Energy efficiency 2009
Renovation of District Heating Systems

Vilnius, Lithuania

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The challenge:

Capital is a limited resource

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“Cost structure”

Investments

“Cost structure”

Investments

Operation

“Cost structure”

Investments

Operation

Maintenance

LCC – Life Cycle Cost

- Focus on cost structure Life Cycle Costs – LCC
  - Investments
  - Operation costs
  - Maintenance costs

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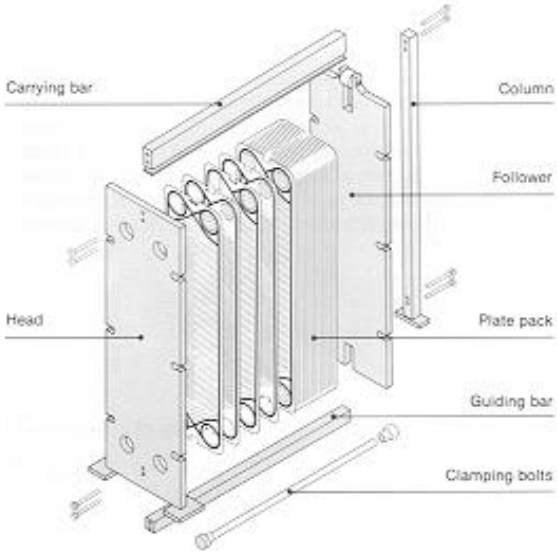
Elements in the “DH-chain”

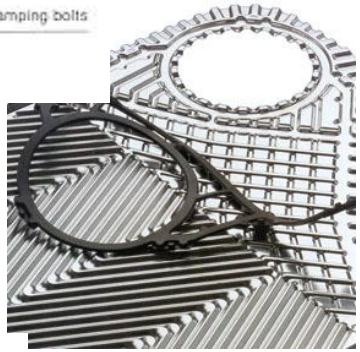
- Production
  - Boilers
- Distribution
  - **Pipe network**
  - **Pumps**

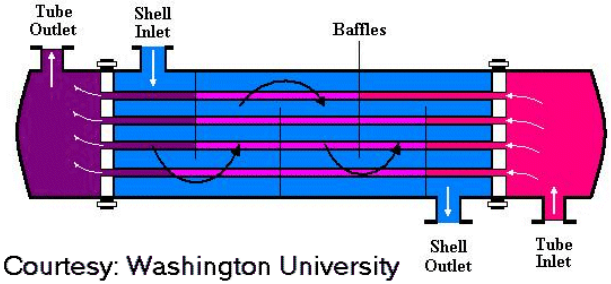
- End-user installations
  - Valves
  - Meters
  - **Heat exchangers**
- SCADA-System
- Engineering

Heat exchangers

- Tube heat exchangers
- Plate exchangers
  - with gaskets
  - without gaskets
- Quality of make-up water







Courtesy: Washington University

Pumps – Case study

Replacement of two 10 years old pumps in a 15.3 MW substation.

- Changji in the western part of China - audit toke place in January 2008.
- Equipment was replaced during summer 2008, and there was made control measurements in January 2009 to verify the result.
- The substation is one out of a total of 64 substation

Pumps – Case study

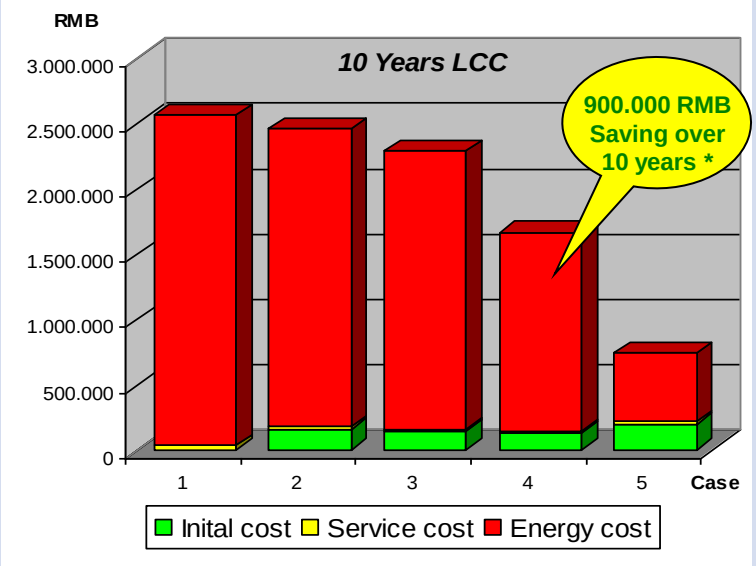
- The findings of the audit was clear in two points:
  - Flow in the system was to high which result in too low differential temperature.
  - Efficiency of the pumps was too low due to old pumps and operation fare from the optimal duty point.

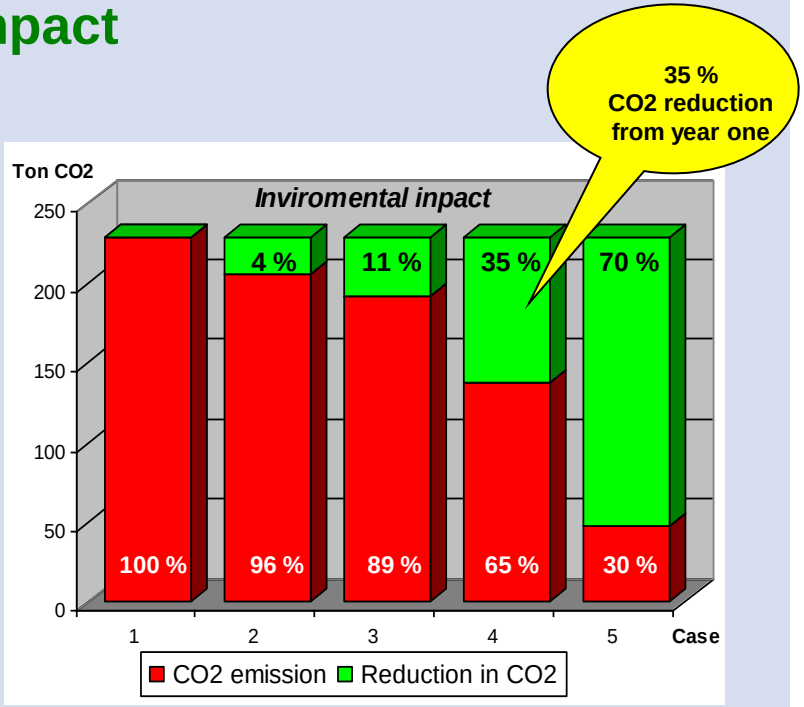
- To evaluate the best long-term solutions 10 years LCC calculations were used, and 5 scenarios for the LCC comparison were set up.

Pumps – Case study

1. Energy consumption on existing pumps system.
2. New pumps based on nameplate on the old pump (no measurements).
3. Simple pump audit measuring flow, head and power, and select pumps based on these data.
4. Energy audit measuring flow, head, power and temperatures including analyze of system, and select **constant speed** pumps based on how the system operates most efficient.
5. Energy audit measuring flow, head, power and temperatures, analyze of system, providing a load profile and operation strategy. Select **variable speed** pumps based on how the system operates most efficient.

