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Article

Determination of the required Power Response of Inverters to provide fast Frequency Support in Power Systems with low Synchronous Inertia

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Abstract: Decommissioning of conventional power plants and the installation of inverter-based renewable energy technologies decreases overall power system inertia. This reduction in system inertia has an impact in the power system frequency response when an imbalance between generation and load occurs, increasing the rate of change of frequency (RoCoF) of the system. In a future scenario where renewables are predominant in power systems and due to the natural variability of the resource, imbalances of 40% or more are prompt to happen. When a system is islanded or operates as such and combined with low inertia, it may lead to frequency collapse. This expected high values of RoCoF shorten the response time needed before load shedding or generation curtailment take place and a subsequent possible black out occurs. Through the simulation of two scenarios with different primary reserve response, the requirements for the fleet of connected inverters was determined in terms of activation time and total power to be provided in order to avoid load shedding. This activation time was determined to be the time at which frequency would reach the load shedding value, known as critical time. With such value and knowing the time required for the synchronous reserve to deploy the imbalance power, a simple expression based on nullifying RoCoF at the critical time was obtained for the required inverter based fast power reserve. It was obtained that full activation time for inverter fast power reserve with penetration above 80% of inverter based generation would need to be between 50-500 ms for imbalances up to 40%; meaning that current frequency measurement techniques and renewable deployment times would not ensure system stability under the foreseen future possible power system conditions. A power ramp in the order of 300% the load per second is necessary for fast power reserve to maintain frequency within the allowed limits.

Keywords: frequency support, flexibilization, renewables, inverters

0. How to Use this Template

1. Introduction

2. Results

This section may be divided by subheadings. It should provide a concise and precise description of the experimental results, their interpretation as well as the experimental conclusions that can be drawn.

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29 description of the experimental results, their interpretation as well as the experimental
30 conclusions that can be drawn.

31 *2.1. Subsection*

32 2.1.1. Subsubsection

33 Bulleted lists look like this:

34 • First bullet
35 • Second bullet
36 • Third bullet

37 Numbered lists can be added as follows:

38 1. First item
39 2. Second item
40 3. Third item

41 The text continues here.

42 *2.2. Figures, Tables and Schemes*

43 All figures and tables should be cited in the main text as Figure 1, Table 1, etc.

Figure 1. This is a figure, Schemes follow the same formatting. If there are multiple panels, they should be listed as: (**a**) Description of what is contained in the first panel. (**b**) Description of what is contained in the second panel. Figures should be placed in the main text near to the first time they are cited. A caption on a single line should be centered.

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entry 1	data	data
entry 2	data	data

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48 *2.3. Formatting of Mathematical Components*

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$$a + b = c \tag{1}$$

50 Please punctuate equations as regular text. Theorem-type environments (including propositions,
51 lemmas, corollaries etc.) can be formatted as follows:

52 **Theorem 1.** *Example text of a theorem.*

The text continues here. Proofs must be formatted as follows:

Proof of Theorem 1. Text of the proof. Note that the phrase 'of Theorem 1' is optional if it is clear which theorem is being referred to. □

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3. Discussion

Authors should discuss the results and how they can be interpreted in perspective of previous studies and of the working hypotheses. The findings and their implications should be discussed in the broadest context possible. Future research directions may also be highlighted.

4. Materials and Methods

As it was explained in chapter 2, the transitory frequency response of the system and therefore its stable and reliable operation after a perturbation, depends on the inherent characteristics of the power system and the counteraction measurements engaged automatically by the system (primary reserve). As the share of inverter based generation increases, the more sensible to instability the power system becomes. In this sense the added inverter based fast power reserve must be capable of maintaining transitory frequency value within the allowed limits. Two terms commonly found in the literature of power system stability will be used along this section:

- **Inertia constant (H):** It has units of seconds (s) and it is the ratio of the kinetic energy stored in the rotating masses of the generators (E_k in MWs) and its nominal capacity (S_{nom} in MVA).

