ALL Power Labs
personal scale power

“The Global Leader in Small-Scale Gasification”

Company Profile

1) APL Milestones
2) Market Opportunity
3) Product Solutions
4) Gasification Process
5) Technology Advantage
6) Support Services
7) Project Summaries
8) Contact Information

August 2014

APL MILESTONES: Global Outreach

“The global leader in small-scale gasification”

We have delivered over 500 of our GEK Gasifiers & Power Pallet units to over 50 countries around the world.

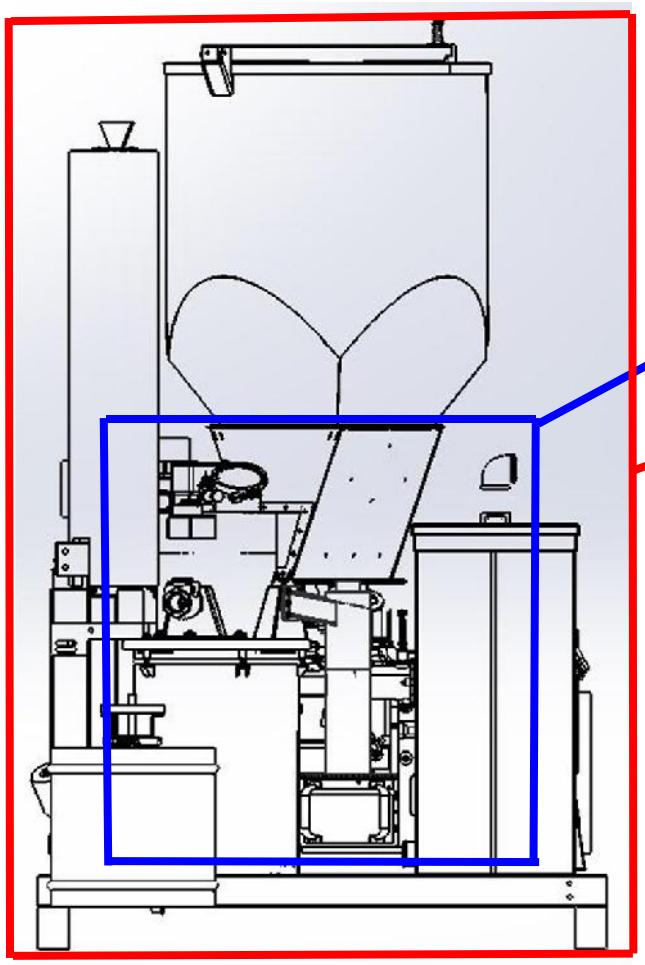
APL MILESTONES: Product Development





2008	2009	2010-13	2014	2015-16
Gasifier Experimenter's Kit (GEK) APL is co-founded by Jim Mason	Hot Tower of Total Thermal Integration Combination of which is called the GEK-TOTTI	The 10kW & 20kW Power Pallet are born by integrating the GEK-TOTTI w/ a GenSet & Process Control Unit (PCU)	The Ver5.01 GEK & 25kW Power Power are launched; CE Certification, Sound Enclosure, Grid-Tied & Turbo Features	Next steps include the development of the 100 kW PowerTainer & Power Pallets w/ rice husks capability

APL MILESTONES: Patents / IPs



The GEK TOTTI Ver5.0 Gasifier & Power Pallet system are protected by international patents filed by the law firm Schox Patent Group.

1. System & Method for the Downdraft Gasifier - Awarded
1. Compact Gasifier-Genset Architecture - Filed

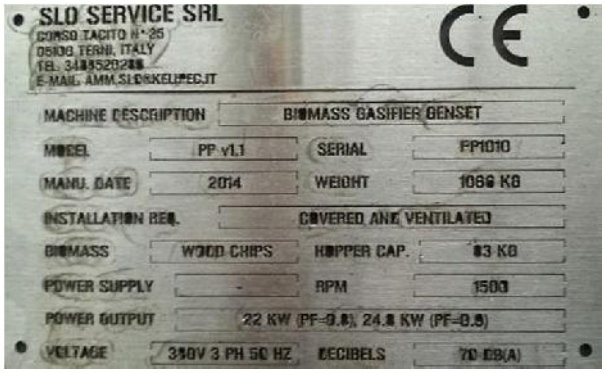
For next generation reactor:

1. Simultaneous Pyrolysis & Comminution for Fuel Flexible Gasification & Pyrolysis - Filed
1. Hybrid Fixed-Kinetic Bed Gasifier for Fuel Flexible Gasification - Filed
1. Gasifier w/ Controlled Biochar Removal System - Filed

APL MILESTONES: CE Certification

In August 2014, APL received its CE Certification for the 25kW Power Pallet (PP25) Turbo.

Jim Mason, Co-Founder & CEO of APL holds up both Patent & CE Certification awardings, with the 25kW Power Pallet behind.



The **CE mark** is a mandatory conformity marking for certain products sold within the European Economic Area (EEA). **The CE marking is the manufacturer's declaration that the product meets the requirements of the applicable EC directives.**

APL MILESTONES: Media Recognition

MARKET OPPORTUNITY: Verticals

Micro-Grid Electrification

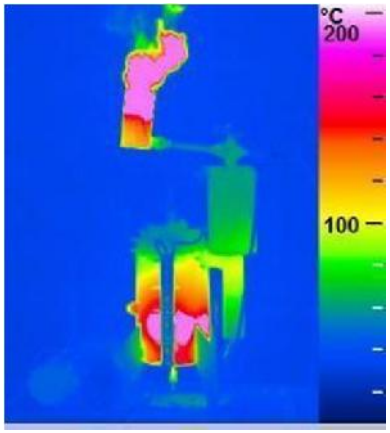
Distributed Generation (DG)

