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European Network of
Transmission System Operators
for Electricity

ENTSO-E
GENERATION AND LOAD SHIFT KEY IMPLEMENTATION GUIDE

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Revision History

Version	Release	Date	Comments
0	0	2015-12-18	First drafting of the document based on discussion with CGMES project team on data exchanges.
0	1	2016-01-16	Version taking into account the comments issued after WG EDI review.
1	0	2016-01-21	Version approved by Market Committee

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1 Objective

The purpose of this document is to enable the exchange of information related to generation and load shift key (GSK and LSK).

GSK and LSK are to be used together with an individual grid model (IGM) or a common grid model (CGM) as soon as studies are to be carried out. Indeed, they enable to handle the changes in generation profile or load profile, e.g. ,on a base case as starting point, carry out a study if there is an increase of X MW in the total load (compute the new load profile at the electrical nodes to comply with the change of load as well as the new generation injections).

Different modes to apply GSK and LSK are existing; the purpose of this document is not to state the most suitable one but only to provide a way to exchange this information.

This document describes the data model of the GSK and LSK document.

2 The GSK and LSK data exchange process

2.1 Overall business context

The GSK and LSK are computed by the TSO in charge of the area and provided to the actors who needs to carry out network studies; these network studies could be coordinated transmission capacity calculation, flow-based market coupling, network studies, etc.

Generation shift key are needed to transform any change in the balance of one bidding zone into a change of injections in the nodes of that area.

Generation and load shift keys are elaborated on the basis of the forecast information about the generating units and loads. In order to avoid newly formed unrealistic congestions caused by the process of generation shift, TSOs should be able to define both generation shift key (GSK) and load shift key (LSK):

- Generation shift: GSK constitute a list specifying those generators that shall contribute to the shift.
- Load shift: LSK constitute a list specifying those load that shall contribute to the shift in order to take into account the contribution of generators connected to lower voltage levels (implicitly contained in the load figures of the nodes connected to the EHV grid).

GSK and LSK are defined for:

- A bidding zone, named in the document as “a”.
- A time interval: GSK and LSK are dedicated to individual daily hours in order to model differences between peak and off-peak conditions per TSO.

If GSK and LSK are defined, a participation factor is also given:

- G(a) Participation factor for generation nodes in area “a”,
- L(a) Participation factor for load nodes in area “a”.

The sum G(a) and L(a), for each area, is to be equal to 1 (i.e. 100%).

Then depending on the calculation methods, TSO can define the following information associated to each generation and load nodes:

- participation factor,
- or maximum and minimum absolute power,
- or maximum and minimum relative power.

2.2 Business Description

Four types of shift can be defined in GSK and LSK lists:

- Proportional to base case generation or load;

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- Proportional to the participation factors;
- Proportional to the remaining available capacity;
- Depending upon a merit order list.

These types are described here after.

2.2.1 Proportional to base case generation or load

Shift in defined generation/load nodes is proportional to the base case generation/load within an area “a”:

- $P_g(n,a)$ active generation in node n, belonging to area a (node n defined in GSK list),
- $P_l(n,a)$ active load in node n, belonging to area a (node n defined in LSK list).

The participation of node n in the shift, among selected generation nodes (GSK) is given by:

$$K_g(n,a) = G(a)\frac{P_g(n,a)}{\sum_i P_g(i,a)}$$

The participation of node n in the shift, among selected load nodes (LSK) is given by:

$$K_l(n,a) = L(a)\frac{P_l(n,a)}{\sum_i P_l(i,a)}$$

The sum of G(a) and L(a) for each area is to be equal to 1 (i.e. 100%).

Table 1 lists the attributes to be described in such a case.

Table 1 - Dependency

Attribute	Generation	Load
domain.mRID	The identification of the area related to all the GSK and/or LSK area(s) described in the document	
subject_Domain.mRID	The identification of the area, a, related to GSK and/or LSK.	
SKBlock_TimeSeries		
businessType	B42	B42
mkPSRType.psrType	A04 – generation	A05 – load
quantity.quantity	Value of G(a) If not provided, it is assumed a 1 value.	Value of L(a) If not provided, it is assumed a 1 value.
flowDirection	Not used	
measurement_Unit.name	C62 – unit for dimensionless quantities	
attributeInstanceComponent.position	Not used	
RegisteredResource	The identification of the generation or load nodes involved in the shift Note: If no registeredResource is provided, the factor is applied to all the generations and/or loads of the subject domain network model.	
mRID	The identification of the resource	
sK_ResourceCapacity.defaultCapacity	Not used	
sK_ResourceCapacity.maximumCapacity	Not used	
sK_ResourceCapacity.minimumCapacity	Not used	

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2.2.2 Proportional to the participation factors

For a list of generation nodes or load nodes in an area, a, individual participation factors are defined. The shift in generation/load node is computed as:

$$K_g(n,a) = G(a)\frac{k_g(n,a)}{\sum_i k_g(i,a)}$$ for generation

And $$K_l(n,a) = L(a)\frac{k_l(n,a)}{\sum_i k_l(i,a)}$$ for load.

Table 2 lists the attributes to be described in such a case.

