio

Application 1 Return temperature control : self action (ABQM + ABQT)



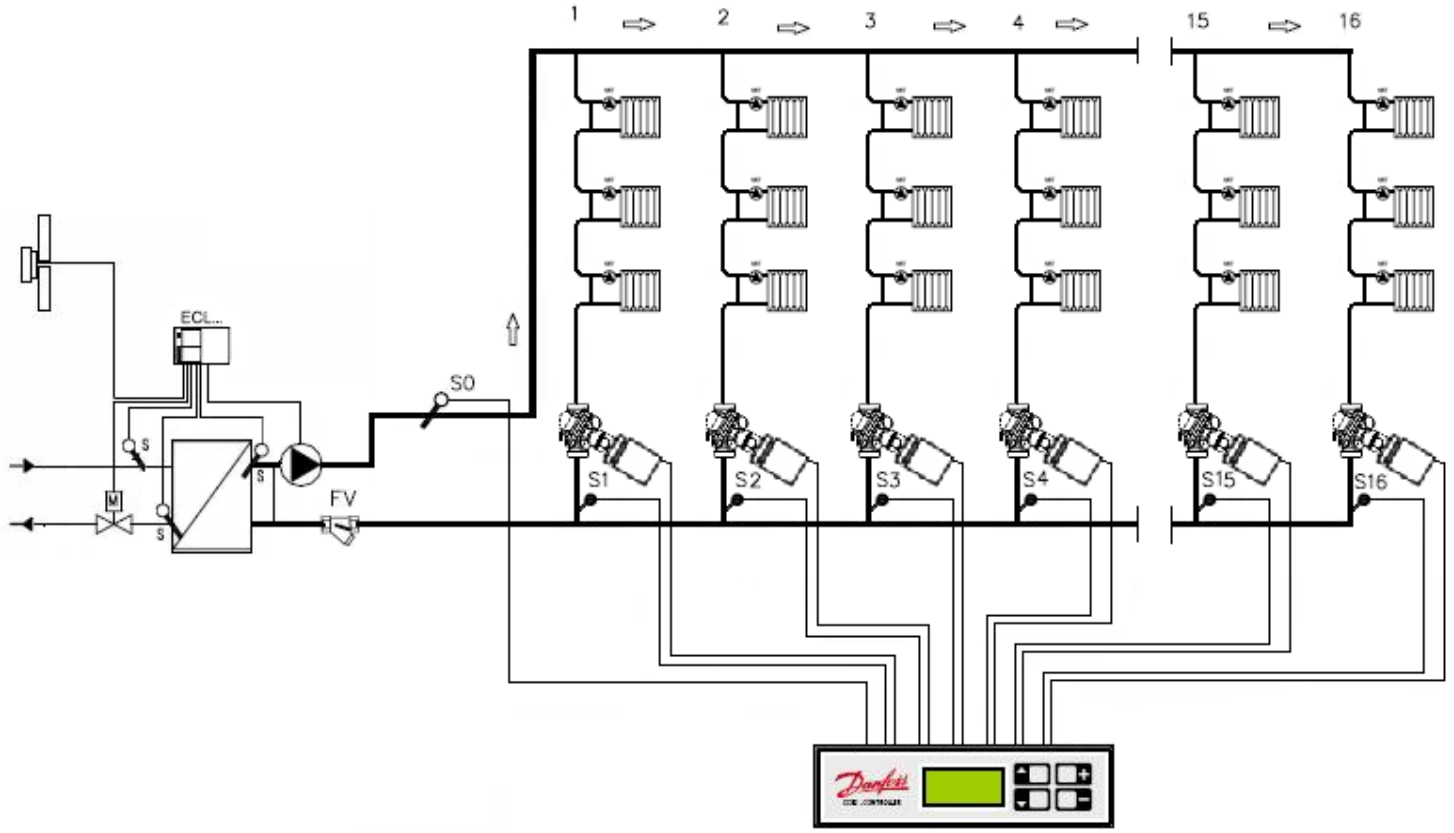
AB-QT makes 1-pipe system adaptive to actual heat demand – flow varied like in 2-pipe system !

Innovative solution

Application 2

Return temperature control : electronic

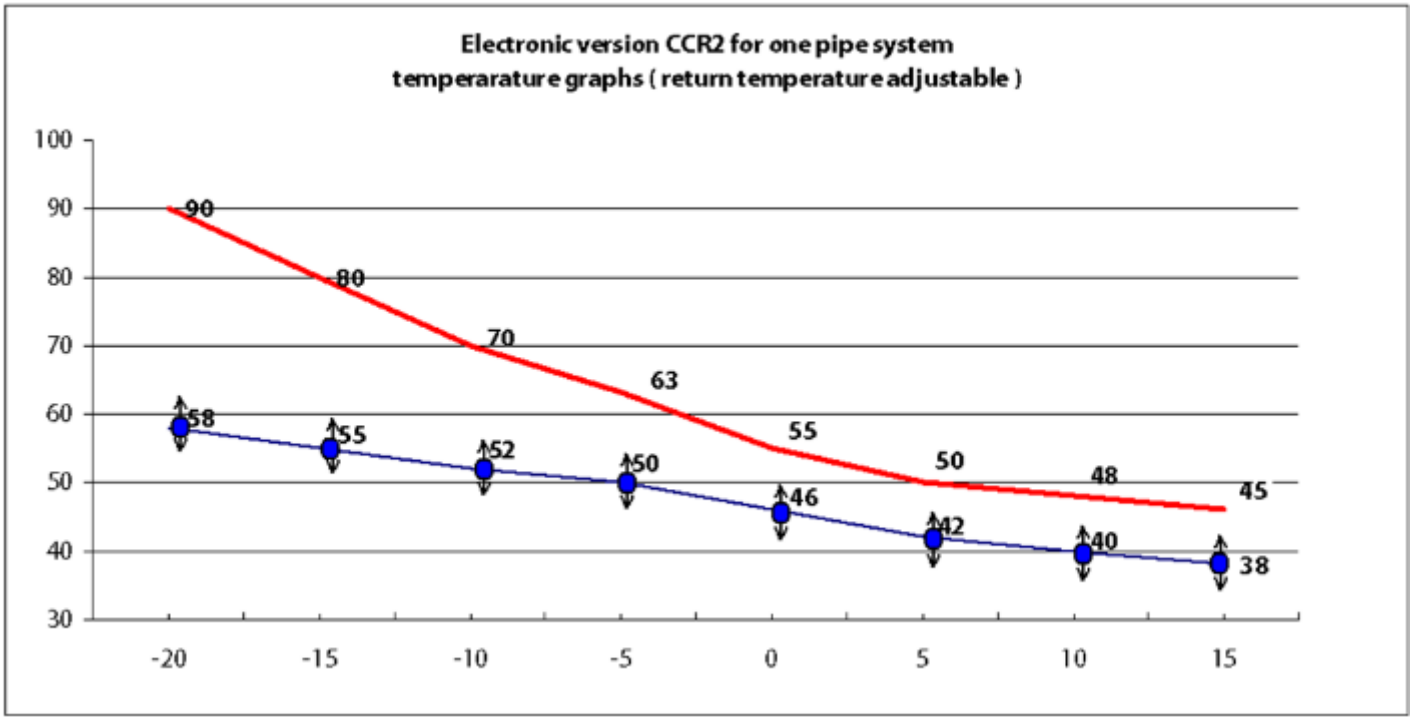
(ABQM + TWA + CCR3 „one pipe version")



ABQM with CCR2 control makes 1-pipe system adaptive to actual heat demand – flow varied like in 2-pipe system !

