Methods of decreasing heat losses in Warsaw district heating network

thesis done for R&D project

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Heat-Tech Center
Research and Innovation
REDEVELOP RECREATE RETHINK
2nd International Research Conference
5-6 November 2013 - Brussels
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Content of presentation

1. Description of Warsaw district heating network
2. Objective of the thesis
3. Current heat losses calculated using:
    - data from heat metrs
    - LOSC methodology
4. Heat losses for 6 pipelines modernization scenarios
5. Conclusions
6. R&D projects in Heat-Tech Center

Warsaw DH Network

- 1700km - length of pipes,
- 85/75°C - average supply temperatures in winter & summer period
- 45°C - average return temperature in both periods
- 20-1200 - nominal diameter (DN) of pipes
- 4 PJ/year of heat losses
- 19.840 substations
- 650 substations in telemetry system

Objective of the thesis

- The goal of thesis was to determine what is the theoretical minimum amount of conductive heat losses which can be obtained in Warsaw district heating network by performing a modernization of pipelines

- The intermediate goal was to find reliable method of calculating conductive heat losses for district heating network which can be used to achieve the goal of thesis

Current conductive heat losses – data from heat meters

- Difference between amount of purchased heat and sold heat is total heat losses
- Due to lekages a part of heat is lost with water losses

$$E_{conductive\ losses} = E_{bought\ from\ sources} - E_{delivered\ to\ customers} - E_{lost\ with\ leakages}$$

- Obtained amount of heat losses :
  - $E_{conductive\ losses}$ = **3402 TJ/year**
  - $E_{lost\ with\ leakages}$ = **600 TJ/year**

Current conductive heat losses – LOSC methodology

- LOSC methodology of calculating unit heat losses [W/m] uses data about DH network geometry and operating parameters which are characteristic for each type of network.

- Calculations of unit heat losses were done individually for each identified type of network.

- Unit heat losses were calculated for each DN, in each technology, for both operating seasons, and both supply and return pipeline.

Current conductive heat losses – LOSC methodology

- Obtained amount of heat losses :
  - $E_{conductive\ losses}$ = **3388.9 TJ/year**
- This value is **0.63%** lower than value calculated with previous methodology (used data form heat meters)

