



European Network of
Transmission System Operators
for Electricity

**ENTSO-E
HVDC LINK PROCESS
IMPLEMENTATION GUIDE**

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19 The force of the following words is modified by the requirement level of the document in which
20 they are used.

- 21 • **MUST:** This word, or the terms "REQUIRED" or "SHALL", means that the definition is an
22 absolute requirement of the specification.
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24 absolute prohibition of the specification.
- 25 • **SHOULD:** This word, or the adjective "RECOMMENDED", means that there may exist valid
26 reasons in particular circumstances to ignore a particular item, but the full implications
27 must be understood and carefully weighed before choosing a different course.
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29 exist valid reasons in particular circumstances when the particular behaviour is acceptable
30 or even useful, but the full implications should be understood and the case carefully
31 weighed before implementing any behaviour described with this label.
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33 vendor may choose to include the item because a particular marketplace requires it or
34 because the vendor feels that it enhances the product while another vendor may omit the
35 same item. An implementation which does not include a particular option **MUST** be
36 prepared to interoperate with another implementation which does include the option,
37 though perhaps with reduced functionality. In the same vein an implementation which does
38 include a particular option **MUST** be prepared to interoperate with another implementation
39 which does not include the option (except, of course, for the feature the option provides.)

40

Revision History

Version	Release	Date	Paragraph	Comments
1	0			Initial release. Approved by Market Committee on 2015-02-04.

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98

INTRODUCTION

99 This document was drafted based on IEC 62325 series. In particular, the IEC 62325-450
100 methodology was applied to develop the conceptual and assembly models.

101 **1 Scope**

102 The objective of this implementation guide is to make it possible for software vendors to
103 develop an IT application for market players that can exchange information relative to HVDC
104 Scheduling process

105 The implementation guide is one of the building blocks for using UML (Unified Modelling
106 Language) based techniques in defining processes and messages for interchange between
107 actors in the electrical industry in Europe.

108 **2 Normative references**

109 The following documents, in whole or in part, are normatively referenced in this document and
110 are indispensable for its application. For dated references, only the edition cited applies. For
111 undated references, the latest edition of the referenced document (including any
112 amendments) applies.

113 IEC TS 61970-2, *Energy management system application program interface (EMS-API) –Part*
114 *2: Glossary*

115 IEC 62325-301, *Framework for energy market communications – Part 301: Common*
116 *information model (CIM) extensions for markets*

117 IEC 62325-351, *Framework for energy market communications – Part 351: CIM European*
118 *market model exchange profile*

119 IEC 62325-450, *Framework for energy market communications – Part 450: Profile and context*
120 *modeling rules*

121 IEC 62325-451-1, *Framework for energy market communications – Part 451-1:*
122 *Acknowledgement business process and contextual model for CIM European market*

123 **3 Terms and definitions**

124 For the purposes of this document, the terms and definitions of IEC 61970-2 apply, as well as
125 the following.

126 NOTE: Refer to IEC 60050, *International Electrotechnical Vocabulary*, for general glossary definitions.

127 **3.1**

128 **high voltage direct current**

129 **HVDC**

130 [SOURCE: entso-e metadata repository]

131 **3.2**

132 **generation shift key**

133 **GSK**

134 Generation Shift Key(s) mean a method of translating a Net Position change of a given
135 Bidding Zone into estimated specific injection increases or decreases in the Common Grid
136 Model.

137 [SOURCE: NC CACM]

138 **3.3**

139 **common grid model**

140 **CGM**

141 Common Grid Model means European-wide or multiple-System Operator-wide data set,
142 created by the European Merging Function, through the merging of relevant data.

143 [SOURCE: NC CACM]

144 4 The HVDC scheduling business process

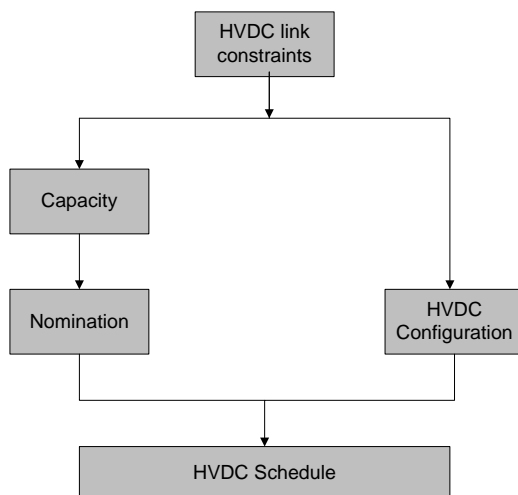
145 4.1 Overall business context

146 The business processes described in this standard are related to the scheduling of HVDC
147 interconnections between TSOs. The HVDC scheduling business process uses some of the
148 existing processes, as for the capacity determination process.

149 The HVDC scheduling process is based on the sequence of successive and dependant data
150 exchanges between the TSOs, which are necessary to determine and agree about the HVDC
151 schedules (as described in Figure 1). As a result, the approach is the following:

- 152 1. Determination of the HVDC link constraints
- 153 2. Determination of the cross-border capacity
- 154 3. Configuration of the HVDC link parameters
- 155 4. Calculation of the HVDC schedule

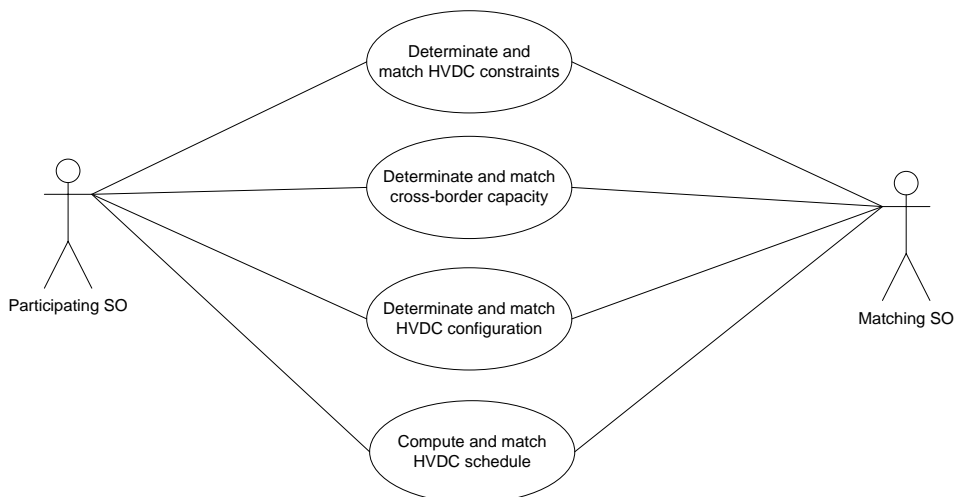
156 These steps are the four identified use cases for the HVDC scheduling process (see Figure 2)
157 and are to be carried out by the TSOs on D-1. In some cases the same process could be
158 carried out in intraday as well.



