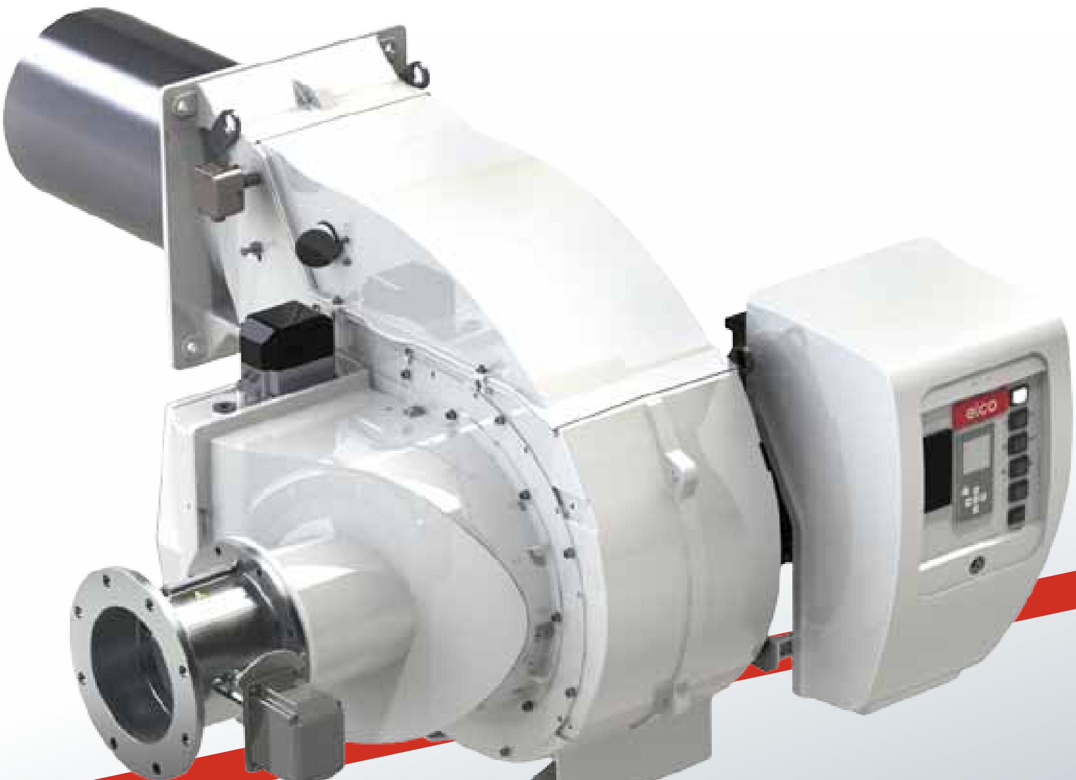
LOW NOx SOLUTIONS AND FGR SYSTEM



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REDUCING POLLUTING EMISSIONS

EUROPEAN STANDARDS AND INTERNATIONAL REGULATIONS

Protection of the environment has been a priority for a long time. The polluting elements released by the combustion of fossil fuels are well known. The means for reducing such emissions are also well known, even if they are not always implemented: political, regulatory and economic considerations significantly affect their application.

The European Union, following the introduction of the NOx Emission Classes according to EN676 and EN267 Standards, has been working to define even more restrictive limits, both as regards energy efficiency and the constant reduction of polluting atmospheric emissions.

EN676 and EN267 European Standards

Emission class	Limit in **light oil** (NOx mg/kWh)	Limit in **gas** (NOx mg/kWh)
1	**250**	**170**
2	**185**	**120**
3	**120**	**80**

France

Output totale in camera caldaia	Limit in **Light oil** (NOx mg/kWh)	Limit in **gas** (NOx mg/kWh)
< 2000 kW	**120**	**80**
> 2000 kW	**150**	**100**
For specific regions (mostly in the South)		
400 kW < P < 2000 kW	**120**	**75**

Germany (BImSchV)

Output	Limit in **Light oil** (NOx mg/kWh)	Limit in **gas** (NOx mg/kWh)	Average temperature
< 120 kW	**120**	**60**	Irrespective of the temperature
120 kW < P < 400 kW	**120**	**80**	
400 kW < P < 10 MW	**185**	**120**	

