

Conference :- Heat Rate Efficiency Summit 2023

Topic :
Decarbonizing Coal Based Power Plant
by Retrofitting Boiler with MOIS –Mini
Oil Gun Ignition Solution & Plasma
Ignition Solution

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Council of Enviro Excellence

**3RD HEAT RATE
EFFICIENCY
SUMMIT 2023**



**At Hyatt Centric ,Janakpuri ,New Delhi -
1 Dec,2023**

Decarbonizing Coal Based
Power Plant by Retrofitting
Boiler with MOIS –Mini Oil Gun
Ignition Solution & Plasma
Ignition Solution

What to do ?



Let us take ownership – We are responsible



Yeah, I'm always extremely busy, converting Oxygen

**Coal Will Remain
Prominent for Decades
Despite Growing
Renewable Power
Capacity**

India Promise To The World



- ▶ Industries to work on demand-management, energy-efficiency improvements; shift towards electrification; carbon capture, utilisation and storage (CCUS); and use of low-carbon fuel-technology choices
- ▶ Corporates to reduce scope 1, 2 and 3 emissions
- ▶ Have strong policy framework and implementation

- ▶ Source funding (from developing countries) for supporting the environmental goals



WHAT'S ACHIEVED SO FAR

India has made big strides in renewable energy

- ▶ India now at 4th global position for overall installed renewable energy capacity
- ▶ Renewable energy has a share of 26.53% in the total installed generation capacity in the country
- ▶ Renewable energy installed capacity increased 286% in the past 7.5 years
- ▶ Solar capacity increased in the past 7.5 years from around 2.6 GW to more than 46 GW
- ▶ Highest ever wind capacity addition of 5.5 GW in 2016-2017

2070

India has promised to cut its carbon emissions to net zero by 2070 (albeit missing the goal of reaching the target by 2050)

SOURCE: MINISTRY OF NEW AND RENEWABLE ENERGY

India 5 Guarantee Towards Climate Action

INDIA'S 5 GUARANTEES TOWARDS CLIMATE ACTION

A look at how the country plans to deal with climate change



- ▶ Achieve net zero by 2070
- ▶ Increase non-fossil energy capacity to 500 GW by 2030
- ▶ Meet 50 per cent of energy requirements from renewable energy by 2030
- ▶ Reduce total projected carbon emissions by one billion tonnes from now till 2030

- ▶ Reduce carbon intensity of the economy by less than 45 per cent by 2030



THE PATH TO SUCCESS

What India needs to do in order to fulfil its pledge to the world



- ▶ Focus on renewable power, close down old and inefficient coal-fired power plants
- ▶ Focus on new technologies and their commercial viability such as green hydrogen, storage, batteries
- ▶ Increase adoption of electric vehicles, make them affordable, and increase charging points.

What is achieved so far



- ▶ Industries to work on demand-management, energy-efficiency improvements; shift towards electrification; carbon capture, utilisation and storage (CCUS); and use of low-carbon fuel-technology choices
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Planned Investment Over Next Decade

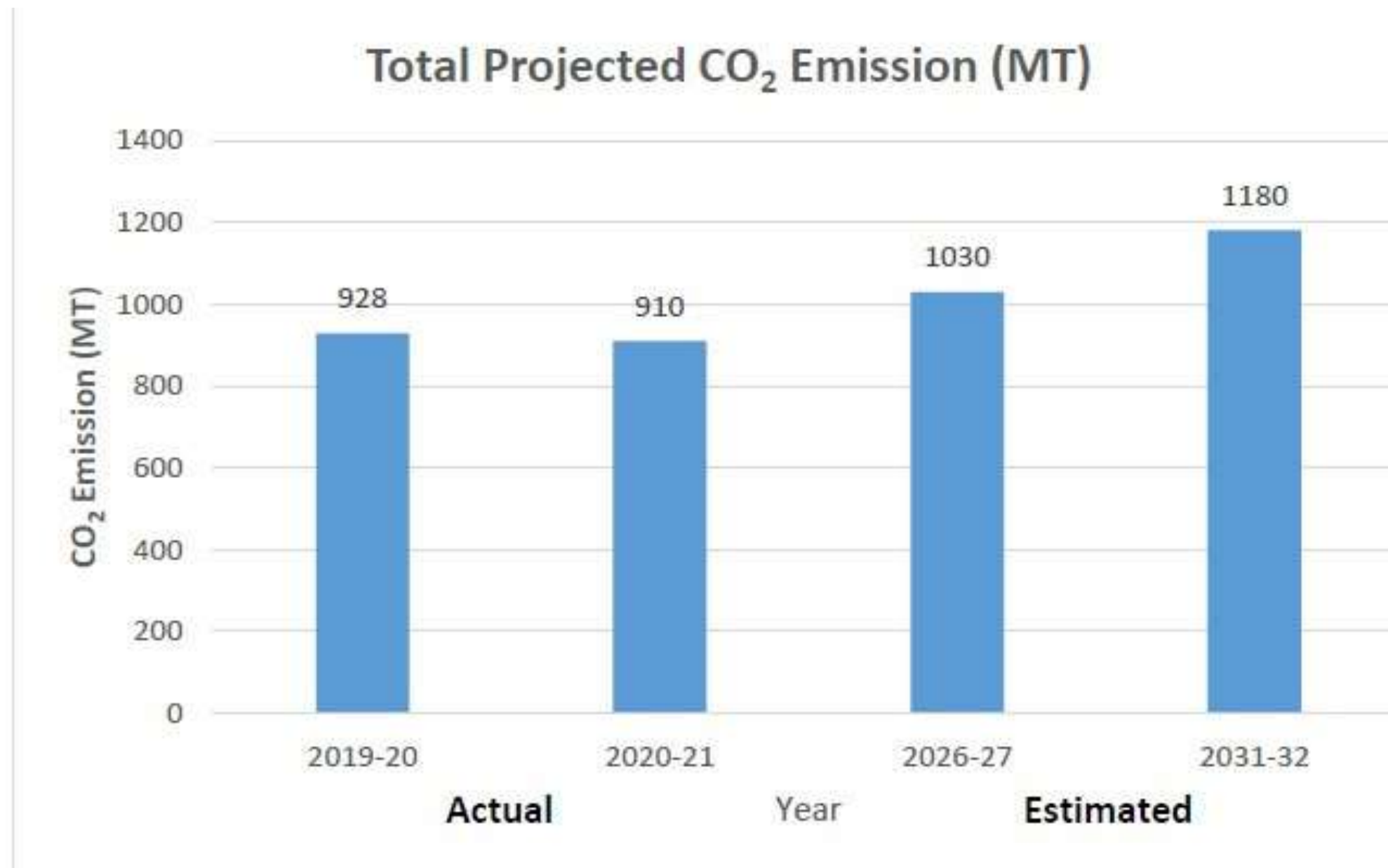
PLANNED INVESTMENTS OVER THE NEXT DECADE

POWER GENERATION, CEMENT AND STEEL

Power generation: To increase capacity of non-fossil fuels	₹35-45 lakh crore (includes investments towards transmission infrastructure and storage capabilities). Beyond 2030, ~₹6 lakh crore/year investments would be needed for renewables
Industry: Cement	<ul style="list-style-type: none"> o Cement companies in India have been investing in zero carbon footprint technologies to replace fossil fuel-based power generation with renewable energy and waste heat recovery systems (WHRS) o ₹1,400-1,700 crore (for WHRS in FY22) by some major cement companies
Industry: Steel	<ul style="list-style-type: none"> o JSW Steel to raise ₹3,700 crore via green bonds as company wants to cut carbon emission o Tata Steel in its capex plan of ₹50,000-60,000 crore over the next 5 years has made provision for making 5 million tonnes of steel through the recycling steel route
Transport	
CNG	₹1.8-2.2 lakh crore (includes 8th, 9th, 10th and 11th round by PNGRB)
Ethanol blending	₹28,000-32,000 crore (for ethanol production)
Biodiesel	Government floated 11 EoIs for 200 locations in the first phase of bio-diesel production. The first supply of biodiesel was given in May 2021
Hydrogen	<ul style="list-style-type: none"> o Oil refining companies (such as RIL, IOCL, etc.) are planning to add green hydrogen production capacities o Adani Group plans to invest ₹1.5 lakh crore in RE and hydrogen
Electric vehicles – two wheelers	₹7,000-9,000 crore by major players

