

The Omni Processor

Peter Janicki

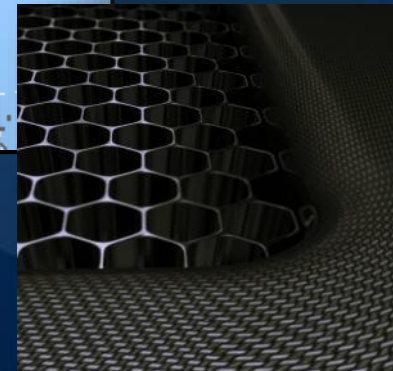
CEO & Founder

Janicki Bioenergy



Founded by Peter and Susan Janicki in 1993

- 730 employees
- 135 engineers



COMPOSITE CREW MODULE

What's going on...

- building a composite crew module,
- gaining hands on design, build, and test experience,
- in anticipation that future exploration systems may be made of composite materials.

**3 years ago we were approached by
the Bill & Melinda Gates Foundation**

They wanted SOLUTIONS:
-from someone with technology development experience
-with a new perspective on sanitation
-not someone entrenched in traditional sanitation solutions

That was the start of the OP journey...

The Problem: How can we destroy human born fecal pathogens such that they cannot make people sick and contaminate the local water supply without adding financial burden to the community?



Kibera slum, Kenya, June 2014

Peter and Susan Janicki entering Mukuru slum, Kenya, July 2012



The Janicki Bioenergy team spent time investigating the problem in order to:

- Drive the vision of the solution and**
- Ensure that the solution would be practical in the real world setting**



2.5 billion people live without access to adequate sanitation



Sara VanTassel, President of Janicki Bioenergy with children in Kibera slum, Kenya, June 2014



Kenya, June 2014



1.5 million children die of diarrhea every year

Kenya, June 2014



The scale of the problem is massive



Ivory Coast, March 2014

The inputs to the problem are varied:

- **Digested and undigested sludge**
- **Very wet to very dry sludge**
- **Garbage**
- **Foreign objects**
- **Dirt and other inorganic content**



Current Solution #1: Manual Emptying of Pit Latrines
-Step 1: Waste goes into pit



South Africa, July 2012



Current Solution #1: Manual Emptying
-Step 2: Waste is manually dug out of pit and placed into cans



**Current Solution #1: Manual Emptying
-Step 3: The waste is emptied back into
the environment**



Current Solution #2: Septic Trucks
-Step 1: Waste is collected and emptied at designated dump site



Current Solution #2: Septic Trucks
-Step 2: Waste is seldom properly treated





Current Solution #2: Septic Trucks
-Step 3: The waste then flows back into the environment

Peter Janicki, CEO of Janicki Bionergy,
Cotonou, Benin, June 2014



Current Solution #3: WWTPs

-Step 1: Sewer systems and WWTPs are constructed utilizing developed world technology



Janicki Team, Dakar, Senegal, June 2014



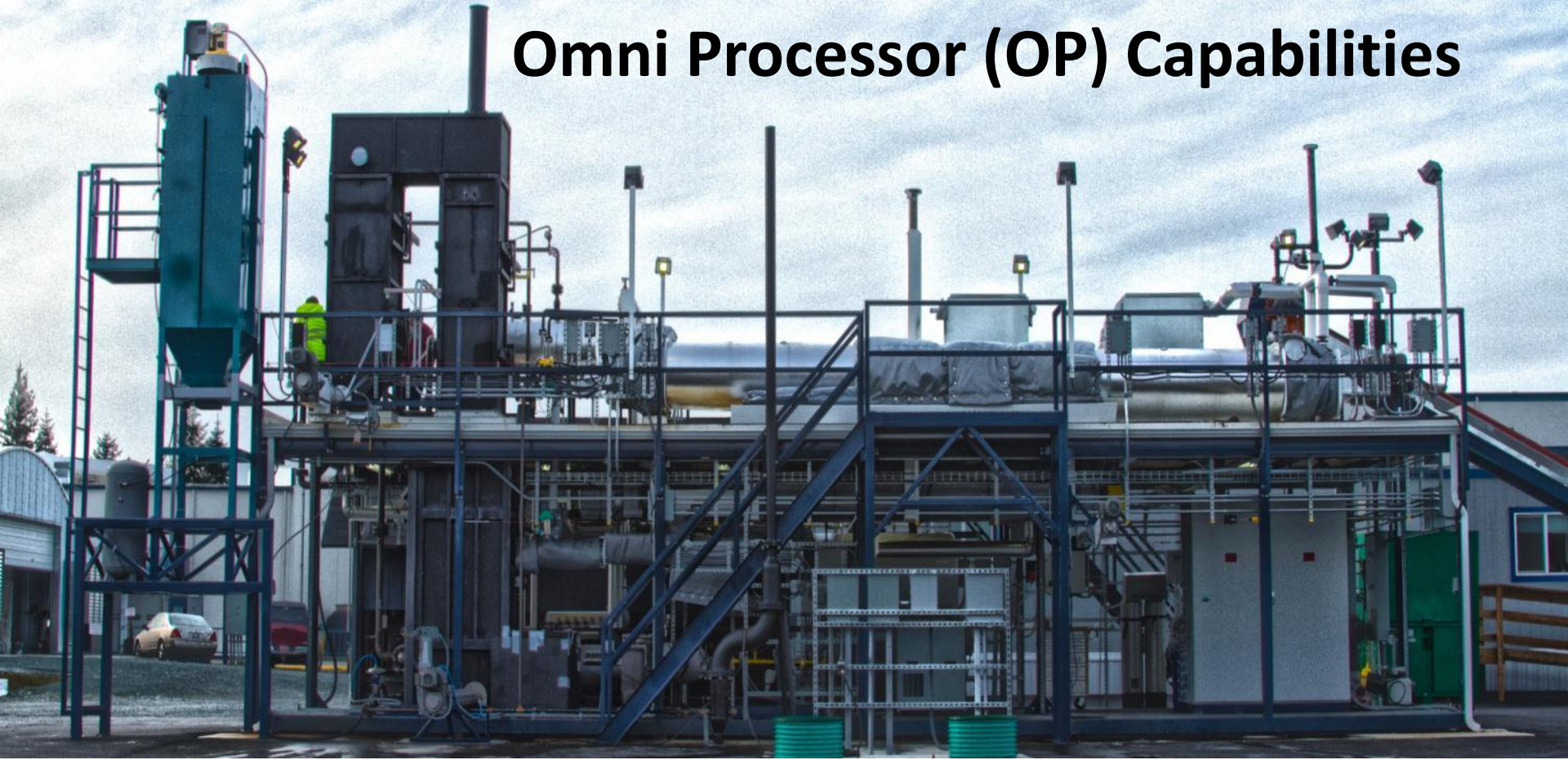
Current Solution #3: WWTPs
-Step 2: Waste is seldom properly treated due to high operational costs of WWTPs