- **Acceleration time constant (T_a):** It also has the units of seconds (s) but this is the ratio of double the kinetic energy (MWs) and generators nominal power output (P_{nom} in MW).
  Acceleration time constant is a measure of the robustness before disturbances of the system. It could be interpreted as the required time to remove the kinetic energy from the rotating masses of the generators connected in a grid, at the rate of the supplied power load. Hence, the higher the time constant, the higher the kinetic energy available. Nowadays Europe's acceleration constant is around 14 seconds [1]. As the share of synchronous generations decreases, this constant decreases proportionally.

With f as frequency, f_0 as nominal frequency and ΔP as power imbalance the swing equation can be expressed as follows:

$$\frac{df}{dt} = \frac{\Delta P * f_0}{2 * H * S_{nom}} = \frac{\Delta P * f_0}{T_a * P_{nom}} = \frac{\Delta P * f_0}{2 * E_k} \tag{2}$$

To describe the penetration of inverter based generation into the grid, these terms can be related to the overall power system. Even though the inertia constant H is most commonly used in the literature; the term of system acceleration time constant T_a is used instead when the penetration of non-synchronous generation in a power system is evaluated ref this due to the fact that it relates the load real power term (MW). In this section the steps and methods applied in order to calculate the required inverter based fast power reserve to maintain frequency stability are presented as well as the inclusion of control strategies to enable wind turbines in the power system to provide inertial power.

4.1. Synthetic Inertia

Synthetic is one of the new techniques that manufactures and researchers are considering to tackle with the low inertia problem in power systems [23, 24]. Frequency support through synthetic inertia was considered with the following assumptions [6, 25]:

1. Power output from synthetic inertia is limited to 10% of wind turbine nominal power.

2. Due to mechanical and thermal stresses, the additional power can be delivered only for a maximum time of 10 s.
3. It is assumed that all wind turbines operate at its maximum power output. The value of 1.5 MW was selected for such purpose.
4. In order to avoid wind turbine stall, the removed kinetic energy from the blades (injected to the grid in electrical form) it is limited to half [26].

To be able to extract energy from the rotating blades of the wind turbine, an adequate control system is needed. From the expression of power as the derivative of energy and the kinetic energy stored in the blades, the rate of energy extracted from the wind turbine can be obtained, considering that rotational speed changes in time ref.

$$P_{pu}(t) = 2 * H_{wt} * \omega_{pu}(t) * \frac{d\omega_{pu}(t)}{dt} \tag{3}$$

Where H_{wt} is the turbine inertia constant and ω_{pu} the rotational speed in per unit.

Equation (3) represents the rate of change of kinetic energy is extracted from the rotating masses from the wind turbine in per unit. Such equation was implemented in SIMULINK with the addition of a gain block K_i, in order to inject more power from the very beginning of the power imbalance. A filter at the signal entrance was added in order to suppress non desired oscillations on the system [24, 25]. Typical values for inertia constant of wind turbines are not openly available from the manufacturers to the public. Hence an approximate value was calculated with the utilization of an equation which relates nominal power and inertia constant for wind turbines [27].

$$H_{wt} \approx 1.87 * P_{nwt}^{0.0597} \tag{4}$$

For a wind turbine with nominal power output of 1.5 MW the value of H corresponds to 4.37 s [28]. It is assumed that all the wind turbines, when operating, are delivering their nominal power output. A nominal rotational speed of 18 rev/min was considered [28]. To avoid the wind turbine to stall, a reduction of 5 rev/min it is allowed by the implementation of the control system. This change of rotational speed equals a change of 3 MWs reduction on kinetic energy out of a total of 6 MWs.

Table 2. : Constants for implementation of synthetic inertia

| T_{wt}	H_{wt} (s)	P_{wt} (MW)	K_i
1	4.37	$1.5*n_{wt}$[1]	10

4.2. Inverter based fast Power Reserve

If a power system is subjected to a negative power imbalance and it is assumed that no load is rejected at UFLS frequency, the frequency continues dropping below 49 Hz. The time at which the system frequency equals the UFLS value is then called critical time. This is the maximum available time for the inverter based reserve to deploy the required power to the system.

