Energy Systems & Design

"Innovative Renewable Energy Systems Since 1980"

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Energy Systems and Design has been producing micro-hydroelectric components since 1980, and offers a wide array of products and services to the renewable energy (RE) marketplace. Now, ***ES&D*** offers the ***LH1000***, low-head propeller turbine, and international installation services.

The ***Stream Engine*** and ***LH1000*** both employ a brushless, permanent magnet alternator which is adjustable, enabling the user to match turbine output to electrical load. It has a higher efficiency than previous alternators, and is capable of outputs over 1 kW, while requiring virtually no maintenance. **ES&D**'s microhydro systems employ high efficiency, precision-cast parts, and non-corrosive alloys for long life and durability. A digital multimeter accompanies each turbine for measuring output amperage. These units can be used in stand-alone, or grid-tied systems.

STREAM ENGINE OPERATION

The ***Stream Engine*** is designed for use in battery-based power systems, with electricity generated at a steady rate, and stored in batteries for use at higher rates than is generated. During times of low demand, power is stored. An inverter is

Stream Engine

used when residential AC power is desired. Water from a stream is channeled into a pipeline to gain enough **head** (the vertical distance the water falls) to power the system. The ***Stream Engine*** operates at heads of about 2m (6 feet) and upward. The water passes through a nozzle, where it accelerates, strikes the bronze turgo wheel, and turns the generator shaft. Up to 4 universal nozzles can be installed on one machine. Nozzles are adaptable in sizing from 3mm(1/8 inch) to 25mm(1inch).

Stream Engine Installation

Typically, these systems operate at 12, 24, or 48 volts, with reconnectable wiring which allows the user to install a standard ***Stream Engine*** at most sites. Custom windings are also available which can produce high voltage (120, 240) at any site.

LH1000 OPERATION

The ***LH1000***, like the ***Stream Engine***, is designed to operate in conjunction with battery-based power systems, in order to store electrical power for use at times when consumption exceeds generation. Power is stored during periods of low demand. When AC loads are desired, extra "**balance of system**" (see below) components are required to convert stored DC to residential AC power.

LH1000

To gain enough **head** to operate the ***LH1000***, water is channeled into a sluiceway. The turbine is mounted in

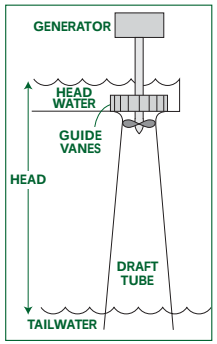
LH1000 Installation

a 18cm (7") opening in the sluice bottom, with the draft tube extending to the tailwater below. The water turns the propeller, creating shaft power. This, in turn, powers the generator, producing electricity.

The ***LH1000*** typically operates at 12, 24, 48, or 120 volts. It can be specially wound to operate at 240 volts, when necessary. Employing the same adjustable, permanent magnet generator as the ***Stream Engine***, the ***LH1000*** has reconnectable wiring for use at a wide range of sites.

POWER OUTPUT & SITE ASSESSMENT

To determine the power available at a site, **head** and **flow** measurements must be taken. **Flow** is the rate at which water moves, measured in liters per second (l/s) or gallons per minute (gpm). This can be measured by channeling the water into a pipeline, then into a container of a known volume, noting the time it takes to do so. A weir can be used to measure flows in larger streams. **Head** can be measured by using a transit, by siting along a level**,** or by using a pressure gauge at the end of

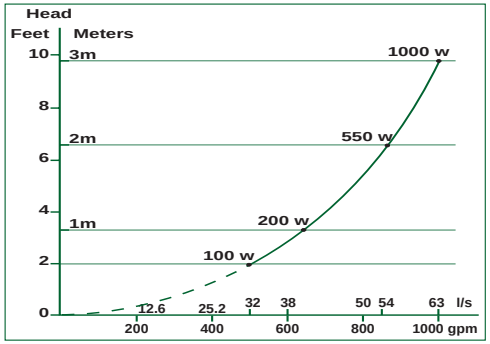


LH1000 Installation

Stream Engine Output (Watts Continuous)

Head Metres (Feet)	Flow Litres/Sec (Gallons/Min) 0.63 (10)	1.3 (20)	2.5 (40)	4.7 (75)	6.3 (100)	9.5 (150)
3 (10)			50	90	120	
6 (20)		40	100	180	230	350
15 (50)	45	100	220	400	550	800
30 (100)	80	200	500	940	1100	
60 (200)	150	400	900	1500		

the pipeline. An altimeter can also be used, so long as it is accurate, and sufficiently sensitive.

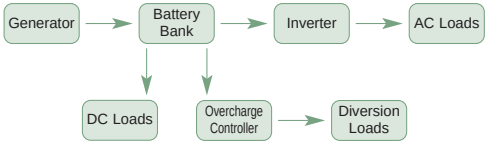


LH1000 Output (Watts Continuous)

It is important to keep in mind that output can only be accurately determined if **head** and **flow** measurements are made correctly, so care should be taken during this process. Two other important factors in a site assessment are **system voltage**, and **transmission distance**. The voltage and distance the power must travel can affect the efficiency and cost of your transmission lines.

"BALANCE OF SYSTEM" & OTHER COMPONENTS

Energy Systems and Design offers system design services. Also available are "**balance of system**" components including batteries, inverters, and charge controllers.