159

160 **Figure 1 - Overall dependency diagram**

161 In case of a change in any input document of the process in intraday, it is recommended to re-
162 generate and re-match the adjusted document as well as every document that was computed
163 using the adjusted document values. However, it is not mandatory: such business rules
164 should be discussed by the two involved TSOs in order for them to agree on the
165 circumstances requiring a re-generation and re-matching of a document in intraday.



166

167 **Figure 2 - Use case of the HVDC scheduling process**

168 Participating System Operator: this is a System Operator who has delegated the matching process to
169 another System Operator.

170 Matching System Operator: this is a System Operator who is responsible for the matching on a border
171 of all data and who has the eventual possibility of applying agreed rules to resolve mismatches.

172 **4.2 HVDC Link constraints determination process**

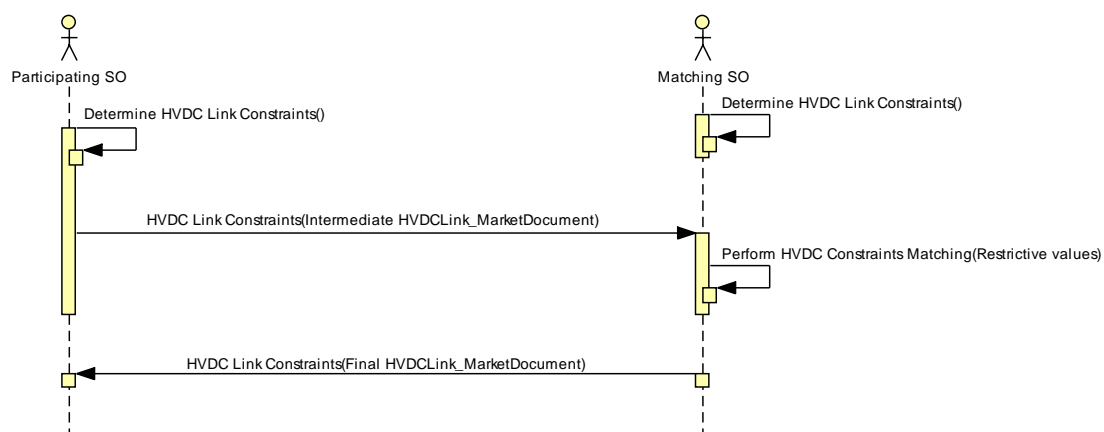
173 The Participating SO sends to the Matching SO the HVDC link constraints document
174 (document type attribute as “HVDC Link constraints”). This document indicates the limits set
175 upon the active power transmission for a given HVDC link. These limits are calculated taking
176 into account various factors, e.g. physical constraints on the cables or on the surrounding
177 grid.

178 The Matching SO then matches the document received from the Participating SO with its own
179 constraints and generates a common HVDC link constraint document using the most
180 restrictive values received from the TSOs.

181 The matched constraints values are then sent to the Participating SO for final acceptance.

182 This process is described in Figure 3; the documents exchanged within this process are
183 indicated.

184 These constraints may be strengthened on a daily scale (e.g. planned maintenance works in
185 the HVDC station) or in real time (e.g. trip of key neighbouring AC lines).



186

187 **Figure 3 –HVDC Link constraints determination process**

188 **4.3 Capacity determination process**

189 Once the HVDC-related capacity values are accepted, they are used as inputs for cross-
190 border NTC determination process. The capacity determination process refers to the ECAN
191 standard IEC 62325-451-3. This process is out of scope of this document.

192 **4.4 HVDC Configuration process**

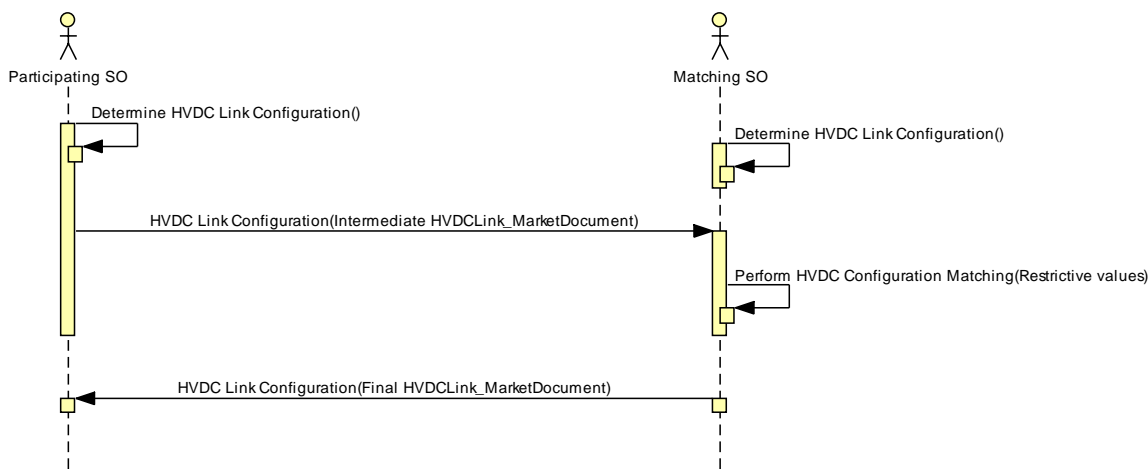
193 Once the HVDC link constraints values are determined and accepted by both TSOs, they are
194 used as inputs for the HVDC configuration process.

195 Both the Matching SO and the Participating SO compute HVDC configuration values. The
196 Participating SO generates and intermediate HVDC configuration document (document type
197 attribute as "HVDC Configuration"). This document provides for a given set of exchange
198 ranges a set of optimized HVDC parameters to be used for the HVDC link scheduling. This
199 information is computed taking into account the NTC previously matched, as well as some
200 other parameters like Generation Shift Key (GSK), Day-Ahead Congestion Forecast (DACF),
201 Common Grid Model (CGM), etc. This HVDC configuration document is then sent to the
202 Matching SO by the Participating SO.

203 The Matching SO then matches the intermediate HVDC configuration document with its own
204 HVDC configuration values and generates a common final HVDC configuration document
205 using the intersection of the HVDC parameter security ranges.

206 The final configuration is then sent to the Participating SO for final acceptance.

207 This process is described in Figure 4; the documents exchanged within this process are
208 indicated.



209

210 **Figure 4 - HVDC configuration process**

211 **4.5 Schedule computation process**

212 Once the HVDC configuration document and the cross-border nominations are exchanged and
213 accepted by TSOs, the HVDC schedule document can be computed.

