

SAIL and NTPC
Summary Report

India

Pilot Survey for Disseminating SME's
Technologies for reflecting the image of the
industrial furnace inside of national steel
plant and national coal thermal power plant
to improve the combustion efficiency by
the Heat Resistant Camera System in India.

September, 2015

Japan International Cooperation Agency
Joint Venture of SECURITY JAPAN CO., LTD.
and OGAWA SEIKI CO., LTD.

1. BACKGROUND

India has experienced rapid economic growth over the past decade. However, the rapid economic growth has also brought about increasing and demanding issues such as unstable power supply and environmental pollution/climate change. Japan and India government established the Japan-India energy dialogue to start consideration of a comprehensive cooperation concerning the electricity supply, energy conservation, coal supply and other relevant matters. The Japan Iron and Steel Federation are also promoting the support of energy conservation technology to India Iron and Steel industry. Thus, the cooperation between Japan and India has been increasing immensely over the past years both in public and private sectors. On the other hands, the Heat Resistant Camera System (hereinafter referred to as Camera System) can bring the internal image of industrial furnace such as coke oven or coal boiler for thermal power under the combustion. The image can be used for analysis like improvement of energy efficiency of furnace. In line with this, Camera System proposed in this survey is expected to also contribute to the Japan-India cooperation in the field of energy saving.

2. OUTLINE OF THE PILOT SURVEY FOR DISSEMINATING SME'S TECHNOLOGIES

(1) Purpose

The purpose of the survey is to verify the visualizing of internal situation of furnace under combustion and improving the efficiency of combustion through reflecting the internal image by Camera System.

(2) Activities

Camera System will be installed into the combustion chamber of coke oven in Bhilai Steel Plant (hereinafter referred to as BSP) of Steel Authority in India Limited (hereinafter referred to as SAIL) and coal boiler in Khalgaon Super Thermal Power Station (hereinafter referred to as KhSTPP) of NTPC Limited (hereinafter referred to as NTPC), to visualizing the internal images of it. The installed camera system will be operated with technical training and support by Joint Venture of SECURITY JAPAN CO., LTD. and OGAWA SEIKI CO., LTD. (hereinafter referred to as JV).

The internal images will provide information and data concerning to combustion efficiency. Therefore, energy saving methodology with the internal image of boiler will be proposed, which will contribute to the reduction of the carbon dioxide emission.

(3) Information of Product/ Technology to be Provided

The proposed Camera System (CCD camera) is the only camera in the world which can be

directly put into furnaces under combustion and provide high resolution camera image of 400k pixels. Camera System can be also sustained up to 1,500 degree Celsius at furnace temperature and operated continuously for 5 years with the appropriate cooling water and air. In most case, the currently operated camera system have shown good durability and performance for more than 10 years.

(4) Counterpart Organization

Steel Authority of India Limited

NTPC Limited

(5) Target Area and Beneficiaries

Target Area

- STEEL PLANT: Bhilai Steel Plant Battery No.4 (Bhilai, Durg distric of Chattisgarh State)
- COAL THERMAL POWER STATION: Kahalgaon Super Thermal Power Station Stage 1 Unit1 boiler (Kahalgaon, Bhagalpur district of Bihar State)

Beneficiaries

The improvement of combustion efficiency is expected to provide various benefits for the people of India. The cost reduction of coal consumption can lead to lower cost of electricity consumers in India. The combustion efficiency can directly lead to stable supply of electricity. It can also reduce greenhouse gas emissions (namely carbon dioxide), which is expected to contribute to mitigation of climate change disasters such as sea level rise.

