Optimal reserve operation in Turkey – frequency control and non-spinning reserves

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Abstract

Fast reserves are needed in order to cover for transients and grid stability challenges. With increasing variable renewable generation, the need for faster and more flexible generation is evident. Modern gas-fired internal combustion engines (ICE) with rapid controls are one of the most appropriate solutions for ensuring that generation meets demand at all times.

TEIAS, the Turkish TSO, has for many years requested testing to ensure compliance with power reserve operation. They have seen the benefits of fast responding primary and secondary reserves for grid stability operation. This paper will show cases of excellent reserve operation of ICE plants in Turkey.

Integration of intermittent renewables requires an increasing share of system reserves. Currently, a large share of these reserves has to be spinning in order to quickly be able to balance any fluctuations in supply or demand. In practice, this means that power plants have to operate at part-load which inevitably decreases their efficiency and increases their per kWh costs.

There is a more efficient way of providing a substantial part of these reserves by utilising flexible, fast-starting power plants. This even applies for secondary reserves, which are typically required to respond within 30 seconds after a contingency and reach their full output within 5–10 minutes. With ICE plants it is possible to fulfil these requirements without standby spinning. While in standby-mode, ICE reserves do not consume any fuel, generate any emissions nor suffer from wear. Moreover, the inefficient part-loading of larger power plants is reduced, which in turn allows the whole system efficiency to be further increased. Finally, by enabling a more stable operation profile for the larger plants, the additional maintenance costs connected with frequent cyclic operation can be reduced. In the second part of this paper, the value of introducing non-spinning reserves in Turkey will be studied.
Chapter 1 Introduction

Turkey - power generation and installed base

Conventional thermal power plants still dominate the electricity generation in Turkey. Gas-fired power plants account for a little above 45 per cent of the generation, followed by coal-fired generation with approximately 25 per cent. Hydro power also plays a central role in the Turkish generation fleet, accounting for some 23 per cent, whereas the other renewables altogether only produce some 4.5 per cent of the total generation. The generation share as of 2013 is illustrated on the left in Figure 1.

Since Turkey in 2001 started to gradually replace its state-dominated power market, the power generation capacity has quickly grown. In 2013 the Turkish generation capacity was already more than 60 GW and is expected to exceed 100 GW by 2020. Some 1.2 GW of this long-term capacity expansion will be in the form of nuclear power plants. The 2013 overall capacity division by technology is illustrated on the right in Figure 1.

![Figure 1. Generation share (produced GWh) vs. capacity share (installed GW) in Turkey 2013 [1].](image)

The quickly increasing electricity demand will likely impact the power system reserve margins in Turkey. Another factor contributing to an increased need of reserve capacity is the quickly growing wind power capacity. Finally, also the introduction of the nuclear power plants, i.e. very large individual units, will have a big impact on the need for reserves.

Reserves in power systems

All power systems require a certain reserve capacity, but the requirements in terms of size and dispatch speed differ considerably. The reserve requirements are defined in the grid code prepared by the transmission system operator (TSO), who is also responsible for maintaining system stability.

Reserve capacity for normal balancing service in any power system traditionally requires that the regulating power plants operate at part-load. On part-load operation, the plant efficiency is lower than at full output, and naturally less power is produced as well. Hence, there is a cost in providing such a service.

Reserve capacity serves two main functions in a power system and is typically defined as follows:

- To stabilise power grids by providing frequency control when there is a deviation between demand and production. The power plants that produce this continuous up and
down frequency regulation must be in operation, i.e. “spinning”, and adjust their load to maintain the delicate balance between demand and supply.

- To provide emergency reserve for maintaining system stability after contingencies such as a trip or failure in the existing power plant or transmission lines. Emergency reserve can be divided into three subcategories – primary, secondary and tertiary. Response times for each are categorised by a country’s grid codes.

In the European power system, there are four reserve control loops in place to arrest and restore the power balance and therewith the frequency deviation in the system:

1. **Primary control:** generators must act on the frequency deviation observed locally to cause the *frequency to be arrested* at a certain stable level.

2. **Secondary control:** for each control area in the European grid (usually a country), the TSO has a control algorithm that calculates how the power set-point of the control area should be changed to *restore power balance and free up primary control*.

