



SUSTAINABLE



TECHNOLOGY & PRODUCTS



Dynamic Performance provides Industrial benefits

Clean Combustion's vision is to greatly improve industrial combustion processes with efficient, manageable, flexible and sustainable technology.

Government policies become stricter while energy prices become more expensive and volatile. Pulp & paper mills inevitably face higher costs. However, investment in more efficient energy extraction technology reduces production costs and environmental impact, optimizing performance and ultimately achieving a sustainable competitive advantage.

Clean Combustion's Dynamic Performance Concept began with the ambition to turn our innovations into results and help operators more efficiently manage their energy resource consumption. Our initial results of improved cost and time efficiency were soon followed by better energy extraction and fewer emissions. The results strengthen our drive and commitment to continually improve the technology towards:

Efficient technology

The core issue is a well-balanced and efficient, dynamic combustion and energy extraction for improved productivity and reduced waste.

Flexible technology

Clean Combustion's flexible technology supports solid, slurry, fluid and gas fuels. It allows for the mixing of different fuels and flows of fuels within one system.

Manageable technology

Our technology facilitates operations of the equipment and provides easily accessible functions, self-cleaning designs and highly reduced and simplified maintenance.

Sustainable technology

Clean Combustion's products will reduce the negative environmental impact in comparison to previous installations and will outperform corporate and governmental policies.





*Multi Fuel Lime Kiln Burner System for Metsä Board AB
Husum, Sweden (2018)*

We create technology to meet the energy challenges of the future

Over the last two decades the world has rapidly developed. The population has increased, the economy has grown and the middle class has expanded, all of which contributes to a growing demand for energy.

This results in unsustainable climate change. Yet awareness of our environmental problems creates a demand for sustainable energy sources. New types of fuels are introduced at an increasing rate, creating demand for new technologies.

Clean Combustion strives to be more efficient, sustainable, flexible and manageable in comparison to previous generations of combustion technologies. This is Dynamic Performance: efficiently operating in different situations. Our Industrial Burner Solutions embraces all types of fuels (gas, liquid, slurry and solid) and approaches a sustainable optimized combustion for every fuel we introduce.

Investments in new technology require a considerable return: cost efficient use of plant assets and fuel resources, legislated reduced emissions (such as NO_x, CO, CO₂ and others), reduced and simplified maintenance, and modernized operations. Additionally, the new technology should embrace efficiency, sustainability, flexibility and manageability in order to embrace the future.



Clean Combustion's Founder & CEO, Kjell Myrén summons up what makes Clean Combustion unique?

"We at Clean Combustion know that we are working in an industry of the future, where green and energy efficient technology is clearly needed. We remain committed to use our long experience, knowledge and the - Blue Sky technology - platform in the challenge to create direct economic sustainable benefits for our customers..."

Dynamic Performance – We stand for efficient and sustainable use of our energy resources...



Dynamic and Designed Burners and Systems



Multi-fuel burner tip: Equipped with lances for liquid and slurry fuels in the center. Surrounding the center there are channels for gas, solid fuels, and air. It also houses the swirl turbulator.



Back of the burner: Connections for different types of fuel, air, and steam. Automatic controlled actuators, for adjustment of the dynamic areas inside burner.

Multi Fuel Burners, from 1-50MW

Clean Combustion's multi-fuel burners, ranging from 1-50MW, will highly improve efficiency, simplify maintenance and lower emissions.

The dynamic technology supports solid, slurry, fluid and gas fuels, at single or multi-fuel operations within the same system. Our burners provide improved energy extraction, resulting in lower emissions, better cost efficiency and higher up-time compared to previous generations.

The combination of the vortex injectors, dynamic gas registers and a adjustable swirl turbulator gives the operator total control of the layout and position of the flame at different fuel flows and speeds. This helps to optimize the process and ensures a complete combustion of the fuel entering the zone, reducing fuel consumption and undesired exhaust particles.

Clean Combustion's manageable design focuses on daily operations. Functions are easily accessible, the design is self-cleaning, and maintenance is reduced and simplified.

The connections for fuels, air, atomization media and actuators are at the back of the burner. The actuators control the dynamic features of the burner. The fuel lances supply the fuel and atomization media to the vortex injector, which mixes the media in-air towards the combustion zone. Burners can be equipped with several gas channels. The gas is sent through the burner by a dynamic outlet channel towards the combustion zone. The adjustable area in the gas channel is automatically controlled by the optimal pressure of the gas entering the combustion zone.