(6) Duration

From November, 2013 to September, 2015

(7) Progress Schedule

work	term	JFY.2013												JFY.2014												JFY.2015								
		6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9					
1. Kick-off Meeting / Work Shop																																		
(1) Explanation to SAIL and NTPC about JICA pilot survey	plan																																	
	result																																	
(2) Exhibition	plan																																	
	result																																	
2. Demonstration for the effectiveness of Heat Resistant Camera for coke oven in steel plant and coal boiler in thermal power plant																																		
(1) Site survey for design of the Heat Resistant Camera in coke oven and coal boiler	plan																																	
	result																																	
(2) Design and Manufacture of Heat Resistant Camera for boiler and coke oven	plan																																	
	result																																	
(3) Transport to boiler site	plan																																	
	result																																	
(4) Installation at boiler site	plan																																	
	result																																	
(5) Technical guidance to the operator and operation check of Heat Resistant Camera at boiler site	plan																																	
	result																																	
(6) Monitoring for verification of effectiveness of Heat Resistant Camera at boiler site	plan																																	
	result																																	
(7) Transport to coke oven site	plan																																	
	result																																	
(8) Installation at coke oven site	plan																																	
	result																																	
(9) Technical guidance to operator and operation check of Heat Resistant Camera at coke oven site	plan																																	
	result																																	
(10) Monitoring for verification of effectiveness of Heat Resistant Camera at coke oven site	plan																																	
	result																																	
(11) Data collection and organization / Verification of the effectiveness of Heat Resistant Camera	plan																																	
	result																																	
(12) Guidance to operator about the maintenance of Heat Resistant Camera after the Pilot Survey	plan																																	
	result																																	
3. Disseminating survey for Heat Resistant Camera business																																		
(1) Marketing survey	plan																																	
	result																																	
(2) Sales organization survey	plan																																	
	result																																	
(3) Business risk assessment in India	plan																																	
	result																																	
(4) Funding scheme survey including ODA	plan																																	
	result																																	
(5) Financial assessment	plan																																	
	result																																	
(6) Build-up strategy	plan																																	
	result																																	
(7) Survey about the contribution to local economy growth	plan																																	
	result																																	

Remarks :
..... Work in India (plan) Work in Japan (plan) SAIL/NTPC work (plan)
——— Work in India (result) ——— Work in Japan (result) ——— SAIL/NTPC work (result)

