

# FastOx<sup>®</sup> Gasification Converting waste to power and profits

# IN 2025 THE WORLD 22 BILLION WILL PRODUCE 2.2 TONS OF WASTE

Data from World Bank



WASTE CREATES **AFIHAN** 16% OF THE WORLD'S **GREENHOUSE GASES** 

Data from EPA



Data from IPCC 20 Year GWP



**300 GIGAWATTS** BASELOAD RENEWABLE POWER DISTRIBUTED TO WHERE PEOPLE ARE **MSW Disposal, Recovery and Generation:** How waste is handled in the U.S. according to the EPA.\*

\*Waste 360

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### LANDFILL

COMBUSTION

COMPOSTING

RECYCLING



# CHINA POLICY LEAVES WORLD DROWNING IN RECYCLING

# INCINERATION IS A BAD SOLUTION

Poor on the environment and poor economic returns

> The U.S. has 210 commercial incinerators, with total capacity of 100,000 Tons Per Day

Data from Energy Justice Network

# Sierra Energy



#### Sierra Energy HQ, Davis CA



- Waste to clean energy company
- Proven FastOx<sup>®</sup> gasification technology developed and tested with the US Army
- Highly profitable solution
- Significant IP (patents and trade secrets)
- Global partners to build and deliver systems
- Large pool of screened customers
- Reduces GHG by eliminating landfill methane emissions
- Experienced management team

## Sierra Energy







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# Waste Diversion / Conversion Technologies

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Recycling	Composting	Anaerobic Digestion	Aerobic Digestion
Pyrolysis	Downdraft Gasifiers	Indirectly-heated Gasifiers	Multi-vessel, Multi-process Gasifiers
Fixed-bed Updraft Gasifiers	FastOx Gasifiers	Fluidized Bed Gasifiers	Microwave Plasma
Molten Baths	Thermal Depolymerization	Methane Capture	Incineration / Mass Burn

# FastOx<sup>®</sup> Gasification: The Future of Waste





- System gasifies virtually any waste with no sorting required
- No process emissions
- Scalable from 50tpd systems up to several thousand tons per day
- Low maintenance with high up-time
- Low parasitic load
- All outputs are salable

# Advantages of FastOx<sup>®</sup> Gasification

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- Game Changer #1: O<sub>2</sub> Injection vs. Air
  - **Improved process efficiency:** Increased productivity; high cold gas efficiency; decreased bed permeability requirements (therefore no coke)
  - Improved syngas: Enabling syngas recycle; smaller vessels and less CAPEX; lower emissions; increased fuel and gross electricity options
  - Inert stone and recovered metals: Melting/tapping; high temps generated through chemical reaction not plasma or fuel injection
  - Lower parasitic load: Better than other slagging gasifiers
  - **ROI/IRR improved significantly:** Even with cost of O<sub>2</sub> production
- Game Changer #2: Existing Proven Vessel
  - **Robust:** No moving parts; no restrictions in material flow
  - Minimal waste processing: Especially for metals / inert materials
  - Low CAPEX: Known technology
- Game Changer #3: FastOx Polisher
  - Instantaneous conversion: Avoid tars; increase syngas output



# Waste Turns into High Value Products





## Core Technology - GPRC





## Core Technology - GPRC





#### FastOx Gasifier

- $_{\circ}$  Feeding
- $\circ$  Charging
- $_{\circ}$  Injection
- $_{\circ}$  Cooling
- $_{\circ}$  Tapping
- Burners & Burner Management
  - Including Syngas Recycling
- Polisher
- Recuperator (Heat Recovery)
- Controls & Instrumentation

# FastOx<sup>®</sup> Facility at Fort Hunter Liggett











SIERRA ENERGY

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## Fort Hunter Liggett Status





- Commissioning completed on wood waste
- Waste-to-syngas system has been brought online and all subsystems are undergoing test and DOX-based optimization:
  - $_{\circ}$  Feeding
  - $_{\circ}$  Gasification
  - Gas cleaning
  - $_{\circ}$   $\,$  Oxygen and steam production  $\,$

# SIERRA ENERGY SECURES SERIES A

Fort Hunter Liggett commissioning leads to \$33,000,000 investment round led by Breakthrough Energy Ventures with Cox Enterprises, BNP Paribas, Twynam, Formica and The March Fund.



# Sierra Energy Calculator



Potential customers share valuable project data on local tipping fees, waste types, volumes and energy costs on the Sierra Energy calculator.