In the critical condition that would lead to load shedding, it is expected from the IBFPR to at least to counteract the RoCoF at the critical time, as illustrated in Figure 3 2. Recalling (2); it is necessary that the machine's accelerating power (power imbalance) become zero at the critical time.

$$P_a(t_{cr}) = P_{mech} - P_{elec} + P_{IBFPR} = 0 \tag{5}$$

---

[1] Number of wind turbines with synthetic inertia control
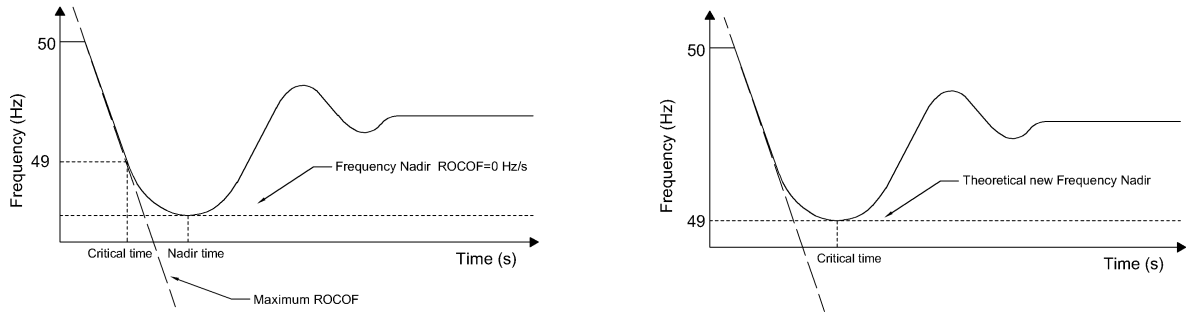
(a) Typical frequency response leading to UFLS

(b) Desired frequency response avoiding UFLS

Figure 2. In (**a**), frequency response goes below the 49 Hz, leading to UFLS at the critical time, whereas in (**b**) the IBFPR is applied avoiding ULFS. In this case the power imbalance is compensated at the critical time by the inverters.

Where P_a is accelerating power, P_{mech} is mechanical power, P_{elec} is electrical power load, t_{cr} is the critical time and P_{IBFPR} is inverter based fast power reserve. From the assumption of a linear mechanical deployment given from the synchronous machines governors, the rate of change in mechanical power, after a power imbalance ΔP, is given by $\Delta P/t_{nadir}$, where t_{nadir} represents the time at which the frequency nadir occurs. Given the power balance (5) at the critical time, t_{cr}; the IBFPR response must be equal to $P_{elec} - P_{mech}$, being P_{elec} equal to ΔP.

Substituting P_{mech} by $\Delta P * t_{cr}/t_{nadir}$ and P_{elec} by ΔP in (5), the following expression is obtained for the P_{IBFPR} at time t_{cr}:

$$P_{IBFPR}(t_{cr}) = \Delta P * (1 - t_{cr}/t_{nadir})$$ (6)

It is assumed that P_{IBFPR} remains with a constant power output after t_{cr} long enough to stabilize the system frequency. The result of the previous equation represents the slope of the power output since the inception of the incident until the critical time, which with the implementation of IBFPR, it will be not any longer critical but rather it will be the new desired frequency nadir time.

$$P_{IBFPR}(t) = \frac{\Delta P * (1 - t_{cr}/t_{nadir}) * t}{t_{cr}}$$ (7)

According to the obtained expression; it can be realized that the desired power response from the inverters depends exclusively on parameters which cannot be directly measured from the grid connection point. In a real situation the values of ΔP, t_{nadir} and t_{cr} cannot be known in advance, representing this factors a challenge in the implementation of this ideal power response. Those values are dependent on the grid characteristics; depending on the primary conventional reserve deployment time and the overall system inertia [18]. Thus two main cases are considered for the remaining analysis with the intent of covering a wider range of systems with different characteristics.

4.3. Simulation Cases

As presented in the previous section, the values of critical time and frequency nadir time depend on the system imbalance and primary reserve deployment time. In chapter 2 it was illustrated the different governor response for different primary reserve type. To be able to assess the influence of the grid size and the primary reserve characteristics, two main cases are considered. In all cases is assumed that the initial steady frequency is the nominal 50 Hz.

- **Small scale grid case:** For the evaluation of this case; typical governor data is considered in a well-known and studied benchmark grid topology as the WSCC model, also known as the IEEE 9 bus model. Synchronous reserve deployment is in the order of a few seconds due to governor response [7, 11].

