

Treating Waste as a Renewable Source of Energy

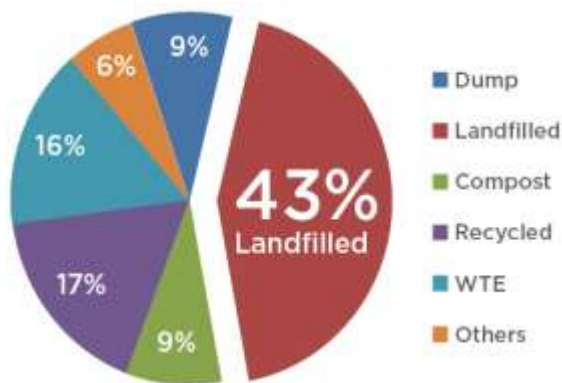
Advanced Thermal Technologies for the conversion of Waste-to-Energy

WRETC - 8th World Renewable Energy Technology Congress & Expo, August 21-23, 2017
Delhi, India



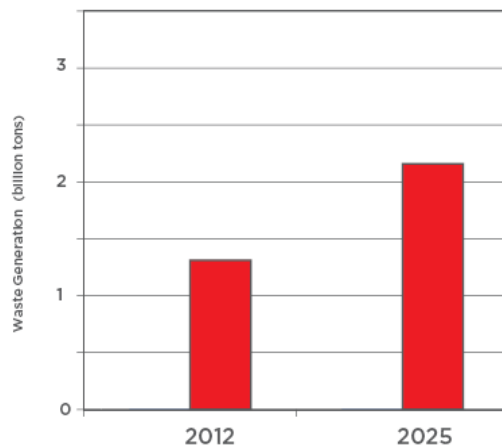
WE HAVE A GLOBAL WASTE & POPULATION GROWTH CHALLENGES

Most of the world's MSW is landfilled



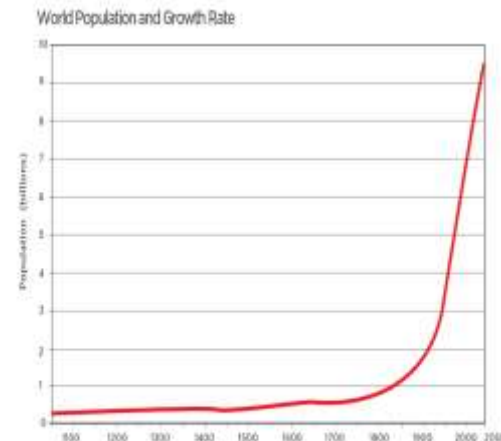
(Source: World Bank, 2012)

MSW generation (billion tpy):



(Source: World Bank, 2012)

World population growth (estimates in billions):



(Source: UN Population, 2014)

Facts are that landfills cause:

- Greenhouse gas emissions, both CO₂ and methane
- Unnecessary land occupation
- Water contamination through leaching
- Emissions that contain hazardous air pollutants that can be dangerous
- Clean up issues for future generations

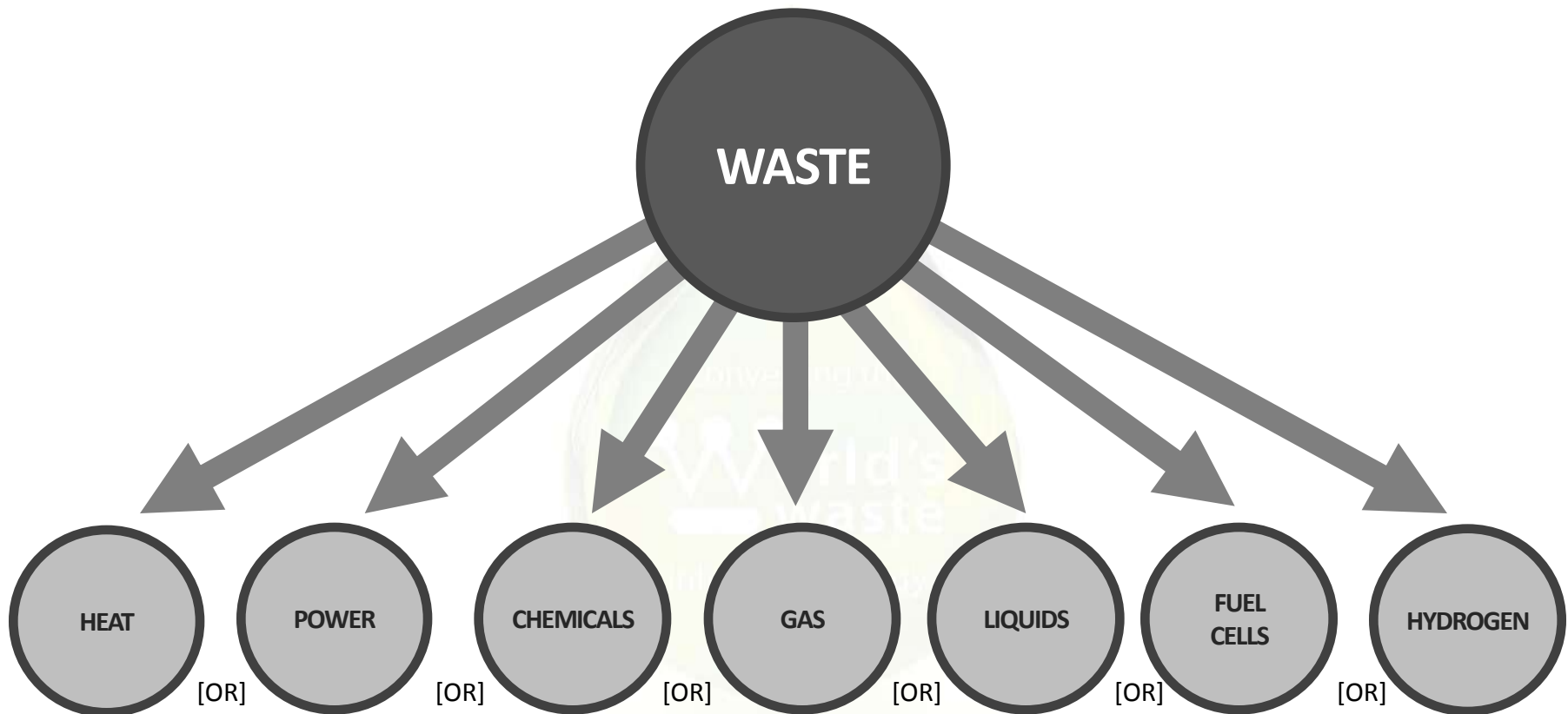
World population growth impacts waste generation:

- World population is projected to reach 9 Billion by 2050
- Urbanization will account for 86% in developed countries; 64% in developing countries
- Increase in urban population and consumption has a direct impact on the increase of waste generation

“Waste generation levels are expected to grow by 69% by 2025.” (World Bank Study, 2012)

WASTE-TO-ENERGY: DEFINITION

Conversion of waste materials into useable energy.



Global Waste Management (Practice & Challenges)

GLOBAL WASTE MANAGEMENT: PRACTICE & CHALLENGES

Waste Management & Evolution	Tier 1 (E.g. Western Europe, Japan)	Tier 2 (E.g. USA, Canada, Australia)	Tier 3 (E.g. Middle East, S. America, E. Europe)	Tier 4 (E.g. Asia/India, Developing Countries)
Waste segregation at source (E.g. 3R's)	HIGH	HIGH	MEDIUM	LOW
Advanced landfilling	HIGH	HIGH	LOW	LOW
Thermal Treatment	HIGH	LOW	LOW	N/A
Environment pollution (E.g. methane gas, CO ₂ , gas flaring, open dumping, health hazard, etc.)	LOW	MEDIUM	HIGH	HIGH

Waste Management (Challenges & Opportunities)



ASIA/INDIA PERSPECTIVE

Challenges:

- Asia is a highly populated region of ~4 Billion people (India - 1.3 Billion); with highly populated urban centres
- Lack of adequate waste management/recycling facilities
- Waste material consists of high moisture content/wet organics
- Country risk, including political, social, changing renewable policies, difficult to obtain 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/sustainable waste practices and GHG reduction

ASIA/INDIA VERSUS NA/EU

	North America / Europe	Asia
Waste	<ul style="list-style-type: none"> • RDF widely used with low moisture/organic content • Low in glass/metals content • High calorific value and energy output 	<ul style="list-style-type: none"> • High moisture/organic content • High in glass/metals content • Lower energy output • Low calorific value
Long-term Contracts	<ul style="list-style-type: none"> • Mostly open markets • Allowance to negotiate long-term waste and energy contracts 	<ul style="list-style-type: none"> • Mostly closed markets • Obtaining secure, low-risk contracts is much more difficult
Revenues	<ul style="list-style-type: none"> • Revenues are higher due to medium/high tipping fees 	<ul style="list-style-type: none"> • Revenues are lower due to low tipping fees
Capital Cost	<ul style="list-style-type: none"> • Medium/high labor and material costs • Higher capital costs to build a facility 	<ul style="list-style-type: none"> • Low labor and material costs • Lower capital costs to build a facility
Political Risk	<ul style="list-style-type: none"> • Stable governments • Long-term policy with predictable business environment 	<ul style="list-style-type: none"> • Less favorable conditions
Permitting	<ul style="list-style-type: none"> • Permitting is a lengthy process due to many stakeholders and stringent permit/license processes 	<ul style="list-style-type: none"> • Permitting often easier due to fewer NGOs and simpler permit/license processes

GLOBAL DEVELOPMENT CHALLENGES

- NGO pressure – anything short of 100% recycling is not acceptable
- Changing or uncertain renewable energy policies
 - Unfavourable mandates or lack of incentives
 - Unavailable/uncertain long-term waste supply agreements/PPAs
 - Waste-to-energy not addressed or not considered renewable
 - Incentives come and go with political change
- Limited access/unavailability to large project development capital/funding
- Less than factual media coverage, speculation and misunderstandings about advanced thermal technologies (e.g. plasma gasification)
- Risk aversion to newer technologies

Government Initiatives & Incentives for Waste Conversion

GOVERNMENT INITIATIVES & INCENTIVES

Country	Landfill Tax	Renewable Energy Mandate	Legislations	First Legislations Enacted
India	✘	✔	✔	1986
China	✘	✔	✔	1989
Australia	✔	✔	✔	2009
EU (27)	✔	✔	✔	2008
USA	✘	✔	✔	1976

