INTEGRATED WASTE MANAGEMENT PROJECT

40 MW Waste To Energy
Lahore, Pakistan

SATAREM

Chohan Group
Business Development

Table of Contents

SATAREM

Chohan Group
Business Development

Introduction

Satarem in a nutshell

SATAREM

Chohan Group
Business Development

Past & Present

Historical

1992 Established in France as a private entity supplying specialized cement equipment and upgrading cement plants with innovative technologies.

2002 Equity shareholding re-structure to become an Euro-Asian intercontinental company with 50% each of French (Jerome Friler) and Hong Kong (Adolf Wong) ownership.

2005 Designed, built and commissioned C-POWER pilot facility in Hong Kong.

2007 Started turnkey cement plant supply business, first line being 5000tpd new line in Luanda, Angola.

2008 Started to develop and promote C-POWER projects in China and the World.

2009 Development and field testing of innovative renewable energy equipment WINDSAT (wind-turbine tower) and PASAT (sea wave power generator).

2010 Strategic partnership with Chinese groups for worldwide WTE projects.

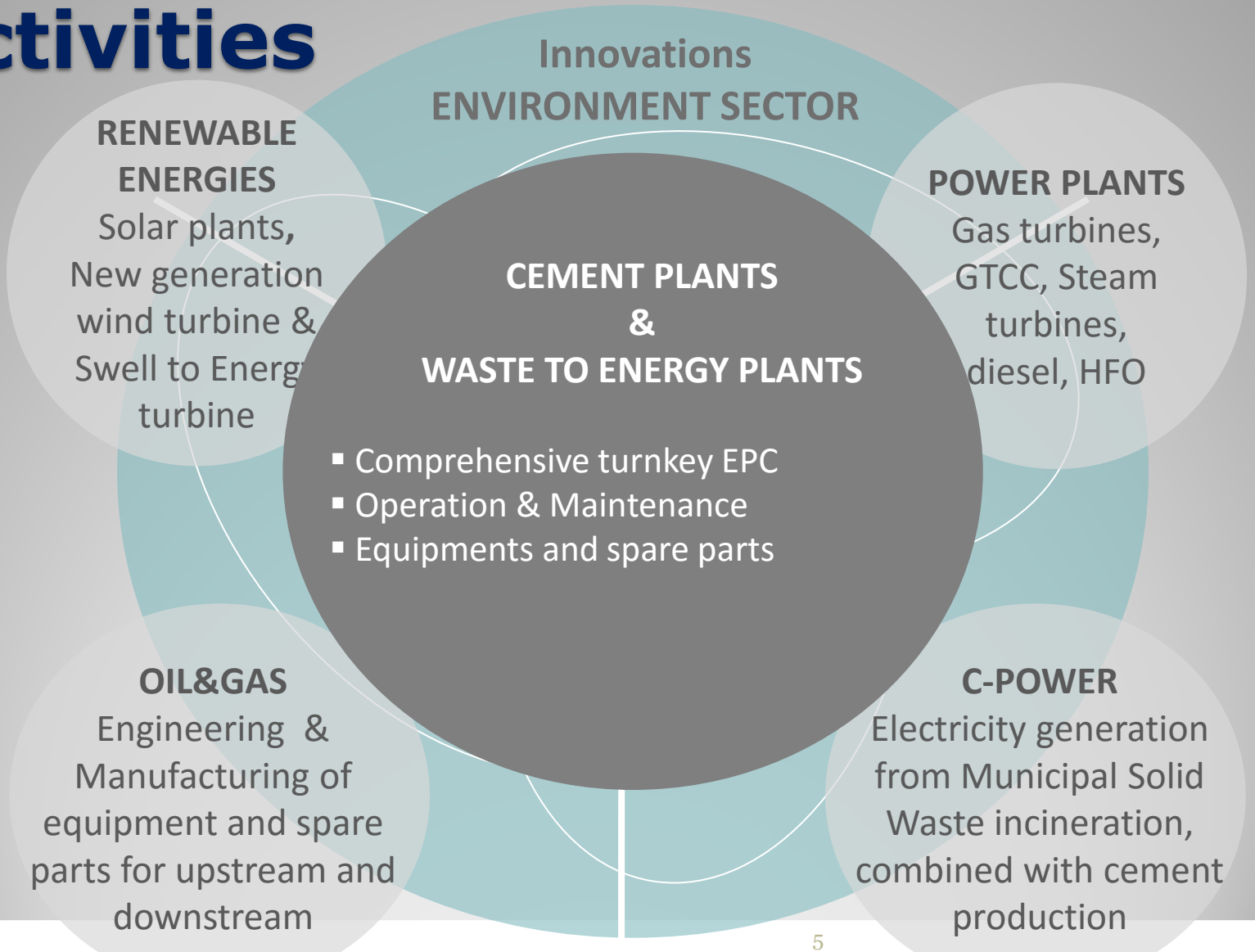
2013 Maisan refinery project award. First BOO project in Iraq of a value of $6B.