Scenario A-Simplified Model: The power system is represented by an equivalent single machine model in which losses are neglected. It is investigated the critical time for inverters' activation and the required IBFPR is also determined. Furthermore, the impact of synthetic inertia and the frequency measurement delay in frequency response is analyzed.

Scenario B-Extended Model: All the power system components (transmission lines, transformers, exciters and governors of the three generators) and its dynamic characteristics are considered in the IEEE 9 bus model.

- **Large scale grid case:** The European grid scale in which all the synchronous machines are modeled and simplified as one single machine, provided with the characteristic expected from the overall system. Synchronous primary reserve deployment is in the order of $\sim$ 30 s [1, 19]. Island frequency response is assumed to be the same that the European response analyzed by ENTSOE ref.

4.4. Simplified IEEE 9 bus Model

As a first step to evaluate the impact of inverter based generation and power imbalances in the grid, the whole system is simplified as one single generating unit; neglecting all losses in the system (Transformers, transmission lines and generators) with the assumption that the mechanical output of the prime mover is the same than the electrical power output at generator terminals. Table 3 gives an overview and summary of the elements comprising the base model

Table 3. :Elements of the IEEE 9 bus model.

	Quantity
Buses	9
Transformers	3
Transmission Lines	6
Generators	3
Load	3 (315 MW)

Figure 3 is the block representation of the swing equation (2), it only differs in the fact that a source representing the inverter based generation has been included. This power source output would typically remain constant during an imbalance. The mechanical power is represented by the output of a steam turbine governor model, which is used to represent the synchronous machine [8]. The addition of the former sources represents the total generation. When steady state conditions are met, the accelerating power resulting from the subtraction of the load from the total generation is zero. When equilibrium is lost, the accelerating power is multiply by the transfer function $1/(2 * H * S)$, where H is the machine's inertia constant and S is the machine's power rating. From 2 this product equals the derivative of frequency, therefore an integrator block, denoted by $1/s$ is added to obtain the frequency response [7, 21, 22]. A feedback loop is added and an error signal obtained from the reference frequency so the synchronous machine can react as frequency deviates from nominal. The values of kinetic energy and time constants of a synchronous machines of 835 MVA were selected to represent the synchronous response, with the load of 315 MW the system acceleration time constant is 14 s [8], which is approximately today's Europe acceleration constant [1]. This is the base scenario, assuming 100% synchronous generation. To evaluate the impact of the penetration of inverter based generation; the values of lower capacity generators were selected [8].

Even though load imbalances up to 40% were simulated in each inertia scenario, the power capacity limit of the generators was disregarded for estimation of the critical time. The negative imbalance was simulated by increasing the system load by the corresponding factor. A block diagram representing the system in the given conditions was designed in MATLAB-SIMULINK. All the acquired
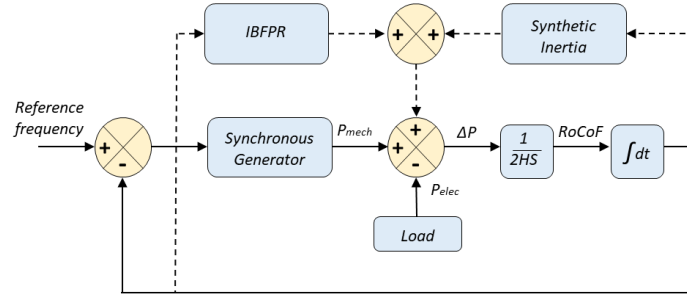
Figure 3. Blocks linked by the solid line represent the conventional swing equation given by (2). Represented with doted lines, the respective frequency signals to the blocks of IBFPR and synthetic inertia, which add power to the system.

values of critical time, as result from the simulations, are then related with the system RoCoF, so a regression can be performed and link the critical time with system RoCoF.

