ALL POWER LABS

Carbon Negative Power & Products

Affordable · Portable · On-Demand
CARBON-NEGATIVE ENERGY
From Biomass-Powered Gensets

Using waste biomass, a Power Pallet can produce 18 kW of on demand, carbon negative power

(with optional CHP)

The Full Solution

ALL Power Labs' Power Pallet is a ***complete biomass power-generation solution*** that converts woody biomass into electricity. It is a compact, automated, renewable energy system starting at the breakthrough price of $1.50 per watt.

Power Pallets are currently available in a 20 kW rating using a GM industrial engine, paired with Mecc Alte AVR generators. The resulting combination delivers ***stable electricity from biomass*** in a variety of international power configurations.

Why It's Different

Power Pallets use agricultural and forestry waste that can be readily sourced very near the point of generation. They are ***compact, portable gensets***, easily transported in the bed of a small pickup truck to where the power is needed. Unlike wind and solar energy, our gasifiers can provide on-demand, high-density power, wherever you need it and, unlike diesel fuel or gasoline, this biomass fuel is often available at little or no cost. But, most importantly, in this climate-challenged time,

Power Pallets are capable of carbon-negative operation.

Using patented ***breakthroughs in electronic control and waste-heat recycling,*** APL gasifiers are extremely efficient, consuming just over one kilogram of biomass per kilowatt hour of electricity. An onboard microcontroller provides much of the expertise usually required from a professional operator and our patented multi-stage gasification architecture, combined with ***innovative gasifier/engine thermal integration,*** significantly improves tar conversion and fuel flexibility.

The APL Power Pallet is a ***complete biomass power solution*** that is able, with proper operator training, to meet expectations for modern power-generation equipment. They are made in California and available now at an affordable price – a sensible answer to the critical global problems of climate change and energy poverty.

Today you can find hundreds of our systems in over 40 countries and supporting research in over 55 universities.

The ***PP20 Power Pallet*** consists of a multi-stage gasifier, spark-fired industrial engine, generator head, and Process Control Unit (PCU). The PCU monitors and controls all internal reactor, engine, and filter conditions, displaying the results on an LCD screen.

The PCU also automatically adjusts the syngas/air mixture via a wide-band Bosch oxygen sensor and shakes the ash grate when required by reactor conditions.

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, reactor grate and biochar removal 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 re-configurable on-site for: 120V to 480V AC at 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 compatible with a variety of filter media.

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

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

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

PP20 POWER PALLET	SPECIFICATIONS
Max. Continuous Power Output	15 kW@50 Hz & 18 kW@60 Hz
Biomass Consumption	1.2 kg/kWh = 22 kg/50 lbs per hr at 18 kW
Fuel Moisture Tolerance	5% to 30%
Dimensions	1.4 m x 1.4 m x 2.2 m 53.5 in x 53.5 in x 88 in
Weight	1065 kg / 2350 lbs
Feedstock Hopper Capacity	330 liters / 88 gal

GEK Gasifier Kit Features

The ***GEK Gasifier Kit*** is the new and updated version of APL's original Gasifier Experimenter's Kit, but unlike the original, it requires only minimal assembly and is ready for your installation of any genset or producer-gas application. It is an ideal choice for research, education or OEM applications.

The Power Pallet's standard automated control system is included on the skid-mounted GEK Gasifier Kit.

Hopper: Standardized hopper ready for Continuous Feed Airlock.

GEK Gasifier: Proven Power Pallet gasifier with automated charash removal system.

Automation: Fully automated gasifier control hardware and software.

Gas Filter: Improved packed-bed filter using activated charcoal.

Standard Skid Mount: All components come mounted on a forklift-ready skid.

GEK GASIFIER	SPECIFICATIONS
Maximum Gas Output	60 m^3/hr: ~20kWe or 380,000 BTU/h
Dimensions	1.4 m x 1.4 m x 2.2 m 53.5 in x 53.5 in x 88 in
Weight	450 kg / 990 lbs

The ***Powertainer (PT150)***, is expected to be available some time after the fourth quarter of 2016. It is a compact and cost-optimized biomass power generation system, enclosed within a standard 20 foot intermodal shipping container. The system is fully automated and complete – including a biomass hopper with airlock system, high-moisture tolerant drying feed process, gasifier and gas filtering, to engine, generator and electrical output control – all fully enclosed within the container's envelope. The goal is a total-system-in-a box, drop-it-off-the-truck, ready-to-run configuration.