2015 Bangalore WTE project, Maisan refinery and Power Plant financial close, Award of first C-POWER large scale in Dalian, China.

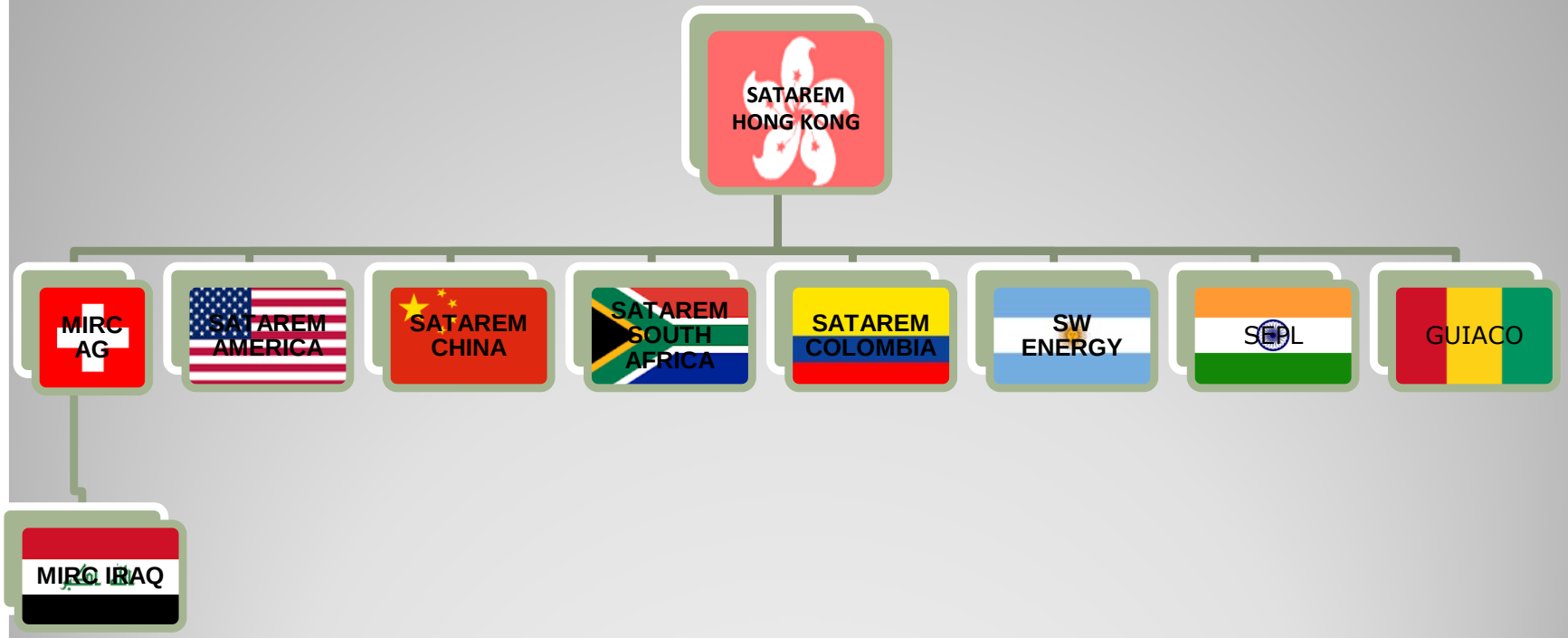
Satarem Today

- Traditional Business Areas
  - Turnkey cement new lines
  - Cement plant modifications
    - Production enhancement
    - Energy efficiency
- New Business Areas
  - WTE, Renewable energies & power plants
  - Refineries
- Represented in 60 countries over 5 continents
- Over 200 employees, 60% in engineering
- 2015 turnover US$ 80 Million
- Pipeline projects value over US$ 7 Billion

Activities


Innovations
ENVIRONMENT SECTOR
RENEWABLE ENERGIES
Solar plants, New generation wind turbine & Swell to Energ turbine
POWER PLANTS
Gas turbines, GTCC, Steam turbines, diesel, HFO
CEMENT PLANTS
&
WASTE TO ENERGY PLANTS
Comprehensive turnkey EPC
Operation & Maintenance
Equipments and spare parts
OIL&GAS
Engineering & Manufacturing of equipment and spare parts for upstream and downstream
C-POWER
Electricity generation from Municipal Solid Waste incineration, combined with cement production

