eltherm®
innovations in heat tracing

eltherm Railway Heating Systems

innovations in heat tracing

Trial Point of Deutsche Bahn, Burbach, 2013-12-06

eltherm GmbH –solutions with electrical heat tracing systems

eltherm GmbH is an international operating company specialising in the field of electrical heat tracing systems.

With more than 40 years of technology know-how, continuous demand for the highest quality and flexibility, this company has grown significantly since its humble beginning. A clear commitment to the production site in Germany strongly emphasizes the philosophy of eltherm, which is to supply its customers with electrical heat tracing system solutions individually customized to their requirements of the highest level.

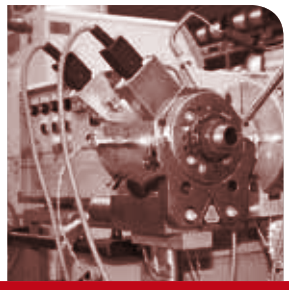
With its own comprehensive production facilities for all types of heating cable and accessories eltherm has built up the engineering expertise to become one of the leading manufacturers of electrical heat tracing systems in the world.

Besides frost protection and temperature maintenance applications up to 1000 °C, eltherm is the competent partner for complete system solutions like heating whole chemical or other industrial plants.

eltherm proved its potential and expertise in different applications for industries such as oil and gas, power plant, construction, automotive and food industries.

The eltherm engineers would like to face your challenge also.

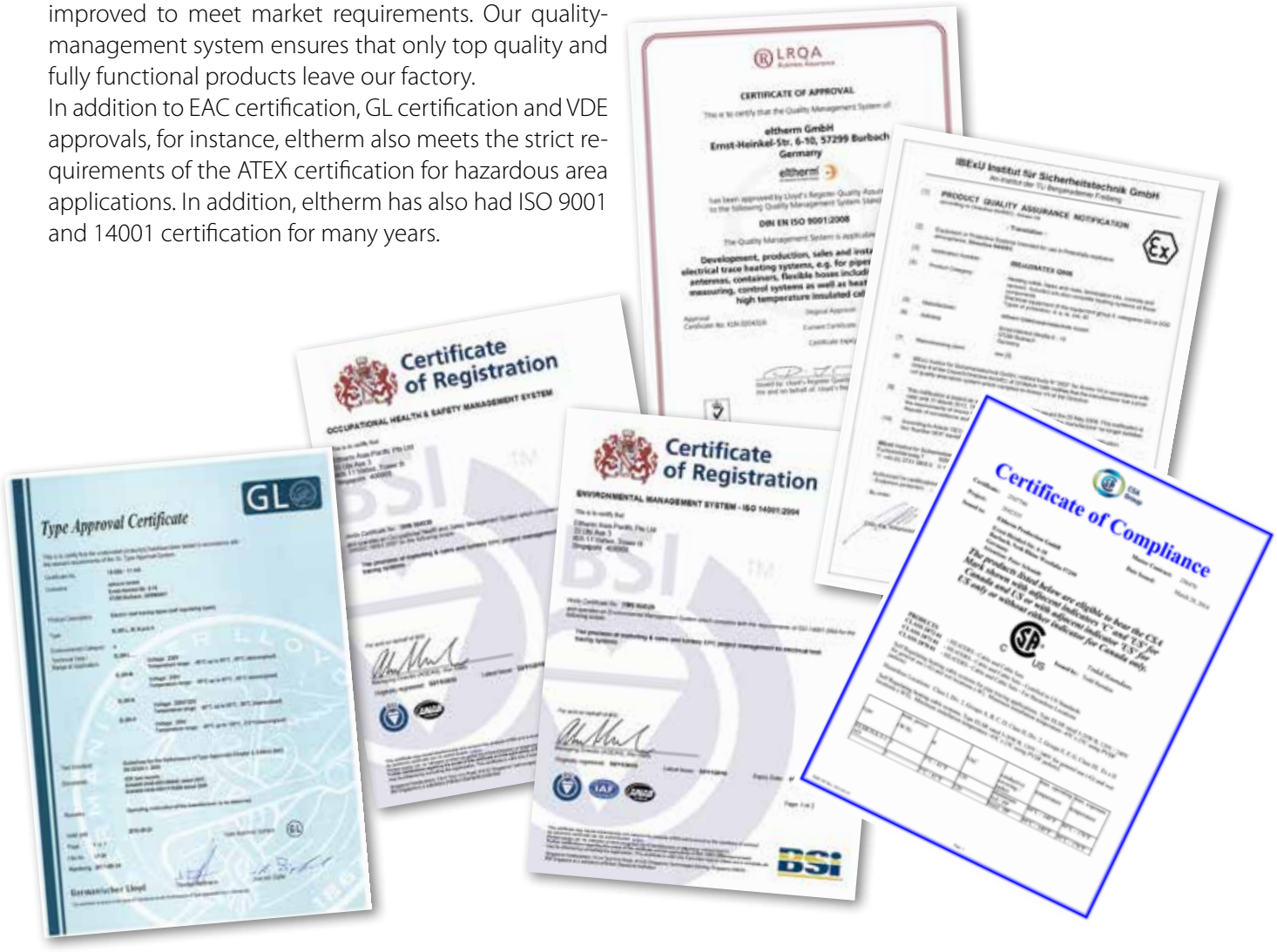
innovations in heat tracing



Solutions for your challenge!

Qualified Solutions

eltherm has its own production facilities and its own research and development team. This is where innovative solutions are born and where products are constantly improved to meet market requirements. Our quality-management system ensures that only top quality and fully functional products leave our factory.
In addition to EAC certification, GL certification and VDE approvals, for instance, eltherm also meets the strict requirements of the ATEX certification for hazardous area applications. In addition, eltherm has also had ISO 9001 and 14001 certification for many years.



Purpose of rail and point heating

The past winters, especially 2010/2011, have shown: For a proper and secure railway transportation and a reliable point switching, frost protection and therefore heating plays a more and more important role.

The eltherm GmbH took the challenge to find the best solution for each frost problem within the railway transportation area.

No matter if its rail heating, point heating or any other heating challenge in the field of railway transportation, the eltherm engineers have developed the most suitable solution.