Output	Limit in **Light oil** (NOx mg/Nm³)	Limit in **gas** (NOx mg/Nm³)	Average temperature
10 MW < P < 20 MW	**180**	**100**	<110°C
	200	**110**	110°C < t < 210°C
	250	**150**	>210°C
20 MW < P < 50 MW	**180**	**100**	<110°C
	200	**110**	110°C < t < 210°C
	250	**150**	>210°C

Modern combustion technologies enable us to satisfy these regulations, for example using the internal recirculation of flue gas, a fluid dynamic phenomenon generated in the combustion chamber when the burner is properly designed and installed on the generator.

In applying this system to its products, ELCO offers burners which easily satisfy the 80 mg/kWh limit requirement of the EN676 Standard, and the 62 mg/kWh requirement of the ErP Directive.

Reducing polluting emissions is also a policy concern outside the European Union, and a number of countries are enacting rigorous regulations supported by incentives to replace polluting equipment.

The geographic area which is currently of greatest interest to burner manufacturers is China, some regions of which have NOx emissions limits of less than **30 mg/kWh**.

Currently available commercial technologies and equipment for forced draught burners cannot satisfy such limits, except by employing the method of **external flue gas recirculation**.

ELCO EXPERTISE

A LONG HISTORY OF INNOVATION AND ECO-FRIENDLY SOLUTIONS

ELCO has always been committed to develop technologies and products whit outstanding energy performance combined with minimal environmental impact.
With its know-how gained over years of experience, and many systems installed in collaboration with its partners, ELCO today offers a complete range of **Low NOx and Ultra Low NOx burners** from 11 kW to 80 MW.

ELCO has enormous experience in the application of low emissions systems, going back to the early Nineties when it first entered the Swiss market, which enforced much more rigid restrictions than elsewhere at the time, and more recently in the European market in general.

ELCO burners equipped with FGR System installed in Switzerland to satisfy the standards required by "Swiss Clean Air Act" (1992)

The installation of burners with the **FGR (Flue Gas Recirculation) technology** has enabled ELCO to further develop and perfect this system over the years, so that it is today extremely reliable and a guarantee of high performance, outstanding value for money, and minimum environmental impact.

ELCO burners with FGR System installed in China able to reach NOx emission level below 30 mg/kWh

The principle of external flue gas recirculation consists in sending a mixture of comburent air and flue gas to the combustion head, thus reducing the NOx emissions.

This technology enables ELCO to guarantee emissions of less than **30 mg/kWh**, a value which is hard to obtain with conventional combustion systems, and offer cutting-edge products which satisfy the requirements of any current regulations.

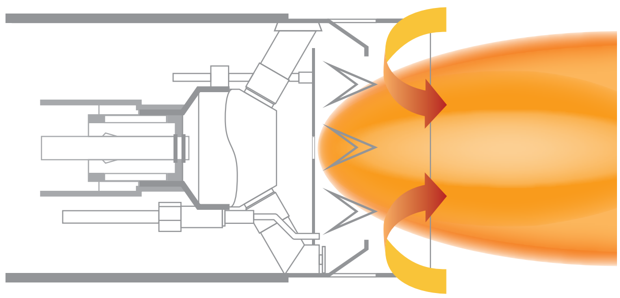
ELCO COMBUSTION TECHNOLOGIES

LOW NOx SOLUTIONS

ELCO R&D Laboratories have capitalised 90 years of experience in the field of standard burners (with normal emission) in order to develop a parallel range of low emissions burners. In addition to scrupulously respecting the limits prescribed by European directives regulating pollutant emission, the goal of ELCO is to guarantee values largely below those established by regulations. In order to reach these results the low NOx burner range takes advantage of innovative combustion technologies.