**The Solution:
Turn the processing of sludge, garbage, and
contaminated water into a profitable business**

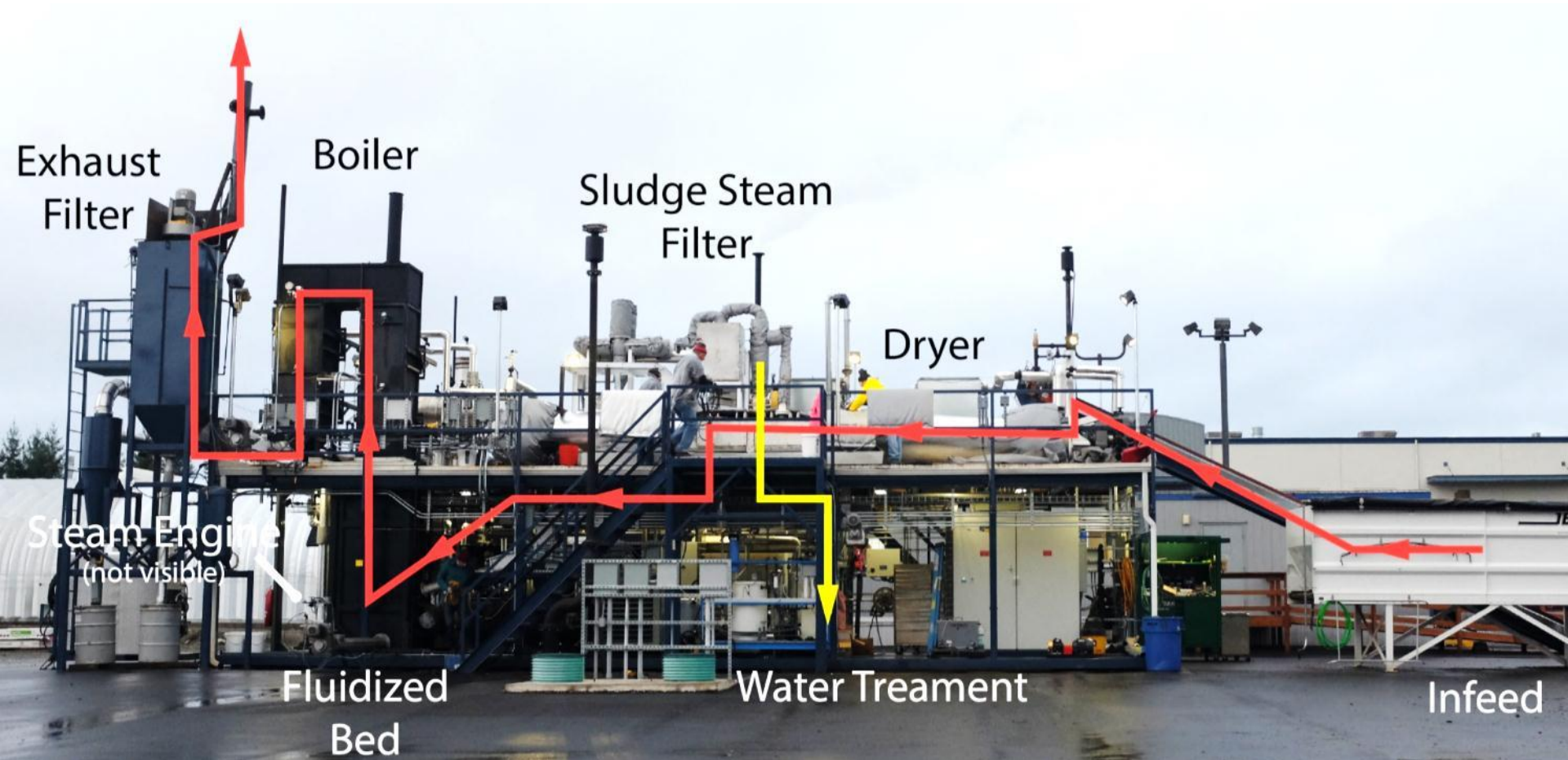


Omni Processor (OP) Capabilities



- Combusts fecal waste, destroying all pathogens
- Recycles water from sludge into clean drinking water
- Creates excess electricity
- Generates usable heat
- Creates ash
- Does not require electrical grid
- Revenue producing and profitable for owner

Gates Notes Video



← Sludge/Combustion Gasses

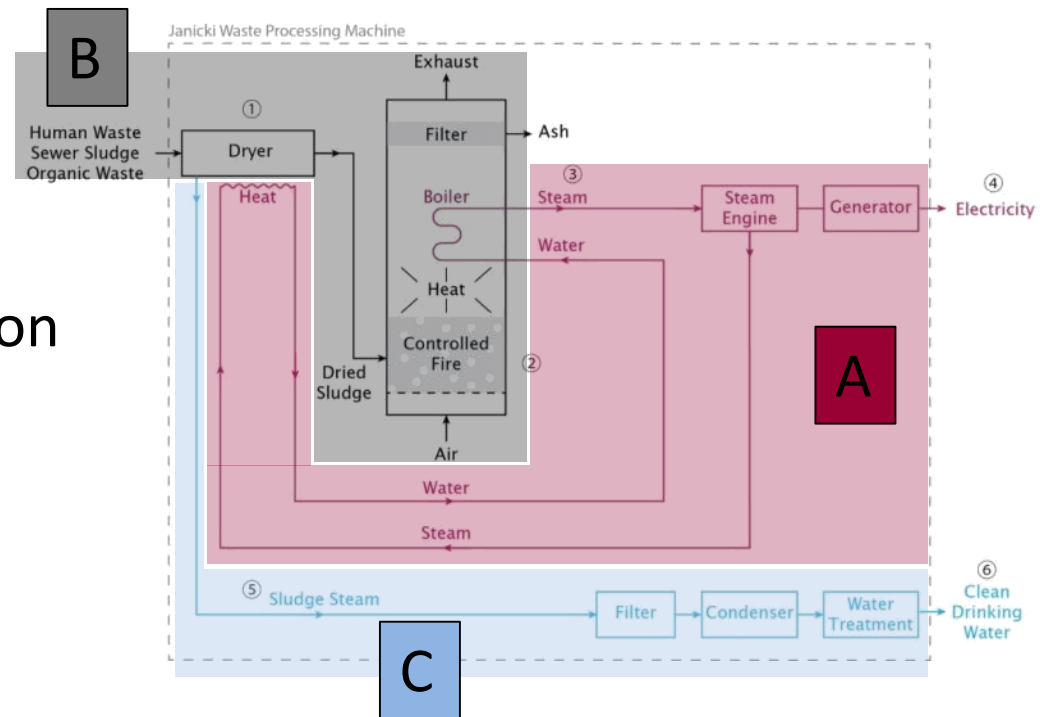
← Recycled Water

Why it Works

The success of the Janicki OP is due to the strategic marriage of three different “industry standard”

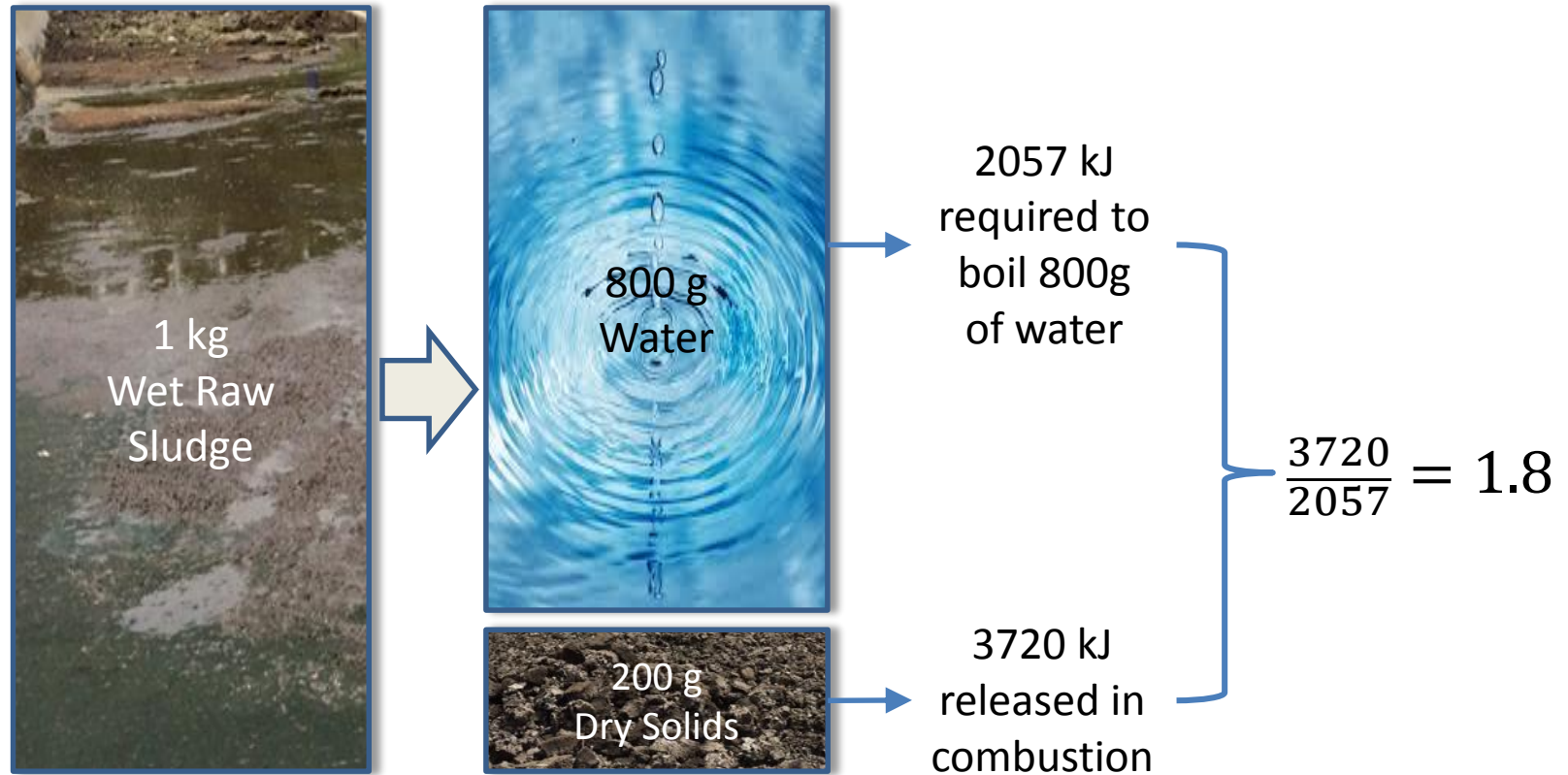
processes:

- A** Steam Power Generation
- B** Solid Fuel Combustion
- C** Water Treatment Plant



- The dryer boils the water with waste heat from the engine
- Boiling is used to separate water from the solid, combustible portion of the sludge
- Boiling also eliminates all pathogens in the water
- The separated solids can now be combusted and the water can be further treated