Weather compensated return temperature

- Each riser can be programmed to individual return temperature dependency from supply temperature



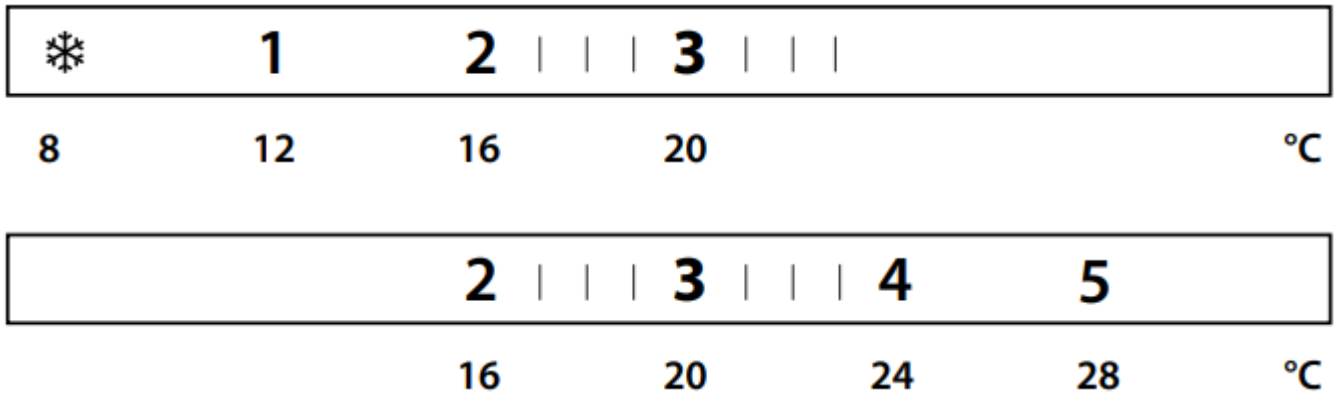
1-pipe solution portfolio

Application	1-pipe systems		
Solution level	AB-QM	AB-QT	AB-QTE
Product level	 - AB-QM	 - AB-QM - QT	 - AB-QM - TWA-Z  -CCR3 -- ESMC
What it does / description	- automatic balance	- automatic balance with self acting thermostat - variable flow control	- automatic balance with electronic control - variable flow control
Main benefits	-reliable system (even heat distribution, no under-heating) -Payback : ~ 1 year (based on reliability)	- reliable system - energy savings (when matters most) - price performance Payback: ~2,5 year (based on energy savings only)	- reliable system - best energy savings possible (best efficiency) - monitoring, service, resetting (individual riser setting) Payback: ~4,5 year (based on energy savings only)

Setting range

Plausible factory limited settings.

- Min limitation – with heat cost allocators.
- Max limitation for systems without heat cost allocators.



Examples

Domestic hot water

- Renovation of heat exchanger stations (supplying hot water to several buildings).
- Implemented by replacing old heat exchanger where old was completely bad.
- Replacing old temperature controllers to a new.
- Implemented by District Heating Companies because of high energy losses in a network and complicated cost allocation.

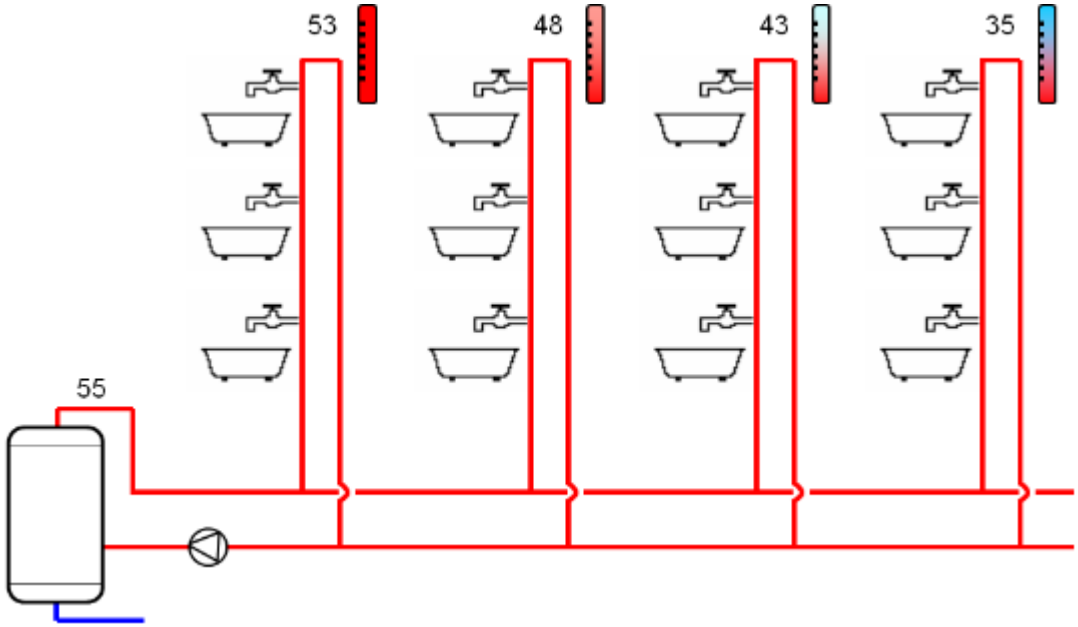
Domestic hot water

- Renovation or installation of new hot water control in multi family houses. Done by installation of new heat exchanger and hot water control. From self-acting thermostats to electronic controllers.
- Implemented by District Heating Companies because of high energy losses in a network.

Unbalanced hot water system

Hot water to consumers is supplied in different temperature:

- The risk of Legionella bacteria infection is high. Legionella can survive in a lower than 20 °C temperature, but it does not multiply. It multiplies abundantly in warm water (22-43°C).
- Consumers which are located further from the heat substation consume more hot water



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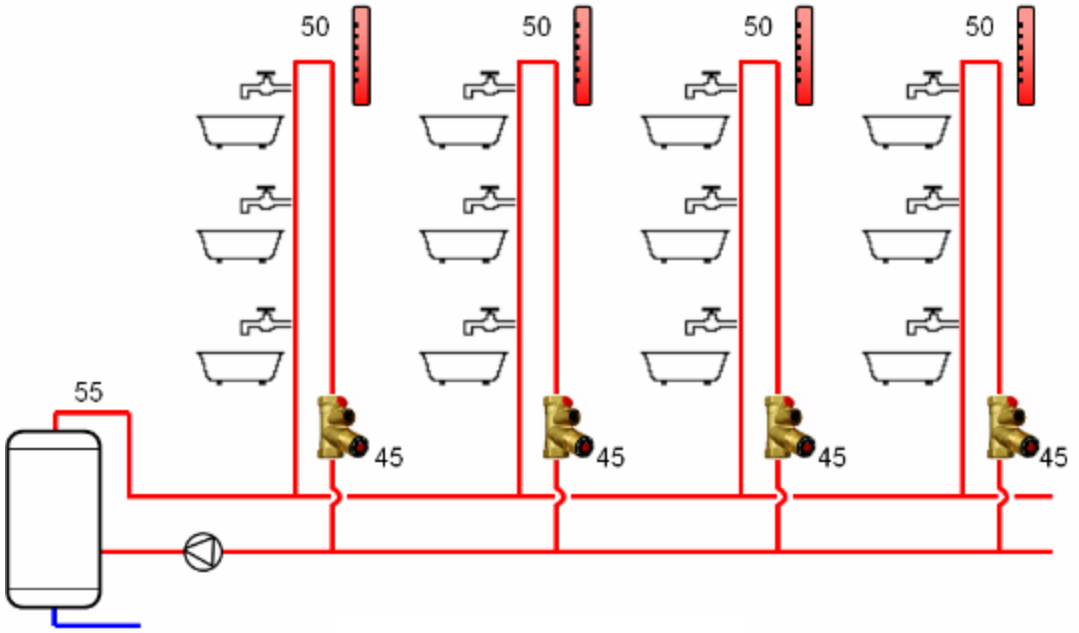