DIAMOND HEAD

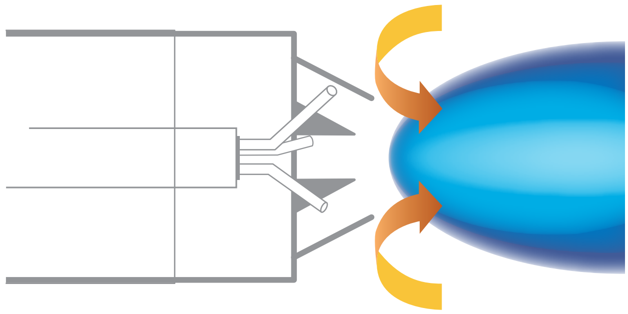
Low emissions and reliable operation



Since the early 90's ELCO has developed a special combustion head, called Diamond Head, suitable for modern gas, light oil and dual fuel burners, with the aim of reducing the emissions of nitrogen oxides.
The principle of this combustion technology is based on the internal recirculation of the combustion flue gases. These are partially drawn into the base of the flame via triangular openings positioned at the end of the combustion head.
The position and geometry of the gas injectors are such that a significant quantity of combustion flue gas is drawn in and rapidly mixed with air and gas at the root of the flame.
This mixture crosses the main reaction area, slowing the combustion, which resulted in lowering the main flame temperature.The result of this staging combustion is a significant reduction in the formation of thermal nitrogen oxides.
The advantage of this internal recirculation technique is an automatic adjustment to the quantity of recycled combustion flue gases: the volume of the flame is always as low as possible, which has a very minor effect on the nominal power of the generator, unlike external recirculation systems.

FREE FLAME

The pinnacle of low-polluting burner engineering



The principle of the Free Flame combustion technology is based on the internal recirculation of the flue gas, combined with high speed flow of the fuel air mixture.
The flame stabilises at the right distance from the combustion head, thus leaving space for the mixture of reagents and flue gas. This phenomenon greatly reduces NOx emissions.
The flame seems to float in the furnace, thus giving the system its name: Free Flame.
The Free Flame technology is used with both liquid and gas fuels.

ELCO COMBUSTION TECHNOLOGIES

ULTRA LOW NOx SOLUTIONS

Thanks to its experience and the technologies it has developed over the years, ELCO offers a wide range of products which use the external FGR technology to reduce NOx emissions and satisfy even the most stringent regulations.

FGR SYSTEM

Ultra low NOx solutions to reach emissions of less than 30 mg/kWh

As previously indicated, the external recirculation sends a mixture of air and flue gas to the burner combustion head. The gases are mixed upline of the combustion process by the burner fan (for monoblock units) or by the external fan (in case of duoblock burners).

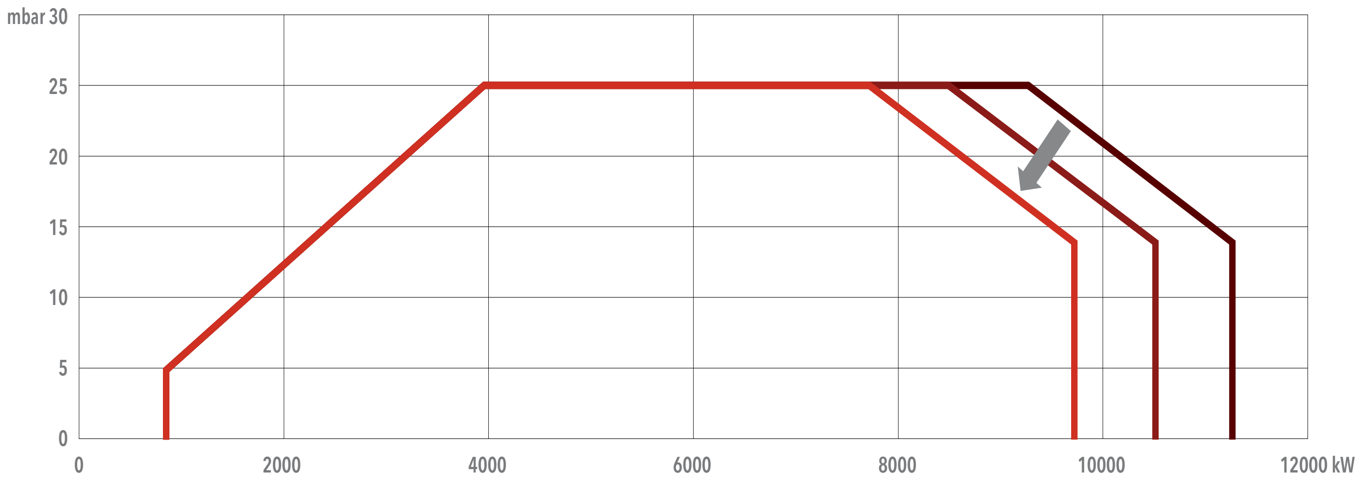
The effect in terms of NOx emissions is the result of numerous factors, the most important of which are:

- burners technical characteristics
- fuel
- type of generator
- comburent air temperature
- vector fluid temperature
- thermal load of the combustion chamber

When the FGR technology in applied to further reduce the NOx level, another parameter comes into play: the flue gas recirculation flow.
The amount of recirculation, which is generally no more than 20% of the total flow generated by the fan, is calibrated for each application in relation to the target value and the system performance without recirculation.

There is not a single percentage value which suits all applications, because of the many factors in play and their interactions, but in any case the flue gas recirculation reduces the power of all monoblock burners, since part of the fresh comburent air is replaced by flue gas.
This results in a lower O_2 content and hence reduces the combustion of fuel.

The outcome is that the working diagram is reduced proportionately.



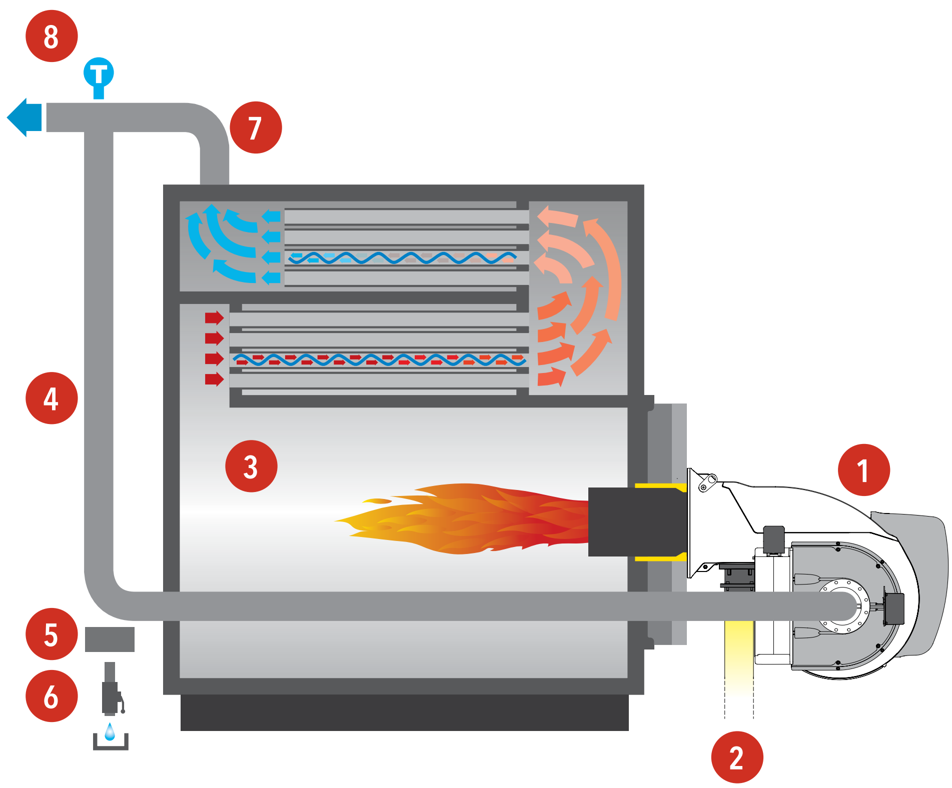
FGR SYSTEM

PRINCIPLE OF OPERATION

MONOBLOCK BURNERS

The FGR system on monoblock burners provides that the flue gas is drawn in by the burner fan.
The installer must therefore install a line connecting the flue gas outlet to the burner fan inlet.
The extraction point is generally at the base of the flue pipe, where the pressure is close to zero.
A suction is generated in the burner intake box which is a function of the fan curve and the air damper position.
In order to ensure an adequate rate of flue gas from the stack and thus to provide the required NOx reduction, the pipeline between the flue and the burner must be sized to minimise the pressure drop.