Energy, LCC and environmental impact



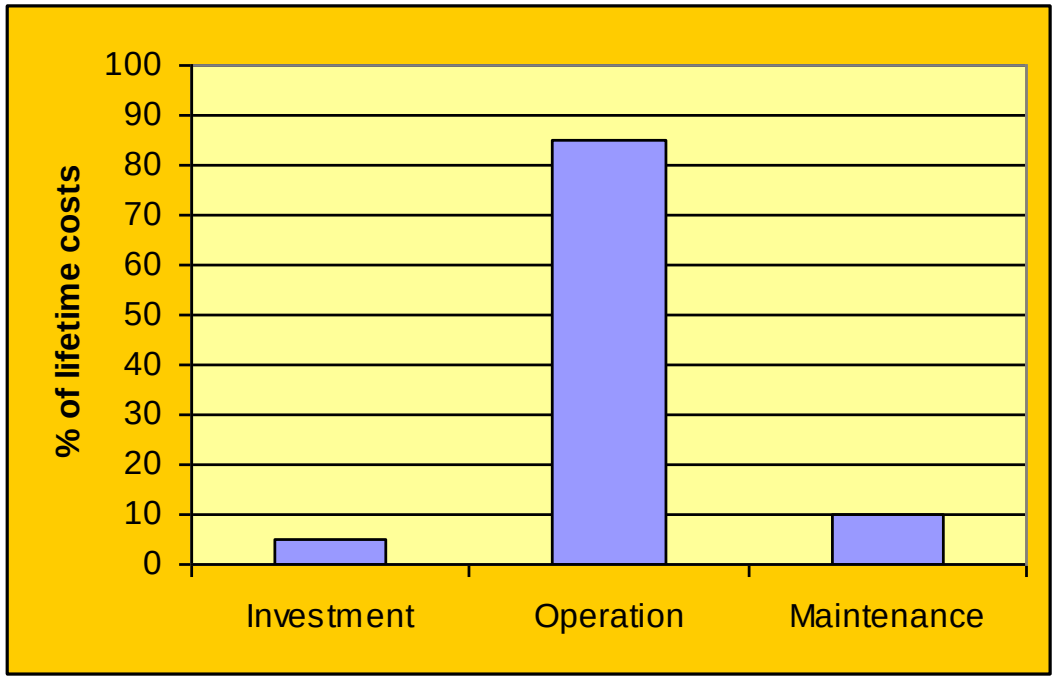


***A solution which only need implementation at the substation**.

Calculation details for the energy and LCC

		Flow	Head	P4	Total η	P1	Hours	kWh	Energy cost	Early energy	Saving	Inital cost	Audit	Total	Pay-back	LCC (10 years) RMB					
	Design duty point	m3/h	m	kW		kW			RMB / kWh	RMB	RMB	RMB	RMB	RMB	Years	Inital cost	Service cost	Energy cost	Total	Saving	**Saving %**
1	1600 m3/h x 20 m	1000	25	68,0	0,63	107,9	3350	361587	0,7	253111	0	0	0	0		0	32.000	2.531.111	**2.563.111**	**0**	**0**
2	1600 m3/h x 20 m	1000	25	68,0	0,7	97,1	3350	325429	0,7	227800	25311	160000	0	160000	6,32	160.000	16.000	2.278.000	**2.454.000**	**109.111**	**4,3%**
3	1000 m3/h x 25 m	1000	25	68,0	0,75	90,7	3350	303733	0,7	212613	40498	144000	20000	164000	4,05	144.000	16.000	2.126.133	**2.286.133**	**276.978**	**10,8%**
4	880 m3/h x 20 m	880	20	47,9	0,74	64,7	3350	216718	0,7	151702	101409	130000	38000	168000	1,66	130.000	16.000	1.517.025	**1.663.025**	**900.086**	**35,1%**
5	880 m3/h x 20 m	880	20	47,9	0,74	64,7	3350	75000	0,7	52500	200611	200000	38000	238000	1,19	200.000	16.000	525.000	**741.000**	**1.822.111**	**71,1%**

LCC for Pumps



- LCC for a pump:
  - Investments **5 %**
  - Operation **85 %**
  - Maintenance **10 %**

Life Cycle Costs for pipe network

- Investments costs
  - Pipe material
  - Pipe installation
  - Excavation and restoration
  - Inspection
- Operation costs
  - Pumping
  - Heat losses
- Maintenance costs
  - Repairs
  - Management

Pipe network - Securing investment

- Optimise the investment through proper design.
- Minimise future operating and maintenance costs.

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Pipe network - Objective

Transport hot water from A to B.

- Use as few components as possible.
- Use shortest possible pipe lay-out

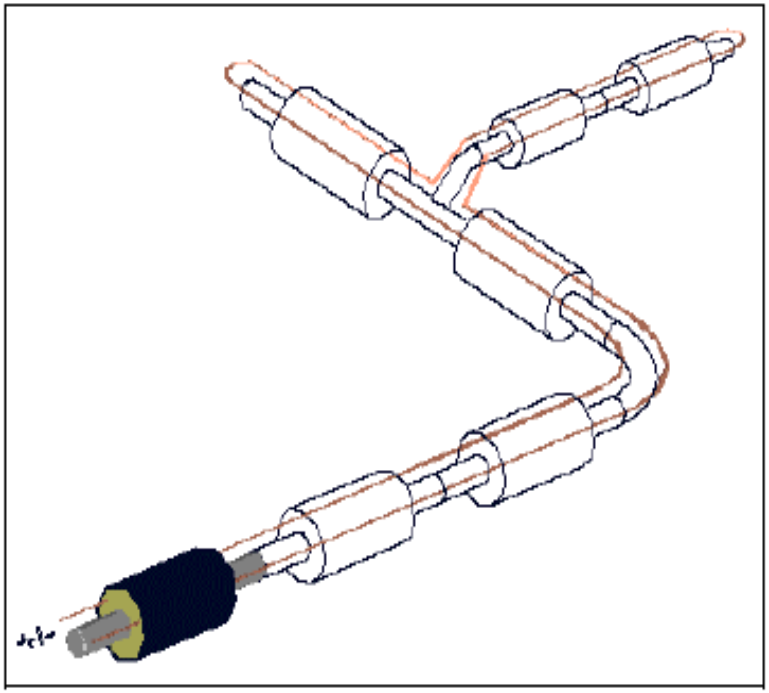
Pipe network – Installation

- Installation phase
  - Make sure that the pipe supplier delivers as specified.
  - Apply a proper level of inspection.
  - Put strict requirements on the installer and allow trained welders and joint fitters only.

Pipe network – Operation

- Draw up clear organisational responsibilities.
- Make sure the monitoring system is working – alternatively apply infrared inspection once a year.

Factors optimising savings



Use monitoring system to achieve:

- installation control
- guarantee insurance
- operation monitoring.

Pipe network – Failures in joints

Cheap casing joints have high failure rates!

Slide-over joints may have > 0,5 failure/km/year.

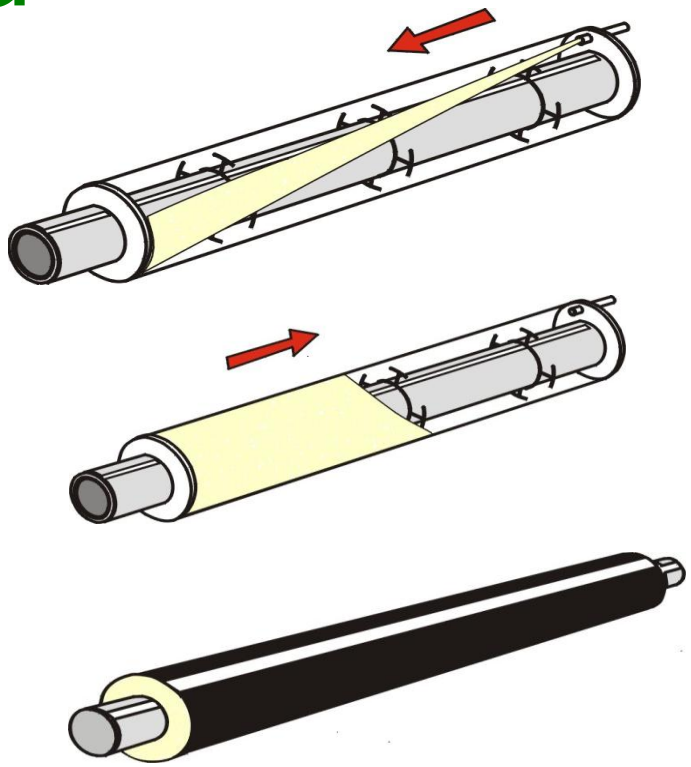
That is **4 times more** than HDPE shrink joints.

Or **40 times more** than cross-linked shrink joints.

Or **40 times more** than electro-welded joints.

Traditional pipe production - influence on lambda

- Before foaming, the service pipe is centred in the casing pipe with spacers.
- The pipe is positioned in an appropriate angle.
- The foam is injected into the casing pipe and expand from bottom to top of the pipe.