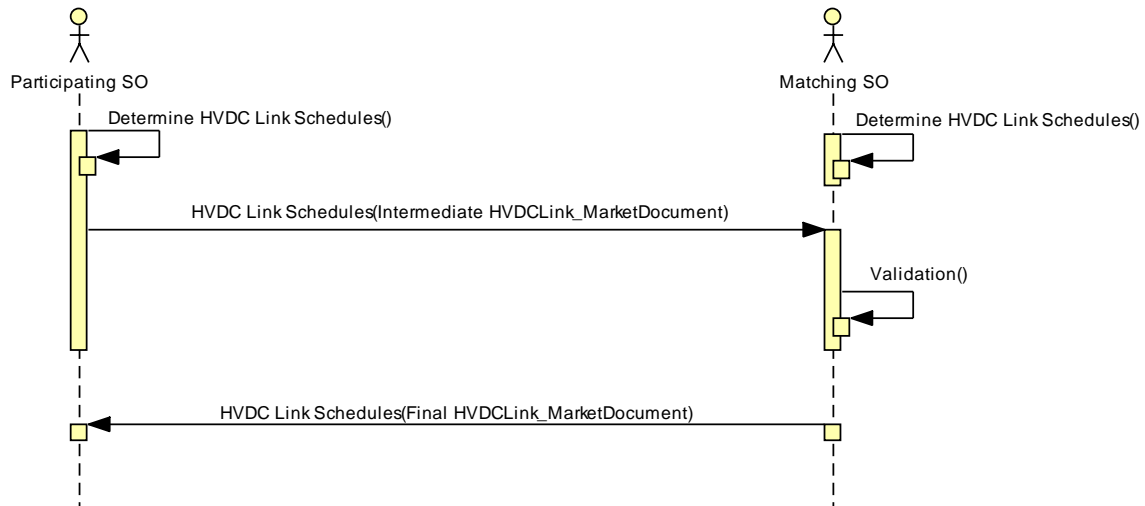
214 Both the Matching SO and the Participating SO compute HVDC schedule values. The
215 Participating SO generates an intermediate HVDC schedule document (document type
216 attribute as "HVDC Schedule"). This document contains the operational information required
217 to operate the HVDC link for a given time period. This information is computed taking into
218 account the HVDC operating mode files and the HVDC configuration files, as well as the
219 cross-border nominations (from ESS standard IEC 62325-451-2). This intermediate HVDC
220 schedule document is then sent to the Matching SO by the Participating SO.

221 The Matching SO then verifies and matches the intermediate HVDC schedule document with
222 its own HVDC schedule values. The intermediate HVDC schedules from TSOs should be
223 identical. If there is a mismatch, the Participating SO has to send new intermediate HVDC

224 schedule until matching is successful. Once the HVDC schedules are matched, the matching
225 SO sends the final HVDC schedule to the participating SO for final acceptance.

226 This process is described in Figure 5; the documents exchanged within this process are
227 indicated.

228 The HVDC schedule process is performed in D-1, intraday and whenever other inputs are
229 adjusted in real time.



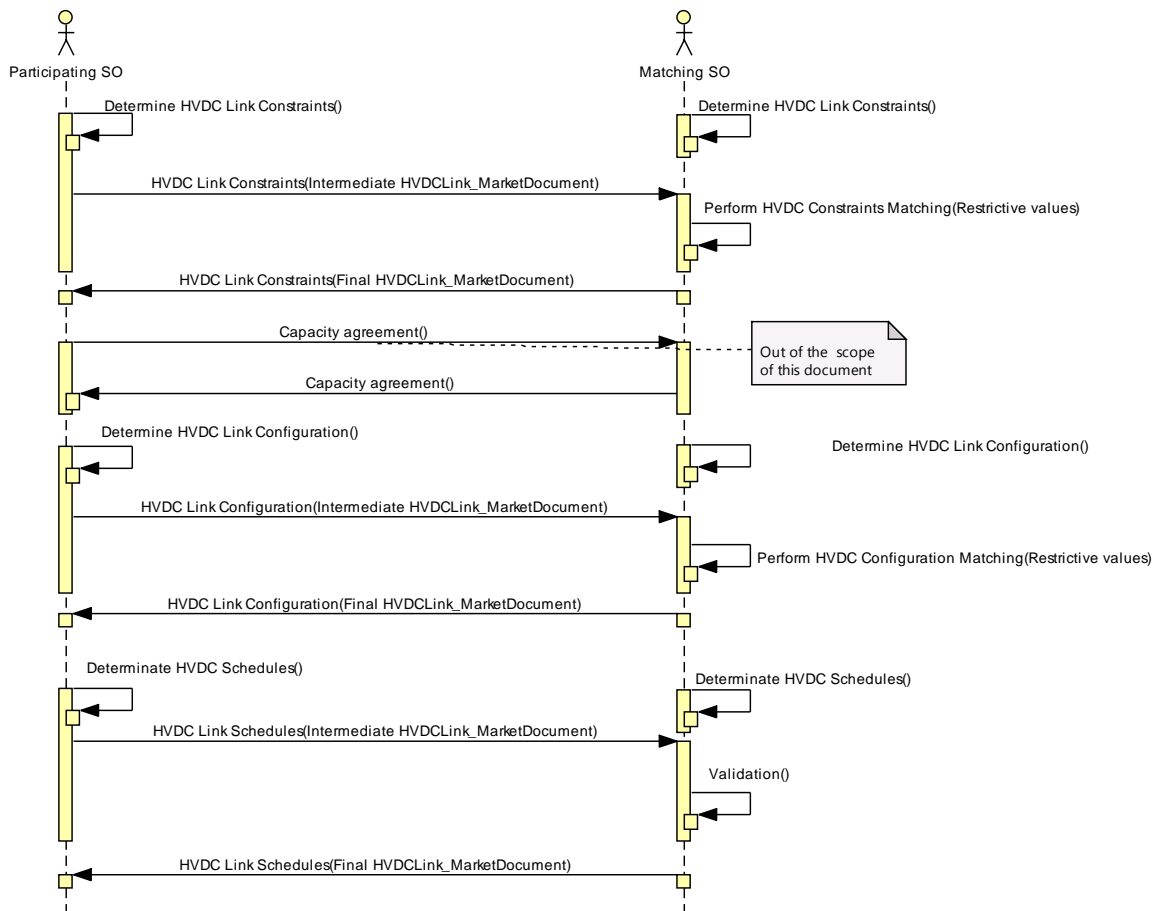
230

231

Figure 5 - HVDC schedule computation process

232 **4.6 Overall exchange workflow**

233 See Figure 6 below for an overview of the HVDC scheduling process workflow.



234

235

Figure 6 - Overall HVDC scheduling process workflow

236 **4.7 Business rules for the HVDC scheduling process**

237 **4.7.1 General rules**

238 For each electronic data interchange defined in this document, an acknowledgement
239 document, as defined in IEC 62325-451-1, should be generated either accepting the whole
240 received document or rejecting it completely.