PT150 Powertainer	SPECIFICATIONS
Maximum Power Output	120 kW@50 Hz & 150 kW@60 Hz
Dimensions	6 m x 2.4 m x 2.6 m 20 ft x 8 ft x 8.5 ft
Footprint	11 m x 7.5 m 36 ft x 24 ft
Emissions	California Regulatory Compliant
Sound	Less than 65 db at 10 m
Feedstock Consumption	120 kg/hr@50hz & 150 kg/hr@60hz 264 lbs/hr@50hz & 330 lb/hr@60hz
Weight	20,000 kg / 44,000 lbs

GENHEAD

Mecc Alte NPE 32

Mecc Alte is a top-quality Italian generator manufacturer and a world leader in the production of synchronous alternators with an excellent reputation for reliability and performance. The NPE 32 uses automatic voltage regulation and is CE, CSA and UL certified. It includes sophisticated monitoring and is easily field-reconfigurable to a variety of power specifications, including the vast majority of global power standards:

- 120/208/240/380/440/480 VAC
- Single, split or three phase
- Configurable as 50 Hz or 60 Hz

ENGINE

GM Vortec 3.0 L I-4

The Vortec 3.0L inline 4-cylinder engine is produced exclusively for industrial and marine applications. It has the longest production history of any GM Powertrain industrial engine, with a well-earned reputation for durability and reliability. The engine as installed on the Power Pallet is factory-configured to run on gaseous fuels, with features including:

- Increased compression ratio
- Sintered-powder-metal exhaust-valve seat inserts for enhanced durability
- Nodular iron crankshaft for increased strength and durability

Grid Tie Control

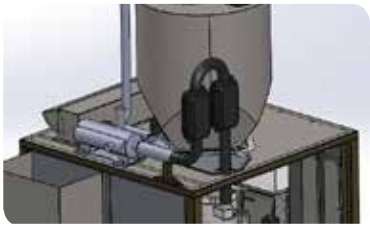
APL's Grid Tie Control Option allows our generators to connect to a utility grid or serve as part of a microgrid with other power generation equipment. The Deep Sea DSE8610 controller synchronizes each unit's output phases for stable operation.

Custom bus and transfer architecture prevents any backfeed into a de-energized grid via automatic mains decoupling. Numerous coupling arrangements are available via APL's custom Deep Sea programming.

Combined Heat & Power (CHP)

For maximized thermal efficiency, APL is now offering a Combined Heat and Power (CHP) Option. For the PP20, we offer an engine-coolant heat exchange system that more than doubles the energy extracted from the feedstock by adding 20 kWt of thermal energy to the 18 kWe of electricity. The water heated by the system can be circulated to any remote location where it can be used for space heating, drying of agricultural products or numerous other useful processes.

As optional equipment for the PC20 Powercube, APL adds exhaust-heat exchange in series with the engine-coolant heat exchange for maximum heat recovery. This dual-heat-exchanger CHP system has its own electronic control, which provides safety features along with the ability to control accessory components, as well as qualifying for top-tier feed-in tariffs by achieving a total efficiency of over 65% by adding an additional 15 kWt of heat.



Continuous-Feed Automated Airlock

To eliminate manual refilling of the hopper, ALL Power Labs is now offering a Continuous Feed Airlock as an option on all Power Pallets. Controlled by an Electronic Control Unit (ECU) with an array of sensors, this system allows a store of feedstock at ground level to be automatically fed, via a standard agricultural feed transport (not included), into the hopper through an automated airlock on the hopper lid.

The airlock, made of stainless steel, attaches with the same camlock as the Power Pallet's standard hopper lid. The system includes the ECU, wiring harness, two reliable rotary level sensors, and two inductive proximity sensors for reliable continuous operation.

Accessory Kits

APL includes a User Kit with every Power Pallet to ensure the successful installation and operation of your equipment. We also offer the additional accessory maintenance and repair kits whose contents are listed below.