SOURCE: ICRA LIMITED

Total Projected CO₂ Emission

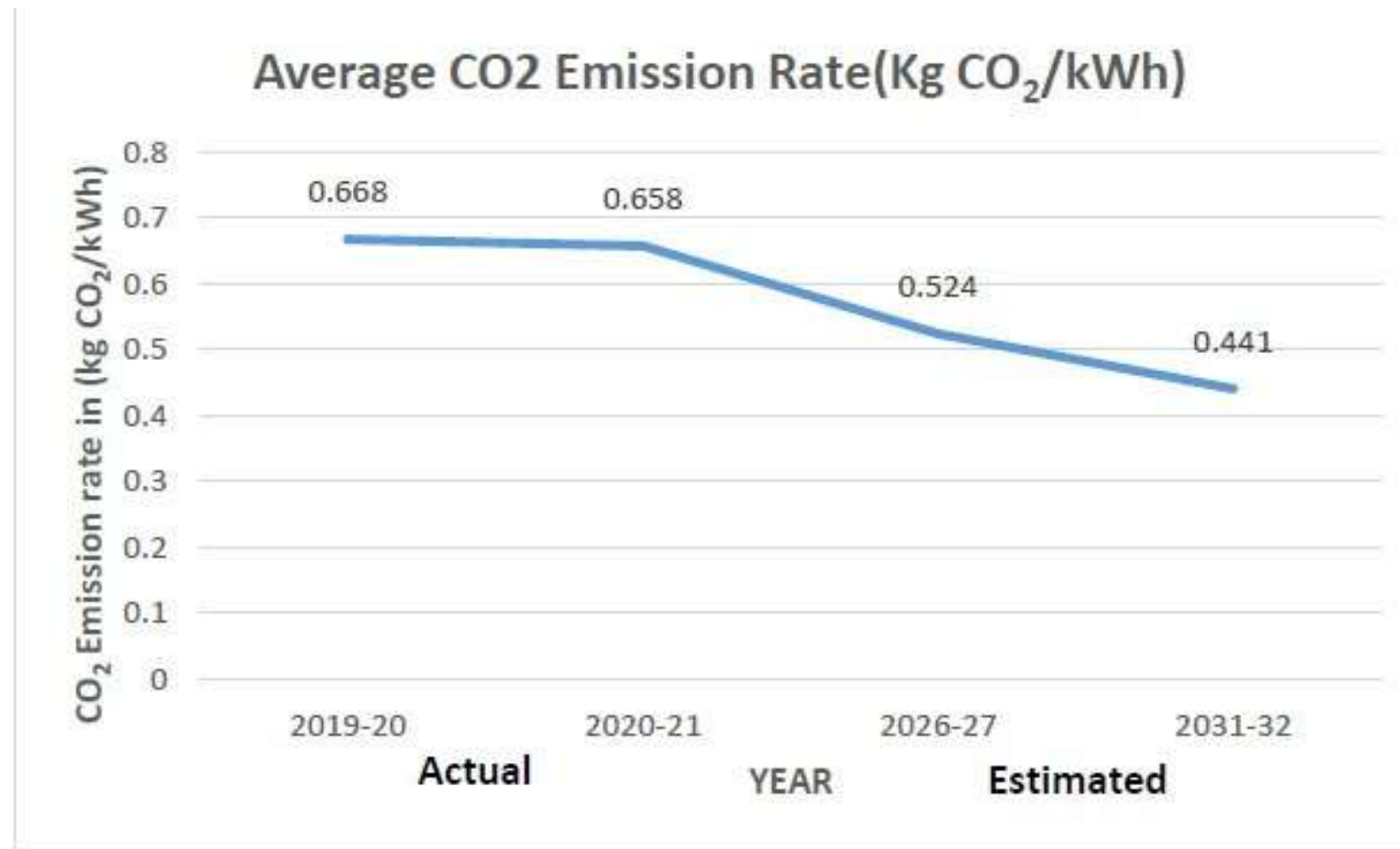


The total CO₂ emissions projected will increase from 910 Million tonnes in 2020-21 to 1030 Million tonnes in the year 2026-27 and 1180 Million tonnes in 2031-32

* REF DRAFT NEP SEPT
2022



Decarbonizing/Reducing Emission from CPP



The average emission factor kgCO₂/kwh from the total generation including renewable energy sources in base case scenario has been estimated and are shown above . It may be seen that the average emission factor is expected to reduce to 0.524 kg CO₂/kWh in the year 2026-27 and to 0.441 kg CO₂/kWh by the end of 2031-32.

* REF DRAFT NEP SEPT
2022



Focus on three important area

The reduction of Carbon dioxide emissions or Decarbonisation can be achieved with a focus on three important areas:-

- Increasing renewable energy capacity,
- **Decarbonising emission-intensive sectors such as transportation, power generation, building/infrastructure sector, cement and construction sector**
- Creating more carbon sinks.

Sectors with potential for Decarbonisation projects:

The following Sectors including energy and land use act as a direct source of global emissions and have potential/opportunities (emission rates as per estimate in report by McKinsey and Company):

Sectors	Power sector	Industry sector	Transportation sector	Building sector	Agriculture sector	Forestry and other land use	Solid Waste
Areas included	Electricity and Heat generation	Production of steel, cement, chemical industry, extraction & refining of oil, gas & coal industry	Road, rail, aviation, maritime and other forms of transportation.	Heating and cooking:	Emission from agriculture practices, fishing, on-farm energy use etc.	Primary land coverage change.	Solid waste disposal, treatment, incineration and wastewater.
Contribution in emission	30 per cent of Co2 emissions and 3 per cent of Nitrous Oxide	30 per cent of Co2 emissions, 30 per cent of Methane emissions and 8 per cent of Nitrous Oxide.	19 per cent of Co2 emissions and 2 per cent of Nitrous Oxide emission.	6 per cent of Co2 emission.	1 per cent of CO2 emissions, 38 per cent of methane emissions, and 79 per cent of N2O emissions	14 per cent of CO2 emissions, 5 per cent of methane emissions, and 5 per cent of N2O emissions	23 per cent of methane emissions, and 3 per cent of N2O emissions