241 **4.7.2 Dependencies governing the HVDCLink_MarketDocument**

242 The dependencies are listed in the tables below.

HVDCLink_MarketDocument			
Attribute Involved	HVDC Link Constraints	HVDC Configuration	HVDC Schedule
type	A99=HVDC Link constraints	B01=HVDC Configuration	B02=HVDC Schedule
docStatus	A01=Intermediate A02=Final	A01=Intermediate A02=Final	A01=Intermediate A02=Final
businessType	B30= HVDC Link settings	B30= HVDC Link settings	B30= HVDC Link settings
HVDCMode_AttributeInstanceComponent.attribute	Not used	A01= HVDC Set point schedules A02= HVDC Proportional external signal A03=HVDC AC emulation	A01= HVDC Set point schedules A02= HVDC Proportional external signal A03=HVDC AC emulation
connectingLine_RegisteredResource.mRID	used as EIC code for link	used as EIC code for link	used as EIC code for link
quantity.MaximumExchange_Quantity.quantity	Not used	used	Not used
quantity.MinimumExchange_Quantity.quantity	Not used	used	Not used
quantity	used	Not used	used
minimum_Quantity.quantity	Not used	used	Not used
maximum_Quantity.quantity	Not used	used	Not used
optimum_Quantity.quantity	Not used	used	Not used