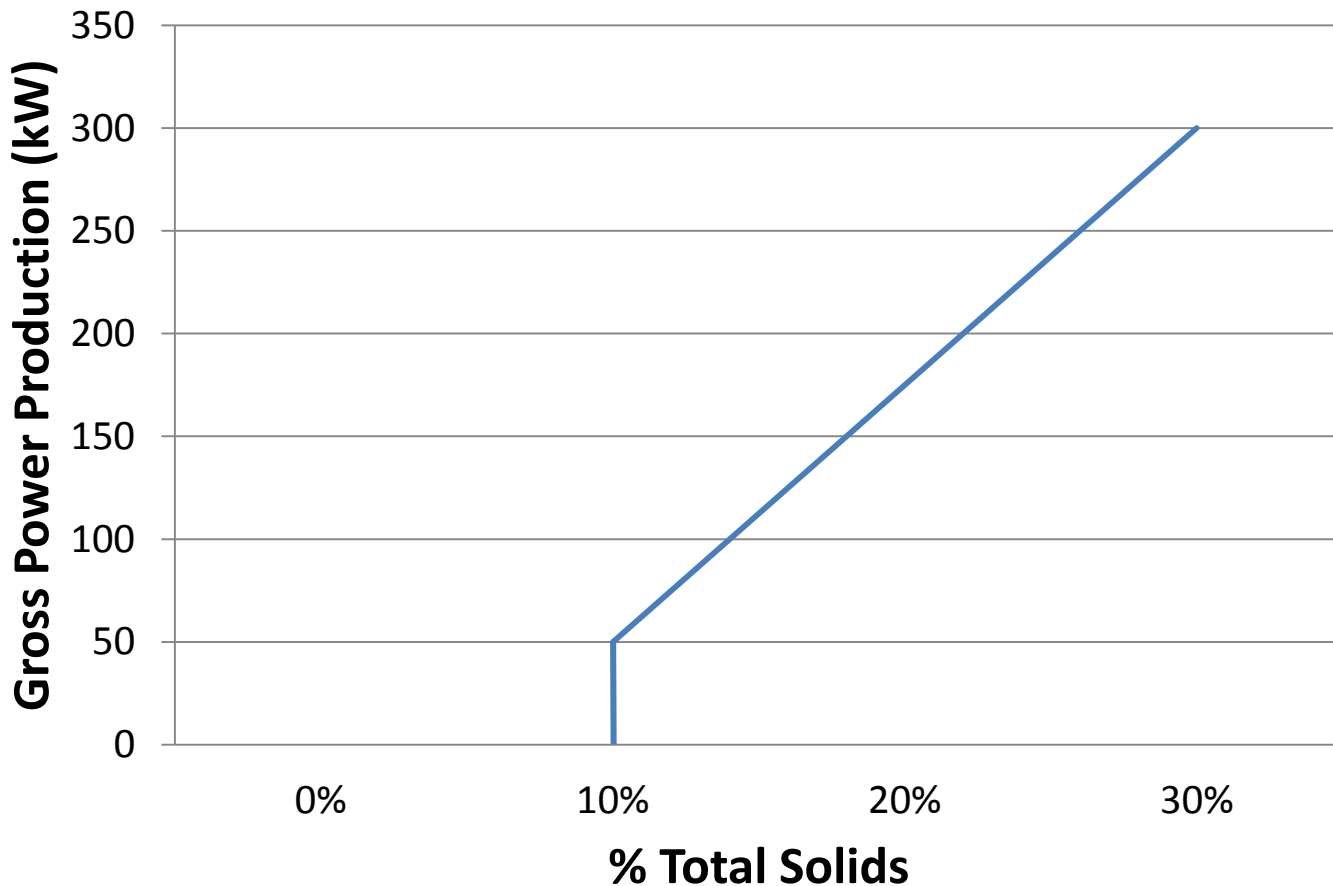
Thermodynamics of the Problem



There is nearly twice the amount of energy within the dry solids of the sludge as there is energy required to boil the water out of the sludge

Breakeven Analysis on Solids Content

As the solids percentage of the sludge is reduced, the available energy is also reduced. Beyond the breakeven point, excess energy production is no longer possible and additional energy is required to continue processing the waste.



Janicki team with workers in landfill
Benin, June 2014



**There is no shortage of garbage.
This garbage can be used as supplemental energy for the system.
Energy in 4 kg of garbage = Energy in 1 kg of Diesel**

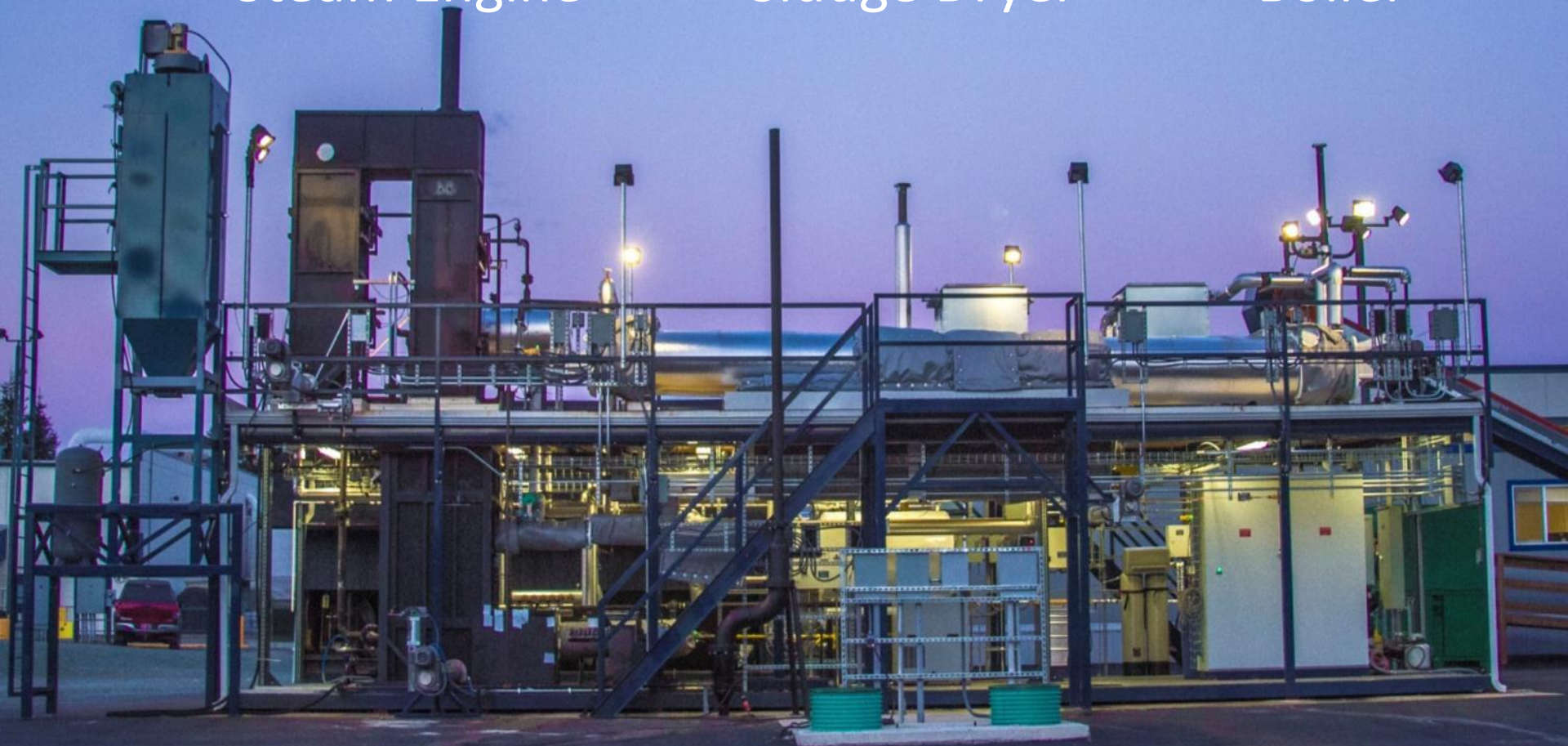
Novel Components

Although the three *processes* are “standard”, novel *components* were required to allow for the technology marriage:

– Steam Engine

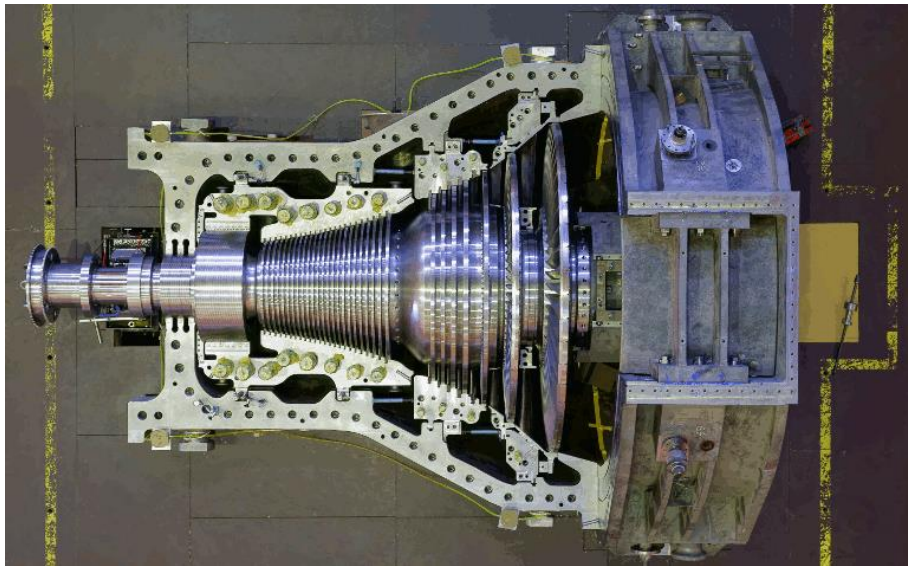
-- Sludge Dryer

-- Boiler



Steam Engine

- Steam power plants typically generate power through the utilization of a steam turbine
- For the OP size range and operating conditions a steam engine is more thermally efficient than a steam turbine
- A steam engine in the required size range and operating conditions is also more economical