Grid-Tie / FIT Applications

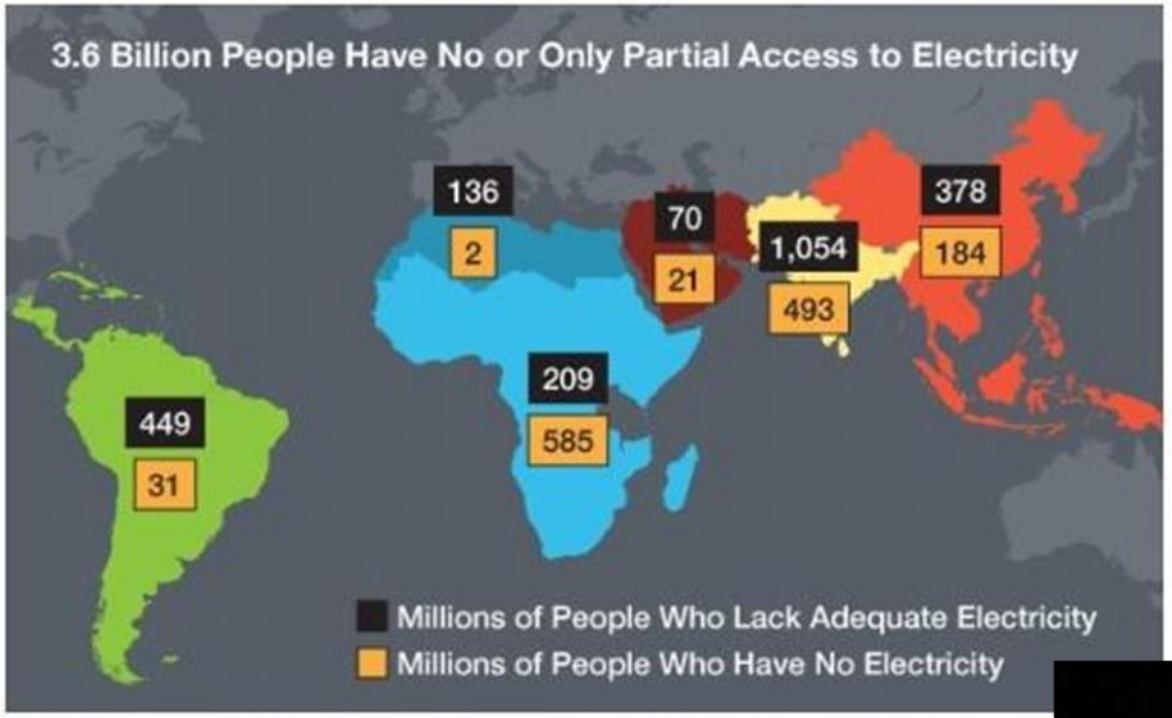
Education

Waste Reduction

Scientific Research



MARKET OPPORTUNITY: 3.6 Billion People in Need



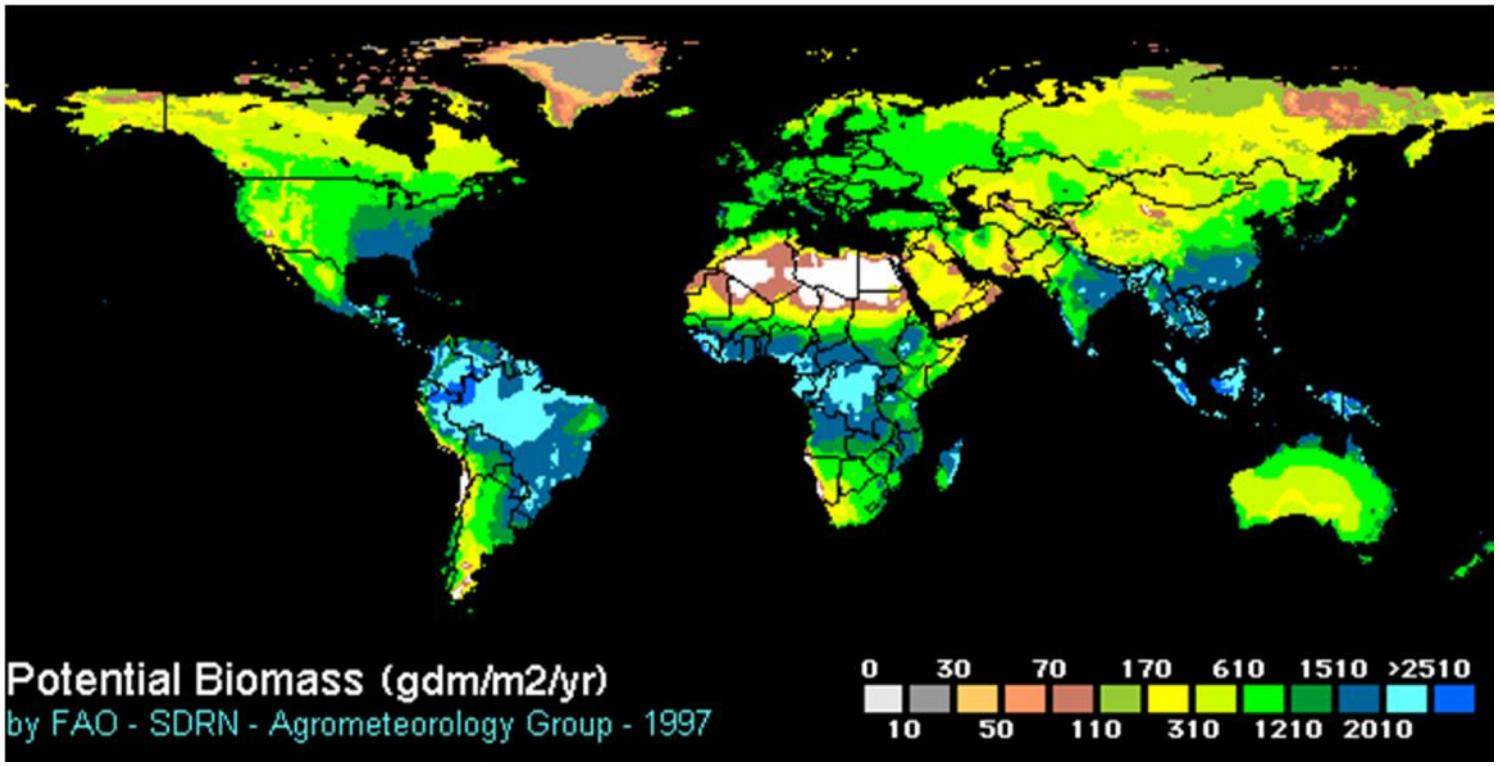
Source: International Energy Agency World Energy Outlook 2011 and The World Bank World Development Indicators 2011

1.5 Billion have no access to electricity

2.1 Billion have little access to electricity

MARKET OPPORTUNITY: Biomass Potential

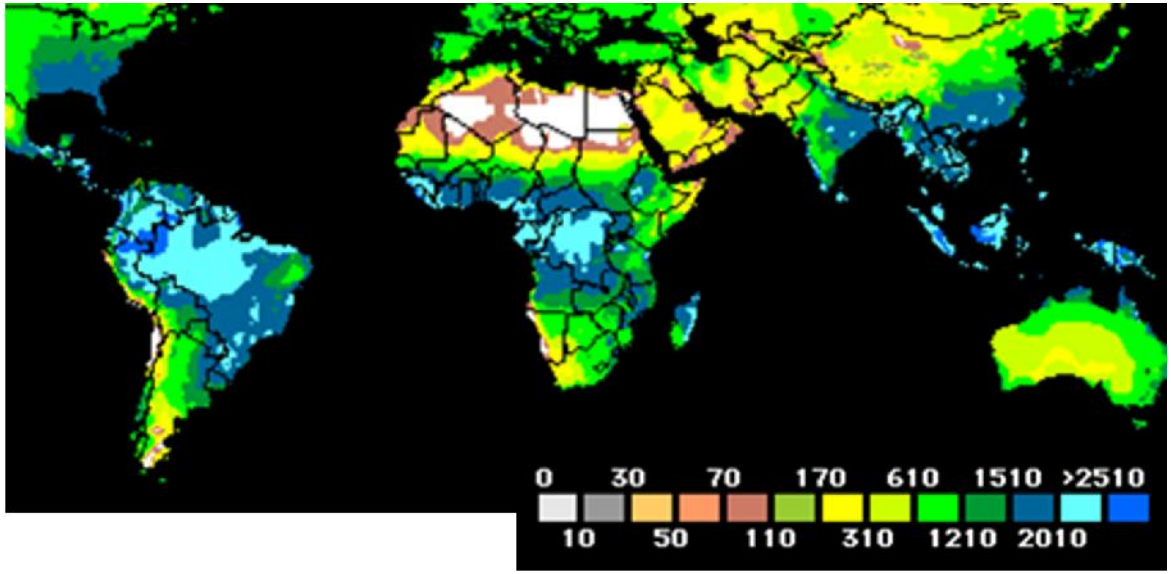
Ironically, the areas in most need of energy, are the very areas that are rich in biomass!