User Kit (included)

Included with every APL Genset, User Kits include everything to assemble and run:

Documentation Package
Hard copies (also USB drive)
- Operator's Manual
- Technician's Handbook
- Subcomponent manuals
  - Engine Manual
  - Generator Manual
  - Governor Manual

Safety Kit
- Carbon Monoxide (CO) Alarm
- Safety Gloves
- (5) Industrial Respirators
- Safety Glasses
- Earplugs
- Graphite Paste

Accessory Kit
- USB Cable
- SD Card
- Assemblies' Fastener Kit
- Squeeze Bottle
- Sani clamps and gaskets
- Spark Plugs
- Battery Holddown

Spare Parts Kit (recommended)

Includes most commonly replaced or lost hardware and maintenance items:

Fasteners Package
- Cowling Nuts & Bolts
- Drying Bucket Nuts & Bolts
- Ash-out Nuts and Bolts
- Exhaust V-Band Clamp

Electrical Package
- Fuses: 10, 15, 25A
- Relay: 30A
- Blower
- Thermocouple
- Spark Plugs
- Spark Plug Wires

Sealing Package
- Sani Gaskets: 2", 4"
- Silicone Sealant
- Ceramic Insulation Strip
- Filter Bulb Seal
- Graphite Rope
- Silicone Tubing/barb

Maintenance Kit (optional)

Included items needed to perform 500-hour maintenance interval service:

Engine
- Oil Filter
- Spark Plugs

Sealing Package
- Hi Temp Silicone RTV
- Ceramic Insulation Strip
- Governor Gasket
- Graphite Rope
- Teflon Tape
- Graphite Paste

Operator Tool Kit (optional)

Hand tools needed to assemble and repair:

- Moisture Meter
- Zerc Grease Gun
- Reactor Poker
- 7 piece Ratcheting Combo Wrench Set
- 1/2" Combo Wrench
- 8mm Combo Wrench
- 9/64" Hex Key
- 2 in 1 Screwdriver
- 12" Groove Joint Pliers

Low Cost Electricity

Electricity can be generated from biomass for as little as $0.10 per kWh, significantly less than gasoline or diesel. And unlike other renewables, you can make energy day or night, rain or shine. Contact us for more specifics on ROI calculations.

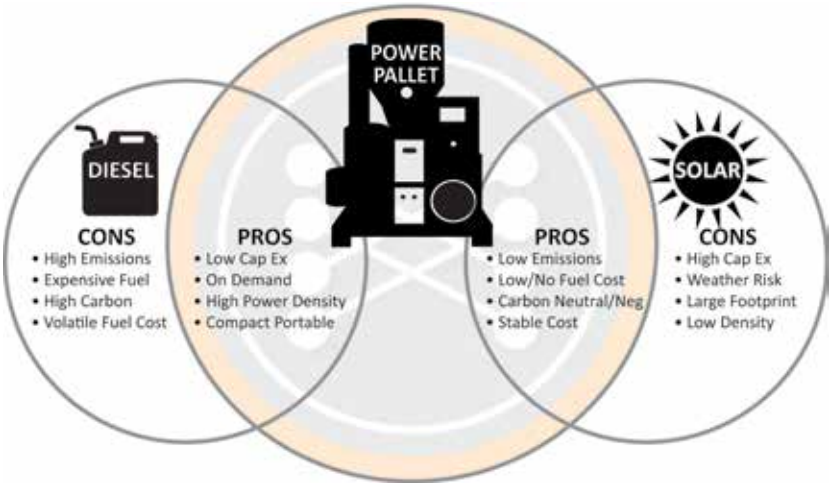
FUEL PRICE COMPARISON	
FUEL	**PRICE RANGE**
Biomass	***$0.10 - $0.30/kWh***
Diesel	$0.35 - $0.70/kWh
Gasoline	$0.50 - $1.00/kWh

Electricity in Remote Areas

The Power Pallet is designed and sized to use locally available fuel. Agricultural and forest wastes are readily available and do not require shipping over long distances. This use of local waste eliminates both the negative land-use impacts of traditional biomass energy as well as the cost and carbon impacts of fossil fuels.

Portable Power: New PP20 Delivery to Nakai Eco Lodge, Malawi

ALL Power Labs' Power Products can provide affordable, high density, on-demand electricity anywhere that waste biomass is available.



Renewable Clean Energy

Biomass gasification is a clean and highly efficient method of producing electricity. Distributed, waste-biomass gasification is a proven technology that is helping to relieve worldwide energy insecurity and solve waste-disposal problems, while reducing our current greenhouse gas emissions and helping to mitigate global climate change.

Affordable

The PP20 Power Pallet is one of the most affordable renewable energy systems on the market, delivering attractive return on investment (ROI) even without economic subsidies. Starting at $1.50 per watt, the capital cost of our system is much less than comparable solar or wind power systems.