(8) Manning Schedule

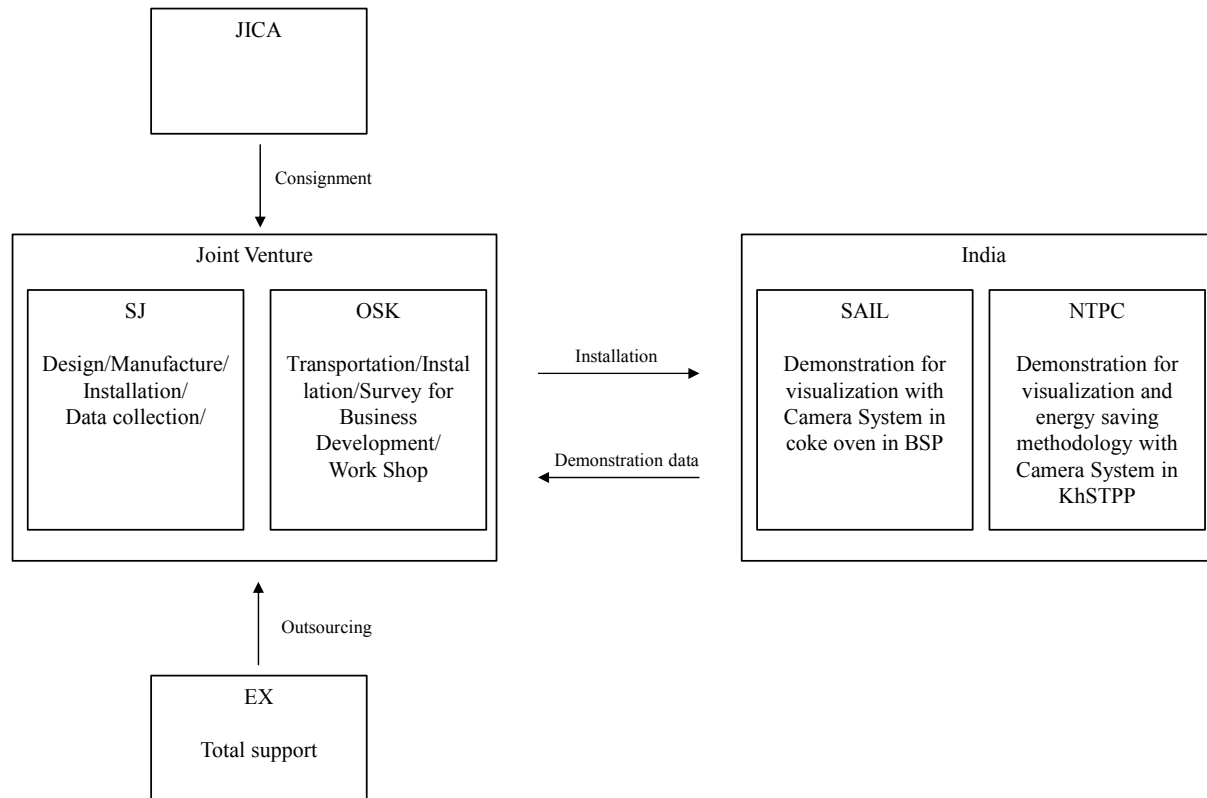
Role	Name	Company	plan	JFY.2013					JFY.2014					JFY.2015					M/M														
				11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	India	Japan					
Chief / Director for Pilot Survey / Manager for SJ portion	SHIMOKAWA Mikio	Security japan Co., Ltd.	plan	310										10					40		0.33	17.50											
			result	6	0	8	20	20	21	15	21	22	19	20	22	18	19	15	20	22	21	18	1	2	1	0	0.00	16.55					
Assistant Director	IWAMI Morikazu	Security japan Co., Ltd.	plan	360																	0.00	18.00											
			result	6	19	11	20	20	21	15	21	22	18	20	22	18	19	15	20	22	21	18	7	3	1	0	0.00	18.75					
Design/Manufacture/Installation for Heat Resistant Camera	FUKAYA Azusa	Security japan Co., Ltd.	plan	14	120										21	55	15	35	12	25	10	20					10	20		2.73	13.75		
			result	6	14	19	19	20	20	21	15	8	13	11	22	18	11	15	22	10	12	19	15	20	22	21	18	0	1	0	0	2.07	16.25
Design/Manufacture/Installation for Heat Resistant Camera	MINAMI Takeharu	Security japan Co., Ltd.	plan	14	120										21	55	15	35	12	25	10	50							2.40	14.25			
			result	6	14	19	19	20	20	21	15	8	13	11	22	19	11	15	22	10	12	19	15	20	22	21	18	0	0	0	0	2.07	16.50
Design/Manufacture/Installation for Utilities	KAWABE Katsuro	Security japan Co., Ltd.	plan	110										21	55	15	35	12	85							1.60	14.25						
			result	6	19	10	20	20	21	15	8	13	11	22	19	11	15	22	10	12	19	15	20	22	21	18	0	0	0	0	1.60	16.05	
Design/Manufacture/Installation for Heat Resistant Camera	OGO Akira	Security japan Co., Ltd.	plan	14	30	6	80										21	200							1.37	15.50							
			result	6	14	19	15	6	20	20	21	15	8	13	11	22	19	20	22	18	19	15	20	22	21	18	0	0	0	0	1.37	17.15	
Design/Manufacture for Heat Resistant Camera	OHKI Tatsushi	Security japan Co., Ltd.	plan	120										21	55	15	35	16	25	10	20					10	20		2.40	13.75			
			result	6	14	19	19	20	20	21	15	8	13	11	22	19	13	12	22	8	14	19	15	20	22	21	11	10	1	1	0	0	1.93
Manager for OSK portion	TOMINAGA Keijyu	OGAWA SEIKI CO., LTD.	plan	250																	0.00	12.50											
			result	5	5	0	5	5	9	15	21	22	21	20	22	18	19	15	19	22	21	18	0	0	0	0	0	0	0	0	0	0.00	14.10
Transport / Demonstration support	MATSUMOTO Takashi	OGAWA SEIKI CO., LTD.	plan	14	120										21	90					16	100					1.70	15.50					
			result	5	14	0	0	10	20	21	15	8	13	11	22	6	20	22	8	14	19	1	0	0	0	21	18	22	8	0	0	1.63	12.45
Transport / Survey in japan**	TAKAYANAGI Tsunenao	OGAWA SEIKI CO., LTD.	plan	250																	0.00	12.50											
			result	14	5	5	8	20	21	15	21	22	16	20	22	18	19	15	19	22	0	0	0	0	0	0	0	0	0	0	0.00	14.10	
Transport / Survey in japan**	SUZUKI Tomoyuki	OGAWA SEIKI CO., LTD.	plan	56																	0.00	2.80											
			result	5	5	5	5	21	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	2.80	
Survey in India*	ANDO Ryoko	OGAWA SEIKI CO., LTD.	plan	14	25	16	80										14	55	14	50					10	20	10	22	10	20		2.93	13.60
			result	6	14	19	7	16	20	20	21	15	7	7	16	18	18	11	14	22	18	19	15	15	5	18	21	11	10	22	22	16	2.47
Transport / Survey in japan**	Alexander BOROVIKOV	OGAWA SEIKI CO., LTD.	plan	152																	0.00	7.60											
			result	4	2	0	5	21	15	21	22	21	20	0	22	18	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	9.50
Consultant / Total Support for Pilot Survey	SUZUKI Shinichi	EX Research Institute Ltd.	plan	60																	0.43	3.00											
			result	13	1	0	0	2	0	0	1	5	6	7	4	0	2	3	4	7	7	6	4	15	0	0	0	0	0	0.43	3.70		
Consultant / Chief Advisor / Total Support for Pilot Survey	NIIDA Kei	EX Research Institute Ltd.	plan	14	25	16	105										15	180							1.50	15.50							
			result	6	14	12	5	16	12	16	10	9	8	13	13	6	15	15	7	15	11	14	3	5	11	9	11	12	13	1.87	11.25		
* . . . "Survey in India" includes marketing, sales organization and business risk assessment for disseminating of Heat Resistant Camera in India																																	
* * . . . "Survey in Japan" includes funding scheme, financial assessment, build-up strategy for disseminating of Heat Resistant Camera and local economy growth by it																																	
																								JointVenture M/M total (plan)		15.5	171.5						
																								JointVenture M/M total (result)		13.1	188.9						
																								Consultant M/M total (plan)		1.9	18.5						
																								Consultant M/M total (result)		2.3	15.0						
																								M/M total (plan)		17.4	190.0						
																								M/M total (result)		15.4	203.8						