Table 2 - Dependency

Attribute	Generation	Load
domain.mRID	The identification of the area related to all the GSK and/or LSK area(s) described in the document	
subject_Domain.mRID	The identification of the area, a, related to GSK and/or LSK.	
SKBlock_TimeSeries		
businessType	B43	B43
mkPSRType.psrType	A04 – generation	A05 – load
quantity.quantity	Value of G(a)	Value of L(a)
flowDirection	Not used	
measurement_Unit.name	C62 – unit for dimensionless quantities	
attributeInstanceComponent.position	Not used	
RegisteredResource	The identification of the generation or load nodes involved in the shift	
mRID	The identification of the resource	
sK_ResourceCapacity.defaultCapacity	$k_g(n,a)$ of the resource	$k_l(n,a)$ of the resource
sK_ResourceCapacity.maximumCapacity	Not used	
sK_ResourceCapacity.minimumCapacity	Not used	

2.2.3 Proportional to the remaining available capacity

Depending upon the shift (up for positive shift or down for negative shift), the generation changes are computed proportionally to the remaining available generation margin:

- For a positive shift $$P(n,a) = P_0(n,a) + \Delta E\frac{P_{\max}(n,a) - P_0(n,a)}{\sum_i (P_{\max}(i,a) - P_0(i,a))}$$
- For a negative shift $$P(n,a) = P_0(n,a) + \Delta E\frac{P_0(n,a) - P_{\min}(n,a)}{\sum_i (P_0(i,a) - P_{\min}(i,a))}$$

Where:

- $P(n,a)$ is the generation output of unit n in area a following the shift.
- $P_0(n,a)$ is the actual generation output in the base case

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- ΔE is the generation shift.
- $P_{\max}(i,a)$ is the maximum output of generation i in area a.
- $P_{\min}(i,a)$ is the minimum output of generation I in area a.

Table 3 lists the attributes to be described in such a case.

Table 3 - Dependency

Attribute	Generation	Load
domain.mRID	The identification of the area related to all the GSK and/or LSK area(s) described in the document	
subject_Domain.mRID	The identification of the area, a, related to GSK and/or LSK.	
SKBlock_TimeSeries		Not used
businessType	B44	Not used
mkPSRType.psrType	A04 – generation	Not used
quantity.quantity	Not used	
flowDirection	A01 – for positive shift A02 – for negative shift	Not used
measurement_Unit.name	The unit of measurement for $P_{\max}(i,a)$ or $P_{\min}(i,a)$	Not used
attributeInstanceComponent.position	Not used	
RegisteredResource		Not used
mRID	The identification of the resource	Not used
sK_ResourceCapacity.defaultCapacity	Not used	
sK_ResourceCapacity.maximumCapacity	$P_{\max}(i,a)$	Not used
sK_ResourceCapacity.minimumCapacity	$P_{\min}(i,a)$	Not used

2.2.4 Depending upon a merit order list

The chosen generation nodes shifts up or down according to the merit order list defined in the group GSKup (GSK time series with a A01 flowDirection) or GSKdown (GSK time series with a A02 flowDirection), as described following:

- Upward list contains the generation nodes which performs the total positive shift in area a.
- Downward list contains the generation nodes which performs the total negative shift in area a.

The merit order position is defined in the attribute attributeInstanceComponent.position, i.e. it is the order to be applied to generation node to be shifted simultaneously. It means that the first group (number defined with merit order position) of generating nodes are shifted together and if it is not sufficient, the next group generating nodes are used to complete the total shift, and so on.

The total shift is distributed to the last group of merit order position generation nodes proportionally to their available margin as defined for reserve shift.

Table 4 lists the attributes to be described in such a case.

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176 **Table 4 - Dependency**

Attribute	Generation	Load
domain.mRID	The identification of the area related to all the GSK and/or LSK area(s) described in the document	
subject_Domain.mRID	The identification of the area, a, related to GSK and/or LSK.	
SKBlock_TimeSeries		Not used
businessType	B45	Not used
mkPSRType.psrType	A04 – generation	Not used
quantity.quantity	Not used	
flowDirection	A01 – for positive shift A02 – for negative shift	Not used
measurement_Unit.name	The unit of measurement for $P_{\max}(i,a)$ or $P_{\min}(i,a)$	Not used
attributeInstanceComponent.position	Order for merit order position (the first group shall have the value 1, the second the value 2, etc.).	Not used
RegisteredResource		Not used
mRID	The identification of the resource	Not used
sK_ResourceCapacity.defaultCapacity	Not used	
sK_ResourceCapacity.maximumCapacity	$P_{\max}(i,a)$	Not used
sK_ResourceCapacity.minimumCapacity	$P_{\min}(i,a)$	Not used

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178 ## 2.3 Business rules

179 All the business rules defined in the IEC 62325-351 are to be applied for this document.

180 An acknowledgment document, IEC 62325-451-1, is to be issued by the receiver of this GLSK
181 document.

182 In addition, there are some specific rules for the mRID of the RegisteredResource; the mRID
183 attribute is composed of the code and the coding scheme identification:

184 • When the coding scheme “EIC” (energy identification coding scheme, attribute value “A01”)
185 is used, the object identified is usually an aggregation, e.g. a production unit composed with
186 different generating units. In such a case, it is assumed that the values provided are to be
187 applied to each individual generating units. A mapping between the EIC code and the mRID
188 of each generating unit is to be provided. This rule is to be applied depending upon the
189 power output of each generating unit:

190 – For a hydro power plant composed of 10 identical generating units, the mRID (W type
191 EIC code) of the hydro power plant as a production unit can be used. In such a case,
192 the values are to be applied to each individual generating units.