And according to a World Watch Institute 2009 report, biomass has the potential to supply half of the world's energy needs.

MARKET OPPORTUNITY: Biomass Potential

If we put the these two maps together then we see that the areas in desperate need of electricity are those which are rich in biomass.



MARKET OPPORTUNITY: Reduce Pollution & Health Hazards

The goal is not only to provide energy, but to reduce pollution as well

Fire Wood Burning

Crop Burning

Diesel Generators

Kerosene Lamps

Equals uncontrollable city pollution!

MARKET OPPORTUNITY: Diesel & Distributive Generation

Market Opportunity

Demand for on-demand, renewable energy is clear and growing

$6.7B

Annual global demand for <220kW diesel gensets
(Source: Frost and Sullivan)

650,000

Grid starved telco towers- avg $9k spend annually
(Source: GSMA)

$5.8B

feed-in tariff market in the EU

$18.4B

annual energy cost for remote communities & telco towers

PRODUCT SOLUTION: The APL Power Pallet

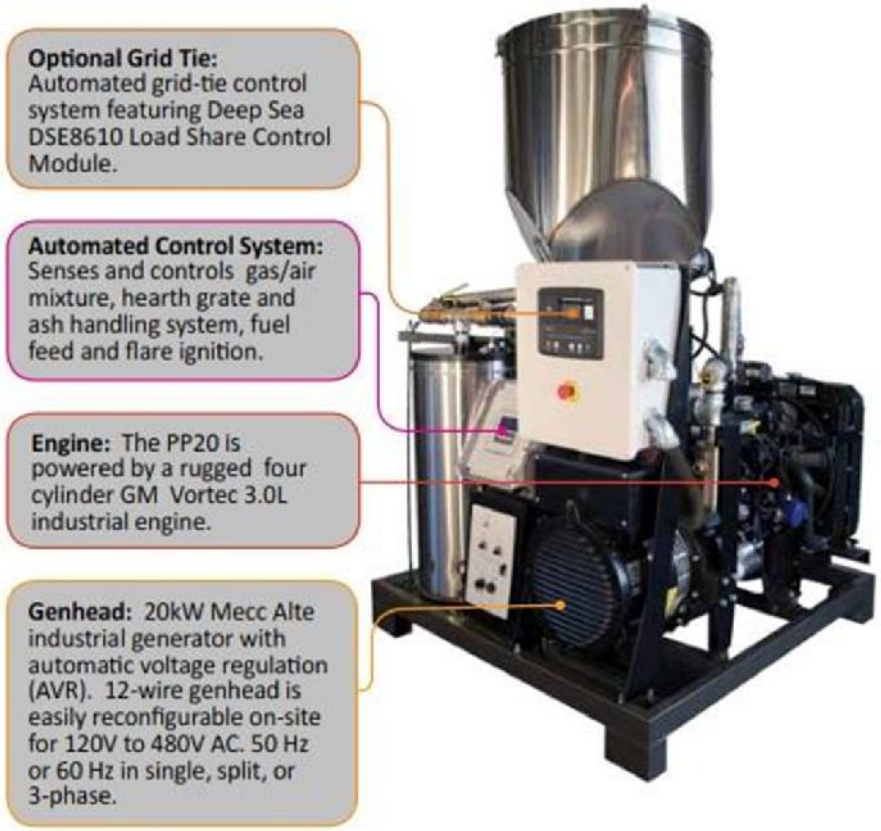
20kW Power Pallet (PP20)

Uses the new Ver 5.01 GEK Gasifier, with Grid-Tie option

25kW Power Pallet (PP25)

Uses the new Ver 5.01 GEK Gasifier, enclosure, CE Certified, Grid-Tie & Turbo

PRODUCT SOLUTION: Power Pallet Features



Optional Grid Tie: Automated grid-tie control system featuring Deep Sea DSE8610 Load Share Control Module.

Automated Control System: Senses and controls gas/air mixture, hearth grate and ash handling system, fuel feed and flare ignition.

Engine: The PP20 is powered by a rugged four cylinder GM Vortec 3.0L industrial engine.

Genhead: 20kW Mecc Alte industrial generator with automatic voltage regulation (AVR). 12-wire genhead is easily reconfigurable on-site for 120V to 480V AC. 50 Hz or 60 Hz in single, split, or 3-phase.

Flare: Premixed swirl burner ensures clean start-up.

PyroReactor: Waste-heat-driven pyrolysis and air preheating system for efficient combustion and tar cracking.