Remarks ■■■■■■ work in India
 work in Japan

(9) Implementation System

JAPAN Side: Japan International Cooperation Agency (hereinafter referred to as JICA), JV and EX Research Institute Ltd. (hereinafter referred to as EX)

INDIA Side: Steel Authority of India Limited (steel plant) and NTPC Limited (coal thermal power plant)



3. ACHIEVEMENT OF THE SURVEY

(1) Outputs and Outcomes of the Survey

<SAIL>

We have succeeded in the installation of Camera System into No.4 of coke oven in BSP, and proved that Camera System can be used to visualize internal image of coke oven at any time. BSP and JV confirmed completion of installation/visualization with each other. JV received Handing Over Certificate from BSP as certificate of completion.

In the pilot survey, we have customized Camera System for coke oven of BSP. We ordinarily sell a set of Camera Jacket, Camera Control BOX and Camera Cable as Camera System. About other equipment such as Crane Stand, Chiller, Air Compressor and etc., Japanese customer designs, manufactures, procures and installs it with their own. At site survey before installation, we have found out there was no supply of water and air, hence, and we achieved simple design such that BSP can easily maintain and improve Camera System by themselves. We had also added Chiller, Air Compressor, Crane Stand and etc. to the set of Camera System. We could have provided SAIL the camera system which can withstand temperature of 1200deg.C for more than 45 minutes.