Source: MEP China; COAG Australia; EC.Europa; EPA/RCRA USA

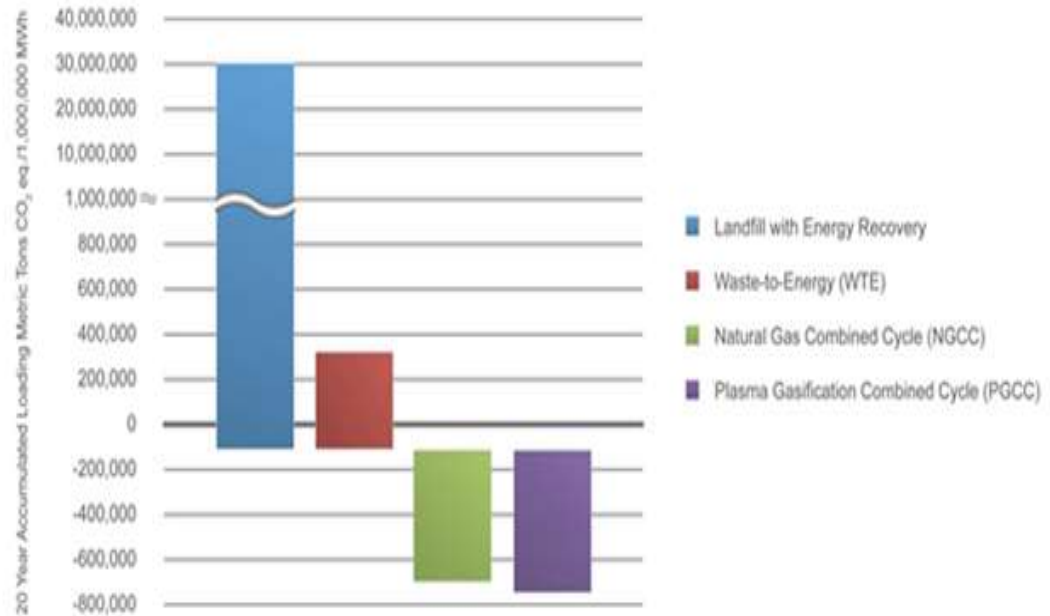
CO₂ Emissions

(Landfill vs. Thermal Treatment)

GHG EMISSIONS COMPARISON

- Plasma gasification reduces greenhouse gas emissions (GHG) by over 50% on a lifecycle basis compared to conventional landfilling
- Emission levels from a combined cycle power plant using plasma gasification are similar to those from a natural gas fired power plant
- The use of waste as a feedstock in a plasma gasification power plant eliminates the GHG produced by otherwise landfilled waste and therefore the technology is expected to be RPS and REC eligible

A 2010 report by Scientific Certification Systems comparing Landfill, Waste to Energy (incineration) and Plasma Gasification Combined Cycle configurations, concluded that a “Plasma Gasification Combined Cycle (PGCC) system provides the lowest greenhouse gas emissions of the evaluated systems for waste disposal.”



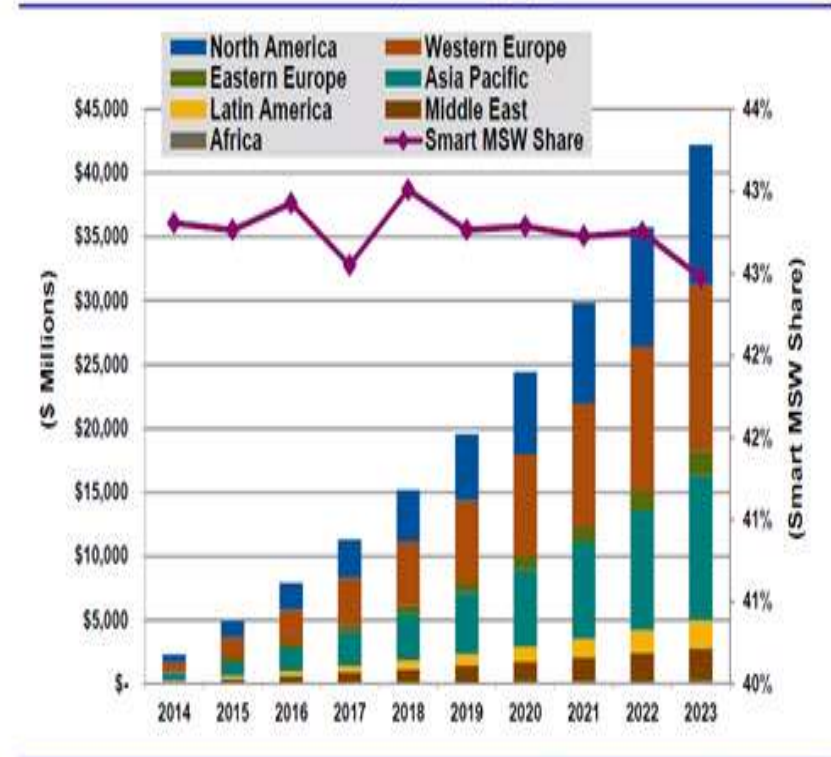
Source: SCIENTIFIC CERTIFICATION SYSTEMS, INC.