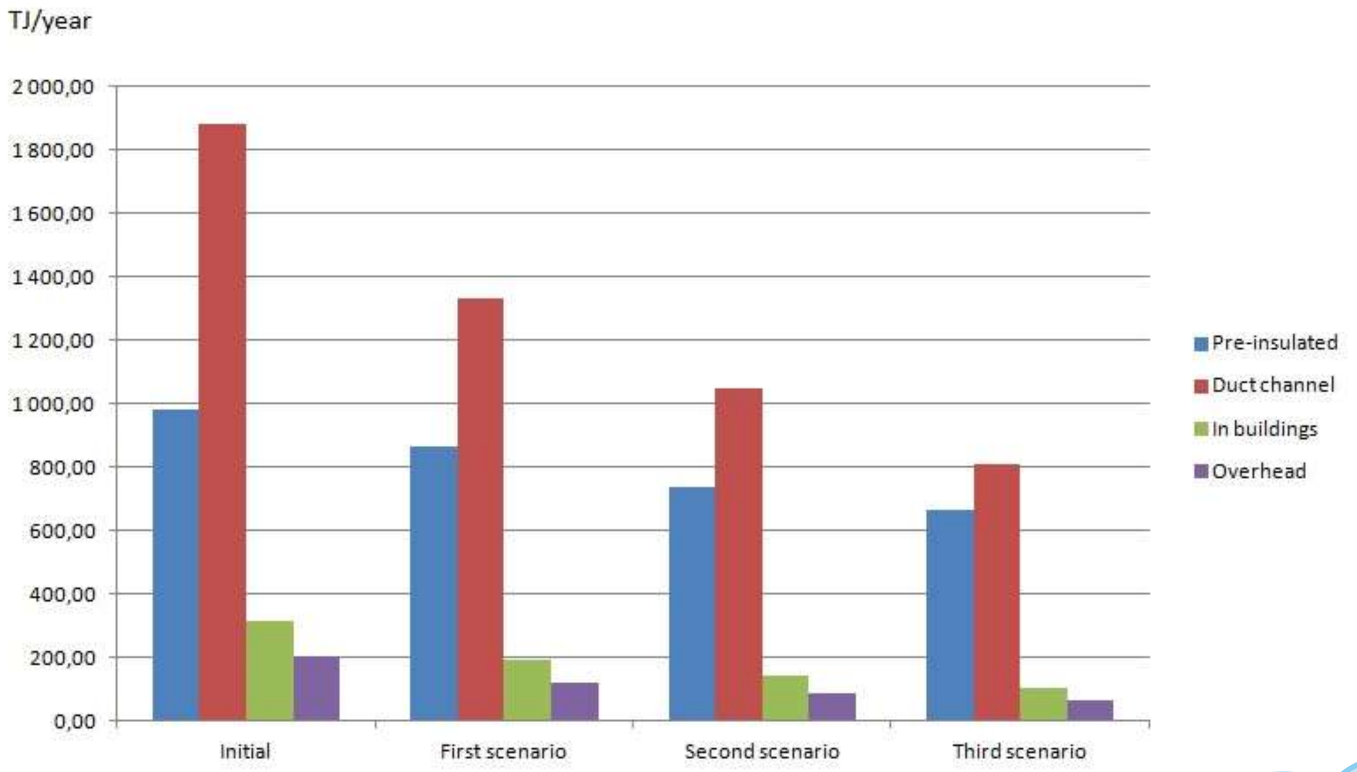
Taking into account complexity of methodology and small error it can be concluded that LOSC methodology is reliable and can be used to calculated heat losses for modernization scenarios

Modernization scenarios

Assumption : no change of insulation thickness

	Scenario 1	Scenario 2	Scenario 3
Group 1 pre-insulated pipes	**new PUR insulation foamed with CO_2** 0.033 W/(mK)	**new PUR insulation foamed with cyclopentane** 0.027 W/(mK)	**new PUR insulation foamed with cyclopentane; continuously produced** 0.023 and 0.026 W/(mK)
Group 2 duct channel pipes, pipes installed in buildings, overhead pipes	**non-aged mineral wool as insulation material** 0.05 W/(mK)	**new mineral wool as insulation material** 0.04 W/(mK)	**new polyurethane foam shells as insulation material** 0.027 W/(mK)