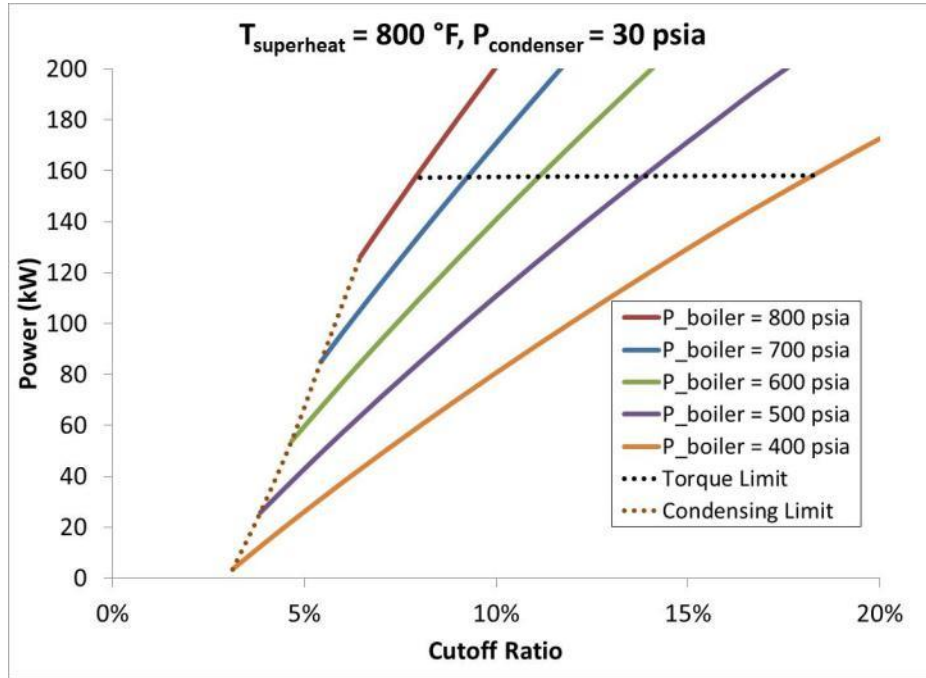
<http://www.alborzturbine.com/Pages/Equipment/Steam%20Turbine.aspx>

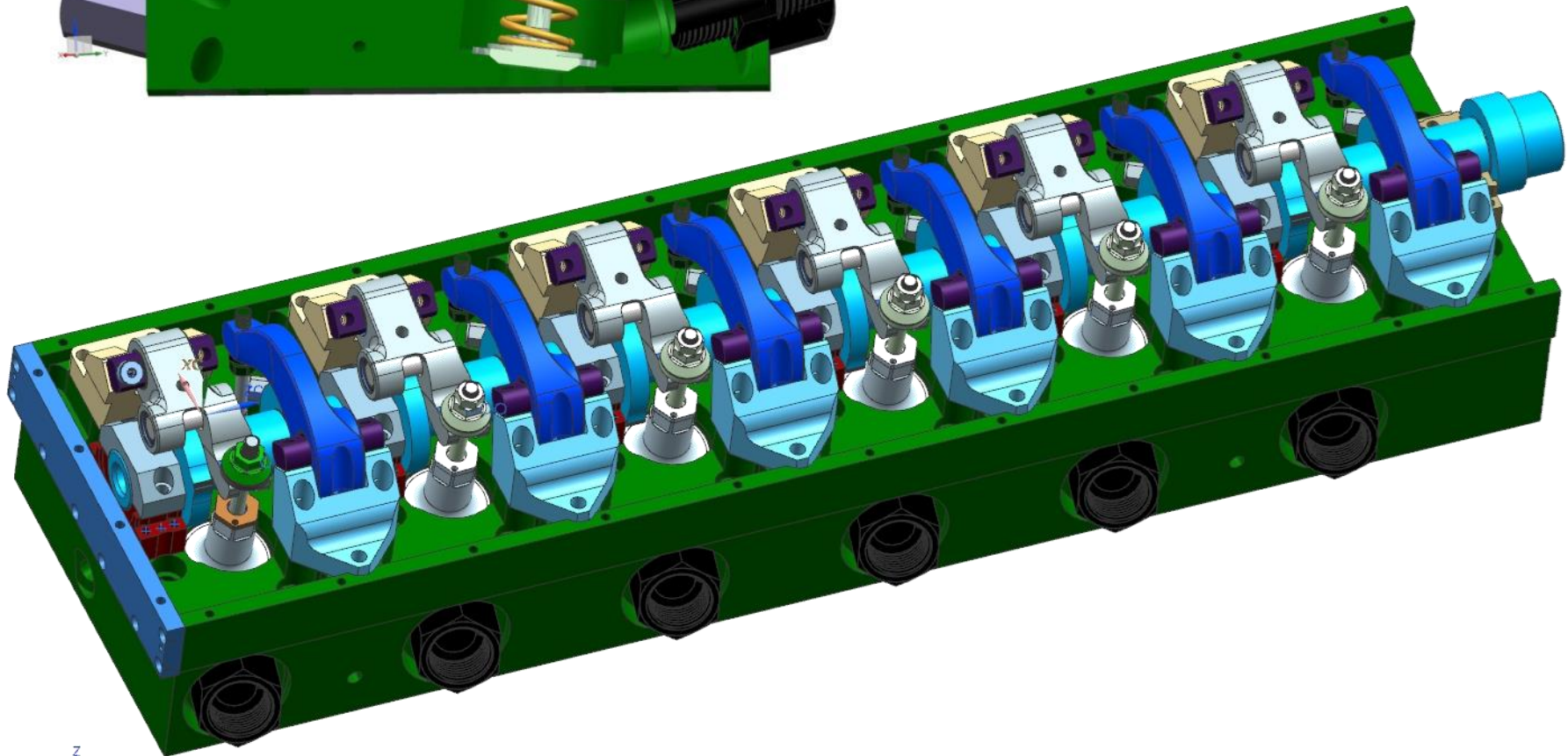
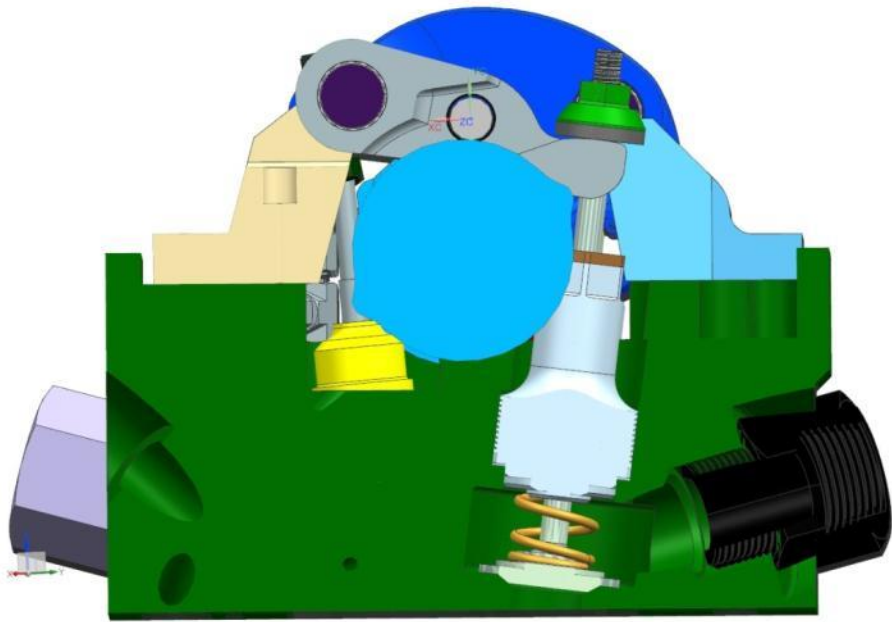
Turbine: Cost Prohibitive