3. **Tertiary control:** after secondary control reserves are used, Tertiary control will *free up secondary control reserves*, in order for the system to be able to respond to the next contingency.

4. **Balancing / Time control:** the integral of the frequency is monitored at system level. If this integral starts to deviate too much from the nominal frequency, the frequency set-point will be adjusted to compensate: *Balancing*.

So, to simplify in one sentence; the main role of the primary reserve is to stop the frequency dip during a transient, the secondary control should bring the frequency back to nominal and free-up the primary reserves while the tertiary reserves can be seen as a backup to the earlier. An overview of this reserve operation is provided in Figure 2.

![Figure 2. European power system, the four reserve control loops and typical times [2].](image-url)
Chapter 2 Reserve operation in Turkey

In this chapter, a review of the operation of the reserves in the Turkish power system will be given.

Primary reserve

When an emergency situation occurs, e.g. a plant trips, the inertia of the system maintains system stability during the first few seconds. The primary reserve then automatically responds to the frequency deviation in the system. As soon as the frequency falls below a set limit, this reserve starts to ramp up without any dispatcher involvement. The primary reserve has to be spinning since the required response time is typically 5-10 seconds and it has 30-60 seconds to ramp up to its full output. In Turkey these time limits are 2 seconds and 30 seconds, respectively.

The minimum size of this reserve capacity is typically equal to the biggest generating unit in the power system, or sometimes the largest grid connection contingency, so that if the largest unit trips, the spinning reserve kicks-in before the system collapses. However, the primary reserve requirement of the Turkish power system is actually smaller and has further decreased from 770 MW to 300 MW, owing to the ENTSO-E interconnection [3].

In Turkey, the TSO TEIAS define that the power generation units should meet the primary reserve regulation set point within 30 seconds, typically tested with a 10% step test. An initial reaction of the generating unit should be seen within 2 seconds. Since the ENTSO-E interconnection, the typical plant primary reserve is 1%.

Wärtsilä commissioned in February 2011 a 52.4 MW gas power plant for Harput Tekstil to the city of Gediz, fairly close to Izmir in Turkey. The HG Enerji power plant consists of six generating sets based on the gas-fired internal combustion engine Wärtsilä 34SG. In Figure 3 results from the Primary Frequency Control testing with 10% reserve (0.873 MW of the generating set output of 8.73 MWe) can be seen. The initial reaction of 2 seconds is met as well as reaching the new set point well in advance of the required maximum 30 seconds. The generating set operation is very stable as can be seen, even though the sample rate for the measurements is 100 ms.

Figure 3: Primary Frequency Control 10% validation at HG Enerji Power Plant in Turkey
TEIAS requires testing of Primary Frequency Control support on both under- and over-frequency operation and the clear results of rapid action and very stable operation of the generating set can be seen in Figure 4.

![Figure 4: Generating Unit active power control response test to simulated system frequency steps (-200 mHz - 0 - +200 mHz) at HG Enerji Power Plant in Turkey.](image)

**Secondary reserve**

The purpose of the secondary reserve is to relief the primary reserve back to its normal condition. It is controlled on-line by the system operator and must be capable of responding in 30-60 seconds depending on the power system. In Turkey, this time limit is 30 seconds. It typically has 5-10 minutes to ramp up to its full output, thereby fully relieving the primary reserve. This time limit is ~15 minutes according to the existing Turkish regulations, however, it will soon be reduced to 5 minutes due to coming regulation changes.

In Turkey the secondary reserve is currently provided in two different ways [3]. Part of this reserve capacity is provided with hydro power, which is a very fast form of regulating power. However, the hydro power allocated for reserve capacity cannot be used for power generation, meaning that some additional thermal generation has to make up for the corresponding amount of hydro reserve. Secondly, gas-fired power plants are utilised for providing secondary reserves.

Typically, the amount of secondary reserve has to cover the full primary reserve and is typically ~ 2 % of total generation capacity connected to the grid. In Turkey, the secondary reserve requirement is currently considerably smaller at 770 MW [3].

