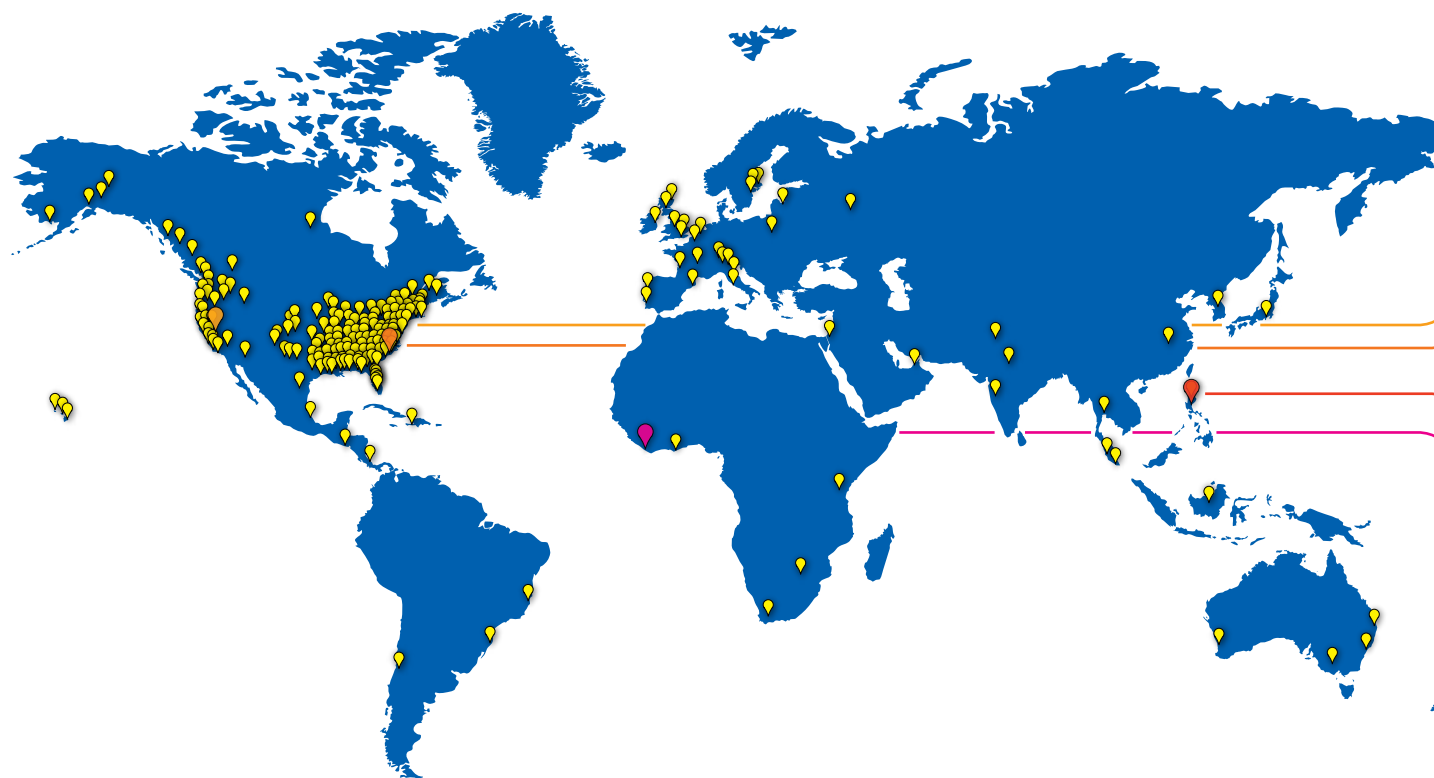




ALL POWER LABS

PERSONAL SCALE POWER





Education

Laguna Creek High School
Elk Grove, California



Research

US Dept. of Agriculture
and 40 Universities



Off-Grid Homes

Tuwā- The Laughing Fish:
Eco-homestead and
Sustainability Center



Developing World Energy

EcoPower Liberia
Africa

ALL Power Labs is the global leader in small-scale gasification. We make biomass gasifiers that are **ready for everyday use** and serve real world distributed energy needs.