Engine: Affordable

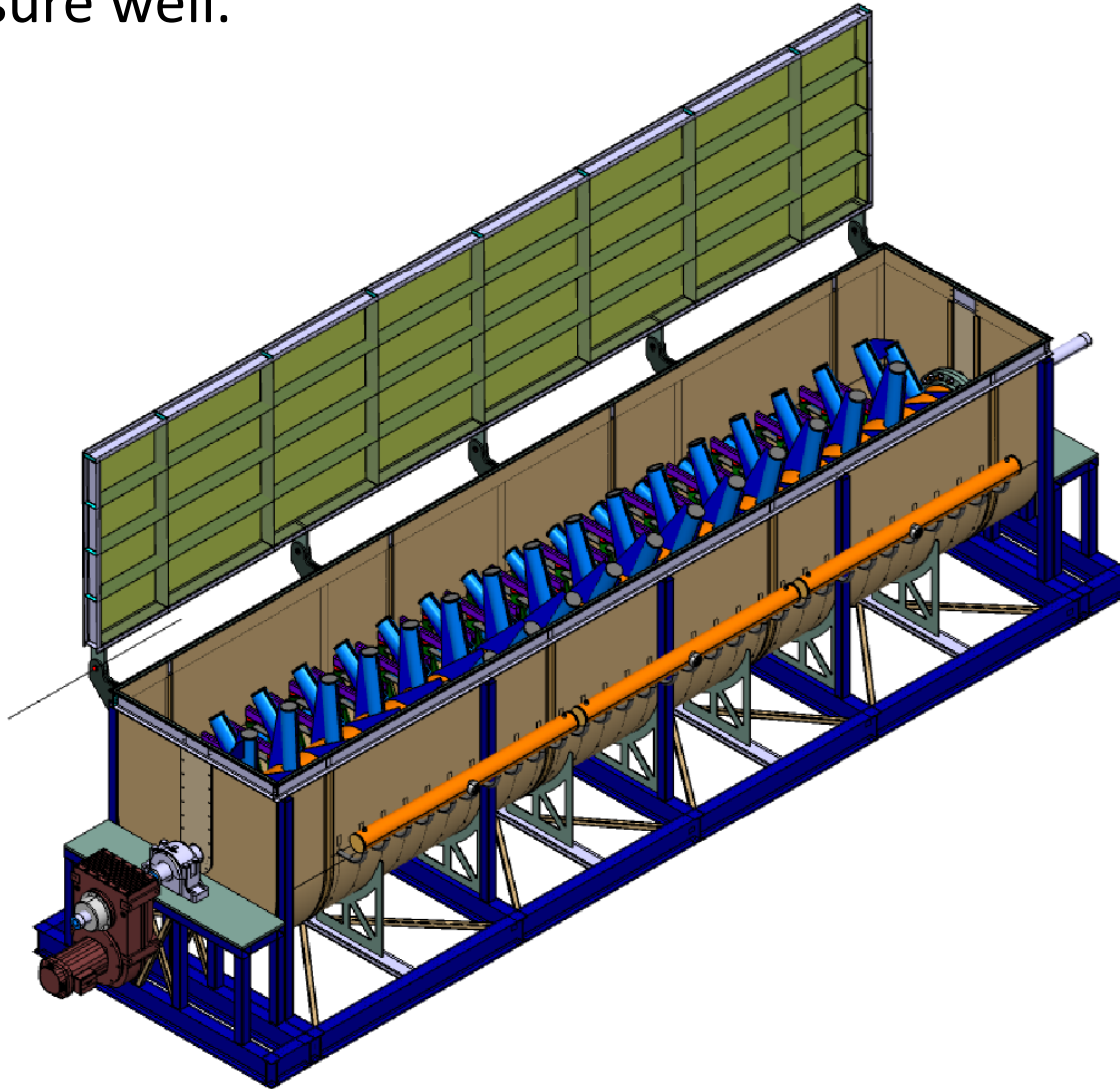
Engine Analysis





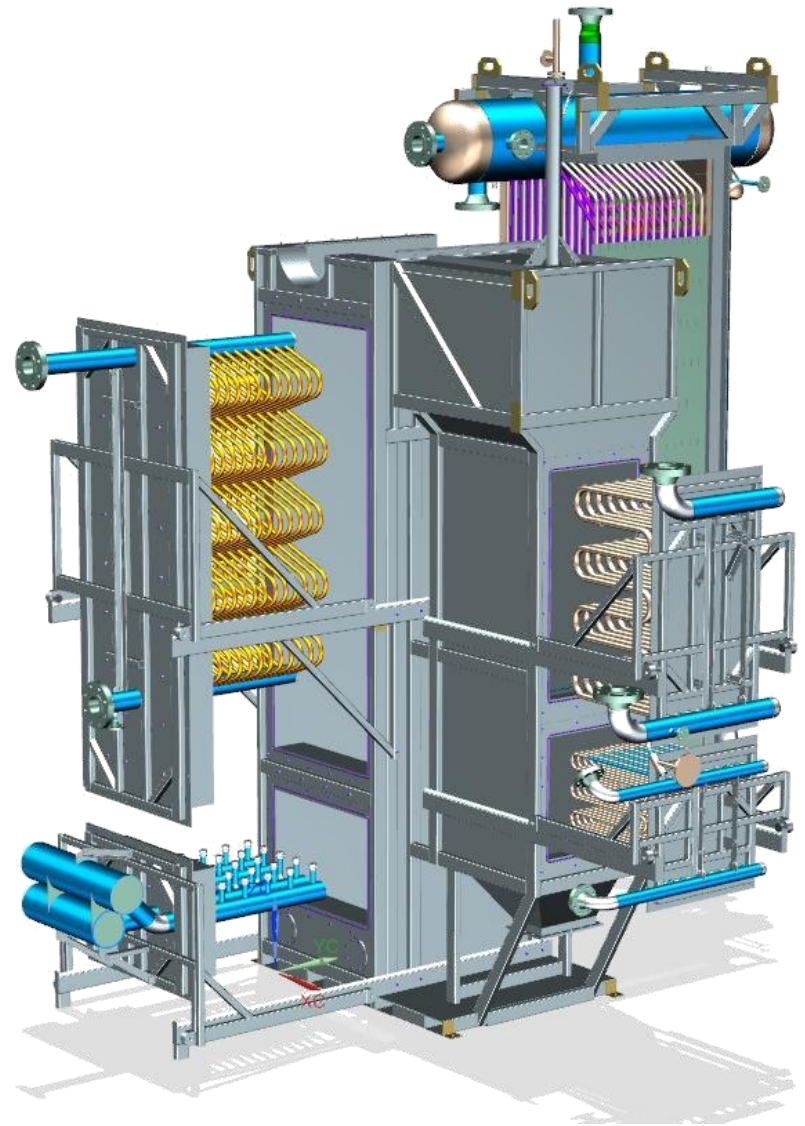
Sludge Dryers

Our dryers are made exclusively of pipe, which are affordable and take pressure well.



Boiler

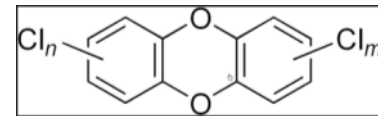
- It is difficult and expensive to find fluidized bed boilers in the size and pressure ranges required for the OP. Most industrial boilers are much larger in scale.
- A smaller scale boiler was developed specific to the processor needs.



Emissions

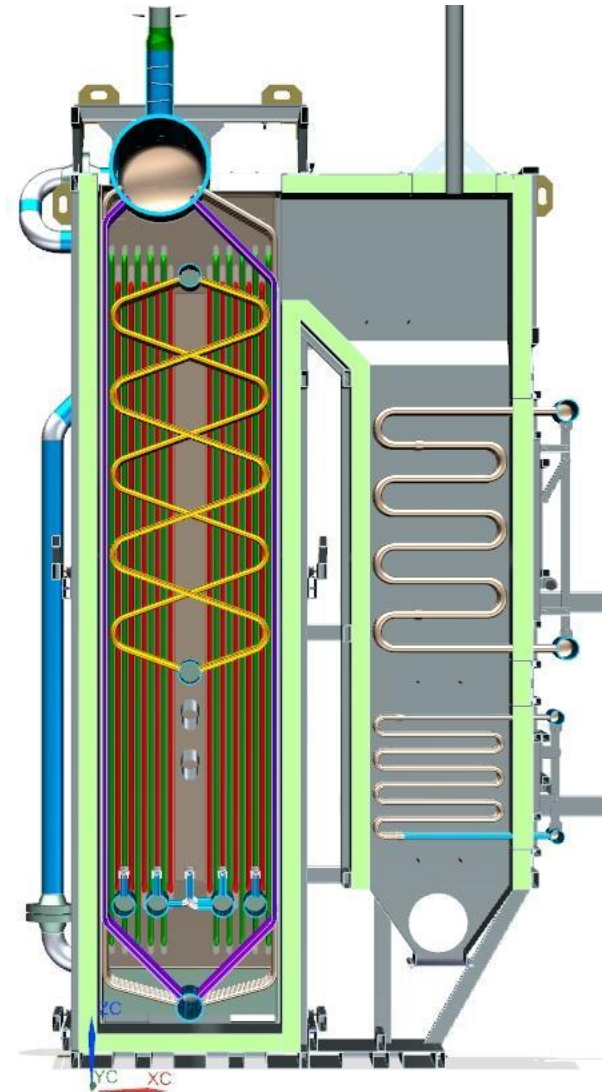


- Air emissions from the boiler meet all applicable US EPA clean air regulations
- Pollutants are controlled two ways
 - Thermal control
 - Addition of absorbents
- NO_x
 - Fluidized bed combustors run too cold to make any thermal NO_x
- Dioxins & Furans
 - Typical dioxin requires chlorine
 - Chlorine contained in sludge is taken care of by dry sorbent injection upstream of the dioxin/furan formation temperature.