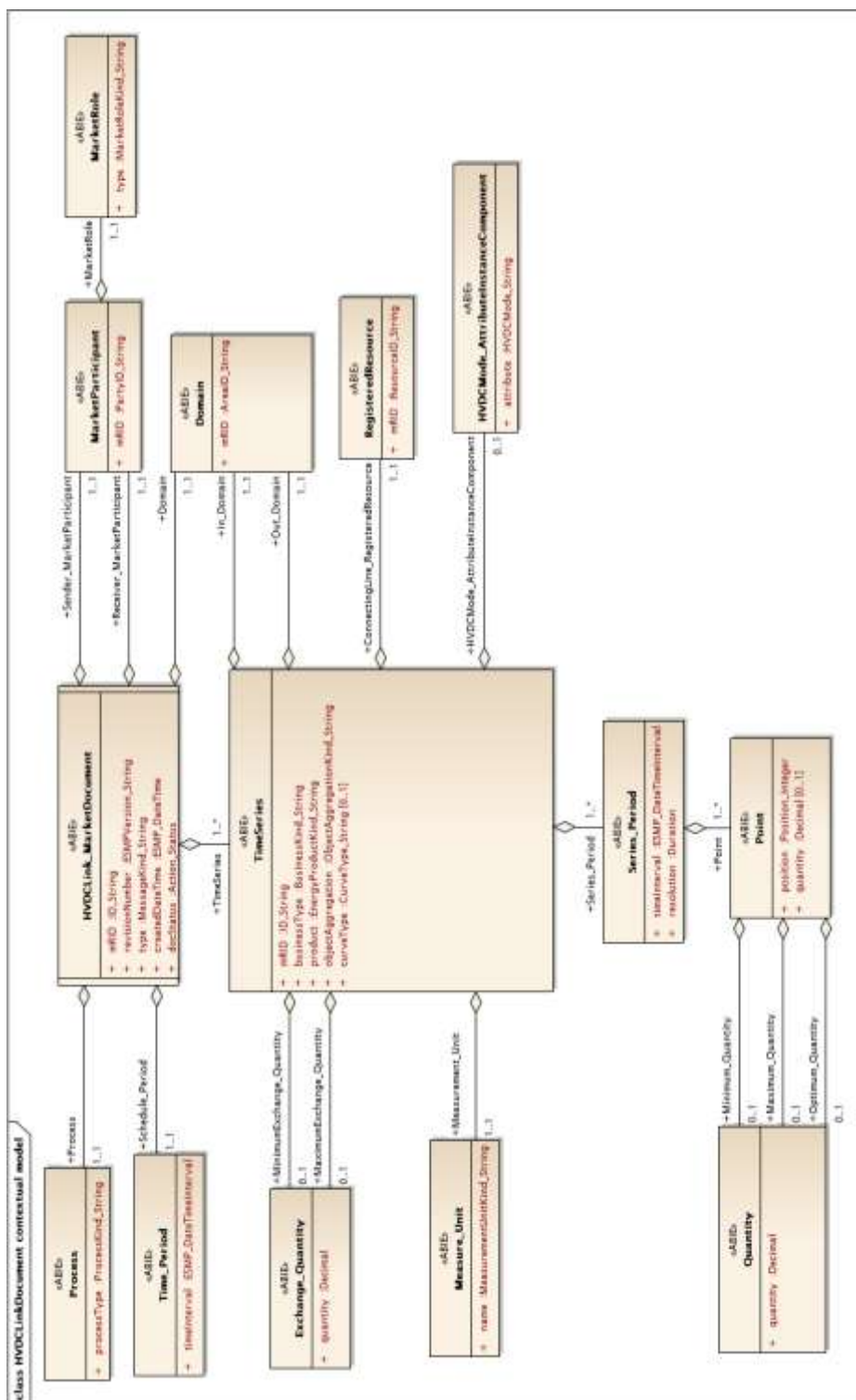
243

244 **5 Contextual and assembly models**

245 **5.1 HVDCLink document contextual model**

246 **5.1.1 Overview of the model**

247 Figure 7 shows the model.



248

249

Figure 7 – HVDCLink document contextual model

250 **5.1.2 IsBasedOn relationships from the European style market profile**

251 Table 1 shows the traceability dependency of the classes used in this package towards the
252 upper level.

253 **Table 1 – IsBasedOn dependency**

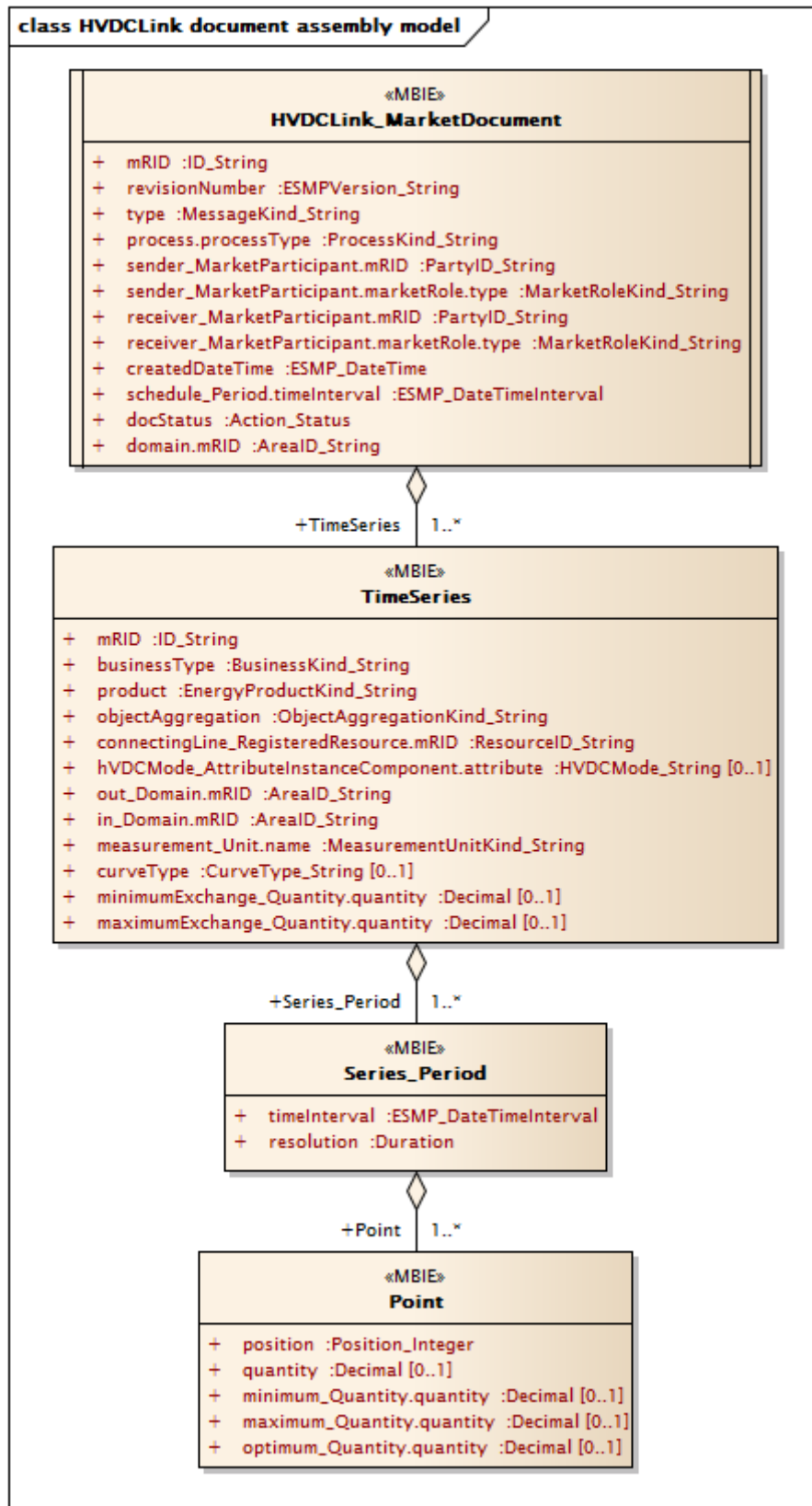
Name	Complete IsBasedOn Path
Domain	TC57CIM::IEC62325::MarketManagement::Domain
Exchange_Quantity	TC57CIM::IEC62325::MarketManagement::Quantity
HVDCLink_MarketDocument	TC57CIM::IEC62325::MarketManagement::MarketDocument
HVDCMode_AttributeInstanceComponent	TC57CIM::IEC62325::MarketManagement::AttributeInstanceComponent
MarketParticipant	TC57CIM::IEC62325::MarketCommon::MarketParticipant
MarketRole	TC57CIM::IEC62325::MarketCommon::MarketRole
Measure_Unit	TC57CIM::IEC62325::MarketManagement::Unit
Point	TC57CIM::IEC62325::MarketManagement::Point
Process	TC57CIM::IEC62325::MarketManagement::Process
Quantity	TC57CIM::IEC62325::MarketManagement::Quantity
RegisteredResource	TC57CIM::IEC62325::MarketCommon::RegisteredResource
Series_Period	TC57CIM::IEC62325::MarketManagement::Period
Time_Period	TC57CIM::IEC62325::MarketManagement::Period
TimeSeries	TC57CIM::IEC62325::MarketManagement::TimeSeries

254

255 **5.2 HVDCLink document assembly model**

256 **5.2.1 Overview of the model**

257 Figure 8 shows the model.



258

259

Figure 8 – HVDCLink document assembly model

260 **5.2.2 IsBasedOn relationships from the European style market profile**

261 Table 2 shows the traceability dependency of the classes used in this package towards the
262 upper level.

263 **Table 2 – IsBasedOn dependency**

Name	Complete IsBasedOn Path
HVDCLink_MarketDocument	TC57CIM::IEC62325::MarketManagement::MarketDocument
Point	TC57CIM::IEC62325::MarketManagement::Point
Series_Period	TC57CIM::IEC62325::MarketManagement::Period
TimeSeries	TC57CIM::IEC62325::MarketManagement::TimeSeries

264

265 **5.2.3 Detailed HVDCLink document assembly model**

266 **5.2.3.1 HVDCLink_MarketDocument root class**

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

269 This document is to be used to exchange the following information for a HVDC link:

- 270 - operational power range through the HVDC link constraints document type
- 271 - power control mode through the HVDC operating mode document type
- 272 - power setpoint through the HVDC configuration document type
- 273 - operational table through the HVDC schedule document type

274 Table 3 shows all attributes of HVDCLink_MarketDocument.

275 **Table 3 – Attributes of HVDCLink document assembly
276 model::HVDCLink_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	[1..1]	process.processType ProcessKind_String	The identification of the nature of process that the document addresses. --- The process dealt with in the document depending upon the document type.
4	[1..1]	sender_MarketParticipant.mRID PartyID_String	The identification of a party in the energy market. --- The document owner.
5	[1..1]	sender_MarketParticipant.marketRole.type MarketRoleKind_String	The identification of the role played by a market player. --- The document owner. --- The role associated with a MarketParticipant.
6	[1..1]	receiver_MarketParticipant.mRID PartyID_String	The identification of a party in the energy market. --- The document recipient.
7	[1..1]	receiver_MarketParticipant.marketRole.type MarketRoleKind_String	The identification of the role played by a market player. --- The document recipient. --- The role associated with a MarketParticipant.

Order	mult.	Attribute name / Attribute type	Description
8	[1..1]	createdDateTime ESMP_DateTime	The date and time of the creation of the document.
9	[1..1]	schedule_Period.timeInterval ESMP_DateTimeInterval	The start and end date and time for a given interval. --- This information provides the start and end date and time of the schedule time interval.
10	[1..1]	docStatus Action_Status	The identification of the condition or position of the document with regard to its standing.
11	[1..1]	domain.mRID ArealID_String	The unique identification of the domain. --- The Domain associated with an electronic document header.