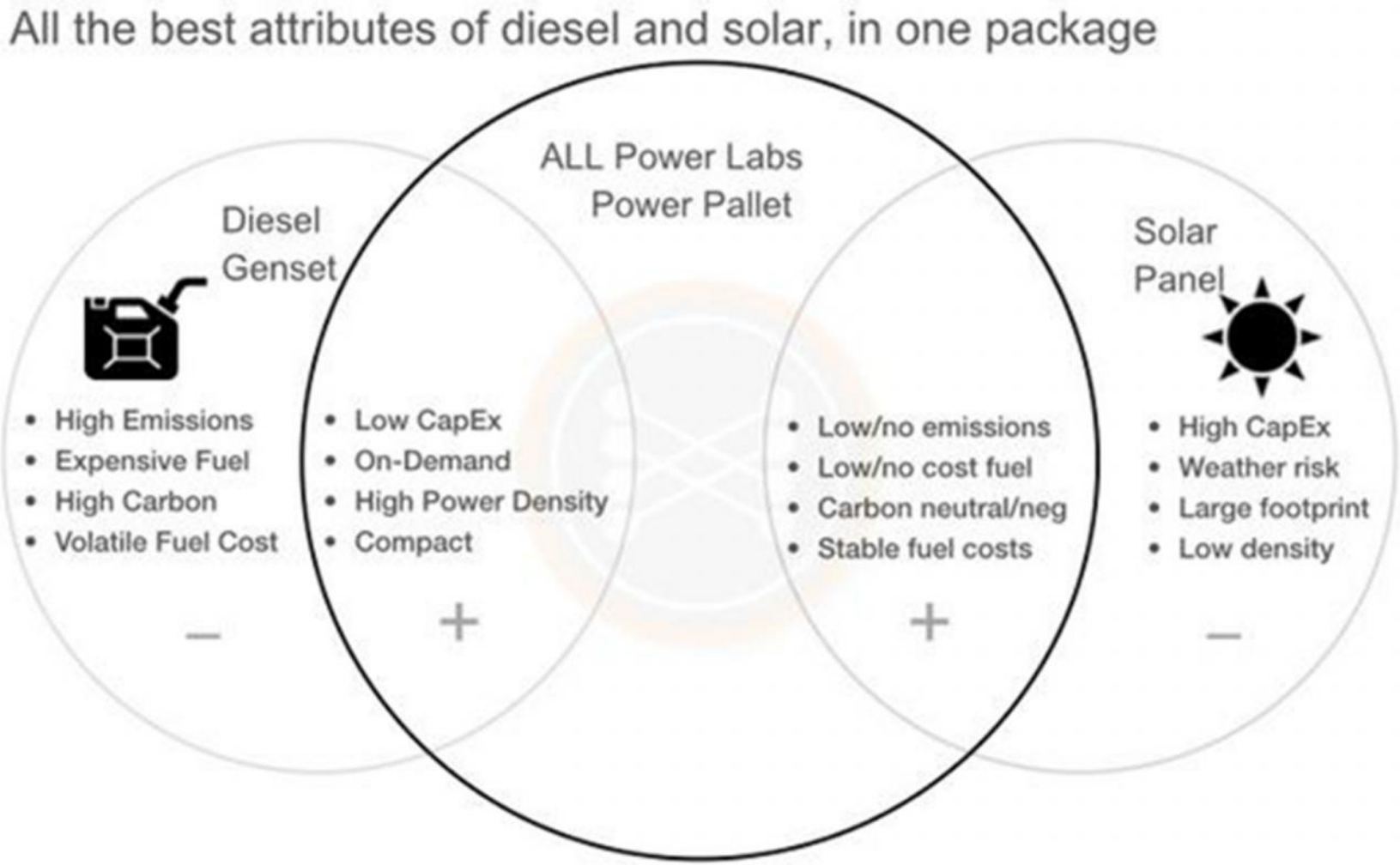
Gas Filter: Packed-bed filter with washable foam elements.

GEK Gasifier: Compact multi-stage downdraft gasifier for efficient gas production.

Skid Base: All components come mounted to a forklift-ready skid.

Automatic Ash Removal: PCU-controlled grate shake, scroll & ash auger with 24 hr. ash vessel.

PRODUCT SOLUTION: Best of Both Worlds



PRODUCT SOLUTION: PP20 Financial Analysis

APL's current strategy is to go after markets with high energy cost (diesel) & FIT rates. Below are the basic assumptions of a basic open skid 20kW Power Pallet:

- Capital investment of about $35,000 (including shipping, training, etc.)
- Feedstock cost of $40-$60 a metric ton
- Operations & Maintenance (O&M) cost of $3.5K a year
- Reactor replacement of a year $3,000 for every 4,000 hours of run time
- 5 hours of labor required for a 16-hour daily run time
- $0.30-$0.40 a kWh of avoided cost of electricity

We get the following results in doing a 6-year financial analysis:

- $0.25 - $0.30 a kWh Levelized Cost of Electricity (LCOE)
- 2 year simple payback
- 76% IRR over 6 years

Please note that the above statements are general; and that your actual returns will depend on your particular use case.

In the near future APL aims to bring the cost of Capital Investment down significantly so we can hit LCOE rates of less than $0.20 a kWh.

PRODUCT SOLUTION: Reduction of Pollution

The measurement of the emissions data below were taken from a snapshot of the operation of a 10kW Power Pallet using woodchips. Pollutant concentrations are adjusted to 15 % oxygen reference levels.

% Composition of Measured Emissions		
N_2 – Nitrogen	71%	
CO_2 – Carbon Dioxide	16%	
H_2O - Water	8%	
O_2 - Oxygen	1%	
Pollutants	0.05%	
Breakdown of Pollutants		
CO - Carbon Monoxide	369 ppm	0.0369%
UHC - Unburned Hydrocarbons	24 ppm	0.0024%
NO_X - Nitrogen Oxide	16 ppm	0.0016%
PM - Particulate Matter*	1 mg/m3	

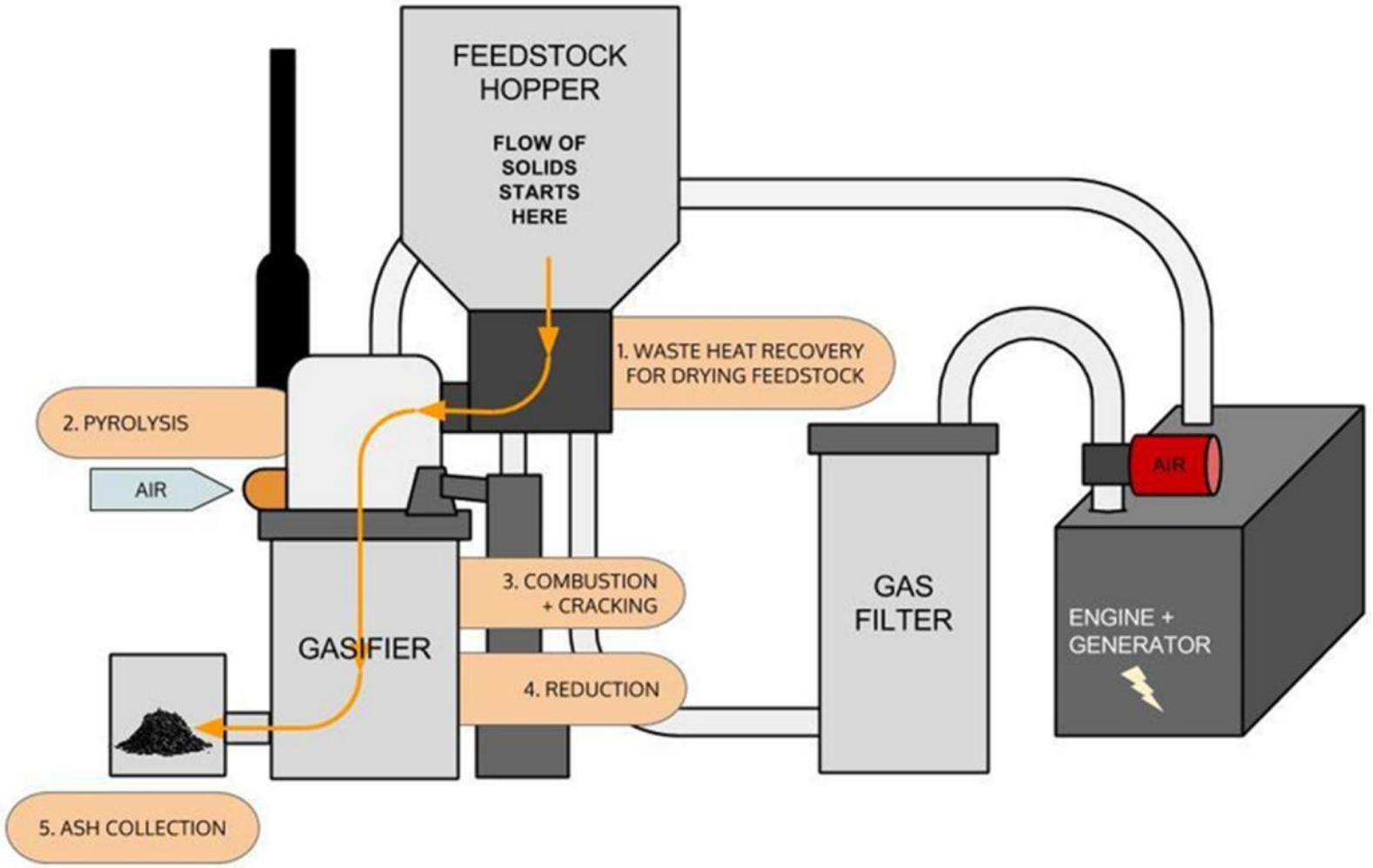
*Note: World Bank standards for “Heavy Diesel” is 150-100 mg/m3 & “Light Diesel” is 30 mg/m3.

