

Alter NRG Plasma Gasification: The Next Generation of Waste-To-Energy Solutions

Deep Dive Workshop on Waste-to-Energy
2016 Asia Clean Energy Forum , 7 June 2016



Life WITHOUT
Landfills

ABOUT US: ALTER NRG

Our Focus and What We Do

- Alter NRG is the marketing entity for Westinghouse Plasma Corporation
- 30+ years of research and development; ~\$2 billion invested in technology
- We divert waste that is otherwise landfilled (including Municipal Solid Waste, Hazardous Waste, Industrial Waste, Medical Waste, Mixed Biomass, Construction & Demolition Waste, etc.)
- We make syngas from multiple waste streams
- Provide large and small scale solutions – 25 tpd to 2000 tpd

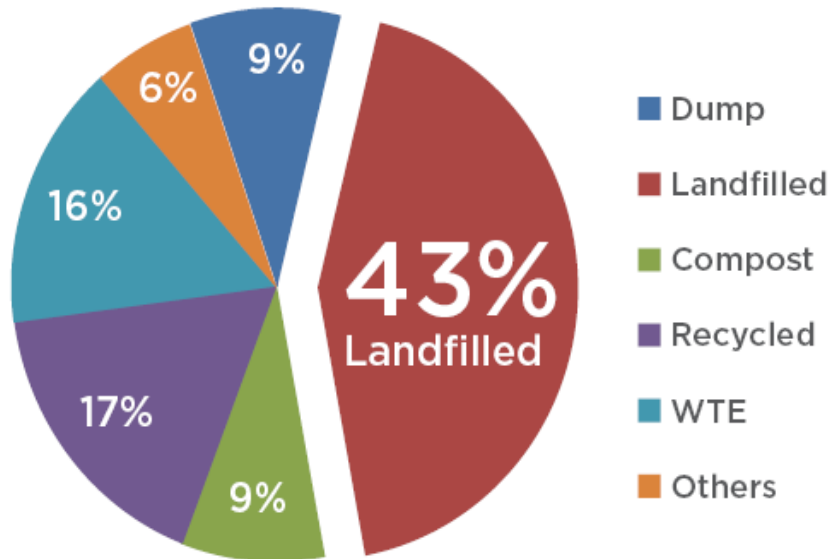
Our Owner: Sunshine Kaidi

- Sunshine Kaidi wholly owns Alter NRG and Westinghouse Plasma
- Sunshine Kaidi was founded in 1992 and headquartered in Wuhan, China
- Builds, owns and operates a portfolio of waste to energy facilities; holds assets in excess of \$6 billion USD
- Generating in excess of 1400 MW to date, and has received permits to build an additional 3000+ MW over the next 5 to 7 year in China alone



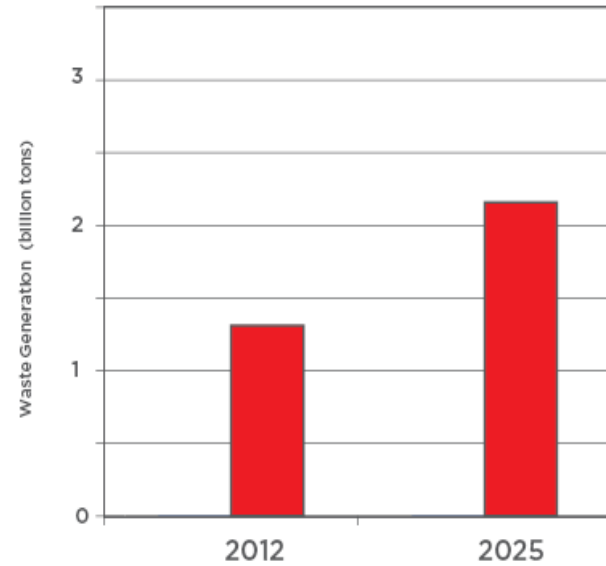
WE HAVE A GLOBAL WASTE PROBLEM

Most of the world's MSW is landfilled
(approximate, million tpy):



(Source: World Bank, 2012)

MSW generation (billion tpy):



