GT New Horizons

Large Gas Turbine

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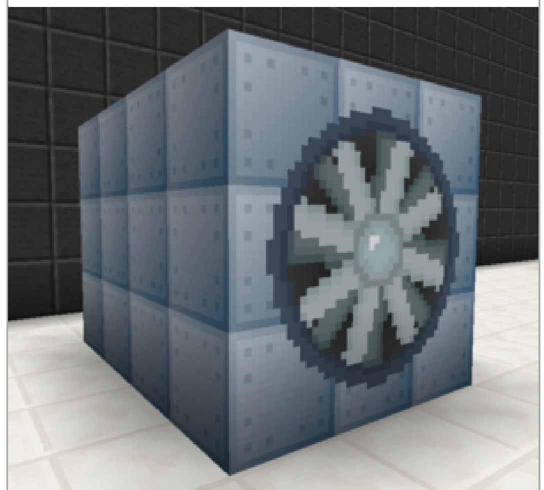	
Mod	Gregtech 5
Type	Tile Entity
Relevant Quest	Gas Turbine
Tier	EV
Size	3x3x4
Pollution	15/t

The **Large Gas Turbine** (LGT) is an EV tier multiblock for generating power from gas. The LGT is a major upgrade from the singleblock gas turbines which have poor fuel efficiency and low power output. A turbine must be placed inside the controller's GUI for the machine to run. Turbines come in four different sizes and many different materials each with their own efficiency bonus and optimal flow rate (L/t of gas). Power is extracted through a *buffered* dynamo hatch on the back of the machine. Do not exceed the dynamo hatch's maximum EU/t output or else it will explode. Save on fuel by automatically enabling/disabling the LGT with an RS-latch connected to a Lapotronic Supercapacitor.

Later on, the player can upgrade to the XL Turbo Gas Turbine which runs as fast as 16 LGT, but only occupies the space of 12. There is also the Solid-Oxide Fuel Cell which oxidizes gas fuels to generate electricity without a turbine and without polluting the environment. However, it requires 100 L/s of oxygen during operation and is locked to 100% efficiency--it does not scale as well and there is no XL equivalent.

Spreadsheet: Large Turbine Calculator (https://docs.google.com/spreadsheets/d/1oyNyHwPdkognPs7-r5HSxdy9RBoWgvbiZcpFTMOZLjM/edit?gid=655714366#gid=655714366)

Construction

The dynamo hatch must replace the center turbine casing on the back of the structure, opposite the controller. Multi-amp and laser energy hatches are NOT accepted, but *buffered* dynamo hatches can output up to 4A and are highly recommended. The remaining hatches can replace any turbine casing on the LGT except the 8 blocks surrounding the controller. The inside of the structure and the 9 blocks directly in front are also mandatory air. Use the Multiblock Structure Hologram Projector to visualize/build the structure.

Requires:

- 1 Large Gas Turbine (controller)
- 8-30 Stainless Steel Turbine Casing
- 1 Maintenance Hatch (any turbine casing, except front)

- 1+ Input Hatch (any turbine casing, except front)
- 1+ Muffler hatch (any turbine casing, except front)
- 0+ Turbine Housing (any turbine casing, except front)

Wallsharing

LGTs can wallshare each of their sides to save on space, casings, and hatches. However, do NOT share the input hatch because the fuel is not split evenly between the LSTs--one consumes everything and the other receives nothing.

Usage

The LGT has two operating modes, listed below, but see the spreadsheet linked at the top for the quantifiable differences between them. The former is better in the early to mid game when gas production is low and the latter is better in the late game when power output is more important than efficiency. Switch modes by using a screwdriver on the controller.

- *Tight Fitting Mode*: High efficiency, Low optimal flow rate (power).
- *Loose Fitting Mode*: Low efficiency, High optimal flow rate (power).

As gas enters the LGT through an input hatch, the speed of the turbine increases linearly up to 100%. Speed is directly proportional to the power output of the machine and takes 50 seconds to reach its maximum value regardless of the turbine size/material. Speed only decays when the turbine is removed, the structure is broken, or the LGT runs out of fuel. Disabling the LGT does NOT reset the speed. View the current speed of the turbine by using a Portable Scanner on the controller or looking at the "efficiency" value in WAILA.