Simple to Use and Maintain

The PP20 Power Pallet is the first system of its kind that makes gasification easy and user-friendly. Our systems are simple to service and can be maintained by most engine or generator mechanics. APL provides extensive personalized support and a range of training videos and manuals to ensure the success of your installation.

Power Pallets and GEK Gasifiers are at work supplying carbon lean energy around the globe. APL machines are helping to solve the global crises in both energy availability and climate change.

Booker Washington Institute - Kakata, Liberia

Hybridnet - Terni , Italy

Limyè Pa w - Tuffet, Haiti

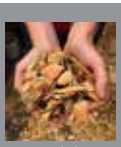
Green Island - Palawan, Phillipines

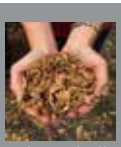
El Jardín Botánico - Bogota, Colombia

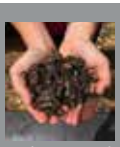
Centre Songhai - Benin, West Africa

Biomass Feedstock

Any chunky, dry, carbon-dense woody biomass.
- Particle size: 1 cm–4 cm (0.5 in –1.5 in)
- Moisture (% dry weight): 5% to 30%
- Ash content: less than 5%


Woodchips


Walnut Shells


Palm Kernel

Green	Known to work with standard operations and maintenance effort.
Yellow	Known to work with increased operations and maintenance effort.
Grey	Untested feedstock unknown operation effort (***use voids warranty).***
Red	Known to be a serious hazard (***use voids warranty).***

VALIDATED FEEDSTOCKS	COMMENTS
Nut Shells - Walnut, Hazelnut	Shell halves & large pieces work, finely crushed shells will not
Softwood Chips - Fir, Pine	Chipped, dried, & sifted
Hardwood Chips - Oak, Beech	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

UNSUITABLE FEEDSTOCKS	USE VOIDS WARRANTY
Wood Pellets	Decomposition 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	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	Particle size and texture specifications are hard to meet
Municipal Solid Waste	Slag risk, heavy metals, plastic content not suitable
Tires	Not chemically compatible
Manure: Cow, Pig, Chicken, etc	High slag, low energy density
Plastics	Melts and fouls auger/reactor
Coal	Burns too hot, releases sulfur and heavy metals

We are always seeking to expand our range of feedstocks. If you wish to use a feedstock not listed, please contact us.

Biomass Energy Density

Typical waste biomass feedstock has an energy density of about one third that of fossil fuels. In other words, about 10 kg (22 lbs) of biomass, when converted by a Power Pallet, will produce about the same amount of electricity as 4 liters (3.5 kg or 1 gal) of diesel fuel would produce in a typical genset.

(1 Kg / 2.2 lbs)

=

(20 W CFL - 75 W Equivalent)

For Five Hours

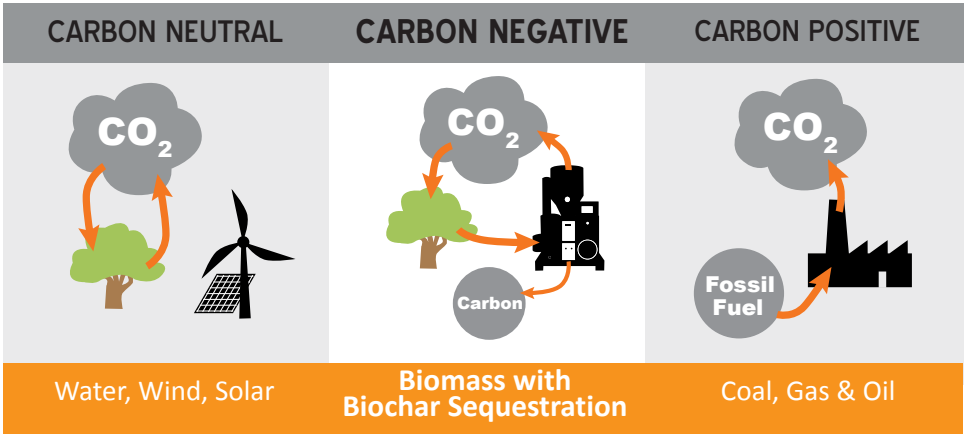
Low, Sustainable Biomass Demand

The ***PP20 Power Pallet*** is designed at a scale that permits individual users to source biomass fuel locally and sustainably from various agricultural and forestry waste. These low biomass requirements allow for operation without dependence on large-scale biomass supply chains, enabling operation in remote locations and developing countries, and preventing damaging land-use impacts.