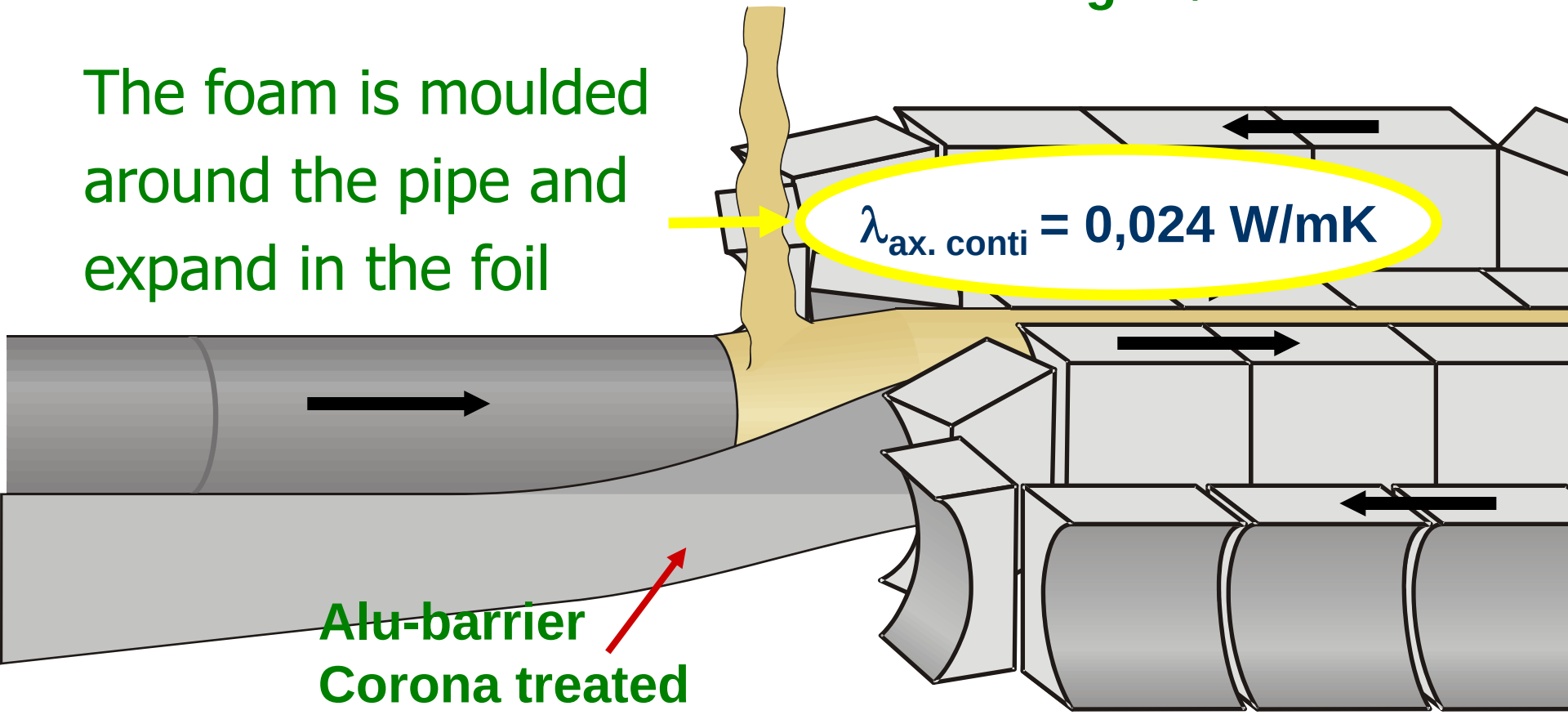


λ_{trad} = 0,027 W/mK

Axial conti pipe production - influence on lambda

Casing <=ø315 mm

The foam is moulded around the pipe and expand in the foil



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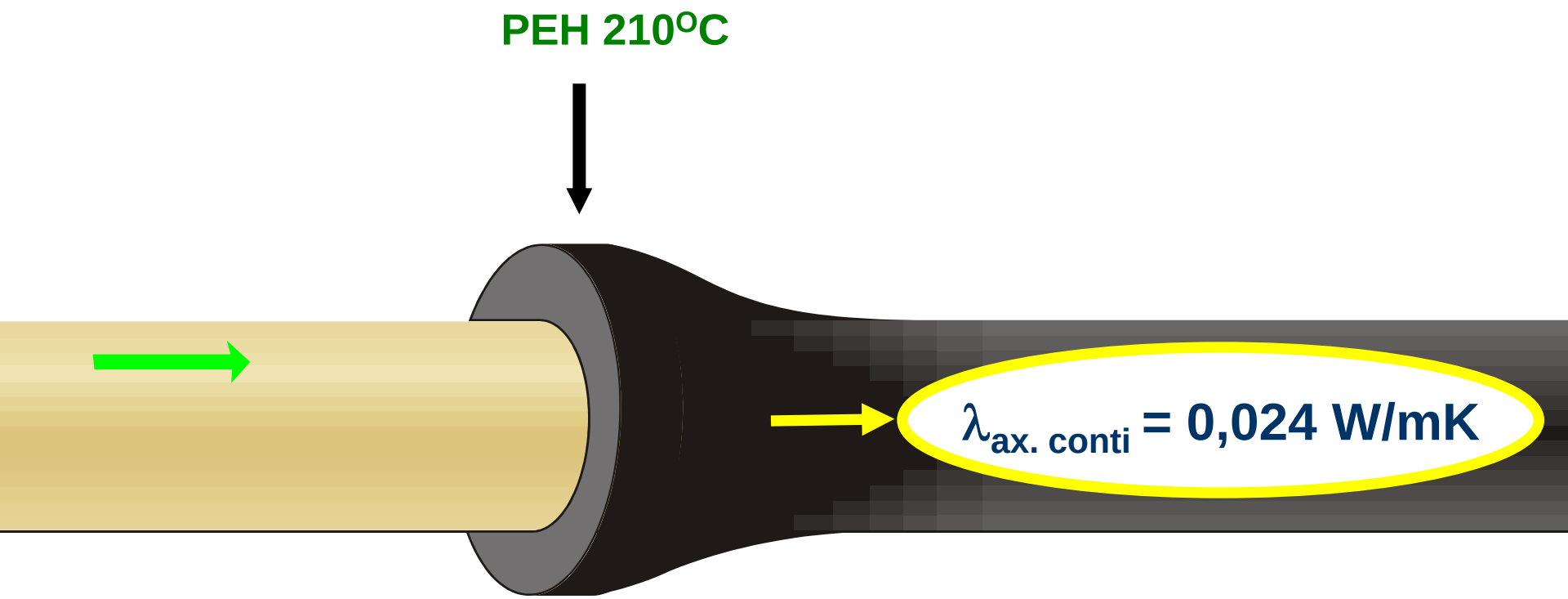
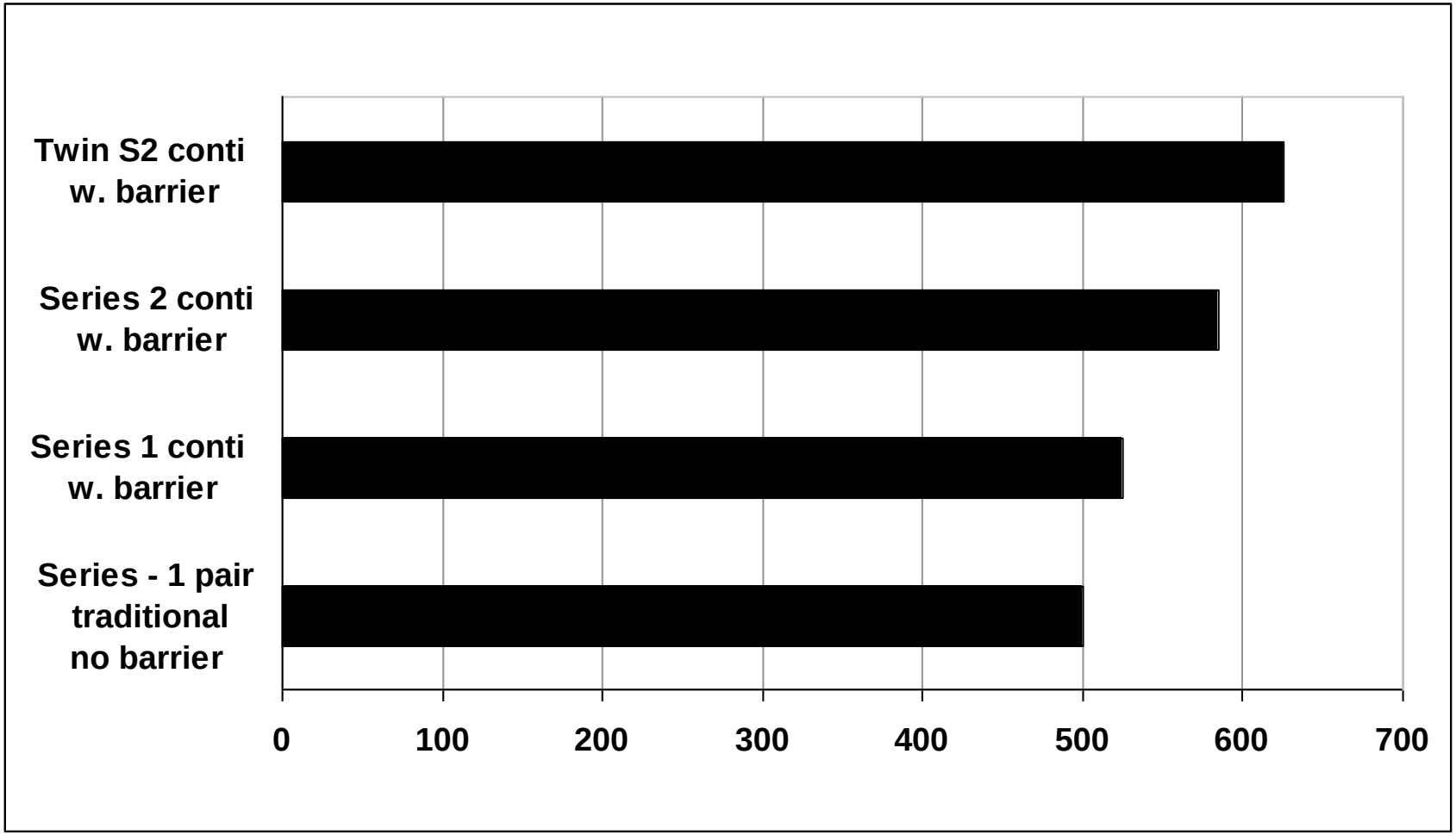
Pipe production – axial conti