EU standards for biomass & solid-liquid fuels is 50 mg/m3 respectively.

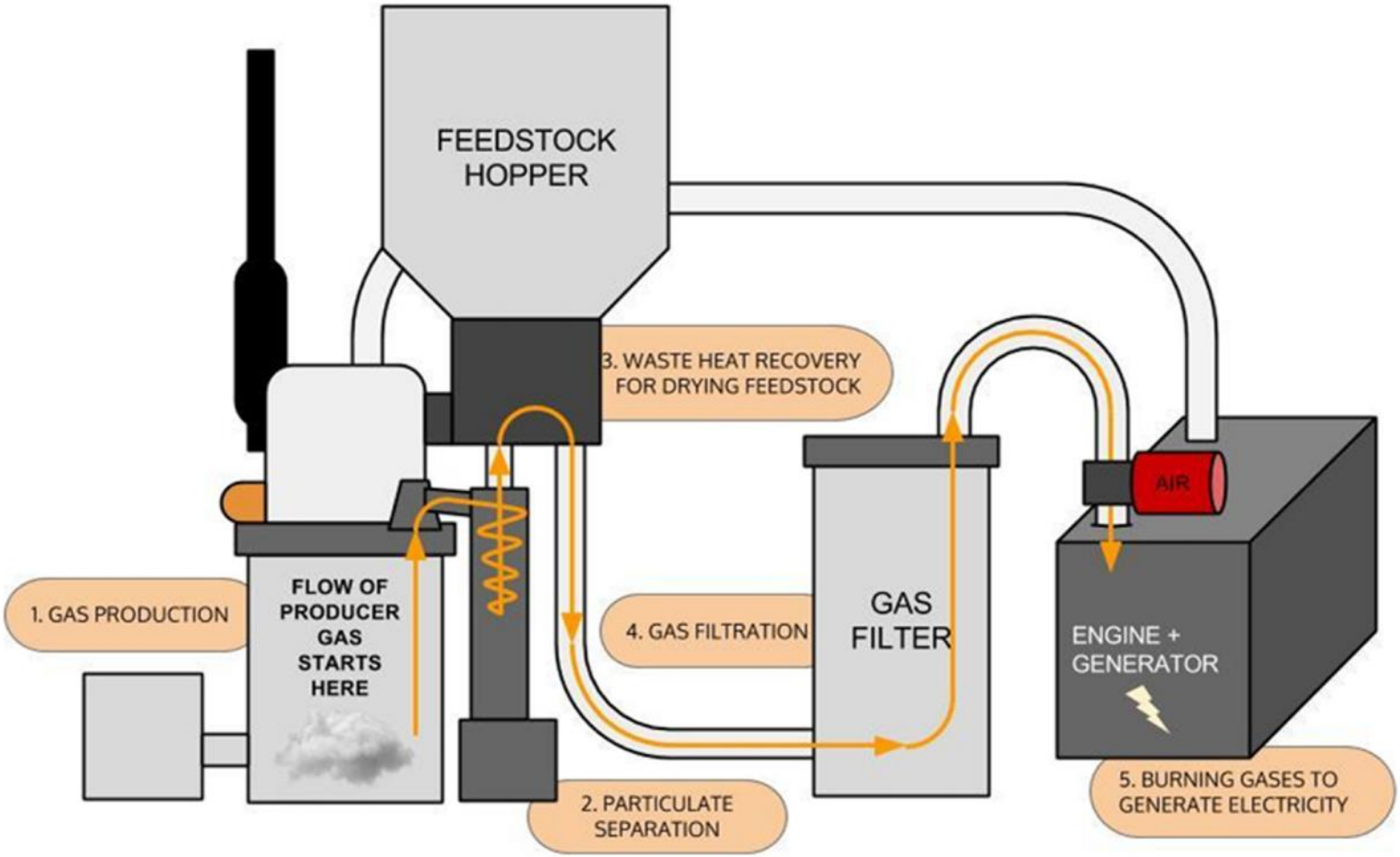
PM is usually measured in mg & not PPM.

Note: Emissions will vary greatly depending on feedstock, air mixture & engine wear (i.e. oil, ignition system, etc.).