In areas with frequent and long frost periods, any surface exposed to open air is likely to be covered by snow and / or ice.

For example with the metrosystems of Lausanne and Marseille, ice or snow covered track running surfaces reducing the friction between the rubber wheels and the track and thus restricting control over the train.

Moreover, ice covered third rails are compromising the reliability of train detection systems – a major safety issue.

Manually recovering frozen or snow covered points can present a severe danger to the track maintenance personnel involved.

For trouble free train operation during winter conditions, rail and point heating is recommended to ensure the track surface remains free of ice and snow and keeps the points moving.

EL-Rail System

Rail heating - basic design consideration

When using electrical trace heating on rails, it is recommended that:

- the number of tracings on the rail is kept to a minimum by
  - choosing a cable of the highest possible output
  - placing it at the most efficient position on the rail
  - ensuring a maximum heat transfer to the rail
- the number of total supply points is kept to a minimum by installing maximum possible circuit length of cable
- the number of total cable terminations and splices is kept to a minimum, again by installing maximum possible circuit length of the cable

All of those considerations are directly linked to providing a cost effective installation, maintenance and to a reliable operation of the heating cable.

With regard to cost effective running of the heating system, suitable controls are required.

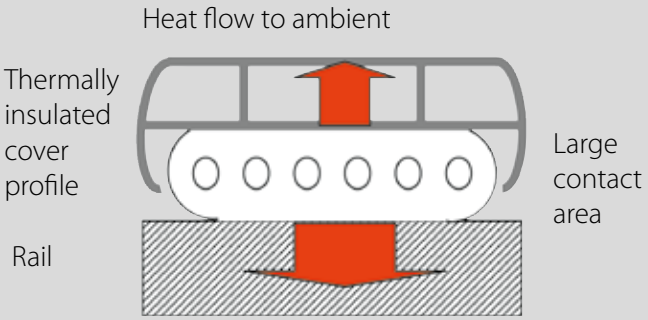
Local track conditions may however give rise to the need for higher loads, depending mainly on the predicted snowfall rate for the specific area and the expected minimum ambient temperature expected.

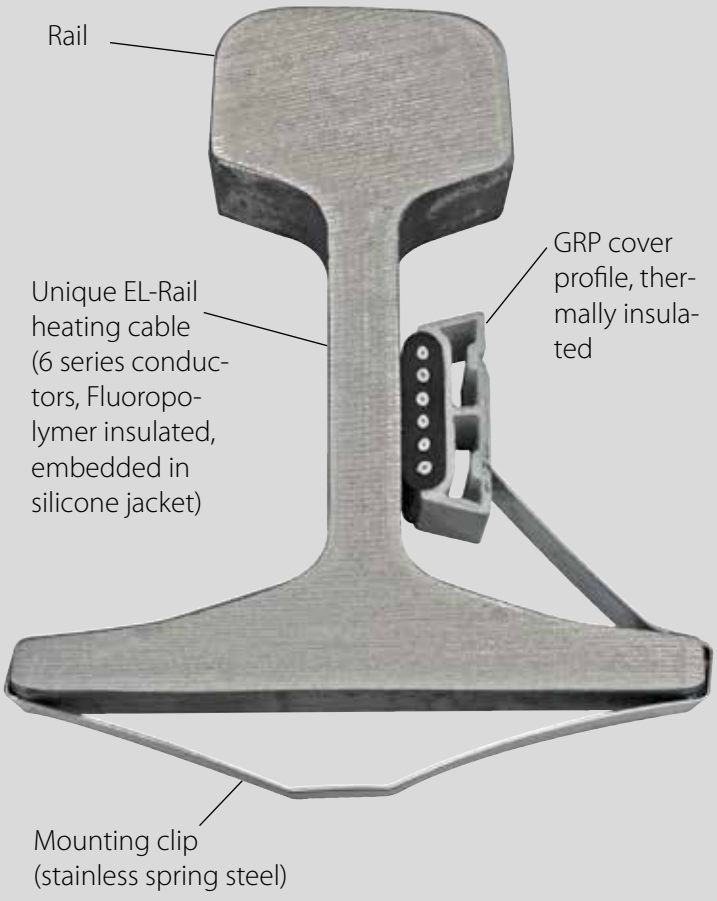
The optimum load required depends on the expected weather conditions and the track availability required.

eltherm Rail Heating System EL-Rail

The eltherm proposal utilizes a single series cable per rail. This cable has an unique flat shape to ensure maximum heat transfer to the rail. This effect is achieved by a rigid, thermally insulated cover profile, which holds the cable firmly against the rail by means of spring steel mounting clips with defined force.

Heat flow for eltherm EL-Rail





Summary of benefits

- **Low number of power supply points required** – heating cable circuit lengths up to 1,000 m.
- **Evenly distributed heat** along the entire rail - voltage drop in El-Rail cable is 0 %.
- **No risk of cold zones** on the rail - no low power or dead cable sections.
- **Excellent thermal efficiency** due to
  - thermally insulating cover profile which directs heat flow toward the rail,
  - good contact between heating cable and rail provided by unique large flat cable surface, rigid cover profile and spring steel fitting clips.

  Which means:

  El-Rail cable achieves a higher surface temperature on top of the rail at a lower power consumption compared to other systems.
- No **special precautions for the handling of inrush currents** necessary.
- Fluoropolymer electric insulation provides **superior temperature withstand properties** along with an unequalled flexibility, thus providing extra electrical safety in case of voltage peaks (El-Rail cable passes 2 kV factory spark test).
- Various connection and end termination sets available: allows on-site termination or factory teminated delivery by eltherm - according to customer requests.
- **Quick and easy installation** due to unique fitting clips that can be fastened either by a MMS bolt directly in the concrete basement of the rail, by means of a spot welded bolt directly on the rail itself or by embracing the bottom flange of the rail.
- **Low maintenance costs** due to
  - low number of power distribution panels, junction boxes and cold end connections,
  - protected position of the heating cable and additional protective cover profile.
- All materials selected for their mechanical properties suitable for heavy duty use and are resistant against oil, glycol, herbicides and UV radiation. The Fluoropolymer insulation layer provides **additional safety against extremely aggressive media** like acids and cleaning solutions etc.
- Extremely low lifecycle costs - the eltherm EL-Rail System is highly engery efficient because of unique power stepping technology.