Corporate Structure



Our values: price and flexibility

High quality
Competitive price
Latest technologies
International experience

Flexibility
Skilled manpower
Turnkey implementation
Special dedicated team for each project

SATAREM

Chohan Group
Business Development

OUR VISION

SATAREM

Chohan Group
Business Development

Satarem's positionning: Walking the talk

Recognized expertise

- Cement plants and waste management
- Developing countries

Role in local economic development

- Hiring and training local staff
- Transfer of Know how

Focus on environmental priorities

- Carbon credit eligibility

Reflected in our contracts/ guarantees

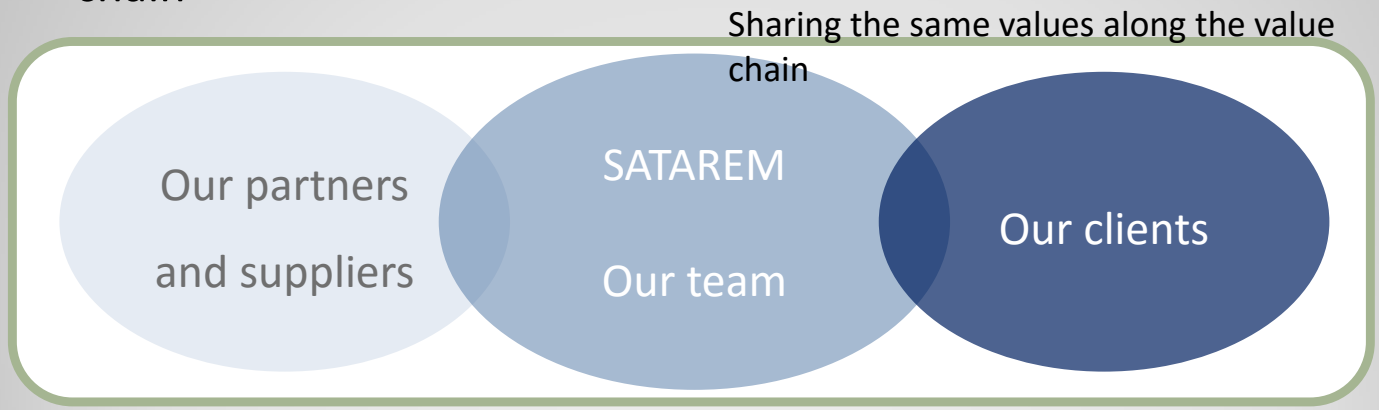
- Turnkey contracts
- Performance and availability guarantee

SATAREM

Chohan Group Business Development

SATAREM's vision of its impact on the environment

- SATAREM's core values include (i) minimizing the environmental impact due to our activities and (ii) supporting sustained economic growth
  - We adopt a unique positioning to ensure complete fulfillment of our commitments
  - We develop environmentally friendly projects and integrate local population to their implementation
  - We pay special attention to defending our values all along our value chain



The values we share with our partners,

Cement, Waste, Power sectors

Our difference

⇨ Respect and promotion of the highest environmental standards

⇨ Equipments strictly compliant with European Norms / standards (emissions, water contamination, noise...

⇨ Ensure eligibility to carbon credit mechanism where possible

A step further…

⇨ Development of environmentally friendly technologies

⇨ Low environmental impact projects

⇨Local population empowerment through employment and training of local staff

⇨ Contribution to higher education of local engineering students to form next generations of plant managers

SATAREM

Chohan Group
Business Development

Satarem WTE References – BOT / BOO Contracts in progress

City	Qty Waste (TPD)	Installed Power (MW)	BOT Duration (year)	Annual Revenues ($)
Buenos Aires	1 500	50	15	53 000 000
Conakry	1 000	20	25	22 000 000
Dakar	4 000	60	20	92 000 000
Hyderabad	1 000	30	25	28 000 000
Bangalore	2 000	60	25	41 000 000
Accra	4 000	60	20	92 000 000
Lome	1 500	45	25	80 000 000
Yaounde & Douala	2 x 2 000	2 x 30	20	2 x 41 000 000
Bangkok	1 500	45	25	80 000 000