Gas engines with very rapid response and fast control provides a perfect match for grid stability and secondary reserve operation. Figure 5 shows a real case from a 150 MW, 8 x Wärtsilä 50SG, power plant in Turkey. In this power plant SCADA screenshot (WOIS, Wärtsilä Operator’s Interface System), the plant set point signal provided to the power plant over a RTU (Remote Terminal Unit) from the TEIAS Grid Control centre is showed with black trend pen colour. The power plant total active power output is showed with red trend pen colour. As can be seen the power plant is following the grid set point immediately and exactly. This, even to the point that it is difficult to distinguish the difference between the control signal from the grid and the plant output following. The two trend pens are more or less on top of each other.
As highlighted in Figure 5, a reserve balancing need from 21 to 127 MW is provided within 37 minutes with some up/down balancing in between. This power plant can provide up/down regulation of a remarkable 48 MW / minute.

In 2014 the total secondary reserve requirement was 770 MW in Turkey and the clear majority of that reserve is provided by fast responding Wärtsilä gas engines. The TSO TEIAS have clearly recognised that this technology can provide a controllable response, the update rate of control set point sent to the plant for the reserve is 1 second and the gas engine driven power plants respond immediately.

Figure 5: Secondary reserve, grid balancing operation with a 150 MW, 8 x Wärtsilä 50SG, power plant in Turkey. The black pen is the grid control set point and the red pen is the power plant output with immediate and exact following.

**Tertiary reserve**

The tertiary reserve has the task of relieving the secondary reserve for the next contingency. It is normally non-spinning and the operation mode is manual i.e. phone calls are the normal way of activating the reserve, and it typically needs to respond in 10-15 minutes. In Turkey the response time for the tertiary reserve is 15 minutes.

The tertiary reserve is traditionally non-spinning capacity, typically large simple cycle gas turbines. During the period for which this reserve is procured, it should in most markets under no circumstances participate in the energy markets i.e. it is only to be used in case of a system fault i.e. contingency. Again the necessary reserve capacity has to do with the largest single contingency i.e. the largest system unit, and with the replacement of the full secondary reserve; the minimum provision is typically around 2-3 % of total capacity on the grid.

Although several different models and criteria for determining the capacity of the tertiary reserve exist, it is very common in Europe to match its size according to the largest unit in the system. This e.g. applies for the power systems of Spain (and additionally 2 % of the expected load during the considered period) [4], France [5], Austria [6] and Kosovo [7]. In Turkey’s case, the above would mean that the tertiary reserve would be the size of the capacity of the Atatürk dam, i.e. 2400 MW.
When there is a trip in the system, the primary reserve is automatically activated first by the frequency dip. The primary reserve is released when the secondary reserve is activated and takes over the load from the primary reserve and so on.

Chapter 3 Smart Power Generation

Smart Power Generation (SPG), in the form of modern gas internal combustion engines (ICE), offers three simultaneous features that are valuable in this context:

- High efficiency – between 45 and 50% simple cycle plant net efficiency at site and up to 54% in combined-cycle mode. In a typical multi-unit installation efficiency remains the same over the wide load range of 3–100%-
- Operational flexibility – fast starting, stopping and ramping, without impact to the maintenance schedule
- Fuel flexibility – natural gas, LNG, biogases, fuel oil (HFO, LFO) and liquid biofuels can be used and switched amongst each other

SPG offers a new way to stabilize power systems. With astonishing performance of starting from stand-by to grid synchronized in 30 seconds, and ramping up to full load in less than 5 minutes, it can provide a secondary reserve function from stand-still, with no fuel cost and emissions. This concept allows low load operation to be no load operation since the units can be started immediately.

SPG is a proven technology based on modern computerised combustion engines. Plant sizes range typically from 20 MW to 600 MW which is the optimum size range for system optimization.

With the Turkish perspective, the operational flexibility features with fast ramping, is one of the key performances that have been appreciated by the TSO and thus also by the customers, a case of this will be presented in the next chapter.

Chapter 4 20% Primary Frequency Control Operation

As discussed earlier, the typical plant primary reserve in Turkey is 1%, but the performance is tested with a 10% step test. At a 7 x Wärtsilä 50SG, 130 MW power plant in Turkey, successful operation of secondary frequency operation has been conducted since 2012, similar to the case presented in Figure 6. In addition to the secondary frequency control operation, the plant started to operate with the full 10% of primary frequency control in the autumn of 2013. In December 2013, the customer approached Wärtsilä to evaluate the possibilities to start to operate with 20% primary frequency control, requesting for a faster ramp rate allowing to reach 3,7 MW within 30 seconds on a unit level.