Optimal Flow Rate (L/t)

The rate at which gas enters the LGT is extremely important. Too little gas and only a fraction of the potential power is generated; too much gas and a tremendous of fuel is wasted. Ideally, gas enters the LGT at the optimal flow rate of the turbine which changes significantly with size/material and the operating mode of the machine. The optimal flow rate (FR) in L/t is calculated with the following equations where k is a multiplier associated with each material, size is a constant between 1=small and 4=huge, EU/L is the energy value of the gas, and η is the efficiency of the turbine.

- *Tight Fitting Mode:* $FR_{opt} = \dfrac{k * size * 50}{EU/L}$
- *Loose Fitting Mode:* $FR_{opt} = \dfrac{k * size * 100 * 1.05^{20(\eta_{base} - 0.8)}}{EU/L}$

The quicker and easier way to calculate the optimal flow rate in tight fitting mode is to divide the optimal STEAM flow rate (visible in NEI) by the energy value of the gas, listed below in the following table. Some have very low energy values and thus very high optimal flow rates--especially if the LGT is in loose mode. The player may need to upgrade their fluid regulator or add a second input hatch to meet the increased demand. Eventually it becomes necessary to switch to AE2 fluid P2P tunnels which effectively have no transfer limit and no regard for temperature or heat capacity.

Fuel	EU/L		Fuel	EU/L		Fuel	EU/L
Natural Gas	20		Methane	104		Phenol	288
Hydrogen	20		Ethylene	128		Butane	296
Carbon Monoxide	24		Refinery Gas	160		LPG	320
Wood Gas	24		Ethane	168		Toluene	328
Sulfuric Gas	25		Propene	192		**Benzene**	**360**
Biogas	40		Butadiene	206		Ether	537
Sulfuric Naphta	40		Naphtha	220		Naquadah Gas	1,024
Cyclopentadiene	70		Propane	232		**Nitrobenzene**	**1,600**
Coal Gas	96		Butene	256			

Overflow & Power

Exceeding the optimal flow rate generates additional power with diminishing returns based on the overflow efficiency of the turbine (visible in NEI). Overflow efficiency is a discrete value separated into three different tiers, listed below. A higher overflow efficiency means the EU/L of the gas decreases at a slower rate and the overall maximum flow rate is higher. For both tight and loose fitting mode, the maximum flow rate is calculated by multiplying the optimal flow rate by the overflow efficiency.

- T1 Overflow Efficiency = 150%
- T2 Overflow Efficiency = 300%
- T3 Overflow Efficiency = 450%

Power is extracted from the LGT via the *buffered* dynamo hatch on the back of the structure. Do not exceed the maximum EU/t of the dynamo hatch and do not break it while the machine is running, or else the LGT will **explode**. Exceeding the total EU in the dynamo's buffer, however, is perfectly safe; the LGT will not explode if an attached battery buffer or Lapotronic Supercapacitor (LSC) is full and there is nowhere for the EU to go. Any additional EU is simply voided. It is highly recommended to automatically enable/disable the LGT with a redstone RS-latch to avoid wasting fuel--see the LSC page for a guide on setting that up.

$$EU/t = FR * \left(1 - \frac{|FR - FR_{opt}|}{FR_{opt} * (3 * OF_{tier} - 1)}\right) * EU/L * \eta$$

Although visible in WAILA, the power output is calculated with the above equation where FR is the flow rate in L/t, OF is the overflow efficiency TIER, EU/L is the energy value of the fuel, and η is the turbine efficiency. This equation applies to both tight and loose fitting modes. Let OF = 2/3 for any flow rates less than the optimal flow rate.

Example

Consider the following graph which relates power output (EU/t) to the flow rate of nitrobenzene (L/t) for an LGT with a large HSS-E turbine in tight fitting mode. The efficiency of the turbine is 175%, the visible for comparison purposes. Notice how quickly the EU/t increases as the flow rate approaches the optimal value and then how quickly the turbine loses efficiency afterwards. Loose fitting mode and every other turbine follows a very similar pattern.

Power curve for an LGT with a large HSS-E turbine in tight fitting mode.

Turbines

A turbine must be placed inside the GUI of the controller for the machine to run. Turbines come in four different sizes and many different materials each with their own efficiency bonus and optimal flow rate. The tier of a turbine means absolutely nothing. There are too many different permutations to list them all here, but the spreadsheet linked at the top has all the relevant information and even a calculator for determining the power output and lifespan of any turbine with any fuel.

- Small turbines are crafted with long magnalium rods // available as early as LV.
- Normal turbines are crafted with long titanium rods // available at the end of HV after traveling to the moon.
- Large turbines are crafted with long tungstensteel rods // available in IV after the tungsten processing line.
- Huge turbines are crafted with long americium rods // available in ZPM after building a Fusion Reactor Mk-II.