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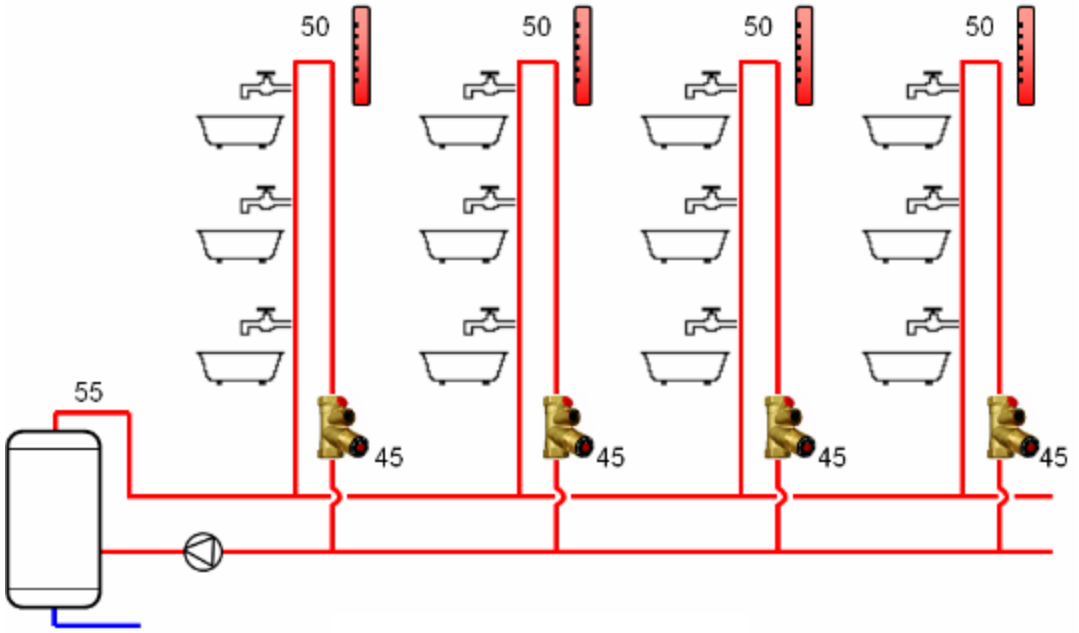

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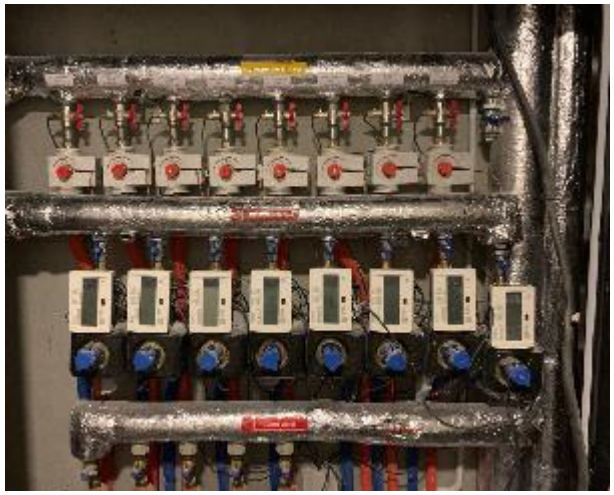
Heating systems. New build

Heating systems. New build

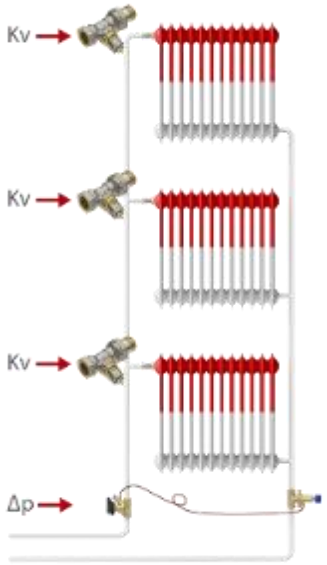


- Distribution manifolds contain metering and balancing of distribution branches.
- Heating systems are either floor or radiator heating.

ASV-PV pressure regulator or RA-DV dynamic thermostatic valve

Where shall we use what

- Pressure stabilization



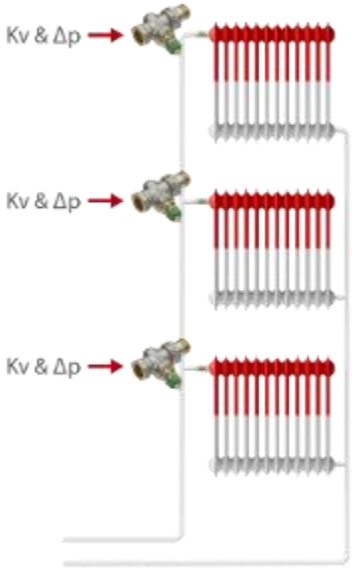
RA-N presetting valve

to limit valve capacity (Kv)

ASV-PV + ASV_BD

keep constant available pressure (Δp)

- Pressure stabilization

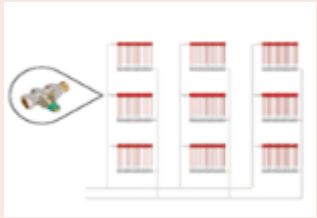
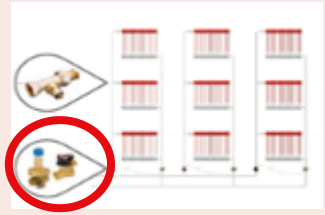


RA-DV Dynamic Valve

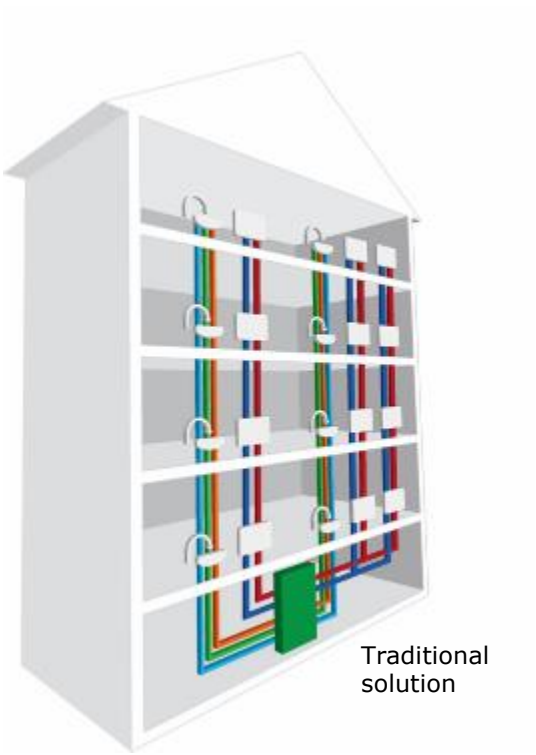
to limit the flow (q_v)