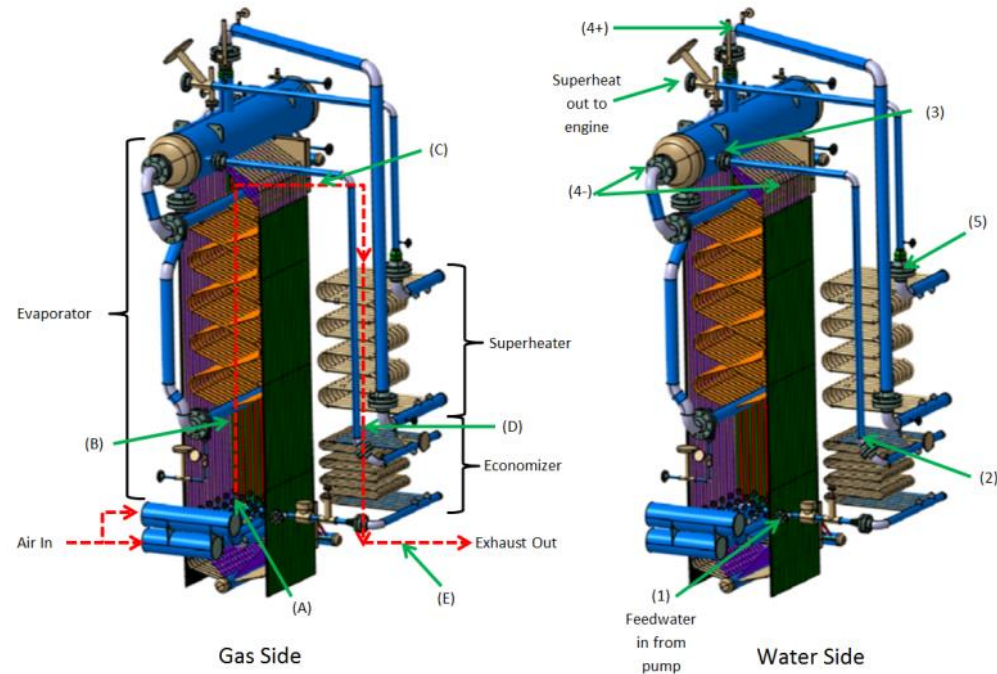
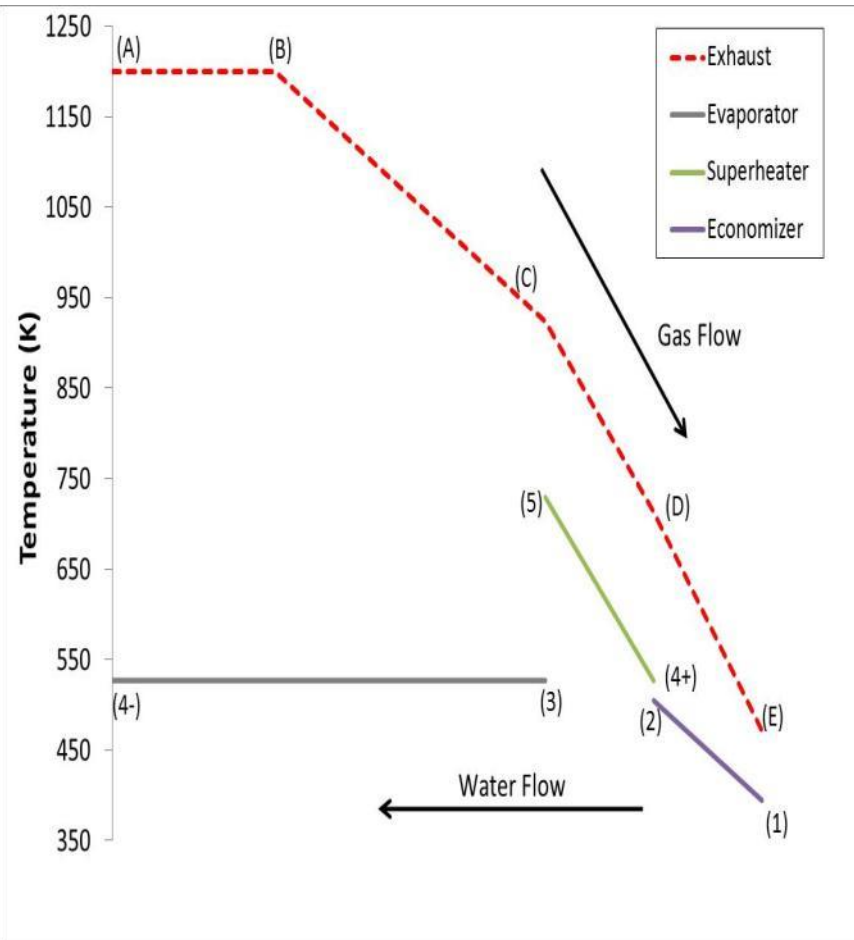


Emissions

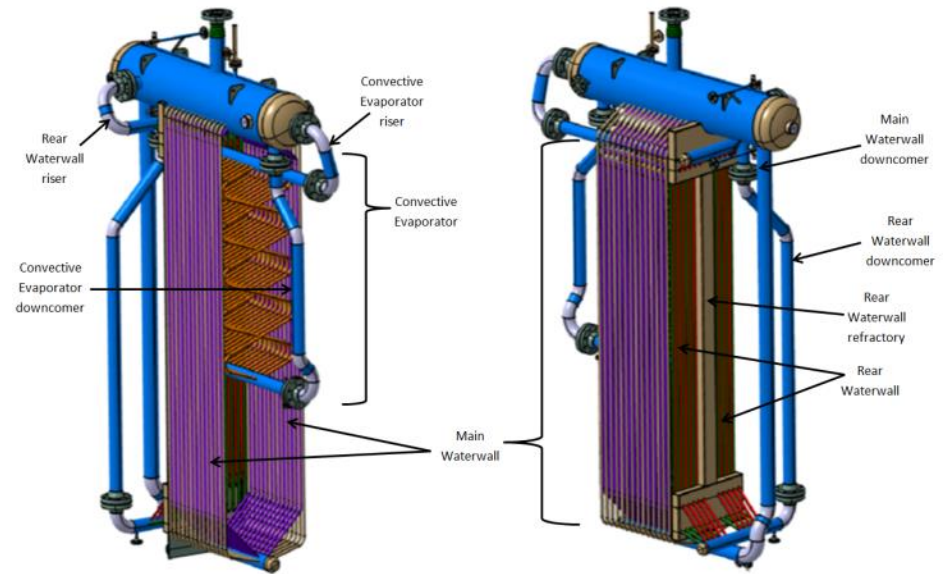
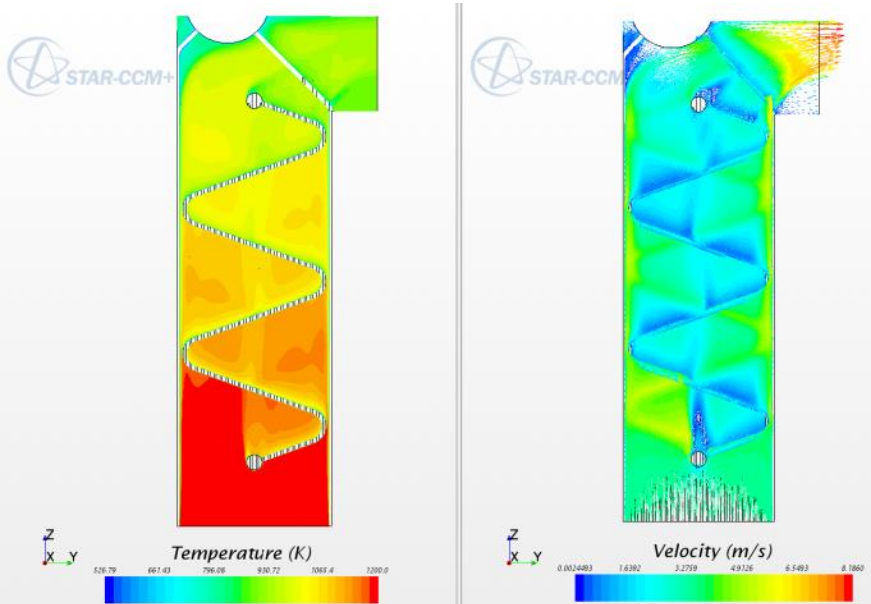
- Sulfur
 - Controlled by adding calcium to the flue gas
 - $(\text{CaCO}_3 + \text{SO}_2 \rightarrow \text{CaSO}_3 + \text{CO}_2)$
- CO₂ & Other Global Warming Gasses
 - While the OP does emit CO₂, the use of this technology eliminates production of methane
 - Janicki Bioenergy will develop future machines that will produce biochar to sequester carbon