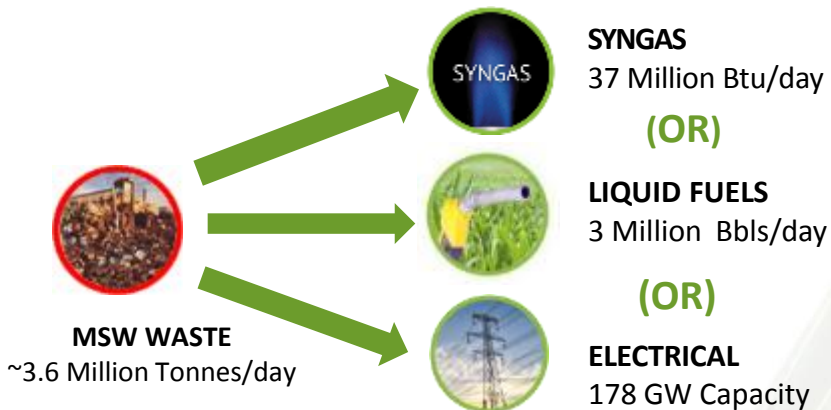
(Source: World Bank, 2012)

“Waste generation levels are expected to grow by 69% by 2025.”

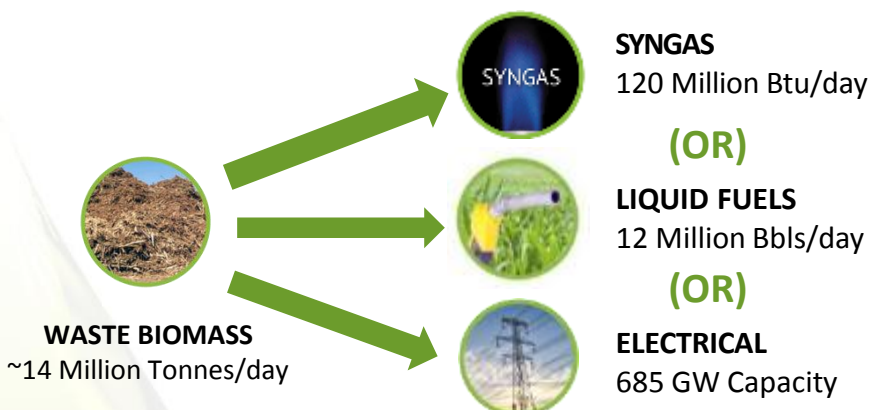
- World Bank Study, 2012

GLOBAL WASTE HAS SIGNIFICANT ENERGY EQUIVALENTS

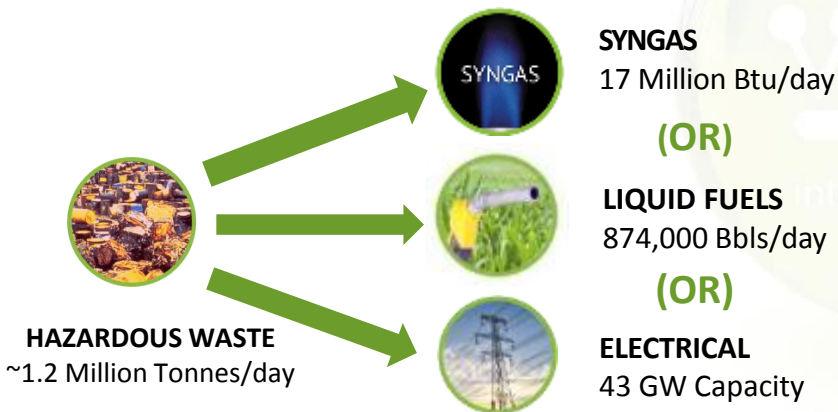
ESTIMATED MUNICIPAL SOLID WASTE



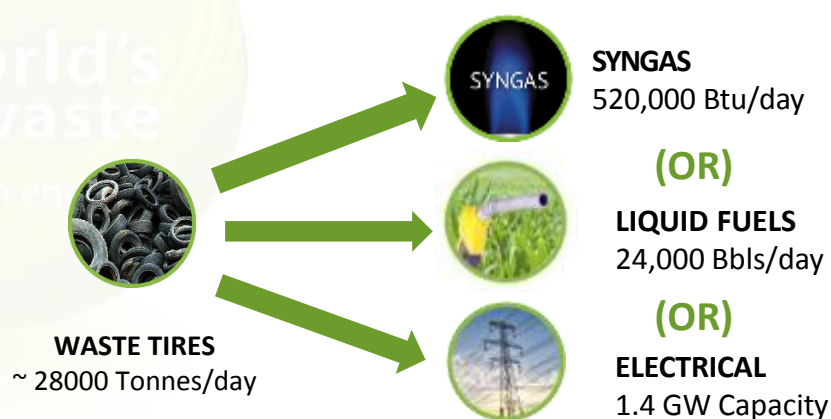
ESTIMATED WASTE BIOMASS



ESTIMATED HAZARDOUS WASTE



ESTIMATED WASTE TIRES



S.E. ASIA PERSPECTIVE

Challenges:

- Highly populated region of ~620 Million people (excluding China); with highly populated urban cities
- Lack of adequate waste management and recycling
- Waste material consists of high moisture content / wet organics
- Country risk, including political, social, changing renewable policies, difficult to obtain a long-term energy price
- Scarcity of development capital and scarcity of credible project developer/owners

Opportunities:

- Waste volumes are growing and majority of waste is largely landfilled
- Acute energy demand for power generation and economic growth
- Limited availability of land for landfilling vs. human habitation
- International pressure for cleaner waste practices and GHG reduction

SE ASIA/CHINA VERSUS NA/EUROPE

- **Waste:** High moisture content, high organic content in SE Asia waste means low calorific value and lower energy output. NA/EU waste is often RDF – low organic, low glass/metals and high calorific value.
- **Long Term Contracts:** Mostly open markets allow for negotiation of long term waste and energy contracts in NA/EU. Obtaining secure, low risk contracts is much more difficult in China/SE Asia.