India was the 4th country in production amount of crude iron of the world in 2014, but there could be a room to improve the energy efficiency of it in Indian Steel plant. In case of coke oven, BFG which is consumed as fuel for making cokes could be reduced with some energy saving measure, and at the same time be contributed to reduce Greenhouse Gas from steel plant in India.

In the survey, demonstration of inserting camera into combustion chamber of coke oven in No.4 battery was performed 10 times or more. All bricks which were visualized in this demo were not damaged. If there were some damaged bricks, BFG would be lost and energy efficiency would be low. In the future, it would be expected that the repair method for damaged brick with camera image could be developed in BSP. There are many chambers in the whole BSP which has 11 coke ovens and more than one hundred chambers per one coke oven. If many damaged bricks were repaired, the energy efficiency of BFG combustion could be improved and Greenhouse Gas could be reduced in steel plant.

<NTPC>

We have succeeded in the installation of Camera System into Unit1 boiler of Stage1 in KhSTPP and proved that Camera System can be continuously operating for a year. And we proposed energy saving methodology with internal image of boiler by Camera System. KhSTPP and

JV confirmed completion of installation/visualization with each other. JV received Handing Over Certificate from KhSTPP as certificate of completion.

In the pilot survey, we have customized Camera System for the boiler of KhSTPP. We ordinary sell a set of Camera Jacket, Camera Control BOX and Camera Cable as Camera System. About other equipment such as Auto-retraction device, Air Compressor, etc. Japanese customer designs, manufactures, procures and installs it with their own. The risk which were shut-down of electricity and high temperature risk of cooling air, especially in May, were expected to be very high in India. Therefore, we had also added Air Compressor, Auto-retraction device, etc., to ordinal set of Camera System. Especially the Auto-retraction device was most required to protect the camera from the heat at the time of emergency, which is necessary device to install the camera system where the cooling utilities are not stable countries. For the request of fire-ball monitoring, we propose the direct view type camera. In many case, side view type camera was chosen for monitoring combustion situation of burner, clinker and fly ash attached to boiler wall, etc. in Japan. To utilize our camera system utmost, we have provided Handy carry water pump to use along with the camera for monitoring at another window. Thus, we had established robustness against the electricity shut-down, unstable cooling air capacity and flexibility. Through the demonstration, Camera System could be working adequately for a year, but the Air compressors which was procured from the local manufacturer has tripped over and over. So, we recommend that KhSTPP would make a maintenance contract with the local manufacturer (ELGI).

In India, average efficiency of coal thermal power generation is likely less than 30%. In generally, improvement of heat exchange between heat and water, air ratio management, or tuning of burner as energy saving method on coal boiler are known. In the survey, we established and proposed energy saving method which is combined camera image with air ratio management method, as energy efficiency improvement. If this method were successfully done, energy efficiency would be improved and Greenhouse Gas reduction in electrical company.

<Contribution to India through Business Development>

Through our marketing survey in India, we had focused our business target on steel plant and coal thermal power station. Sales activities to steel company including SAIL and private electricity company will be carried on by Ogawa Seiki CO., LTD. (hereinafter referred to as OSK) and sales agent of us in India. The sales agent will be supported by OSK until they could be self-sustained. We also have plan of On the Job Training in Japan for the sales agent at the first order. Heat Resistant Camera is core technology of Camera System,

therefore it should be manufactured by Security japan CO., LTD., but other equipment should be manufactured or procured in India in terms of cost. Other cost such as site survey for quotation, installation, follow-up service should be separately request. We intend to success Camera System sales in India as “B to B” business within 3 years.

(2) Self-reliant and Continual Activities to be Conducted by Counterpart Organization

<SAIL>

Provided items : The items as below could be available at any time in coke oven.

- Heat Resistant Camera (Camera Jacket)
- Camera Control BOX (PC, Blu-ray Recorder, etc.)
- Camera Cable
- Crane Stand
- Valve Stand
- Chiller
- Air Compressor
- Reservoir Tank
- Operation Manual, May 01, 2015

Preparation and Operation of Camera System : Kindly refer to the operation manual.