ASV-PV or RA-DV

Where shall we use what

Solution	Pressure	Radiator	System	Economy
Radiator fitted Dynamic Valve™ 	Max differential pressure = 60 kPa	Max flow =135 l/h P = 1570 W at △T = 10 P = 2355 W at △T = 15 P = 3140 W at △T = 20	- Best choice for **complex riser design** - Best choice when **risers/pipes are difficult to access** - Best choice when **main riser/return pipes are distant** from each other	Best choice for **risers with few radiators**
Riser fitted ASV + radiator fitted RA-N 	Max differential pressure =250 kPa	No flow (l/h) limitations	- Best choice if the **max differential pressure is unknown** - Best choice when **well-functioning pre-setting valves are present** - Only choice for systems with **built-in valves**	Best choice for **risers with many radiators**

The evolution of flat stations for flats and apartment buildings



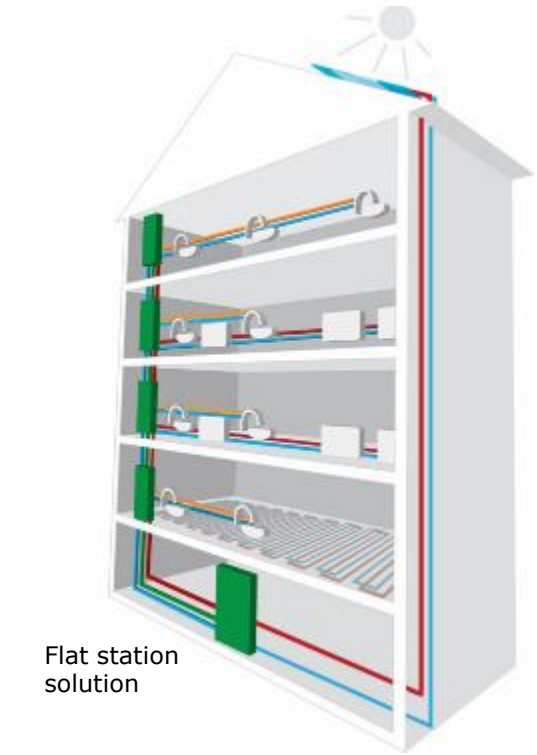
Traditional solution

Since flat stations

- Simplified system design
- Reduced number of pipes
- Increased comfort for residents
- Increased energy efficiency
- Fair heat cost

Flat stations outperform traditional systems

Legionella contamination



Flat station solution

Flat stations

- Central station is supplying energy to a station in a flat (staircase). Hot water is made for each flat separately.
- Clear costs of consumption for energy and water.

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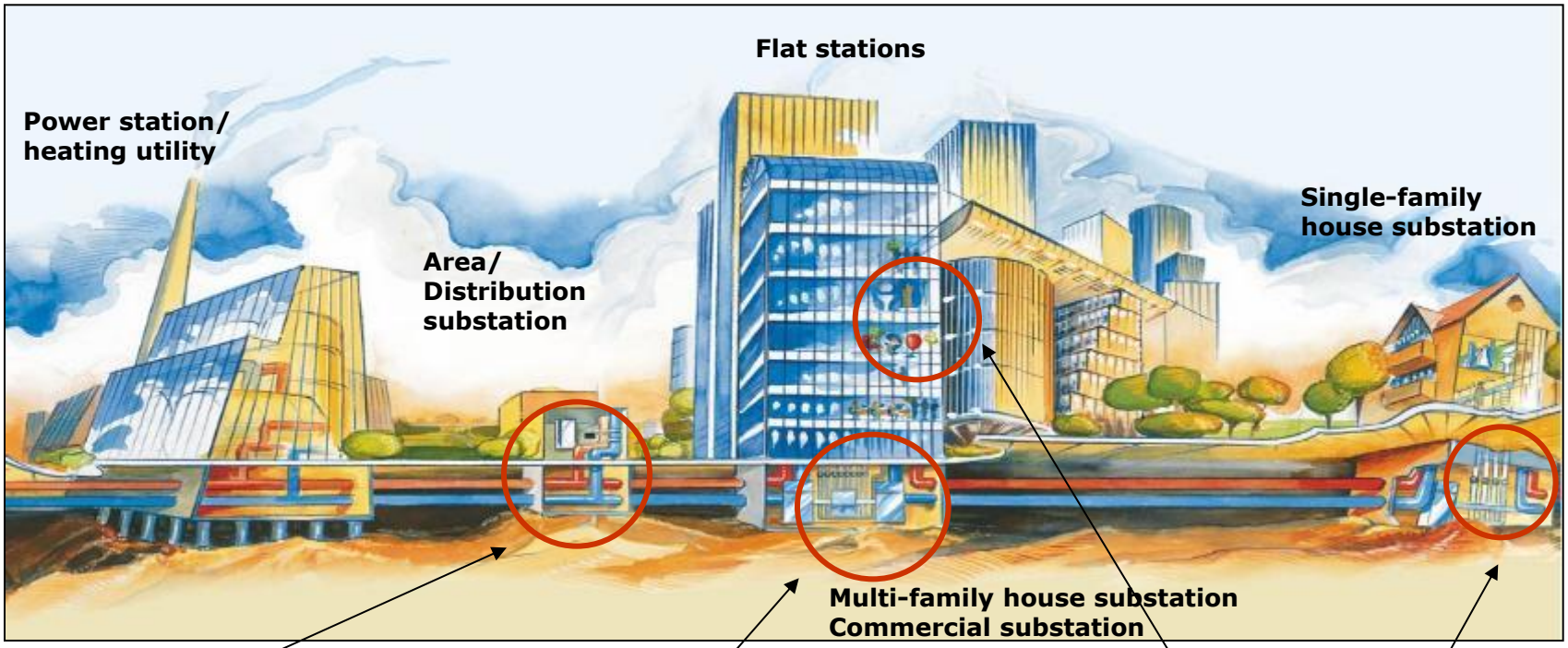
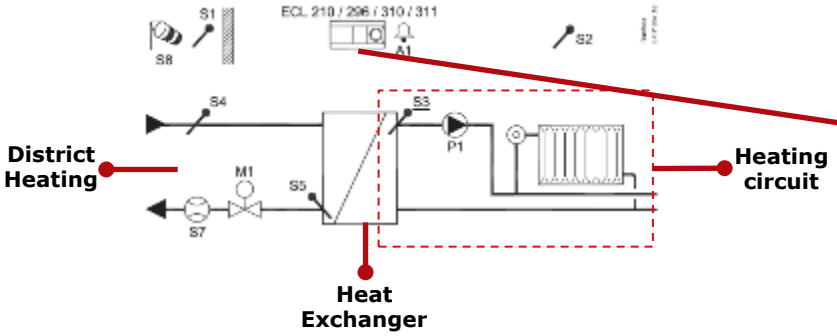
Substations