Air is supplied through the swirl turbulator and mixed with the gas and the fuel before entering the combustion zone to ensure an optimized fuel/air ratio. This flexible Clean Combustion system provides high combustion rates even with variations of fuel and fuel quality, allowing the mixing of several fuels.

Custom made Burners and Systems

For optimized combustion different fuels have different optimum speed entering the combustion zone, depending on desired effect a burner will deliver different amount of flow of that fuel. Clean Combustion have components designed for different effect of each possible fuel. By using several fuels running independently or combined together one can reach different registry and output effects. Startup can be done on low effect with one fuel, for more effect switch to next fuel, add more fuels and a mix of those to reach full effect. Clean Combustion builds custom made multi fuel burners and systems according to customers desires and needs by combining our components.

Examples of Fuels

Liquid

- Light oil
- Heavy oil
- Methanol
- Pitch oil
- Tall Beck oil

Solid

- Coal
- Biofuels
- Wood Dust

Gas

- Natural Gas
- Bio Gas
- NCG
- Stripper

Adjustable Swirl Turbulators

Clean Combustion's adjustable swirl turbulators promote efficient combustion.

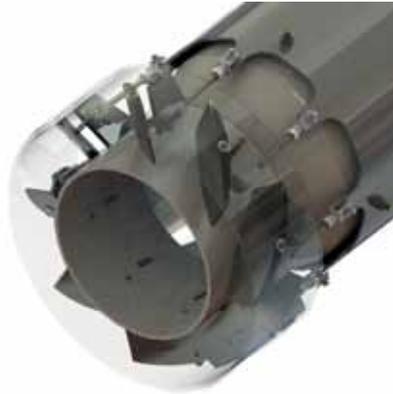
The swirl turbulator is used to steer and shape the flame in the combustion zone. Air is injected into the channel leading to the swirl turbulator while a speed-controlled fan regulates the flow to keep a constant over-pressure. The adjustable swirl turbulator controls rotation and stoichiometry of the air without losing pressure or speed.

Clean Combustion's design enables optimized combustion for a high variation of fuel flows. There is an additional cooling channel on the outside of the swirl turbulator to prevent the entire burner from over-heating.

Open 0%



Open 50%



Open 100%



Fuel Lances

Clean Combustion's fuel lances can easily be customized to meet all requirements.

In the center of each Clean Combustion burner there is room for up to three fuel lances designed for liquid and slurry fuels. The lance, its connections and the vortex injector have different sizes depending on the characteristics and desired effects of the designated fuel. Clean Combustion's flexible design allows the fuel lance to be independently pulled out while another is in operation.



Unique Vortex Injector Design

Liquid and slurry fuels entering the combustion chamber must be atomised to generate an efficient combustion.

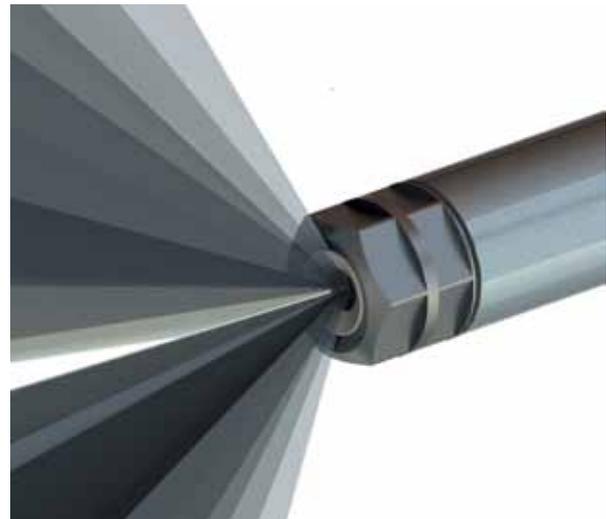
Clean Combustion uses a unique external mixing injector, replacing the function of the nozzle. Each burner can be equipped with several injectors to support different fuel types at the same time. The injector creates a vortex of the liquid/slurry fuel, it then applies the atomising media to create a conical shaped fuel mist directed into the combustion zone. The atomising media is either pressurised air or steam.