Maintenance : Crane Stand including Heat Resistant Camera, Camera Control BOX and Valve Stand should be stored in corner of top of coke oven with a water-dustproof cover. Air Compressor, Reservoir Tank and Chiller should be stored in 2nd floor of coke oven with a dust proof cover. PC, Monitor, Blue-ray Recorder and other OA devices should be separately stored in a cool place away from direct sunlight.

In case of trouble : For Air Compressor or Reservoir Tank, we recommend SAIL to directly contact the manufacturer. For other Equipment, SAIL should contact our sales agent in India. Contact information is given in operation manual or guidance kept inside of each equipment. Concerning to guarantee is explained in equipment guarantee.

<NTPC>

Provided items : The items as below are operating or available at any time.

- Heat Resistant Camera (Camera Jacket)
- Camera Control BOX
- Camera Cable
- Auto-retraction device
- Monitor and DVR

- Valve Stand
- Air Compressor-2set
- Reservoir Tank
- Hand-carry water pump (available at any time)
- Operation Manual, April 28, 2014

Operation : Kindly refer to the operation manual.

Maintenance consignment : Air Compressors were troubled during demonstration again and again. Therefore, we recommend to outsource maintenance for Air Compressors to manufacturer (ELGI).

In case of trouble : For Air Compressor or Reservoir Tank, we recommend NTPC to directly contact the manufacturer (ELGI). For other Equipment, NTPC should contact our sales agent in India. Contact information is given in operation manual or guidance kept inside of each equipment. Concerning to guarantee is explained in equipment guarantee.

4. FUTURE PROSPECTS

(1) Impact and Effect on the Concerned Development Issues through Business Development of the Product/ Technology in the Surveyed Country

Through our market survey in India, we have learned that not many cameras are installed at plants / stations yet. We have seen cameras installed, unfortunately many have been out of usage due to loss of cooling. Our installation at NTPC is permanent, Camera System is providing internal images of the boiler since installation, contributing for safety operation of the boiler and convincing its ability to operate under Indian utilities.

The application of Camera system are to monitor internal image of the boiler to observe burner combustion, clinker occurrence, bricks damages, positioning of the product, the flame color, etc. By locating the mal function and taking necessary action to adjust mal function, it leads to energy efficiency.

For calculation of saving amount of coal consumption in one year, let us suppose that the existing power generation efficiency is 35.5% and could be improved to 36% by Camera System,

$$(220MW * 0.75 * 24h * 365days * 0.8) / 0.355 * 3.6GJ/MWh * 12t/GJ = 977,172t,$$

$$(220MW * 0.75 * 24h * 365days * 0.8) / 0.360 * 3.6GJ/MWh * 12t/GJ = 963,600t,$$

where, load factor: 75%, capacity factor: 80% and coal weigh per unit energy: 12t/GJ.

Therefore, the saving amount of coal is as below,

$$977,172t/year - 963,600t/year = 13,752t/year.$$

If the coal price would be 80\$/t, total amount of coal would be as below,

$$13,572t/year * 80\$/t = 1,085,746\$/year.$$

It is easily calculated that the price of Camera System will be covered after one year.

Camera System truly corresponds to customer's requirement to monitor inside at high temperature with clear and sharp images. By just seeing the internal image, it enables to provide much information to the operators at plants / stations. Identifying the problem at furnaces is very effective to improve energy efficiency and the product quality as well. Especially in steel making, the cameras are essential to have better quality of iron products.

As for thermal power station, Camera Systems are the key to understand what is actually going inside the boiler and take necessary action in advance, which leads to energy efficiency and prevention of serious accidents.

Unlike other cameras which have been out of usage, we are confident that Camera Systems simply withstand at high temperature and could provide images upon customer's requirement.

(2) Lessons Learned and Recommendation through the Survey

We have nothing to say to NTPC and SAIL, other than sincere appreciation. The officers who had been involved in our pilot survey gave us the maximum support all the time which we could never ask for more.