Coal not going to phased out earlier than 40 years

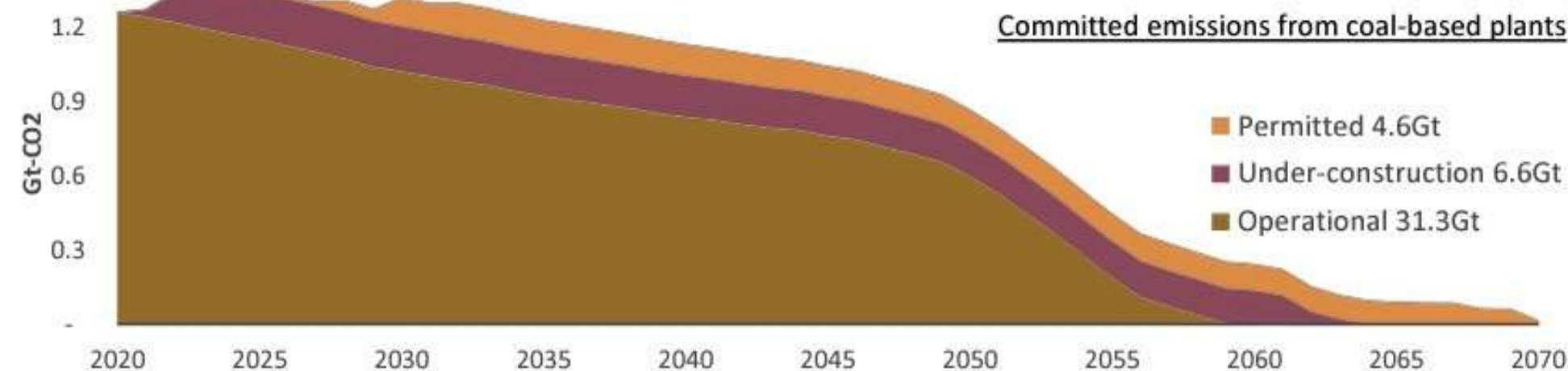
WELCOME

Towards a Strategy for India's Decarbonisation

Montek Singh Ahluwalia & Utkarsh Patel

06 Aug 2021

When can we phase out Coal-based Electricity?



- CEA is assuming that all thermal plants will operate for their normal life of 40 years. In that case **coal would not be phased out for a long time.**
- **If RE is cost competitive, some of the existing plants could be phased out earlier than 40 years.** Those approved but not under construction need not be taken up at all to avoid asset stranding.



Decarbonizing Measures

- **Oil Consumption Reduction**

- **Mini Oil Gun Retrofit**

- **Plasma Ignition (Oil less boilers)**

- **Benefits of Mini Oil Gun & Plasma Ignition for Flexible Operation**

- Fuel Flexibility

- Fuel switch coal to bio-mass (Carbon Neutrality Approach)

- MSW to Green Coal burning in Boiler

- Bio Mass Co-firing

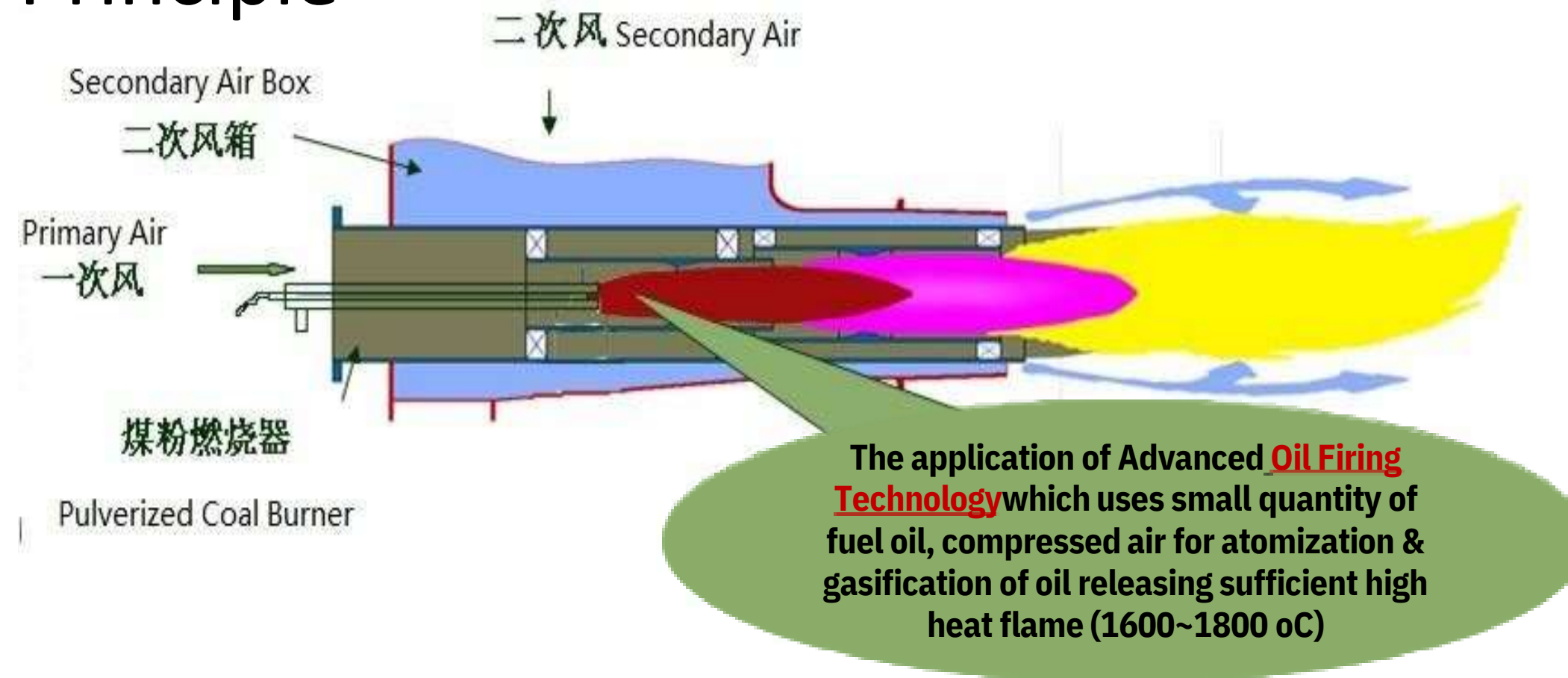
- Green Ammonia firing in Coal Based Power Plant

- Role of hydrogen energy on GHG reduction

- Repowering

- Carbon Capture

Mini Oil Ignition Principle



A strong and stable oil torch with high temperature of 1600~1800 deg C can be obtained by burning a small quantity of fuel oil only. The pulverized coal goes through the oil flame and quickly absorbs the heat, releasing volatile matters which quickly burst the coal particles and ignite. The startup and low load operation can be achieved with minimal (negligible) oil consumption.