- **Revenues:** Revenues are lower in China/SE Asia due to very low tipping fees for waste.
- **Capital Cost:** Low labor and material costs in China/SE Asia mean lower capital costs to build a facility.
- **Political Risk:** Stable governments and policy in NA/EU long term predictable business environment. Less so in many SE Asia countries.
- **Permitting:** Permitting often easier in SE Asia/China due to fewer NGOs and simpler permit/license processes.

DEVELOPMENT CHALLENGES WORLDWIDE

- Less than factual media coverage, speculation and misunderstandings about plasma gasification
- NGO pressure – anything short of 100% recycling is bad!
- Changing or uncertain renewable energy policies
 - Unfavourable mandates or lack of incentives
 - Energy from waste not addressed or not considered renewable
 - Incentives come and go with political change
- Risk aversion to newer technologies

ALTER NRG / WESTINGHOUSE PLASMA GASIFICATION TECHNOLOGY



PLASMA GASIFICATION MILESTONES – COMMERCIALY PROVEN



1983
PLASMA FIRED CUPOLA APPLICATION

General Motors; Defiance, Ohio - commissioned in 1987
Demo – 50 tpd



2002
WORLD'S 1ST COMMERCIAL SCALE PLASMA GASIFIER

Mihama Mikata, Japan - operational in 2002



2012
BIOMASS FACILITY

Kaidi, China – operational Q4 2012



1995
INCINERATOR ASH VITRIFICATION

Kinuura, Japan - commissioned in 1995



2009
SECOND GENERATION ETHANOL FACILITY

Coskata Lighthouse, U.S. - commissioned in Sept. 2009



2016/2017
ENERGY FROM WASTE FACILITIES, Tees Valley, UK – 2,000tpd MSW to combined cycle power Under construction, commissioning dates: TV1 – 2017 and TV2 - 2018



