Lab CRIGEN – ENGIE's research centre focused on green gases and decarbonising the energy uses

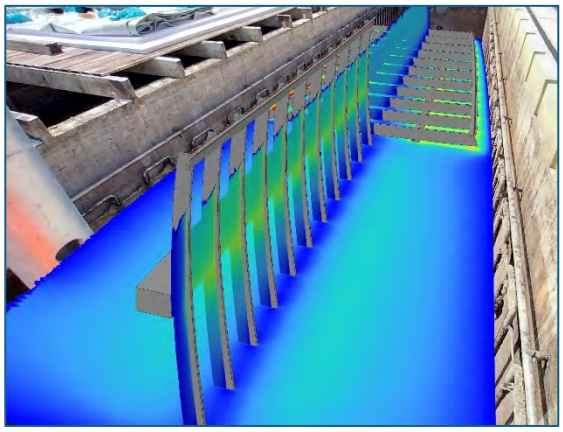
Lab CRIGEN is ENGIE's research centre is focused on green gases and decarbonising the energy uses. We provide the expertise needed to enable the Group achieve its energy transition objectives.

We screen existing and emerging technologies, and assess their potential, adapting and enhancing them to provide innovative, competitive, and sustainable solutions. We also ensure optimal integration for all our clients and help them to unlock new value opportunities over the medium and long term.

Within ENGIE R&I, we develop an agile working ecosystem based on individual and collective expertise, in a safe, transparent, and supportive environment.

The High-Temperature Industrial Test Furnace, the Industrial Test Boiler Facility and the Plug-and-Play Zone for Combustion Integration equipment are a part of ENGIE Lab CRIGEN's modular test hall (7350 m², 24/7 testing), unique of its kind, dedicated to the experimentation of new green gas processes (hydrogen, biogas) and energy uses for buildings and local energy infrastructure for districts and cities.

[Image: Biomethane Factory : An analysis and testing laboratory dedicated to first- and second-generation biomethane]



[Image: CFD simulation capabilities: Advanced numerical simulation for fluid and multiphase flows, thermal processes, and combustion]

[Image: Semi-virtual test bench and climate chamber: A testing environment able to replicate diverse climatic conditions]

[Image: H_2 factory: Around ten modular spaces enabling various testing of hydrogen technologies and their uses]

Testing the Future of Industrial Heat: Inside ENGIE Lab CRIGEN's High-Temperature Industrial Furnace Facility

Industrial heat is among the most challenging sectors to decarbonize. Industries such as steel, aluminium, ceramics, cement, and glass depend on extremely high temperatures, often exceeding 1,000°C, while maintaining stringent requirements for reliability, energy efficiency, and product quality. As these sectors move toward low-carbon energy systems, a critical question emerges: how can innovative combustion technologies be tested, validated, and optimized under real industrial conditions before large-scale deployment?

To address this challenge, ENGIE Lab CRIGEN continuously develops and operates the High-Temperature Industrial Test Furnace. This unique facility provides a controlled yet realistic environment to assess next-generation industrial heating solutions at industrial power levels, bridging the gap between innovation and operational reality.

Testing in the High-Temperature Industrial Test Furnace provides validated performance data under realistic operating conditions, while significantly reducing technical and financial risks prior to scale-up. It enables optimized system sizing, lower pollutant emissions, and a faster time-to-market for innovative industrial heating solutions.

A Reference Platform for High-Temperature Innovation

The High-Temperature Industrial Test Furnace is ENGIE Lab CRIGEN's reference experimental platform for industrial combustion systems. Designed to operate at temperatures of up to 1,300°C, it enables manufacturers, technology providers, and industrial operators to evaluate a broad range of combustion-based and hybrid heating solutions under realistic, controlled, and fully reproducible conditions.

Unlike conventional laboratory-scale facilities, this furnace operates at true industrial power levels, allowing precise and representative assessment of energy performance, pollutant emissions, and operational robustness under conditions close to actual industrial use..

[Image: Overall view of the 500 kW high-temperature industrial test furnace]

Why Real-Condition Testing Matters

The transition toward low-carbon industrial heat requires more than theoretical performance claims or small-scale demonstrations. Industrial stakeholders need reliable, measurable evidence of energy efficiency, pollutant emissions, operational stability, and flexibility across a wide range of operating conditions.