MOIS

Functions

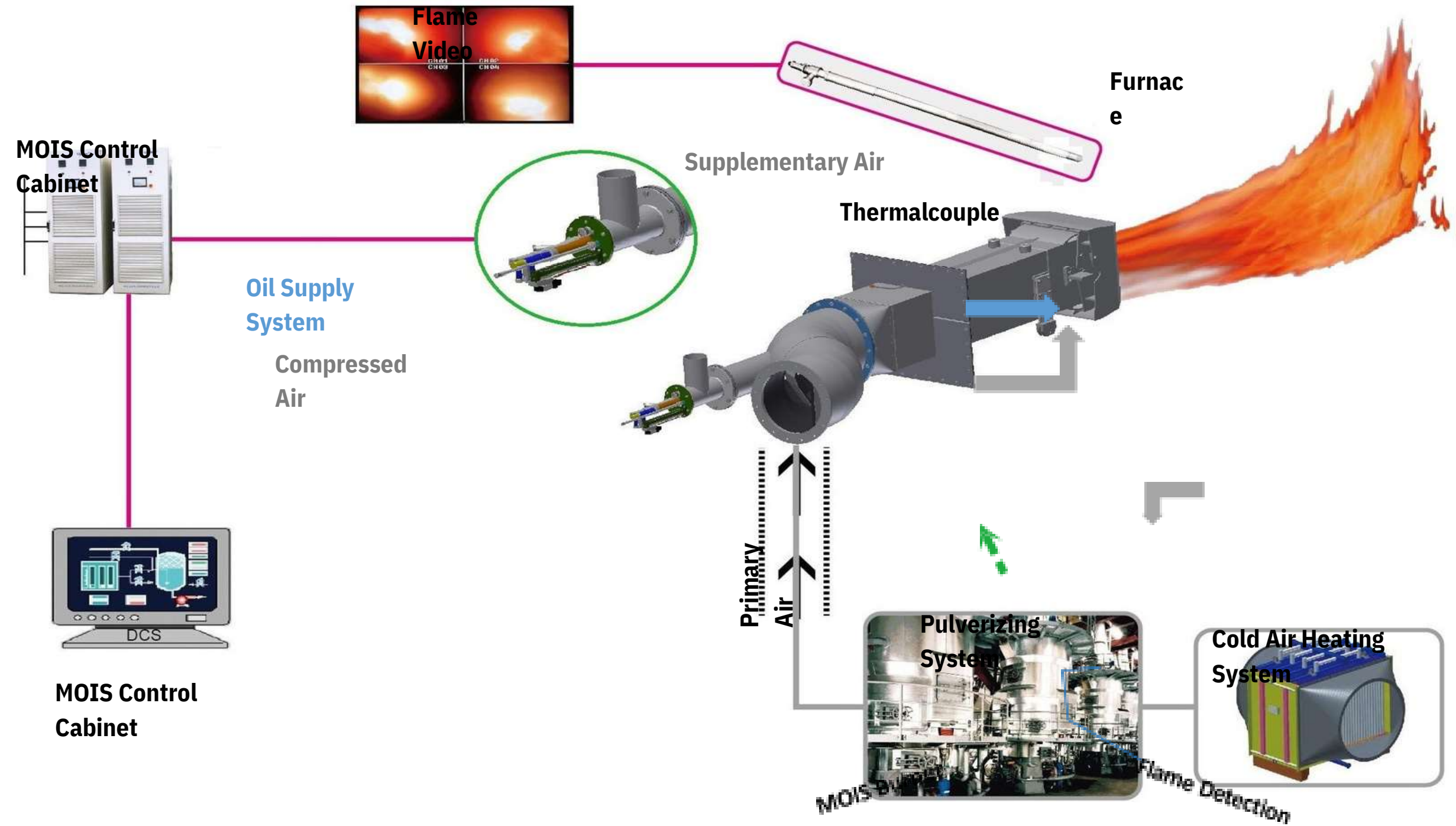
Mini-oil ignition coalburner

- In the process of boiler start-up and/or shutdown, providing stable and high- efficient firing that ensures the operation process of boiler start up and/or shutdown.
- In the process of boiler low load operation, providing combustion support to the furnace in stead of traditional oil burners.

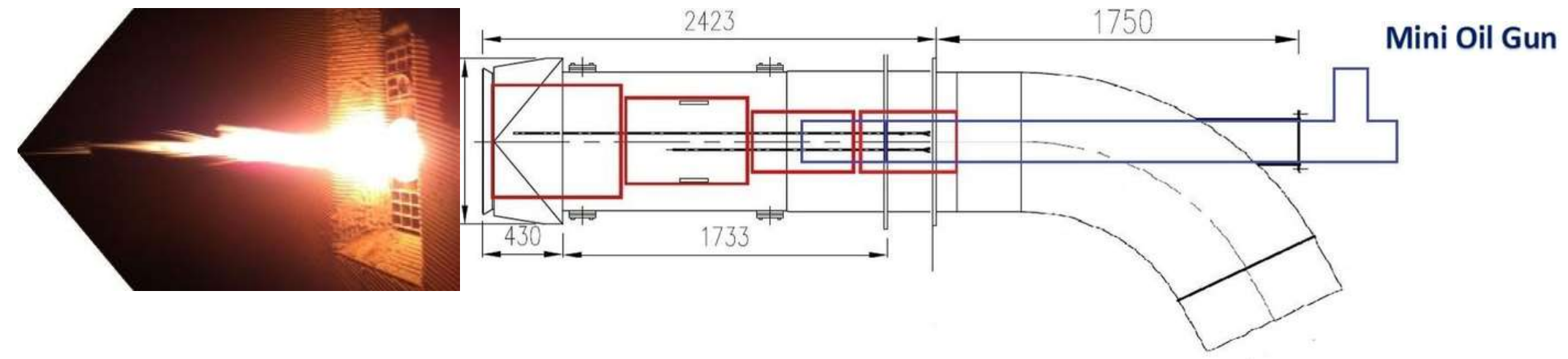
Main Burner

- After the boiler startup and in its normal operation of the boiler, mini-oil ignition burner acts as the original coal burner with the same performance.

MOIS Components



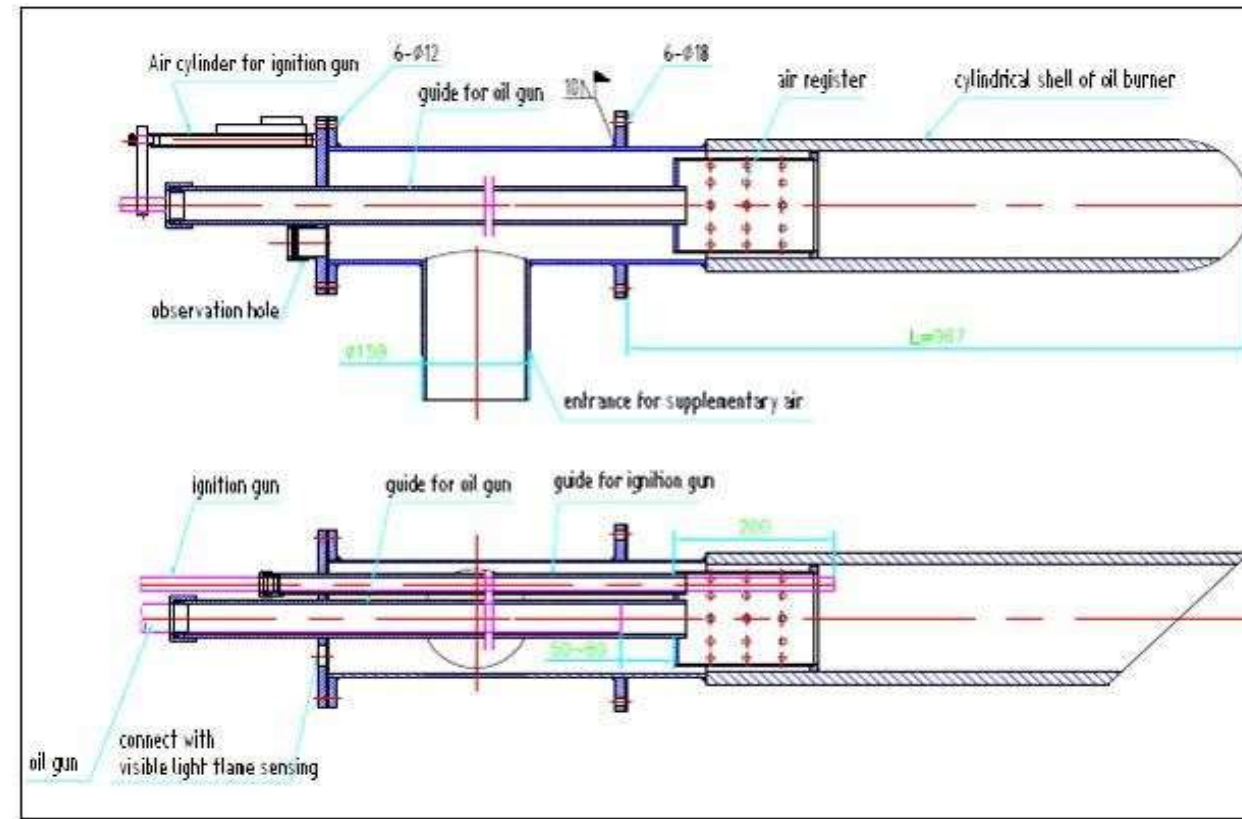
MOIS burner



The coal nozzle sand in let bend of coal burner strobe replaced with MOIS burners together with its dedicated inlet bends, while the tip area of MOIS burner is the same as that of original burner.