EL-Rail Heating Cable

The eltherm EL-Rail is a flat cable, combining six Fluoropolymer insulated series heating conductors in a silicone over-jacket. Superior properties of the heating system, low installation and operation costs with professional support from eltherm make the EL-Rail the first choice in rail heating applications.

Available resistances:	wide range available upon request
Dimensions:	8 x 34 mm
Min. bending radius:	50 mm
Weight:	approx. 400 g/m
Max. circuit length:	up to 1,000 m

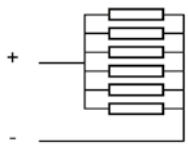
Cable specifications

Insulation Class:	2
First insulation:	Fluoropolymer
Second insulation:	Silicone (Insulation based on VDE 0253 standard)
loading:	1 - 150 W/m (upon request)
Voltage:	1 - 1,000 V (upon request AC, DC, three-phase current)
Max. temp. operated:	50°C
Max. temp. de-energized:	150°C
Min. installation temp.:	– 40°C
Ohm values:	according to site conditions

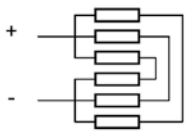
Resistant against UV rays, Glycol, mineral oil and herbicides

Possible Connections:

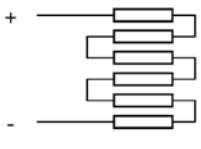
6 parallel



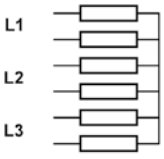
3 parallel 2 series



6 series



Star



up to 30% Energy - Saving!*

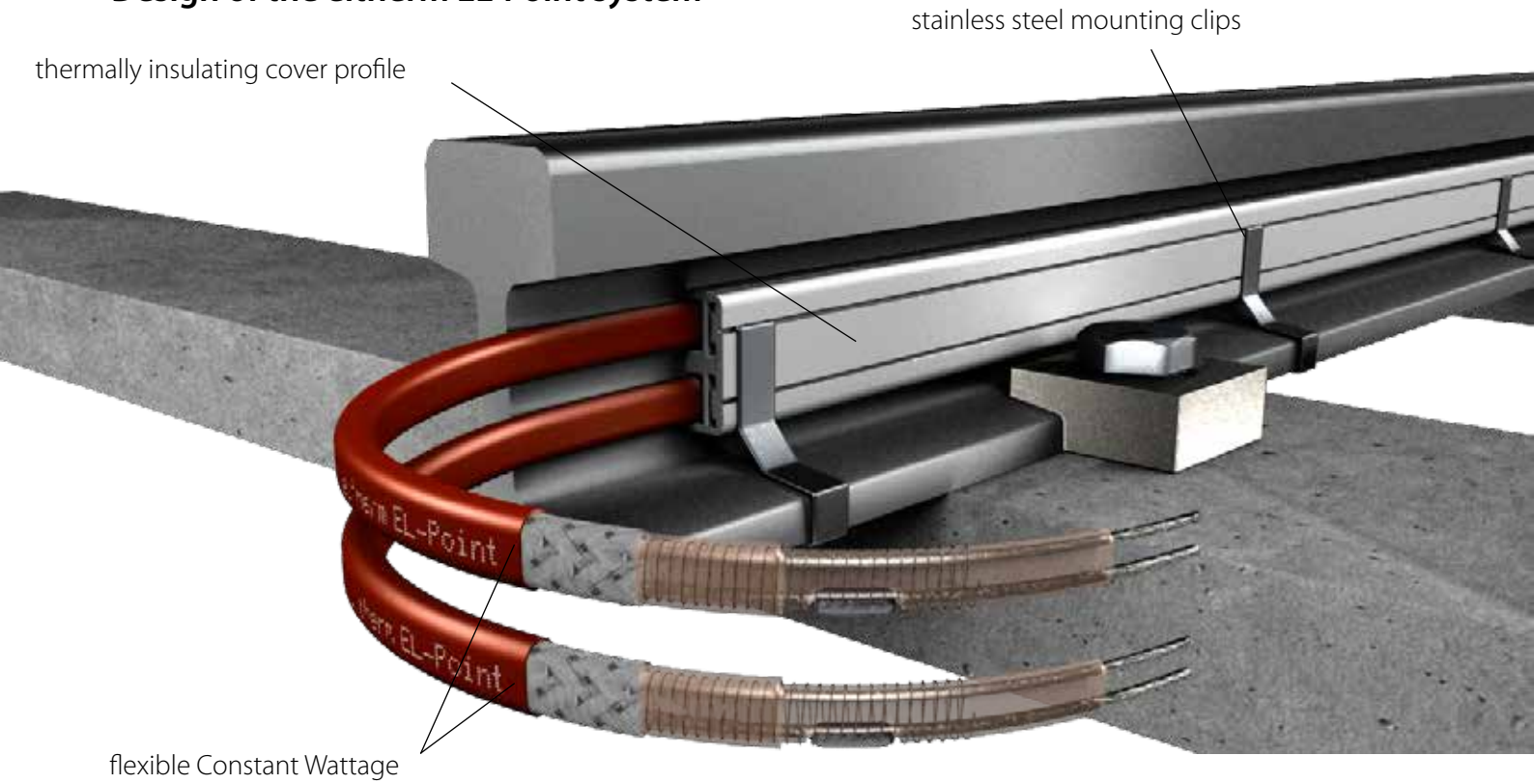
EL-Point System

* In comparision with conventional point heating systems

Technical details

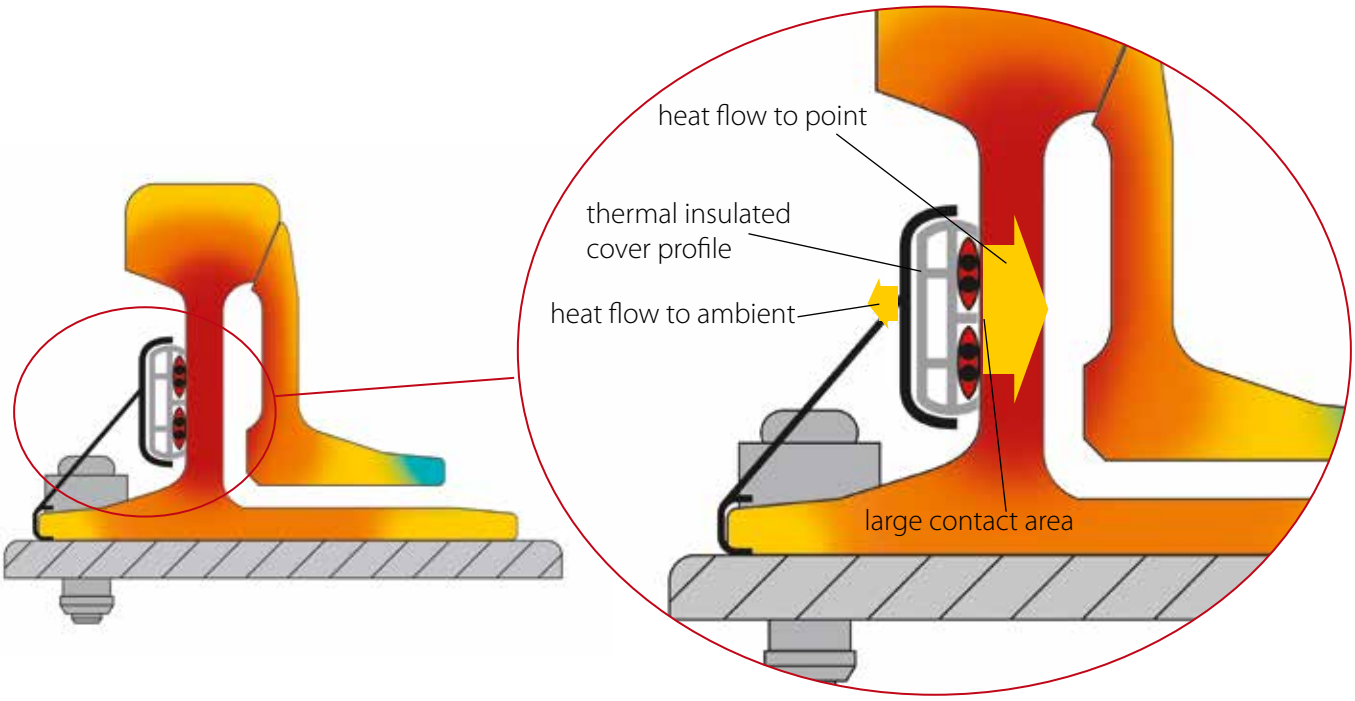
- ‚Cut-to-length' constant wattage heating cable
  (W x H approx. 15 x 7 mm, distance between contact points approx. 500 mm)
- Versions from 50V up to 750V as standard (other voltages upon request)