Our project began with the open source Gasifier Experimenters Kit (GEK) for research and education. Three years later, it has evolved into the Power Pallet - a fully **automated solution for biomass power generation**.

Today you can find our 250+ systems in over 30 countries and supporting research at over 40 universities.

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The Full Solution

The GEK Power Pallet is a **complete biomass power generation solution** that converts woody biomass to electricity, heat, and PTO shaft power. It is a compact and fully automated system - from wood chips in to electricity out - delivered at the breakthrough price point of \$1- 2/watt.

Power Pallets are available in 10kW and 20kW sizes using Kubota and GM industrial engines, paired with Mecc Alte AVR gen heads. The resulting combination delivers stable electricity from biomass at 120/208/240vac, 60hz or 50hz, in single, split or three phase.

Why it's different

The GEK Power Pallet is distinguished by its ease of use, compact size and affordable price. It is a solution that delivers the **hands-off, non-tended operation** expected from contemporary power generation equipment.

These advantages are the result of breakthroughs in electronic control and waste heat recycling. An onboard computer provides the expertise usually required from a trained operator. A multi-stage gasification architecture, combined with an innovative gasifier-engine thermal integration, significantly improves tar conversion and fuel flexibility (see page 13 for more info on the TOTTI).

The result is a compact and technically advanced gasification solution that is **practical for everyday users**.



The **GEK Power Pallet** is comprised of the multi-stage gasifier, spark fired industrial engine, generator head, and electronic controller. The system automatically adjusts syngas/air mixture via a wide band Bosch oxygen sensor, shakes the grate when reactor conditions require it, and removes ash via a mechanical auger. The Process Control Unit (PCU) monitors and responds to all internal reactor, filter and engine conditions, displaying the results on an LCD screen.

PCU: Automated control system, oxygen sensor, syngas/air adjustment, and ash grate shaker.

Engine: The Power Pallet is offered with two engine choices.

- Kubota 3cyl, 962cc for 10kW
- GM 4 cyl 3.0L for 20kW

Genhead: 10kW or 20 kW Mecc Alte industrial gen head with automatic voltage regulation (AVR). 12 wire gen head is reconfigurable on-site to 120/208/240vac, 60hz or 50hz, in single, split or three phase.



Hopper: Stainless steel hopper holds up to 10 hours of fuel.

Flare: Premixed swirl burner ensures clean start-up.

Gas Filter: Multi-stage packed bed filter and washable foam elements.

GEK TOTTI: A multi-stage downdraft gasifier with full recovery and recirculation of "waste heat".

Ash Take Out: External ash auger and collection bin.

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

GEK POWER PALLET SPECS	10 kW	20 kW
Power Output	1-10 kW	3-20 kW
Biomass Consumption	12kg / 26lbs per hour at 10 kW	22kg / 50lbs per hour at 20 kW
Fuel Moisture Tolerance	Up to 30%	Up to 30%
Dimensions	1.2m x 1.2m x 2.5m 48" x 48" x 84"	1.2m x 1.3m x 2.5m 48" x 50" x 84"
Weight	400kg / 900lbs	550kg / 1200lbs





10kW

Kubota DG 972

Kubota engines have a well earned reputation for high reliability and extreme longevity in a wide variety of applications. Robust performance and compact footprint have made them the engine of choice for small scale industrial, agricultural and generator applications.

This 962cc 3-cylinder inline gaseous fuel engine is based on the company's acclaimed diesel engines. The new combustion chamber, designed exclusively for the gaseous fuel engine, reduces emissions and raised compression ratio increases efficiency.



20kW

GM Vortec 3.0L I-4

The Vortec 3.0 inline 4cyl 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 comes factory configured for 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.