Modernization scenarios

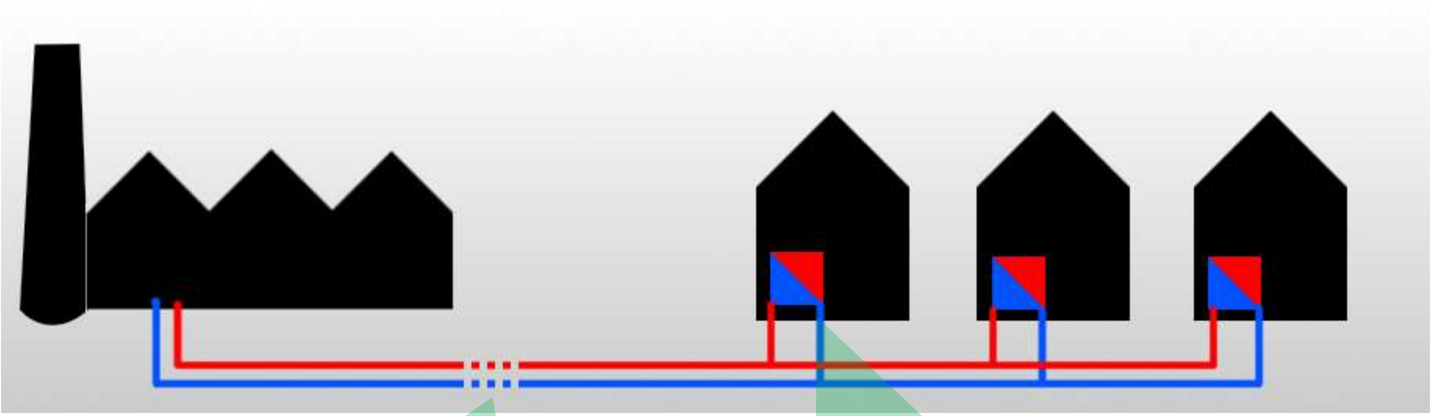


By applying scenarios #3 from both group the highest heat losses reduction is achieved

Conclusions from thesis

- LOSC methodology gives results comparable to methodology which uses data from heat metering
- Theoretical minimum amount of conductive heat losses which can be obtained in case of 3rd scenarios for both groups is 1639.21 TJ/year (48% of initial conductive heat losses)
- Evaluation of of different modernization scenarios was based only on heat losses reduction. Other factors as investment costs, failure rate, and costs of maintenance were not included. Taking those factors into account may change the benefits of selected scenario.