277

278 Table 4 shows all association ends of HVDCLink_MarketDocument with other classes.

279 **Table 4 – Association ends of HVDCLink document assembly**
280 **model::HVDCLink_MarketDocument with other classes**

Order	mult.	Role	Class type name	Description
12	[1..*]	TimeSeries	TimeSeries	The planned resource schedule time series. MXM to be detailed. Association Based On : HVDCLink document contextual model::HVDCLink_MarketDocument.[] ----- HVDCLink document contextual model::TimeSeries.TimeSeries[1..*]

281

282 5.2.3.2 Point

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

284 Table 5 shows all attributes of Point.

285 **Table 5 – Attributes of HVDCLink document 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.
1	[0..1]	quantity Decimal	The principal quantity identified for a point. --- The value of the scheduled product. This information is dependent. The attribute quantity is used in case there is only one quantity needed for a given market period, otherwise the optimum quantity is used.
2	[0..1]	minimum_Quantity.quantity Decimal	Quantity value. --- The minimum value of power exchange on the HVDC line for a scheduled point. This information is dependent of the document type.
3	[0..1]	maximum_Quantity.quantity Decimal	Quantity value. --- The maximum value of power exchange on the HVDC line for a scheduled point. This information is dependent of the document type.
4	[0..1]	optimum_Quantity.quantity Decimal	Quantity value. --- The value of the optimum power exchange on the HVDC line for a scheduled point. This information is dependent onof the document type.

286

287 5.2.3.3 Series_Period

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

289 Table 6 shows all attributes of Series_Period.

290 **Table 6 – Attributes of HVDCLink document 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.

291

292 Table 7 shows all association ends of Series_Period with other classes.

293 **Table 7 – Association ends of HVDCLink document assembly model::Series_Period with**
294 **other classes**

Order	mult.	Role	Class type name	Description
2	[1..*]	Point	Point	The Point information associated with a given Series_Period.within a TimeSeries. Association Based On : HVDCLink document contextual model::Series_Period.[] ----- HVDCLink document contextual model::Point.Point[1..*]

295

296 5.2.3.4 TimeSeries

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

298 Table 8 shows all attributes of TimeSeries.

299 **Table 8 – Attributes of HVDCLink document assembly model::TimeSeries**

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	mRID ID_String	A unique identification of the time series.
1	[1..1]	businessType BusinessKind_String	The identification of the nature of the time series.
2	[1..1]	product EnergyProductKind_String	The identification of the nature of an energy product such as power, energy, reactive power, etc.
3	[1..1]	objectAggregation ObjectAggregationKind_String	The identification of the domain that is the common denominator used to aggregate a time series.
4	[1..1]	connectingLine_RegisteredResource.mRID ResourceID_String	The unique identification of a resource. --- The identification of the HVDC link or group of HVDC links.
5	[0..1]	hVDCMode_AttributeInstanceComponent.attribute HVDCMode_String	The identification of an attribute for a given request component. --- A specific characteristic associated with a TimeSeries. This information provides the mode in which the HVDC link is set. Permitted codes are: - A01 HVDC power setpoint schedule - A02 HVDC proportional external signal. - A03 HVDC AC emulation This information is dependent of the document type.

Order	mult.	Attribute name / Attribute type	Description
6	[1..1]	out_Domain.mRID AreaID_String	The unique identification of the domain. --- The area where the product is being extracted.
7	[1..1]	in_Domain.mRID AreaID_String	The unique identification of the domain. --- The area where the product is being delivered.
8	[1..1]	measurement_Unit.name MeasurementUnitKind_String	The identification of the formal code for a measurement unit (UN/ECE Recommendation 20). --- The unit of measure associated with the quantities in a TimeSeries.
9	[0..1]	curveType CurveType_String	The identification of the coded representation of the type of curve being described.
10	[0..1]	minimumExchange_Quantity.quantity Decimal	The quantity value. --- The minimum value of a power exchange range between the In_Domain and the Out_Domain of the timeseries. This information is dependent of the document type.
11	[0..1]	maximumExchange_Quantity.quantity Decimal	The quantity value. --- The maximum value of a power exchange range between the In_Domain and the Out_Domain of the timeseries. This information is dependent of the document type.

300

301 Table 9 shows all association ends of TimeSeries with other classes.

302 **Table 9 – Association ends of HVDCLink document assembly model::TimeSeries with**
303 **other classes**

Order	mult.	Role	Class type name	Description
12	[1..*]	Series_Period	Series_Period	The time interval and resolution for a period associated with a TimeSeries. Association Based On : HVDCLink document contextual model::TimeSeries.[] ----- HVDCLink document contextual model::Series_Period.Series_Period[1..*]