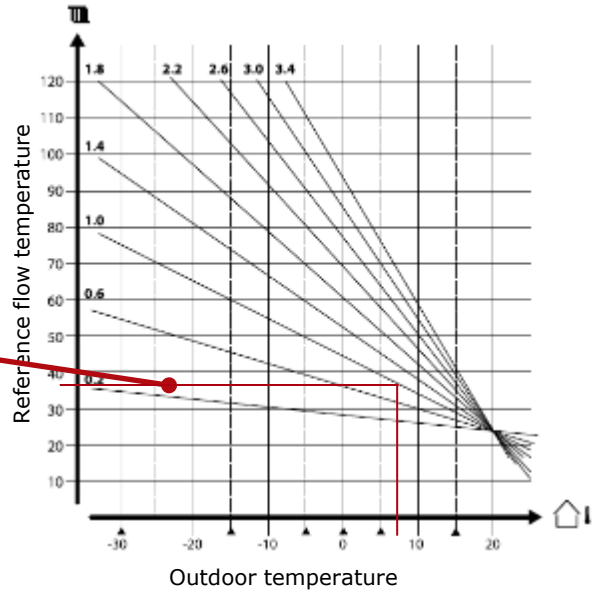
Designed for every application



Heat curve enabling the Weather Compensation

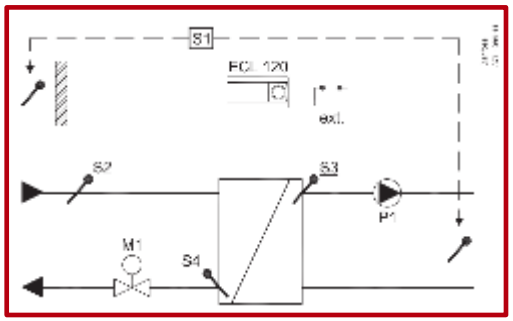


Heat curve diagram

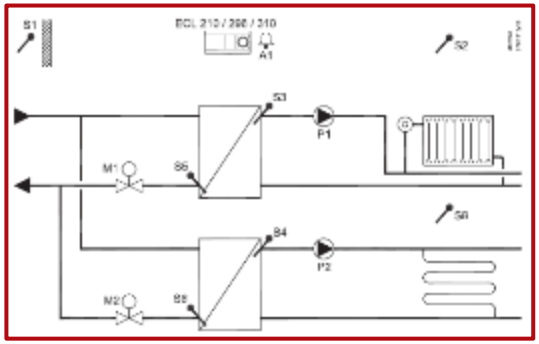


Typical Heating applications

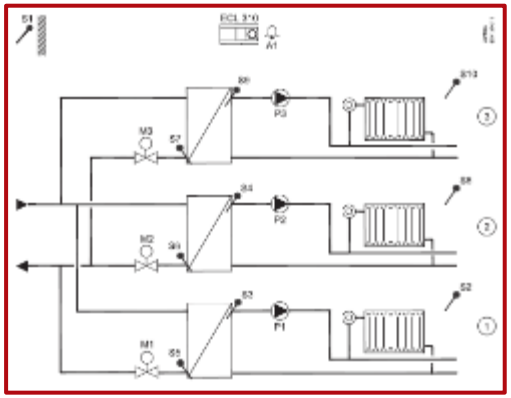
One circuit



2 circuits