Global Economic Impact (Revenues & Employment)

MSW AS AN OPPORTUNITY

- Waste-to-energy (WTE) technologies are combustion, gasification and anaerobic digestion
- \$42.2 billion in cumulative revenue; annual revenue from smart MSW technology (e.g. WTE) is expected to experience a 12.2% compound annual growth rate, significantly more than the anticipated 4% revenue growth from conventional MSW technology
- The market for WTE technologies is projected to reach \$29.2 billion by 2022, up from \$6.2 billion in 2012
- WTE plants will treat a minimum of 261 million tonnes of waste annually by 2022

Chart 1.1 Cumulative Smart MSW Technology Revenue by Region, World Markets: 2014-2023



(Source: Navigant Research)

Source: Navigant Research

Technology Readiness for Waste Management

ALTERNATIVES FOR WASTE TREATMENT

BURY

Landfilling waste:

200 kWh (net)
recovered per
tonne of waste



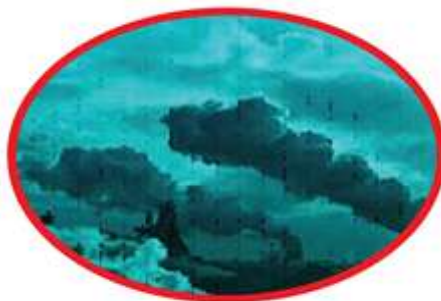
RESULTS:

Passes the problem to
future generations

BURN

Incinerating waste:

500-650 kWh (net)
recovered per
tonne of waste



RESULTS:

Creates ash requiring
secondary processing or
landfilling

CONVERT

Advanced Thermal Treatment



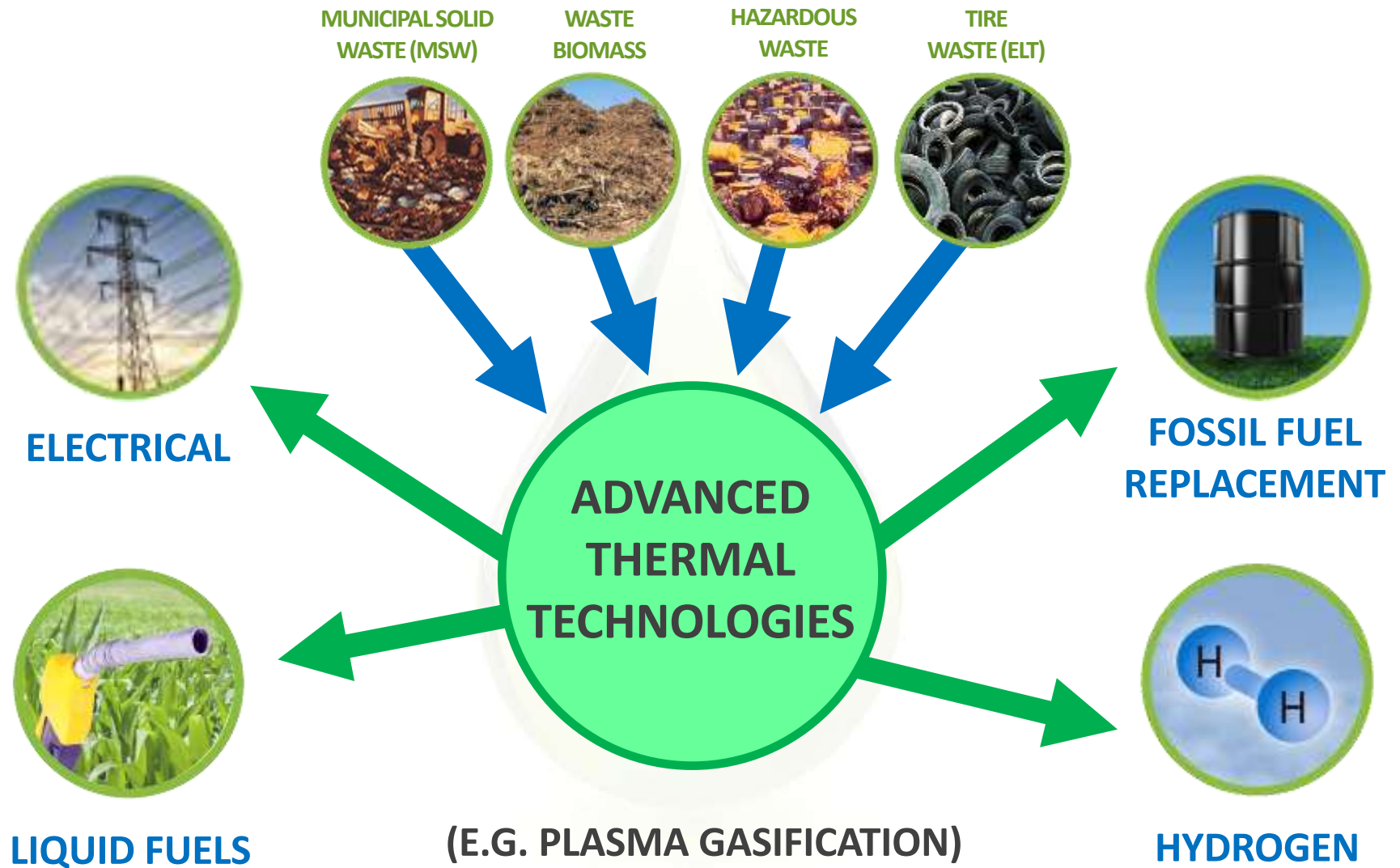
In addition to electricity the plasma
gasification process can also create: ethanol
gasoline, diesel fuel or oil replacement