R&D Projects in Heat-Tech Center



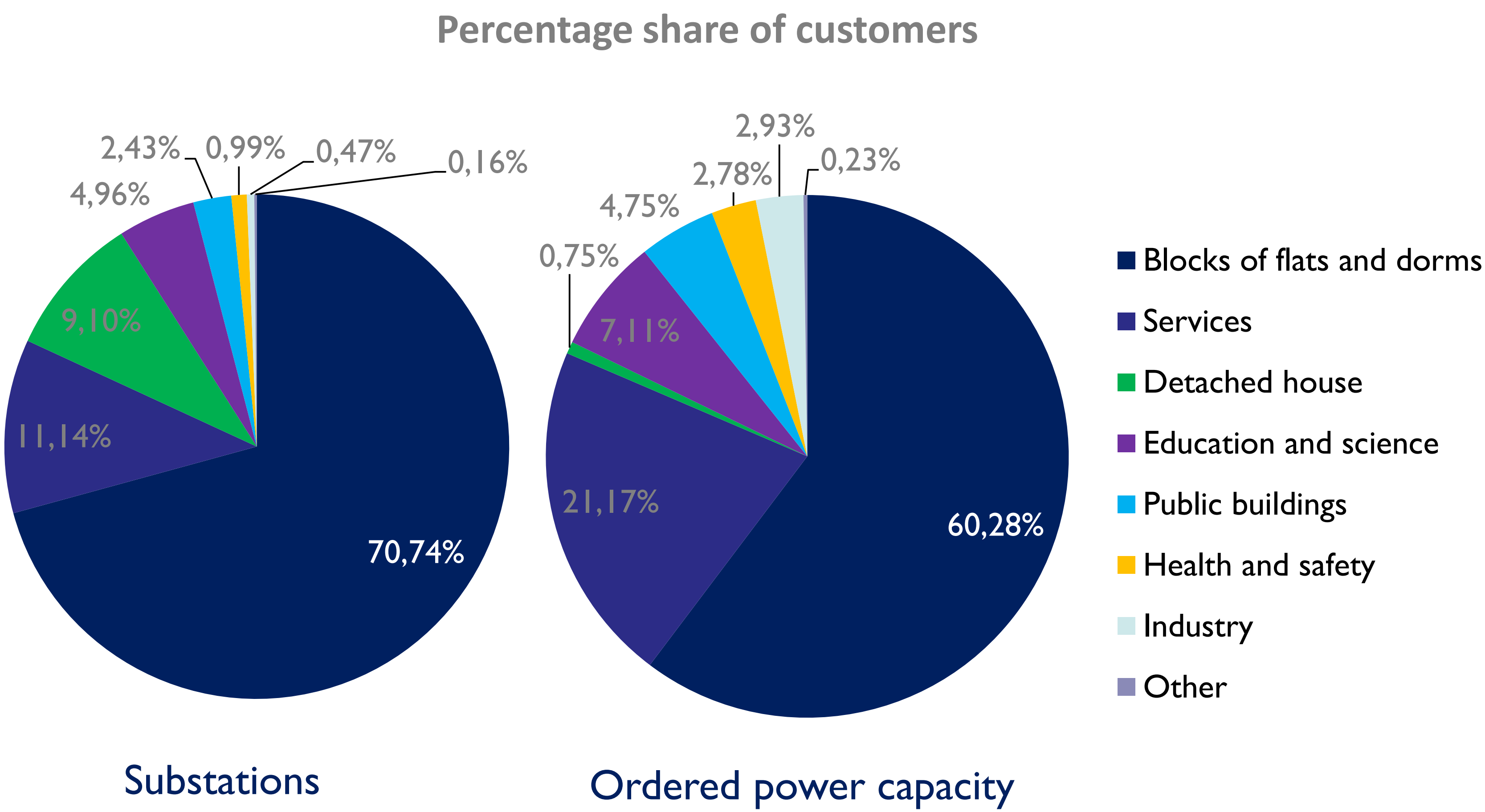
RELIABLE DH PROJECT

IT tool **to improve the reliability of the district heating network** by monitoring the level of heat losses and the risk of failure, what will allow to decide more accurately which parts of district heating network should be repaired or replaced