193 – For a nuclear power plant, usually each nuclear reactor has a W type EIC code as mRID.

194 • When the coding scheme “CGM” (common grid model coding scheme, attribute value “A02”)
195 is used, the object has the same granularity as in the CGMES requirements for the common
196 grid model or the individual grid model (IGM).

197 The following codes values are to be used in XML instances in the GLSK_MarketDocument
198 section:

199 • type: A95 for “Configuration document”

200 • process.processType: A01 for “Day ahead”

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2.4 GLSK contextual model

2.4.1 Overview of the model

Figure 1 shows the model.

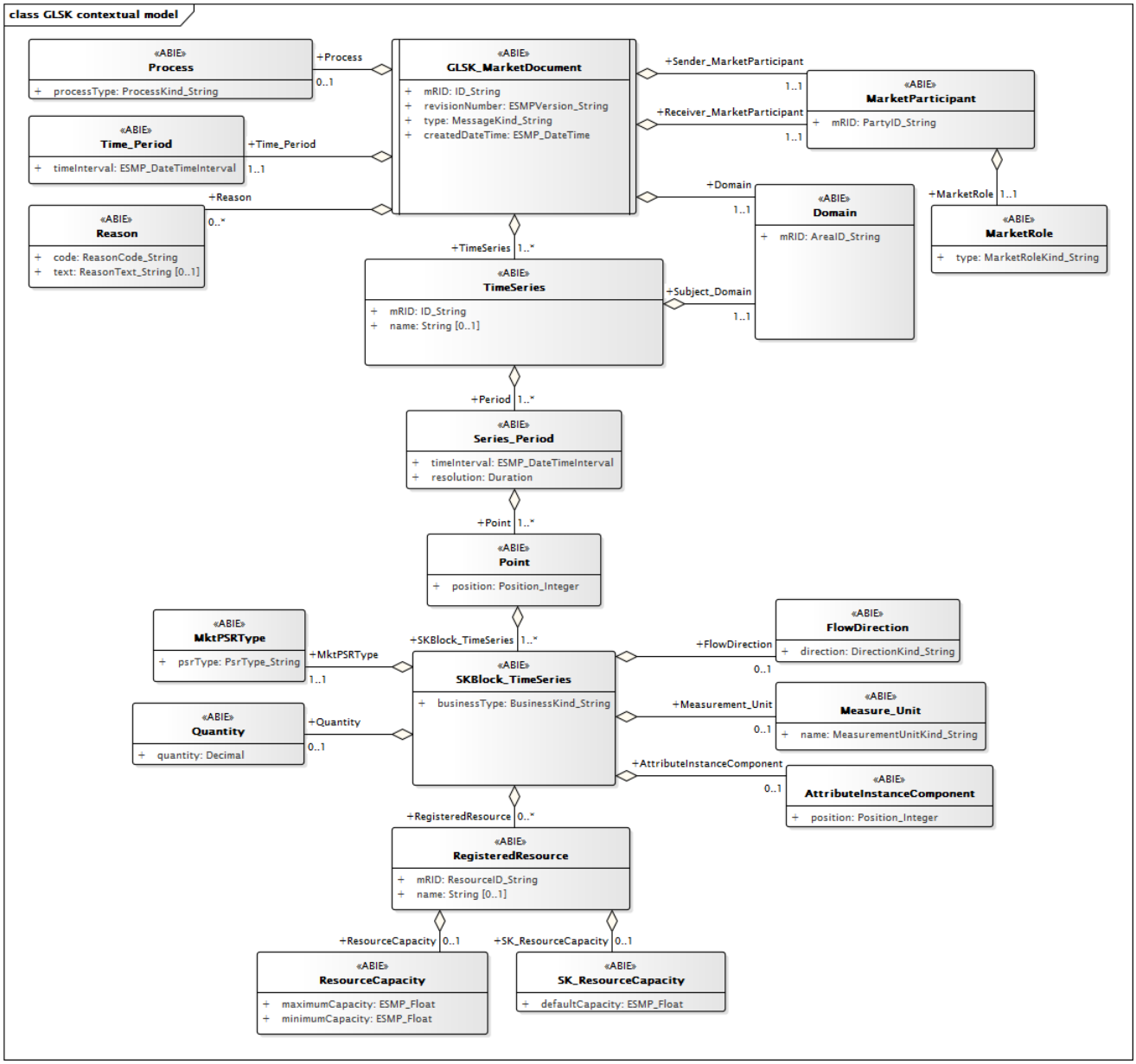

Figure 1 - GLSK contextual model

2.4.2 IsBasedOn relationships from the European style market profile

Table 5 shows the traceability dependency of the classes used in this package towards the upper level.