4.5. Extended IEEE 9 bus Model

Since it is desired to compare the results of the system with such simplifications against some model that takes into account the whole system components, losses and dynamics; An extended representation of the IEEE 9 bus model was implemented in SIMULINK [20]. In this representation, simulations for different values of system inertia and load imbalance were performed, similarly as it was done with the simplified representation of the model. Figure 4 shows the extended IEEE 9 bus grid architecture with IBG added. In order to evaluate the validity of the equation describing the IBFPR
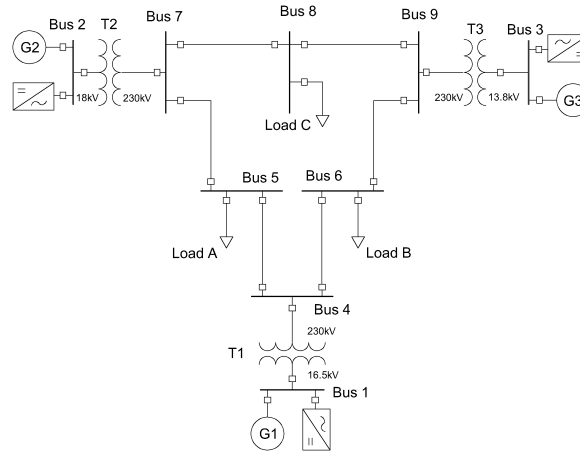
Figure 4. One line diagram of the IEEE 9 bus model. At the same bus of the generating units the inverter based frequency response has been added.

needed to avoid ULFS, the IEEE model was modified with the insertion of ideal controlled power sources blocks, which were set up to inject power into the grid accordingly to the simulated scenario. Therefore, no means of frequency measurement were included and only IBFPR was assessed. Similarly as it was done in section 4.4, the total acceleration time constant of the system equals 14 s. Hence the same kinetic energy should be distributed among the three generators' rotating masses in the extended model as in the simplified representation. From (8) for system acceleration time constant, it can be easily calculated that the system kinetic energy with 14 s (100% synchronous generation) is 2205 MWs.

$$T_{sys} = (2 * E_k)/P_{load} \tag{8}$$

Due to the fact that inverter based generation reduces the system kinetic energy; for different levels of inverter based generation, the generators nominal capacity values were kept constant and the

185 inertia constant of each machine multiplied by the synchronous share factor (fss). Total system kinetic
186 energy is the summation of all units together. In this way, the synchronous generators in the initial
187 state of equilibrium represent both power sources, inverter based plus synchronous.
188 In order to start the simulations in steady state, a load flow calculation of the grid was carried out
189 with the objective of calculating the initial conditions for the exciter and prime mover models. Table4
190 summarizes the main values for setting system initial conditions; acquired from the power flow tool
191 provided by SIMSCAPE.

Table 3 2:

Table 4. : Steady state initial conditions of the system

Bus number	Bus Type	Voltage (pu)	Active Power (MW)	Reactive Power (MVAr)
1	Slack	$1.04\,\underline{/0°}$	72.2	25.64
2	PV	$1.025\,\underline{/9.83°}$	163	8
3	PV	$1.025\,\underline{/4.63°}$	85	-9.41
5	PQ	$0.9949\,\underline{/-4.42°}$	125	50
6	PQ	$1.01211\,\underline{/-4.16°}$	90	30
8	PQ	$1.0172\,\underline{/0.17°}$	100	35

192

4.5.1. IBFPR Representation

194 Similarly as it was done in the simplified block model, a subsystem is implemented in the extended
195 model in order to represent the IBFPR and analyze the system behavior with the addition of this power.
196 To do so, the IBFPR was modeled as controlled current sources; such controlled sources inject active
197 power according to the load imbalance and system inertia simulated. The continuous measurement of
198 voltage is required in order to determine the amount of current needed to supply the requested power.
199 Figure 3 12 depicts the schematics of the IBFPR control.