FUNCTIONAL DIAGRAM



Legenda

1	Burner
2	Gas inlet
3	Furnace
4	Flue pipeline
5	Drainage
6	Drainage valve
7	Stack
8	Temperature probe

FGR SYSTEM

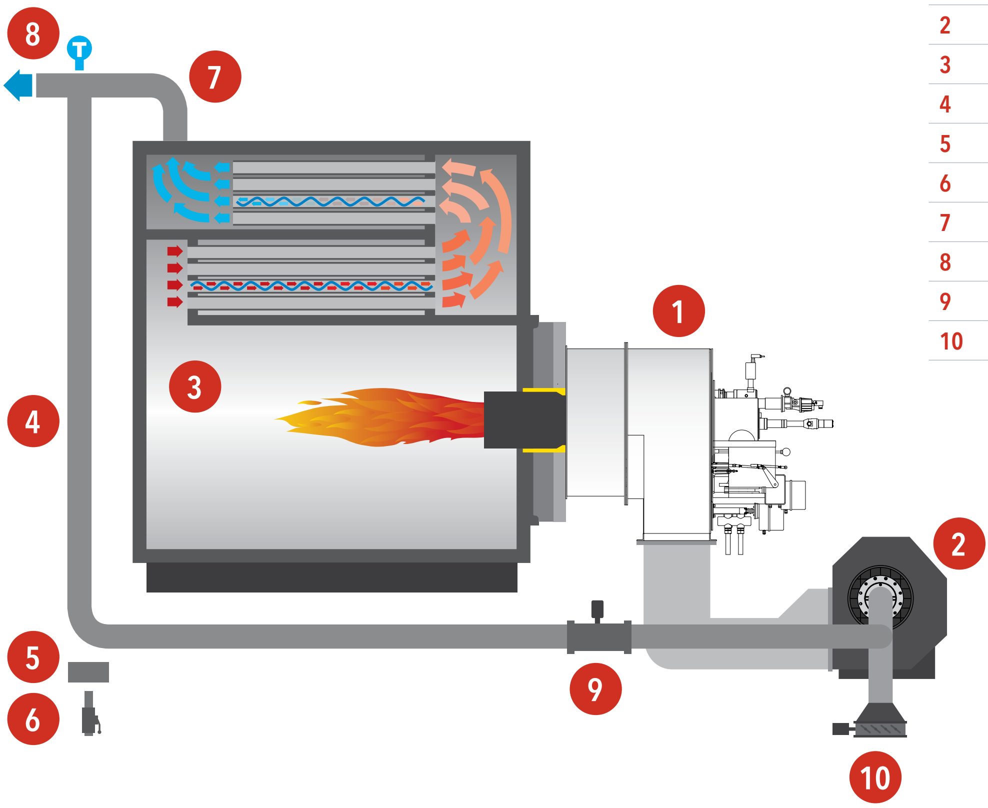
PRINCIPLE OF OPERATION

DUOBLOCK BURNERS (LAYOUT "A")

The FGR system for duoblock burners, since the draught fan is installed far from the burner, needs a layout different from the one of the monoblock ones.
On such a layout, the flue duct ends upstream of the draught fan. In order to produce the needed suction to get flue from the stack and to mix it with the fresh air, the air damper is fitted upstream of the draught fan and upstream of the flue duct end, too.

As for monoblock burner, the flue duct has to be properly sized in order to minimize the pressure drop.

FUNCTIONAL DIAGRAM



Legenda

1	Burner
2	Draught fan
3	Furnace
4	Flue pipeline
5	Drainage
6	Drainage valve
7	Stack
8	Temperature probe
9	FGR valve
10	Air damper