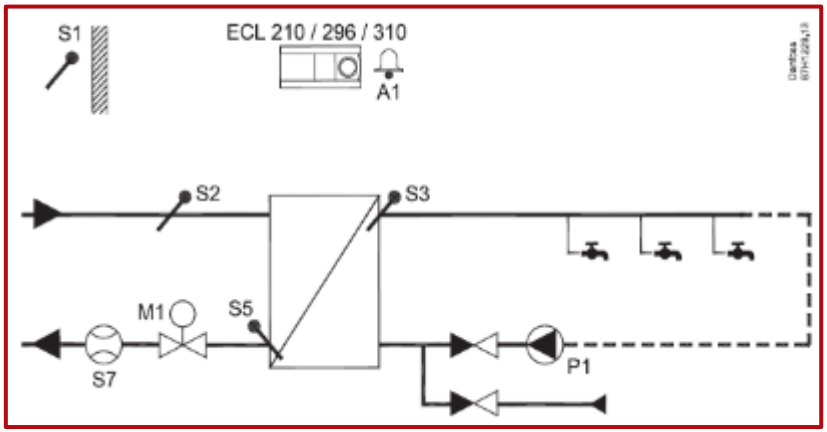


Multi circuits

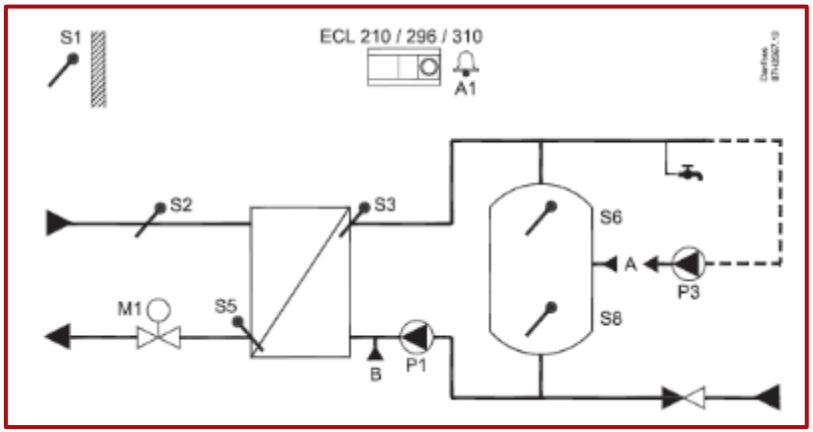


Domestic Hot Water (DHW) applications

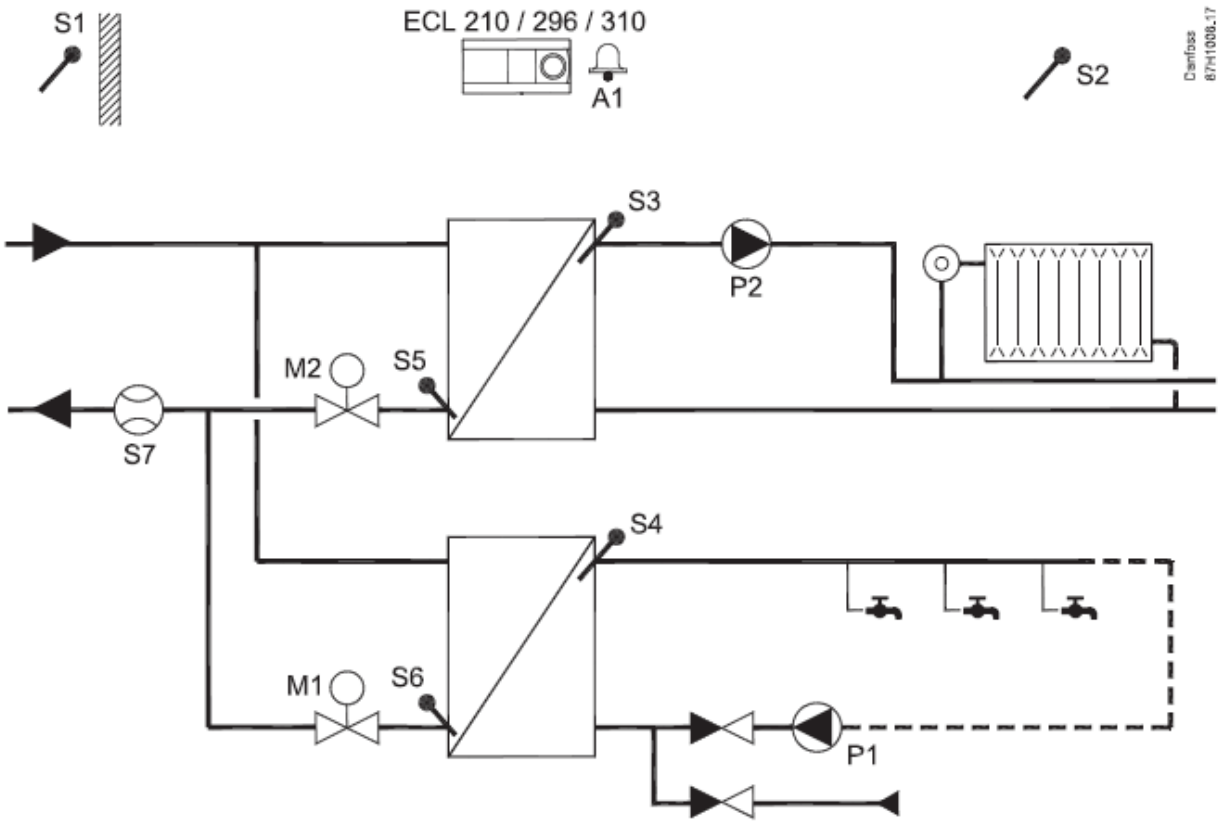
Instantaneous



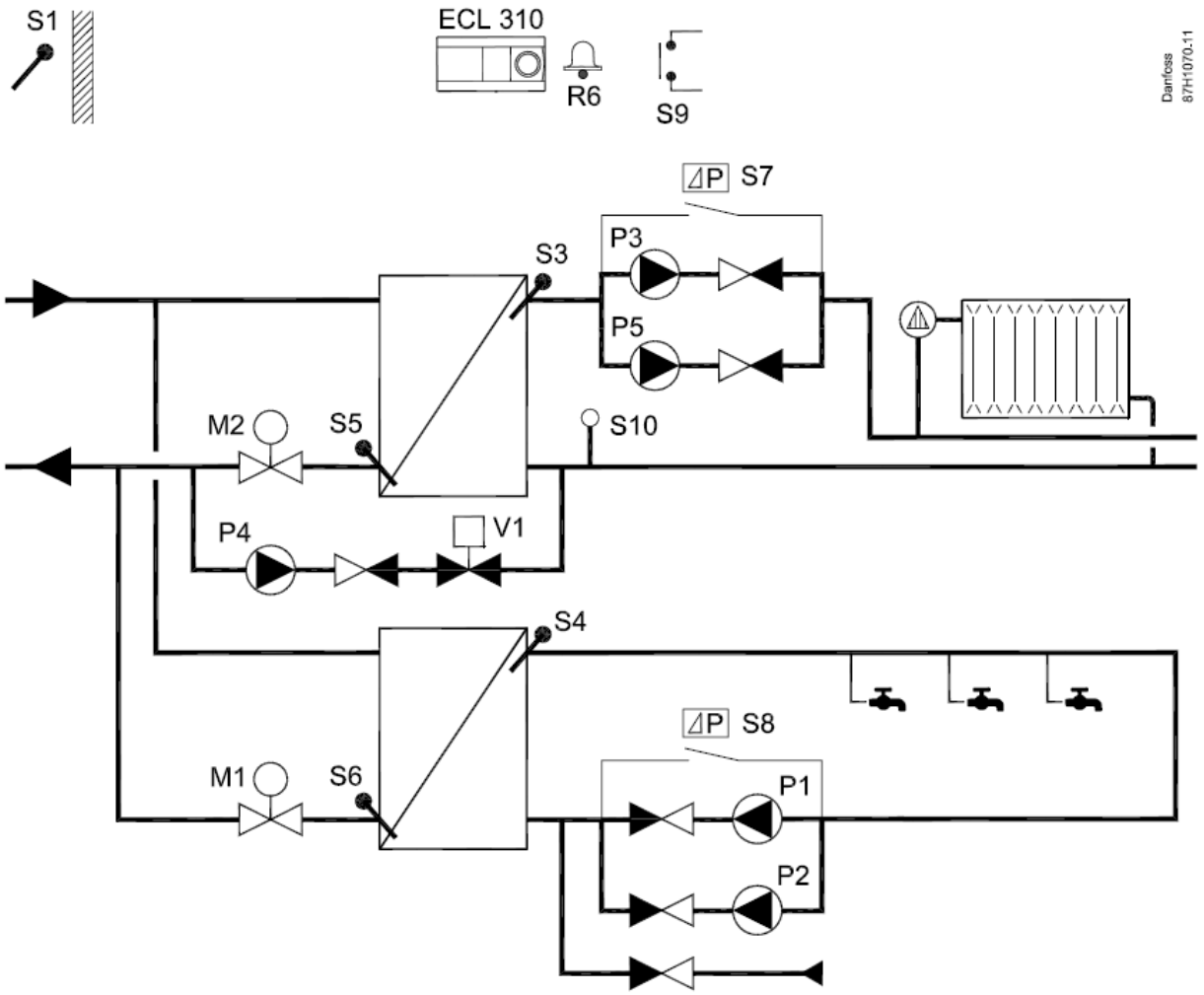
Charging system



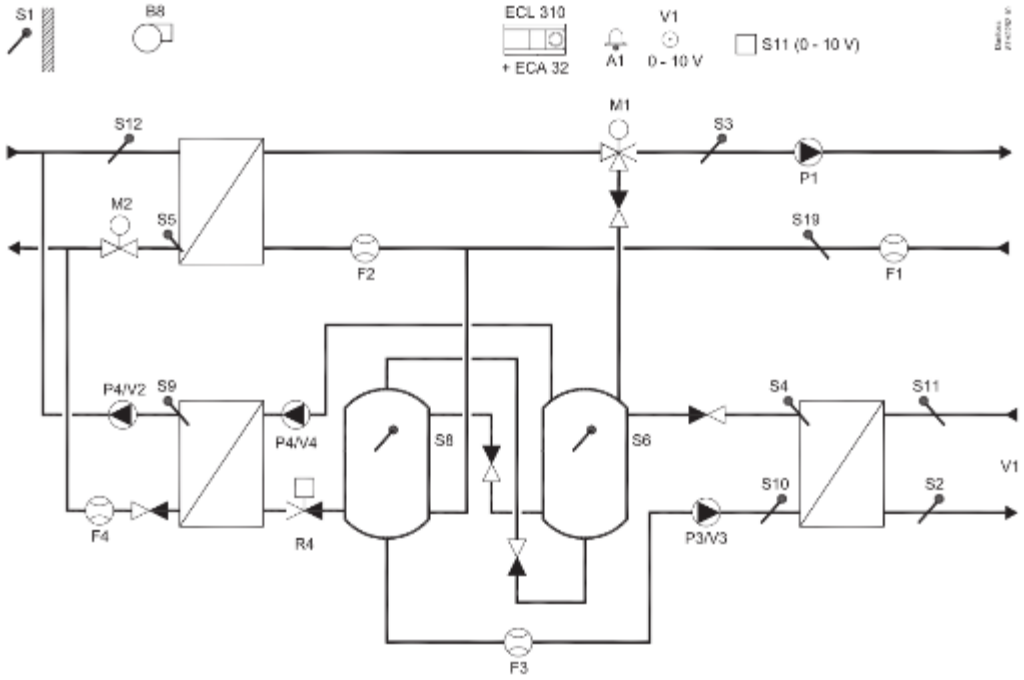
Typical application for residential building