The injectors are designed according to flow rate and fuel characteristics. By later analysis of the combustion data, further improvements can be made through tuning the injector with interchangeable parts. The tuning controls the scattering angles and the rotation of the fuel mist, to ensure an efficient delivery to the combustion zone.



Main Advantages:

- ✓ Reduced fuel pressure
- ✓ Homogenous flame
- ✓ Reduced energy consumption
- ✓ Reduced emissions
- ✓ Increased uptime, 12-24 months
- ✓ Self cleaning design
- ✓ Control of viscosity by regulating fuel temperature
- ✓ Turn down ratio 1-6, 1-12



Automatic Gas Injectors

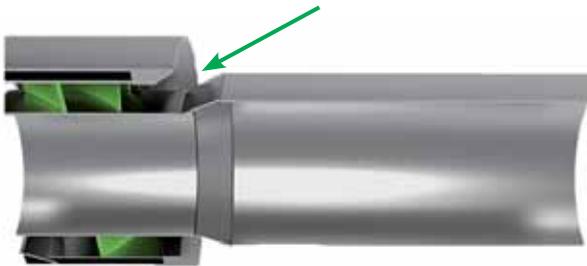
Clean Combustions automatic gas injectors are used in incinerators and gas burners, they can also be used as a mixer and gas control unit before a multi-fuel burner.

The automatic gas injector facilitates alignment and operation of ejectors, which normally drive the combustion gases. The gas injectors constantly measure the gas pressure, when a desired pressure is reached the injector automatically opens its valves and allows the gas to flow through into the combustion zone. Independently of the gas flow, the valves can be controlled automatically or manually from the control room.

The gas injector is controlled either by using steam or water pressure, which also functions as an additional back-fire barrier in the gas outlet. During low or almost no gas flow the valves remain closed and prevents the occurrence of back-fire.

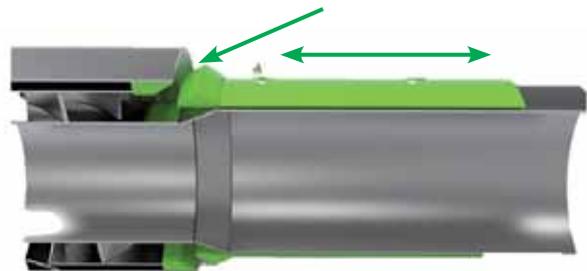


Gap flow fully open with no control



Static

Controllable Gap flow



Dynamic

High Quality Valve Trains

We offer the highest quality and expertise within Valve Trains and Feed Trains, to ensure the optimal quality of input.

Projects covering retro-fit of burners commonly requires modifications or additions to its Valve Trains. The activity is planned in accordance of established mill design criteria.

Clean Combustion delivers a cabinet covered solution based on Siemens Technology, unless other is agreed. A retro-fit valve train could also be an addition to existing valve train to allow combustion of a new fuel in the process. We call it “Valve Train Expansion”. The valve train cabinet is easily connected to the other modules of the BMS.

We encourage usage of existing equipment of good quality that remains within current regulations and standards (NFPA, IEC, and ANSI/ISA). Note that new regulations requires upgrading of older and existing equipment that everything is brought up to current requirements.

Our base component offering for complete or expansive valve trains in burner applications are:

- ✓ Safety components such as isolation valves, electronic safety shut-off valves, and pressure switches
- ✓ Unit components such as inlet drip leg, filter/strainer
- ✓ General components as pressure regulators, flow meters, control valves



Furnace Monitoring

Clean Combustion solutions offer total flame control through intelligent surveillance. We design, manufacture and supply equipment which allows our clients to monitor high temperature processes.

The imaging solutions provided by Clean Combustion help to maximize performance by showing the flame, fuel and air flow in the burning zone. The knowledge gained allows our clients to run their plants efficiently, safely and more environmentally friendly.

All equipment are designed to operate in the hottest and toughest combustion areas so our clients always know what is happening in their processes. Our camera models have high durability for harsh environments. The equipment can handle dusty environments with CaO and other chemicals in ambience. The automatic operation of the camera ensures that it is not overheated and that the lens is kept clean.