- Thermally insulating GRP cover profile (W x H approx. 40 x 11 mm, length approx. 2000 mm)
- Stainless steel fitting clips
- Up to 2 heating cables per cover profile
- Power output from 120 W/m
  (one heating cable per cover) to approx. 300 W/m (two heating cables per cover)
- All components UV-resistant and resistant against oil, grease, herbicides, salt and de-icing fluids
- Optional: Flexo plugs pre-fitted to heating cable or intermediate cold lead
- Very high efficiency compared to other point heating systems
- Non conductive outer material

Design of the eltherm EL-Point system



EL-Point System

Point heating with eltherm EL-Point system

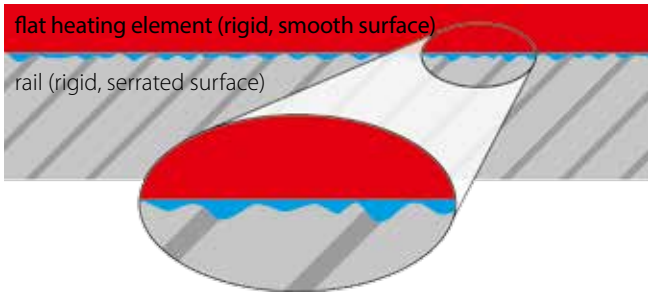


The thermally insulating cover profile reduces heat losses to ambient and directs the heat flow toward the rail. The big, dark rail surface turns into a radiator - the heat radiation frees the gap between stock rail and switch-blade effectively from snow and ice. That means: **High efficiency due to high heat radiation ratio** and partial thermal insulation of rail surface by cover profile.

EL-Point System

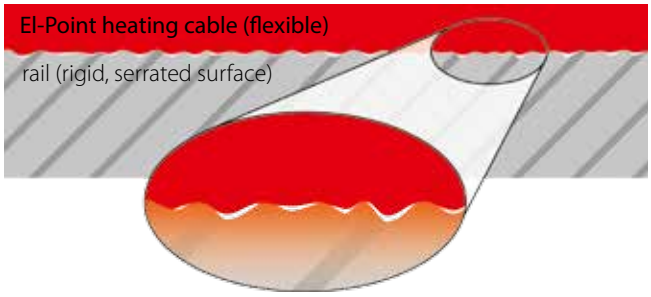
eltherm EL-Point System in comparison with conventional flat heating element

Point heating with rigid flat heating element



Between the rail and heating element surface, a number of small gaps occur because of the irregularities in the rail surface and the inflexibility of the heating element sheath. The result is a comparatively poor heat transfer into the rail and thus a comparatively low rail temperature.

