PAVING WAY FOR WIND POWER
Generation capacity that can be online in minutes generates major revenue for the owner.

As more and more power generated from the wind is being employed, new solutions are needed to make sure power grids remain stable. The global wind power capacity has nearly tripled in the last five years and the ever-increasing share of intermittent power is changing the way power systems are managed. The challenges also come with new possibilities. With the right technology at hand, substantial revenues can be attained. For more than a decade, Wärtsilä has provided cutting-edge wind following solutions.

WIND FOLLOWING
Some call it wind chasing or wind following, others wind firming. However, it remains a fact that the inherently variable output of wind generation has to be dealt with. Reliable backup power capability is, therefore, necessary to ensure electricity supply and grid stability.

The increased wind penetration is bound to lead to a more variable and intermittent dispatch of fuel-based generation. Fuel-based generation must be able to quickly reduce its output and shut down to make room for renewable generation, or
quickly start and load in order to make up for any shortfalls – due to either forecast errors or sudden reductions in wind generation output.

In power systems with a high degree of renewable power generation, conventional power plants will have to constantly respond to changing conditions, in order to make space for the fluctuating wind and solar output. Figure 1 illustrates how the new operational environment of fuel-based generation looks due to the introduction of considerable amounts of renewable capacity.

With the increasing share of wind power, the ability of a generator to cope with frequent starts and stops is essential. Combustion engine technology is unrivalled in terms of this kind of frequent cyclic operation. An easy analogy can be made to modern cars, with engines that stop at red lights, for reasons of emission reduction and fuel efficiency. Modern combustion engine-driven generators do the same, depending on the need for output. They can quickly be shut down and restarted without any operational penalties. This ability saves fuel, wear and emissions, as running the engines idle is not necessary.

Figure 2 shows a real case of wind following from the Colorado Dispatch Center, Xcel Energy. Simultaneously with the load peak in the morning, the output from the wind turbines starts to decrease quickly and steeply. The Plains End I & II Power Plant immediately responds and ramps up to its full output. As soon as the larger gas plants have caught up with the situation, Plains End I & II starts unloading and gradually returns to standby mode. The grid was at no point at risk.
A pre-heated Wärtsilä engine can start and be ready to synchronize in less than 30 seconds and go up to full load in 2 minutes, then completely unload in 30 seconds – only to immediately be ready to take load again. If the generating set has to be shutdown, it can be restarted within 5 minutes. This operational sequence is highlighted in Figure 3.

The operational flexibility, in terms of power output ramping capability of fuel-based generation, is valuable for grids with considerable amounts of wind power. High ramping capability and accurate power output control are essential in order to compensate sudden fluctuations in variable generation output, short-term forecast errors, and, in case of high penetration of non-dispatchable generation, to compensate for the effects of a decreased system inertia.

Besides short ramping times, another unique ability of Wärtsilä’s multiple unit power plants is cascading operation, which allows operational efficiency to be kept close to optimal at virtually all loading conditions. Cascading operation means that generating units are started and stopped according to the load or dispatch request. An example of this is shown in Figure 4.

A power plant consisting of 10 engines can easily run at 7% of nominal plant output without noticeable loss in fuel efficiency. If extremely low load operation is necessary, one single modern combustion engine can operate at a mere 10% of its nominal power for prolonged periods of time – corresponding to 1% of nominal plant output in the previous example.

VALUE OF WIND FOLLOWING
Aside from fast start-up capability, which gives the owners the ability to technically control the stability of their grid system, what is the actual monetary value of owning a wind following power plant?

Wärtsilä’s technology provides great economic benefits to its customers as markets are reducing the clearing time on the procurement of electricity. Markets are moving from one-hour-ahead procurement, to 15-minute intervals, and the future trend is heading for even shorter ones. This means that a plant with the ability to start and be at full output in five minutes, allows the owner to examine the market, start up the engines, and sell a 15-minute block of electricity if the market price is advantageous, then shut down and wait for cashing in the next market price spike. Such spikes could be caused
not only by sudden drops of wind power output, but also by rapid load increases.

Additional benefits of Wärtsilä’s technology are derived from the ancillary services market. These balancing services address short-term imbalances in electricity markets by rapidly dispatching resources, i.e. by quickly adjusting plant outputs in response to system load changes. The ability of Wärtsilä’s combustion engine technology to alternate between minimum and full load outputs at a 100%/minute rate when on automatic dispatch, is far superior to that of any other fuel-fired technology.

A second ancillary service is black start capability, referring to the ability to restart a grid that has blacked out. The possibility to re-energise a power system for very little additional cost makes the Wärtsilä technology a winner for this purpose.
Another branch of ancillary services where Wärtsilä technology excels is within system reserves. Traditionally, a large share of the balancing reserves in any power system must be “spinning”, i.e. the regulating power plants operate at part load. However, markets are increasingly changing their definition of spinning reserve, allowing plants to be in standby-mode – as long as they comply with reaching full plant output in a specific time, with 10 minutes being the most common time span. A significant cost benefit is hereby obtained by plant owners, who need not run their plants at minimum plant load with poor efficiencies, but instead can utilise rapidly-starting stand-by plants.

Firming up wind power with combustion engine-based power plants is not a future concept. These plants are already out there.

The increasing share of wind power generation creates a growing demand for ancillary services. The significance of being able to provide these services is that plant owners receive remarkable additional revenues, separate from the normal cash flow attained through the regular electricity market.
Wärtsilä is a global leader in complete lifecycle power solutions for the marine and energy markets. By emphasising technological innovation and total efficiency, Wärtsilä maximises the environmental and economic performance of the vessels and power plants of its customers. Wärtsilä is listed on the NASDAQ OMX Helsinki, Finland.