Industrial Decarbonisation Solutions
Bosch Group

- €78.7 billion euros in sales
- 403,000 associates

**Mobility Solutions**
- One of the world’s leading providers of mobility solutions

**Industrial Technology**
- Leading in drive and control technology, packaging, and process technology

**Energy and Building Technology**
- One of the leading manufacturers of security and communication technology
- Leading manufacturer of energy-efficient heating products, hot-water solutions and Industrial Boilers

**Consumer Goods**
- Leading supplier of power tools and accessories
- Leading supplier of household appliances
Industrial Boilers - Decarbonisation

Overview of Bosch Industrial Boilers

Tailored steam and hot water boilers for industrial & commercial applications

Bosch Industrial Boilers

~1400 Industrial Boilers manufactured per year

More than 120,000 systems in 140 countries

~450 Industrial Boilers installed in the UK & Ireland
**Industrial Boilers - Decarbonisation**

**History – specialist in boiler construction since 1865**

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1865</td>
<td>Foundation by Philipp Loos in Neustadt (Pfalz, Germany)</td>
</tr>
<tr>
<td>1917</td>
<td>New production site in Gunzenhausen (Bavaria, Germany), starting of a series production of vertical 3-pass boilers</td>
</tr>
<tr>
<td>1952</td>
<td>Patent of horizontal 3-pass flame tube/smoke tube boilers</td>
</tr>
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<td>1958</td>
<td>Further production site in Schlungenhof, 2 km away from the headquarters in Gunzenhausen</td>
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<td>Further production site in Bischhofshofen, Austria for the production of heating boilers</td>
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<td>1964/1965</td>
<td>30,000 delivered boilers, 100th anniversary of company Loos</td>
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<td>1977</td>
<td>Expansion of the production site in Schlungenhof</td>
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<tr>
<td>1987</td>
<td>50,000 delivered boilers</td>
</tr>
<tr>
<td>2005</td>
<td>Further expansion of the Schlungenhof site, 100,000 delivered boilers</td>
</tr>
<tr>
<td>2007</td>
<td>New production line for large boilers at the Schlungenhof site</td>
</tr>
<tr>
<td>2009</td>
<td>Loos becomes a subsidiary of Bosch</td>
</tr>
<tr>
<td>2012</td>
<td>Brand switch: Loos is now Bosch</td>
</tr>
<tr>
<td>2015</td>
<td>Company anniversary: 150 years Bosch Industriekessel</td>
</tr>
<tr>
<td>2017</td>
<td>First digital efficiency assistant for the industrial boiler market</td>
</tr>
</tbody>
</table>
Bosch pioneers to become truly CO₂ neutral

Our path to climate neutrality

When it comes to the climate, words are not enough. Companies need to aim for carbon neutrality, here and now.

DR. VOLKMAR DENNER,
CHAIRMAN OF THE BOARD OF MANAGEMENT

From 2020 on Bosch is carbon neutral at its 400 locations worldwide.
New build or existing system
What’s your current situation?

20 – 30% of the industrial energy use can be reduced by using the best available technologies.

The future use of alternative fuels should be considered in the planning stages of new builds.
Various CO₂ reduction measures can be implemented at comparatively low cost and achieve significant savings at the same time.

- Hydrogen upgrade
- Biofuel upgrade
- CO₂ efficiency upgrade

300,000 plants with outputs between 100 kW and 36,000 kW in Germany*

Only 17% of all plants with state-of-the-art technology*

*Source: BDH – Bundesindustrieverband Deutschland Haus-, Energie- und Umwelttechnik
Significant energy-saving potentials with system technology

- **Economizer**
  - up to 7% fuel saving

- **Flue gas condenser**
  - up to 7% fuel saving

- **Air preheating**
  - up to 2.5% fuel saving

- **Feed water cooling**
  - up to 1.8% fuel saving

- **Water treatment**
  - increased water quality
  - improved steam quality
  - lower desalting rates