Visual HD Cameras

Our visual camera solutions include water cooled flame monitor cameras, with high definition, high speed cameras that provide high quality imaging from inside the kiln or cooler. Our systems provide real time display of the combustion inside the kiln/cooler and indicates the flame position, furnace health, exhaust gases and other details of the combustion process.

Thermal HD Cameras

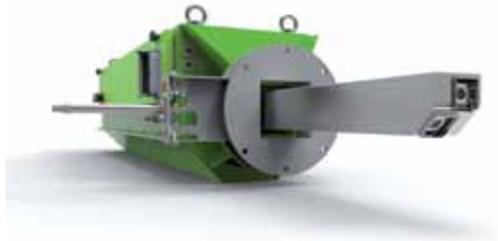
Provides real time radiometric imaging with accurate temperature measurement. Internal Thermal Cameras can locate temperature fluctuations in the flame and the flame bed, while our external Thermal Cameras will find changes in temperature in the process or kiln.

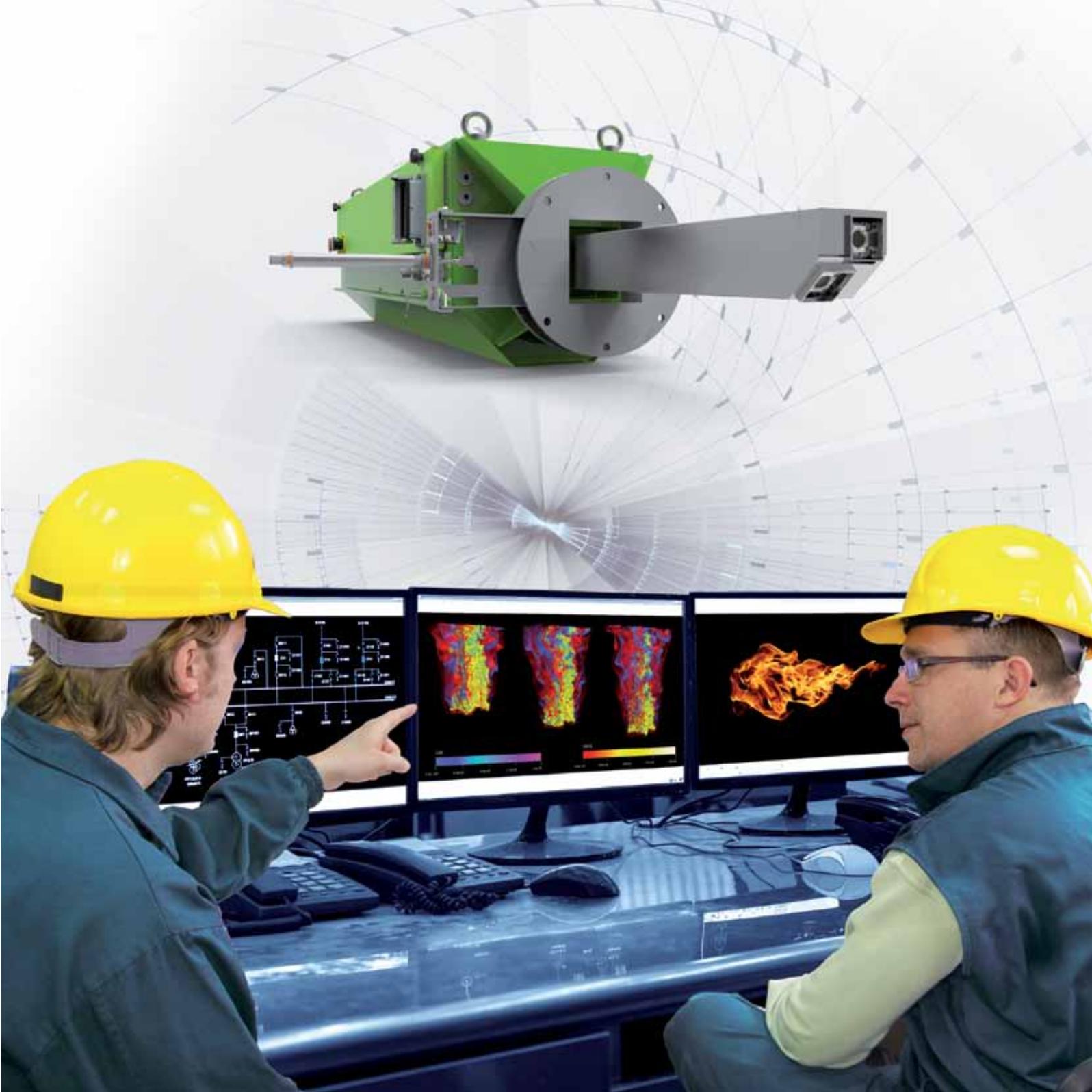
Kiln Shell Scanning Systems

Kiln Shell Scanning System incorporates the latest digital technologies with flexible configuration options which allow optimum and cost-efficient cabling throughout the plant using new or existing infrastructure. Fibre optic signal transmission ensures error-free communications in harsh environments.

Process Monitoring Systems

Thermally driven processes in modern manufacturing industrial production plants require accurate and reliable monitoring for the overall plant success. IR measurement science offers ideal tools for process monitoring and optimization. The challenge of supplying effective instrumentation products starts with the harsh environments typical in cement plants, lime plants, paper mills, power plants and steel mills.