The High-Temperature Test Furnace meets this need by providing a controlled, fully instrumented, and modular testing environment, effectively bridging the gap between research activities and real-world industrial deployment.

A Highly Flexible and Instrumented Furnace

Designed for Industrial Power Levels

The furnace is designed to accommodate high-power combustion systems directly on its burner side wall, with capacities of up to 1,000 kW for gas and 1,000 kW for electric heating. Its modular architecture allows easy adaptation to a wide range of burner sizes and technologies. In addition, a dedicated air preheating system can supply preheated air up to 1,000°C at industrial flow rates, enabling realistic emulation of demanding operating conditions.

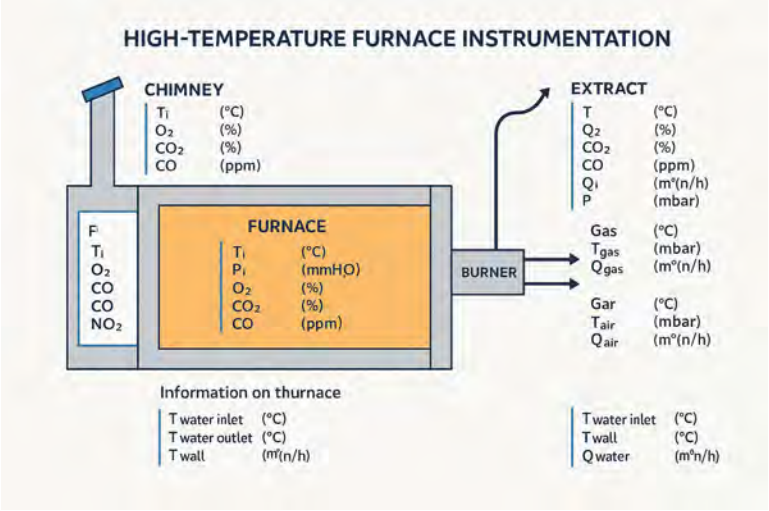
[Image : Furnace façade]

Advanced Measurement and Supervision

To ensure reliable and actionable results, the furnace is equipped with a comprehensive set of high-precision sensors measuring temperature, pressure, flow rates, and gas composition. Continuous monitoring of CO, NOx, O_2, and CO_2 is combined with real-time data acquisition at a temporal resolution of up to 0.1 seconds, enabling detailed analysis of transient and steady-state behaviour.

A fully instrumented flue gas exhaust duct allows in-depth flue gas analysis, while a dedicated supervision and safety system ensures secure and controlled operation throughout all test phases.

[Image : Flue gas exhaust duct view]



Fast Response and Load Flexibility

Thanks to its insulated walls and optimized design, the furnace reaches thermal stability within approximately one to one and a half hours. Water-cooled adjustable pins enable precise temperature regulation and allow the simulation of a wide range of thermal loads, from full-load operation to reduced or standby conditions.

The furnace interior combines a refractory brick floor, providing controlled thermal inertia, with alumina fiber walls that ensure fast thermal response and high operational flexibility.

[Image : Furnace interior with adjustable cooling pins]

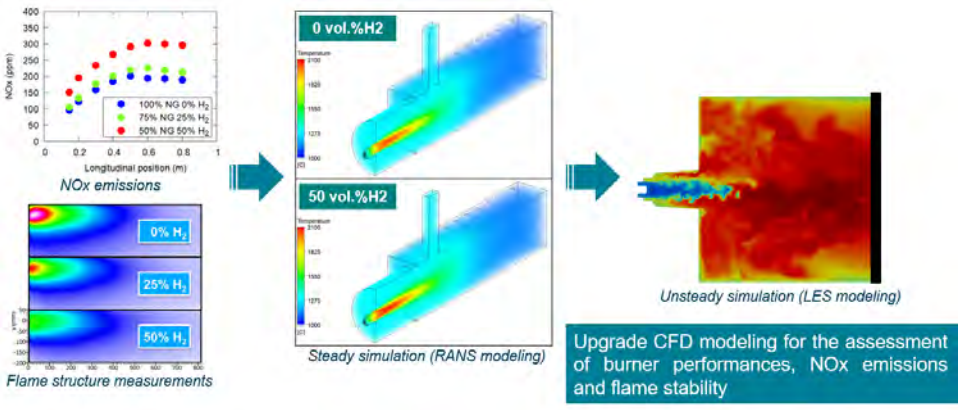
Supporting All Types of Heating Technologies

The platform is technology-agnostic and can accommodate a wide range of heating systems, including gas burners, hydrogen and hydrogen-blended solutions, hybrid gas-electric systems, oxy-fuel and regenerative burners, as well as radiant industrial burners.