BIOMASS FUEL CONSUMPTION		
PP20 Genset (@ 75% load)		
Runtime	Biomass Weight	Power Output
1 Hour	18 kg / 40 lb	15 kWh
8 Hours	144 kg / 317 lb	120 kWh
24 Hours	432 kg / 950 lb	360 kWh

Note: 1.2 kg biomass produces roughly 1 kWh electrical output in a PP20

The climate change caused by our unsustainable emissions of CO_2 and other greenhouse gases (GHG) will have profound, and possibly catastrophic, effects on life on earth. We believe our technology can be an important tool to help draw down the greenhouse gases that are warming our planet.



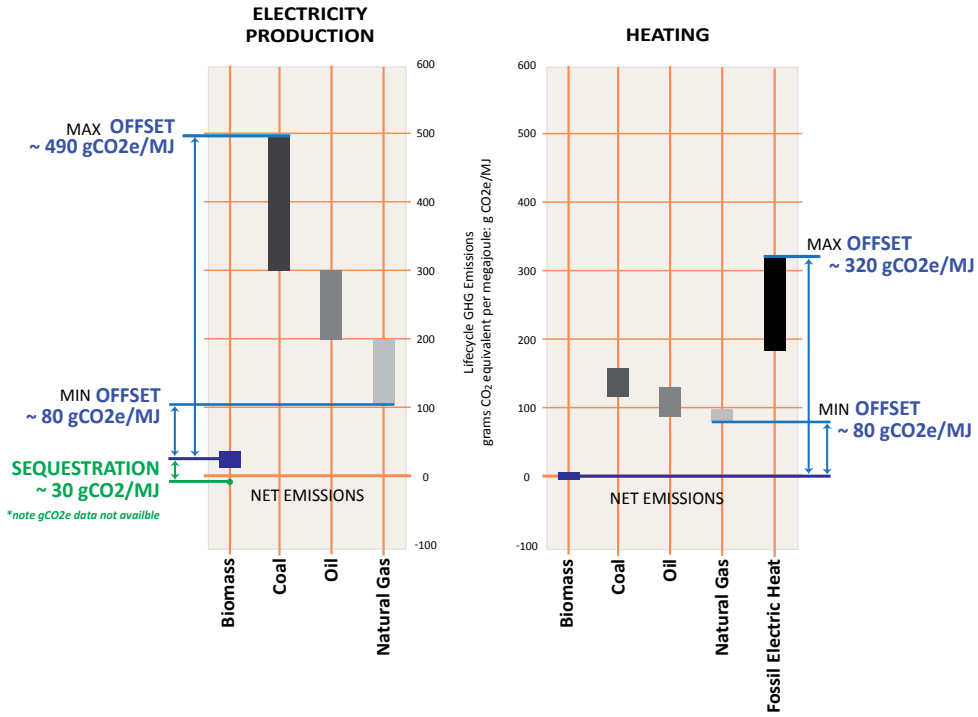
Power Pallets help reduce GHGs first, by off-setting power that would otherwise have been generated with fossil fuel, and then by converting some of the carbon from their waste-biomass fuel, which would have otherwise been released during natural decomposition, into biochar – a carbon rich by product. When added to soil, that carbon is sequestered and the process becomes carbon negative.

Power Pallet generators are among the only currently and globally deployed carbon negative technologies.

Carbon Profiles

QUANTITIES:	POWER PALLET 20 kW Rated	POWERTAINER 150 kW Rated
OUTPUT (MWh/yr)	53	530
CONSUME (tonne biomass/yr)	63	630
SEQUESTER (tonne CO_2e/yr)	3	30
(tonne C/yr)	11	110
OFFSET Electrical (tonne CO_2e/yr)	15-930	150-9300
CHP (tonne CO_2e/yr)	28-121	280-1210