Gasifying **1 kg of biomass**

produces about **2 m³ of gas**

which produces about **1 HP**

which produces about **0.70 kW**

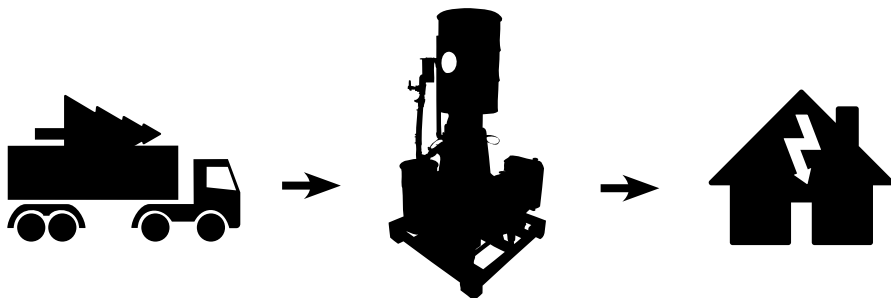
The best fuel for the GEK gasifier is chunky, dry, carbon-dense woody biomass. Fuels such as wood chips, chunks, nut shells and coconut shells ranging in size from 0.5" to 2" (10mm to 50mm) are ideal.

Many factors impact how frequently the hopper will need to be refilled. Generator load is the main variable in fuel consumption rate. However, bulk density varies with different biomass species, shape and size, thus hopper "fill capacity" varies as well.

FUEL TYPE	WILL IT WORK	HOW WELL	COMMENTS
Hardwood Chips	Yes	Excellent	1/4" to 2" (10mm – 50mm) chips
Softwood Chips	Yes	Excellent	1/4" to 2" (10mm – 50mm) chips
Nut shells	Yes	Excellent	Needs least preparation
Coconut Shell	Yes	Excellent	Broken into chunks
Coffee Grounds	Yes	Fair	Pelletized
Sawdust	Yes	Fair	Pelletized
Corn Cobs	Yes	Fair	Broken to chunks
Manure	Yes	Fair	Dried to 30% moisture
Rice Husks	Under development		High silica content
Straw or Husks	Under review and research		
Palm Pressings	Under review and research		
Algae	Under review and research		
Paper, Sugar Bagasse, Coconut Husk, Corn Stover, Poultry Litter, Municipal Solid Waste, Trash, Tires, Leather Dust			These fuels are not appropriate for use with the GEK Power Pallet at this point. With varying level of processing, some could be used in the future.



The **GEK Power Pallet** provides reliable, low-cost electricity anywhere biomass is available.



IDEAL USES AND INDUSTRIES

Small Businesses	Forestry
Rural Electrification and Microgrids	Off-Grid Homes
Cell Towers, Radio Station Operators	Pumps, Wells and Boreholes
Food Processors	Hospitals and Clinics
Commercial Refrigeration	Colleges and Universities
Agriculture	Energy Research

Power on Demand

The GEK Power Pallet generates electricity as long as it is fed with biomass. Unlike solar or wind power, it is not effected by cloud coverage or wind strength.

Renewable Clean Energy

Power generation from biomass is clean and carbon neutral.

Affordable

Capital equipment costs from US \$1.50 - 2.25 per watt, depending on specifications. This is 80% less expensive than comparable solar or wind power systems. The GEK Power Pallet is one of the most affordable renewable energy systems on the market and delivers attractive ROI without economic subsidies.

Simple to Use and Maintain

The GEK Power Pallet is simple to use after a short course of training. In addition, it is designed for ease of service and can be maintained by most engine or generator mechanics.

Low Cost Electricity

Electricity can be generated from biomass for as low as US \$0.02 per kWh. Generating power with diesel is dramatically more expensive. The cost of generating power with solar or wind is often prohibitively expensive without subsidies

FUEL PRICE COMPARISON

Fuel	Price Range
Diesel	\$0.35 - 0.50 kWh
Biomass	\$0.02 - 0.05 kWh

Low Biomass Demand

The GEK Power Pallet is designed at a scale that allows individual users to easily source biomass fuel locally and sustainably. This feature allows for easy operation and management without dependence on large-scale biomass supply chains, thus enabling operation in remote locations and developing countries.

BIOMASS FUEL CONSUMPTION

	10 kW Engine (@ 75% load)		20 kW Engine (@ 75% load)	
	Biomass Weight	Power Output	Biomass Weight	Power Output
1 Hour	9 kg	7.5 kWh	18 kg	15 kWh
8 Hours	72 kg	60 kWh	144 kg	120 kWh
24 Hours	216 kg	180 kWh	432 kg	360 kWh

Note: \approx 1.2 kg biomass per 1 kWh electrical output

Electricity in Remote Areas

The GEK Power Pallet uses locally available fuel. Unlike diesel, agricultural and forest waste are readily available and do not require shipping over long distances.



