Generic Business Use Case: Contribute to the efficient integration of intermittent renewable energies in the Electric Power System

***1 Description of the use case***

***1.1 Name of use case***

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| ***Use case identification*** | | |
| ***ID*** | ***Area /Domain(s)/ Zone(s)*** | ***Name of use case*** |
|  | Area: Energy System  Domain: Energy Storage | GBUC-Contribute to the efficient integration of intermittent renewable energies in the Electric Power System |

***1.2 Version management***

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| ***Version management*** | | | | |
| ***Version No.*** | ***Date*** | ***Name of author(s)*** | ***Changes*** | ***Approval status*** |
| 0.1 | 2014.03.10 | Joseph Maire, Gauthier Delille | First draft (name, short description) | WD Working Document |
| 0.2 | 2014.05.27 | Denis Bonneau | Complements | WD Working Document |
| 0.3 | 2014.07.24 | Joseph Maire, Gauthier Delille | Complements (scope, objective) | WD Working Document |
| 0.4 | 2014.09.18 | Gauthier Delille | Complements (complete description, Smart Grid Functions) | WD Working Document |

***1.3 Scope and objectives of use case***

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| ***Scope and objectives of use case*** | |
| ***Scope*** | Use of an Electrical Energy Storage associated physically (hybrid plant) or not (virtual plant) to a solar or wind farm connected to the transmission or distribution network.  Small generation capacities (with a power inferior to 5MW for instance) are out of the scope of the Use Case. |
| ***Objective(s)*** | * Facilitate the integration of renewable energy sources onto the grid, by limiting their local impacts, enabling their contribution to the functioning of the electric power system, reducing their grid connection and access costs and delays, or balancing their intermittent power supply. |
| ***Related business case(s)*** | * Deliver EES services at best cost. |

**1.4 Narrative of Use Case**

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| ***Narrative of use case*** |
| ***Short description*** |
| The Generic Business Use Case describes how the EES Operator delivers services at the request of the Producer in order to facilitate the integration of a plant in the Electric Power System. |
| ***Complete description*** |
| Renewable Energy Sources such as solar or wind farms are variable and uncertain by nature, and for the most part, interfaced with power electronics convertors. These specificities limit their penetration in power systems in conditions ensuring system security and without implementing support measures that can be costly for the collectivity. Furthermore, a majority of these generation capacities are connected to distribution networks, which have historically not necessarily been designed to accommodate large shares of decentralised generation. This may lead to grid connection costs that can be very high for the collectivity.    Energy Storage can be used to mitigate the specificities of renewable energy sources and therefore facilitate their integration onto distribution networks and power systems more generally. Applications may include short-term fluctuations smoothing – which can impact the quality of supply (flicker) –, the valorisation of unavoidable energy with time shifting, reduced grid connection costs and delays with production peak shaving, or the balancing of intermittent power supply – especially in small or island power systems.  It should be noted that the applications described below are not necessarily exclusive but may be combined. For instance, a Producer may use an EES to optimize the value of renewable energy with time-shifting, while ensuring a constant power output.  ***1-Reduce the costs implied by the provision of ancillary services support***  In some systems, Producers may be required to provide ancillary services to System Operators in order to ensure system security. For instance, they may be asked to provide active power reserve to contribute to frequency regulation. In this case, part of the available renewable energy cannot be sold. To avoid this loss, storage can be used to provide control power, instead of a voluntary degradation of primary energy conversion. This service enables a Producer to maximise the use of his available power. In addition, its use allows the Producer to provide guaranteed control power to the system, which would not be possible otherwise because of the variability of renewable sources.  ***2-Limit local disturbances induced by the intermittent power supply of renewable energy sources***  Renewable energy sources are by nature uncertain and variable. Their intermittent power supply may cause operational challenges, such as flicker, particularly in weak grids. In such cases, storage can be used to absorb or inject active power in order to mitigate voltage fluctuations caused by short-term variations of the renewable energy source’s power supply. From the Producer’s standpoint, it offers an alternative to conventional options, such as the upgrade of circuits and/or transformers or the installation of capacitators or static VAR compensators.  ***3-Store unavoidable energy following a power limitation request***  Storage can be used to store energy produced by a renewable energy source which would not be supplied in case the Grid Operator requests the Producer to limit his power in order to prevent operational problems. The Producer may contract such a service with an EES Operator.  A power limitation request can be sent by the Grid Operator to the Producer upon detection of a constraint on the network (overcurrent, risk of violation of the voltage limits, etc.). The use of storage could allow the Producer to respond to the request with a limited generation loss.  The Producer requests the EES Operator to store the energy which cannot be exported because of the power limitation request. The EES Operator charges the storage and informs the Producer.  ***4-Valorise unavoidable energy with time shifting***  Storage can be used to store electric energy during off-peak periods and inject it during peak periods, when its price is high. This allows the Producer to maximise his profits while offering energy when it is most needed by the Power System.  ***5-Guarantee a production schedule elaborated before real-time operations (capacity firming)***  As described above, power output from renewable energy sources vary over short (ramping) or long periods of time. Storage can be combined with a renewable energy generation in order to make the power output somewhat-to-very constant. This may reduce the need for dispatchable generation capacity to accommodate these rapid changes or counterbalance forecasts errors. In other words, storage can be used to guarantee a generation schedule of otherwise as-available generation sources. The storage could in this case be an alternative to the use of on-site/local dispatchable generation, such as Diesel fuelled generators for instance.  The Producer elaborates short-term generation forecasts.  Based on these forecasts, the Producer elaborates a schedule (in day-ahead for instance) and sends it to the EES Operator.  The EES Operator uses the storage in real-time operations to reduce the difference between the schedule and real generation output. |