Mini-oil Gun



Mini Oil Gun Retrofit Solution ROI



SI No	Particulars	As per AOP FY'23	BTL (Warm)	AOH (Cold)	Other FO (Hot)	BTL (Warm)	AOH (Cold)	Other FO (Hot)
		No of Outages	6	1	2	6	1	2
		Avg KL/Start-up	50	90	20	18	45	5
		UoM	YTD Approx Oil consumption in Start-ups as per present trend in one unit			YTD Expected Oil Consumption in Start-ups as per present trend in one Unit (considering same time before & after)		
1	Unit capacity(MW)	MW	600			660		
2	No of Units	Nos	1			1		
3	PLF	%	95			95		
4	Gross generation(MU)	Mus	5493			5493		
5	Net Energy sent out (Mus)	Mus	5163			5163		
6	Present Annual oil Consumption	kL	43			163		
7	Specific Oil Consumption (SOC)	kg/MWH	0.078			0.030		
8	Oil price per kilo liter HSD	Rs/kL	92000			92000		
9	Present Annual Expenditure on Oil Consumption	Rs(Crores)	1.96			1.50		
10	Likely Annual Oil Consumption of after installation of MOIS in %	kL	--			38%		
11	Saving of Annual consumption after installation of MOIS (in kL)	kL	--			267		
12	Saving of Annual Expenditure on oil after installation of MOIS(Savings=Item 8 × Item 11)	Rs(Crores)	--			2.46		
13	Cost of MOIS for 1 unit.	Rs(Crores)	--			1.25		
14	Payback period (period=Item 13/Item 12)	Months	--			6.0		

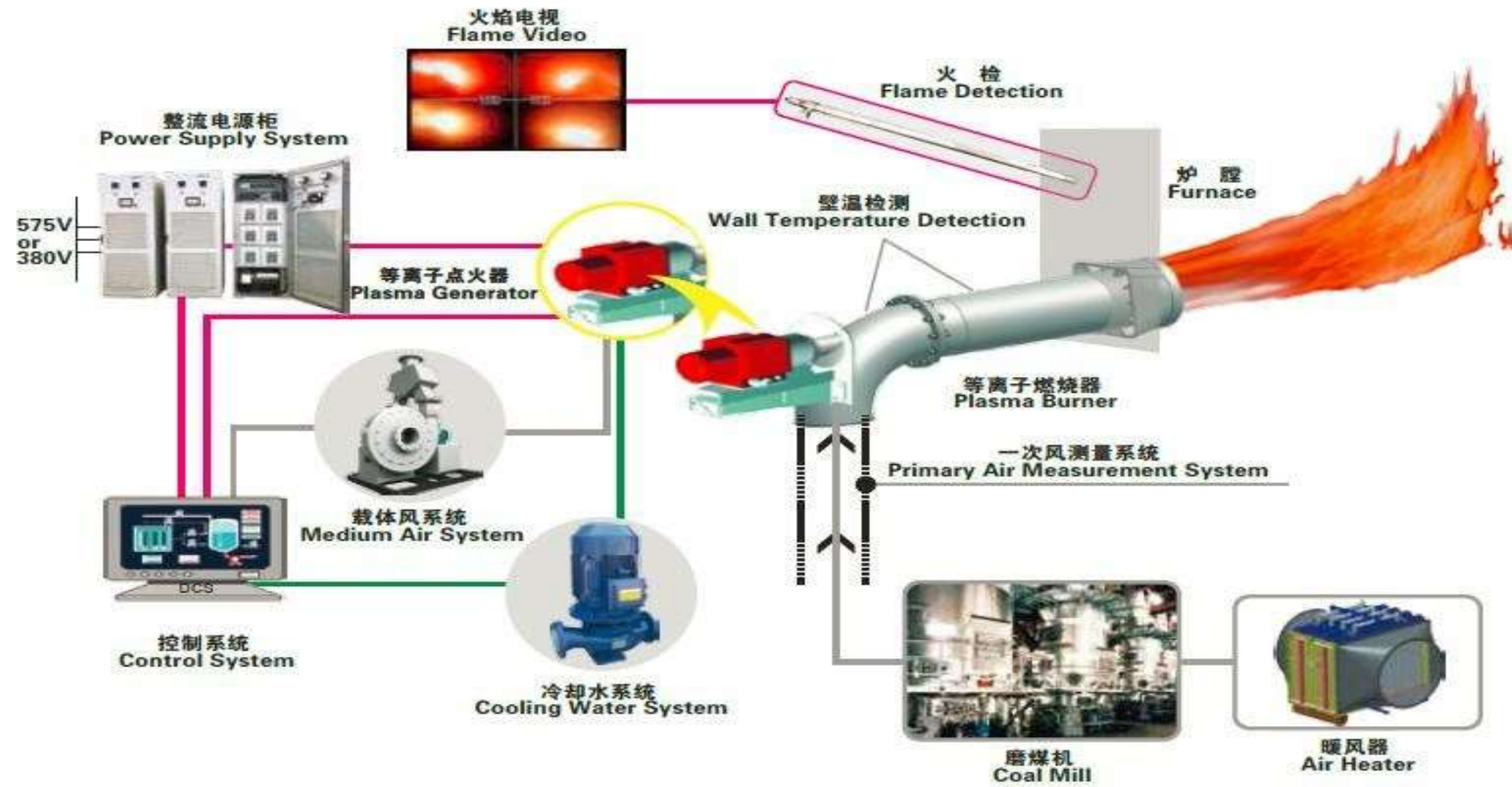
Pay back is 6-18 Months
Carbon Credits / Better Health



MOIS References

No.	Name of Power Plant	Unit Capacity	Retrofit/New	Corner(T)-/wall-fired	Coal	Status
1	India Jhajjar CLP	2x660MW	New	T-fired	High-ash coal	In operation
2	India Adani	12x600 MW	Retrofit	T-fired	High-ash coal	In Operation
3	Cambodia Sihanouk Port	3x135MW	New	T-fired	High-moisture coal	In operation
4	Indonesia Jenepono	2x125MW	New	T-fired	High-moisture coal	In operation
5	Indonesia East Kalimantan	1x60MW	New	T-fired	High-moisture coal	In Operation
6	Pakistan Ruyi	2x660 MW	New	T-fired	Bituminous	In Operation
7	Tajikistan Dushanbe	2x50 MW	New	T-fired	Bituminous	In Operation
8	Turkey Hurutu	2x660 MW	New	T-fired	Bituminous	Under Construction
9	Zimbabwe Hwange Phase III	2x335 MW	New	T-fired	Bituminous	Under Construction