Temperature and Heat Transfer Map of Boiler

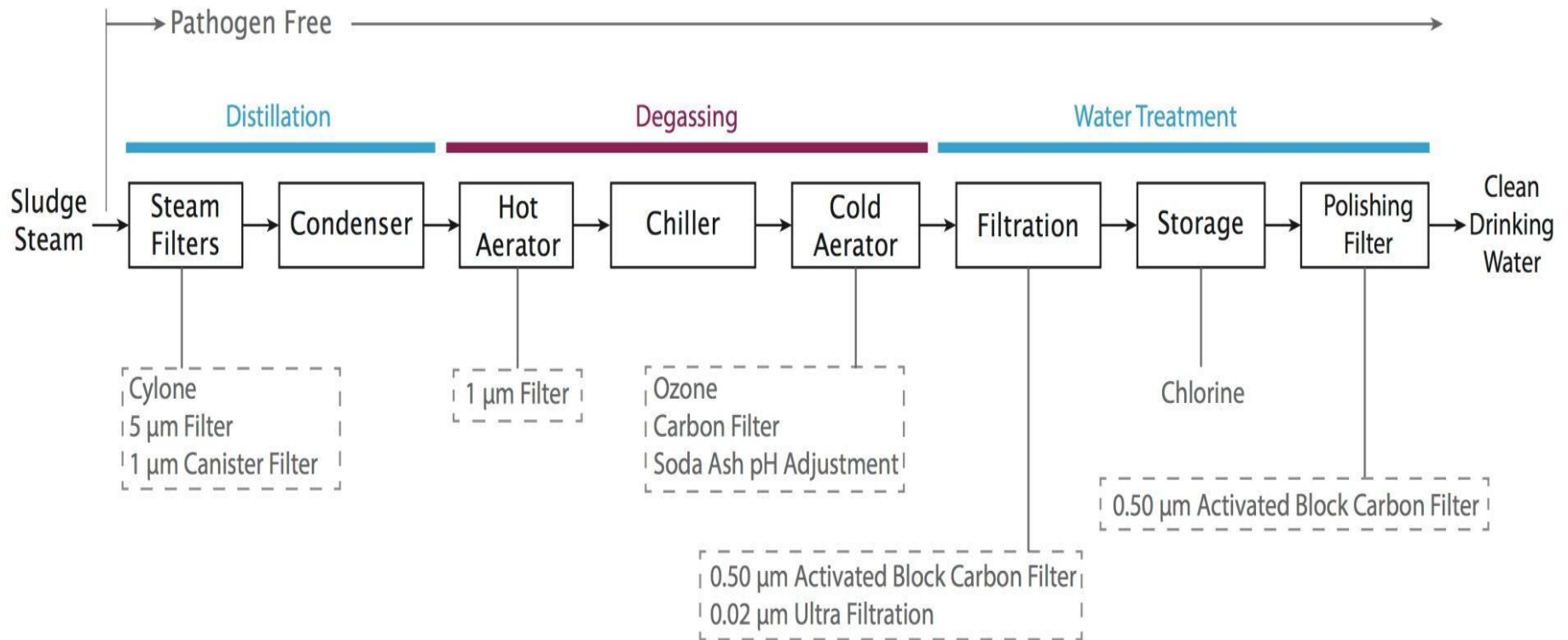


Computational Fluid Dynamics (CFD) Analysis



| Heat Exchanger | Surface Area (m ²) | Heat Absorbed (kW) | % of Heat Absorbed |
|-----------------------|--------------------------------|--------------------|--------------------|
| Main Waterwall | 9.36 | 238.75 | 25% |
| Rear Waterwall | 2.93 | 57.3 | 6% |
| Convective Evaporator | 10.7 | 659 | 69% |

Water Treatment System

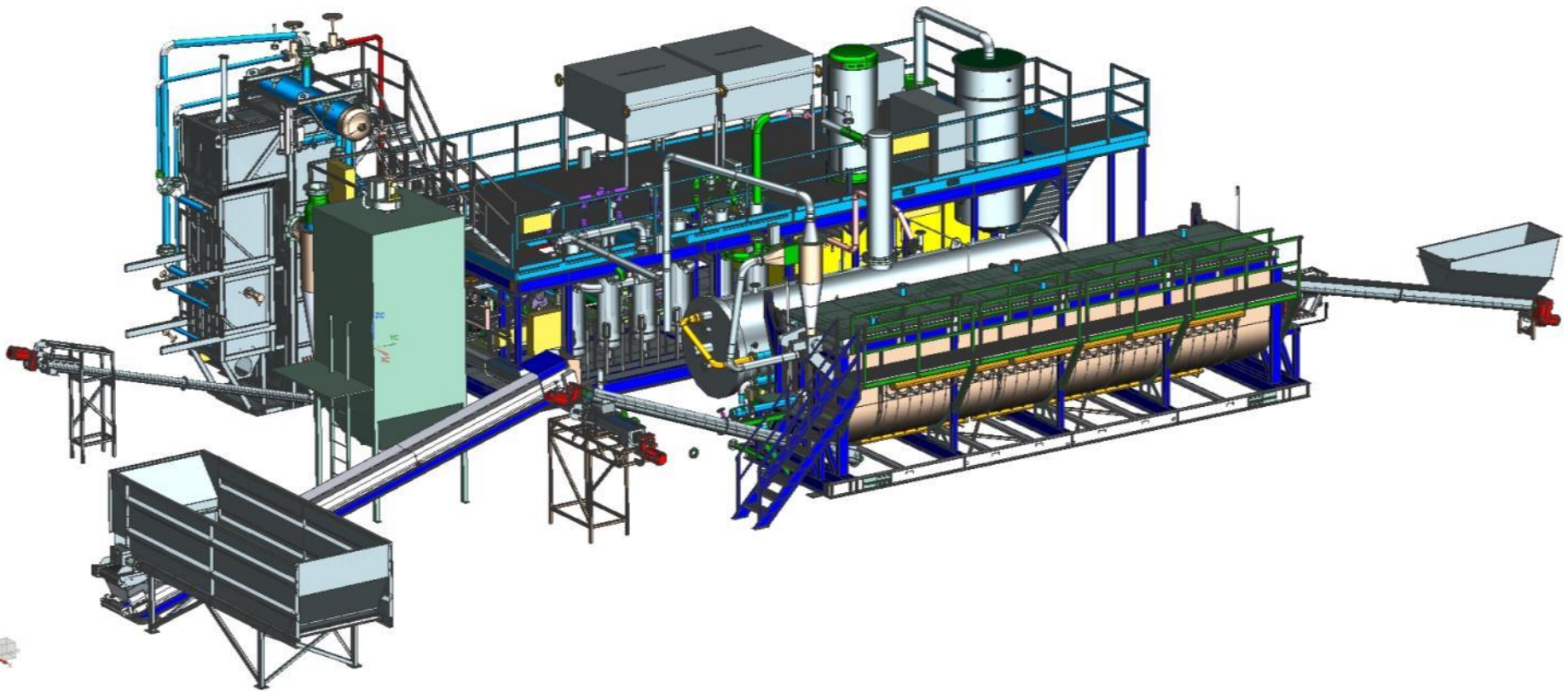


Water Treatment Results



Water from the OP meets US EPA municipal and WHO potable water standards

OP S200 Plant Overview



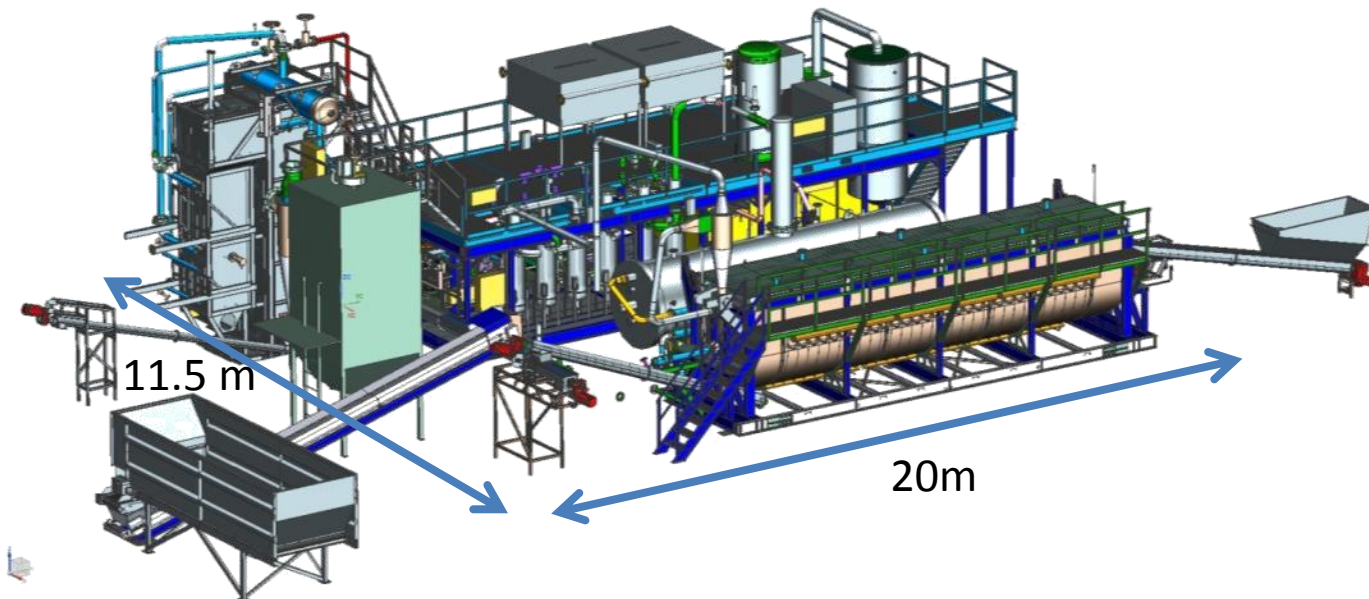
OP S200 Specifications

| Property | S200 Value |
|--------------------------------|--------------------------|
| Maximum sludge processed | 92.3 m^3/day |
| Maximum power produced | 300 kW |
| Maximum potable water produced | 86,000 l/day |
| Footprint | 100 m^2 |
| Parasitic load | 50 kW |
| Dryer pressure | 4 bar |
| Fuel | Sludge, Biomass, Garbage |
| Maximum moisture in fuel | 99 % |
| Number of people served | 100,000-200,000 |

Scale

The Janicki OP is much smaller than typical power plants. This provides several benefits to the sanitation solution:

- Small footprint in community
 - Shortens transport distance of waste
 - Increased market due to minimal real estate needs
- Shippable
 - Couples with the manufacturing philosophy to allow for mass production and shipment worldwide



Example of City Wide Network: Dakar, Senegal

- Population: 2.4 million

- Reduce trucking distance from hours to minutes

- Even if there is no direct dumping fee for the sludge, if the driving distance is reduced then:

- Fuel cost is reduced

- Opportunity cost in being able to empty from more sites per day is reduced

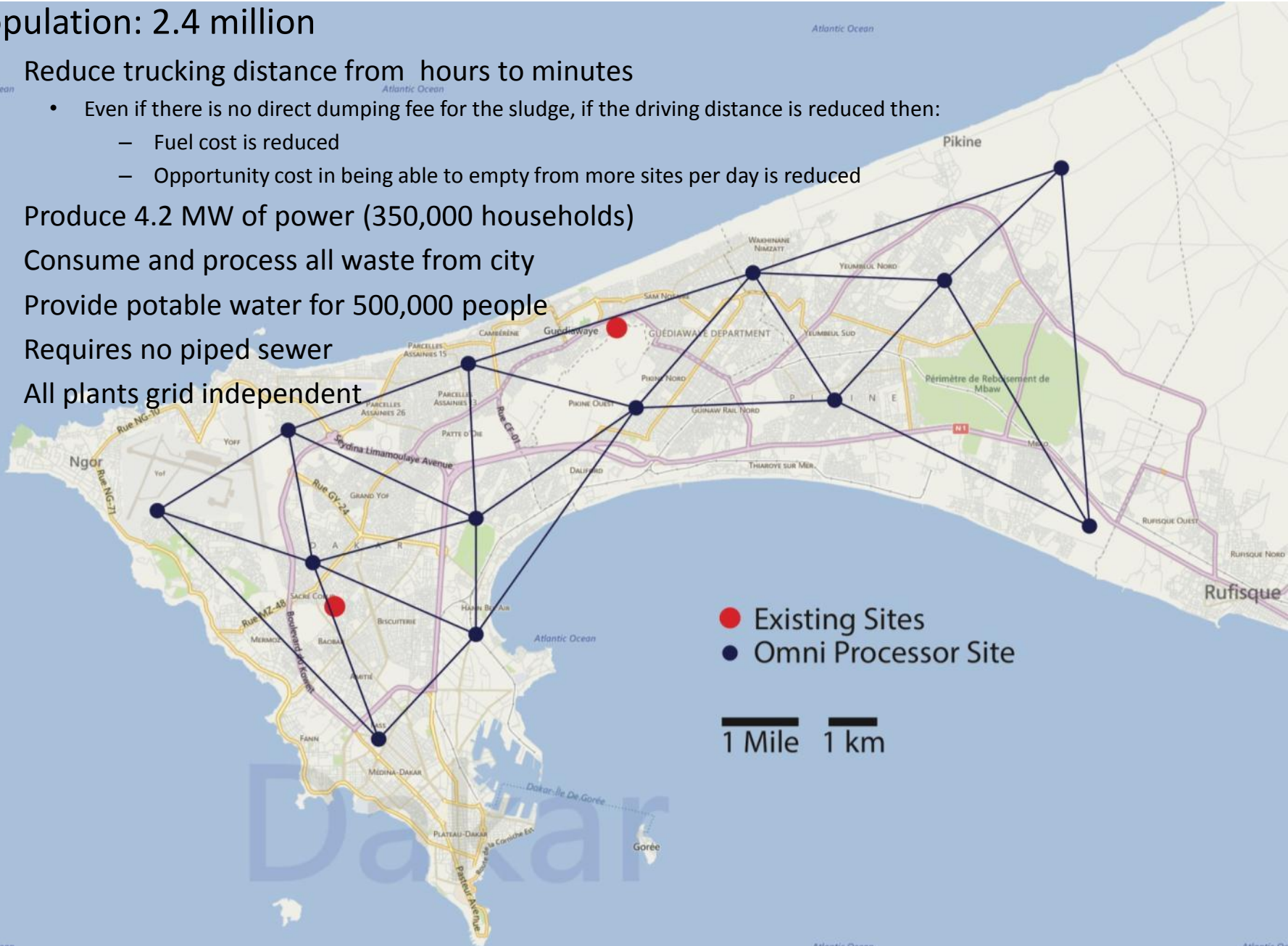
- Produce 4.2 MW of power (350,000 households)

- Consume and process all waste from city

- Provide potable water for 500,000 people

- Requires no piped sewer

- All plants grid independent



Manufacturing Process



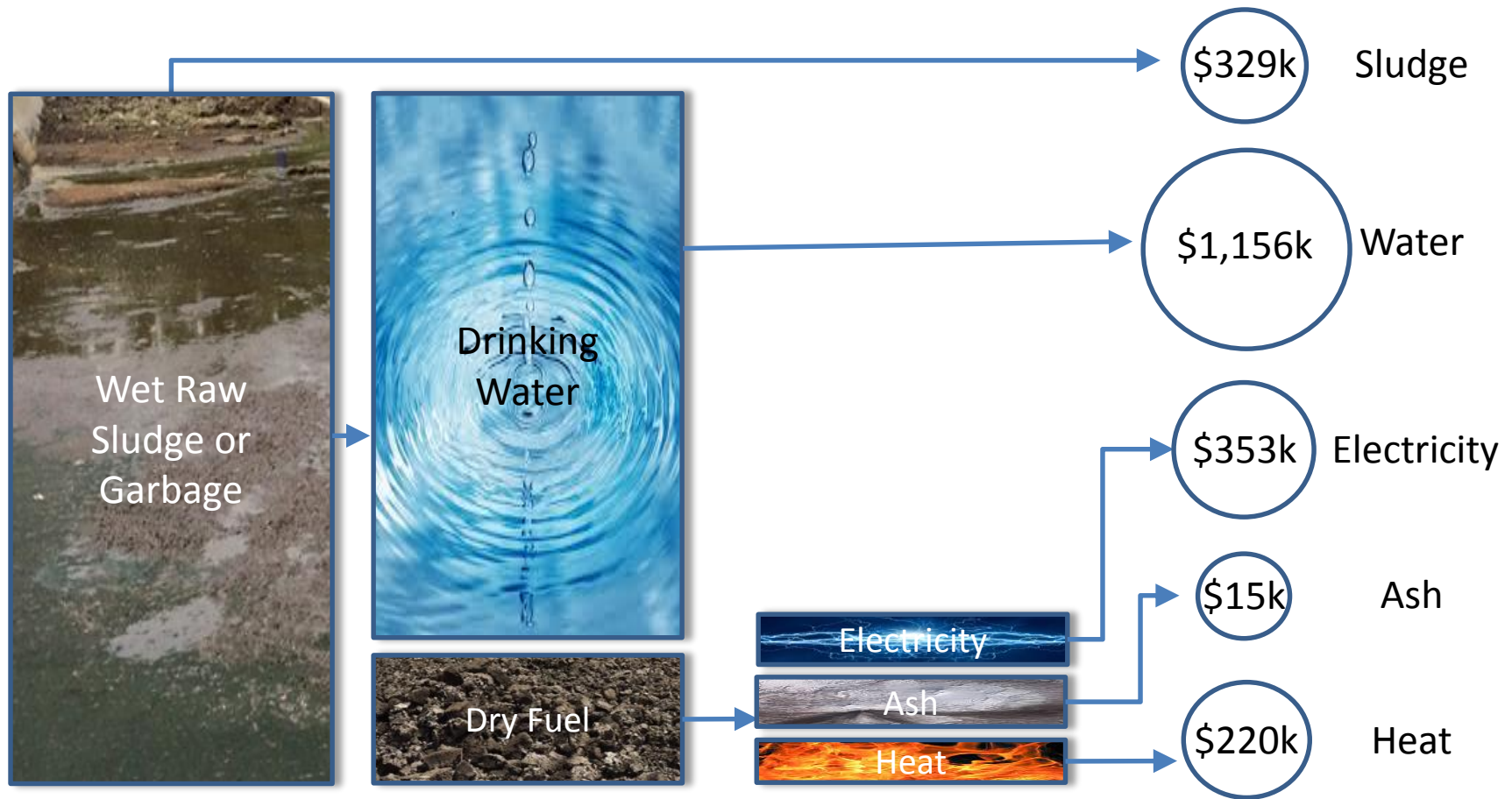
- Power plants and incinerators are primarily custom designs and hand built.
- Because our machine can take any sludge and other combustible fuel sources, every machine will be identical.
- Therefore, we will be able to take advantage of mass production techniques, thereby providing high value to the customer.

Disruptive Technology

- With this combination of technology and business/manufacturing philosophy, the Janicki OP revolutionizes the treatment of fecal sludge and other waste products providing revenue potential instead of a parasitic cost to society



Economics of the Solution



The economics show possible revenues of \$2.1MM/year

- water at \$0.05/l
- sludge at \$10/ton
- electricity at \$180/MW
- ash at \$20/ton
- heat at \$0.70/therm

Payback on the Investment

- If you can sell the water for \$.05/liter the plant should pay for itself in less than 2 years
- If you get paid a reasonable fee to take the sludge and sell the electricity (but do not sell the water), the processor should pay for itself in 5-6 years



Will People Drink Recycled Water?



If the water you and your family are drinking is making you sick it is an easy choice.

If you have to travel far to get the water it will be an easy choice.



However, we may have to give the water away initially to get people to accept it.

Current Water Options

- Piped water
 - not guaranteed safe
- Well water
 - not guaranteed safe
- Rivers, lakes, etc.
 - not guaranteed safe
- **Bottled/sachets**
 - **Only guaranteed safe option**



Janicki Bioenergy is Seeking Partners

- **Technical distribution** partners to help sell, support and distribute the processor.
- **Financing partners** that would help our customers finance their OMNI processor. Some organizations will do this simply to make money. Others may provide financing so that those that need this equipment the most will be able to acquire it.
- **Business development** organizations that can help entrepreneurs sell the outputs and receive fees for the inputs to the processor.