- **Condensate systems**
  - up to 12% fuel saving
  - make-up/raw water saving
  - waste water reduction
  - up to 90% savings on chemicals

- **Thermal degassing system**
  - up to 80% savings on chemicals

- **Expansion and heat recovery module**
  - up to 1% fuel saving
  - up to 1% make-up water saving
  - up to 100% cooling water saving
  - up to 70% waste water saving

- **Vapour heat exchanger**
  - up to 0.5% fuel saving

- **Modulating firing**
  - up to 1% fuel saving
  - wear reduction

- **Speed-controlled fan**
  - up to 75% electrical savings

- **O₂/CO burner control**
  - up to 1% fuel saving

- **Settings and maintenance**
  - up to 3% fuel saving
  - extended service life
  - process reliability
  - improved operation

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  - up to 1.8% fuel saving

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Industrial Boilers - Decarbonisation

Example: 10 t/h boiler with medium load profile

Modernisation with efficiency components and controls

Amortisation time of roughly 1.6 years

Savings of roughly 2 Mio. € and 18 000 tons of CO₂ over 15 years
# Industrial Boilers - Decarbonisation

## Portfolio industrial boilers

<table>
<thead>
<tr>
<th>Boilers</th>
<th>Efficiency</th>
<th>Components</th>
<th>Boiler and system controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil / gas fired boilers</td>
<td>Waste heat steam boiler</td>
<td>Hydraulics</td>
<td>Intelligent control technology:</td>
</tr>
<tr>
<td>Heating / hot water, warm water</td>
<td><strong>Output</strong>: ~1 MW</td>
<td>e.g. pump modules</td>
<td>- Boiler controls</td>
</tr>
<tr>
<td></td>
<td><strong>T max</strong>: 110 °C</td>
<td><strong>Waste heat boiler</strong></td>
<td>- Boiler system controls</td>
</tr>
<tr>
<td></td>
<td><strong>p max</strong>: 6 bar</td>
<td><strong>Steam/Hot water</strong></td>
<td>- Remote access</td>
</tr>
<tr>
<td></td>
<td><strong>Output</strong>: &lt;1-25 MW</td>
<td></td>
<td>- Efficiency assistant</td>
</tr>
<tr>
<td></td>
<td><strong>T max</strong>: 120 °C</td>
<td><strong>Modules for:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>p max</strong>: 16 bar</td>
<td><strong>Water</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Output</strong>: &lt;1-19 MW</td>
<td><strong>Condensate</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>T max</strong>: 190 °C</td>
<td>+12 %</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>p max</strong>: 30 bar</td>
<td><strong>Steam</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Output</strong>: &lt;1-18 MW</td>
<td>+2 %</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>T max</strong>: 240 °C</td>
<td><strong>Waste heat boiler</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>p max</strong>: 30 bar</td>
<td><strong>Steam/Gas</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Output</strong>: 13-38 MW</td>
<td><strong>Waste heat recovery &amp; utilisation</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Components**

- **Waste heat steam boiler**
- **Waste heat boiler**
- **4-pass boiler with burner**
- **Customised waste heat boiler**

**Boiler and system controls**

- Boiler controls
- Boiler system controls
- Remote access
- Efficiency assistant

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**Fuel**

- e.g. gas regulation module
Industrial Boilers - Decarbonisation

Competence at every stage: Planning, project business, service

- Dimensioning/Support
- Floor plan/diagram
- BIM/3D data

- Commissioning
- Operator training
- Optimisation

- Remote diagnosis and programming
- Troubleshooting

- Acceptance test
- Local permits support

- Maintenance services
- Recurring boiler inspections

- Modernization
- System Analysis
- Efficiency consulting

- 24h readiness
- 24h hotline for spare parts service

- 24h readiness
- 24h hotline for spare parts service

- Boiler Repairs
- Retrofits
Industrial Boilers - Decarbonisation

Service coverage in UK & Ireland

Over 30 service experts
for commercial and industrial boilers in the UK & Ireland are here for you around the clock.