SMART SUBSTATION PROJECT

Main goal is:
to develop methodologies and tools to improve sub-stations performance and the use of heat in buildings
&
Development of new services downstream heat meters

Smart Substation R&D Project



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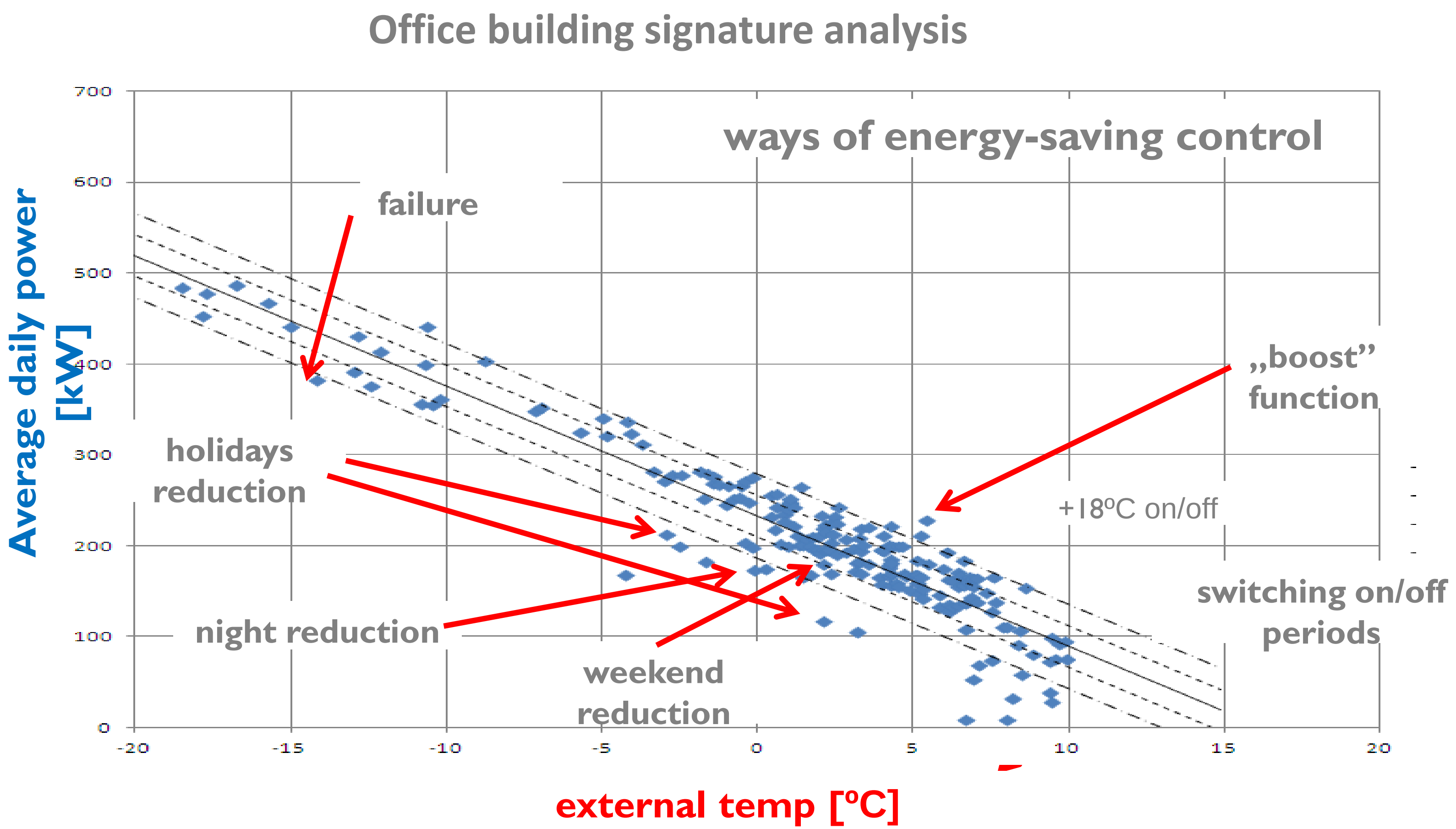
Smart Substation R&D Project