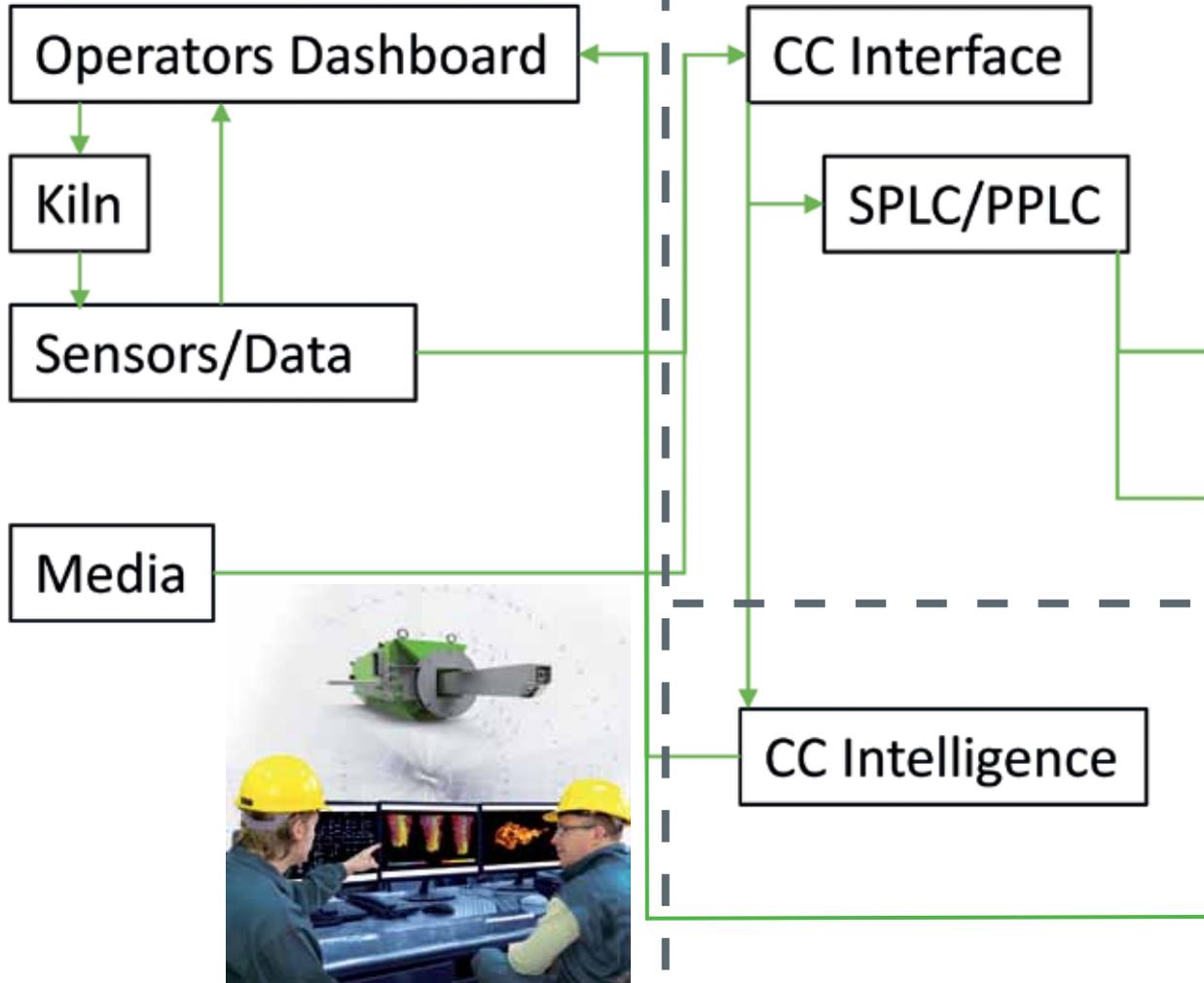




Plants Systems

CC Control

Clean Combustions control system is the key system for analyze, control and optimizing of combustion data. The control system gives an efficient integration between plant system and Clean combustion burner products.



Systems

CC Burner Hardware



Automatic Control

Multifuel Burners

Valve Train

Incinerators



Furnace Monitoring



Service and Maintenance

Clean Combustion's Service & Maintenance Program improves plant availability, optimizes performance and increases productivity and up-time. This cost-effective service is provided to the client at a price they know in advance.

Clean Combustion's products have long intervals between services due to self-cleaning designs, clean burning and low emissions. By monitoring combustion data from the plant we can quickly see if efficiency is falling, and through our systems identify the cause and advise on corrective measures. The plant is tuned for optimum performance and is under constant control and inspection of our service organization both locally and remotely.

Fixed Charge

Our Service & Maintenance Program clients are billed a fixed charge and require no capital investments. There are no hidden costs: all components, tools and freight charges to and from the facility are included. We plan and manage maintenance, service, tuning and spare parts in collaboration with our customers for the best cost effectiveness.

Preventive Maintenance

To ensure the highest availability and avoid production disruptions Clean Combustion's service engineers visit the plant facility on a fixed maintenance schedule for trimming and inspection, done by appointment. This provides effective protection against unexpected breakdowns and unwanted costs.

Guaranteed Assistance

Clean Combustion's Service & Maintenance Program includes responsibility for the maintenance of a stock of spare parts, including access to the standard "Auxiliary Burners" from our supply. We guarantee door to door service within 24 hours or less. This causes that the facility owner can optimize their security costs in their budget.

Workflow