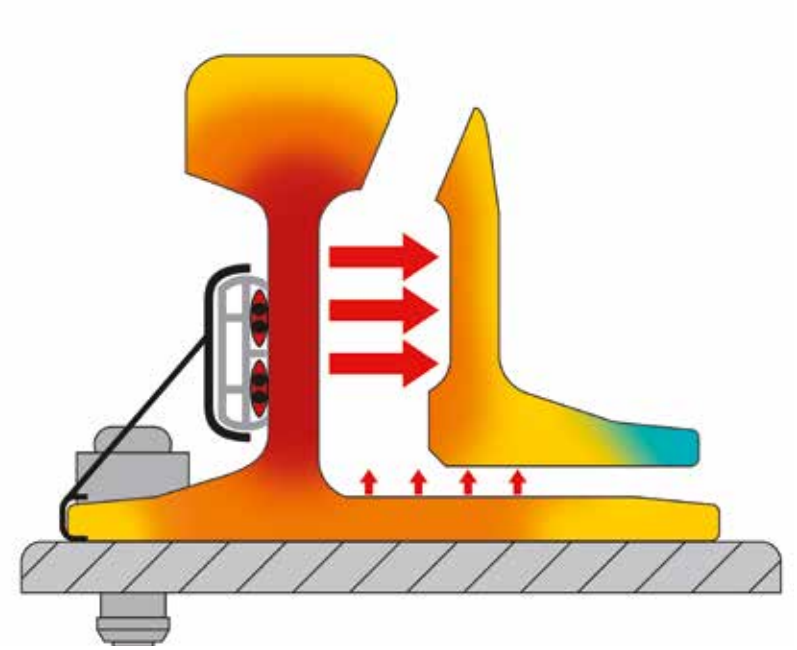
Point heating with eltherm EL-Point



Due to its flexibility, the heating cable can equalise most of the rails irregularities. Thus the **heat transfer into the rail is enhanced** and results in a higher rail temperature at relatively low energy consumption.

Point heating with eltherm El-Point system:

resulting heat radiation in gap between stock rail and moving rail (open position)



Advantages of the eltherm Point Heating System EL-Point

- **Reduced stock and easy handling**
  - only one product is needed for all turnout geometries
  - heating cable can be taken off reel and cut to length
- **Optimised heat transfer** from heating cable to point rails
  - flexible heating cable adapts in the best possible way to the point rail, thus minimising gaps
  - thermal insulating cover profile reduces heat loss to ambient and directs heat flow towards the point rail
  - large, dark rail surface is thus turned into a radiator – the high heat radiation ratio clears the gap between stock rail and moving rail effectively from snow and ice
  - high efficiency due to high heat radiation ratio and partial thermal insulation of rail surface by cover profile
- **Fast and easy mounting**
  - due to radiation effect, installation on the outside of the stock rail is possible –easy cutting and on-site termination
  - no risk of short circuit of rails due to fluoropolymeric heating cable surface and cover profiles, thereby easy installation on existing track circuits
  - heating cable comes pre-terminated with plugs and / or cold lead if required
  - cutting to length automatically creates cold length of 500 mm for splicing or connecting to junction box
- **Low maintenance requirements**
  - moisture problems are avoided by use of polymeric electrical insulation and jacket
  - easy access to the heating cable due to position on the outside of the stock rail whilst still optimal protection by rigid cover profile
- **No risk of blocked signalling rail-circuits** because of non-conductive outer material

* In comparision with conventional point heating systems

Control technology

Control and monitoring systems

A detailed analysis of all parameters at the installation site is required to ensure the highest energy saving and the lowest life-cycle costs. Besides weather data, available connecting loads as well as customer-specific data like travel and maintenance periods are included in the concept.

The individual concept of a control system can be integrated in an overall concept with various interlinked components. Both the connection to a visualisation system as well as the integration in existing higher-level control devices and condition-monitoring systems are possible at any time.

Depending on configuration, the following data will be processed in the logic:

- Actual power consumption
- Energy consumption per day / week / month / year
- Status signal of all heating circuits available
- Energy storage
- Power supply data (power / current / energy)
- Error messages
- Warning messages to ensure preventive maintenance works
- Weather data:
  - Wind direction and speed
  - Precipitation type and quantity
  - Air and rail temperature

Technical options:

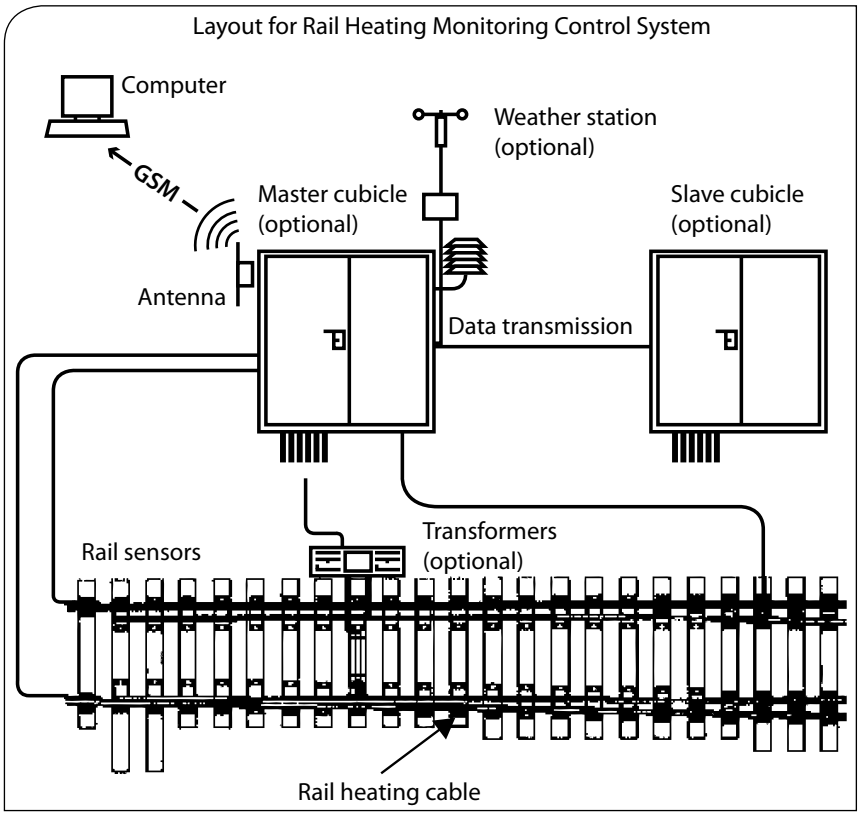
- Nominal voltages from 24 V up to 1000 V AC and DC, supply via local network or overhead line
- Stand-alone or connection to the control system through glass fibre or copper wires (GSM, GSM-R, Tetra, etc) - mixed operation of different medias possible
- Control cabinet systems made of steel, stainless steel, aluminum sheet or glass fiber reinforce plastic (GRP) in protection classes up to IP 68 K
- Surge protection systems
- Evaluation of weather forecasting services to ensure a timely preheating of facilities

eltherm systems do more than just trigger heating. They also monitor the complete system and detect errors – if any.