304

305 5.2.4 Datatypes

306 The list of datatypes used for the HVDCLink document assembly model is as follows:

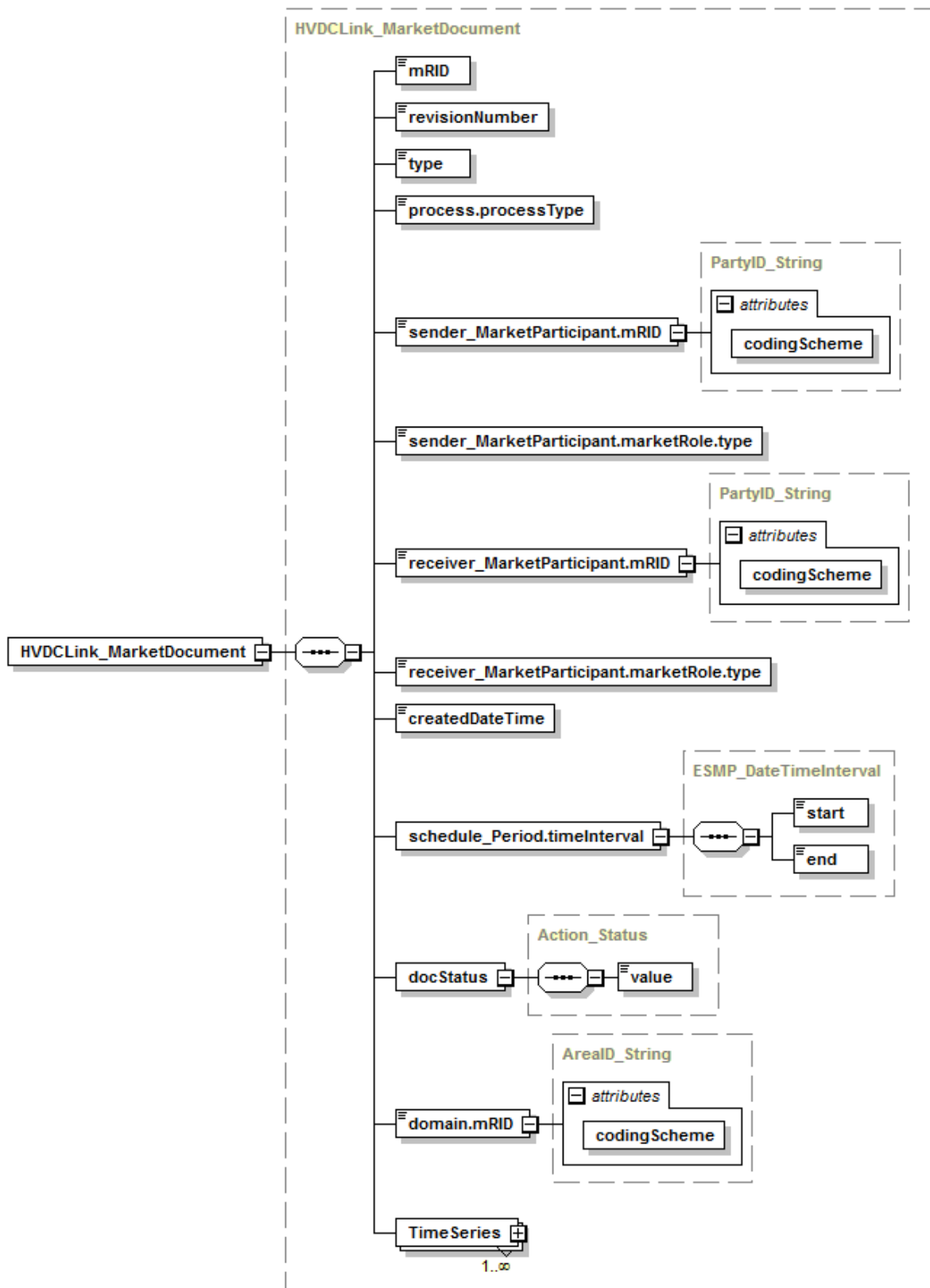
- 307 • Action_Status compound
- 308 • ESMP_DateTimeInterval compound
- 309 • AreaID_String datatype, codelist CodingSchemeTypeList
- 310 • BusinessKind_String datatype, codelist BusinessTypeList
- 311 • CurveType_String datatype, codelist CurveTypeList
- 312 • EnergyProductKind_String datatype, codelist EnergyProductTypeList
- 313 • ESMP_DateTime datatype
- 314 • ESMPVersion_String datatype
- 315 • HVDCMode_String datatype, codelist HVDCModeTypeList
- 316 • ID_String datatype
- 317 • MarketRoleKind_String datatype, codelist RoleTypeList

- 318 • MeasurementUnitKind_String datatype, codelist UnitOfMeasureTypeList
- 319 • MessageKind_String datatype, codelist MessageTypeList
- 320 • ObjectAggregationKind_String datatype, codelist ObjectAggregationTypeList
- 321 • PartyID_String datatype, codelist CodingSchemeTypeList
- 322 • Position_Integer datatype
- 323 • ProcessKind_String datatype, codelist ProcessTypeList
- 324 • ResourceID_String datatype, codelist CodingSchemeTypeList

325 **6 XML schema**

326 **6.1 Schema structure**

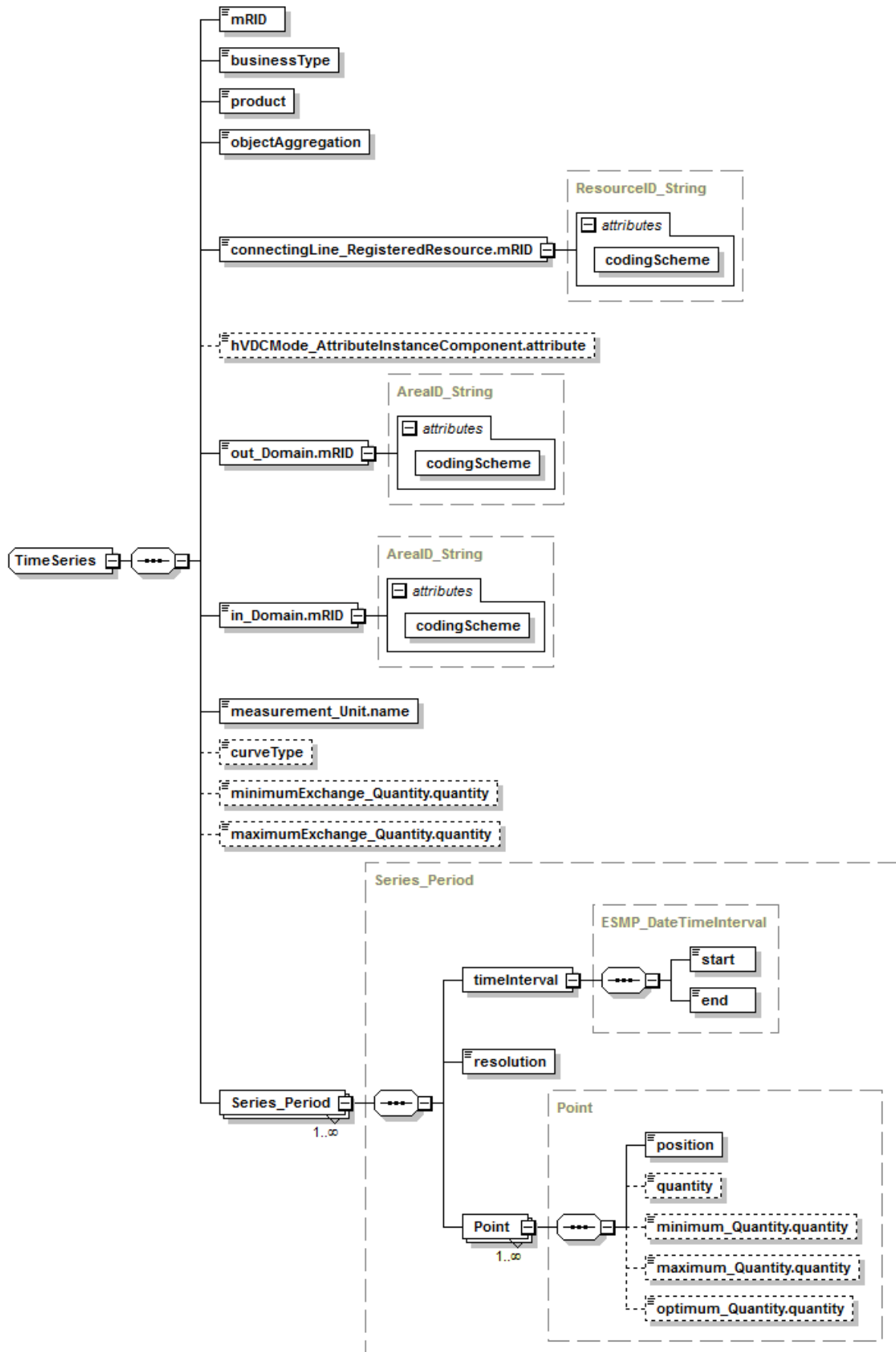
327 Figure 9 and Figure 10 provide the structure of the schema.