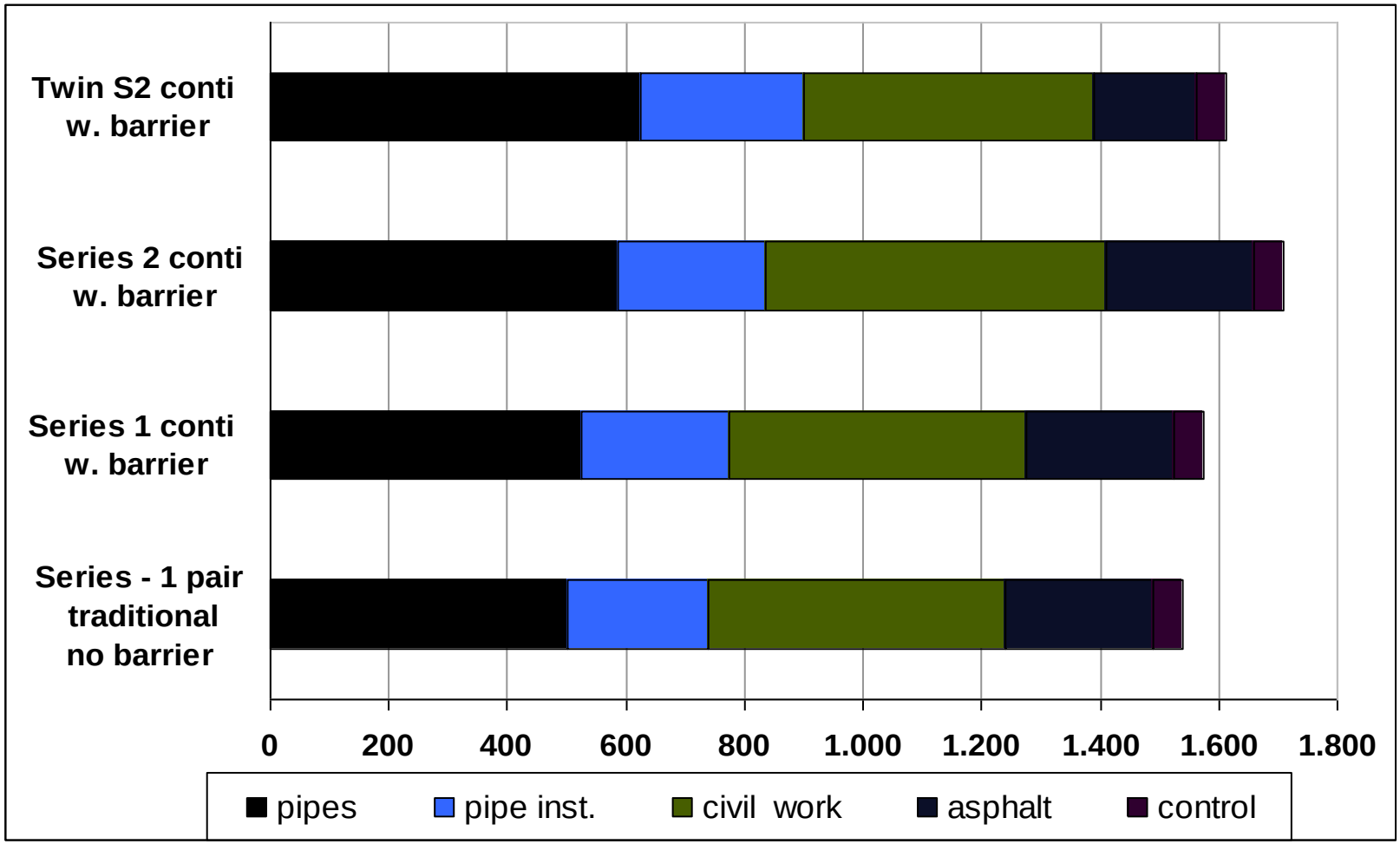
The casing is extruded on the foam



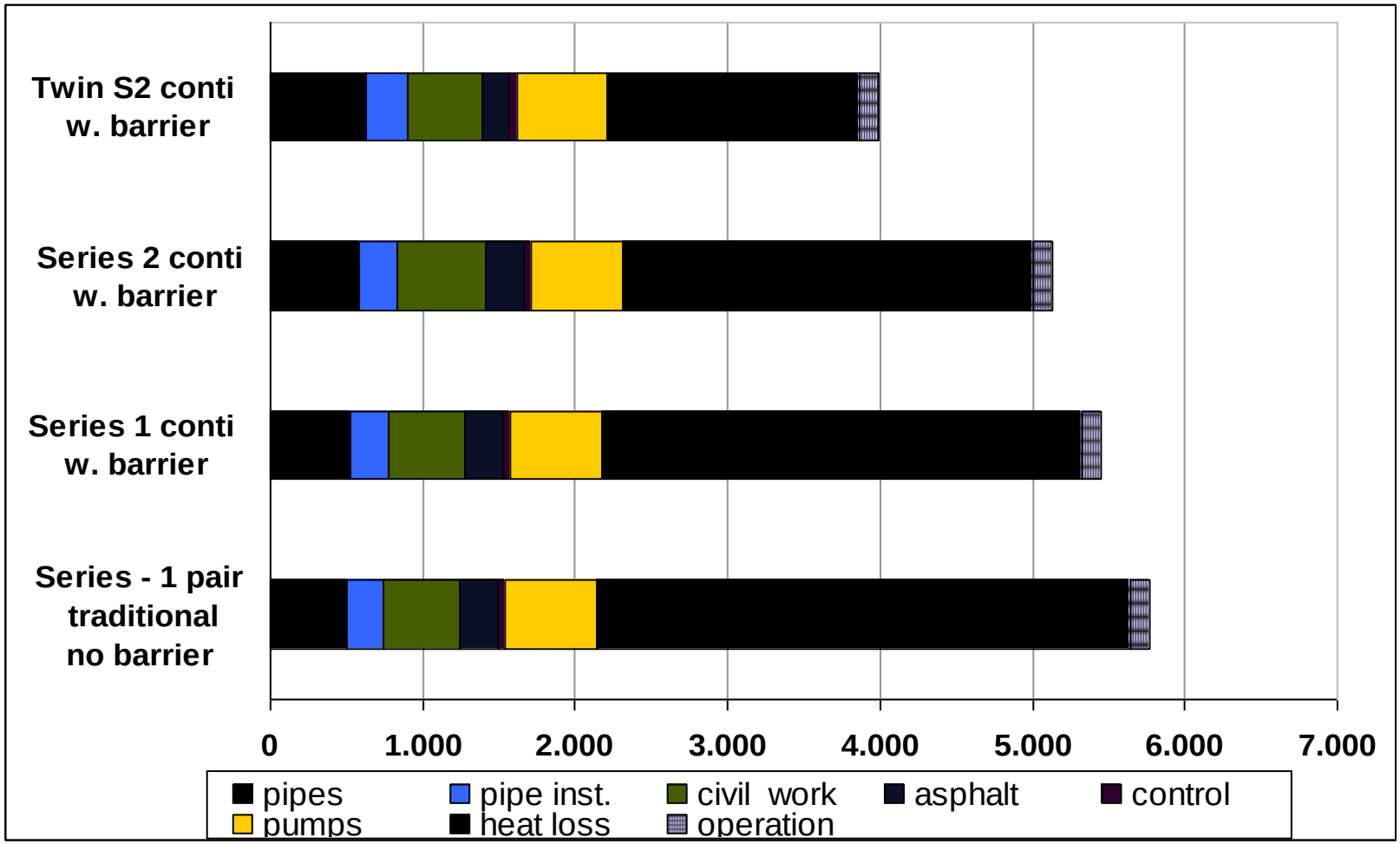
LCC - Pipes


Twin S2 conti w. barrier
Series 2 conti w. barrier
Series 1 conti w. barrier
Series - 1 pair traditional no barrier
0
100
200
300
400
500
600
700

LCC - Pipes + installation

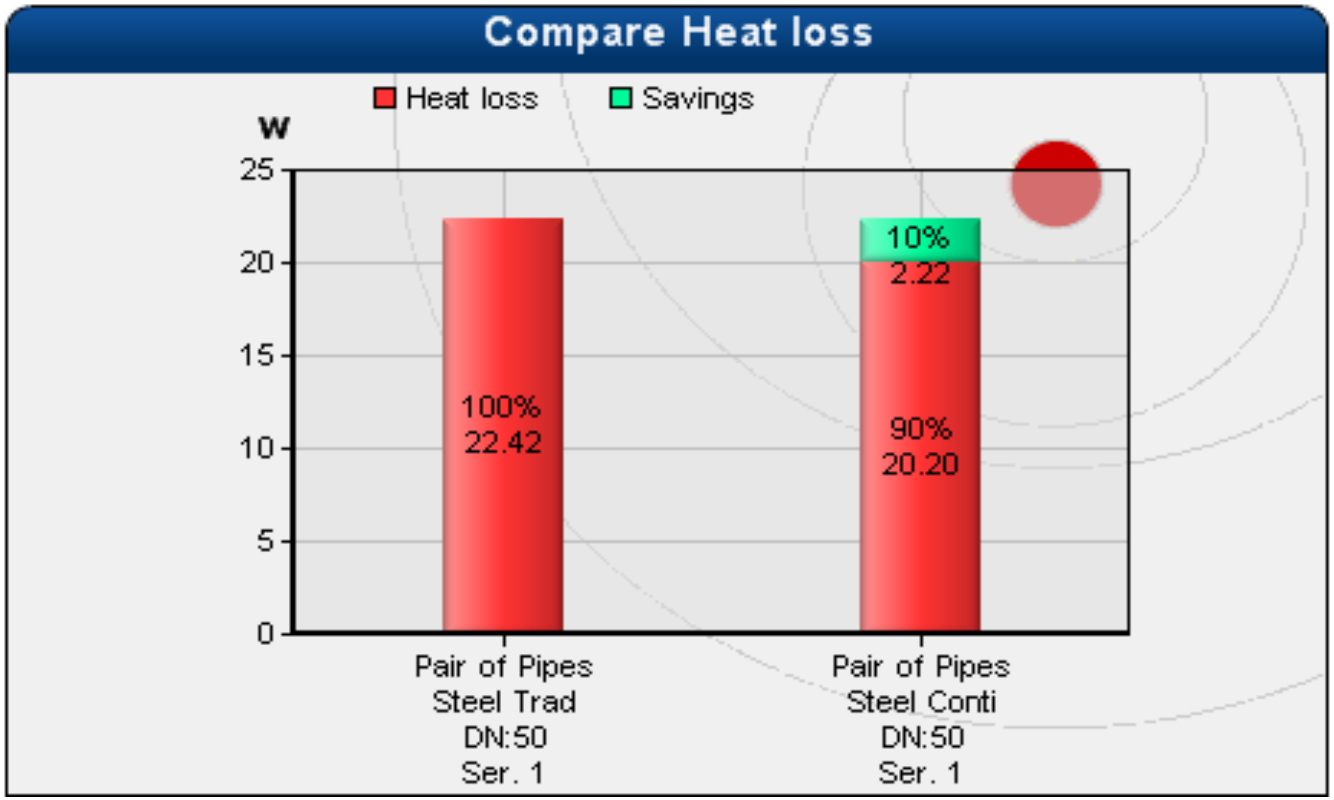


LCC - Pipes + installation+ heat loss + operation



Traditional / Conti

Difference in heat loss



Difference from λ 0,027 to 0,024 W/mK
without influence of ageing

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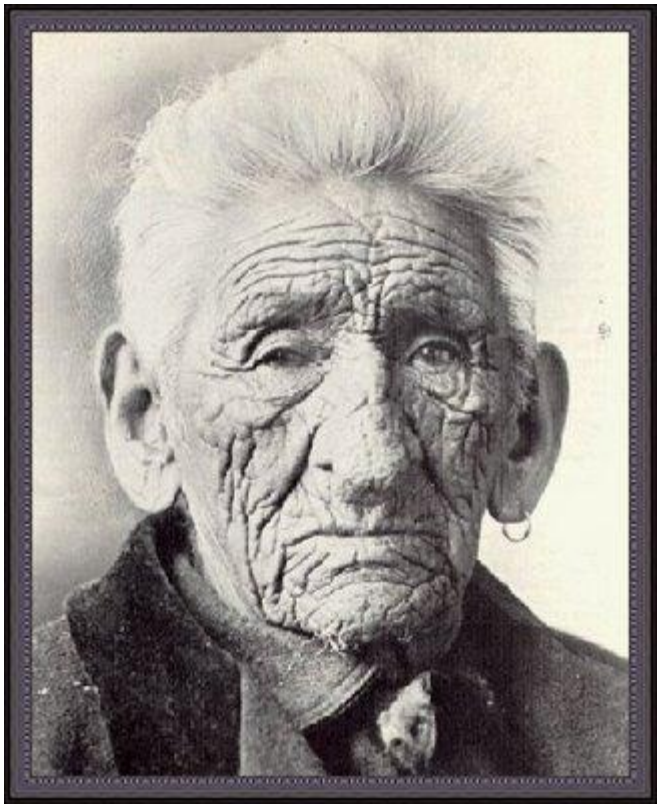
Ageing