RESULTS:

**Life without
landfills**

EVOLUTION OF THE WASTE CONVERSION PROCESS

WASTE TREATMENT USING ADVANCED THERMAL TECHNOLOGIES



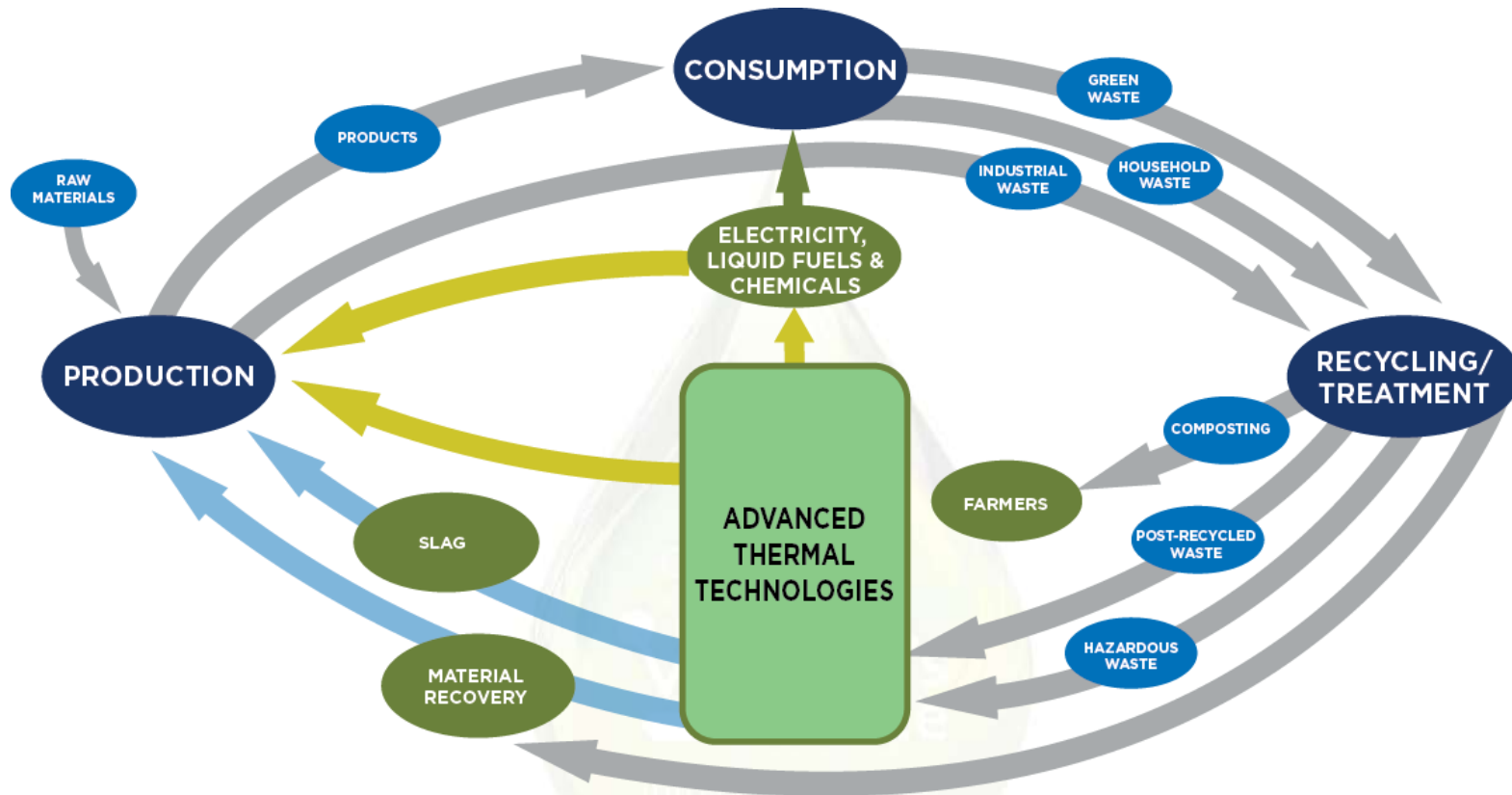
WASTE DIVERSION RATE BY TREATMENT METHOD

(E.g. 1000 tpd waste handling/treatment)

	Recycling/MRF	Incineration	Advanced Thermal Technologies
Waste Diversion	~20%	~70%	~98%
Waste for Treatment or Landfilling	~80%	~30%	~2%

- Recycling/MRF alone cannot eliminate majority of waste
- Incineration creates significant amount of residual waste that still require landfilling/disposal
- Advanced thermal technologies creates minimal residual waste for landfilling/disposal