This high level of flexibility makes it a key asset for evaluating future-proof heating technologies and supporting industrial decarbonization strategies.

From Physical Testing to High-Fidelity Numerical Models

ENGIE Lab CRIGEN combines experimental testing with the development of high-fidelity multi-physics numerical models of the tested heating systems. By combining experimental data with 3D numerical simulations and CFD, these models help optimize test protocols, extrapolate results to extended operating conditions, and significantly reduce development risks.



[Image : H2 industrial combustion - From experiment to high-fidelity CFD]

Supporting the Decarbonization of Industrial Boilers: Inside ENGIE Lab CRIGEN's Industrial Test Boiler Facility

Industrial boilers play a critical role in energy consumption and greenhouse gas emissions across a wide range of industrial sectors. Today, they account for nearly half of industrial natural gas usage, supplying heat and steam to processes with stringent requirements for availability, energy efficiency, and operational safety.

As industries accelerate their transition toward low-carbon energy systems, boiler technologies must evolve rapidly. Ultra-low NOx combustion, fuel flexibility, hydrogen readiness, and compatibility with biomethane or other alternative fuels are becoming essential performance criteria. Moving from innovation to industrial deployment therefore raises a key question: how can new boiler and burner technologies be tested, validated, and de-risked under real industrial operating conditions?

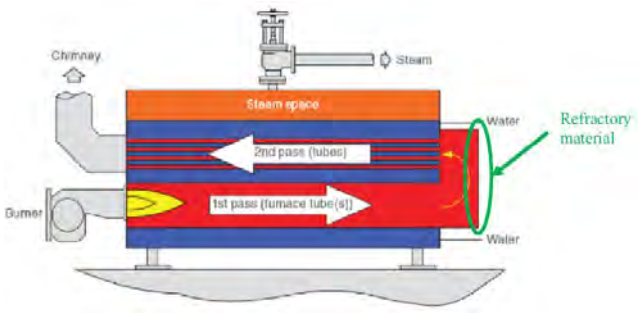
To address this challenge, ENGIE Lab CRIGEN has developed a dedicated Industrial Test Boiler, designed to bridge the gap between laboratory development and full-scale industrial operation.

As industrial boilers remain a cornerstone of industrial energy systems, their transformation is essential to achieving climate objectives. The Industrial Test Boiler at ENGIE Lab CRIGEN provides the industry with a unique capability to test, validate, and de-risk low-carbon boiler technologies under realistic operating conditions. By combining industrial-scale testing, high-quality measurements, and advanced numerical simulation, the platform supports the development of cleaner, more efficient, and future-ready industrial boiler solutions.

A Reference Platform for Industrial Boiler Testing

The Industrial Test Boiler is ENGIE Lab CRIGEN's reference experimental platform for industrial boiler heating systems. Operating at power levels of up to 1,000 kW, it enables manufacturers, technology providers, and industrial operators to evaluate boiler burners and combustion systems under realistic, controlled, and fully reproducible conditions.

Unlike laboratory-scale test rigs, the platform reproduces true industrial operating regimes, allowing robust and representative assessment of energy performance, pollutant emissions, and operational behaviour under conditions closely reflecting actual industrial use.



[Image : Gas boiler view]

Meeting the Needs of a Rapidly Evolving Industry

Decarbonizing industrial heat requires more than incremental improvements. Industrial stakeholders need measured and objective data to support technical decisions, investment strategies, and regulatory evolution. In particular, they require testing platforms capable of replicating real boiler operating conditions, accurately measuring energy and environmental performance, evaluating innovative combustion concepts over extended durations, and reducing technical and economic risks prior to market deployment.

The Industrial Test Boiler meets these requirements by providing a fully instrumented, modular, and secure testing environment, accelerating innovation while ensuring strong industrial relevance and robustness of results.

A Flexible and Instrumented Boiler System

Designed for Industrial Power Levels

The test boiler is equipped with a dedicated burner mounting system designed to accommodate high-power combustion solutions, with thermal inputs of up to 1,000 kW using natural gas. It is also compatible with alternative fuels such as hydrogen blends, syngas, and biomethane, supporting the evaluation of fuel-flexible and low-carbon combustion concepts.