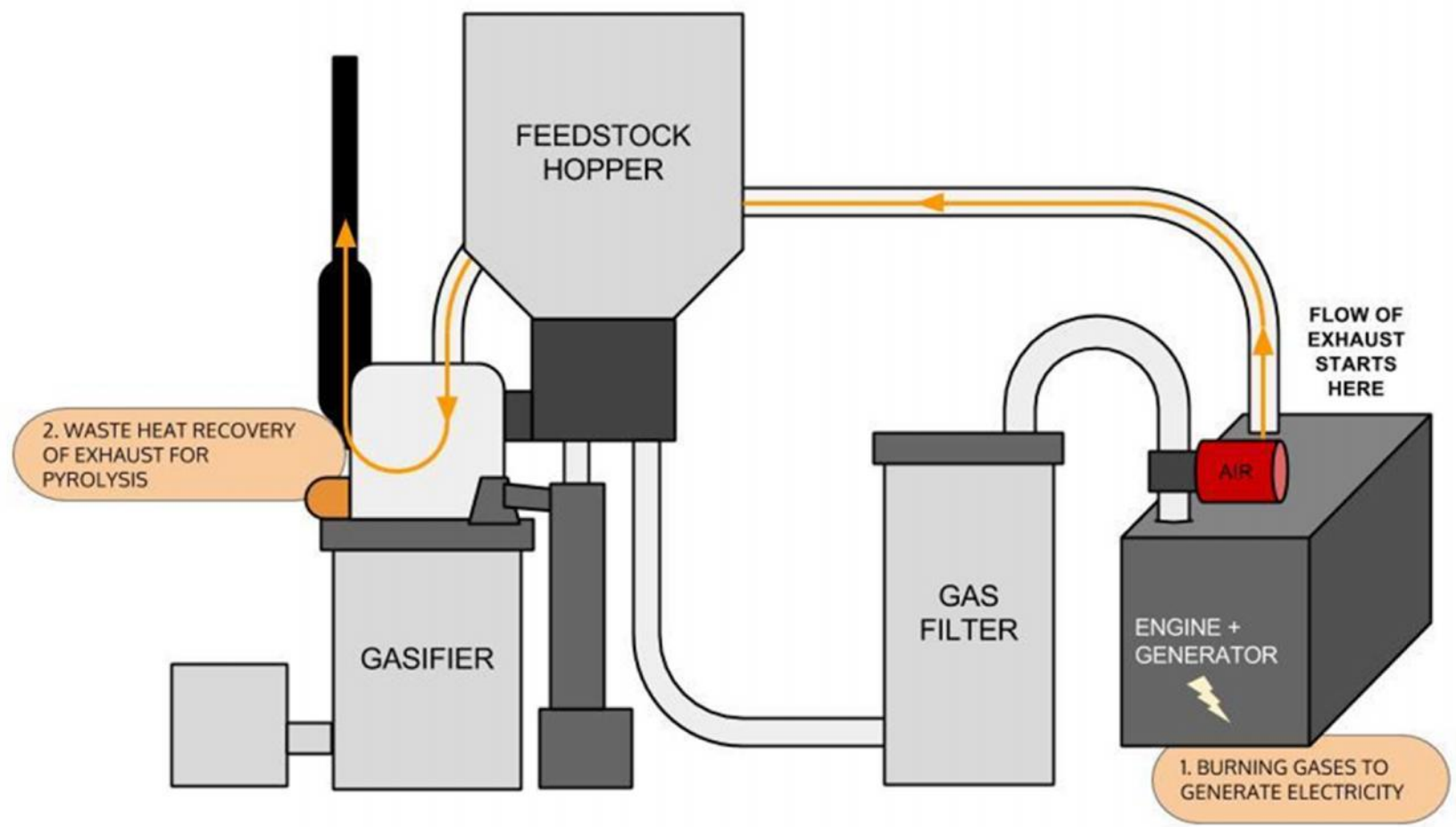
APL GASIFICATION PROCESS: Flow of Solids



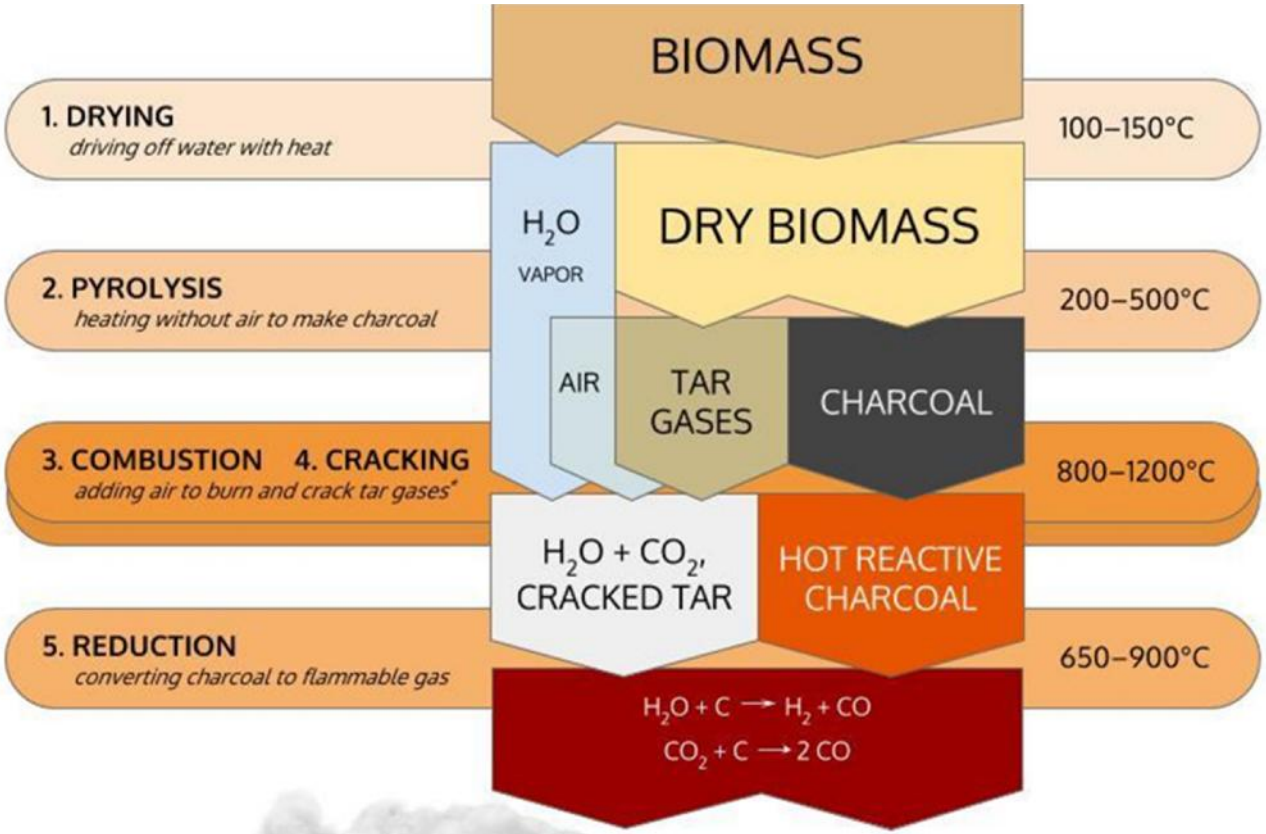
APL GASIFICATION PROCESS: Flow of Gasses