SATAREM Chohan Group Business Development

Satarem WTE References in China

Project	Description	Role	Status
Nanhai WTE, China	400tpd, grate type, 12MW	Overall design	Commissioned 2002
Likeng WTE,China	1200tpd, fluidized bed, 30MW	Design & Build	Commissioned 2006
Shenzhen WTE, China	Revamping of flue gas treatment	Design & Build	Commissioned 2006
Ningbo WTE, China	600tpd fluidized bed, 24 MW	Overall design	Commissioned 2007
Jiangyin WTE, China	800tpd, grate type, 12MW	Overall Design	Commissioned 2007
Nanhai WTE, China	800tpd, grate type, 12MW	Overall design	Commissioned 2008
Kunming WTE, China	2200tpd, fluidized bed, 45MW	Overall design	Commissioned 2010
Zhongshan WTE, China	1000tpd, grate type, 24 MW	Design & Build	Commissioned 2011
Boyang WTE, China	500 tpd, grate type, 10 MW	Design & Build	Commissioned 2013
Zhenjiang WTE, China	1050tpd, grate type, 20 MW	Design & Build	Commissioned 2014
Yiyang WTE, China	600tpd, fluidized bed, 12 MW	Overall Design	Under construction
ZuZhou WTE, China	1500tpd, grate type, 30 MW	Design & Build	Under construction
Puket WTE, Thailand	700 tpd, grate type 14 MW	Overall Design	Under construction
Guangzhou WTE, China	2000tpd, grate type, 50 MW	Design & Build	Under construction

SATAREM

Chohan Group
Business Development

Waste Management

Waste Management Options

Unmanaged Dumping: EHS Unacceptable

Environmental Hazards :

- Land pollution by stockpiled garbage
  - Toxic heavy metals
  - Organic pollutants
  - Non biodegradables
- Ground water pollution by leachate (garbage juice)
- Air pollution by VOC
  - Landfill gas methane (potent Green House Gas =21x CO_2)
  - Other fugitive gas: dioxins & furan, POP, hydrogen sulphite, ammonia

Safety Hazards:

- Spontenous burning of garbage pile, major source of dioxin emission
- Landfill gas explosions - safety risk to scavengers & personnel on site

SATAREM

Health Hazards :

- Land, water and air pollutants
- Breeding ground for vectors & diseases
- Odor and toxic air emissions problem

Sanitary Landfills: Not Highly Sustainable

Leach Prevention : Difficult to Manage

Leachate Treatment: Another Challenge

Occupy Large Land Area

Landfill Gas – Maximum 70% Collection

Waste Management

What is WTE –Waste to Energy

SATAREM

Chohan Group
Business Development

WHAT IS WASTE TO ENERGY (WTE) ?

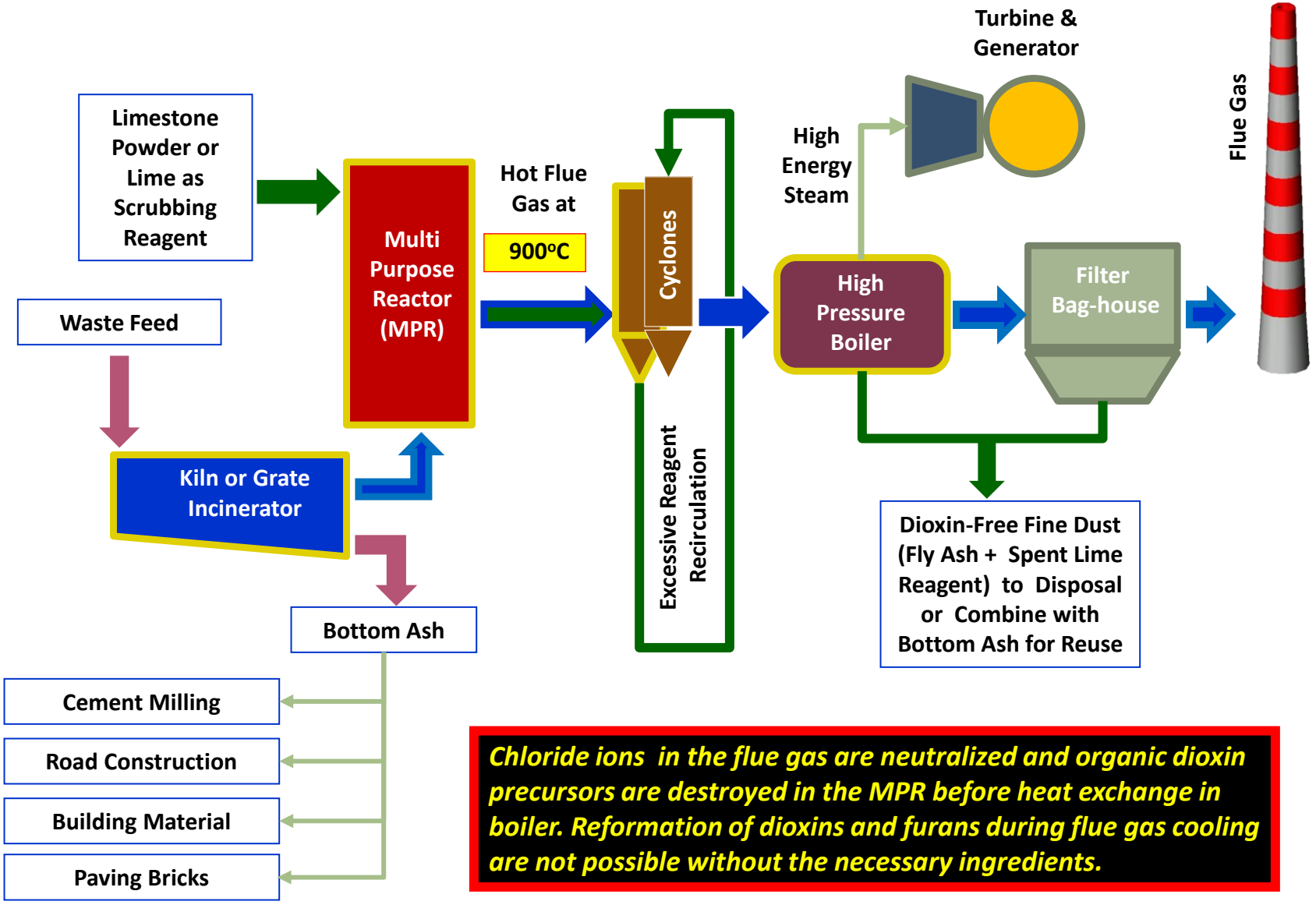
WTE is the only technology able to:

- **Suppress large quantities of waste**
- **Produce high amounts of energy**
- **Create construction materials from the ashes**

SATAREM possesses a patented technology that allows the transformation into electricity of large quantities of any kind of waste, without sorting, without emission of dioxin nor harmful gases and at competitive price.

SATAREM Chohan Group Business Development

MPR Enhanced Waste-to-Energy (M-WTE)



Chloride ions in the flue gas are neutralized and organic dioxin precursors are destroyed in the MPR before heat exchange in boiler. Reformation of dioxins and furans during flue gas cooling are not possible without the necessary ingredients.

SATAREM Incineration & Waste-to-Energy Design

- **Various Applications**
  - Municipal solid waste
  - Hazardous industrial waste
  - Medical waste
  - Sewage and industrial sludge
  - Special waste
- **Versatile Design**
  - Stationary bed incinerators
  - Fluidize bed incinerators
  - Rotary kiln incinerators
  - Mechanical grate incinerators
- **Superior Environmental Performance**
  - Incorporation of MPR® technology for front-of-pipe removal of chlorine and persistent organic pollutants
  - “Near Zero” dioxins – beats EU Specifications






SATAREM

Chohan Group
Business Development

Which kind of waste?

- Used tyres
- Plastics
- Paper
- Wood
- Glass
- Agricultural wastes
- Refuse derived fuel
- Oil, grease and solvents
- Green wastes
- Coal ash
- Distillation bottom
- Desulphurization gypsum
- Oil tank cleaning waste

Any kind

- Sewage sludge
- Industrial WWTP sludge
- Municipal solid waste
- Metal refining slag
- Toxic heavy metal sludge
- Construction waste
- Clinical waste
- Electronic scraps
- Leachate
- Concentrated
- Animal carcass
- High toxic substance
- Ore processing waste
- ….

SATAREM

Chohan Group
Business Development

Lahore Project

Lahore

- Lahore and its surrounding, with a population of approx. 8 Million people is generating approx.8 000 TPD of waste. Most of this waste is collected by the Municipalities and dumped.

- Some landfills are being installed, but their management is not according to the European safety standards.

- SATAREM could bring its technology and know-how in WTE in addition to the appropriate financing in order to build a first WTE line of 2 000TPD.

- A recycling unit will be installed on the same site to valorize recycling material (metals, plastics, glass…)

- ***The existing wastes stocked in dumps can be recycled in the new facility to create electricity if the dump sites are close enough to the new facility***

- *A second line of 2 000 TPD will then be built*

Environmental benefits

- Environmental protection and control
- Wild landfills elimination
- Elimination of diseases and contamination
- Efficient control of polluting gases
- Elimination of methane and carbon dioxide
- Green and renewable energy

SATAREM

Chohan Group
Business Development

Benefits

Revitalization of region through primary and secondary improvements on local infrastructure

- **Job Creation**
  1. The plant will create 300 direct and 2 000 indirect jobs. Prior and post construction the local community will be hired for the WTE plant.
  2. Post graduated students will now have employment opportunities locally.
- **Training Centres**
  1. A state of the art, modern, fully equipped training centre will provide all training requirements.
  2. School for primary children will be provided.
- **Health**
  1. The plant will host a fully functional hospital for both staff and local community.
  2. Prevention of infectious diseases related to waste, especially amongst children.
- **Infrastructure Development**
  1. Project will update road infrastructure and create power supplies for local community.
  2. Implementing WTE plant will directly contribute to poverty alleviation by providing the energy needed for creating businesses and employment.