# of PUR

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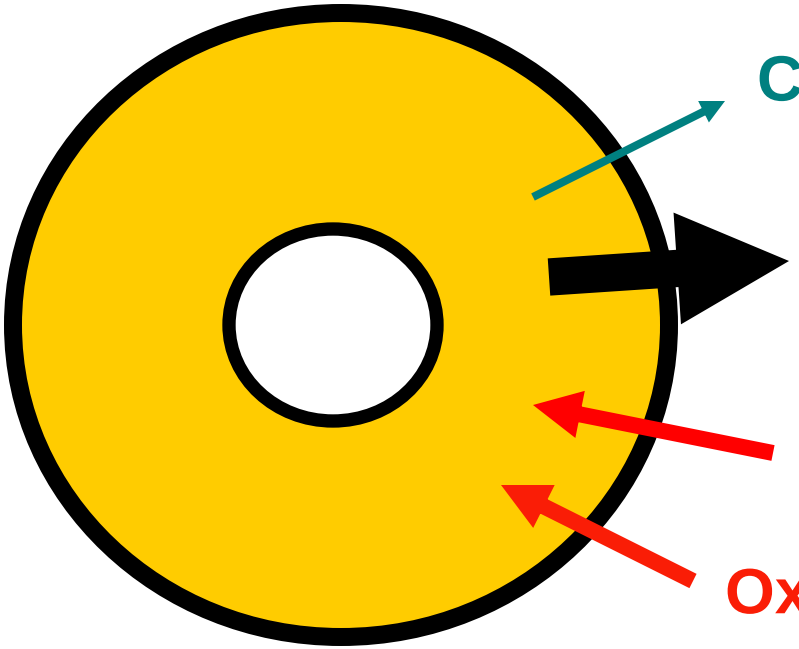
PUR

