5.2. Use of storage technologies for ancillary services provision and its potential for climate change mitigation

Appendix B

Methodology for calculating the Regulatory Reserve Requirement

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Appendix B

Methodology for calculating the Regulatory Reserve Requirement

The calculation of the Regulation Reserve requirement is made on an hourly basis, considering the components that have a very short-term effect on the load-generation balance of the system. These components are as follows.

1.- Demand of the National Interconnected System (SIN)

· *Typical day profile*: An ideal profile of the real behaviour of the demand is considered.

· *Hourly demand change*: the hourly demand is examined to determine the direction and magnitude of the changes every 10 minutes, based on the typical profile selected.

· *Demand Variability*: The hourly standard deviation is determined by the type of variation increase/decrease, based on changes in demand every 10 minutes.

2.- Scheduled net exchange

· *Changes in programmed net exchanges*: The hourly changes of the programmed net exchange are included, considering the ramp value and the magnitude of the programmed exchange.

3.- Industrial Load

· *Typical variations*: The typical behaviour of the real differences of the industrial load is taken into account.

· *Hourly gap*: In this topic, the industrial load is determined every ten minutes, an average of the 10-minute differences corresponding to the increases or decreases of the industrial load is achieved.

· *Hourly variability*: The standard deviation of the hourly variations of the increments and decrements is determined separately using the averages of the industrial load obtained every 10 minutes.

4.- Wind Generation

· *Previous day profile*: The actual generation profile of the last day is considered, or if necessary that of the previous day that has elapsed closest to the calculation date.

· *Time difference*: In this topic, we obtain the 10-minute variations of the wind power generation and we get the average of these variations separately from the increases and decreases during the hour. The reductions will impact the calculation of the regulatory requirement to increase, while the additions to the amount of the regulation reserve to decrease.

· *Hourly Variability*: The standard deviation of wind generation is determined using the averages attained every 10 minutes.

5.- Results

The amounts collected for each component are added together to obtain the total number of the regulatory reserve requirement. Based on historical information, it is verified that the hourly obligation is such that it guarantees the load-generation balance at each moment and that the established reliability standards are complied with.

Methodology for the spinning reserve requirement calculation

The calculation of the spinning reserve requirement is made based on the provisions of the manual for the verification of dispatch instructions and ancillary services. For the forecast, the average hourly demand of a typical day is taken into account, and the percentage established in the manual for the spinning reserve requirement is attained.

Area reserve requirements

Based on the actual behaviour of the reserves, hourly distribution factors by area are obtained, through which the CENACE distribute the calculated requirements.

The secondary frequency control reserve

It is activated to balance production and consumption. Therefore, the reserve varies in function of the size and portfolio considered. Within the Union for the Co-ordination of Transmission of Electricity (Europe) (UCTE), the calculation of secondary reserves originates from an empirical formula [UCPTE (1991)]. This formula was developed during the seventies from half-hourly measurements of production and consumption. The means used at that time were relatively limited, such as hand-calculation based on the information given by phone by operators of generating units. The first formula has then evolved. Table B.1 provides an overview of the evolution of the secondary reserve R_{sec}, by considering a few systems within the UCTE and depending on the available information. The current UCTE formula (i.e., since 2004) is a compromise based on all the previous methods. However, TSOs prefer to take margins to increase the security of the system, especially during fast variations of the load. Lastly, note that the UCTE recommends that the loss of the largest unit in the zone be compensated by both secondary and fast (i.e., deployed in less than 15 min) tertiary frequency control reserves [UCTE (2004b)].

Table B.1 Recommendations for secondary reserve in some systems within the UCTE

At least since	System	Fórmula	References
1991	Germany	$R_{sec} = \frac{1}{2}\sqrt{\frac{2500}{\hat{P}_{\max\ generación}}}\,\hat{b}\,\hat{P}_{\max\ generación}$ $\hat{P}_{\max\ generación}$ = estimate of the peak generation for the day (in MW)	UCPTE (1991)

At least since	System	Fórmula	References
		$\hat{b}$ = estimated power deviation in % related to $\hat{P}_{\max\ generación}$. The average of $\hat{b}$ was around 3.5%, and the maximal value 9% during rapid load fluctuations (6-9 h)	
1991	France	$R_{sec} = 2.8\sqrt{\hat{P}_{consumo}}$ R_{sec} = 0.02 $\hat{P}_{consumo}$ during rapid load fluctuations $\hat{P}_{consumo}$= estimate of the internal consumption (in MW)	UCPTE (1991)
1991	Italy	R_{sec} = 0.0125 $\hat{P}_{consumo}$	UCPTE (1991)
1998	Spain	$R_{sec} = 3\sqrt{\hat{P}_{\max\ consumo}}$ $R_{sec} = 6\sqrt{\hat{P}_{\max\ consumo}}$ during rapid load fluctuations and energy $\hat{P}_{\max\ consumo}$= estimate of the maximal internal department consumption (in MW)	Industria Española (1998)
2004	UCTE	$R_{sec} = \sqrt{10\,\hat{P}_{\max\ consumo}} + 22500 - 150$	UCTE (2004b)
2006	France	R_{sec} = min(500, $\sqrt{10\,\hat{P}_{\max\ consumo}} + 22500 - 150$) $Rsec = \frac{GradienteDemanda}{6}$ If the demand gradient is higher than 12000 MW/h	Texier-Pauton (2007)

UCTE: Union for the Co-ordination of Transmission of Electricity (Europe)

UCPTE Union for the Co-ordination of Production and Transmission of Electricity (Europe)

The UCTE formula is a compromise between previous methods, which were developed during the seventies when the portfolio and the measurement means were different than what is available today.