Table 5 - IsBasedOn dependency

Name	Complete IsBasedOn Path
AttributeInstanceComponent	TC57CIM::IEC62325::MarketManagement::AttributeInstanceComponent
Domain	TC57CIM::IEC62325::MarketManagement::Domain
FlowDirection	TC57CIM::IEC62325::MarketManagement::FlowDirection
GLSK_MarketDocument	TC57CIM::IEC62325::MarketManagement::MarketDocument

Name	Complete IsBasedOn Path
MarketParticipant	TC57CIM::IEC62325::MarketCommon::MarketParticipant
MarketRole	TC57CIM::IEC62325::MarketCommon::MarketRole
Measure_Unit	TC57CIM::IEC62325::MarketManagement::Unit
MktPSRType	TC57CIM::IEC62325::MarketManagement::MktPSRType
Point	TC57CIM::IEC62325::MarketManagement::Point
Process	TC57CIM::IEC62325::MarketManagement::Process
Quantity	TC57CIM::IEC62325::MarketManagement::Quantity
Reason	TC57CIM::IEC62325::MarketManagement::Reason
RegisteredResource	TC57CIM::IEC62325::MarketCommon::RegisteredResource
ResourceCapacity	TC57CIM::IEC62325::MarketOperations::ReferenceData::ResourceCapacity
Series_Period	TC57CIM::IEC62325::MarketManagement::Period
SK_ResourceCapacity	TC57CIM::IEC62325::MarketOperations::ReferenceData::ResourceCapacity
SKBlock_TimeSeries	TC57CIM::IEC62325::MarketManagement::TimeSeries
Time_Period	TC57CIM::IEC62325::MarketManagement::Period
TimeSeries	TC57CIM::IEC62325::MarketManagement::TimeSeries

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2.5 GLSK assembly model

2.5.1 Overview of the model

Figure 2 shows the model.

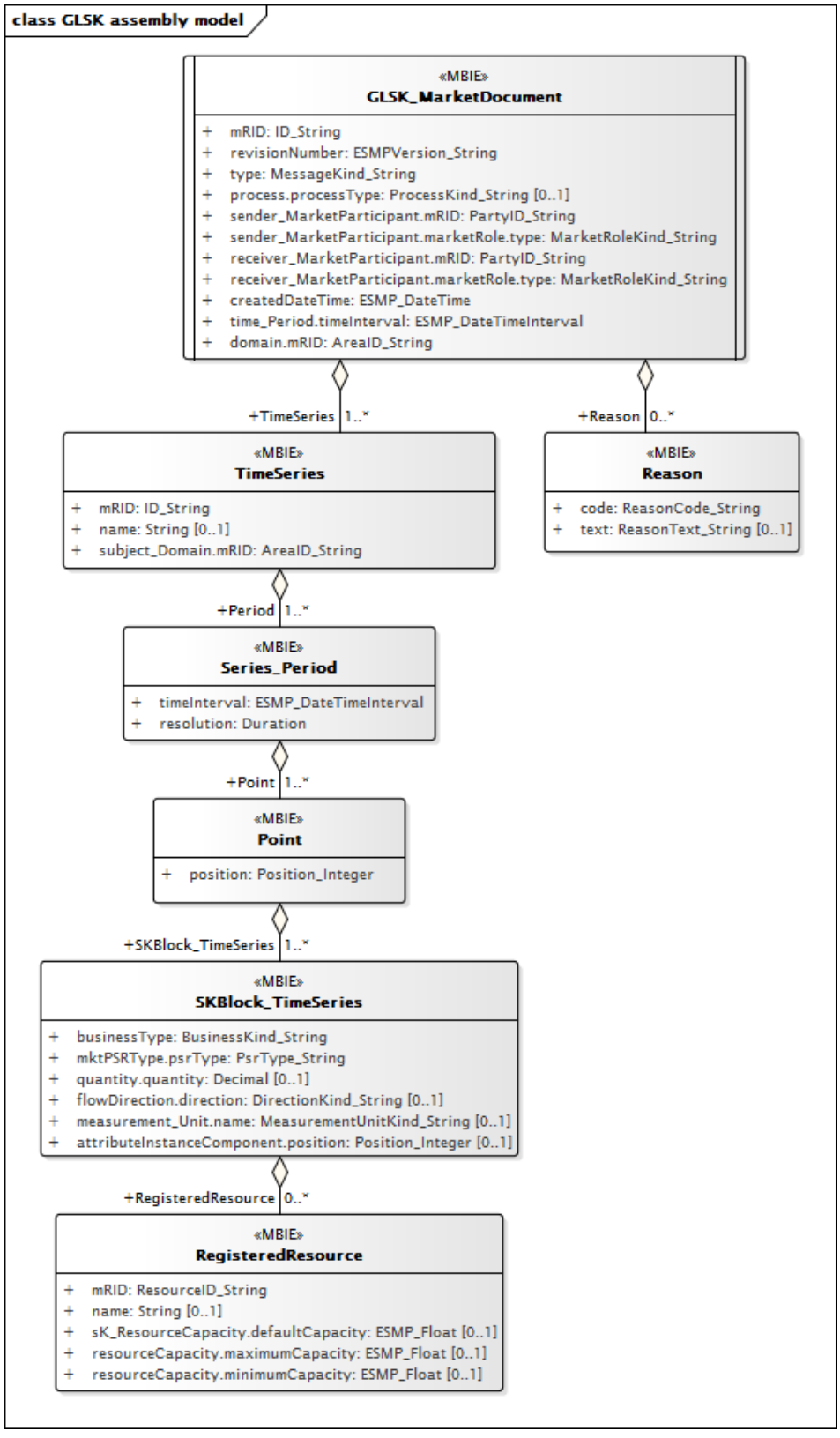

Figure 2 - GLSK assembly model

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2.5.2 IsBasedOn relationships from the European style market profile

Table 6 shows the traceability dependency of the classes used in this package towards the upper level.