Diffusion of gasses



Cyclopentan, λ = 0,012 W/mK

CO_2 , λ = 0,017 W/mK

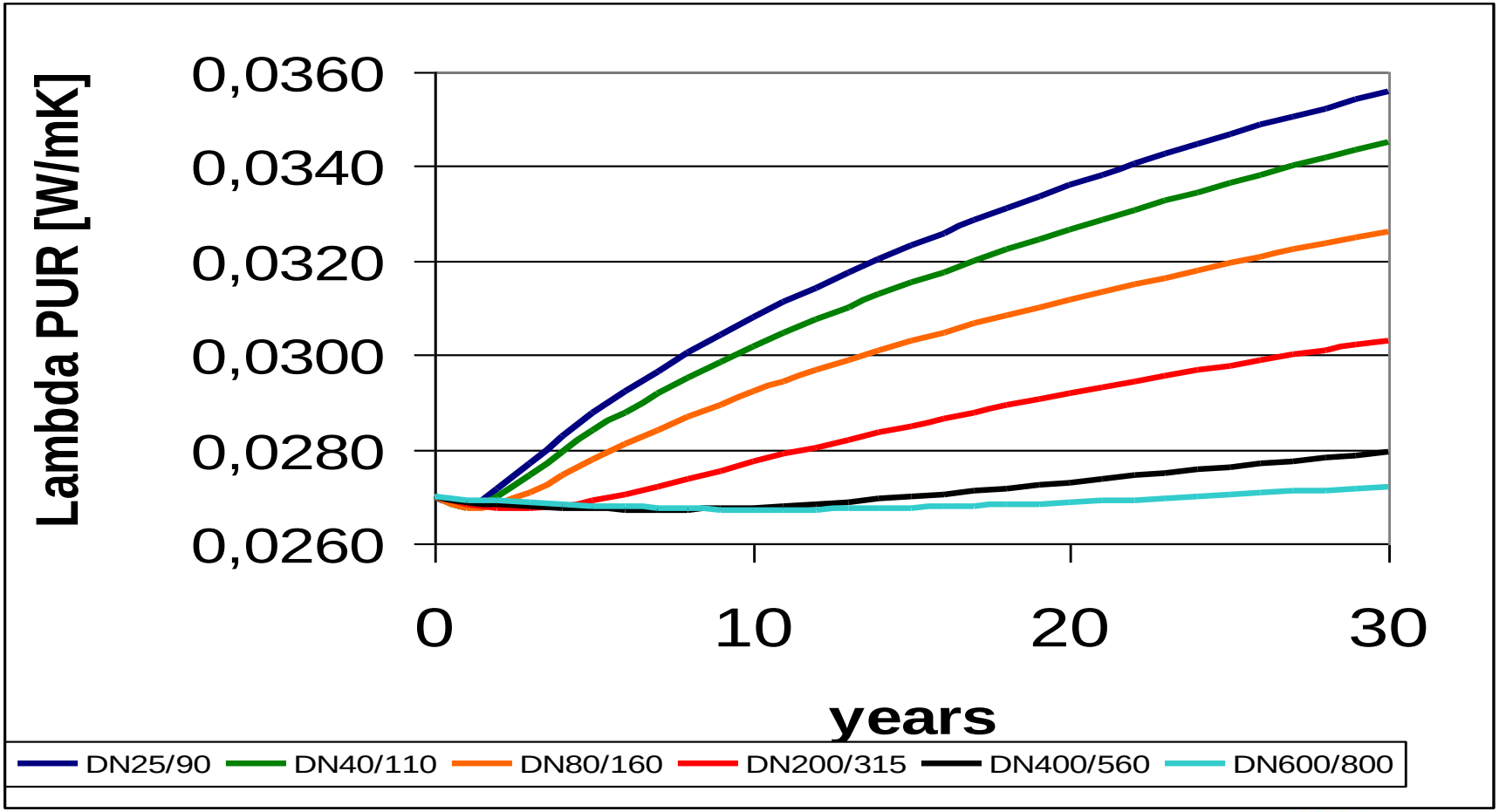
Nitrogen

λ_{air} = 0,027 W/mK

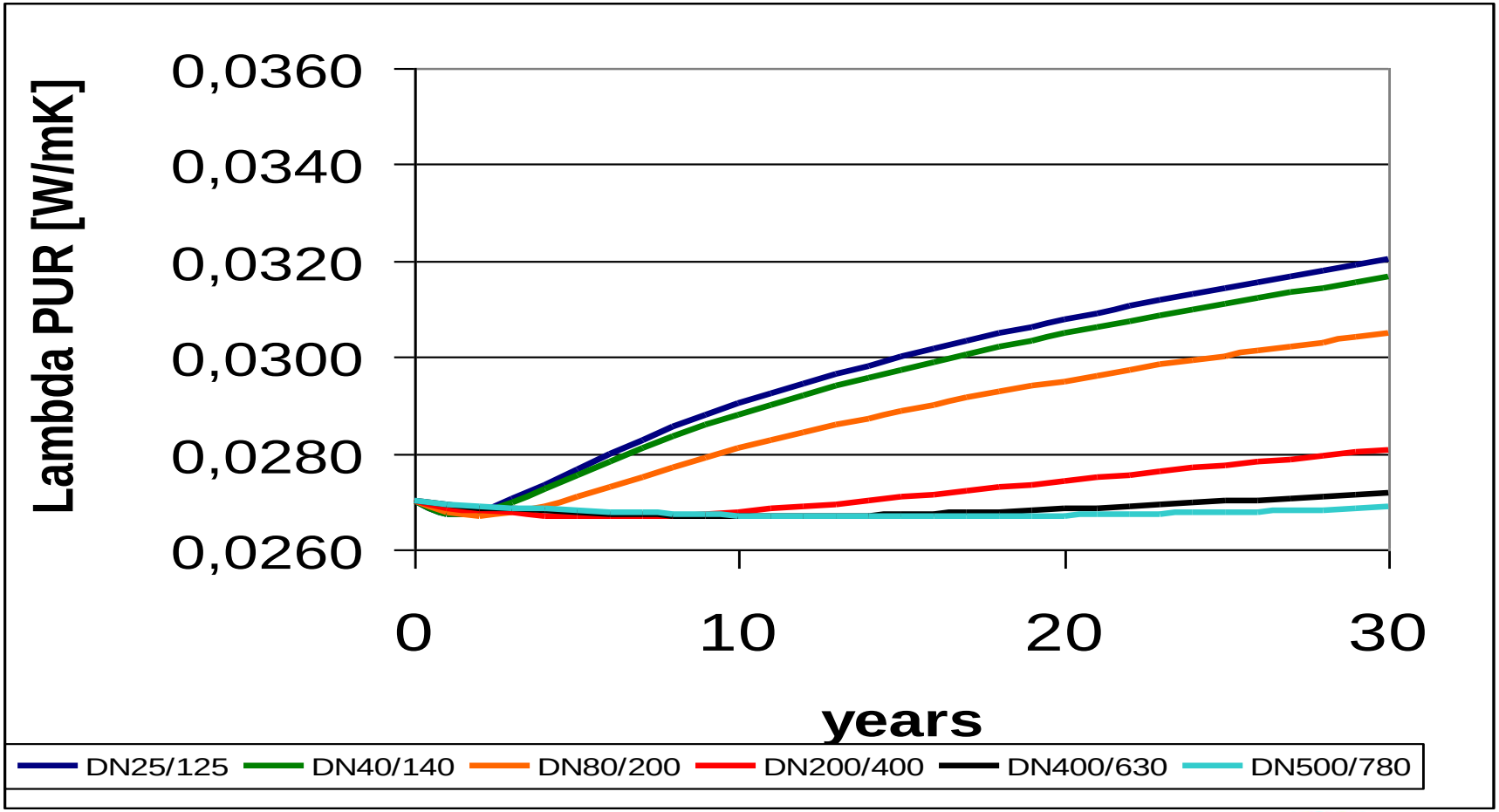
Oxygen

$$\lambda_{PUR} = \lambda_{SOLID} + \lambda_{RAD} + \lambda_{GAS}$$

Agein Traditional - Series 1

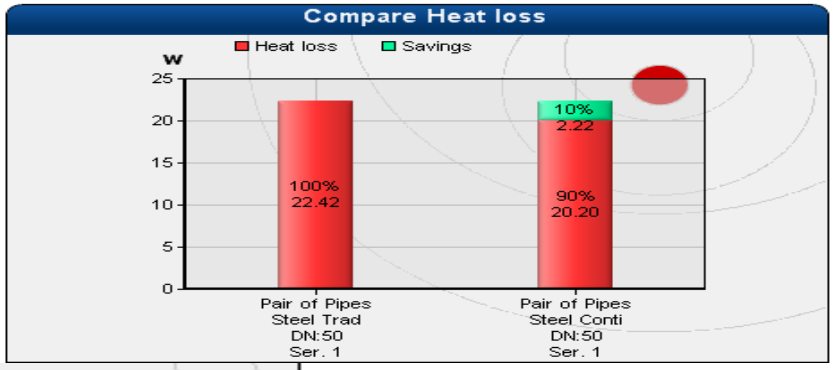