The ports are connected at the medium voltage side of the system (generator's side). The
resistance must have a high value (negligible current flowing through); this is a requirement for the
implementation of SIMSCAPE current sources. Figure 3 12 shows the block diagram implemented to
obtain the positive symmetrical component of line voltage and the positive sequence of current that
will be provided by the subsystem to meet to needed power from the ramp input depending on the
voltage readings. From the definition of complex power and voltage symmetrical components in three
phase systems, the positive sequence component of phase voltage and line current are obtained. The
positive sequence component of complex power is equal to the complex balanced power [21]:

$$S^1_{3\varphi} = 3 * V^1_{LN} * \bar{I_L}^1 \tag{9}$$

This equation is valid for RMS values of voltage and current; nevertheless the measured voltage values
and the sought current values are given in peak values, the equation for power and current become:

$$S^1_{3\varphi} = \frac{3 * V^1_{LNpeak} * \bar{I_{Lpeak}}^1}{2} \tag{10}$$

$$I^1_{Lpeak} = \frac{2 * \bar{S}^1_{3\varphi}}{3 * V^1_{LNpeak}} \tag{11}$$

With the help of the **a** operator $(-0.5 + j\sqrt{3}$ or $1\underline{/120°})$ the values of the positive sequence component of phase voltage can be obtained.

From $V_a + V_b + V_c = 0$ and $V_a^1 = \frac{V_a + aV_b + a^2V_c}{3}$:

$$V_a^1 = \frac{V_a + aV_b - a^2V_b - a^2}{3}$$
$$= \frac{V_a * (1 - a^2) + aV_b * (1 - a)}{3}$$

Since $V_{an}^1 = \frac{V_a^1}{\sqrt{3}\underline{/30°}}$, $\sqrt{3}\underline{/30°} = 1 - a^2$ and $\sqrt{3}\underline{/-30°} = 1 - a$ then after some algebraic manipulation the expression for V_{an}^1 becomes:

$$V_{an}^1 = \frac{V_a - a^2V_b}{3} \tag{12}$$

With the obtained expressions for the positive sequence of phase voltage and complex power, the needed current to supply the IBFPR related to the measured voltages can be implemented. The ramping function will last until the critical time is reached, afterwards, the IBFPR output will remain constant.

4.6. Large Scale Case: Europe Power System

Under normal operation ENTSOE has reported values of RoCoF in the range of 5-10 mHz/s for power outages of 1 GW in the current interconnected power system. If an imbalance event of more than 3 GW occurs with depleted primary reserve, extraordinary values of frequency and RoCoF might be reached. After serious disturbances the Continental European Power System has experienced RoCoF between 100 mHz/s and 1 Hz/s. Imbalances of 20% or more along with RoCoF greater than 1 Hz/s have been determined by experience to be critical [1]. ENTSOE has determined that under the case of the reference scenario (The loss of 3 GW generation with 150 GW load and 2%/Hz self-regulation) in the interconnected operation, the influence of inverter based generation, and therefore the reduction of system inertia would not jeopardize system stability. Due to the expected increase of non-synchronous generation in the future, international power trade and renewables variability; ENTSOE estates in its future split reference scenario that the power system must be capable of withstanding imbalances greater than 40% with RoCoF of 2 Hz/s or higher. Under these circumstances the resulting islands must avoid load shedding. Hence, only the split scenario is considered for further analysis.

When considering the system blackout of November 4th 2006, in which four electric islands resulted from the European system split; system blackout due to under frequency was experienced in the so known western area. This island, at the moment of split, had approximately a load of 190 GW (27% more than the low load ENTSOE scenario) [29]. For its comparable 'size' and the uncertainty of knowing beforehand the resulting islands after a major contingency, the selected load for simulation was the same as the ENTSOE reference scenario as well as the primary reserve deployment time. To simulate the behavior of the resulting island in the European split scenario; a simplified approach was selected. Similarly as it was done with the simplified block model for the IEEE 9 bus model, in the equivalent European representation all the synchronous generation will be represented by a single machine, which will provide governor response when a perturbation takes place. Additional to the synchronous response, a load response of 2% was added to the model, which means that for every Hertz reduced or augmented, the load will reduce or increase by a 2% [1].

Figure 3 15 depicts the results of ENTSOE for the interconnected reference scenario frequency response model. It is intended that the implemented model for the island would perform in a similar way like the ENTSOE model for the same conditions [1]. To fit the behavior of the system to the modeled by ENTSOE, a PID controller was added in the SIMULINK micro-grid model to the steam

237 turbine governor; this was done with the intention of adjusting the time response of the primary
238 reserve as much as possible to the desired one. With the PID approach, the primary power reserve
239 can be easily tuned with the assistance of the Control System Tuner App available in MATLAB. The
240 period of time of utmost interest for analysis is from the inception of the power imbalance and the
241 nadir time. Therefore, the system must perform as similar as possible in this region compared to the
242 ENTSOE reference, whereas after the nadir time, the disparity between responses can be neglected. In
243 the European scale the reserves must be completely deployed within 30 s after the occurrence of the
244 disturbance.