ADVANCED THERMAL TECHNOLOGIES ARE PART OF THE 'CIRCULAR ECONOMY'



- Advanced thermal technologies are part of the 'circular economy' and product life-cycle
- E.g. Plasma Gasification is suitable for processing post-recycled waste/RDF or waste that cannot be recycled and require appropriate disposal (e.g. hazardous waste)

Waste-to-Energy in India: (Proposed Tariffs, Policy Measures & Incentives)



WASTE-TO-ENERGY IN INDIA: PROPOSED TARIFFS, **POLICY MEASURES & INCENTIVES**

Proposed tariffs:

- Bio-Power (biomass/gasification and bagasse cogeneration) - US ¢ 11.5 – 13.5
- Waste-to-Power (RDF route) - US ¢ 12

Policy measures:

- Interest subsidy to reduce the rate of interest to 7.5%
- Financial assistance of up to 50% of capital cost per MW for demonstration size projects (limited to Rs. 3 crores/US\$ 448,800)
- Financial incentives for power generation per MWe (Rs. 15 lakh/US\$ 22,440) ; cost-free waste feedstock supply to site; land on a long-term lease (30+ years)

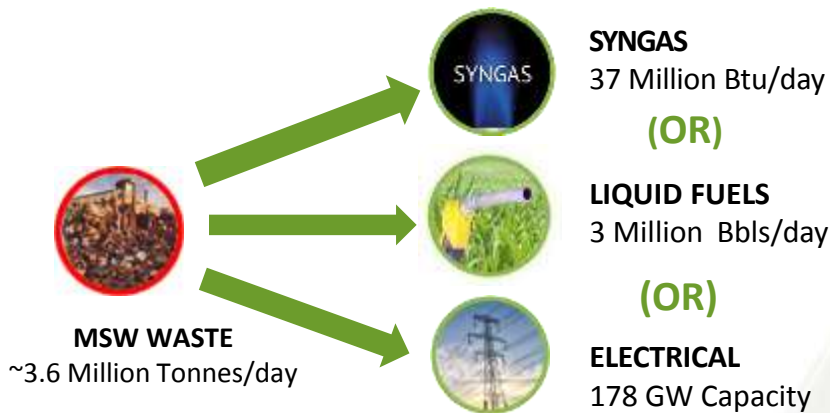
Power generation incentives:

- MSW/RDF route (Rs. 15 million/US\$ 224,400); MSW on gasification/pyrolysis /plasma arc (Rs. 39 million/US\$ 583,440); Bio-methanation technology and processes
- Others: per project development assistance and capacity building initiatives

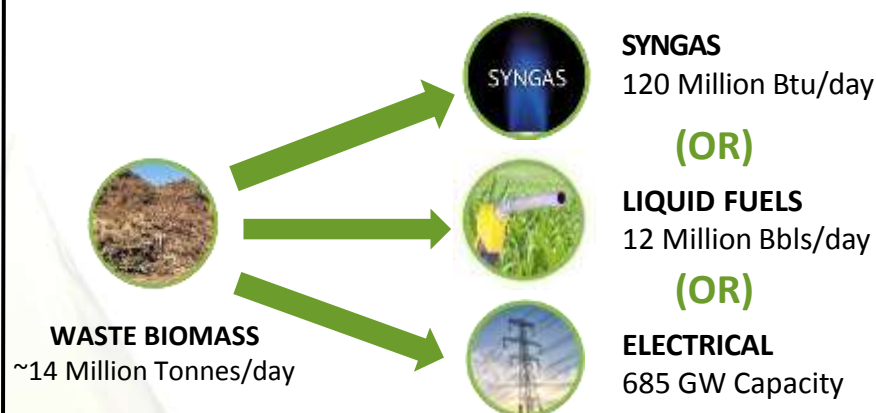
Waste Management - as a renewable source of energy