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United States			1. 1922
STATE	(101)	5 × 100 1	NE
California 🔹	A State	Ū	1 Alto
COUNTY		AT LOCAL AND	
Yolo 🔻	1		
POPULATION OF COUNTY 198,889 estimated waste produced (mt/day) 397		Mao data G	2017 Goode Terms of Use Report
FEEDSTOCK		TIPPING FEE	
Municipal Solid Waste 👻	s	49	(/MT)
END PRODUCT		SALE PRICE (IN USD) i	
Electricity v	s	0.11	(/kWhe)
LOCAL NATORAL BAS PRICE (IN 030)	1	LOCAL ELECTRICITY PRICE (IN USD)	

4	ELECTRICITY Capital Investment (including est. Engine Annual Income: Simple Payback: Annual Office		OJECTIONS		
ALTERNATIVE	END PRODUCTS:	SYSTEM SPECIFICATIONS System Size (MT/day): 50	INVESTMENT ECO Capital Investment: \$8,0		
	HYDROGEN Capital Investment (including est. Engine	Electricity Created (KWe(Net)): 560.67 Electricity Sale Price (/KWhe): \$0.11 Jobs Created: 10 Local Natural Gas Cost (/MMBTU): \$2.50	Annual Operating Incor Simple Payback: 30 yea Annual ROI: 3.3%		TOR RESULTS
	Annual Income: Simple Payback: Annual ROI:	ANNUAL REVENUES		Joe Smith, Landfill Owner	Yolo County, California
Ĩ	DIESEL Capital Investment (including est. Engine Annual Income: Simple Payback: Annual ROI:	Tipping Fee received: Sale of Electricity: Sale of Recovered Materials: Carbon Credits: RIN Credits: Estimated Revenue:		6/26/2017 FEEDSTOCK Municipal Solid Waste	50 TPD END PRODUCT Electricity
6	AMMONIA Capital Investment (including est. Engine Annual Income: Simple Payback: Annual ROI:	ANNUAL EXPENSES Labor and Benefits: System Maintenance: Electricity Consumed: Fuel Consumed: Supplies and Materialis: Estimated Expenses:		ABOUT SIERRA ENERGY Stem Dorgy is a water a prilodo and somewolk energy company heapstrated in Date, California, Our Franco- guiter, calvade from the user maining bias familie, efficiently converts nearly any form of waste linco renewalde energy.	
	OPERATING INCOME Annual Revenue: Annual Expenses: Projected Income:		Sime Theory that information is behaviour of a two sime to Experience of Orbitom Revealed Broger Transition Court (PECT) to sear it do not at ACCIain do from Barrier is benerosing, children and the Children do from Barrier That participants are highed of gathtams between the transition of the Simon and a courter of systems. Our gather to gate sear and course to		



# REPORT PREPARED FORLOCATIONJoe Smith, Landfill OwnerYolo County, CaliforniaDATESYSTEM SIZE5/7/201850 TPDFEEDSTOCKEND PRODUCTMunicipal Solid WasteElectricity

#### SYSTEM SPECIFICATIONS

System Size (MT/day): **50** Primary Tipping Fee [/MT]: **\$54.00** Electricity Created [MWe(Net)]: **1.99** Electricity Sale Price [/KWhe]: **\$0.12** Jobs Created: **13** 

#### **INVESTMENT ECONOMICS**

Capital Investment: **\$13,670,500** Annual Operating Income: **\$1,900,000** Simple Payback: **7.2 years** Annual GHG Savings: **108,000 MTCO<sub>2</sub>e/yr** 

#### **ANNUAL REVENUES**

Total Tipping Fee:	\$986,000
Sale of Electricity:	\$1,992,000
Sale of Recovered Materials:	\$129,000
Carbon Credits:	\$0
RIN Credits:	\$0
Estimated Revenue:	\$3,107,000
ANNUAL EXPENSES	
Labor and Benefits:	\$644,000
System Maintenance:	\$306,000
Support Costs:	\$197,000
Supplies and Materials:	\$59,000
Estimated Expenses:	\$1,207,000
OPERATING INCOME	
Annual Revenue:	\$3.107.000

Projected Income:	\$1,900,000
Annual Expenses:	\$1,207,000
Annual Revenue:	\$3,107,000



#### **HYDROGEN**

Capital Investment (including est. Engineering): Annual Income: Simple Payback: \$14,405,000 \$4,959,000 2.9 years



#### ELECTRICITY

Capital Investment (including est. Engineering): Annual Income: Simple Payback: \$13,670,500 \$1,900,000 7.2 years

Note: Tipping fee is based on US average. Electricity sales price based on customer input average on SE online calculator tool. Heat recovery not calculated.

# Thank you