System Composition of PICS

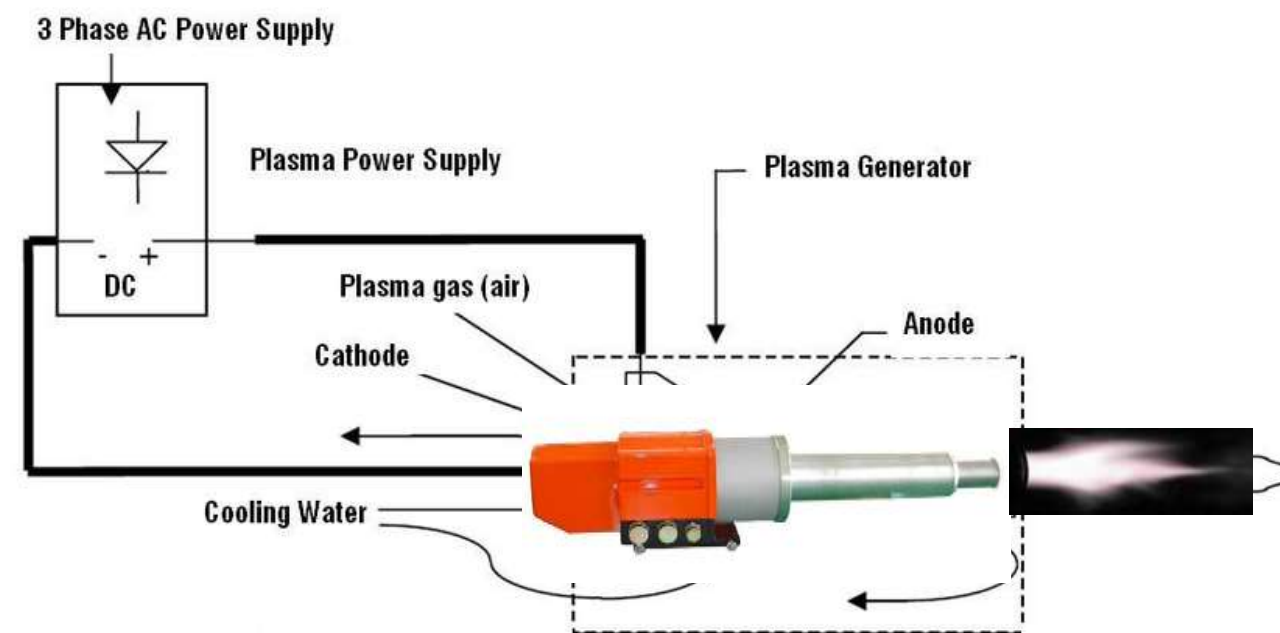
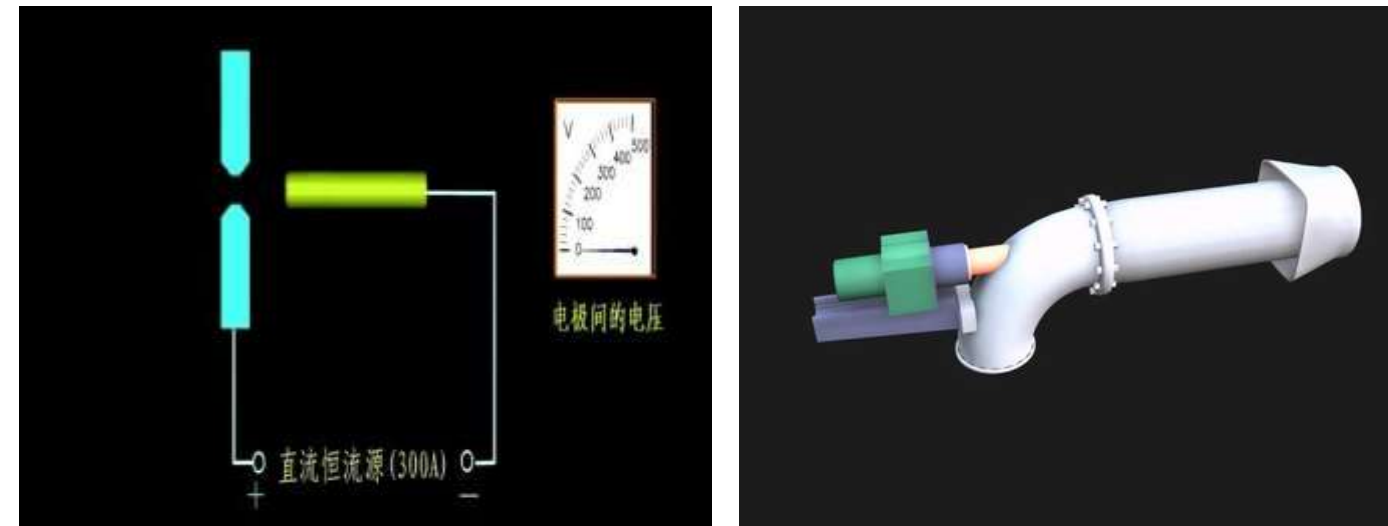


Plasma Ignition of PICS

□ Plasma is considered the 4th state of matter .

□ Gas particles get ionized (a loss or gain of electrons of the molecules or atoms of the gas), then turned into a plasma, containing charged particles: positive ions and negative electrons.

□ High temperature of the order of **5,000°C** can be achieved by the Plasma Technology.

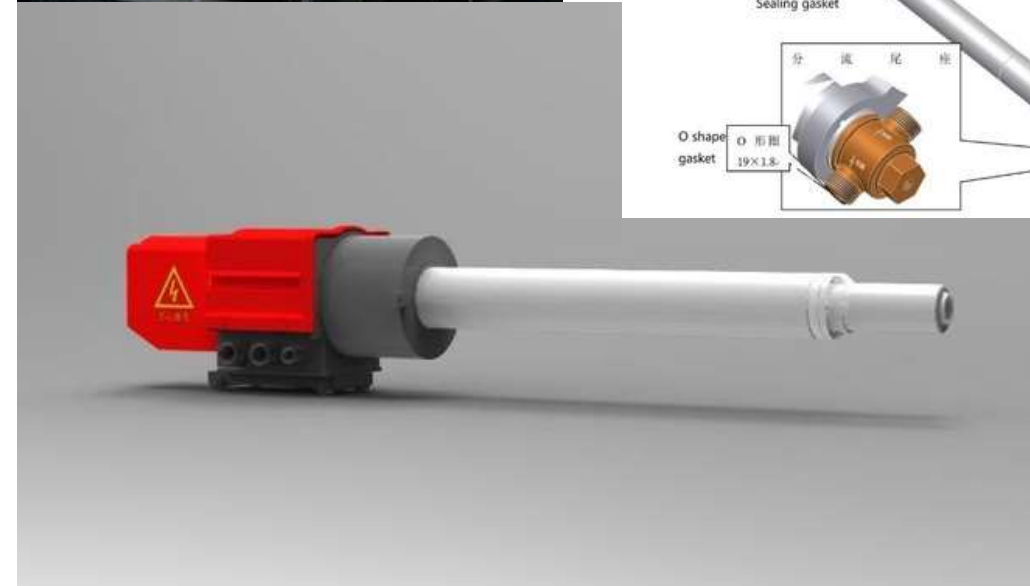
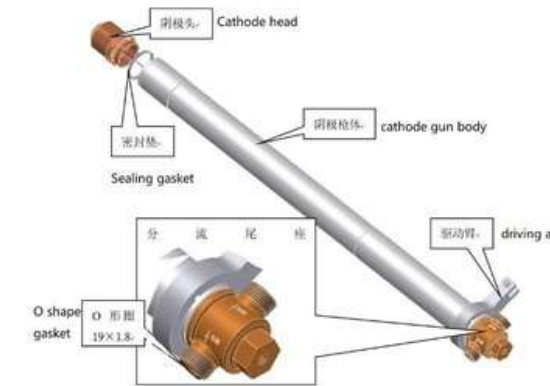
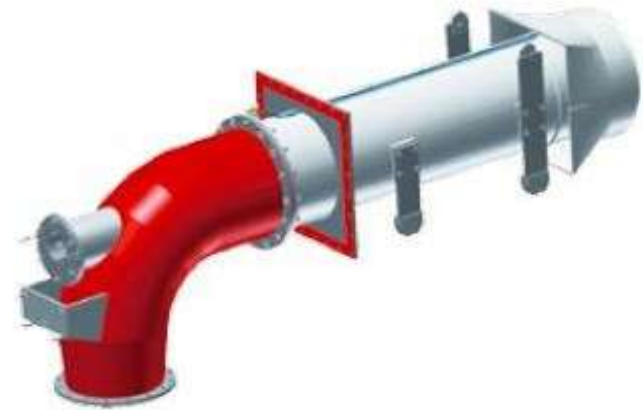




PICS main equipment-Plasma Burner & Plasma Generator

Plasma Burner

The pulverized coal-fired burner equipped with a plasma generator which is used for ignition and combustion stabilization in low load operation. Output of plasma burner and air velocity of the burner nozzle shall be designed as origin, PICS will not change combustion state inside the furnace. In addition, the multi-barrel structure is applied on plasma burner for promotion of the ignition performance.