GLOBAL WASTE HAS SIGNIFICANT ENERGY DEVELOPMENT OPPORTUNITIES

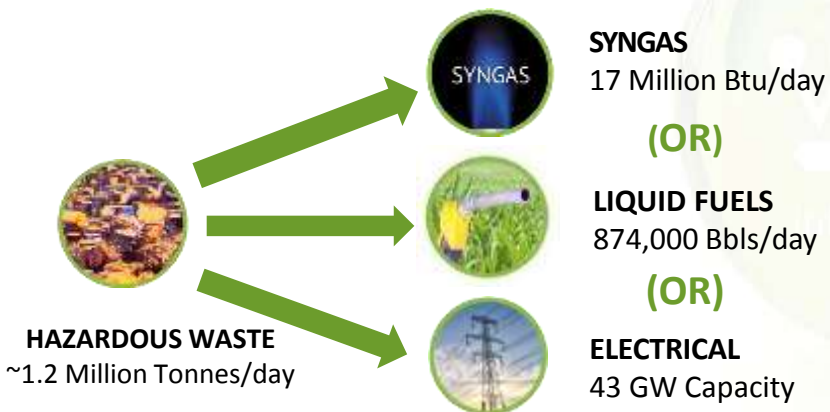
ESTIMATED MUNICIPAL SOLID WASTE



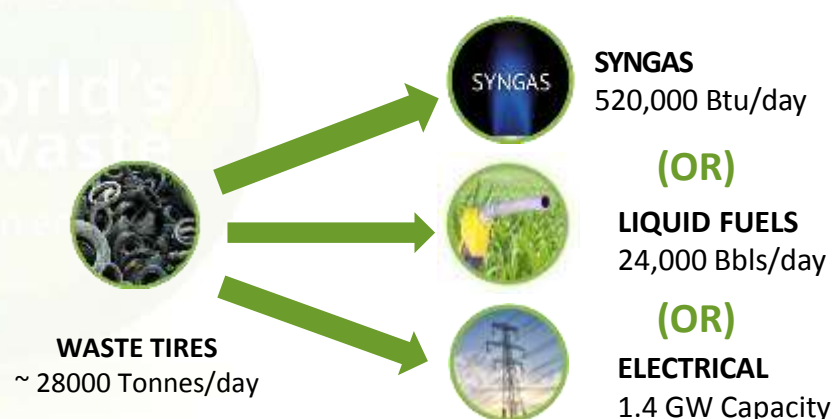
ESTIMATED WASTE BIOMASS



ESTIMATED HAZARDOUS WASTE

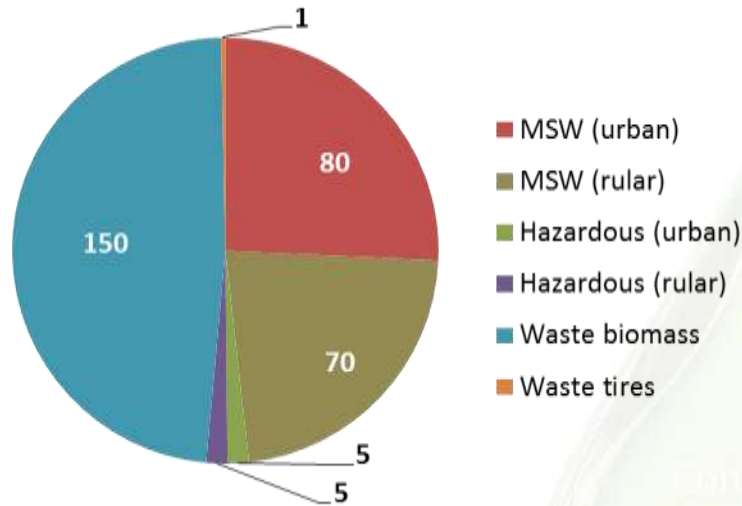


ESTIMATED WASTE TIRES

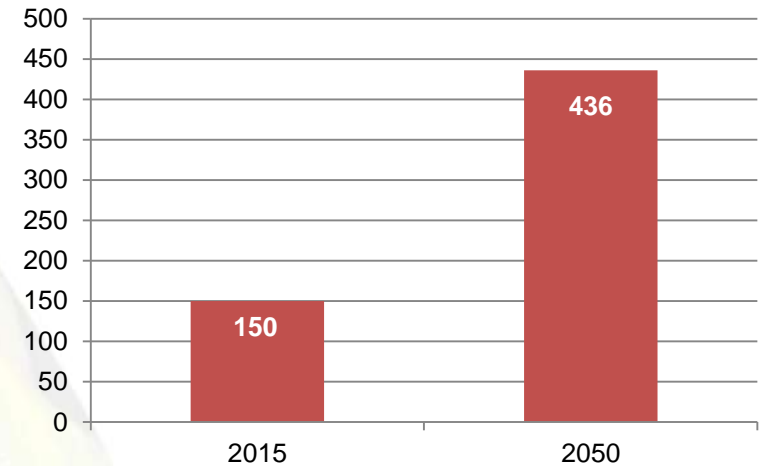


INDIA'S WASTE CHALLENGES

~80% of MSW is landfilled
(approximate, million tpy):



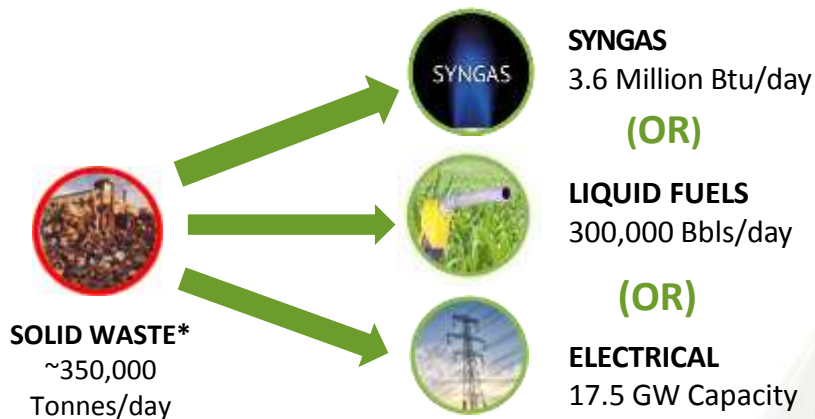
MSW generation
(approximate, million tpy):