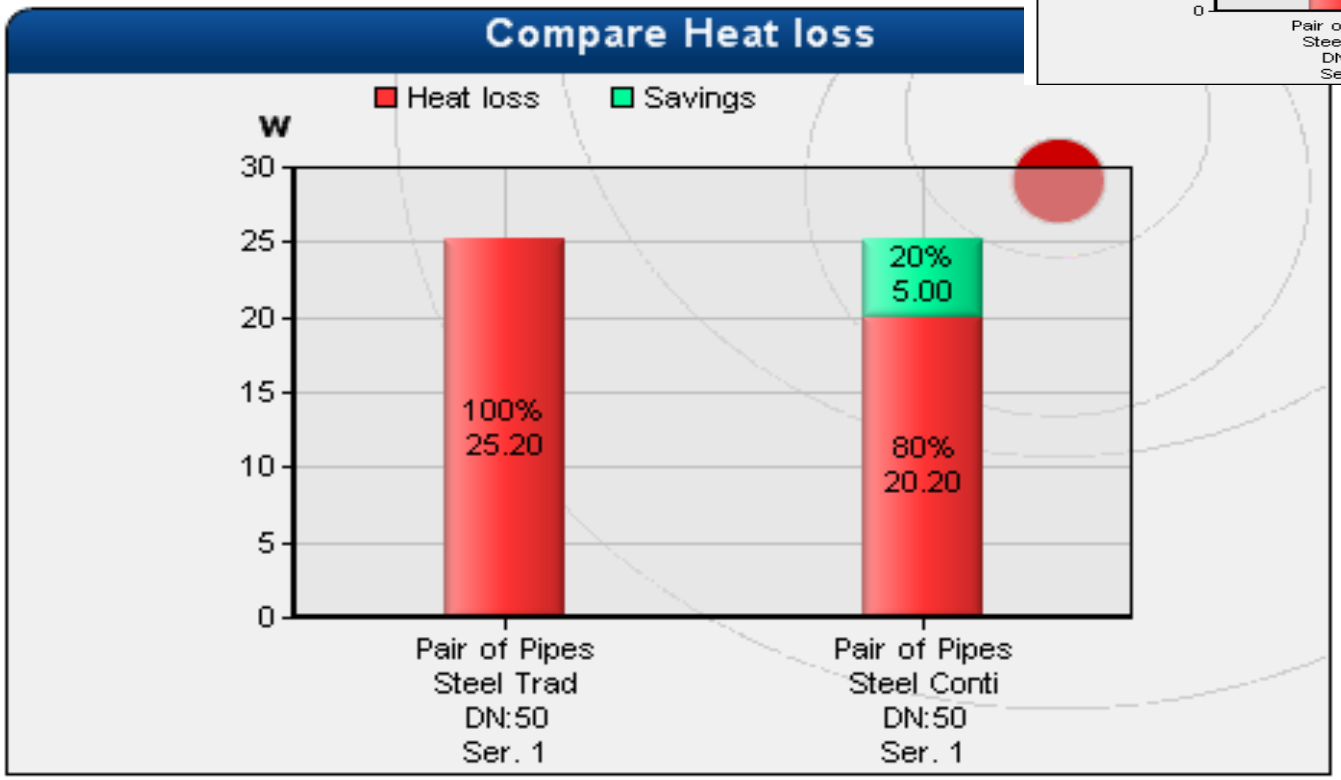
Ageing Traditional - Series 3



Traditional / Conti

Difference in heat loss





Difference from λ 0,027 to 0,024 W/mK with influence of ageing

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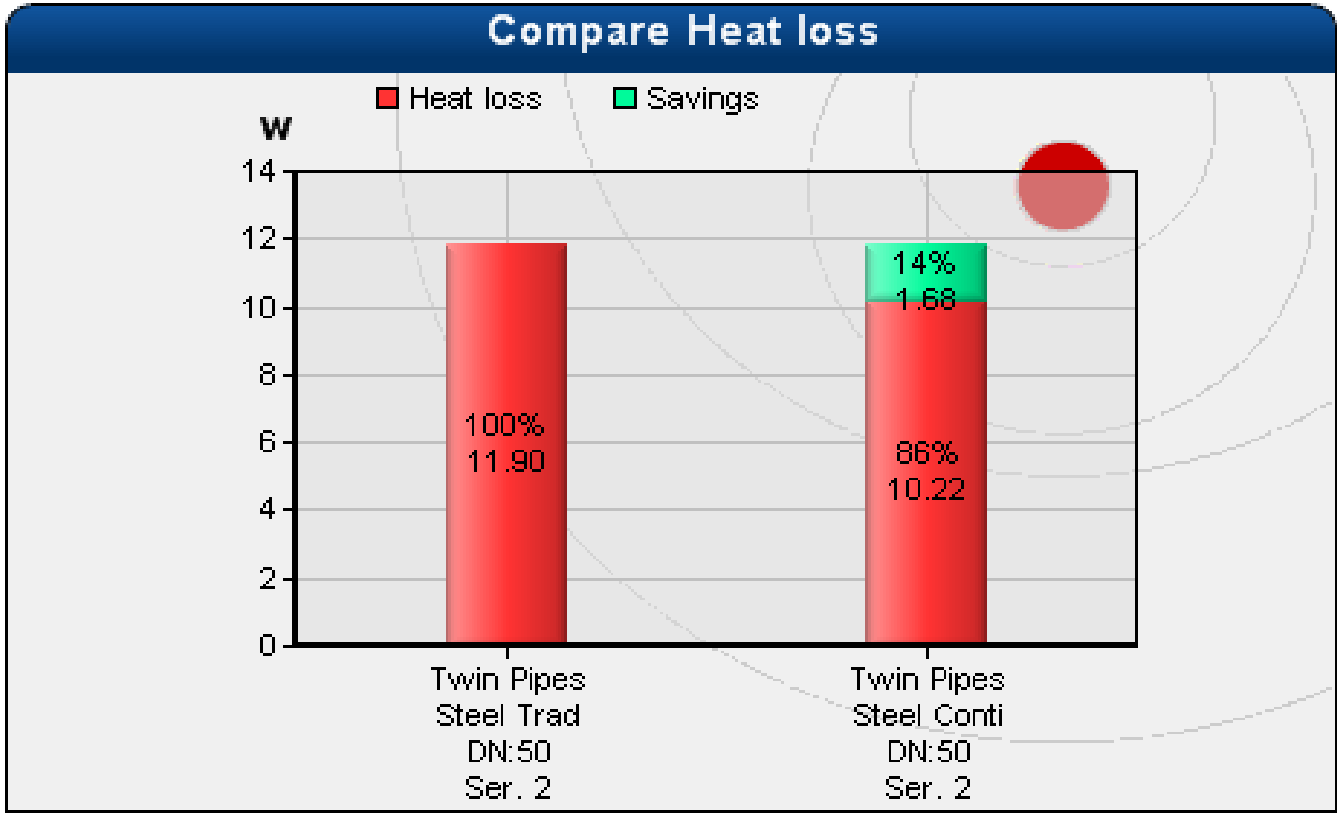
Traditional / Conti