1999
PLASMA GASIFICATION OF MUNICIPAL SOLID WASTE (MSW)

Hitachi Metals; Yoshi, Japan - commissioned in 1999



2008
WORLD'S LARGEST PLASMA HAZARDOUS WASTE FACILITY

Pune, India – operational in 2009



2012
MARC-3 TORCHES

Guanchuan, China – delivery Q1, 2013



1989
INDUSTRY-LEADING TECHNOLOGY

Plasma technology by others such as Alcan – over 500,000 hours of industrial use



2003
WORLD'S LARGEST PLASMA GASIFIER FOR MUNICIPAL WASTE

Utashinai, Japan - operational in 2003; 200 tpd



2014
DEMONSTRATION FACILITY INTEGRATED WITH EXISTING INCINERATOR

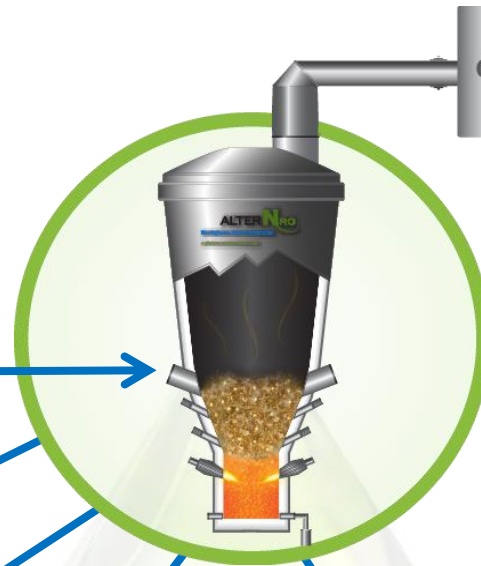
Shanghai, China – operational in Q1, 2014; 30 tpd

ALTER NRG PLASMA GASIFICATION PROCESS – A WASTE REDUCTION TECHNOLOGY

Waste Feedstocks:
Municipal, Hazardous, Industrial, Medical, Mixed Biomass, Construction & Demolition, Coal, Tires, etc.



1000 Tons/day



20 Tons/day
Sludge to landfill



20 Tons/day
Recycled into the Gasifier



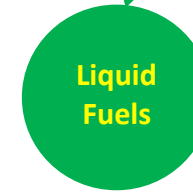
1 Ton/day
For sale to market



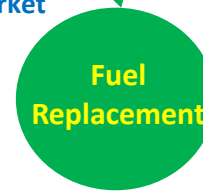
250 Tons/day
For sale to market as aggregate



50 MW Gross
(~41 MW Net to the grid)
For sale to market



800-1200 Barrels/day
For sale to market



10,420 Btu/day
(3.8 MMBtu/year)

IN SUMMARY:

1000 tpd Waste Processed
Using Alter NRG Gasifier



250 tpd Slag for Sale
To the Market as Aggregate



40 tpd Waste for Disposal
20 tpd Particulate Matter + 20 tpd Sludge for Landfill Disposal OR Recycled back into Alter NRG's Gasifier

CASE STUDY: LARGE SCALE MSW COST AND REVENUE COMPARISON



TYPICAL PROJECT COSTS

Project Costs (\$USD)	Duration	G-65 (1000 tpd)
Front-End Engineering	4-6 Months	\$ 2
Detailed Engineering	2-4 Months	\$ 5
Equipment and Construction	18-24 Months	\$ 220
Commissioning	1-2 Months	\$ 18
Total Estimated Cost		\$ 235

TYPICAL CAPITAL COST & REVENUES: G-65 GASIFICATION FACILITY (ALL COSTS STATED IN \$MILLION USD)

Project Costs	North America	Europe	Asia
Equipment and Materials	\$ 105	\$ 110	\$ 80
Installation Cost	\$ 75	\$ 80	\$ 35
Owner Costs and Contingency	\$ 55	\$ 60	\$ 35
Total Project Capital Cost	\$ 235	\$ 250	\$ 150
Typical Annual Revenues	\$ 50	\$ 75	\$ 30
Annual Variable Costs	\$ 10	\$ 10	\$ 8
Annual Fixed Costs	\$ 10	\$ 12	\$ 9
Net Power Generation	25 MW	30 MW	15-20MW

Assumptions: 1000 tpd; MSW to Power Steam Cycle; Equity financing of 100%; 25 year project life

13

**SMALLER SCALE
APPLICATIONS
HAZARDOUS AND INDUSTRIAL
WASTE SOLUTIONS**



TURNKEY HAZARDOUS WASTE SOLUTION

Commercial operations:

- In India (since 2008).
- In China (since 2013).