Table 6 - IsBasedOn dependency

Name	Complete IsBasedOn Path
GLSK_MarketDocument	TC57CIM::IEC62325::MarketManagement::MarketDocument
Point	TC57CIM::IEC62325::MarketManagement::Point
Reason	TC57CIM::IEC62325::MarketManagement::Reason
RegisteredResource	TC57CIM::IEC62325::MarketCommon::RegisteredResource
Series_Period	TC57CIM::IEC62325::MarketManagement::Period
SKBlock_TimeSeries	TC57CIM::IEC62325::MarketManagement::TimeSeries
TimeSeries	TC57CIM::IEC62325::MarketManagement::TimeSeries

2.5.3 Detailed GLSK assembly model

2.5.3.1 GLSK_MarketDocument root class

This document enables to exchange information about the GSK and LSK factors.

- Generation shift key (GSK): list specifying those generators that shall contribute to the shift.

- Load shift key (LSK): list specifying those load that shall contribute to the shift in order to take into account the contribution of generators connected to lower voltage levels.

If GSK and LSK are defined, a participation factor is also given:

- G(a) Participation factor for generation nodes

- L(a) Participation factor for load nodes

The sum of G(a) and L(a) for each area has to be to 1 (i.e. 100%).

An electronic document containing the information necessary to satisfy the requirements of a given business process.

Table 7 shows all attributes of GLSK_MarketDocument.

Table 7 - Attributes of GLSK assembly model::GLSK_MarketDocument

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	mRID ID_String	The unique identification of the document being exchanged within a business process flow.
1	[1..1]	revisionNumber ESMPVersion_String	The identification of the version that distinguishes one evolution of a document from another.
2	[1..1]	type MessageKind_String	The coded type of a document. The document type describes the principal characteristic of the document.
3	[0..1]	process.processType ProcessKind_String	The identification of the nature of process that the document addresses.
4	[1..1]	sender_MarketParticipant.mRID PartyID_String	The identification of a party in the energy market. --- Document owner.
5	[1..1]	sender_MarketParticipant.marketRole.type MarketRoleKind_String	The identification of the role played by a market player. --- Document owner.

Order	mult.	Attribute name / Attribute type	Description
6	[1..1]	receiver_MarketParticipant.mRID PartyID_String	The identification of a party in the energy market. --- Document recipient.
7	[1..1]	receiver_MarketParticipant.marketRole.type MarketRoleKind_String	The identification of the role played by a market player. --- Document recipient.
8	[1..1]	createdDateTime ESMP_DateTime	The date and time of the creation of the document.
9	[1..1]	time_Period.timeInterval ESMP_DateTimeInterval	The start and end date and time for a given interval. --- The beginning and ending date and time of the period covered in the document.
10	[1..1]	domain.mRID AreaID_String	The unique identification of the domain. --- The identification of the domain that is covered in the settlement document.

Table 8 shows all association ends of GLSK_MarketDocument with other classes.

Table 8 - Association ends of GLSK assembly model::GLSK_MarketDocument with other classes

Order	mult.	Class name / Role	Description
11	[1..*]	TimeSeries TimeSeries	Association Based On: GLSK contextual model::TimeSeries.TimeSeries[1..*] ----- GLSK contextual model::GLSK_MarketDocument.[]
12	[0..*]	Reason Reason	Association Based On: GLSK contextual model::Reason.Reason[0..*] ----- GLSK contextual model::GLSK_MarketDocument.[]

2.5.3.2 Point

The identification of the values being addressed within a specific interval of time.

Table 9 shows all attributes of Point.

Table 9 - Attributes of GLSK assembly model::Point

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	position Position_Integer	A sequential value representing the relative position within a given time interval.

Table 10 shows all association ends of Point with other classes.

Table 10 - Association ends of GLSK assembly model::Point with other classes

Order	mult.	Class name / Role	Description
1	[1..*]	SKBlock_TimeSeries SKBlock_TimeSeries	TheTimeSeries provides additional information related to a Position within a given time interval. Association Based On: GLSK contextual model::SKBlock_TimeSeries.SKBlock_TimeSeries[1..*] ----- GLSK contextual model::Point.[]

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248 #### 2.5.3.3 Reason

249 The motivation of an act.

250 Table 11 shows all attributes of Reason.

251 **Table 11 - Attributes of GLSK assembly model::Reason**

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	code ReasonCode_String	The motivation of an act in coded form.
1	[0..1]	text ReasonText_String	The textual explanation corresponding to the reason code.

252

253 #### 2.5.3.4 RegisteredResource

254 A resource that is registered through the market participant registration system. Examples
255 include generating unit, load, and non-physical generator or load.