MEC Remote service access
for remote analyses, fault tracking, parameter settings and programming by our service experts.
Some of our customers in the UK and Ireland
Remote access using MEC Remote

Using MEC Remote, operators can gain remote access to their hot water and steam boiler systems conveniently. MEC Remote allows to visualise the surface of the control system and retrieve all relevant data.

Benefits

- Access operating data from any location, at any time
- Overview of all boiler systems at all locations
- Particularly beneficial in rural locations / Islands
- Visualisation of the entire boiler and system controls
- Quick, convenient monitoring of system data
- Multi-level security concept
- If required, live support from Bosch service experts
- Optional alarm notifications via SMS or e-mail in combination with MEC Optimize
ALTERNATIVE FUELS
Industrial Boilers - Decarbonisation
Requirements for future energy sources

Most probably future energy supply will be a mix from different fuels depending on the feasibility of certain conditions.

**Ecological**
Sustainable energy supply will be of utmost importance in the future.

**Economical**
Fair fuel prices are essential part of the ROI for large boiler plants.

**Available**
Stable energy supply is crucial for reliable boiler operation.

**Storable**
For daily use the fuel has to be safe and easy to store and transport.
Industrial Boilers - Decarbonisation

Specifics of using hydrogen

- Smallest atom in the world → diffuses through metal and impacts piping
- Flame temperature roughly 2000 °C → flame is not visible
- Heating value comparison with natural gas 1:3 → At 100 % hydrogen combustion three times the amount of gas volume is needed
- Several ways of hydrogen generation for power generation (examples)
  - „Blue“: Waste product of gas extraction
  - „Green“: Generated with green power
Industrial Boilers - Decarbonisation

The Technical Challenge | Hydrogen vs Methane

- Calorific Value
- Density
- Wobbe
- Flame Speed
- Ignition Energy
- Flame Temperature
Hydrogen boiler solutions

Handling and firing of hydrogen in boiler plants requires expertise know-how, comprehensive competence and high-quality construction.

- The proportion of hydrogen in many of today’s gas networks can be max. 10–15 %
- Thermal NO$_x$ generation → special measures against NO$_x$ necessary
- Fast combustion → burner with soft ignition
- Careful handling of hydrogen is required
- Need for using special materials

![Diagram of hydrogen boiler solutions](image)
Industrial Boilers - Decarbonisation

Hydrogen firing or Hydrogen ready options

Bosch can offer two solutions

**Hydrogen Firing**

Boiler and Burner fully equipped to burn H₂. The main criteria to have 100% hydrogen firing in a project, is the availability of H₂.

- Oversize boiler body +10%
- Special gas supply components
- External recirculation installed
- Fully equipped H₂ burner (+100%)

**Hydrogen Ready**

Boiler ready to burn 100% hydrogen. Burner, gas supply, controls, etc. has to be modified/replaced in the future to burn hydrogen.

- Oversize boiler body +10%

Advantages:
- Boiler has not to be replaced when using H₂
- Bosch supports a CO₂ free future

If hydrogen becomes the “fuel of the future”, e.g. within the next 20 years, a burner replacement is pending anyway.

Main criteria for boiler selection and emissions is the current and future available fuel on site
Decarbonisation of heating and process heat
Industrial Boilers - Decarbonisation

Example: Pharma-company Switzerland 20 t/h steam 13 bar

Summary:
- Triple fuel for maximum reliability
- Priority 100 % H₂ when available
- Natural gas as secondary fuel
- Light oil as worst case backup on site
- Mini exhaust gas recirculation from reversal chamber for NOₓ optimization
- Soft ignition measure blending in H₂

Triple-fuel burner ideal solution for full flexibility and maximum availability.
Industrial Boilers - Decarbonisation