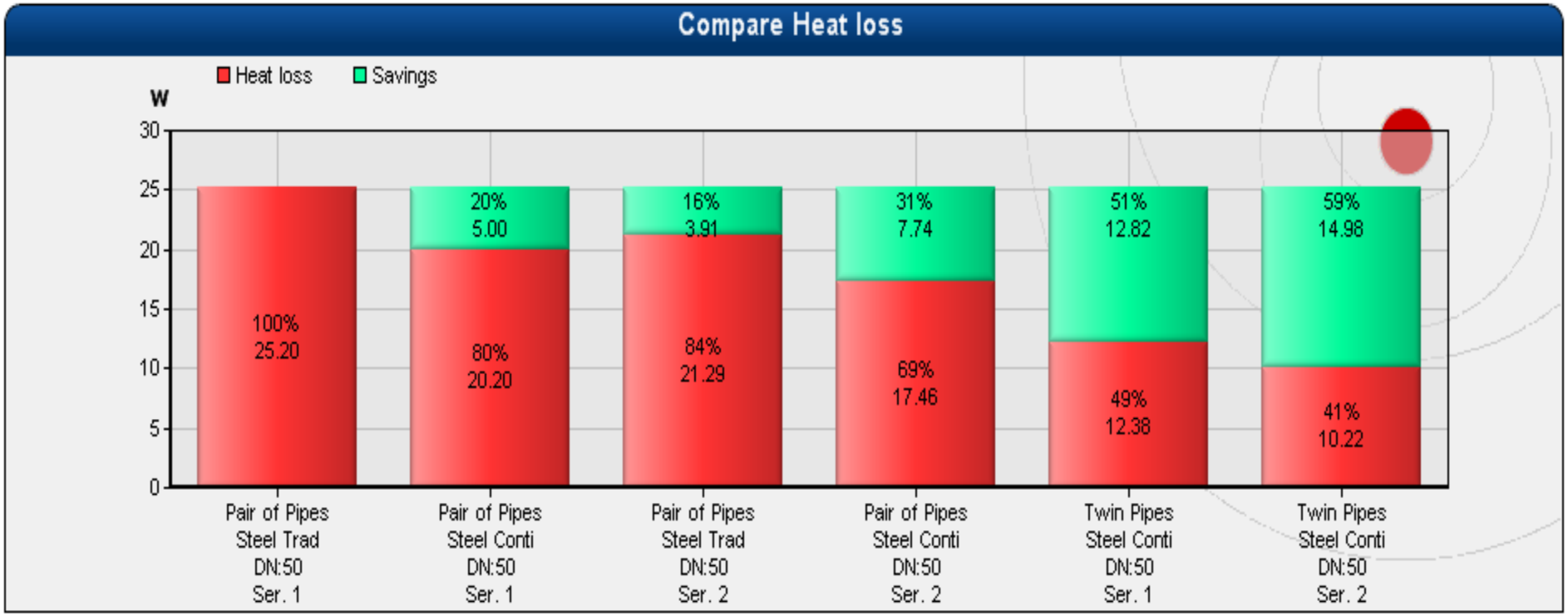
Difference in heat loss at Twin pipes



Difference from λ 0,027 to 0,024 W/mK with influence of ageing

Heat loss DN 50

Pair of pipes / Twin



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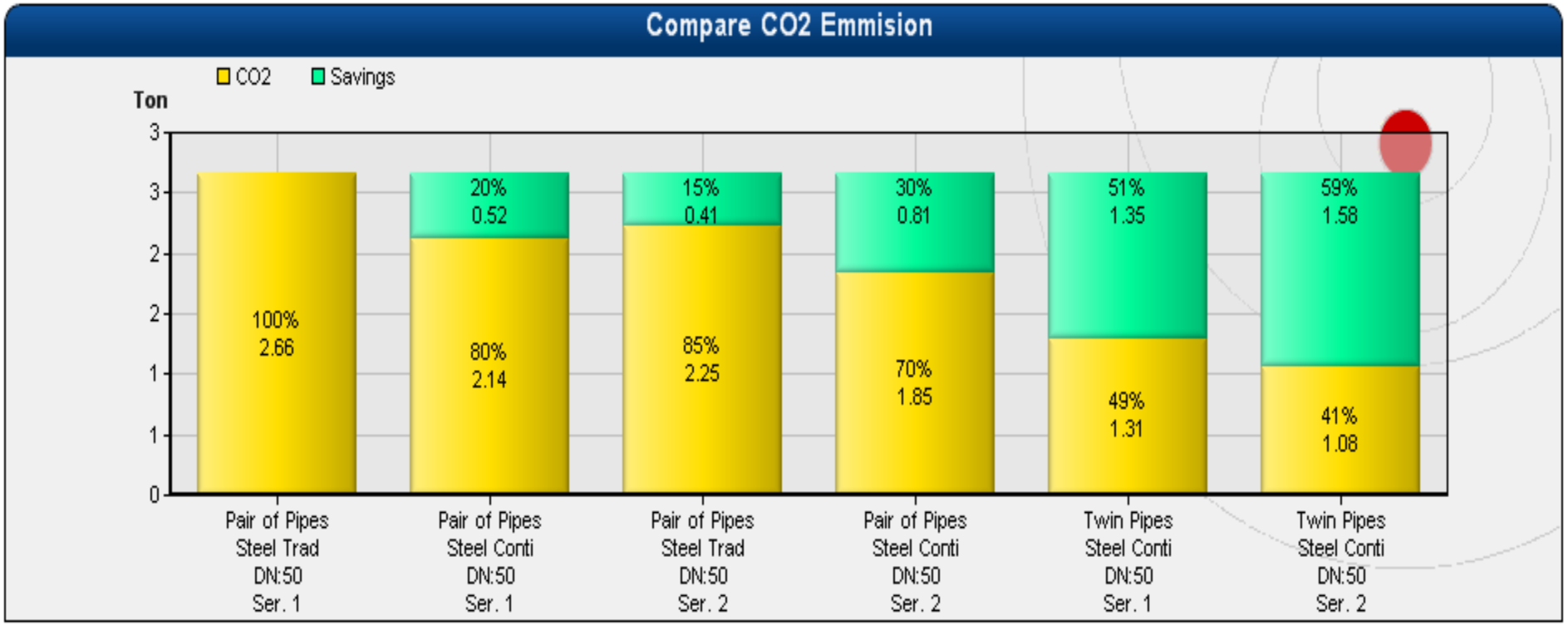
CO_2 emission DN 50

Pair of pipes / Twin



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Summary

- In the long run it can be expensive to buy cheap……

Summary

- … if you want to save money - and make business - you have to put focus on life cycle costs:

LCC

Thank you

For further information:

www.dbdh.dk

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