256 Table 12 shows all attributes of RegisteredResource.

257 **Table 12 - Attributes of GLSK assembly model::RegisteredResource**

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	mRID ResourceID_String	The unique identification of a resource.
1	[0..1]	name String	The name is any free human readable and possibly non unique text naming the object.
2	[0..1]	sK_ResourceCapacity.defaultCapacity ESMP_Float	Default capacity. --- The shift key of the registered resource.
3	[0..1]	resourceCapacity.maximumCapacity ESMP_Float	The maximum capacity is used with the remaining available capacity, or merit order methods.
4	[0..1]	resourceCapacity.minimumCapacity ESMP_Float	The minimum capacity is used with the remaining available capacity, or merit order methods.

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259 #### 2.5.3.5 Series_Period

260 The identification of the period of time corresponding to a given time interval and resolution.

261 Table 13 shows all attributes of Series_Period.

262 **Table 13 - Attributes of GLSK assembly model::Series_Period**

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	timeInterval ESMP_DateTimeInterval	The start and end time of the period.
1	[1..1]	resolution Duration	The definition of the number of units of time that compose an individual step within a period.

263

264 Table 14 shows all association ends of Series_Period with other classes.

265 **Table 14 - Association ends of GLSK assembly model::Series_Period with other classes**

Order	mult.	Class name / Role	Description
2	[1..*]	Point Point	Association Based On: GLSK contextual model::Point.Point[1..*] ----- GLSK contextual model::Series_Period.[]

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267 **2.5.3.6 SKBlock_TimeSeries**

268 4 types of shift keys can be defined in GSK and LSK lists:

269 • B42: proportionally to base case generation or load.

270 • B43: according to the participation factors.

271 • B44: proportionally to the remaining available capacity.

272 • B45: generating nodes shift according to different merit order lists for shifting up and down.

273 A set of time-ordered quantities being exchanged in relation to a product.

274 In the ESMP profile, the TimeSeries provides not only time-ordered quantities but also time-
275 ordered information.

276 Table 15 shows all attributes of SKBlock_TimeSeries.

277 **Table 15 - Attributes of GLSK assembly model::SKBlock_TimeSeries**

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	businessType BusinessKind_String	The identification of the nature of the time series.
1	[1..1]	mktPSRType.psrType PsrType_String	The coded type of a power system resource. --- The type of the resources within the time series, i.e. either generation for GSK or load for LSK.
2	[0..1]	quantity.quantity Decimal	The quantity value. The association role provides the information about what is expressed. --- The shift key value applicable to all resources. This is a value in the range [0,1]. The quantity information associated to a TimeSeries.
3	[0..1]	flowDirection.direction DirectionKind_String	The coded identification of the direction of energy flow. --- For the merit order list (GSK or LSK), provide the information if the registered resource contributes either as "UP" or "DOWN" units.
4	[0..1]	measurement_Unit.name MeasurementUnitKind_String	The identification of the formal code for a measurement unit (UN/ECE Recommendation 20). --- The unit of measure of the attributes based on ResourceCapacity class.
5	[0..1]	attributeInstanceComponent.position Position_Integer	A sequential value representing a relative sequence number. --- To be used only for merit order participation factor. This attribute provides the identification of order in which the groups are called (1 is the first, 2 the second, etc.)

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279 Table 16 shows all association ends of SKBlock_TimeSeries with other classes.

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Table 16 - Association ends of GLSK assembly model::SKBlock_TimeSeries with other classes

Order	mult.	Class name / Role	Description
6	[0..*]	RegisteredResource RegisteredResource	The identification of a resource associated with a TimeSeries. Association Based On: GLSK contextual model::RegisteredResource.RegisteredResource[0..*] ----- GLSK contextual model::SKBlock_TimeSeries.[]

2.5.3.7 TimeSeries

A set of time-ordered quantities being exchanged in relation to a product.

Table 17 shows all attributes of TimeSeries.

Table 17 - Attributes of GLSK assembly model::TimeSeries

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	mRID ID_String	A unique identification of the time series.
1	[0..1]	name String	The name is any free human readable and possibly non unique text naming the object.
2	[1..1]	subject_Domain.mRID AreaID_String	The unique identification of the domain. --- The identification of the area.

Table 18 shows all association ends of TimeSeries with other classes.

Table 18 - Association ends of GLSK assembly model::TimeSeries with other classes

Order	mult.	Class name / Role	Description
3	[1..*]	Series_Period Period	The receiver shall completely reject documents with any time intervals outside the accounting period. Association Based On: GLSK contextual model::Series_Period.Period[1..*] ----- GLSK contextual model::TimeSeries.[]

2.5.4 Datatypes

The list of datatypes used for the GLSK assembly model is as follows:

- ESMP_DateTimeInterval compound
- AreaID_String datatype, codelist CodingSchemeTypeList
- BusinessKind_String datatype, codelist BusinessTypeList
- DirectionKind_String datatype, codelist DirectionTypeList
- ESMP_DateTime datatype
- ESMP_Float datatype
- ESMPVersion_String datatype
- ID_String datatype
- MarketRoleKind_String datatype, codelist RoleTypeList

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- MeasurementUnitKind_String datatype, codelist UnitOfMeasureTypeList
- MessageKind_String datatype, codelist MessageTypeList
- PartyID_String datatype, codelist CodingSchemeTypeList
- Position_Integer datatype
- ProcessKind_String datatype, codelist ProcessTypeList
- PsrType_String datatype, codelist AssetTypeList
- ReasonCode_String datatype, codelist ReasonCodeTypeList
- ReasonText_String datatype
- ResourceID_String datatype, codelist CodingSchemeTypeList
- YMDHM_DateTime datatype

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2.5.5 GLSK_MarketDocument XML schema

Figure 3 to Figure 5 provide the structure of the schema.