245 4.6.1. System Parameters

A power system of n number of synchronous machines is assumed; having each of them a capacity
S in MVA, a nominal power P_n in MW. Assuming that each machine operates at a de-load factor dl of
P_{nom}; with an acceleration constant equal to T_{nom} then the number of machines n, for the load $P_{syncload}$,
served by synchronous machines is:

$$n = \frac{P_{syncload}}{P_{nom} * dl} \tag{13}$$

Then the time acceleration constant of the system T_{sys} can be obtained as follows:

$$\begin{aligned}
T_{sys} &= \frac{\sum_{i=1}^{n} P_i * T_i}{P_{LOAD}} \\
&= \frac{n P_{nom} * T_i}{P_{LOAD}} \\
&= \frac{P_{syncload} * T_{nom}}{P_{LOAD} * dl} \\
&= \frac{Syncshare * T_{nom}}{dl}
\end{aligned} \tag{14}$$

246 In this sense the base system time acceleration constant (synchronous share 100%) is calculated
247 from the values of $T_{nom} = 10$ s [1, 8], synchronous share $Syncshare = 1$, and a de-load factor $dl = 0.8$
248 having as a result $T_{sys} = 12.5$ s The values of the PID controller and the step response characteristics of
249 the model are set in order to have a step response with 2% overshoot and a time constant of 8 seconds
250 [22]. Step response before and after PID tuning can be observed in Figure 3 and Figure 3 . Considering
251 only the swing equation, as done in the model, it can be demonstrated that the RoCoF and therefore
252 the frequency response of the system is only dependent on the percentage of load imbalance and the
253 system acceleration time constant. From the definition of RoCoF as $\frac{df}{dt} = \frac{\Delta P * f_0}{2 * E_k}$ and $T_{sys} = \frac{2 * E_k}{P_{LOAD}}$:

$$\begin{aligned}
\frac{df}{dt} &= \frac{\Delta P * f_0}{P_{LOAD} * T_{sys}} \\
&= \frac{\Delta P_{pu} * f_0}{P_{LOAD} * T_{sys}}
\end{aligned} \tag{15}$$

254 In Equation 3 14, the value of ΔP_{pu} is the normalized value of power imbalance having as base power
255 the value of load P_{LOAD}. As shown in the equation, when only the swing equation is considered,
256 the frequency response is only dependent on system acceleration constant and the relative value of
257 imbalance. This relative value of imbalance varies during time, depending on load response to change
258 on frequency and the response of primary reserve of the system.

259 **5. Conclusions**

260 This section is not mandatory, but can be added to the manuscript if the discussion is unusually
261 long or complex.

6. Patents

This section is not mandatory, but may be added if there are patents resulting from the work reported in this manuscript.

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Abbreviations

The following abbreviations are used in this manuscript:

MDPI	Multidisciplinary Digital Publishing Institute
DOAJ	Directory of open access journals
TLA	Three letter acronym
LD	linear dichroism

Appendix A

Appendix A.1

The appendix is an optional section that can contain details and data supplemental to the main text. For example, explanations of experimental details that would disrupt the flow of the main text, but nonetheless remain crucial to understanding and reproducing the research shown; figures of replicates for experiments of which representative data is shown in the main text can be added here if brief, or as Supplementary data. Mathematical proofs of results not central to the paper can be added as an appendix.

Appendix B

All appendix sections must be cited in the main text. In the appendixes, Figures, Tables, etc. should be labeled starting with 'A', e.g., Figure A1, Figure A2, etc.

References

1. Author1, T. The title of the cited article. *Journal Abbreviation* **2008**, *10*, 142–149.
2. Author2, L. The title of the cited contribution. In *The Book Title*; Editor1, F., Editor2, A., Eds.; Publishing House: City, Country, 2007; pp. 32–58.

Sample Availability: Samples of the compounds ...... are available from the authors.