Comments on Andrew Roscoe's data- Part 1

Introduction

A number of changes have been proposed by several members of the work group that change the meaning of several definitions in the existing GBGF Grid Code.

These definition changes have been made to clarify the operation of the GBGF technology as defined in the existing GBGF Grid Code, but they do not change the basic actions of the GBGF technology.

By producing a list of the definition changes makes it easier to understand the changes in the next edition of the GBGF Grid Code and also makes it easier to consistently implement the changes.

The 8 definition changes are listed below followed by the corresponding new legal text.

1. The word "**Real**" is now "**Active**" to align with the existing Grid Code drafting in a consistent format.
2. The words "**Phase Jump Active Power**" are now "**Active Phase Jump Power**".
3. The words "**Real Inertia Power**" are now "**Active Inertia Power**".
4. The words "**Damping Active Power**" are now "**Active Damping Power**".
5. The words "**Control Based Real Droop Power**" are now "**Active Control Based Droop Power**".
6. The words "**Control Based Real Power**" are now "**Active Frequency Response Power**.

   This is to better define the active power produced by a GBGF- I inverter after a delay of one second by the actions of the control system for a consistent change in AC Grid frequency.
7. The words "**Grid Forming Active Power**" is a new definition.

   This is to confirm that **Active Grid Forming Power** is the inherent active power produced by GBGF technology that includes **Active Inertia Power** plus **Active Phase Jump Power** plus **Active Damping Power.**
8. The words "**ROCOF Response Power**" are now "**Active RoCoF Response Power**".

   This is to confirm that **Active RoCoF Response Power** is the sum of **Active Inertia Power** and **Active Frequency Response Power** to enable the design of a GBGF- Inverter to be optimised to give the maximum active power for a consistent change in AC Grid frequency.

For each of these definitions the new Legal text are:

Active Phase Jump Power	The transient **Active Power** transferred from a **Grid Forming Plant** to the **Total System** as a result of changes in the phase angle between the **Internal Voltage Source** of the **Grid Forming Plant** and the **Grid Entry Point** or **User System Entry Point**. In the event of a disturbance or fault on the **Total System**, a **Grid Forming Plant** will instantaneously supply **Active Phase Jump Power** to the **Total System** as a result of the phase angle change. For **GBGF-I Plant** as a minimum value this is up to the **Phase Jump Angle Limit Power**. **Active Phase Jump Power** is an inherent capability of a **Grid Forming Plant** that starts to respond naturally, within less than 5 ms, and can have frequency components to over 1000 Hz.
Active Inertia Power	The injection or absorption of **Active Power** by a **Grid Forming Plant** to and from the **Total System** during a **System Frequency** change. The amount of **Active Power** supplied or absorbed by the **Grid Forming Plant** is a function of the energy storage capability of the **Internal Voltage Source** and **ROCOF** or, in the case of an **HVDC System**, is a function of the **Active Power** provided by either the **Remote End HVDC Converter Station** or some extra **Plant**. For the avoidance of doubt, this includes the rotational inertial energy of the complete drive train of a **Synchronous Generating Unit**. **Active Inertia Power** is an inherent capability of a **Grid Forming Plant** to respond naturally, within less than 5 ms, to changes in the **System Frequency**.

	For the avoidance of doubt the **Active Inertia Power** has a slower frequency response compared with **Active Phase Jump Power**
Active Damping Power	The **Active Power** naturally injected or absorbed by a **Grid Forming Plant** to reduce **Active Power** oscillations in the **Total System**. More specifically, **Active Damping Power** is the damped response of a **Grid Forming Plant** to an oscillation between the voltage at the **Grid Entry Point** or **User System Entry Point** and the voltage of the **Internal Voltage Source** of the **Grid Forming Plant**. For the avoidance of doubt, **Active Damping Power** is an inherent capability of a **Grid Forming Plant** that starts to respond naturally, within less than 5 ms to low frequency oscillations in the **System Frequency**.
Active Control Based Droop Power	**The Active Control Based Power** output supplied by a **Grid Forming Plant** through controlled means (be it manual or automatic). For **GBGF-I Plant** is equivalent to that of a **Synchronous Generating Unit** with a traditional governor coupled to its prime mover. **Active Control Based Droop Power** is used by **The Company to** control **System Frequency** changes through the instruction of **Primary Frequency Response** and **Secondary Frequency Response**.
Active Frequency Response Power	**Active Frequency Response Power** is the transfer of **Active Power** injected or absorbed by a **Grid Forming Plant** to and from the **Total System** during a deviation of the **System Frequency** away from the **Target Frequency**. For a **GBGF-I Plant** this is very similar to **Primary Response** but with a response time to achieve the declared service capability (which could be the **Maximum Capacity** or **Registered Capacity**) within 1 second. For **GBGF-I Plant** this can rapidly add extra **Active Power** in addition to the phase-based **Active Inertia Power** to provide a system with desirable **NFP** plot characteristics. **The Active Frequency Response Power** can be produced by any viable control technology.
Grid Forming Active Power	**Grid Forming Active Power** is the inherent **Active Power** produced by GBGF technology that includes **Active Inertia Power** plus **Active Phase Jump Power** plus **Active Damping Power**.
Active RoCoF Response Power	**ROCOF Response Power** is defined as the **Active Inertia Power** developed from a **Grid Forming Plant** plus the **Active Frequency Response Power** that can be supplied by a **Grid Forming Plant** when subject to a rate of change of the **System Frequency.**

SGRE Item 1.1.

If you are not offering to provide and being paid for any GB Grid Forming “GBGF” services then you only need to comply with the standard Grid Code as the GBGF Grid Code section is non-mandatory.

If you are being paid for any GBGF services, including being in a standby mode at low power, then you must comply with the requirements of new GBGF Grid Code as and when it is approved by the Regulator (Ofgem).

The service that must be provide are the power levels defined by each supplier for a specific equipment in the data charts listed in the GBGF Grid Code.

For the avoidance of doubt the rating values defined for the **Phase Jump Active Power**, the **Active RoCoF Power** and the **Active Damping Power** are the values that can be provided by a specific compliant equipment.

SGRE Item 1.2.

The aim of the GBGF Grid Code is present the main features of a GBGF system.

Your suggestion to add the ENTSO-E data is a good proposal but in our opinion this data is best moved into the introductory section of the GB Grid Forming **Best Practice Guide**. It should also be noted that the Grid Code sets out the high level requirements but is not intended as a detailed technical / functional specification covering every detail. This approach has been used in the Grid Code over the last 30 years with further detail added through the Bilateral Connection Agreement or other User Guides / Standards.

The main reason for this is that is very difficult to change the Grid Code once it is approved while the **Best Practice Guide** can be easily amended as the GBGF technology develops and in the light of further industrial experience.

The expert group for the **Best Practice Guide** should be starting very soon and this is one of key topics to be included in the guide.

SGRE Items 1.3 and 1.4

The SGRE comments have been carefully considered and by combining the comments of both these sections has resulted in the changes defined in the **Introduction.**