FGR SYSTEM

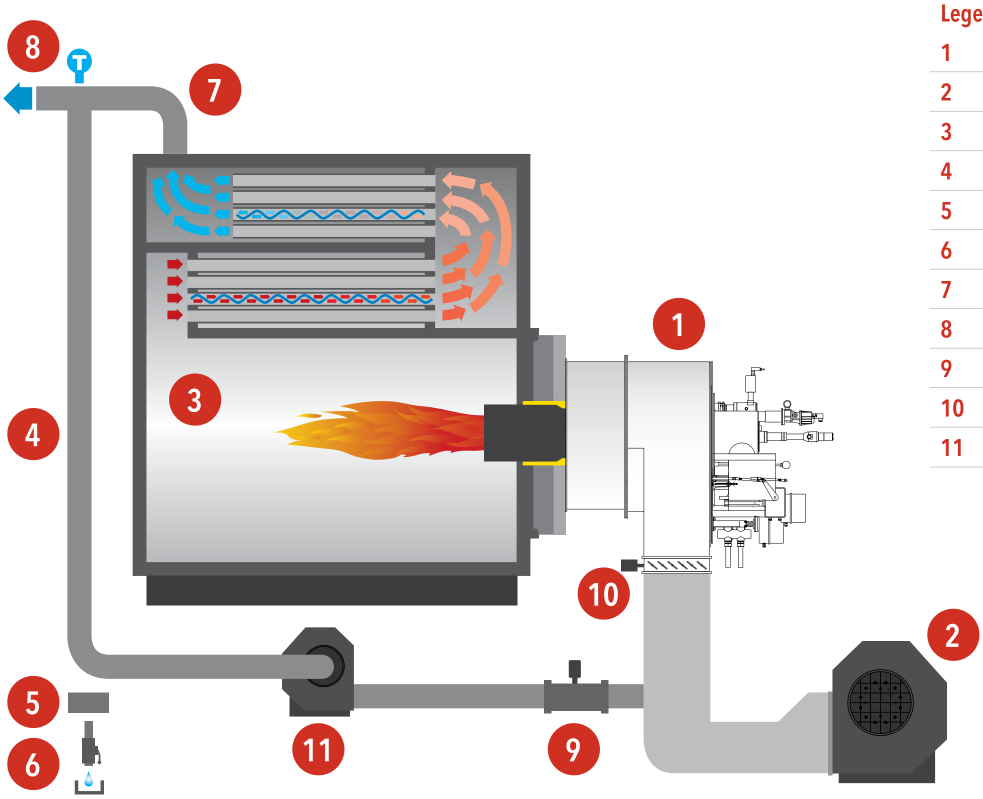
PRINCIPLE OF OPERATION

DUOBLOCK BURNERS (LAYOUT "B")

An alternative layout to layout "A" provides a further draught fan dedicated to the flue.
It takes the flue from the stack and pushes it into the duct between the burner and the fresh air draught fan. The flue damper is just after the flue fan. The air damper is on burner board and therefore it adjusts the rate of the mixture between the flue and the fresh air.

As for monoblock burner, the flue duct has to be properly sized in order to minimize the pressure drop.

FUNCTIONAL DIAGRAM



Legenda

1	Burner
2	Fresh air draught fan
3	Furnace
4	Flue pipeline
5	Drainage
6	Drainage valve
7	Stack
8	Temperature probe
9	FGR valve
10	Air damper
11	FGR draft fan

FGR: RESEARCH & DEVELOPMENT

LABORATORY TESTING

Decades of presence on the international market have enabled ELCO to develop considerable experience in customising burners and developing innovative technologies which are attentive to the issue of polluting emissions, even in the most demanding applications.
ELCO is therefore well placed to provide solutions for the growing number of markets which are enacting ever more restrictive emissions regulations.

In its laboratories in Pirna, Germany, and Resana, Italy, ELCO's technicians are able to simulate real-life working conditions and measure the performance of burners fitted with Low NOx Diamond Head and Free Flame combustion heads and the FGR system.

The excellent results obtained in this field have enabled ELCO to offer a complete range of monoblock and duoblock products equipped with the FGR technology.

Pirna, Germany

FIELD TESTING AND DATA COLLECTION

Thanks to its numerous installations worldwide, ELCO has been able to demonstrate the effectiveness of its solutions, not just in the laboratory, but in the real world.
Its well-established technical collaborations with dealers have allowed ELCO to monitor the development of specific projects with very low NOx emission limits.

Its active role in commissioning installations, recording data and calibrating operating equipment to obtain the perfect thermal coupling with the generators on which its burners are installed - all of these have enabled ELCO to collect a vast amount of information and data directly in the field.