Example: District heating Germany 5 MW up to 100% H₂

- Up to 100 % hydrogen operation
- Natural gas as backup
- Realisation 2021
- Use of heat for district heating and for commercial use as heat for drying wood

Using excess green electricity for 10 MW electrolysis. Hydrogen multi-fuel boiler as flexible consumer.
Industrial Boilers - Decarbonisation
Generation/source and combustion of biofuels

- Burner technique with centrifugal tumbler recommended
- Boiler has to be adjusted for lower emissions and in size
- As some fuels tend to soot filters or air-pressurized sootblowers should be installed
- Lower heating value than natural gas
- CO and O₂ sensors should be used due to unstable heating value

An advantage of biofuels is the shortly bound CO₂
Industrial Boilers - Decarbonisation

Hybrid boilers by Bosch

Electrical heating supply

▶ Equipment of conventional steam and hot water boilers with an additional heating device saves space and increases supply reliability
▶ Maximum flexibility due to individual planning depending on available energy mix
▶ Hybrid boilers with up to 5 MWe (plus burner)

Advantages

▶ Using surplus electricity – Power to Heat
▶ Participate in the balancing energy market
▶ Keeping warm functionality provided by electrical heater
▶ Fast availability and high efficiency (99%)

Electrical boilers are only CO₂ neutral when the power comes from CO₂ neutral sources
Industrial Boilers - Decarbonisation
Electrical steam boilers by Bosch – 1st Pilot projects

Steam generation using electricity from 350 to 7,500 kg/h

Very high efficiency of 99%

As one unit plug & play compatible with all Bosch water treatment modules

Zero emissions

Optimum control range due to thyristor/contactor combination

Long service life of the heating elements due to U-shape

* Looking for pilot projects and analysing market potential

ELS 1 350 kg/h (238 kW)
ELS 2 700 kg/h (476 kW)
ELS 3 1,500 kg/h (1,021 kW)
ELS 4 3,000 kg/h (2,041 kW)
ELS 5 5,000 kg/h (3,402 kW)
ELS 6 7,500 kg/h (5,104 kW)
Ready for the future with Bosch: Use alternative fuels in your project now or be prepared for its future use

**CO₂ neutral boilers**
- Up to 100% CO₂ neutral
- Up to 100% hydrogen (H₂)
- Up to 100% biogas
- Up to 100% biofuel/ethanol

**Hybrid boilers**
CO₂ neutral electrical steam generation with regenerative power supply.
- **Hybrid boilers**
  - Up to 5 MW heating coil combined with burner
  - Hybrid-capable option for partial electric supply in the future

**Electrical boiler**
- Pilot project since beginning of 2021
- Green steam generation with green electricity
- Available steam outputs from 350 to 7,500 kg/h
Hydrogen Home - Gateshead
Manufacturers Day – Visits available in 2022
New Technologies
Primary Heating Technology Gap/Transition - UK

Worcester Bosch, Energy & Utilities Alliance and Energy Networks Association are suggesting by 2025 only ‘Hydrogen Ready’ boilers should be placed onto the market.

* Hydrogen Ready = NG Condensing boilers prepared for simple conversion to Hydrogen

UK TECHNOLOGY MIX TO DIVERSIFY AS DECARBONISATION TAKES HOLD
MARKET VALUE TO INCREASE AS MARKET DECARBONISES
Decarbonisation – What next?
A “Technology Neutral” approach

TECHNOLOGY #1
Hydrogen Ready Boilers

TECHNOLOGY #2
Heat Pumps

TECHNOLOGY #3
Hybrids

TECHNOLOGY #4
Heat Interface Units
Thank you

Hans Bahnsen
Head of Industrial Sales - UK & Ireland

Bosch Thermotechnology Ltd. | Cotswold Way | Warndon
Worcester WR4 9SW | UNITED KINGDOM

Mobile 07813 016842 | hans.bahnsen@uk.bosch.com

www.bosch-thermotechnology.co.uk