Gasifier Experimenters Kit (GEK®)

The basic GEK kit includes all components needed for a full gasification system. Included is a gas making reactor, stainless steel hearth, fuel hopper, gas cowl and ash handling, cyclone, packed bed filter, ejector venturi gas pump, fuel/air mixer, swirl burner and instrumentation. The GEK will **quickly get you over the starting hurdles of gasification** and on to the more rewarding work of making clean tar-free gas.



Level III: You Weld

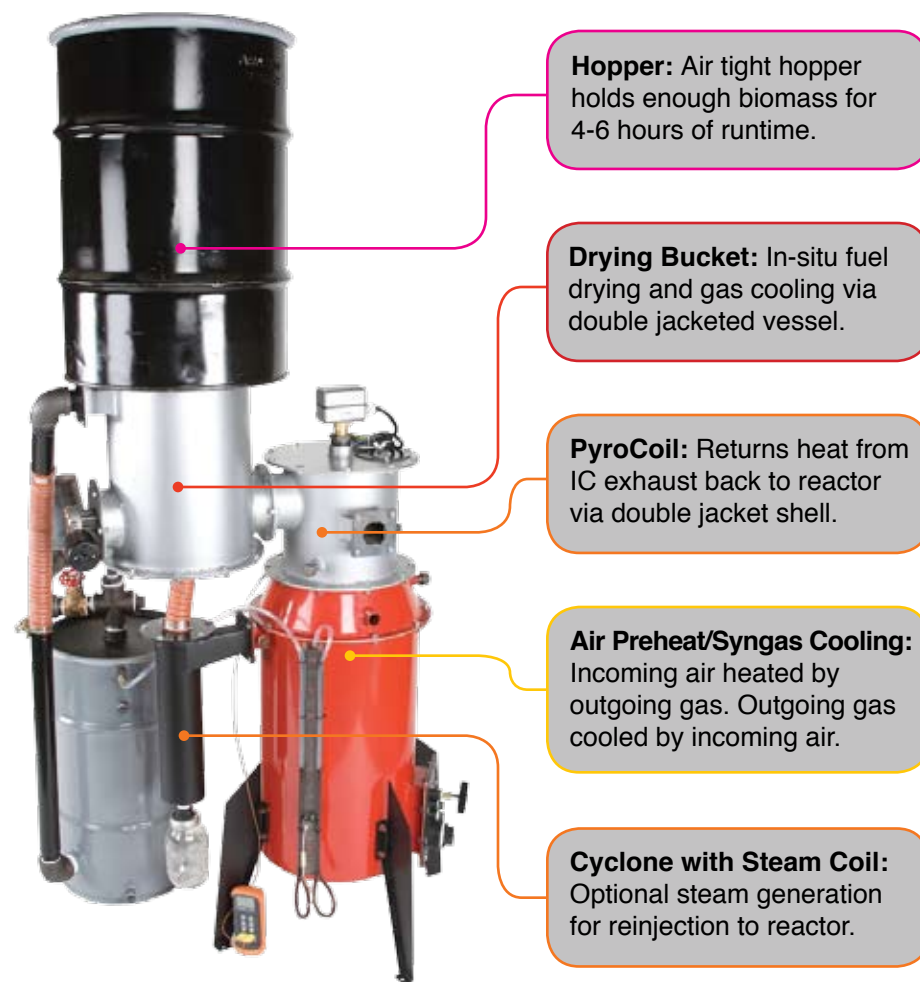
The GEK as a ready-to-weld kit. Includes all the rolled tubes, flange rings and end plates needed to make all vessels, as well as plumbing and accessory parts to complete the full GEK gasifier system.

Level IV: You Assemble

Arrives at your door with fabrication complete, ready for you to assemble and run. Assembly is minor, requiring only basic wrench turning and plumbing. No welding or other metal work is required.