SATAREM

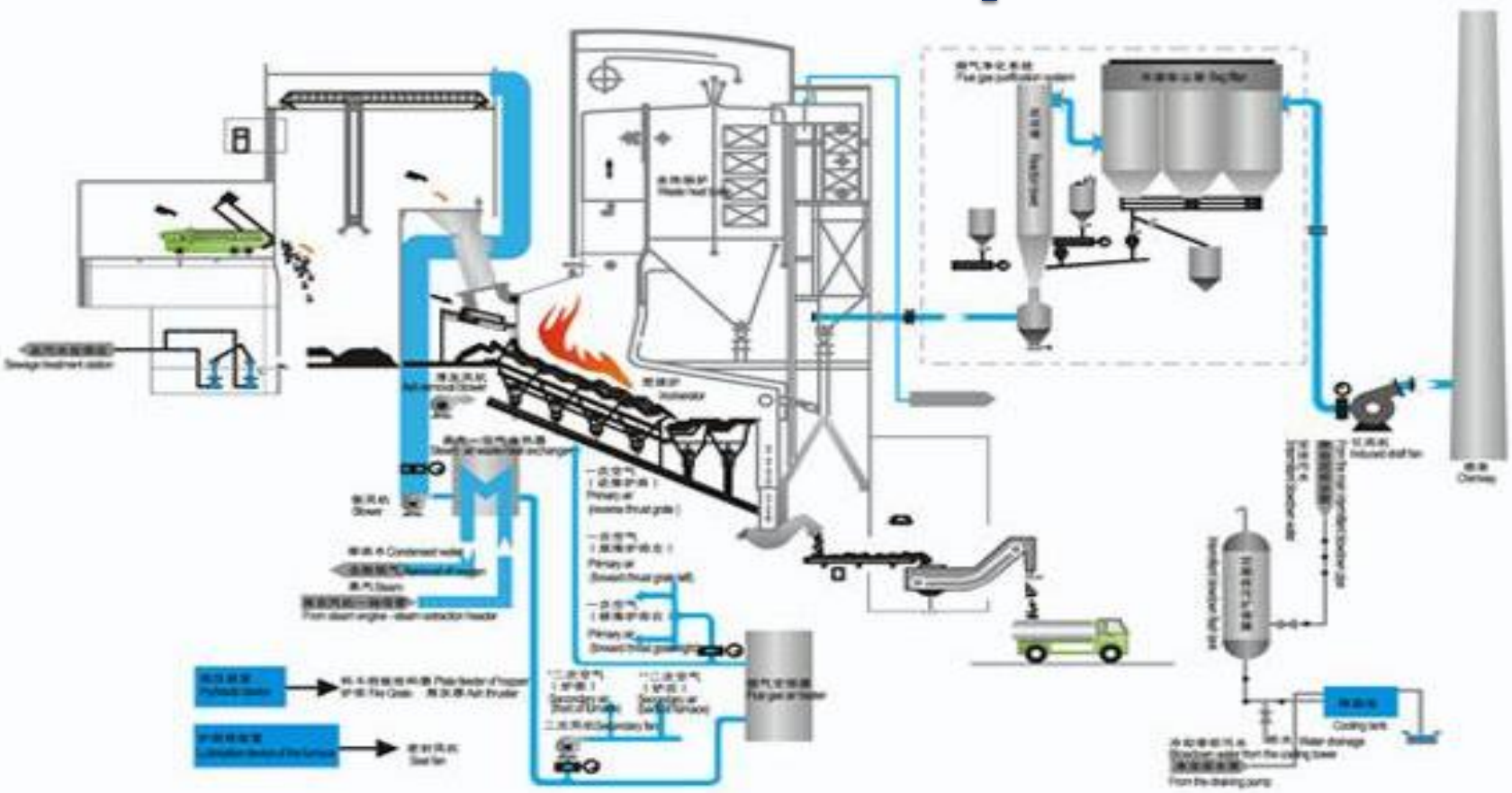
Chohan Group
Business Development

Technology Description

SATAREM

Chohan Group
Business Development

Process Description



SATAREM

Chohan Group
Business Development

Technology Description

- Trash truck enters into the plant area, after being weighed, to reach the waste pit. The waste will be stored in the pit for about 7 days.
- Waste pit is an enclosed building with negative pressure air to avoid any smell.
- The waste inside the pit is grabbed and delivered to the incinerator's hopper by the waste crane's grab bucket, and then is evenly delivered to the incinerator for combustion via feeding grate.
- Incinerator has ignition burner and auxiliary burner and uses diesel oil as the auxiliary fuel. The ignition burner is used for ignition and temperature rise.
- Through the drying, combustion and burnout areas, after the complete combustion of the combustible components of waste, the slag falls into the slag extractor.
- Above the slag storage pit there is bridge grab crane, which is used to collect slag and load the trash truck with waste for transportation and comprehensive utilization.
- The waste that cannot be utilized will be sent to the landfill site.

