THYCON

Est.1968

Peak Lopping Inverters

PLI 100–1600kVA

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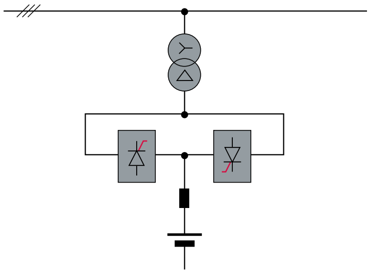

Fig. 1 – Thycon peak lopping system

Concept

"Peak Lopping", "Peak Shaving" or "Load Shifting" are terms used to describe electric power management systems which "lop off" the top of a user's exceptional peak power consumption curve, either by restricting the amount of power he uses or by supplying the peak requirements from an alternate source.

Domestically, peak lopping refers to the first approach where non-critical loads are shed or delayed (dish washers, washing machines) to prioritise the consumers' preferences (lighting, heating, cooking).

Industrially, peak-shaving invariably refers to the provision of an alternate power source of which there are many choices, depending on the application, as described.

In either case, the motivation for this kind of equipment is either economical (the utility penalises consumers who exceed a given rating – sometimes by charging up to 100 times more per kWh) or practical, the normal supply simply cannot provide more power. A special case of the latter can be found in solar farms not connected to a power grid such that each passing cloud might necessitate the (brief) activation of an alternate source (e.g. a diesel generator-set).

In general terms, whatever the motivation for peak "lopping" or "shaving", the technology falls into the category of power regulation in networks increasingly supplied by intermittent resources such as wind and solar power.

The principle of Thycon power electronics for peak Lopping is illustrated in Fig. 1. The battery is the usual storage system but alternatives are also possible and will be described later. Unlike an Uninterruptible Power Supply (UPS), the full power does not flow through the system but directly to the intended load. The Peak Lopper operates in parallel and assists the source when the demand exceeds its capacity.

Typical Energy Storage Systems.

Two or more approaches, generally combined, may be used for the alternate source(s): the storage of electrical energy from the prime supply (e.g. Utility, Solar Panel) and the independent generation of power from a tenable (stored) resource (e.g. diesel). The Power Management System oversees the requirements and switches the alternate sources in and out according to availability and economics.

The economics are partly determined by the nature of the alternate source: where this, typically, is a diesel engine, it is undesirable to make frequent and rapid starts as the life expectancy and service requirements of such machines depends on the number of cold starts that they make, so the activation of stand-by generators is always avoided for short peak requirements which are best met by battery or other energy storage systems and offer the added advantage that they can "start" within milliseconds as opposed to the tens of seconds required to bring a diesel engine or gas turbine up to operating speed. The generator set is thus used for long-duration power peaks or overloads, while the battery system provides short-duration peaks and avoids the more cumbersome starting of the generator sets, except when really needed.

Batteries

The most common tenable electric energy is secondary cell storage. Common battery technologies include lead-Acid, Nickel-Cadmium, Sulphur-Sodium, Lithium Ion and Vanadium Redox. Such systems cover a wide range of possible powers from a few hundred kilowatts up to 40MW or more, for periods of up to 15 minutes. Longer periods at lower powers are always possible but the 15 minute reference is based on the assumption that peak or “over” loads cannot last longer than this (or they can no longer be considered “exceptional”).

Pumped Storage

This is the original method of “smoothing” the demands on power stations: during periods of low power demand (typically at night) the capacity of thermal power stations can be used to pump water to a high altitude reservoir from rivers or lakes at lower altitudes. At periods of high demand, water from the storage reservoir is returned to the lower altitude via the same pumps which now act as generators. Clearly, such systems are usually utility-level installations, requiring major civil engineering works with ratings up to 3GW but systems as small as 10MW have been built. It is interesting to note that tidal energy is a renewable form of pumped storage.

Kinetic Energy Storage

Flywheels store kinetic energy which can be recovered as electricity and fed to the grid if the flywheel is connected to a generator and frequency converter.