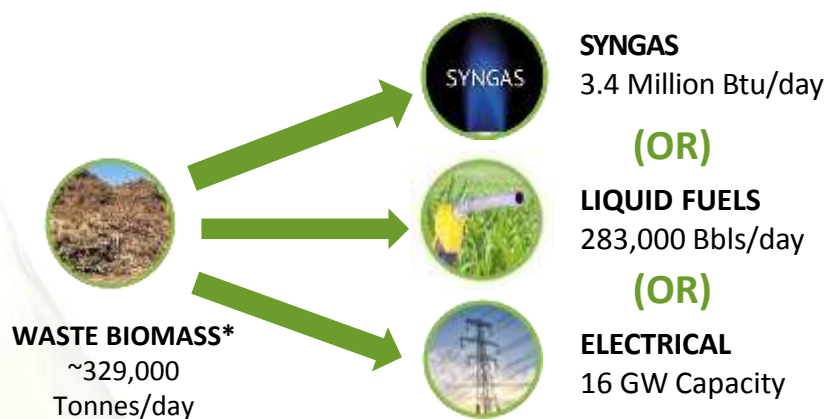
- Growing population, urbanization increases waste volumes and environmental concern
- On a cumulative basis, current 'urban' MSW generation is ~80 Million Tonnes/year; (estimated to reach ~436 Million Tonnes/year by 2050)
 - It is estimated, that an additional 70-80 MM TPY of 'rural' MSW would be generated but unaccounted (per capital basis)
 - ~80% of MSW is landfilled and ~20% is treated/recycled
- Additional waste streams are: hazardous/medical (~5 MM TPY); surplus waste biomass (~150 MM TPY; waste tires (~1 MM TPY) are generated
 - It is estimated, that an additional 1-3 MM TPY of 'rural' hazardous waste would be generated but unaccounted

MONETIZING WASTE IN INDIA: A RENEWABLE SOURCE OF ENERGY

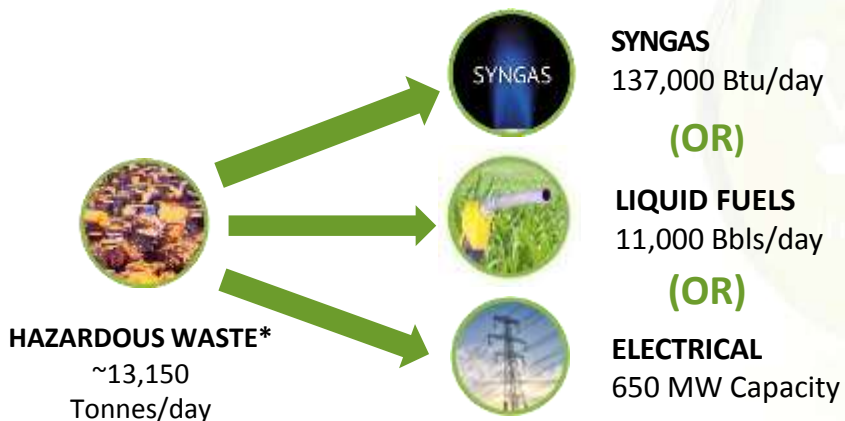
ESTIMATED SOLID WASTE



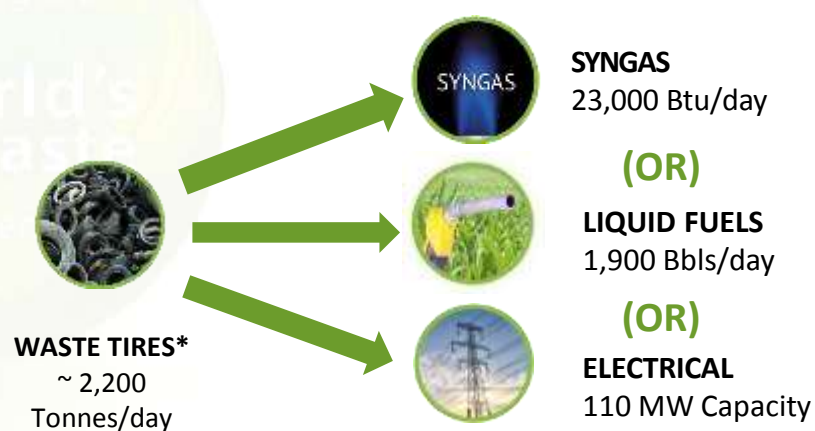
ESTIMATED WASTE BIOMASS



ESTIMATED HAZARDOUS WASTE



ESTIMATED WASTE TIRES



*~80% of urban/rural waste volumes)

THE WRAP UP

- Growing population/urbanization increases waste volumes and environmental concern
- Waste management is a global challenge but presents multiple opportunities
- Converting waste into renewable energy for the growing economies
- Waste management has global economic benefit on revenue growth and employment opportunities
- Some governments are providing meaningful regulations, policy framework and incentives to accelerate the development of the waste-to-energy sector
- Advanced thermal technologies (e.g. Plasma Gasification) provide clean, reliable and flexible waste-to-energy solutions
 - Diverting multiple waste streams from landfills (~98%), while creating power, liquid fuels or as a fossil fuel replacement
 - Enable governments/municipalities to implement their mandates on waste reduction, reuse, recycling (3Rs), while fostering the 'circular economy' plan.



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THANK YOU



Waste-TO-Energy

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