SATAREM

Chohan Group
Business Development

Technology Description

- The high temperature flue gas, which arises from waste combustion, is cooled to 200°C via boiler and then enters into the flue gas treatment system.

- The flue gas enters into the reaction tower first, fully blends with the lime milk with a certain concentration and causes chemical reaction.
  - After the chemical reaction, the acid gas in flue gas is removed.
  - Spray active carbon into the flue between reaction tower and fabric filter, so as to absorb the heavy metal and dioxin in flue gas.
  - With the aid of fabric filter, the dust and reaction resultant are eliminated, the flue gas is sent to the chimney and discharged to the atmosphere via air fan.

- Boiler uses water as the working medium, absorbs the heat in the high temperature flue gas and supplies it to the turbo-generator unit for electric power generation. The electric power is used for the waste to energy plant and transmitted to the regional power grid.

SATAREM Chohan Group Business Development

Typical Plant Emissions Results

Air Pollutant	EU Emission Standards (mg/m^3)	Actual Emission Data (mg/m^3)
Dioxins (in TEQ ng/m^3) *	0.1 ng/m^3	0.015 ng/m^3
Total organic carbon (TOC)	10	2
Hydrogen chloride (HCl)	10	2
Hydrogen fluoride (HF)	1	0.02
Sulphur dioxide (SO_2)	50	18
Nitrogen oxides (NOx)	200	50
Carbon monoxide (CO)	50	45
Particulates Matter (PM)	10	4
Heavy Metals (Group 1) :Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V	0.5	0.2
Heavy Metals (Group 2) : Cd & Th	0.05	0.003
Heavy Metals (Group 3) : Be, Se	No regulatory limit	0.025
Mercury (Hg)	0.05	0.003

* All emission levels, including results of multiple (14 samples over 6 months) dioxin sampling, complies with and were well below EU standards

SATAREM

Chohan Group
Business Development

GUANZHOU LIKENG PLANT EXAMPLE

Capacity	1040tpd (2x520 tpd)
Commissioning	October 2005
Project	Engineering, procurement and construction
Process	Mechanical Grate Reactors + Boilers
Design & performance of the energy generation	2 boilers + 1 steam turbine Capacity installed: 1x22MW Efficiency conversion energy: ~24% Consumption power internal: 20,322 MWh/Year Power exported to grid : 102,842 MWh/Year Capacity Annual Waste Treatment : 376,000 ton
Environmental Performances	Ashes: Wt. loss on heating < 3% Air emission: Particules ~ 7 mg/Nm^3 NOx ~ 144 mg/Nm^3 HCl ~ 34 mg/Nm^3 SO_2 ~ 19 mg/Nm^3
Ownership	Guangzhou Municipal Administration Bureau
Operator	Veolia Environmental Service
EPC	CCEPC
SATAREM	Design and Process caclulations in collaboration with CCEPC Supply Grate and Turbine Smoke and ashes treatment Start-up and emissions control