Offset and Sequestration Compared with Fossil Fuels

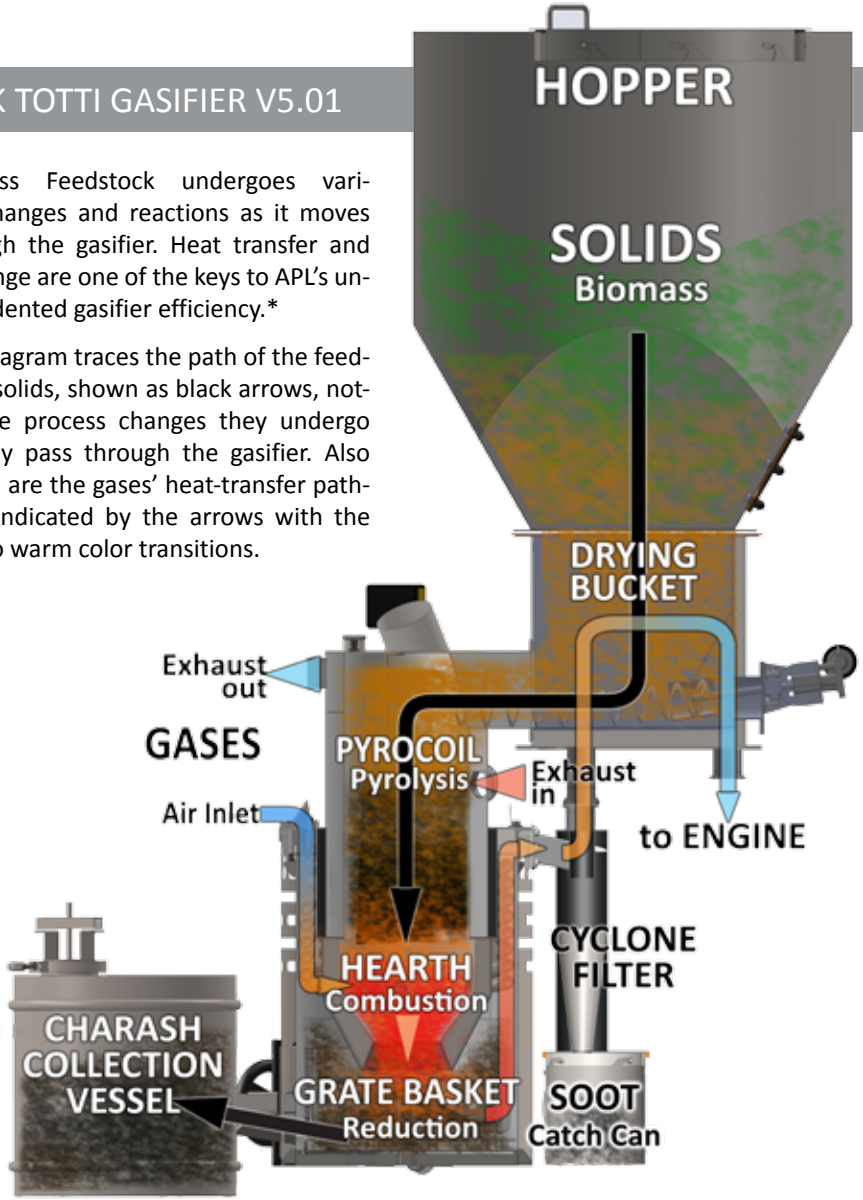


Flow of Gases and Solids

GEK TOTTI GASIFIER V5.01

Biomass Feedstock undergoes various changes and reactions as it moves through the gasifier. Heat transfer and exchange are one of the keys to APL's unprecedented gasifier efficiency.*

This diagram traces the path of the feedstock solids, shown as black arrows, noting the process changes they undergo as they pass through the gasifier. Also shown are the gases' heat-transfer pathways indicated by the arrows with the cool to warm color transitions.



* APL technology is covered by multiple U.S. and international patents

ALL Power Labs is the global leader in small-scale gasification. Our biomass gasifiers are currently serving real-world distributed energy needs all over the globe**.** Our project began in 2008 with the open-source Gasifier Experimenters Kits (GEK) for research and education. It has since evolved into the Power Pallet – an automated solution for biomass power generation.

The ALL Power Labs team is a combination of university-trained scientists and engineers, DIY artists, and professional fabricators. The result is a powerful combination of technical ability and physical know-how for developing innovative energy solutions.

We are committed to supporting and developing biomass energy conversion by curating and disseminating comprehensive information and data on gasification science and technology – online, in free open house events, and via our archive of open-source gasifier development.

With our affordable, ready to run Power Pallet systems, APL makes it possible to finally deploy sensible, carbon negative energy strategies anywhere on earth.

The APL Team

If you are planning to be in the Bay Area, please contact our sales team to schedule a visit to our facility. We would love to show you what we are up to.

ALL POWER LABS

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The GEK Gasifier was developed and is manufactured by ALL Power Labs in Berkeley, CA.
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