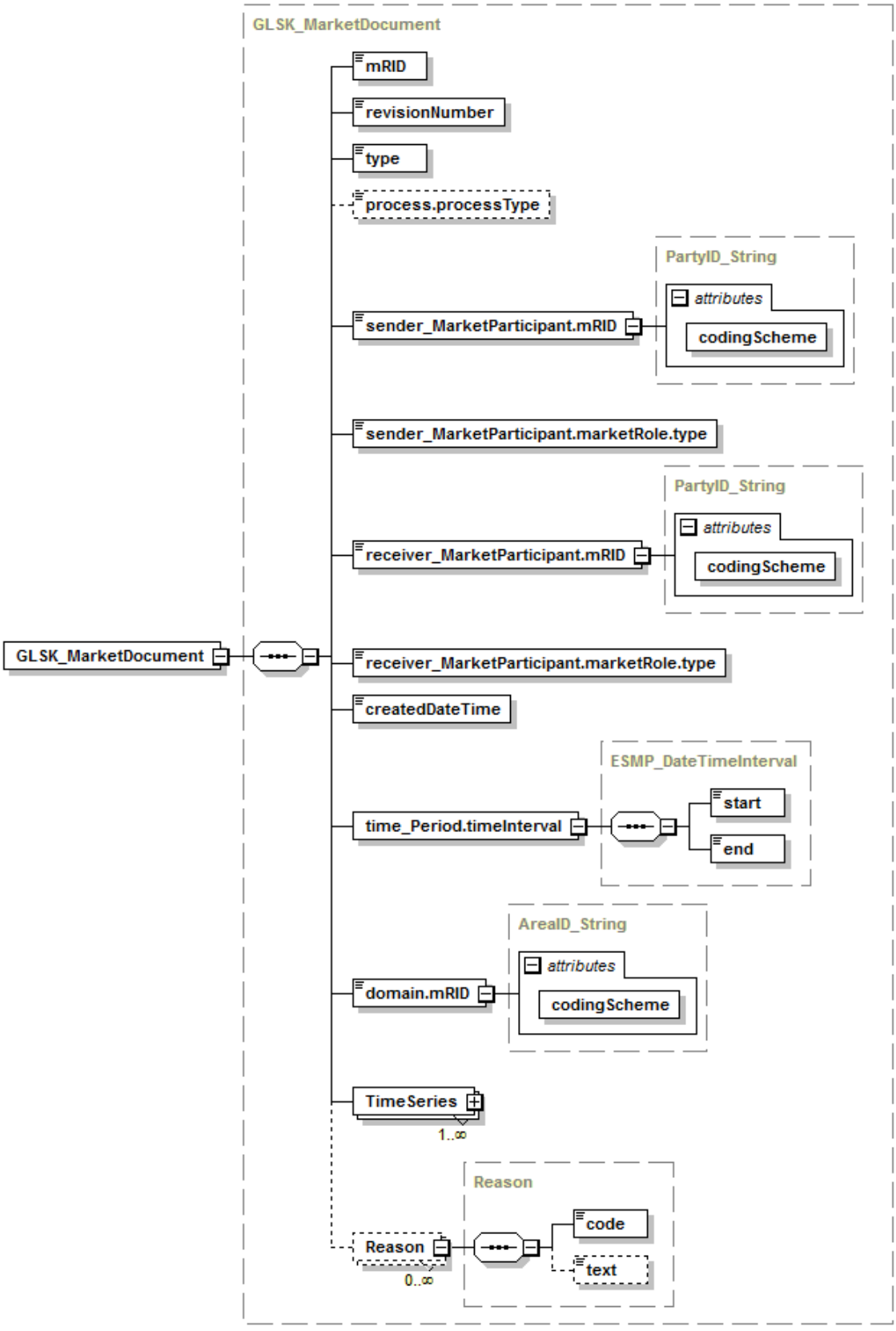

Figure 3 - GLSK schema structure 1/3

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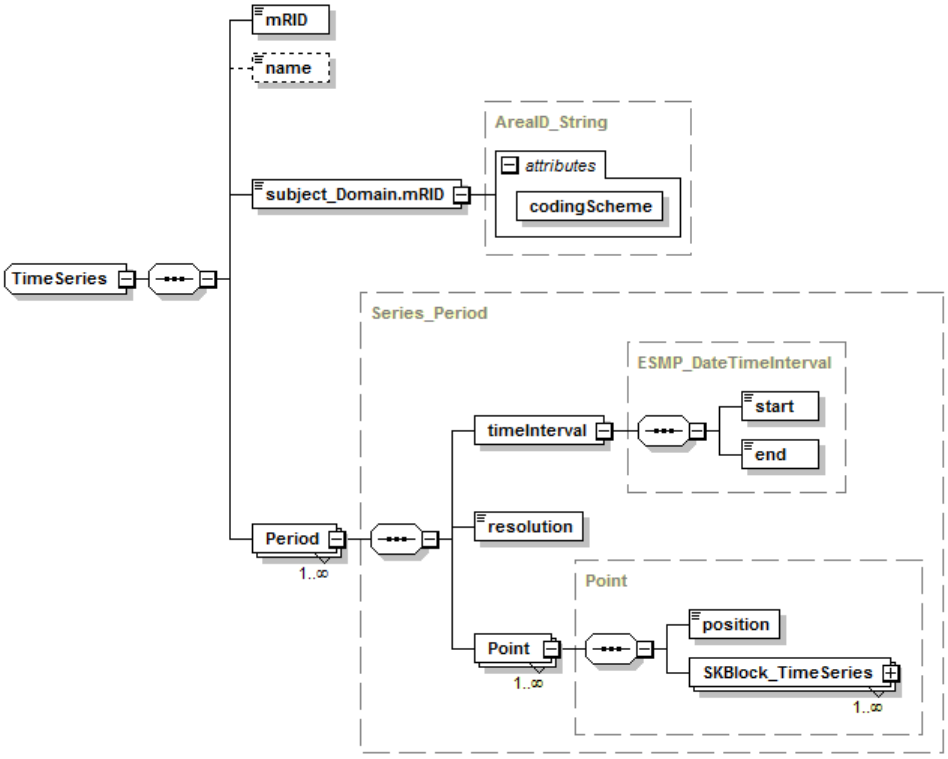

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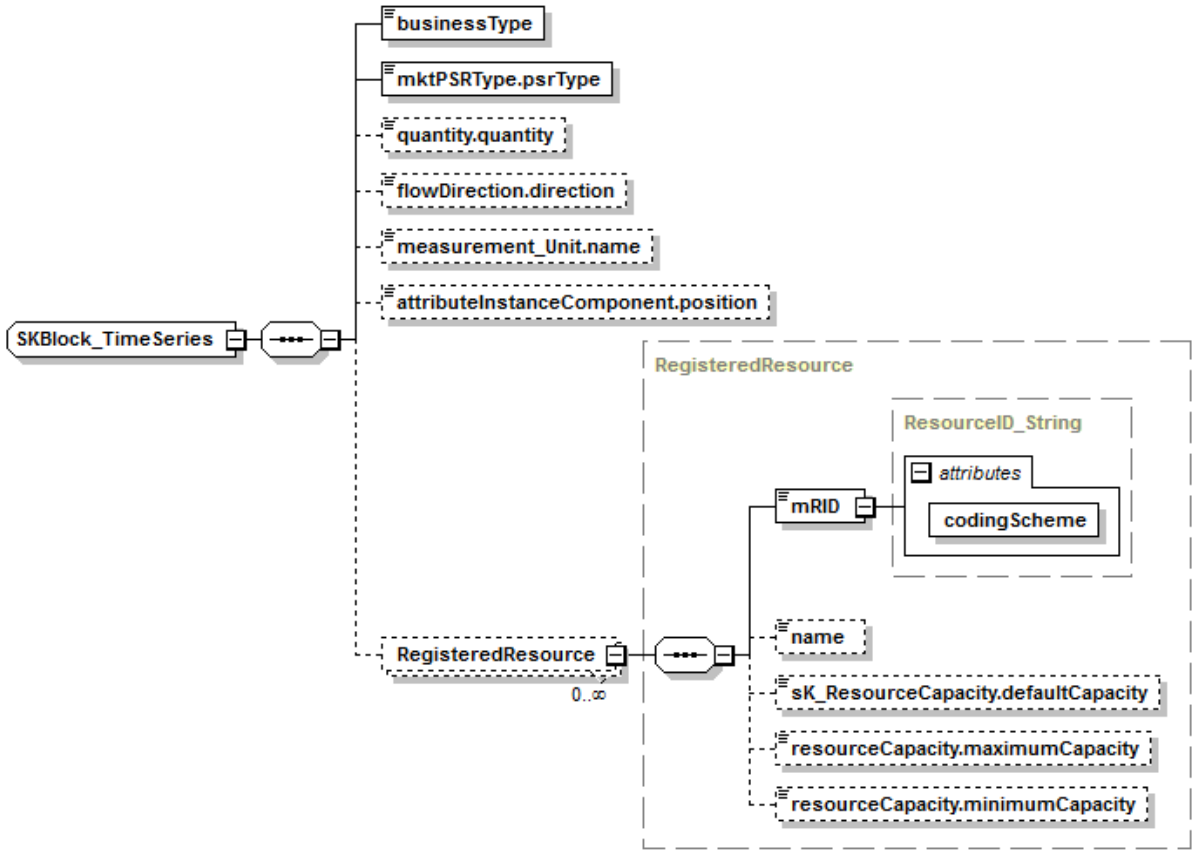
317 **Figure 4 - GLSK schema structure 2/3**



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319 **Figure 5 - GLSK schema structure 3/3**

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