Server based control system

The central server offers several benefits:

- Central modem pool
- All alarms are sent to one place
- All alarms are stored in the same database
- Alarms can be rerouted into e-mails, SMS messages via server
- All software is stored in one place, which means easy maintenance, upgrades and back-up routines
- Customised user rights management



Energy efficiency

Consideration of energy efficiency - eltherm EL-Point compared with flat heating elements

Preliminary

The values which are the basis of this calculation have been determined at the eltherm laboratory under reproducible and realistic conditions and can be reviewed upon request.

Readings of heating experiment

Highest temperature difference between rail and the environment (after 250 minutes):

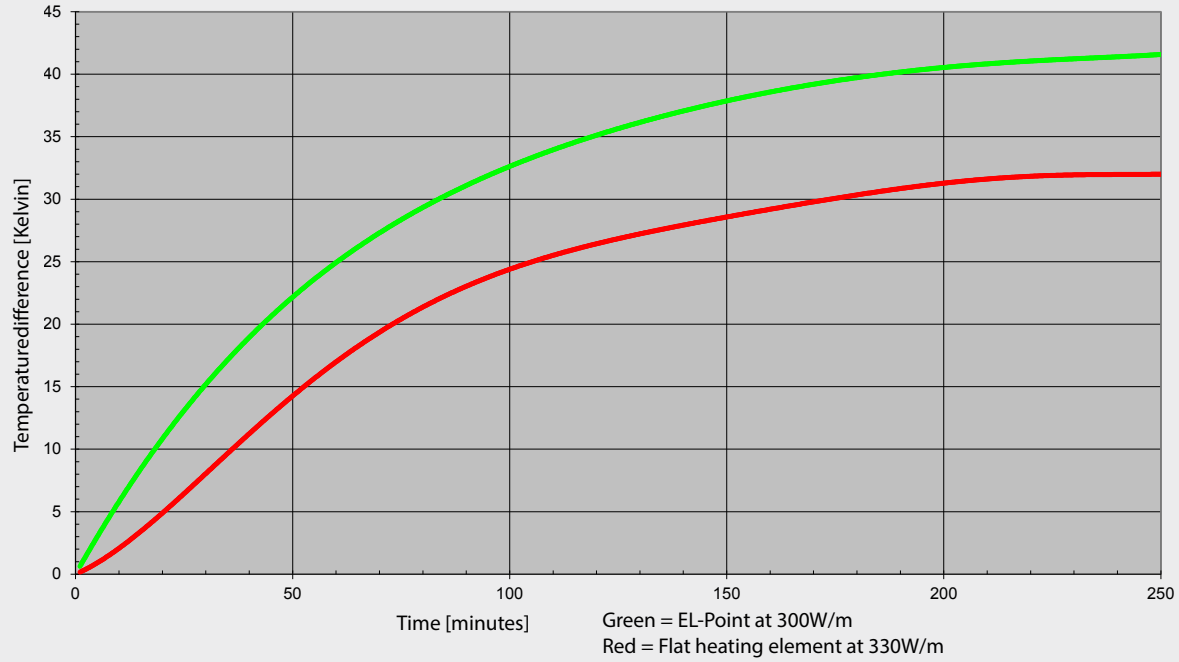
- Flat heating element: 3.4 K (at 330 W/m)
- EL-Point: 41.8 K (at 300 W/m)

With eltherm EL-Point a 30% higher temperature difference can be reached with 10% less power.

Heat up sequence in time elapse

	Temperature difference stock rail versus environment							
	>5 K	>10 K	>15 K	>20 K	>25 K	>30 K	>35 K	>40 K
Flat heating element	20 min	36 min	53 min	73 min	102 min	172 min	never	never
EL-Point	8 min	18 min	29 min	42 min	60 min	83 min	119 min	179 min
Time advantage	**60 %**	**50 %**	**45 %**	**42 %**	**41 %**	**52 %**	**-**	**-**

Heat-up characteristic



Model calculation

As reference a switch point type EW49-500 has been chosen, which was assembled with flat heating elements according to Standard "Ril 954.9101" of Deutsche Bahn. The effective heated length of each side is 12 m, the total installed power oft the flat heating elements is 7800 W.

The heating with eltherm EL-Point is realized with 12 m each side. The total installed power is 7200 W.

An energy price of 12 ct/kWh electrical energy was assumed. At higher energy costs the EL-Point System is even more advantageous!

Scenario 1 – Continuous Operation from October to April

Basic data

- Operation time: 182 days = 4368 hours
- Energy costs = Time x connected power x energy price

Consideration flat heating element

- Energy costs = 4368 h x 7.8 kW x 0.12 €/kWh =34,070.4 kWh x 0.12 €/kWh = 4,088.45 €

Consideration EL-Point

- Energy costs = 4368 h x 7.2 kW x 0.12 €/kWh =31,449.6 kWh x 0.12 €/kWh = 3,773.95 €

Comparison: Energy saving due to EL-Point

Energy saving= 34,070.4 kWh – 31,449.6 kWh
= 2,620.8 kWh

Money saving = 4,088.45 € - 3,773.95 €
= 314.50 €

Energy and cost saving

Model calculation

Scenario 2 – Operation with ambient thermostat

Basic data

- Days below 3°C: 93 days
- Nights below 3°C: 208 nights

Total operation time

- Total operation time = 93 d x 12 h + 208 n x 12 h = 3.612 h

Consideration flat heating element

- Energy costs = 3,612 h x 7.8 kW x 0.12 €/kWh = 28,173.6 kWh x 0.12 €/kWh = 3,380.83 €

Consideration EL-Point

- Energy costs = 3,612 h x 7.2 kW x 0.12 €/kWh = 26,006.4 kWh x 0.12 €/kWh = 3,120.77 €

Comparison: Energy saving due to EL-Point

Energy saving= 28,173.6 kWh – 26,006.4 kWh = 2,167.2 kWh

Money saving = 3,380.83 € - 3,120.77 € = 260.06 €

Scenario 3 – Operation with ambient thermostat and power stepping (El-Point only)

Basic data

- Days below 3°C: 76 days
- Nights below 3°C: 135 nights
- Days below -5°C: 17 Days
- Nights below -5°C: 73 nights
- Power output at temperatures <3 °C and >-5°C: 3.6 kW
- Power output at temperatures <-5 °C: 7.2 kW

Total operation times

- Total operation time (@3.6 kW)= 76 d x 12 h + 135 n x12 h = 2,532 h
- Total operation time (@7.2 kW)= 17 d x 12 h + 73 n x12 h = 1,080 h
- Total energy= 2,532 h x 3.6 kW + 1,080 h x 7.2 kW = 9,115.2 kWh + 7,776.0 kWh = 16,891.2 kWh
- Total energy costs = 16,891.2 kWh x 0.12 €/kWh = 2,026.95 €

Comparison: Energy saving due to EL-Point

As a power stepping with flat heating elements is not possible, the comparison has to be carried out by using the results of scenario 2.