PICSmain equipment-PlasmaBurner

□ Plasma Burners used during start up and low load operation.

□ After the boiler startup and in its normal operation of the boiler, Plasma burner acts as the original coal burner with the same performance. Plasma system is kept in shut down condition.

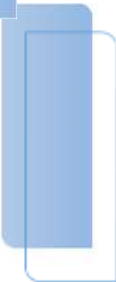


4th Gen

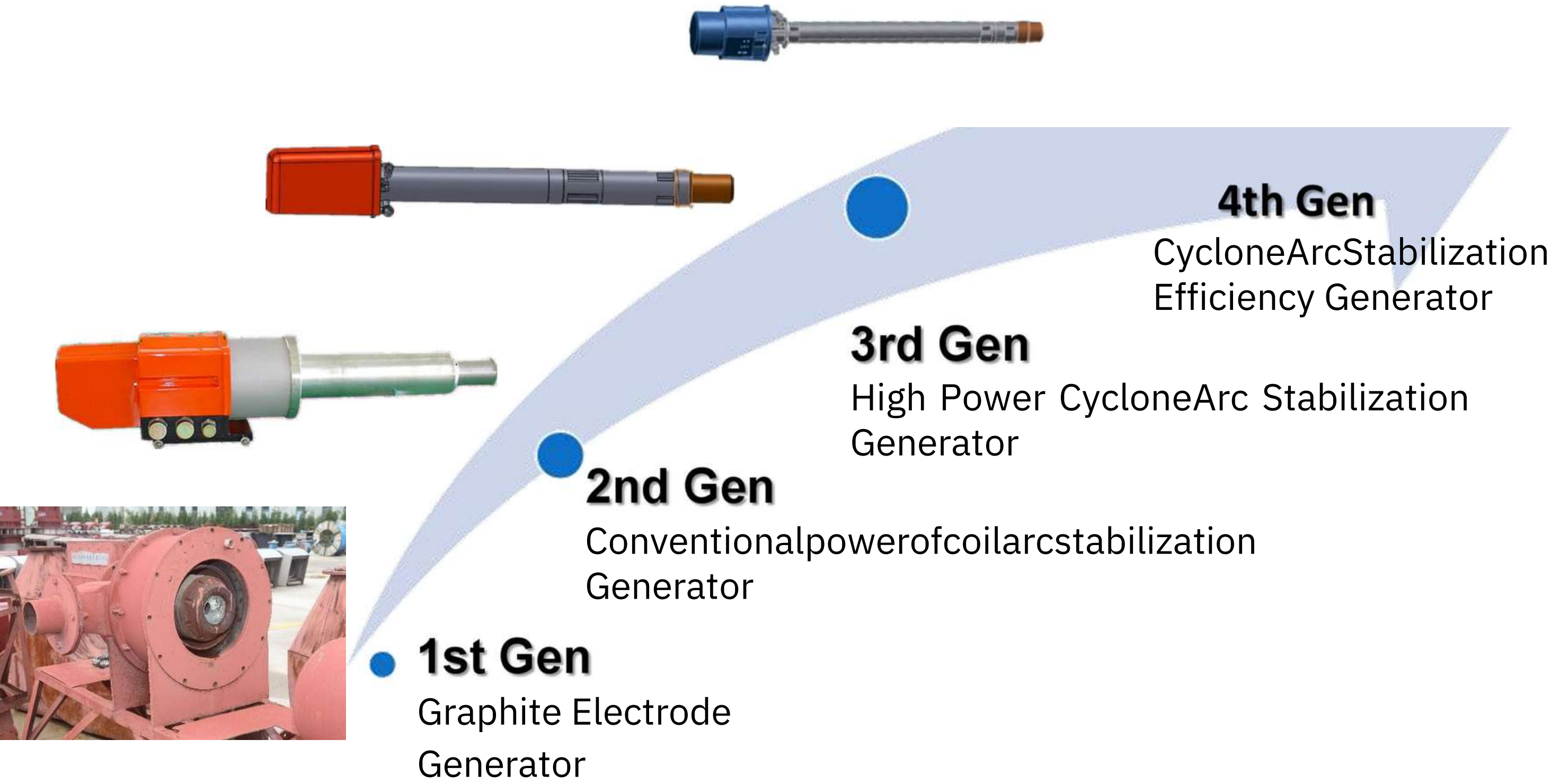
3rd Gen



2nd Gen



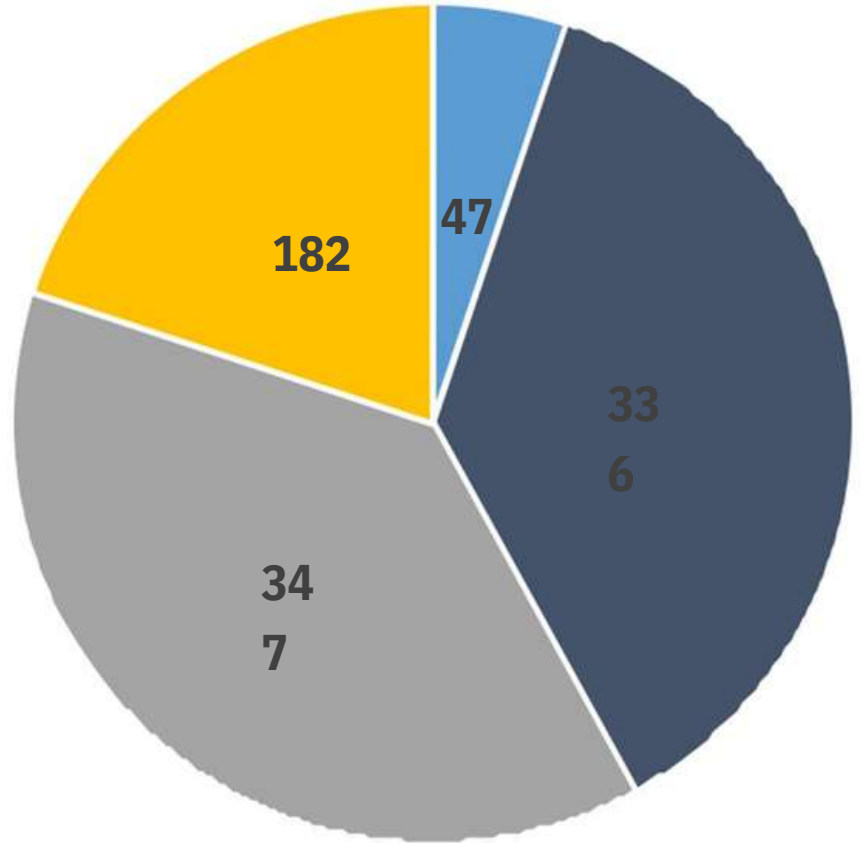
PICS main equipment-Plasma Generator





PICS Applications

Applications: 912 Boilers



1000MW 600-800MW 300-500MW 50-200MW

Overseas Applications

Item	Name	Unit Capacity	Retrofit/ New	Wall/ Tangential	Coal Type	Plasma Burners Quantity per Boiler
1	Korea Samchonpo	1×560MW	Retrofit	T-firing	Bituminous	4
2	Korea Yonghung	#4 870MW	New	T-firing	Bituminous	4
3	Korea Hadong	2×500MW	New	T-firing	Bituminous	4
4	Russia Khabarovsk 3rd	#1 180MW	Retrofit	Wall Firing	Bituminous	8
5	Taiwan of China Heping	#1, #2 660MW	Retrofit	T-firing	Bituminous	4
6	Indonesia Suralaya	#6 600MW	Retrofit	Wall Firing	Bituminous with High Moisture	6
7	Korea Yonghung	#5, #6 870MW	New	Wall Firing	Bituminous	7
8	Turkey Eren	2×600MW	Retrofit	Wall Firing	Bituminous	4
9	Turkey Zetes (III)	2×600MW	New	T-firing	Bituminous	4
10	Turkey Karabiga	2×660MW	New	T-firing	Bituminous	8
11	Tajikistan Dushanbe TPS	2×150MW	New	T-firing	Sub-bituminous	4
12	Vietnam Wuxi Huaguang Paper	320t/h	New	T-firing	Lignite	4
13	Indonesia Nanshan Bintan (under construction)	6×220t/h	New	T-firing	Lignite	4
14	Zimbabwe Hwange (under construction)	4×120MW, 2×220MW	Retrofit	T-firing	Bituminous	8

Application

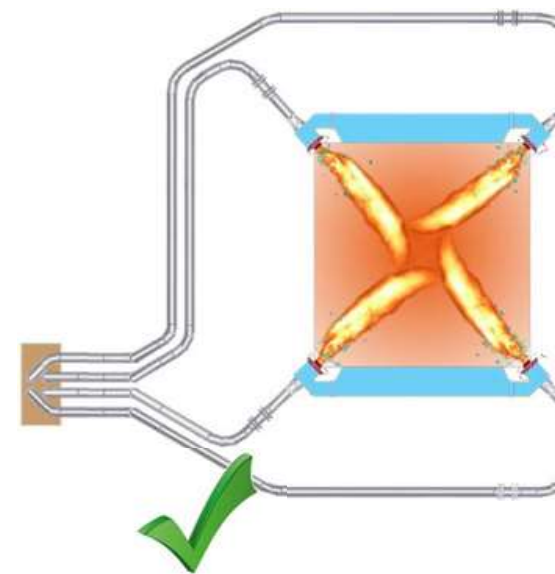
Adaption

Types of Coal

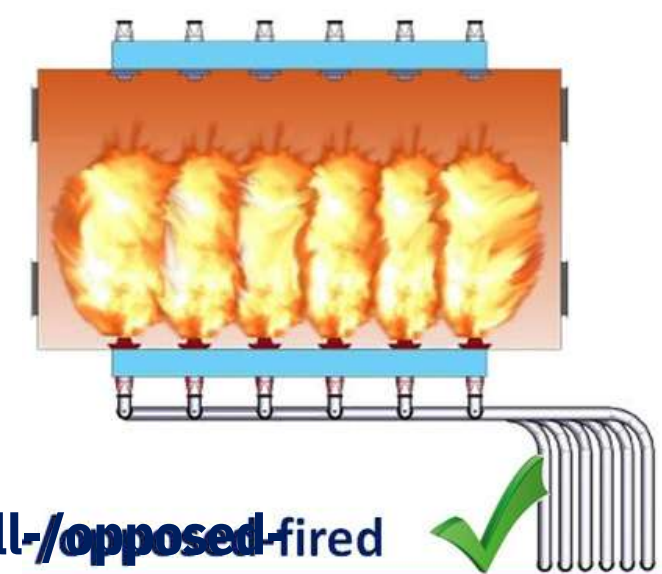
- ✓ Bituminous coal
- ✓ Sub-bituminous
- ✓ Lignite
- ✓ Lean coal

Combustion System

Corner-fired ✓



Wall-opposed-fired ✓



Overview

high plasma temperature build-up slags?

NO

electromagnetic interference on other instrumentation?

NO

high plasma temperature higher levels of erosion?

NO

increase in NOx emissions?

NO

- The plasma burner is low NOx burner.
 - The combustion chamber is designed to prevent slag build-up.
 - The burner is designed to prevent electromagnetic interference on other instrumentation.
 - The burner is designed to prevent high plasma temperature higher levels of erosion.
 - The burner is designed to prevent an increase in NOx emissions.
- The length of the plasma main the center of the burner is not more than 300mm, and its direction is same with pulverized coal, the pulverized coal flame enters the furnace.

Environmental Benefits

- Avoiding black smoke during unit startup, keeping a blue sky
- Improving ESP performance



ESP de-energized during the startup of boiler with oil ignition



ESP energized during the startup of boiler with MOIS



Relative Advantages over conventional Light-

- up **No oil or extremely small quantity of oil is required for startup (Boiler light-up up to 40% BMCR load)**