Flexible operations:

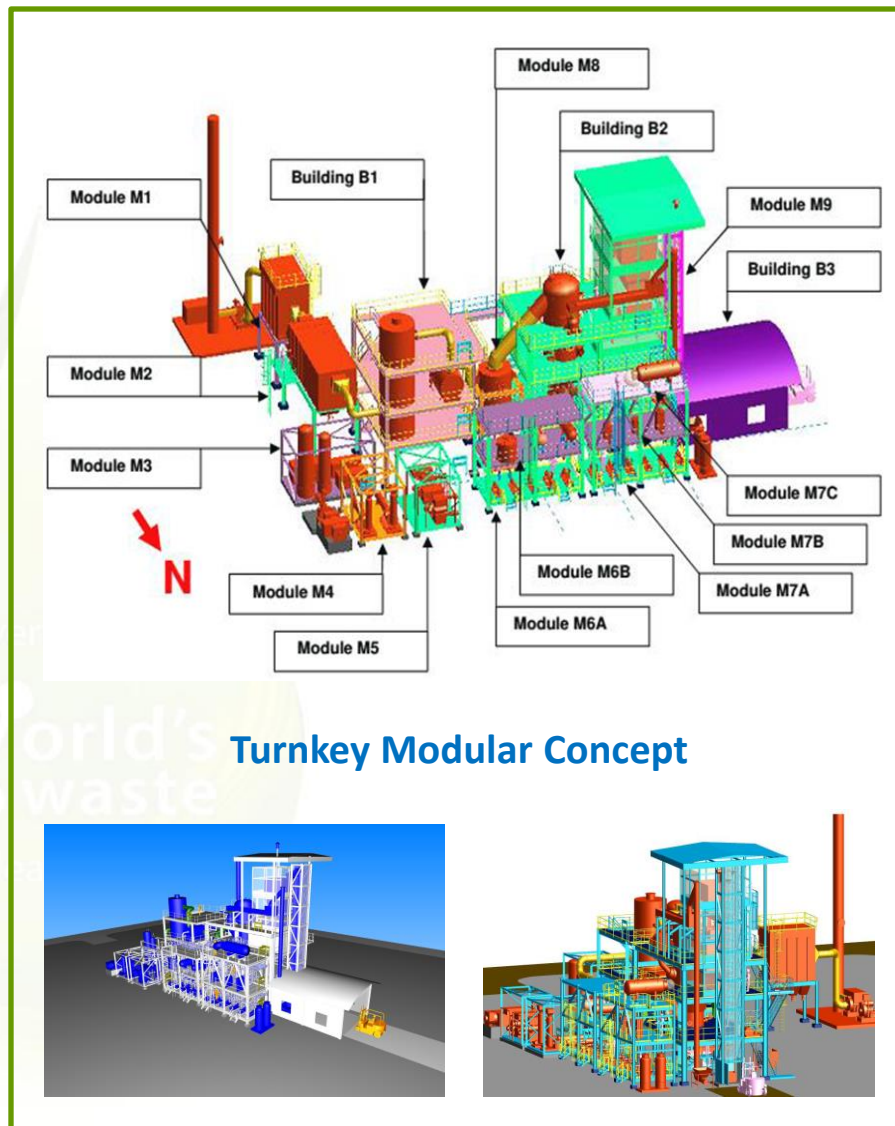
- Processed over **600+** hazardous waste streams since 2008.
- Syngas can be utilized for steam, power or process fuel.

Turnkey modular facility:

- Can be co-located with industrial facility
- Compact facility footprint: **~2,000 m²**
- Reduces project time lines
- Approximately \$25-35m USD solution depending on location

Environmentally sustainable:

- Slag has commercial uses (construction aggregate, rock wool insulation, etc.)
- WPC's high temperature gasification process does not create furans or dioxins.