APL GASIFICATION PROCESS: Flow of Exhaust

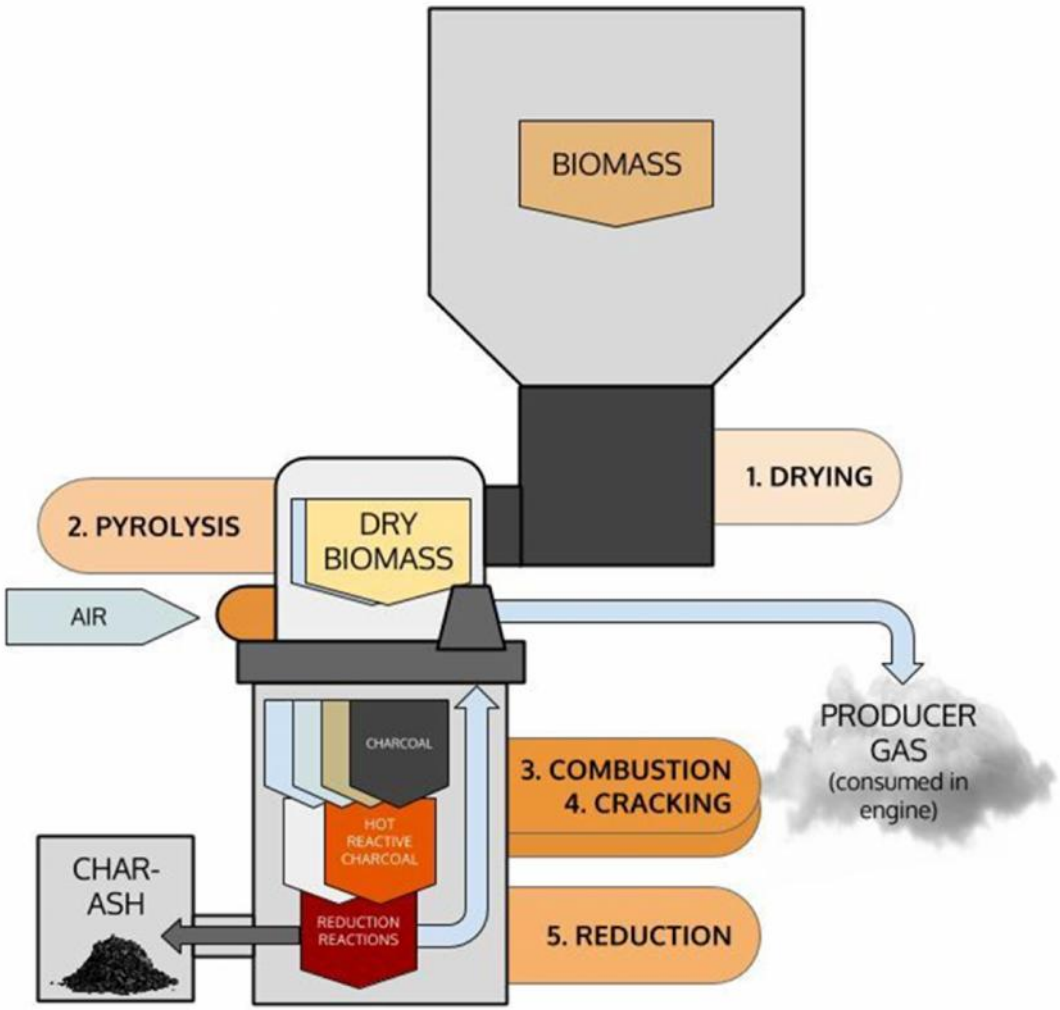


APL GASIFICATION PROCESS: The Five Processes



* tar cracking is the breakdown of tar into H_2, CO, and other flammable gases by exposure to high temperatures.

APL GASIFICATION PROCESS: The Five Processes

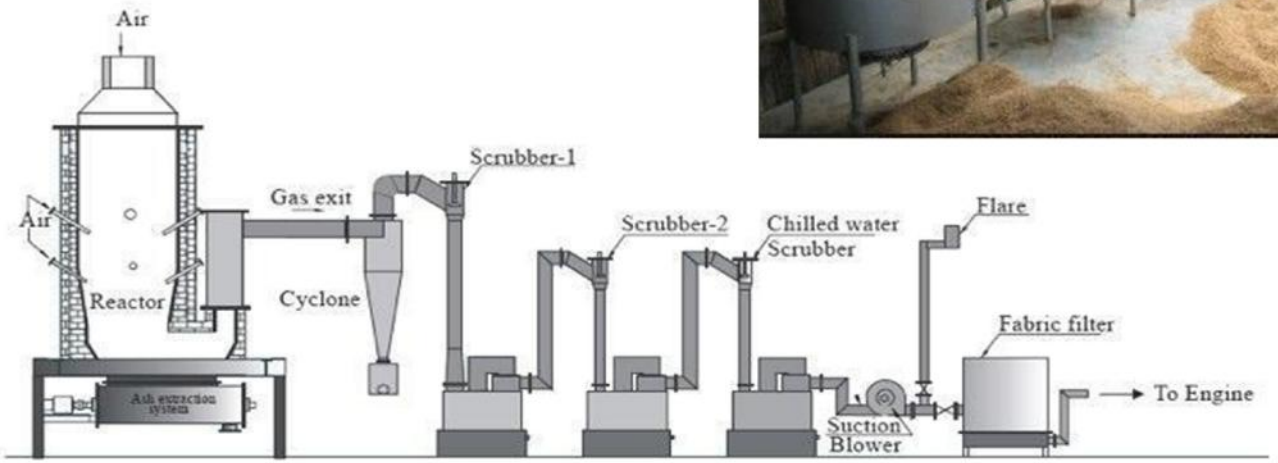


TECHNOLOGY ADVANTAGE: Feature Comparison

	APL	Others
Footprint	Small / Mobile / Secure	Large / Immobile / Unsecure
Technology	Heat Recovery / Automation	Wet Scrub / Manual Labor
Output	1.2kg = 1 kWh	2 -1.5kg = 1 kWh
Mass Conversion	90-95% gas / 10-5% ash	80-85% gas / 20-15% ash
Country	USA	India

TECHNOLOGY ADVANTAGE: Feature Comparison

A gasifier system that uses the scrubber mechanism for filtration, occupies a lot of space.



TECHNOLOGY ADVANTAGE: Power Output

Gasifying ***2.5lb (1.2 kg) of biomass***

produces about ***2.5 m^3 of gas***

which produces about ***1.25 HP-hr***

which produces about ***1 kWh***

BIOMASS FUEL CONSUMPTION		
PP20 Genset (@ 75% load)		
Runtime	Biomass Weight	Power Output
1 Hour	18 kg	15 kWh
8 Hours	144 kg	120 kWh
24 Hours	432 kg	360 kWh

TECHNOLOGY ADVANTAGE: Appropriate Fuels

Dark Green	Known to work with minimal operations and maintenance effort.
Green	Known to work with increased operations and maintenance effort.
Yellow	Will work with increased operations and maintenance effort. May have increased slagging and other downtime impacts.
Red	Not tested or not known to work.

FUEL TYPE	COMMENTS
Walnut Shells	Shell halves & large pieces work; finely crushed shells will not.
Softwood Chips - Fir, Pine	Must be chipped, dried, & sifted.
Hardwood Chips - Oak, Beech	Also chipped, dried, & sifted. Thick chips may bind auger.
Coconut Shells	Broken into chunks and sized. Large pieces may cause jams.
Corn Cobs	Increased risk of slagging. Chopped to size. No husks.
Palm Kernel Shells	Risk of high temps unless blended with lower temp feedstock.
Wood Pellets	Decompostion requires special handling.
Rice Husks	High silica content leads to slagging.
Switchgrass/Miscanthus	High silica, low bulk density.
Sugar Cane Bagasse	Too stringy, not physically compatible.
Corn Stover	High ash content; silica content leads to slag
Poultry Litter	Caution: High slag, low energy density.
Saw Dust	Too fine, not physically compatible.
Coffee Grounds	Pellets of grounds prone to disintegration.
Coconut Husk	Not physically compatible.
Bamboo	Processing into chips is difficult.