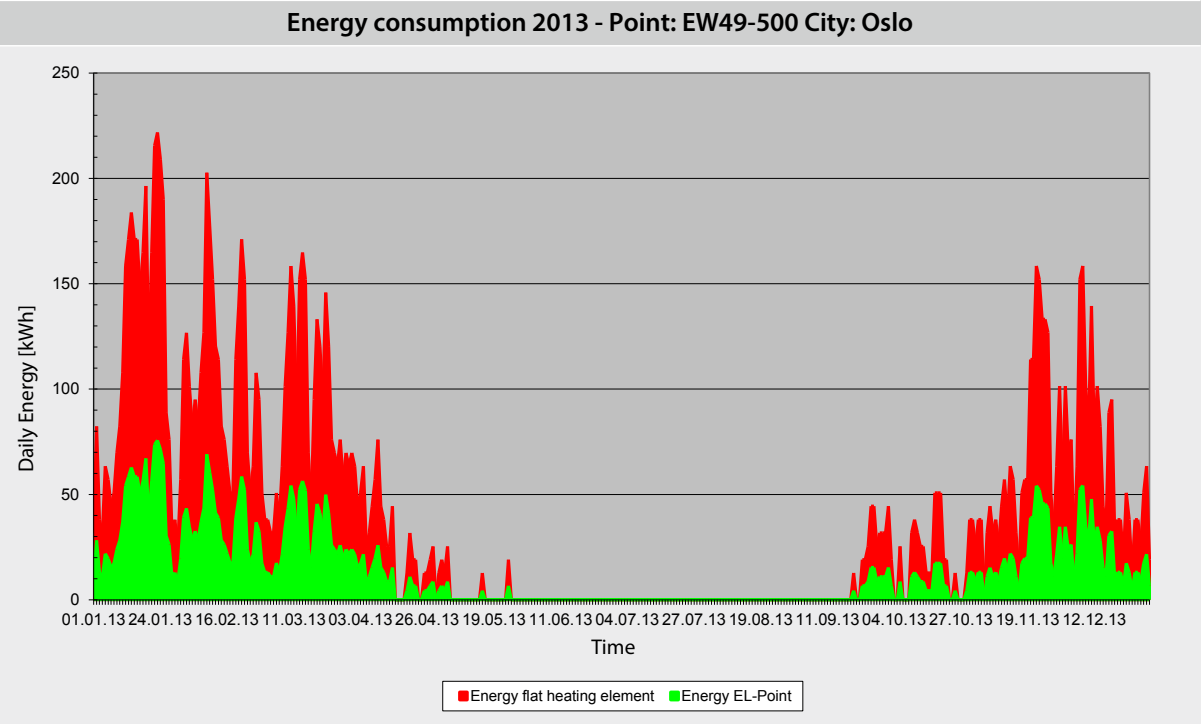
Energy saving= 28,173.6 kWh – 16,891.2 kWh = 11,282.4 kWh

Money saving = 3,380.83 € - 2,026.95 € = 1,353.88 €

Model calculation

Scenario 4 – Operation with hot-rail-thermostat and power stepping

For evaluation of this scenario approximate 6,000 individual results have to be considered. Therefore a detailed numerical presentation is not possible here.



Added the following annual values result:

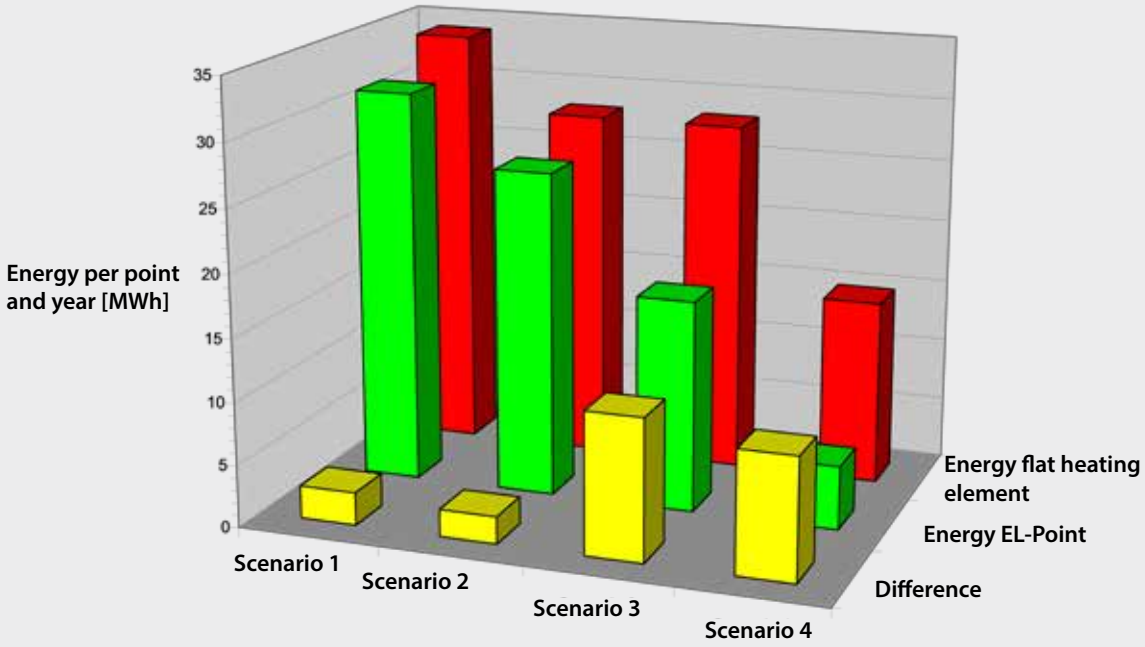
- Converted energy flat heating element:**14,807.2 kWh**
- Converted energy EL-Point: **5,069.7 kWh**
- Energy cost flat heating element: **1,776.87 €**
- Energy cost EL-Point: **608.36 €**