THE WRAP UP

- Alter NRG provides a turnkey waste-to-energy solution
- Alter NRG will finance, build, own and operate the complete facility though Sunshine Kaidi (principal owner)
- Provide investment opportunities for project/ equity partners if needed
 - Provide total project guarantees and warranties for the entire facility through its EPC and strategic partners
 - Is modular, cost effective that reduces project time lines and increases economic returns
- Can handle multiple waste streams, where inorganic materials are transformed to an inert non-leaching vitrified slag product that can be sold for beneficial use
- The high temperature process does not create furans or dioxins and is environmentally superior



460, 227 – 11 Avenue S.W.
Calgary, Alberta
Canada T2R 1R9

www.alternrg.com

THANK YOU



SUPPLEMENTAL SLIDES



SUNSHINE KAIDI PROJECTS

Biomass Power Plants



Fujian, China – 12 MW



Anhui (Ningguo), China – 12 MW



Anhui (Wangjiang), China – 30 MW



Hubei, China - 30MW

Hydro Power Plants



Yunnan, China – 315 MW



Nanbuhe, China – 5 MW



Bajiu, China – 22 MW

In 2008, Sunshine Kaidi received approvals for biomass power projects in 266 municipalities and counties in China, where the feedstock will be agricultural and forest waste. Currently, Sunshine Kaidi has 37 projects in commercial operation and 34 projects under construction.

Wind Power Plants



Pinglu, China – 49 MW

Sunshine Kaidi has signed twelve investment agreements for wind power projects throughout China. These projects include operating facilities in in Pinglu, Fuxin and Yanchi, all of which have 49 MW (each) of installed power capacity. Currently, Sunshine Kaidi has eight wind power projects under construction.

Sunshine Kaidi has 16 more hydropower projects proposed within Yunnan Providence, China along the Jingping River Valley, Chitong River Valley and Sanjia River Valley.

SUNSHINE KAIDI PROJECTS

Power Plant Installations



- **Mao Khe, Viet Nam**
- 2 plants of 200 MW each
- Provided turnkey EPC services
- Construction period of 42 months; completed 3.5 months ahead
- Unit 1: operating since 2012; Unit 2 - operating since 2013



- **Henan, China**
- 2 plants of 155 MW each
- Provided turnkey EPC services
- Unit 1: operating since 2008; Unit 2: operating since 2009



- **Quảng Ninh, Viet Nam**
- 2 plants of 300 MW each
- Provided turnkey EPC services
- Obtained buyer's credit and a commercial loan
- Construction completed on time/budget within the 45 months period



- **Henan, China**
- 2 plants of 135 MW each
- Provided turnkey EPC services
- Unit 1: operating since 2005; Unit 2: operation since 2007



- **Hai Duong, Viet Nam**
- 2 plants of 600 MW plant each
- Provided full turnkey EPC services
- Obtained buyer's credit and a commercial
- Construction completed on time/budget within the 48 months period



- **Shanxi, China**
- 2 co-generation plants of 200 MW each
- Unit 1: operating since 2008; Unit 2: operating since 2008

By the end of 2014, Sunshine Kaidi had successfully implemented more than 200 turnkey power projects as an EPC contractor – both domestically and internationally.

TEES VALLEY, UK: ADVANCED GASIFICATION ENERGY-FROM-WASTE PLANTS



TV1



TV2



Overview:

- **2,000 tpd** of Municipal Solid Waste
- **100MW** (gross) electrical base load production via combined cycle
- World's first combined cycle Energy from Waste facility