Feedstock General Requirements

- ½ to 1½ inch
- <15% moisture on startup
- <30% moisture during operation
- <5% ash content

MD812 Moisture Meter

TECHNOLOGY ADVANTAGE: A Larger Hopper

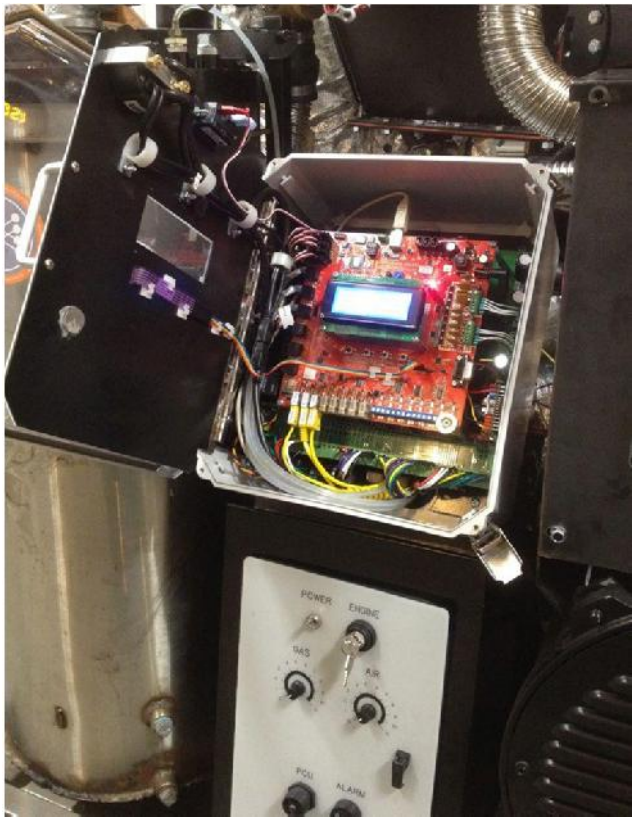
55 Gallon Hopper
36 kg of wood chips
2 hrs estimated run at 15 kWh

80 Gallon Hopper
54 kg of wood chips
3 hrs estimated run at 15 kWh

TECHNOLOGY ADVANTAGE: New Ver 5.0 Gasifier

TECHNOLOGY ADVANTAGE: Process Control Unit (PCU)

The PCU performs the following functions:



Monitoring:

- Gasifier Temperature
- Gasifier pressure
- Oxygen level sensing for clean combustion
- Engine state

Mechanical Functions:

- Auger fuel feeding
- Grate shaker & auger ash removal
- Combustion air mixture

Safety Functions:

- Alarms to alert the operator
- Execute emergency shutdowns if necessary

TECHNOLOGY ADVANTAGE: Grid-Tie & Paralleling

Currently countries that APL has deployed PP Grid-Tie units to Italy for the Feed-in-Tariff.

The Grid-Tied capability also allows for parallel stringing. Hence five 20kW systems can equal a 100kW system.

TECHNOLOGY ADVANTAGES: Summary

- ✓ **Modular design** allows for ease of deployment, operation & maintenance.
- ✓ **Pallet size configuration** enables for easy shipping / transporting; & operating in a small enclosed / secured space.
- ✓ The **"Heat Waste Recovery Design"** allows for more efficient gasification & more tolerance of moisture content in the feedstock.
- ✓ The **Process Control Unit (PCU)** monitors and responds to all internal reactor, engine & filter conditions.
- ✓ **Grid-Tie & Paralleling** in series which allows one to take full advantage of FIT programs.

TECHNICAL SUPPORT: Overview

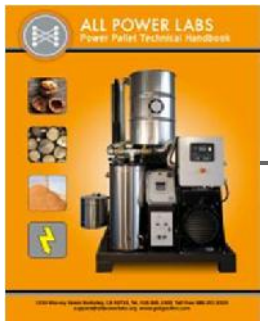
Our customers are our Partners!
They play a crucial role in the success of the product!

- **Customer Readiness:**
  - Use Case Scenario
  - Feedstock Resources & Preparation
  - Operations & Maintenance (O&M)
- **Customer Feedback:**
  - Operators Log Book
  - Performance
  - Troubleshooting
  - Product Improvement

The APL Technical Support Team

The Ver5.0 GEK Gasifier was born out of these two customer processes!

TECHNICAL SUPPORT: Training Products

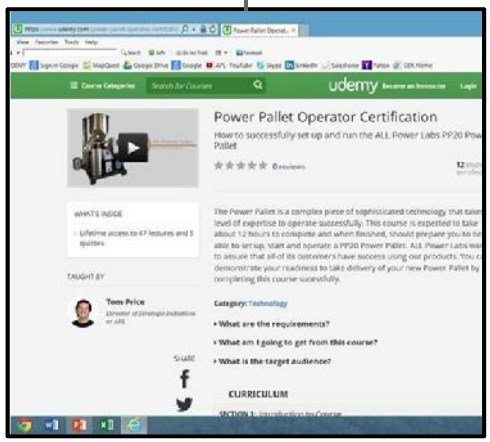


Training Manuals

Technical Support Department

Training Videos

Online Training



Onsite Training

Inhouse Training

PROJECT SUMMARY: Palawan, Philippines

Island Micro-Grid for 50 Families

Wind = 5.0 kW / Solar = 2.5kW / Power Pallet = 20kW

(a) Green Island Community, (b) local NGO PCART, (c) Project Developer SURE, (d) Local Government, (e) USAID & (f) APL.

PROJECT SUMMARY: Kakata, Liberia

Training & Education for Students in West Africa

This Renewable Energy Center project is partnered by the (a) NGO **-** Booker Washington Institute, (b) Project Developer - Winrock International, (c) Liberian Government, (d) USAID & (e) APL.

At the left Willie McGill demonstrates the Power Pallet. Below are the 3 Ver5.01's to be used.

PROJECT SUMMARY: NUS, Singapore

Scientific Research on Feedstock Testing

The NUS Department of Chemical and Biomolecular Engineering purchased a 10kW Power Pallet to experiment on sewage sludge

The 20% sewage sludge with 80% wood chips gasification is “successful”. The producer gas quality of mixture feedstock is lower than pure wood chips.

PROJECT SUMMARY: Italy

Italy Biomass Feed-in-Tariff (FIT) Program

With its CE Certification & Grid-Tie capabilities, APL is setting-up shop in Terni, Italy, to work closely with partners & customers who are aiming to take advantage of Italy's biomass FIT program, that goes on till 2015.

SLO Factory - APL's base in Italy

Woodchip Feedstock
& the 25kW Grid-Tie
Power Pallet

CONTACT INFO: APL Family

CONTACT INFO: Please Come Visit Us!

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Just 14 miles from San Francisco!