This information from practical applications is an asset which allows ELCO to manage its products to best effect and make its installations ever more efficient and reliable, as well as setting the base for the development of new technical solutions.

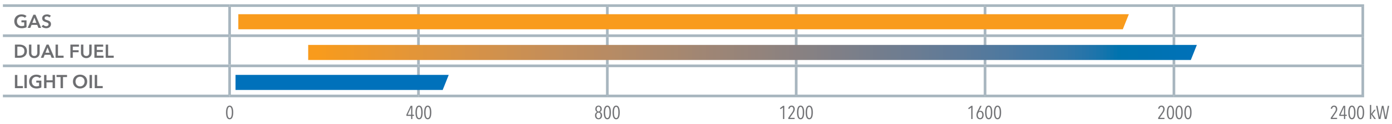
RANGE OVERVIEW

LOW NOx AND ULTRA LOW NOx MONOBLOCK RANGE

VECTRON Range

Low NOx versions
from 11 kW to 2050 kW

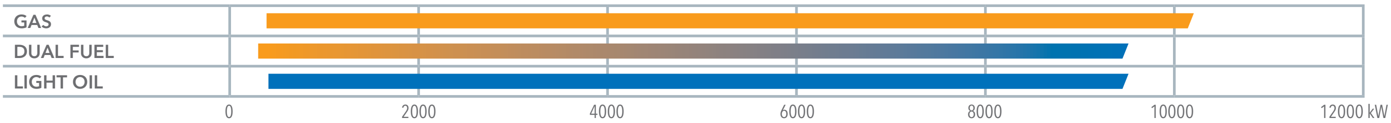
Free Flame Technology
FGR Versions
ErP compliant Versions



NEXRON Range

Low NOx versions
from 280 kW to 10200 kW

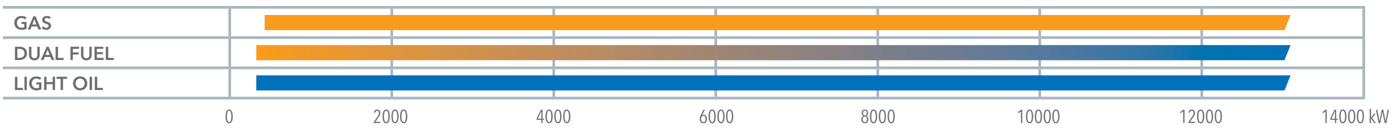
Free Flame Technology
Diamond Head Technology



EK EVO Range

Low NOx versions
from 280 kW to 13000 kW

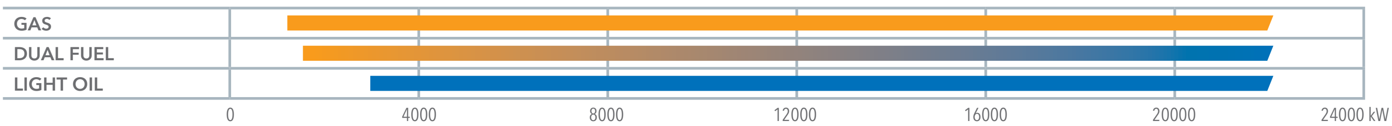
Free Flame Technology
Diamond Head Technology
FGR Versions