Tower Of Total Thermal Integration (TOTTI™)

Hot output syngas and IC engine exhaust have tremendous potential for augmenting the thermally challenged processes in a gasifier. The GEK TOTTI demonstrates a powerful new method to **recover these waste heats and return them to the gasifier** to do useful work. The result is higher combustion temperatures for improved tar conversion, increased tolerance for high moisture fuels, and increased gasifier efficiency. The TOTTI is an add-on to the basic GEK kit.



GEK Process Control Unit (PCU)

The PCU is an Arduino, open source sensing and control board based on the Atmel AVR processor. The board is specifically designed for the types of instrumentation and automation needs found in biomass thermal conversion projects, whether research or commercial.

The board offers a generous number of thermocouple, pressure, analog signal, and rpm timer inputs, with a similarly generous array of PWM speed control, servo driver and higher current DC switched outputs. Networking to other devices is supported via USB, serial, SD card and CANbus (the networking standard for contemporary engine systems).

The PCU is ideal for applications which require integrated instrumentation, datalogging and control.



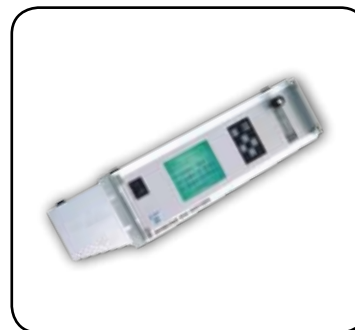
Research Instrumentation Kit

The Research Instrumentation Kit includes all the basic temperature, pressure, flow and tar testing accessories needed for gasification research and teaching. The following accessories are compatible with data input ports on the PCU.

Tar Testing	Temperature
Colorimeter to measure tar concentration	(6) K-type 24" point probe thermocouples
Pump, filter and filter holder for gas sampling	(10) K-type hard probe thermocouples (2", 12", 24")
(100) Filter discs	Fittings and Bushings for TC mounting
(100) Vials for tar dissolution	
Flow Rate	Pressure
(2) Calibrated orifice flow meters (air in, gas out)	Barbs and plumbing to connect PCU to tap points
Proportional servo valve to control gasifier flow rate	Silicone tubing
Silicone tubing, barbs and plumbing	

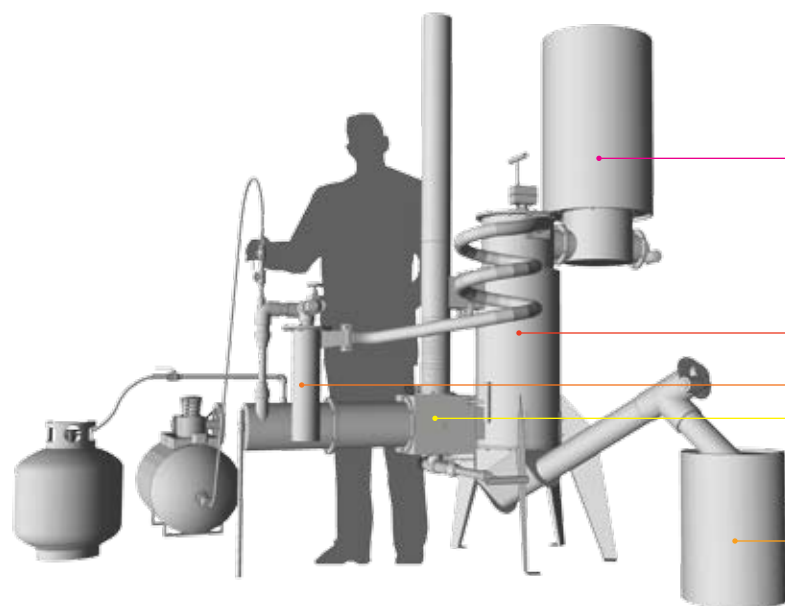
Portable Infrared Gas Analyzers

The Gasboard 3100 (online, rack mounted) and Gasboard 3100P (portable) infrared gas analyzers can be used to measure the concentration of up to 6 gases such as: CO, CO₂, CH₄, H₂, C_nH_m, O₂, and calculate the caloric value automatically. These analyzers are typically used for gas analysis in biomass or coal gasification, various chemical processes, steel production blast furnaces, coking, and direct iron ore smelting reduction processes.