First, we meet with the client on site to understand their current situation and future needs, as well as to present ourselves. Clean Combustion provides a preliminary analysis to recommend preferred solutions for the unique situation which exists at each facility. This report may detail the economic life of previous investments, control over future costs, fuel efficiency and the reduction of emissions. In many cases this has been crucial to the continued operation, increased capacity or licensing of the facility.

Our commitment extends from analysis and evaluation to turnkey package, which also includes support, service and necessary training. With a fruitful exchange of knowledge with the customer, we use the preliminary analysis to be the basis for the custom solution package.



 **LEAN COMBUSTION**[®]
DYNAMIC PERFORMANCE

Benefits for our customers

Vision	<i>Efficient and flexible combustion with manageable technology, that improves corporate and environmental sustainability</i>			
Innovation	<i>Designed for improved efficiency and flexibility</i>		<i>Designed to improve manageability and maintenance procedures</i>	
Technology	<i>Improved fuel atomisation</i>	<i>Dynamic fuel flows</i>	<i>Remote and precise control</i>	<i>Self cleaning, Easy maintenance</i>
Operation	<i>24 months uptime</i>	<i>Increased control range</i>	<i>Decreased fuel pressure</i>	<i>Multi-fuel combustion</i>
Efficiency	<i>Improved resource, capacity, and plant usage</i>			
Sustainability	<i>Efficient usage of energy and plant</i>	<i>Reduced environmental impact & emissions</i>		<i>Improved uptime and shortened maintenance</i>

In 2013 Clean Combustion began a partnership with Elof Hansson AB, an international specialist in the pulp and paper industry, originally founded in 1897. The company have subsidiaries and agents in more than 100 countries, each involved in one or more of the Group's business areas.

Their partnership has continued to strengthen and evolve, and in 2016 Elof Hansson joined with ALMI Invest (Government Investment fund) to invest further in Clean Combustion. This new partnership and its resources support Clean Combustion's future international expansion. Since 2018, Elof Hansson is the majority owner in Clean Combustion Technology Sweden AB.



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