- Greater than 80% to even 100% oil saving achieved as compared to conventional light up method.**
- Startup can be controlled smoothly matching the boiler temp & pressure ramp-up curves**

- Less maintenance as compared to conventional oil gun system.**

- Clear chimney conditions during cold start-ups as plasma ignition enable the ESP in service.**
- Very consistent, stable & concentrated plasma arc enabling coal combustion during start-up**
- Long time (several hours) cannot be synchronized, due to the turbine or other equipment problems, will not significantly impact the SOC KPI.**

- It can meet the need of flexible peak regulation of the boiler and ensure the stable combustion of the boiler under the condition of low load, which can quickly meet the requirements of peak regulation of the power grid, realize the full load peak regulation of the unit without shutdown, and guarantee the safety of the unit and the power grid.**



Flexible operation

For purpose of flexible operation and implementation of 40% or even lower TML, we need to consider various aspects like safety of heating surface, parameters of steam&water, denitration, and etc.

Besides, low load combustion stabilization is one of most important factors to realize this.

Content

S

PICS/MOIS contribute to flexible operation

Support stable combustion

- Save
oil**



Support stable combustion

PICS/MOIS can replace traditional oil guns to starup boiler& support furnace combustion during boiler's low load operation

- In the process of boiler start-up and/or shutdown, providing stable and high- efficient firing that ensures the operation process of boiler start up and/or shutdown.
- In the process of boiler low load operation, providing combustion support to the furnace in stead of traditional oil burners.



Support stable combustion

Excellent low load combustion stabilization function

PICS/MOIS can startup the boiler from cold state without traditional oil guns.
Thus PICS/MOIS can support stable combustion from ignition(initial power input is 5%-10%BMCR) to Technical Minimum Load(TML)



Support stable combustion

PICS/MOIS support stable combustion that contribute to achieving lower TML

If the boiler need to operate under TML or even lower load, then we have to put oil guns to support furnace stable combustion in traditional way. While after retrofit, we can use PICS/MOIS to provide combustion support to the furnace in stead of traditional oil guns.



As compared to conventional light up method with oil guns

- PICS can achieve more than 80% to even 100% oil saving
- MOIS can achieve 50% to 90% oil saving

And when requirements for low load operation and shift operation rise

□ we have to consume more oil according to traditional method

or

□ we can apply PICS/MOIS to make flexible operation easier & more economical.

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