N Range

Low NOx versions
from 1300 kW to 22000 kW

Diamond Head Technology
FGR Versions



RANGE OVERVIEW

LOW NOx AND ULTRA LOW NOx DUOBLOCK RANGE

NOx

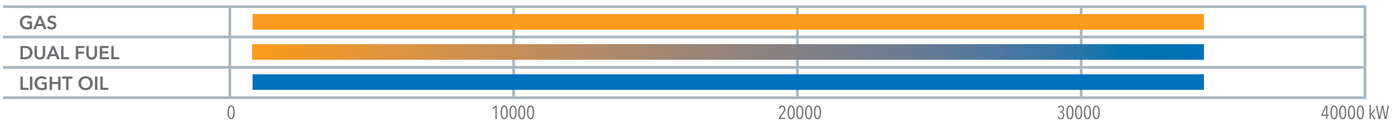
ULTRA LOW NOx

D-TRON Range

Low NOx versions
from 230 kW to 34000 kW

Diamond Head Technology

FGR Versions

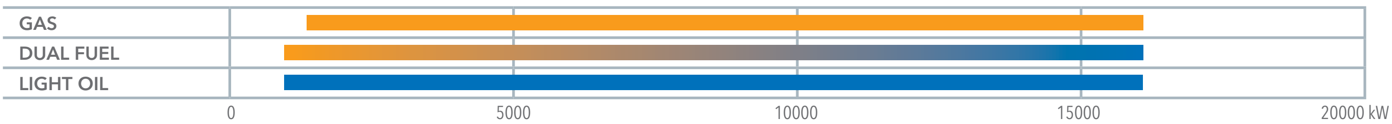


EK-DUO Range

Low NOx versions
from 600 kW to 16000 kW

Diamond Head Technology

FGR Versions

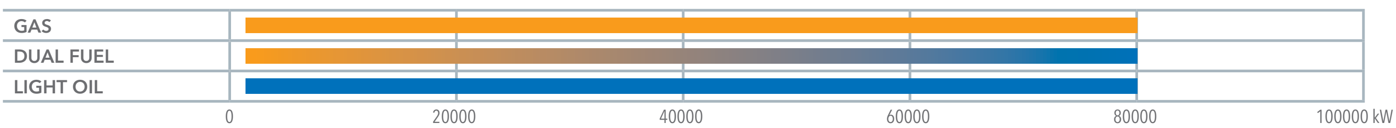


RPD Range

Low NOx versions
from 500 kW to 80000 kW

Diamond Head Technology

FGR Versions



REFERENCES

LOW NOx INSTALLATIONS

Altchemnitz, Germany

Fuel:
Natural gas

Total nominal output:
132 MW

Burners:
6x N11.22000 G-EU1

Sergiyev Posad, Russia

Fuel:
Natural gas

Burners:
2x N6.2900 G-R
2x N7.3600 G-R

Stavanger, Norway

Location:
District heating plant

Fuel:
Natural gas

Burners:
2x EK-DUO 4.1600 G-E

REFERENCES

LOW NOx INSTALLATIONS

Beijing, China

Fuel:
Natural gas

Total nominal output:
180 MW

Burners:
4x RPD 100 G-EU

Seoul, South Korea

Fuel:
Natural gas

Total nominal output:
50 MW

Burners:
7x N8.7100 G-EU3

Saint Petersburg, Russia

Fuel:
Natural gas

Total nominal output:
64 MW

Burners:
4x EK-DUO 4.1600 G-EU2

REFERENCES

ULTRA LOW NOx INSTALLATIONS

Beijing, China

Fuel:
Natural gas

NOx emissions:
Installation with FGR system to reach NOx levels below 30 mg/kWh

Burners:
2x N10.16000 G-EU2 FGR

Beijing, China

Fuel:
Natural gas

NOx emissions:
Installation with FGR system to reach NOx levels below 30 mg/kWh

Burners:
2x EK EVO 7.3600 G-EF3 FGR
2x EK EVO 7.4500 G-EF3 FGR

Trondheim, Norway

Fuel:
Natural gas

NOx emissions:
Installation with FGR system to reach NOx levels below 30 mg/kWh

Burners:
2x N10.16000 G-EU FGR

REFERENCES

ULTRA LOW NOx INSTALLATIONS

Beijing, China

Fuel:
Natural gas

NOx emissions:
Installation with FGR system to reach NOx levels below 30 mg/kWh

Burners:
1x EK EVO 7.4500 G-EF3 FGR
1x EK EVO 8.5800 G-EU3 FGR

Beijing, China

Fuel:
Natural gas

NOx emissions:
Installation with FGR system to reach NOx levels below 30 mg/kWh

Burners:
1x EK EVO 8.5800 G-EU3 FGR
2x EK EVO 8.7100 G-EU3 FGR

Beijing, China

Fuel:
Natural gas

NOx emissions:
Installation with FGR system to reach NOx levels below 30 mg/kWh

Burners:
1x EK EVO 8.5800 G-EU3 FGR
2x EK EVO 7.3600 G-EF3 FGR

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