**1.5  *Key Performance Indicators***

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| ***Key performance indicators*** | | | | |
| ***ID*** | ***Name*** | ***Calculation*** | ***Scope*** | ***Objective*** |
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***1.6  Use case conditions***

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| ***Use case conditions*** |
| ***Assumption*** |
| * Some of the services described in the Use Case require that regulatory mechanisms such as renewable energy power purchase obligation (feed-in tariffs) are not implemented. |
| * A contract between the Producer and the EES Operator is in place. |
| ***Prerequisite*** |
| * Real-time communication interface between the EES Operator and the Producer. |
| * Configuration of the EES. |

***1.7 Further information to the use case for classification / mapping***

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| ***Classification information*** |
| ***Relation to other use cases*** |
| GBUC-Make necessary contracts with customers and relevant parties |
| GBUC-Configure EES to be able to provide services to relevant parties |
| GSUC-Make measurements at PCC (f, V) |
| GSUC-Compute power reference in real-time |
| GSUC-Charge storage |
| GSUC-Discharge storage |
| GSUC-Make measurements of renewable sources instant power |
| GSUC-Perform renewable energy forecasts |
| GSUC-Elaborate a charge/discharge schedule |
| ***Level of depth*** |
| Short version |
| ***Prioritisation*** |
|  |
| ***Generic, regional or national relation*** |
| Generic |
| ***Nature of the use case*** |
| Business Use Case |
| ***Further keywords for classification*** |
| Renewable Energy Sources, ancillary services support, time shifting, capacity firming |

**1.8 General remarks**

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| ***General remarks*** |
| Some of the services described in the Use Case may not necessarily be relevant in large power systems, but have a particular interest in island power systems.  Besides, to be efficient from a technical and economic perspective, some of these services would require the use of large storage units.  Considering the current technological state of EES systems, some of these services may not be cost-efficient, their costs exceeding their overall benefits. The combination of EES services and their provision to various stakeholders of the Electric Power System may be considered as a cost-efficient solution to share the benefits of storage. |

**2 Diagrams of use case**

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| ***Diagram(s) of use case*** |
| *Use Case Overview diagram*    *Domain Overview diagram*    *BUC-SUC Relations diagram* |

***3 Technical Details***

***3.1 Actors***

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| ***Actors*** | |
| ***Grouping*** | ***Group Description*** |
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| ***Actor name*** | ***Actor type*** | ***Actor Description*** | ***Further information specific to this Use Case*** |
| --- | --- | --- | --- |
| EES Operator | Role |  |  |
| Producer | Role |  |  |
| Grid Operator | Role |  |  |
| System Operator | Role |  |  |

***3.2 References***

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| ***References*** | | | | | | |
| ***No.*** | ***References Type*** | ***Reference*** | ***Status*** | ***Impact on use case*** | ***Originator / organisation*** | ***Link*** |
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***4 Step by step analysis of use case***

***4.1 Overview of scenarios***

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| ***Scenario conditions*** | | | | | | |
| ***No.*** | ***Scenario name*** | ***Scenario description*** | ***Primary actor*** | ***Triggering event*** | ***Pre-Condition*** | ***Post-Condition*** |
| 1 |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |
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***4.2 Scenarios***

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| **Scenario name:** | | **No. 1 – X** | | | | | | |
| ***Step No.*** | ***Event*** | ***Name of process/ activity*** | ***Description of process/ activity*** | ***Service*** | ***Information producer (actor)*** | ***Information receiver (actor)*** | ***Information exchanged (IDs)*** | ***Requirements   R-IDs*** |
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| **Scenario name:** | | **No. 2 – X** | | | | | | |
| ***Step No.*** | ***Event*** | ***Name of process/ activity*** | ***Description of process/ activity*** | ***Service*** | ***Information producer (actor)*** | ***Information receiver (actor)*** | ***Information exchanged (IDs)*** | ***Requirements   R-IDs*** |
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| **Scenario name:** | | **No. 3 – X** | | | | | | |
| ***Step No.*** | ***Event*** | ***Name of process/ activity*** | ***Description of process/ activity*** | ***Service*** | ***Information producer (actor)*** | ***Information receiver (actor)*** | ***Information exchanged (IDs)*** | ***Requirements   R-IDs*** |
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***5 Information Exchanged***

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| ***Information exchanged*** | | | |
| ***Information exchanged ID*** | ***Name of information*** | ***Description of information exchanged*** | ***Requirements IDs*** |
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***6 Requirements (optional)***

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| ***Requirements (optional)*** |

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| ***Category ID*** | ***Categories for requirements*** | ***Category description*** |
|  |  |  |
| ***Requirement ID*** | ***Requirement description*** | |
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| --- | --- | --- |
| ***Category ID*** | ***Categories for requirements*** | ***Category description*** |
|  |  |  |
| ***Requirement ID*** | ***Requirement description*** | |
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***7 Common Terms and Definitions***

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| ***Common Terms and Definitions*** | |
| ***Term*** | ***Definition*** |
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***8 Custom Information (optional)***

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| ***Custom Information (optional)*** | | |
| ***Key*** | ***Value*** | ***Refers to Section*** |
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