Advanced application for residential building

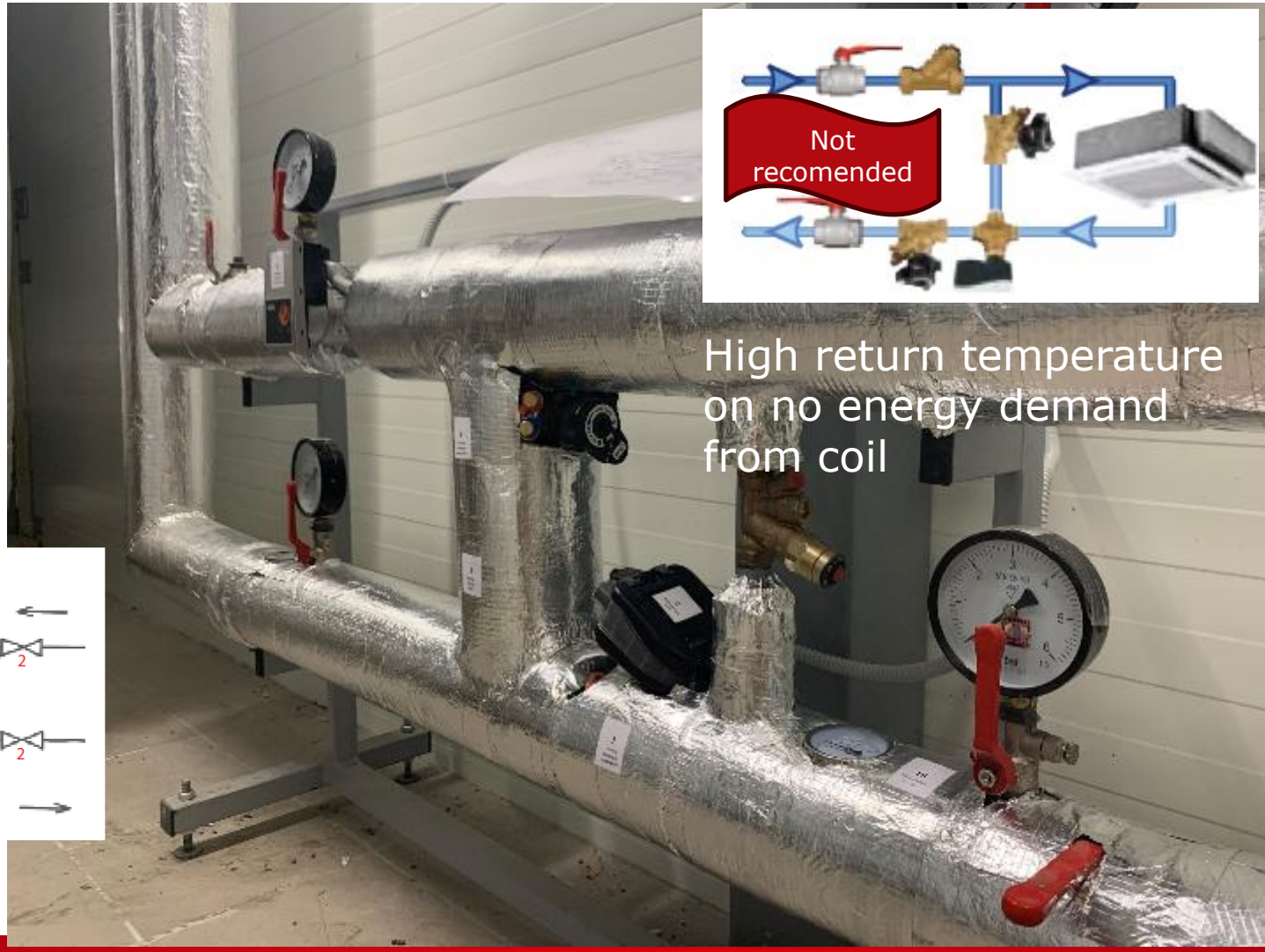


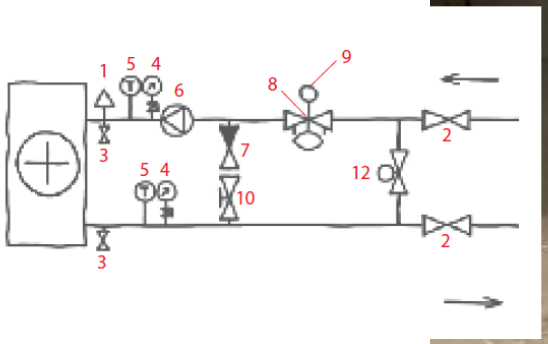
Heat recovery (HRU)