FEATURES (V3.02)	FULL FILL	LITE FILL
Processor	Atmel ATmega 1280	
Thermocouple Inputs	16 K-type	4 K-Type
Pressure Inputs (+/- 28" H ₂ O)	6	2
FET Outputs (5 A continuous)	8	4
Analog Inputs (10-bit, Phidgets connectors)	8	4
Frequency Counter Input	1	0
R/C Hobby Servo Outputs	3	1
Display (4x20 Character)	YES	YES
4 Button Keypad	YES	NO
MicroSD Slot	YES	NO
CANbus Hardware	YES	NO
RS-232 Interface	YES	NO
Prototype/Expansion Area	YES	YES





The Biochar Experimenters Kit (BEK™)

The BEK is a **multi-mode pyrolysis machine** for characterized biochar and bio-oil making. The BEK supports multiple pyrolysis process modes in direct combustion (updraft, TLUD and stratified downdraft), indirect combustion retort, and sweep gas heat transfer.

The goal of the BEK is to provide a **flexible reactor platform for comparative biochar research**. A mixer box let's the user choose between the different modes, or mix them in desired combinations. Temperature, residence time, and ramp rate are similarly variable, with thermocouples provided to monitor the results.

The BEK can be run in either batch or continuous feed operation. An optional condensing circuit will separate bio-oil from the output gas if desired. Clean combustion is ensured by a propane assisted swirl burner and always *on* silicone nitride lighting elements.

Hopper

55 gallon stainless steel hopper stores feedstock in an air and moisture tight environment.

Reactor

Vessel where feedstock is pyrolyzed in variable modes.

Bio-Oil Condensing Circuit

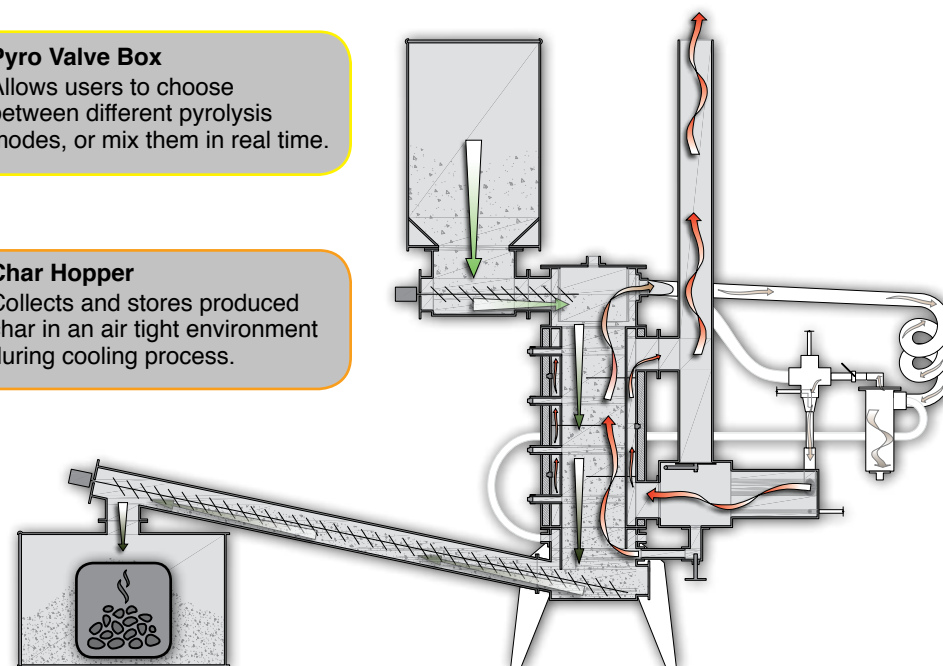
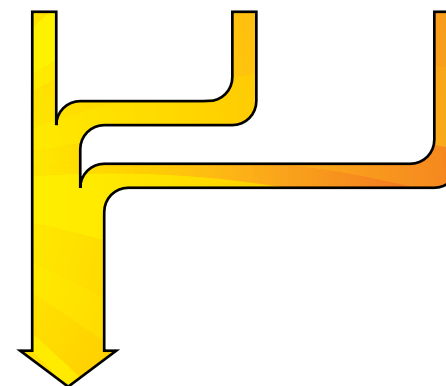
Optional component separates and collects tars produced from the pyrolysis process.