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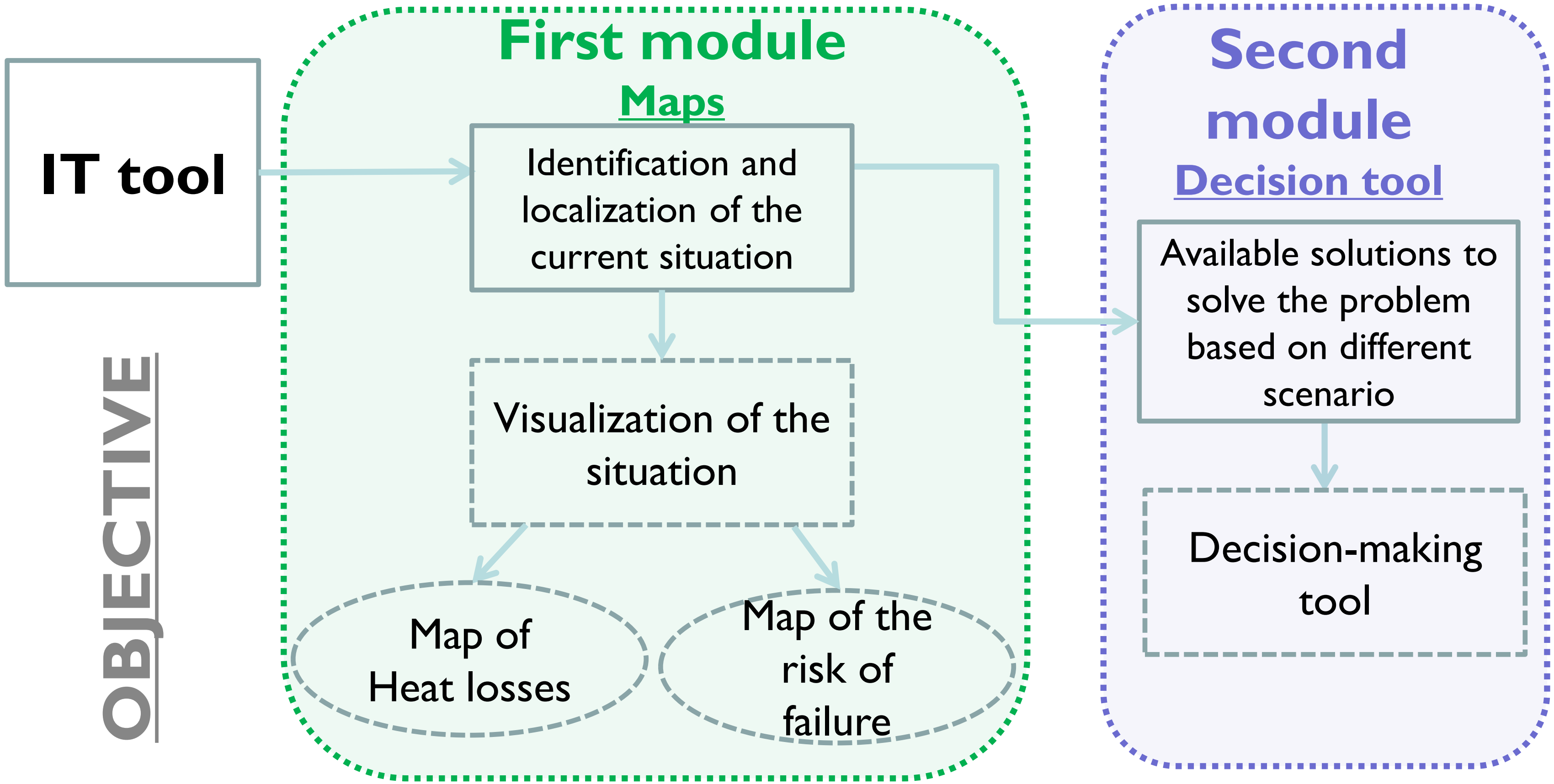
Smart Substation R&D Project