Advantage EL-Point: 1,168.51 €

Evaluation

	Evaluation (annual values of energy)			
	Scenario 1	**Scenario 2**	**Scenario 3**	**Scenario 4**
Energy flat heating element	34,070.4 kWh	28,173.6 kWh	28,173.6 kWh	14,807.2 kWh
Energy EL-Point	31,449.6 kWh	26,006.4 kWh	16,891.2 kWh	5,069.7 kWh
Difference	2,620.8 kWh	2,167.2 kWh	11,282.4 kWh	9,737.5 kWh
Savings	**7.7 %**	**7.7 %**	**40.0 %**	**65.8 %**

Evaluation (annual values of energy)



Evaluation

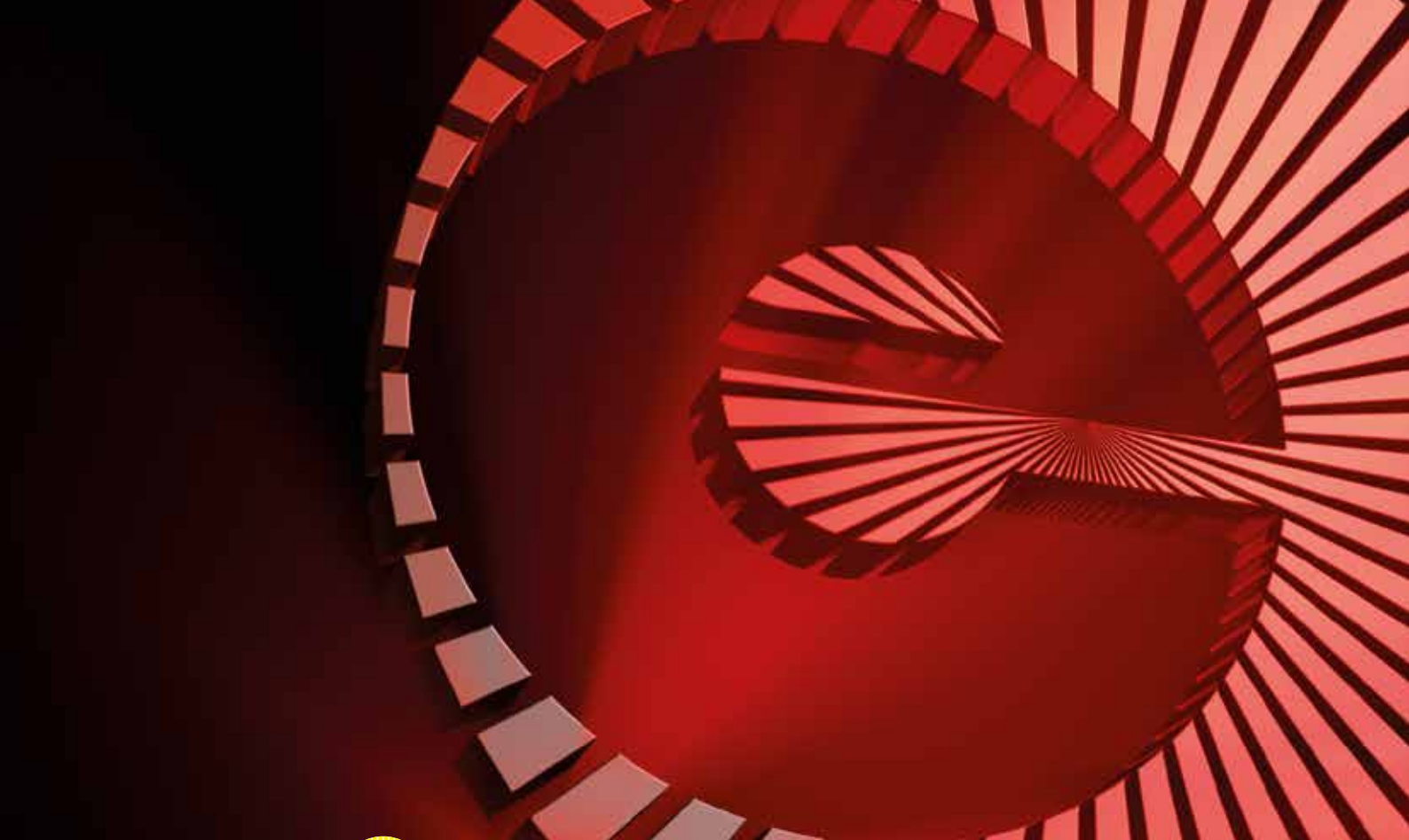
	Evaluation (annual values of money)			
	Scenario 1	**Scenario 2**	**Scenario 3**	**Scenario 4**
Flat heating element	4,088.45 €	3,380.83 €	3,380.83 €	1,776.86 €
EL-Point	3,773.95 €	3,120.77 €	2,026.95 €	608.36 €
Difference	314.50 €	260.06 €	1,353.88 €	1,168.51 €

	Evaluation (annual values of carbon dioxide)			
	Scenario 1	**Scenario 2**	**Scenario 3**	**Scenario 4**
Flat heating element	20.3 t	16.8	16.8 t	8.8 t
EL-Point	18.7 t	15.5 t	10.0 t	3.0 t
Difference	1.6 t	1.3 t	6.8 t	5.8 t

Summary

Retrofitting an existing switch from flat heating elements in continuous operation to El-Point with an intelligent control system leads to **energy savings of 29,000.7 kWh**. At a energy price of 12 ct/kWh this will sum up to an annual **cost reduction of 3,480.09 €**.

Considering a ratio of 596 g carbon dioxide per kWh, this is summing up to an **environmental relief of 17.3 tons of carbon dioxide** per switch point and year!



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