SATAREM

Chohan Group
Business Development

Photos Likeng WTE Plant

Architecture

Waste Unloading

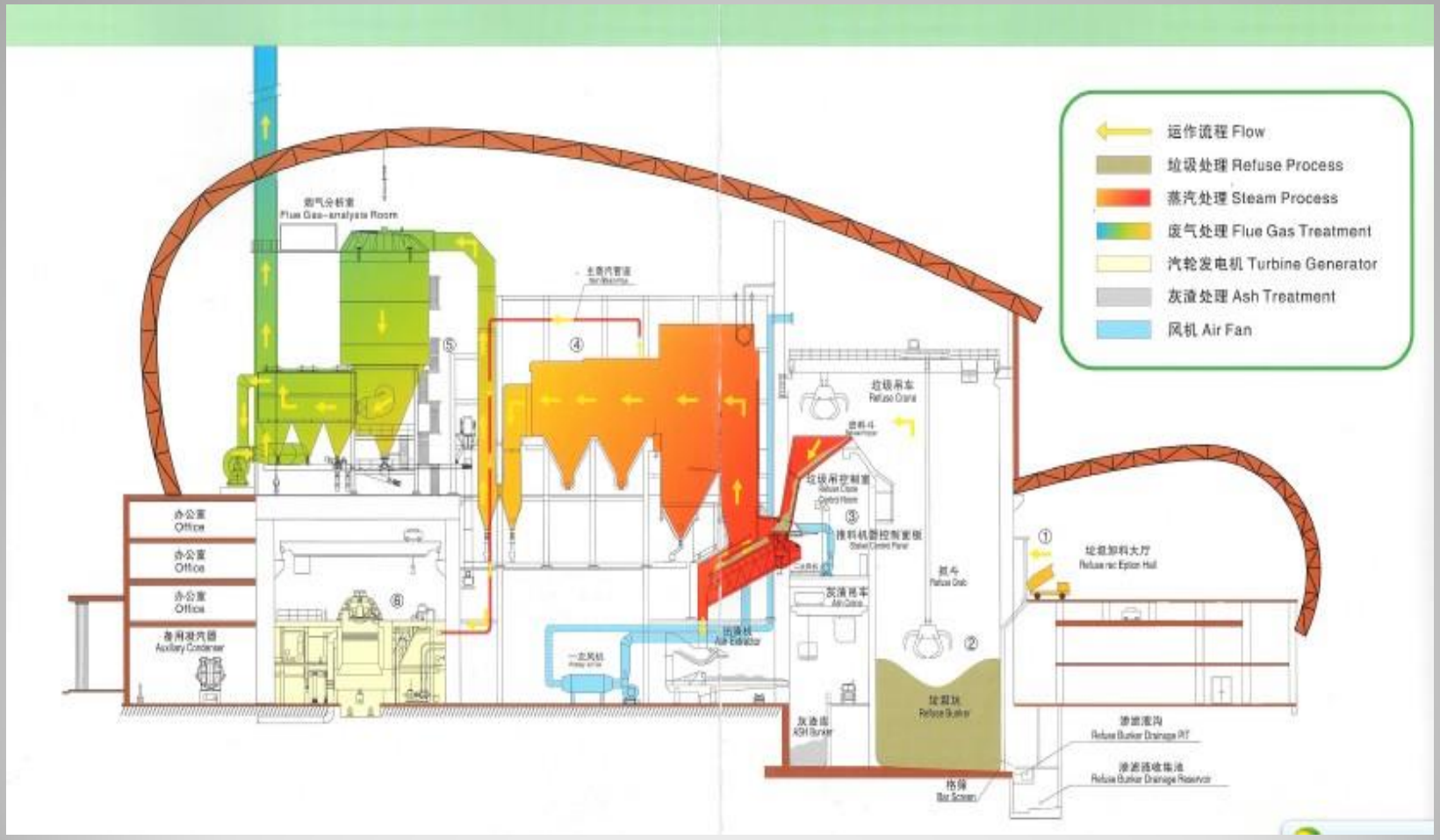
Grate

The Likeng plant is located inside the City of Guanzhou. Its design id in harmony with the city. No smell can be felt. The emissions fulfill the European standards, are measured in real time and are publicly monitored.

SATAREM

Chohan Group
Business Development

Section drawing



SATAREM

Chohan Group
Business Development

Voltage switch system

Turbine

Boiler

Refuse crane control room

SATAREM

Chohan Group
Business Development

Cooling tower & Truck weigh bridge

SATAREM

Chohan Group Business Development

Ash bunker& Fuel oil tank

On-line monitoring display

SATAREM

EU standard, Chinese standard and discharge index of Likeng plant

污染物名称 Pollutant Names	单 位 Unit	国标GWBK-2002 National Standard	欧盟标准 EU standard	本厂排放指标 Discharge Index of Likeng Plant
颗粒物 Dust	mg/Nm^3	80	30	10
HCl	mg/Nm^3	75	50	50
HF	mg/Nm^3	–	2	2
NOx	mg/Nm^3	400	–	200
SOx	mg/Nm^3	260	300	100
CO	mg/Nm^3	150	100	100
Hg及其化合物 Hg&its Chemical Compound	mg/Nm^3	0.2	0.1	0.1
Cd及其化合物 Cd&its Chemical Compound	mg/Nm^3	0.1	0.1	0.1
Pb及其化合物 Pb&its Chemical Compound	mg/Nm^3	1.6	–	0.5
烟气黑度 Flue Gas Density	林格曼级 Lingeman Degree	1	–	1
二恶英类 Dioxin	$ngTEQ/Nm^3$	1.0	0.1	0.1

SATAREM

Chohan Group Business Development

BOT
Contract

Build/Operate/Transfer (BOT)

SATAREM

Chohan Group
Business Development

BOT Contract Structure

Supply of MSW + Land

PPA Contract

25 years **Contract** with the Municipality to collect and to treat 2 000 tpd of waste

2 contracts must be linked by Cooperation Agreement between the Municipality and the Electricity Company

25 years **Contract** with National Electrical Company to supply 40 MW

SATAREM

Chohan Group Business Development