Durability

Turbines slowly lose durability as power is generated. The total durability of a turbine depends on the material and instantly voids once it reaches 0%. Turbines cannot be inserted or extracted from the controller, but turbine housing buses can automatically replace turbines after they break. By default, turbine housings check if the controller is empty once every 1200 ticks (60 seconds). Use a screwdriver

The following equation is for calculating the lifespan of a turbine (in hours) from the power output of an LGT. Turbines generally have lifespans of several hundred hours (or more) so they should not need to be replaced very often.

$$Lifespan = \frac{Durability}{36 * min\left(0.2 * EU/t, (EU/t)^{0.6}\right)}$$

Recommended Progression

The following are the best available turbines for the LGT as the player progresses. It is very common to skip a few of these because the cost of replacing healthy turbines may not be worth a slight boost in performance. The power and lifespan of the turbines are strictly based on the optimal flow rate and varies with any deviations. Note that this list is slightly different from the other large turbines and even the XL Turbo Gas Turbine because different fuels have different energy values and the LGT is very limited by the size of the dynamo hatch.

Tier	Material	Size	Efficiency	Mode	Fuel	Optimal Flow Rate	Power	Dynamo	Lifespan
HV	Vibrant Alloy	Small	95%	Tight	Benzene	2 L/t	684 EU/t	Buffered HV	223.8 h
HV	Manyullyn	Small	105%	Tight	Benzene	3 L/t	1,134 EU/t	Buffered HV	83.60 h
HV	Shadow Metal	Small	95%	Tight	Benzene	4 L/t	1,368 EU/t	Buffered HV	298.8 h
EV	Shadow Metal	Normal	120%	Tight	Benzene	8 L/t	3,456 EU/t	Buffered EV	342.8 h
EV	Terrasteel	Normal	130%	Tight	Benzene	8 L/t	3,744 EU/t	Buffered EV	408.3 h
EV	Oriharukon	Normal	130%	Tight	Benzene	8 L/t	3,744 EU/t	Buffered EV	408.3 h
IV	Oriharukon	Large	155%	Tight	Nitrobenzene	3 L/t	7,440 EU/t	Buffered EV	405.7 h
IV	HSS-E	Large	175%	Tight	Nitrobenzene	3 L/t	8,400 EU/t	Buffered IV	377.2 h
IV	HSS-S	Large	185%	Tight	Nitrobenzene	3 L/t	8,880 EU/t	Buffered IV	364.8 h
IV	MAR-Ce-M200 Steel	Large	145%	Tight	Nitrobenzene	14 L/t	32,480 EU/t	Buffered IV	3,351 h
LuV	Ichorium	Large	225%	Tight	Nitrobenzene	18 L/t	64,800 EU/t	Buffered LuV	9,190 h
ZPM	Ichorium	Huge	250%	Tight	Nitrobenzene	24 L/t	96,000 EU/t	Buffered LuV	9,679 h
ZPM	Duranium	Huge	240%	Tight	Nitrobenzene	64 L/t	245,760 EU/t	Buffered ZPM	265.4 h
ZPM	Ext. Unst. Naquadah	Huge	175%	Loose	Nitrobenzene	119 L/t	332,819 EU/t	Buffered ZPM	973.3 h
ZPM	Cosmic Neutronium	Huge	183%	Loose	Nitrobenzene	126 L/t	369,634 EU/t	Buffered ZPM	830.8 h
ZPM	Adamantium	Huge	167%	Loose	Nitrobenzene	172 L/t	460,134 EU/t	Buffered ZPM	36.43 h
UV	Ichorium	Huge	183%	Loose	Nitrobenzene	252 L/t	739,267 EU/t	Buffered UV	2,844 h
UV	Duranium	Huge	175%	Loose	Nitrobenzene	609 L/t	1,703,251 EU/t	Buffered UV	83.05 h
UHV	Infinity	Huge	223%	Loose	Nitrobenzene	547 L/t	1,953,884 EU/t	Buffered UV	4,895 h
UIV	Transcendent Metal	Huge	264%	Loose	Nitrobenzene	1,010 L/t	4,267,856 EU/t	Buffered UHV	9,190 h
UIV	Spacetime	Huge	288%	Loose	Nitrobenzene	1,494 L/t	6,880,766 EU/t	Buffered UHV	9,200 h