The Wärtsilä 18V50SG is the world’s largest gas-powered internal combustion engine based generating unit and has outstanding reserve load ramping performance. A unit operating at its nominal operating temperatures can ramp up from 10% to 100% in just 42 seconds, thus providing an excellent base for answering the Turkish customer request for 20% primary frequency control operation.
Updated ramp rates were provided to the customer and the official 20% primary frequency control tests were conducted in January 2014. From February 2014 onwards the customer has been able to operate with the 20% primary frequency control in addition to the secondary control which in a way can be seen more as a balancing operation. This case is a perfect example of full utilisation of one of the three corners of the SPG, the Operational Flexibility, which have been further enhanced for this customer and their operation.

Considering that the plant was primarily intended to operate in base load operation, thanks to very fast reserve operation, the customer could extend its ancillary services with first the 10% and then 20% primary frequency control with minor control system parameter changes. The time-to-market timeline of 2 months with the 20% primary frequency control was also very short in this excellent case.

Chapter 5 Non-Spinning Secondary Reserve

One of the most interesting features with SPG based on Wärtsilä gas engines is the 30 seconds to reach synchronization from a stand-by operation, stopped mode. This enables a non-spinning secondary reserve operation where a vast majority of reserves can be in stand-by and both fuel and water usage and emissions minimized. According to several studies (examples from UK and California, USA), substantial system level savings can be made, since other existing conventional generation reserves can be minimized and thus the total system efficiency will be higher [9] [10] [11].

5.1 Technological challenge

Most traditional thermal plants are based on steam cycles and offer good efficiency by using high pressure superheated steam in their processes. Starting and stopping power plants with such cycles is always a major undertaking, a slow process requiring modest heat-up rates. Starting these power plants in less than 1 hour exposes the technology to high thermal stresses and causes wear and tear. Start-up times for coal-fired power plants are around 4 hours in hot stand-by conditions, and 1-1.5 hours for gas turbine combined cycles.
It is obvious that such thermal plants cannot provide any off-line services to the system stability requiring 5 seconds to 15 minutes start-up times. As a consequence, both primary and secondary reserves need to be online i.e. “spinning”. However, running thermal power plants on part-load considerably reduces their efficiency, hence increasing the fuel consumption and emissions. In the case of Turkey, considerable amounts of such ramp-up capacity is currently kept continuously available.

The question is: is there a more optimal way of operating the power system assets, and still provide the necessary stability services?

5.2 Optimizing the Turkish power system with Smart Power Generation

Making complete use out of the potential of the hydro power assets in Turkey is at the top of the list in the strategic plan of the Turkish Ministry of Energy and Natural Resources [12]. From a national perspective, in order to make the most use of the hydro power in Turkey, this non-fuel-consuming power could entirely be allocated for power generation, i.e. for providing baseload electricity.

Instead of hydro-based reserves, gas-fired power plants could provide full system reserves. In this paper, the use of Smart Power Generation vs. the use of combined cycle gas turbines (CCGT) will be assessed.

Table 1 presents a summary of the proposed optimisation of the use of reserves in Turkey, in terms of allocating the different plant types to power generation vs. reserve provision, based on their fuel consumption. Next, these two scenarios for providing the gas-fired reserves will be assessed.

Table 1. Fuel consumption for power generation and providing reserves (secondary & tertiary).

<table>
<thead>
<tr>
<th>Plant Type</th>
<th>Power Generation</th>
<th>Reserve provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydro</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SPG</td>
<td>X</td>
<td>~0</td>
</tr>
<tr>
<td>CCGT</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

The traditional way of providing secondary reserves with thermal units, such as CCGTs is to keep them spinning, i.e. operating on part-load. This way, the units are able to increase their output rapidly, but at the cost of constantly running below their nominal efficiency.

The amount of required secondary reserve in Turkey is 770 MW. As the required response time is 30 seconds, the gas-fired share of this capacity is today spinning. The grid code also clearly stipulates that this should be spinning.