Pyro Valve Box

Allows users to choose between different pyrolysis modes, or mix them in real time.

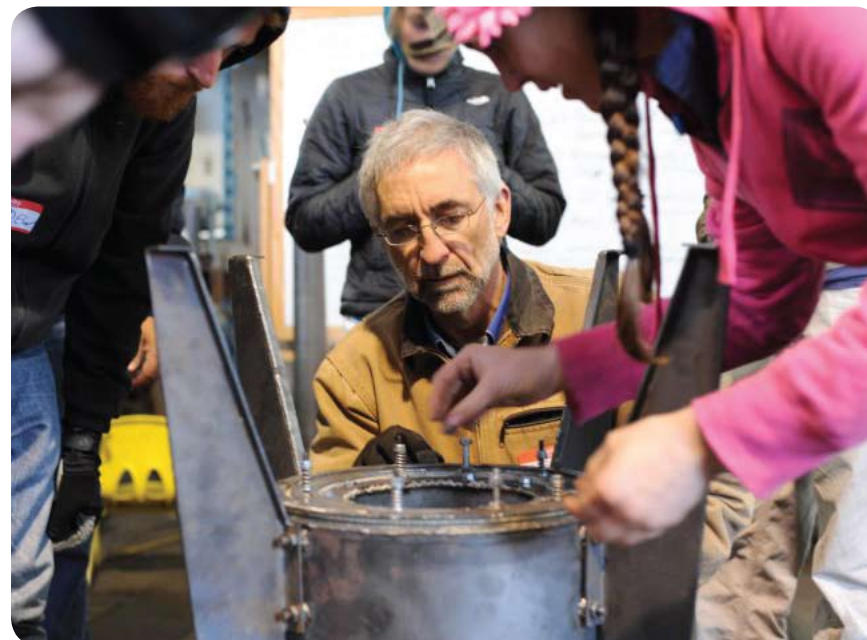
Char Hopper

Collects and stores produced char in an air tight environment during cooling process.



ALL Power Labs is an incubator for open-source alternative energy solutions and the leading manufacturer of equipment for small-scale biomass gasification. Through GEK workshops hosted around the world, free online fabrication plans for individuals and affordable ready-to-run systems, APL makes it easy for you to run high performance solutions in small-scale gasification and pyrolysis.

The ALL Power Labs team is an unusual combination of junkyard fabricators and university trained scientists and engineers. The result is a powerful combination of technical ability and physical know how for building real things in the real world. We focus on products that can be built and deployed, quickly, in volume, with broad impact and relevance.



Workshops

Each quarter, participants from around the world converge at ALL Power Labs to gain hands-on experience with the latest developments in gasification. Researchers, DIY enthusiasts, farmers, and development workers share experience and knowledge in a collaborative environment.

Whether you are a gasification expert or new to the technology, APL workshops will get you past the technical hurdles of biomass thermal conversion and provide opportunities to learn more about reliable power generation or making biochar for soil amendment.





ALL POWER LABS
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GEK® Power Pallets™

2910	10 kW GEK® Power Pallet	\$16,995		
2920	20 kW GEK® Power Pallet	\$25,995		

Gasifier Experimenters Kits

2505	GEK® Level IV, Welded Ready to Assemble, Stainless Steel	\$2,995		
2501	GEK® Level III, Unwelded, Mild Steel	\$1,795		

GEK® Add-ons - TOTTI™ Components (3500 + 3600 comprise the Hot TOTTI)

3500	Auger Feed Drying Bucket	\$1,395		
3600	Pyrocoil IC Exhaust Heat Recycle	\$1,195		

Controls and Instrumentation

3700	PCU Full	\$1,395		
3701	PCU Lite	\$395		
3710	PCU NEMA Box Enclosure and Mounting Hardware	\$295		
3720	Research Instrumentation Package	\$2,395		
3100	Online Infrared Gas Analyzer	\$8,650		
3100-P	Portable Infrared Gas Analyzer	\$8,650		

Biochar Experimenters Kit

2600	BEK™ Level IV, Ready to Assemble	\$4,995		
2601	Bio-Oil Condensing Circuit	\$595		

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