Intermediate goals

Methodologies to improve sub-stations performance and the use of heat in buildings	**Development of new services downstream heat meters**
• Automatic detection and diagnostics of problems in substations • Automatic evaluation of building's energy signature (space heating and domestic hot water) • Monitoring of heat consumption --> locating of buildings which need heat consumption optimization • Locating buildings which should change ordered power capacity	• Two-way communication between heat provider and consumer • Acces to information about current heat consumption and its price --> rational way of managing heat consumption, what has influence on bill

Realiable DH R&D Project - Objective



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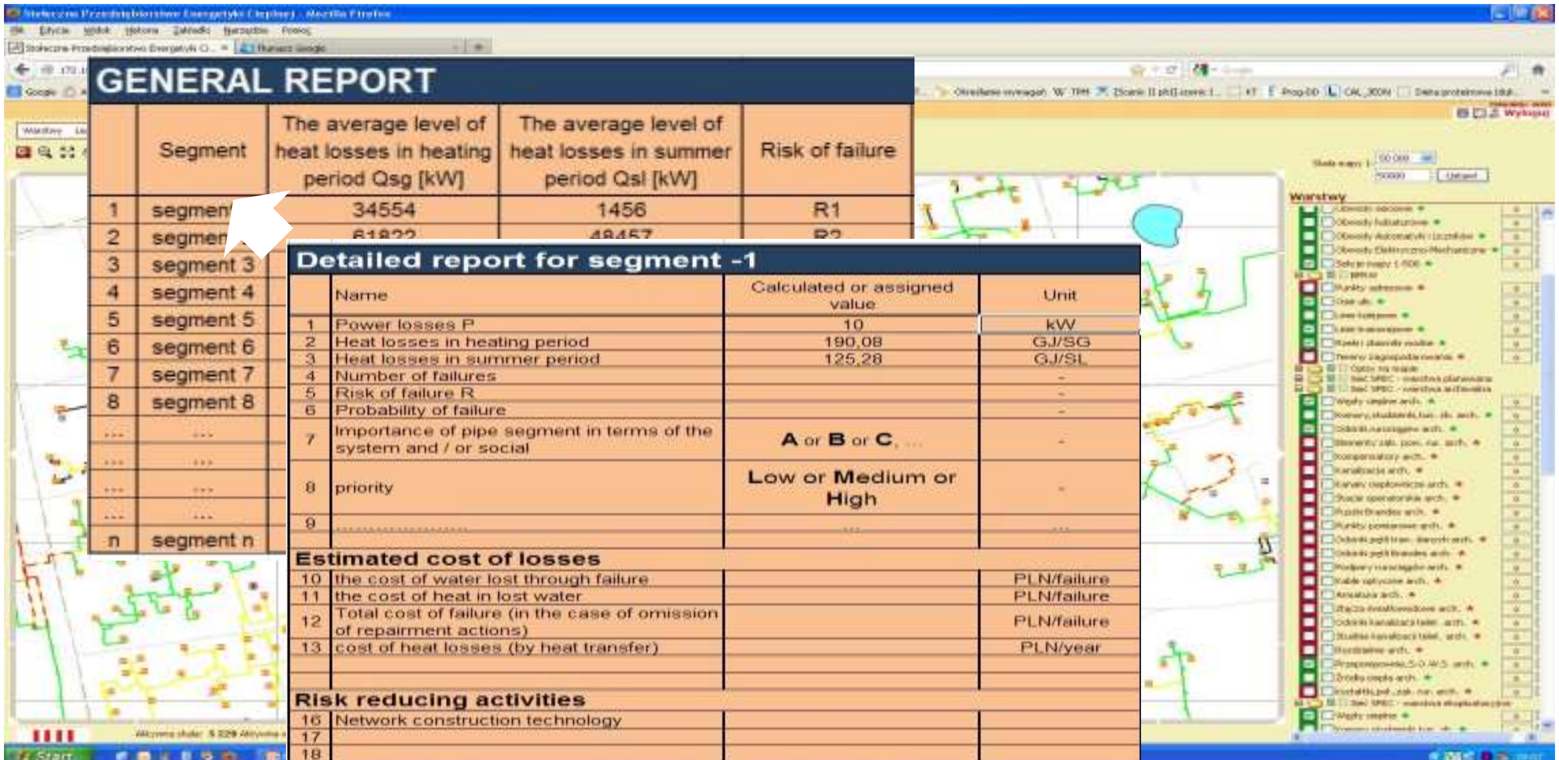
Realiable DH R&D Project - Asset's condition

First results:
Vizualization of risk of failure

Realiable DH R&D Project - Decision-making tool



GENERAL REPORT

	Segment	The average level of heat losses in heating period Qsg [kW]	The average level of heat losses in summer period Qsl [kW]	Risk of failure
1	segmen	34554	1456	R1
2	segmen	61822	48457	R2
3	segment 3			
4	segment 4			
5	segment 5			
6	segment 6			
7	segment 7			
8	segment 8			
...	...			
...	...			
...	...			
...	...			
n	segment n			

Detailed report for segment -1

	Name	Calculated or assigned value	Unit
1	Power losses P	10	kW
2	Heat losses in heating period	190,08	GJ/SG
3	Heat losses in summer period	125,28	GJ/SL
4	Number of failures		-
5	Risk of failure R		-
6	Probability of failure		-
7	Importance of pipe segment in terms of the system and / or social	**A** or **B** or **C**, ...	-
8	priority	**Low or Medium or High**	-
9	....	...	...
Estimated cost of losses			
10	the cost of water lost through failure		PLN/failure
11	the cost of heat in lost water		PLN/failure
12	Total cost of failure (in the case of omission of repairment actions)		PLN/failure
13	cost of heat losses (by heat transfer)		PLN/year
Risk reducing activities			
16	Network construction technology		
17			
18			
19			
Risk reduction activities and their estimated cost			
21	Cost remedial actions		PLN
22	Effects		PLN/year
23			
24			
25			
26			

Thank you for your attention

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