When required, an electric air preheating system can supply preheated air up to 1,000°C at industrial flow rates, enabling advanced combustion testing under demanding operating conditions. The boiler is based on a smoke-tube design, allowing the production of low-pressure steam and providing realistic heat-exchange behaviour representative of industrial boiler installations.

Advanced Instrumentation and Supervision

To deliver reliable and exploitable results, the platform integrates a comprehensive measurement system, including sensors for temperature, pressure, and flow rates, continuous monitoring of combustion gases (CO, NOx, O_2, CO_2), real-time data acquisition with automatic recording, and a fully instrumented exhaust system dedicated to flue gas analysis.

All tests are managed through a dedicated supervision and safety control system, ensuring safe and controlled operation throughout all testing phases, including start-up, steady-state operation, and transient regimes.

Supporting a Wide Range of Test Configurations

The Industrial Test Boiler enables testing of burners operating with cold or preheated air, comparison of different burner technologies under identical and reproducible reference conditions, and evaluation of energy efficiency, pollutant emissions, and dynamic behaviour. It also supports long-duration testing, allowing assessment of system stability, reliability, and durability under representative industrial operating regimes.

From Physical Testing to High-Fidelity Numerical Models

ENGIE Lab CRIGEN combines experimental testing with the development of multi-physics numerical models of the tested boiler systems. By combining experimental data with 3D numerical simulations and CFD, these high-fidelity numerical models enable optimization of test protocols, extrapolation of results to extended operating ranges, and a significant reduction in development time and technical risk.

Concrete Industrial Applications and Value

Testing campaigns conducted on the Industrial Test Boiler deliver tangible value to industrial stakeholders. They provide validation of real-world performance, reduce uncertainty prior to scale-up or deployment, enable optimized boiler and burner sizing, lower pollutant emissions, improve environmental compliance, and ultimately support a faster time-to-market for innovative solutions.

A Plug-and-Play Zone for miscellaneous combustion equipment

To complement our furnace and boiler platforms, we operate an Open Utilities Plug-and-Play: a configurable “free zone” designed to integrate and commission miscellaneous combustion equipment at industrial scale.

The area provides ready-to-use utilities such as multiple fuels (natural gas, hydrogen blends as available), cold and preheated air, and three-phase electricity, so partners can focus on technology validation rather than site logistics.

What you can do here

- Mount & hook-up skids or burner assemblies (radiant, regenerative, oxy-fuel, hybrid gas-electric) on standardized frames with quick-connect fuel and air manifolds.
- Run functional and endurance tests (start/stop sequences, ramp-up, turndown, cycling) before deploying to a production line.
- Verify combustion stability, emissions, and controls integration in a realistic industrial environment.

Utilities & infrastructure

- Fuels: regulated gas trains, flow control, and certified leak-testing; optional H_2 blend injection where permitted.
- Air systems: ambient air supply plus preheated air capability for high-excess-air or staged-combustion trials.
- Power: 400 V / 50 Hz three-phase.
- Instrumentation: high-speed data logging for transients, temperature, pressure, differential pressure, flow, and flue-gas analysers (CO, NOx, O_2, CO_2).

Safety & Compliance

- Zoned areas with ATEX-aware practices, flame safety devices where needed, emergency shut-off valves, and gas detection.

Value for partners

- Cut integration lead time from weeks to days by eliminating utility build-outs.
- De-risk commissioning before factory trials; confirm interfaces, sequencing, and maintenance access.
- Generate decision-grade data for scale-up, certification dossiers, or customer demos.
- Dedicated platform for hands-on scientific training under the supervision of highly qualified experts, enabling industrial furnace operators and supervisors, process engineers, technical sales engineers, process automation specialists, and related profiles to safely familiarize themselves with combustion systems and integration practices.

References

Endurance testing (4,000 hours of testing) of burners operating on hydrogen and natural gas blends for Solaronics. Other combustion systems and fuel mixtures can also be tested.

The burners are radiant-type industrial burners used for paper drying applications. The use of hydrogen supports the manufacturer’s “H_2-ready” burner certification process. While ENGIE Lab CRIGEN does not deliver certification, it enables the manufacturer to generate the technical evidence required for certification.

[Image : Radiant burners endurance tests]