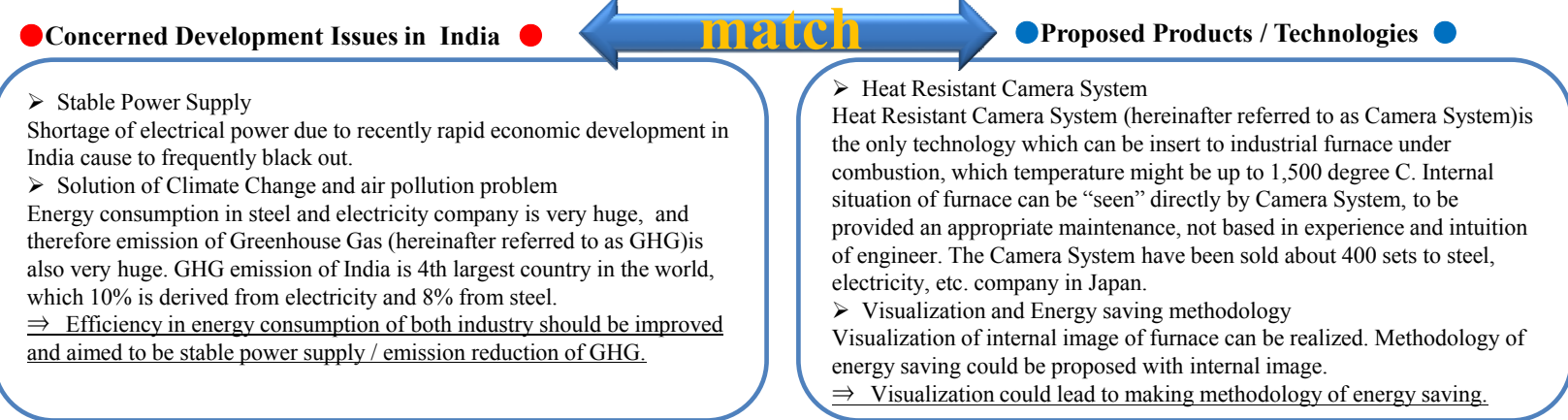
For NTPC Khalgaon, we would like to utilize our Camera System for portable usage, too. By inserting the camera from various points, the camera could capture images which no one ever could see. If they find the point where they think the camera may be useful, we would like to provide a new camera system. By monitoring the bricks damages, clinker occurrence, NTPC Khalgaon will be able to plan appropriate maintenance.

As for SAIL, we would like them to inspect as many combustion chambers as possible to grasp the bricks damages of coke oven. Then our camera system may be useful to heat the cokes evenly. Addition to it, we would like to SAIL to consider camera system for another steel making section, such as reheating furnaces, where SAIL is facing difficulties for smooth operation.

THE PILOT SURVEY FOR DISSEMINATING SME'S TECHNOLOGIES
Reflecting the image of the industrial furnace inside of national steel plant and national coal thermal power plant to improve the combustion efficiency by the Heat Resistant Camera System (India)

Outline of the Survey

- Proposed by : Joint Venture of Security japan CO., LTD. and Ogawa Seiki CO., LTD.
- Counterpart Organization : SAIL (Steel Authority of India Limited), NTPC (NTPC Limited)
- Target area and Beneficiaries :
- Duration : From November, 2013 to September, 2015



Implemented Activities in the Survey

- Verifying visualization internal image of coke oven in Bhilai Steel Plant of SAIL and boiler in Khalgaon Super Thermal Power Station of NTPC.
- Study of energy saving methodology with camera image for boiler.
- Marketing survey, risk assessment, survey of business alliance candidate like sales agent, manufacturer, manufacturing subcontractor, assessment of finance scheme and business plan, and making of strategy for business in India.



Outputs and Outcomes of the Survey

- Visualization internal image of coke oven for several times, continuously boiler for a year.
- Energy saving methodology with camera image for boiler was proposed to Khalgaon Super Thermal Power Station.
- Business strategy for Heat Resistant Camera System in India has been developed.



Impact on the Concerned Development Issues in India

- Improvement of energy efficiency in industrial furnace with camera image, and it leads to GHG reduction in India.