Both secondary and tertiary reserve capacity could be provided by SPG, which would be non-spinning i.e. on stand-by, burning no fuel and generating no emissions, waiting for a system operator’s activation signal and then starting and synchronizing to the grid in just 30 seconds. The main change to the current situation is that the secondary reserve would not need to be spinning anymore. Furthermore, the primary reserve could be relieved 50 % faster than at the
present requirement, in 5 minutes instead of 10. This would naturally reduce the vulnerability of the system.

By using SPG for secondary reserve, some of the older, inefficient combined cycles, that provide the service now, could be stopped, and the other ones could be loaded to full or almost full load, providing additional base load power or serving as primary reserve. This would increase the electrical efficiency of all CCGT plants and it would lower the electricity price as the most expensive generators would be stopped.

Providing tertiary reserves the size of the capacity of the largest unit, i.e. Atatürk dam 2400 MW, with a required response time of 15 minutes, could naturally also be done with SPG. Although it is stipulated that this can be non-spinning, spinning units are used at the moment due to a lack of suitable non-spinning capacity. SPG could also provide this service more efficiently, much better than the old steam power plants that typically end their lifecycles in this function.

5.3 National savings

Freeing up the CCGT-capacity that is currently kept for emergency reserve, and stopping the older CCGTs through the use of SPG could deliver significant system level savings for Turkey.

How could the savings be evaluated?

In the first scenario, it is assumed that only CCGTs are used as reserve providers. Let us do a safe assumption that the reserve provision is distributed evenly within the Turkish gas-fired fleet, represented by CCGTs. That means that the CCGTs are running on part-load in order to provide reserves. The total gas-fired capacity is about 22.6 GW and if all the CCGTs participated in providing 3.17 GW of secondary and tertiary reserves it would mean that all the CCGT plants would need to run with 14% lower output to provide reserves.

In the second scenario, those CCGTs would not need to operate on part-load anymore and reserves could be provided by non-spinning SPG-units, impacting the total efficiency of the whole system. Increasing the CCGT output by 14 % has an impact on CCGT’s efficiency which is 2.8 % (i.e. 1.4 %-unit for typical CCGT which has 48-55 % efficiency). The relation between output and relative efficiency can be seen in Figure 7.

1. Increase output by 14 %
2. Impact on efficiency 2.8 %
Figure 7. H-Class CCGTs (2-2-1 configuration) relative efficiency\textsuperscript{1} [13].

Even only replacing the secondary reserves with SPG would yield considerable savings. With the total secondary reserves at 770 MW, i.e. 3.4\% of the total CCGT capacity, SPG would enable an increase in the electrical efficiency of each CCGT plant by 0.3 \%-unit.

The technical impact of introducing 3.17 GW or 770 MW of flexible SPG capacity is described in detail in Table 2 below.

\textit{Table 2. Technical calculation}

<table>
<thead>
<tr>
<th>Technical impact</th>
<th>Replacing 3170MW reserves</th>
<th>Replacing 770MW reserves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total CCGT capacity providing reserves</td>
<td>MW</td>
<td>22 598</td>
</tr>
<tr>
<td>Required reserves</td>
<td>MW</td>
<td>3 170</td>
</tr>
<tr>
<td>Reserves share of total CCGT capacity (each CCGT could increase its output this amount if there would not be any need to provide reserves)</td>
<td>%</td>
<td>14.0%</td>
</tr>
<tr>
<td>Impact on each CCGT’s efficiency when increasing output by above row %</td>
<td>%</td>
<td>2.8%</td>
</tr>
<tr>
<td>Fuel consumed [14], [15] (historical)</td>
<td>TWh</td>
<td>202.0</td>
</tr>
<tr>
<td>Fuel consumed (optimized)</td>
<td>TWh</td>
<td>196.3</td>
</tr>
<tr>
<td>Reduction in fuel consumption</td>
<td>TWh</td>
<td>5.7</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>2.8%</td>
</tr>
</tbody>
</table>

According to a recent forecast from the U.S. Energy Information Administration the Henry Hub spot price for natural gas will rise to $7.65/MMBtu in 2040, i.e. an increase of almost 60 \% from today’s $4.80/MMBtu [15]. Assuming that a similar price development will take place in Turkey, replacing 3.17 GW of CCGT reserves with flexible SPG will provide annual fuel cost savings of €175 million (at 2013-2040 average gas price) and the cost of the investment can be paid back in 10.8 years. Correspondingly, replacing 770 MW of CCGT reserves with

\textsuperscript{1} Even though some of the CCGT fleet capacity is currently not in use, the starting point for this calculation does not affect the results, since the relation between output and relative efficiency is almost linear.
SPG will yield savings of €43 million per, with the same payback time. The detailed economic impact of replacing the CCGT reserve capacity with SPG units is shown in Table 3.