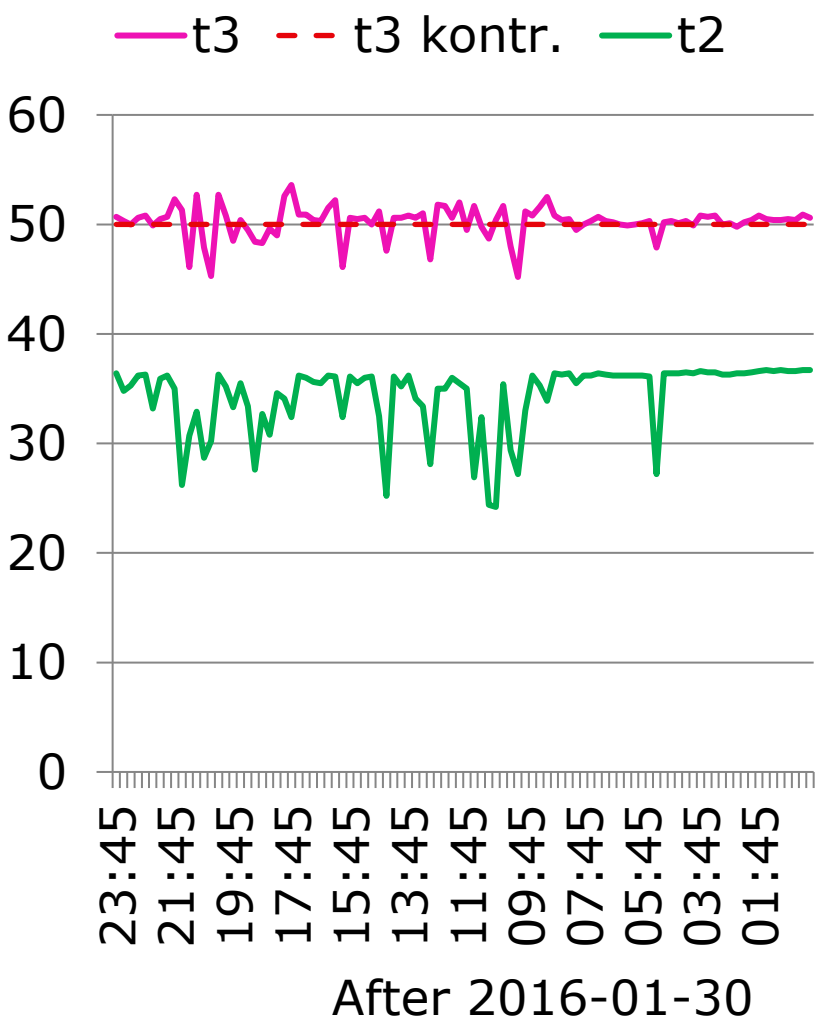
Air handling unit solution

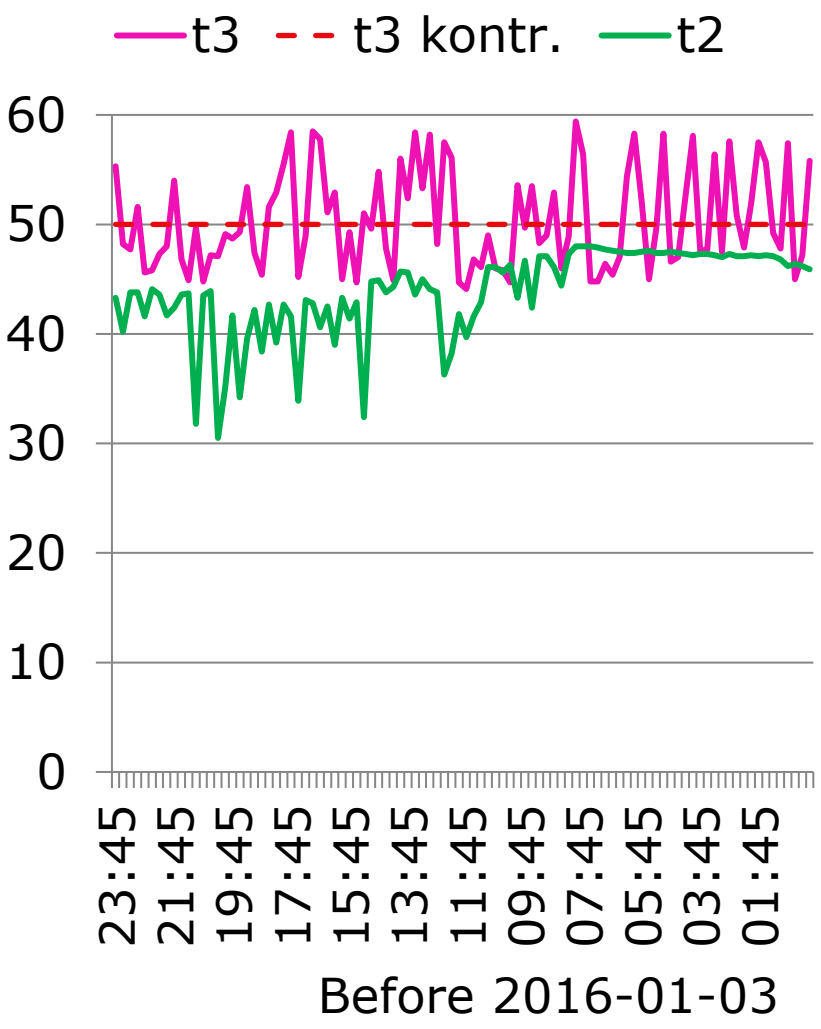
- Variable flow
- Low return





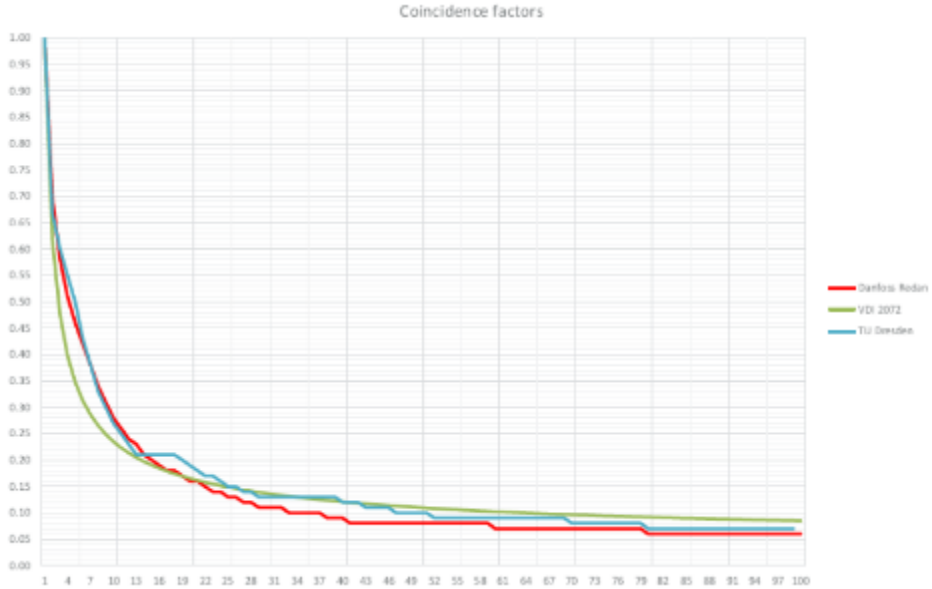
Remote commissioning



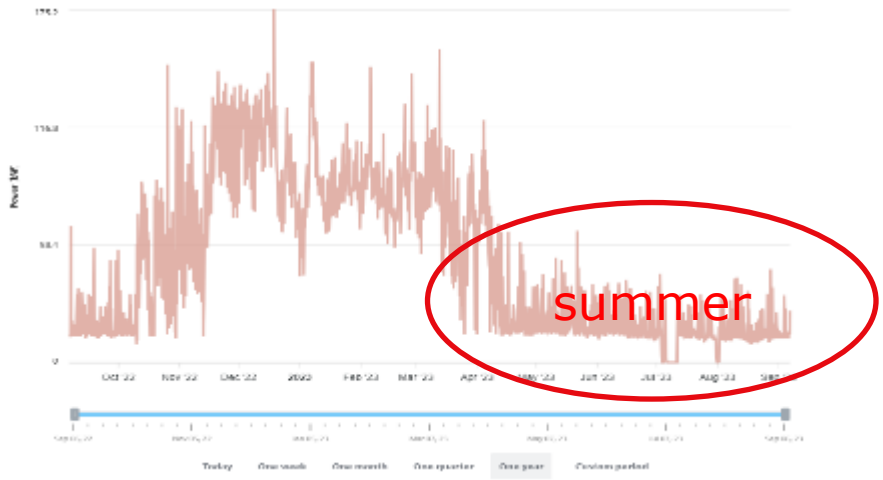


Demand for Hot water. Calculated vs realized

- Coincide factors
- From 140 kW to 300kW



- Historical data
- Realized < 100 kW



iNET - Intelligent network balancing

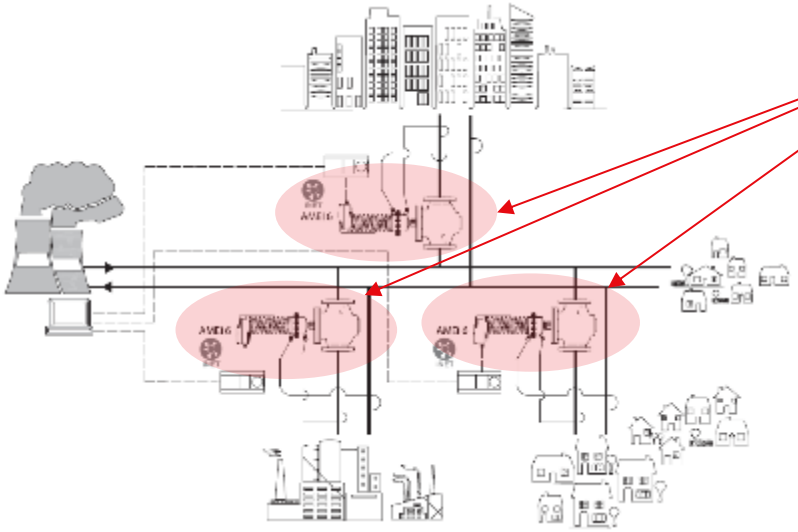
Optimal network design

ENERGY **SOURCE**
AND TRANSPORTATION
NETWORK

DISTRIBUTION
NETWORK

SUBSCRIBER
SUBSTATION

Changing heat consumption requires changes in heat distribution. Therefore the Δp should be optimized at each branch. With **iNET** the Δp can be remotely adjusted.
Input for pump optimization.



Danfoss offering

- Wide portfolio for heating and cooling applications.


Leanheat® Production


Leanheat® Network


Leanheat® Monitor


Leanheat® Building

Value of data:
flow, supply & return temperature, power, alarms, position of valves etc.

Heat exchangers

District energy balancing and controls

Substations Flatstations

Heat meters

Intelligent controllers

Floor heating

Residential balancing and control

Commercial balancing and control

Information

- Information in slides and more…

This slide and some others sourced from Viktor Pyrkov

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