The principal advantages of flywheels over the more commonly used batteries are:

- 97% charge-discharge efficiency, virtually independent of power
- 20-year life - 150k charge-discharge cycle
- up to 100kW for 15mins from a single unit; up to 20MW plants possible (200 flywheels)
- very low maintenance (every 1 to 6 years with magnetic bearings, major service every 20 years)
- wide temperature operating range (no HVAC requirements)
- fast charge and discharge cycles (seconds to minutes)
- accurate knowledge of the state of charge at all times
- no gas emissions, no electrolytes

The disadvantages of these systems is their 10 times higher capital costs per kWh.

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SMES Systems have the advantage that the energy storage is virtually lossless and the charge-discharge cycle is fast and highly efficient (about 95%) Energy can be drawn at very high powers, very quickly. Bulk storage is possible and the technology has been used experimentally in utility power systems but remains limited for reasons of cost.

Compressed Air Energy Storage

CAES is a relatively inexpensive energy storage technique, costing about 7 times less than batteries per kWh. It is has been used in 100MW systems in utilities and has been suggested for use with wind farms but there are no current examples at low or medium power. Theoretical adiabatic cycle efficiency can approach 100% but practical systems will tend to 70%.

Superconducting Magnetic Energy Storage SMES

SMES systems store energy in the magnetic field created by the flow of direct current in a superconducting coil which has been cryogenically cooled to a temperature below its superconducting critical temperature. The current free-wheels through diodes until such time as the load requires extra power when coil current is diverted to the DC link via a chopper.

Standard Peak Lopping Systems

Most peak lopping systems today use batteries which allow the lowest installation costs and as a leading supplier of UPS systems, Thycon has a 40-year experience of battery application and selection.

The choice of battery depends on usage: discharge depth, number of cycles, ambient temperature, peak power/duration and allowable recharge time. All these parameters will affect the choice of battery and in particular, its life expectancy which can lie between 3 and 15 years for lead-acid types. Limiting the discharge depth greatly extends battery life but also increases the capital costs as the depth is a function of nominal capacity. The application therefore needs to be clearly specified by the prospective user to ensure an optimal service life for given battery capacity.

Conclusions

The growth of renewable energy, with its inherent intermittence, is creating a new requirement for network power regulation whether for "peak lopping" or simply for storing excess energy harvests for times of need.Thycon's long experience of energy storage and high-power uninterruptible power supplies together with the latest generation of peak-lopping inverters makes Thycon a key supplier of regulation equipment to the solar energy industry.

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PLI Peak Lopping Inverter

AC Output	*PLI-400*	*PLI-800*	*PLI-1200*	*PLI-1600*
Nominal power	***400kW***	***800kW***	***1200kW***	***1600kW***
Operating voltage - VAC	240/415VAC	240/415VAC	240/415VAC	240/415VAC
Voltage range - deltaV	-10% +10%	-10% +10%	-10% +10%	-10% +10%
Operating frequency - Hz	50Hz	50Hz	50Hz	50Hz
Frequency range - delta Hz	+/- 3Hz	+/- 3Hz	+/- 3Hz	+/- 3Hz
Power factor	0.99	0.99	0.99	0.99
THD of output current	<5%	<5%	<5%	<5%
DC voltage (transformerless)	477VDC	477VDC	477VDC	477VDC
Efficiency	97.50%	97.50%	98%	98%
Cooling	Fan forced	Fan forced	Fan forced	Fan forced
Ambient temp range	+50 deg C	+50 deg C	+50 deg C	+50 deg C
Relative humidity (non-condensing)-RH	95%	95%	95%	95%
Enclosure IP rating (indoor/outdoor)-IP	IP 20/55	IP 20/55	IP 20/55	IP 20/55
Enclosed material	Powder coated steel	Powder coated steel	Powder coated steel	Powder coated steel
Overall dimensions (w x h x 1800)	1200x1000	1800x1000	2400x1000	2400x1000

Specifications are subject to change without notice

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