**Table 3. Financial calculation**

<table>
<thead>
<tr>
<th>Financial impact (average gas price 2013-2040)</th>
<th>Replacing 3170MW reserves</th>
<th>Replacing 770MW reserves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel price (average 2013-2040) [16]</td>
<td>TL/GJ 30,16</td>
<td>TL/GJ 30,16</td>
</tr>
<tr>
<td></td>
<td>€/MWh 30,96</td>
<td>€/MWh 30,96</td>
</tr>
<tr>
<td>Fuel cost, historical dispatch</td>
<td>Mill € 6 253,7</td>
<td>Mill € 6 253,7</td>
</tr>
<tr>
<td>Fuel cost, optimized dispatch</td>
<td>Mill € 6 078,2</td>
<td>Mill € 6 211,1</td>
</tr>
<tr>
<td>Fuel cost savings</td>
<td>Mill € 175,5</td>
<td>Mill € 42,6</td>
</tr>
<tr>
<td>SPG capacity needed</td>
<td>MW 3 170</td>
<td>MW 770</td>
</tr>
<tr>
<td>Investment cost (EPC)</td>
<td>€/MW 0,600</td>
<td>€/MW 0,600</td>
</tr>
<tr>
<td>Total investment cost</td>
<td>Mill € 1902</td>
<td>Mill € 462</td>
</tr>
<tr>
<td>Savings per year</td>
<td>Mill € 175</td>
<td>Mill € 43</td>
</tr>
<tr>
<td>Simplified payback time</td>
<td>years 10,8</td>
<td>years 10,8</td>
</tr>
</tbody>
</table>

**Chapter 6 Conclusion and Summary**

Smart Power Generation based on gas engines provides numerous and unique combinations of valuable features with multiple operation modes and fuel flexibility allowing clear benefits for power system operators and power producers.

In Turkey, both the customers and the total power system have found clear value in modern combustion engines being very suitable for grid stability support. Reserve operation is excellent, fast and efficient both in primary and secondary frequency control mode. The latest case of 20% primary frequency control, officially approved by TEIAS, is yet another development where the operational flexibility is further developed and applied according to customer requests and system needs.

The new potential of non-spinning secondary reserve is the next interesting value enhancement from a total power system perspective. When considering renewable integration ensuring fast and efficient load following, SPG based on gas engines is the obvious choice.

By introducing fast-starting, non-spinning, gas-fired power system reserves, Turkey would be able to utilise its hydro power resources to the fullest, instead of allocating them for reserve provision. Moreover, with the increasing risk of power shortages prior to the commissioning of the new nuclear power plants, Turkey also needs to consider installing reserve capacity that can be brought on stream quickly. SPG provides a highly viable alternative with construction times of less than 1.5 years.

The addition of these flexible gas-fired power plants will not only fill a potential power gap but will allow the entire system to operate more efficiently and economically by providing system reserve capacity with higher efficiency and lower costs, even after new large base load capacity comes online.
To allow the use of SPG as secondary reserve, the grid code would have to be modified to allow the secondary reserve to be non-spinning.

Summary of benefits of the Smart Power Generation solution for Turkey:

- A quick remedy for the acute capacity deficit – delivery of 3 GW within 1.5 years
- Contribution to power system stability through rapid Primary Frequency Control
- Contribution to power system stability through rapid secondary reserves
- Annual savings of €175 million compared to using only spinning CCGT-units for provision of reserves
- Reduced import of gas – up to 2.8% per year
- Lower wholesale electricity price
- Reduced CO₂ emissions
- Improved system stability due to faster replacement of primary reserves – 5 minutes instead of 10 minutes
- Improved reserve readiness for the quickly growing wind power capacity
- Improved reserve readiness for the adding large individual nuclear power plants

Finally, the key features of SPG and the value they provide are presented in Table 4.

Table 4. Key values and features with SPG based on multiple gas engines.
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[4] Resolución de 13-7-2006, BOE 21/07/06.