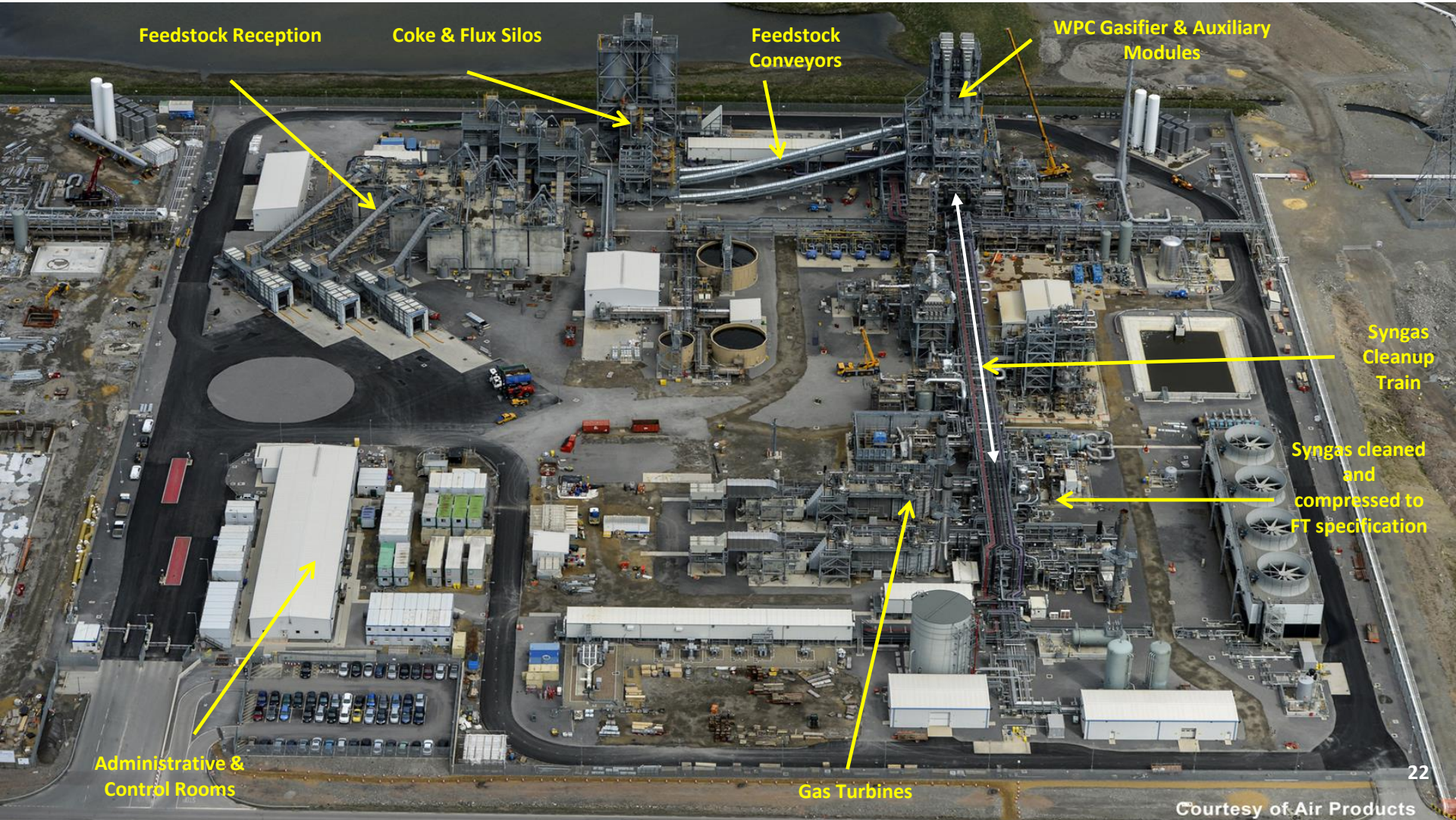
Update on both phases:

- TV1 (1,000 tpd) – completed construction and commissioning; in startup and will be fully operational in 2016
- TV2 (1,000 tpd) – currently under construction; commissioning late 2016



WPC Gasifier and Auxiliary Modules installed at TV1

TEES VALLEY, UK: TV1 - 2015



THE OPERATION OF THE TEES VALLEY PROJECT DEMONSTRATES:

1. Industrial / Commercial scale volumes of syngas from waste:

- 2,000 tpd of feedstock will produce ~7 Million MMBtu/year of syngas
- 100 MW (gross) electrical, base load production of energy
- Equivalent production of 1,600 – 2,000 Bbls/day of liquid fuels

2. The ability to consistently produce syngas at the required specification:

- To ensure reliability, the syngas must consistently meet the fuel specification of the gas turbine
- Gas turbine syngas specification is similar to liquids conversion technology syngas specification

3. The ability to create negative to low cost syngas from feedstock's

- Tipping fee revenues reduce the operating cost of making clean syngas

KEMI, FINLAND: BIOMASS TO BIOFUELS FACILITY



Overview:

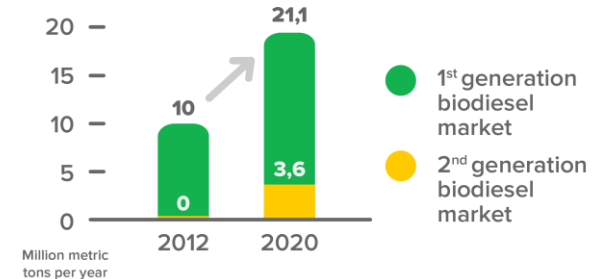
- The facility will produce **200,000** metric tons/year of biofuels from waste biomass; **75%** biodiesel and **25%** bio-gasoline
- Established permitting, engineering and design; construction will start in **2017** and planned commercial operations in **2019**
- Will utilize Alter NRG's plasma gasification system and Rentech's Fischer-Tropsch (FT) liquids processes (both owned by Kaidi)



Benefits:

- An investment of EUR 1 billion, with a tax revenue of over EUR 200 million
- Will create 4,000 man-years of construction work; over 150 permanent positions once operational
- Be part of the EU's Renewable Energy Directive - 20% of energy consumption from renewable sources by 2020
- Be part of Finland's goal to reach a target of 40% biofuels usage by 2030

EU market size for biodiesel



SHANGHAI, CHINA: HAZARDOUS WASTE FACILITY

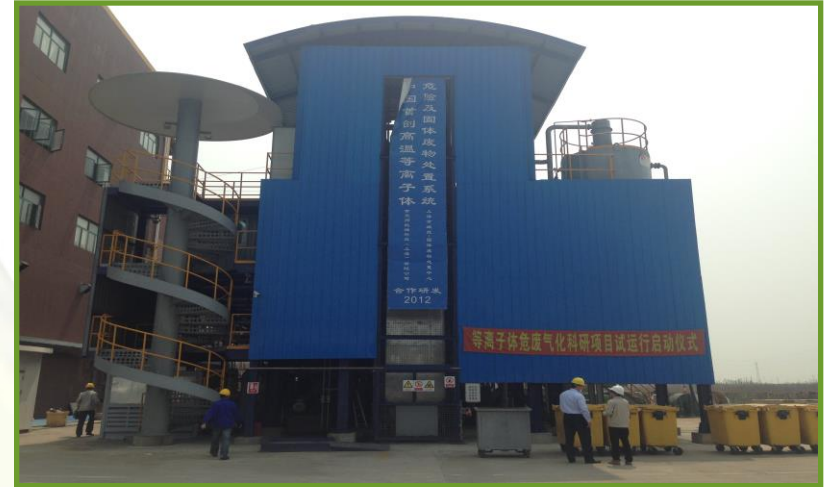


Overview:

- **30** tpd of medical waste and incinerator ash.
- Co-located with Shanghai Chengtou hazardous waste facility.
- Facility was commissioned in **Q1, 2014**
- WPC offers this plant globally as a turnkey solution.
- **Successfully completed 150+ day continuous operation.**

Benefits:

- Vitrifies hazardous incinerator ash.
- Inorganic materials are transformed into non-leaching marketable slag.
- Creates steam that is utilized in a steam turbine.



WUHAN, CHINA: WASTE-TO-BIOFUELS FACILITY



Overview:

- **150 tpd** of mixed wood biomass.
- Creates diesel and naphtha using catalytic Fischer-Tropsch (FT) process.
- Facility was commissioned in **Q4 2012**.
- **Successfully completed 2+ years in operation.**

Update:

- Development of (3) **2000 tpd** commercial facility in progress.
- Wuhan Kaidi uses both proprietary cobalt and Rentech's iron slurry FT technology.



PUNE, INDIA: COMMERCIAL HAZARDOUS WASTE FACILITY



Overview:

- Designed to process **72** tpd of hazardous waste
- Routinely processes 40-60 different waste streams on weekly basis.
- Over **600** different waste streams processed since plant start-up
- Syngas is used to create electricity which is exported to the grid.
- Facility was commissioned in **2008**.
- **Successfully completed 7+ years in operation.**



MIHAMA-MIKATA, JAPAN: ENERGY FROM WASTE

- Hitachi Metals 2nd project with Westinghouse Plasma Corp.
- Serves the two cities of Mihama and Mikata, Japan
- WPC Plasma gasification of **20** tpd of *MSW* and **4** tpd of *waste water sludge*.
- Oldest operating facility; Commissioned in **2002**.
- Syngas is combusted; resulting heat is used to dry sewage sludge prior to gasification.
- **Successfully completed 13+** years in operation.