A Typical "Stand-Alone" RE System

Batteries

Batteries are an integral part of the self-sufficient energy system. Lead-acid, deep-cycle batteries are usually used in hydro systems. Deep-cycle batteries are designed to withstand repeated charge and discharge cycles typical in renewable

energy systems. Ideally, lead-acid batteries should not be discharged more than about half their capacity. Alkaline batteries, such as nickel-iron and nickel-cadmium, can withstand complete discharge with no ill effects.

Inverters

A battery bank does not enable users to live with all of the conveniences of modern living, as most appliances use high voltage AC (alternating current), while batteries can supply only DC (direct current). Inverters are used to convert DC into AC so that stored battery power may be used, as needed, by appliances and other loads. Modern inverters are available in almost every size, from small, recreational to industrial types, and are designed for user friendliness, durability, and reliability.

Charge Controllers

When the load demand is less than the generator output, power is available to charge the batteries. When the batteries are charged to capacity, the power is diverted to a secondary, "diversion" load, such as hot water heaters. The diversion of the generated power is accomplished by using a **charge controller**. Many types are available to perform this function.

MICRO-HYDROELECTRIC COMPONENTS

Turbine Wheels

Turgo- This rugged bronze turbine wheel is adaptable to a wide range of sites from 2m (6 feet) of head and up. This wheel can handle large flows though it has only a 10cm (4-inch) pitch diameter; it can accommodate nozzles up to 1" (25mm).

Bronze Turgo Wheel 10cm/4" pitch diameter

The turgo wheel fits a Ford or Delco alternator, with a 17mm shaft and a 1.25mm thread pitch (20 tpi.). Its approximate weight is 2.5kg (5.5 lbs), and is supplied balanced and machined.

Pelton- This popular, plastic pelton wheel is useful in higher head/lower flow situations and where outputs will not be excessive. With a 10cm pitch diameter (4 inch), it is ideal for small, do-it-yourself applications, and has been used in the "L'il Otto" micro-hydroelectric systems for years. The peltons are supplied with a 13mm (1/2") bore.

Polyurethane Pelton Wheel 10cm/4" pitch diameter

Permanent Magnet Alternators

The **Energy Systems and Design** permanent magnet alternator has been designed specifically for micro-hydroelectric applications. With an output of 500watts/1000rpm, it is over 80% efficient at full load. Operating without brushes, and with its windings encapsulated in epoxy, maintenance is minimal, and usually limited to bearing replacement.

The rotor is adjustable so as to enable the user to vary the field strength, and match the output to the load. With a variety of wiring configurations, the permanent magnet alternator is ideal for most sites. It has a 17mm shaft and a 1.25mm thread pitch. Sealed ball bearings are used to give reliable performance and provide for easy procurement of spares.

The **Energy Systems and Design** permanent magnet alternator is available in a **series design** (outputs up to 30 amps) and a **parallel design** (outputs up to 60 amps). A **high voltage design** is useful for long distance transmissions (120 or 240 volt), and can be used with ***ES & D* transformer panels** to step power down to battery voltages (contact us for details).

Transformer panels are built inside an aluminum junction box, containing a transformer, a rectifier, wiring lugs for connecting the wiring to the loads, and a precision shunt for output amperage measurement, using the supplied digital multimeter.

Universal Nozzles

Energy Systems and Design has developed a new type of nozzle. It is conical in shape, with gradations marked on it which correlate to a range of nozzle sizes, 3mm (1/8 inch) to 25mm (1 inch). The nozzle is cut to the appropriate size and the end is sanded to a smooth finish.

Turbine Housings

Turbine housings are made of cast aluminum, and powder coated white for lasting protection. The side walls are angled to accommodate the nozzles, in conjunction with the use of the turgo wheel. Turbine housings are available unmachined or prepared to user specifications.

INSTALLATION SERVICES

Boiestown, NB, Canada

Energy Systems & Design offers design and installation services to international communities at competitive rates. Our team of technicians designs and prepares your system at our facility in Canada, and then completes the installation at your site. We are prepared to handle any system, from solar hot water systems to photovoltaic, wind and microhydro. Contact us for details.

Morant Bay, St. Thomas Parish, Jamaica

Boiestown, NB, Canada

APPENDIX

a/ Power available at any given site can be assessed using the formula:

head (feet) x **flow**(gpm) /10= **Watts**
e.g., 100 feet x 30 gpm /10= 300 **Watts**
or
head (m) x **flow** (l/s) x 5 = **Watts**
e.g., 30 m x 2 l/s x 5= 300 **Watts**

b/ Before considering the purchase of a **Stream Engine** or **LH1000**, perform the above estimate. If it is determined that your site is viable, contact your dealer to discuss **pipelines**, **transmission distance**, and **system voltage**. Power from the **Stream Engine** or **LH1000** is limited according to the available **head**. See "Power Output and Site Assessment" for power charts.

c/ The length, diameter, and type of **pipeline** must be determined in order to predict losses due to friction.

d/ Many factors affect **system voltage** including output and **transmission distance**. Power is usually generated at battery voltage, but where transmission distances are too great for low voltage transmission (12, 24, or 48 V), higher voltages can be generated and transformers can be effectively used to step down to battery voltage.

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