328

329

Figure 9 – HVDCLink_MarketDocument XML schema structure 1/2



330

331

Figure 10 – HVDCLink_MarketDocument XML schema structure 2/2

332 6.2 Schema description

```

333 <?xml version="1.0" encoding="utf-8"?>
334 <xs:schema xmlns:cl="urn:entsoe.eu:wgedi:codelists"
335 xmlns:sawsdl="http://www.w3.org/ns/sawsdl" xmlns="urn:iec62325.351:tc57wg16:451-
336 8:hvdclinkdocument:1:0" xmlns:cimp="http://www.iec.ch/cimprofile"
337 attributeFormDefault="unqualified" elementFormDefault="qualified"
338 targetNamespace="urn:iec62325.351:tc57wg16:451-8:hvdclinkdocument:1:0"
339 xmlns:xs="http://www.w3.org/2001/XMLSchema">
340   <xs:import schemaLocation="urn-entsoe-eu-wgedi-codelists.xsd"
341 namespace="urn:entsoe.eu:wgedi:codelists" />
342   <xs:element name="HVDCLink_MarketDocument" type="HVDCLink_MarketDocument" />
343   <xs:simpleType name="ID_String" sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-
344 schema-cim16#String">
345     <xs:restriction base="xs:string">
346       <xs:maxLength value="35" />
347     </xs:restriction>
348   </xs:simpleType>
349   <xs:simpleType name="ESMPVersion_String"
350 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#String">
351     <xs:restriction base="xs:string">
352       <xs:pattern value="[1-9] ([0-9]) {0,2}" />
353     </xs:restriction>
354   </xs:simpleType>
355   <xs:simpleType name="MessageKind_String"
356 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#String">
357     <xs:restriction base="cl:MessageTypeList" />
358   </xs:simpleType>
359   <xs:simpleType name="ProcessKind_String"
360 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#String">
361     <xs:restriction base="cl:ProcessTypeList" />
362   </xs:simpleType>
363   <xs:simpleType name="PartyID_String-base"
364 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#String">
365     <xs:restriction base="xs:string">
366       <xs:maxLength value="16" />
367     </xs:restriction>
368   </xs:simpleType>
369   <xs:complexType name="PartyID_String"
370 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#String">
371     <xs:simpleContent>
372       <xs:extension base="PartyID_String-base">
373         <xs:attribute name="codingScheme" type="cl:CodingSchemeTypeList"
374 use="required" />
375       </xs:extension>
376     </xs:simpleContent>
377   </xs:complexType>
378   <xs:simpleType name="MarketRoleKind_String"
379 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#String">
380     <xs:restriction base="cl:RoleTypeList" />
381   </xs:simpleType>
382   <xs:simpleType name="ESMP_DateTime"
383 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#DateTime">
384     <xs:restriction base="xs:dateTime">
385       <xs:pattern value="((( [0-9] {4} ) [-] (0 [13578] | 1 [02] ) [-] (0 [1-9] | [12] [0-
386 9] | 3 [01] ) | ( [0-9] {4} ) [-] ( (0 [469] ) | (11) ) [-] (0 [1-9] | [12] [0-9] | 30) ) T ( ( [01] [0-9] | 2 [0-
387 3] ) : [0-5] [0-9] : [0-5] [0-
388 9] ) Z) | ( ( [13579] [26] [02468] [048] | [13579] [01345789] (0) [48] | [13579] [01345789] [2468] [048]
389 | [02468] [048] [02468] [048] | [02468] [1235679] (0) [48] | [02468] [1235679] [2468] [048] | [0-
390 9] [0-9] [13579] [26] ) [-] (02) [-] (0 [1-9] | 1 [0-9] | 2 [0-9] ) T ( ( [01] [0-9] | 2 [0-3] ) : [0-5] [0-
391 9] : [0-5] [0-
392 9] ) Z) | ( ( [13579] [26] [02468] [1235679] | [13579] [01345789] (0) [01235679] | [13579] [01345789] [
393 2468] [1235679] | [02468] [048] [02468] [1235679] | [02468] [1235679] (0) [01235679] | [02468] [123
394 5679] [2468] [1235679] | [0-9] [0-9] [13579] [01345789] ) [-] (02) [-] (0 [1-9] | 1 [0-9] | 2 [0-
395 8] ) T ( ( [01] [0-9] | 2 [0-3] ) : [0-5] [0-9] : [0-5] [0-9] ) Z) " />
396     </xs:restriction>
397   </xs:simpleType>
398   <xs:simpleType name="AreaID_String-base"
399 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#String">

```

```

400     <xs:restriction base="xs:string">
401         <xs:maxLength value="18" />
402     </xs:restriction>
403 </xs:simpleType>
404 <xs:complexType name="AreaID_String"
405 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#String">
406     <xs:simpleContent>
407         <xs:extension base="AreaID_String-base">
408             <xs:attribute name="codingScheme" type="cl:CodingSchemeTypeList"
409 use="required" />
410         </xs:extension>
411     </xs:simpleContent>
412 </xs:complexType>
413 <xs:simpleType name="Status_String"
414 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#String">
415     <xs:restriction base="cl:StatusTypeList" />
416 </xs:simpleType>
417 <xs:complexType name="Action_Status"
418 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#Status">
419     <xs:sequence>
420         <xs:element minOccurs="1" maxOccurs="1" name="value" type="Status_String"
421 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#Status.value">
422     </xs:element>
423 </xs:sequence>
424 </xs:complexType>
425 <xs:simpleType name="YMDHM_DateTime"
426 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#DateTime">
427     <xs:restriction base="xs:string">
428         <xs:pattern value="((([0-9]{4}) [\-] (0[13578]|1[02]) [\-] (0[1-9]| [12] [0-
429 9] |3[01]) | ([0-9]{4}) [\-] ((0[469]) | (11)) [\-] (0[1-9]| [12] [0-9] |30)) T(( [01] [0-9] |2 [0-
430 3]) : [0-5] [0-
431 9]) Z) | ((([13579] [26] [02468] [048] | [13579] [01345789] (0) [48] | [13579] [01345789] [2468] [048]
432 | [02468] [048] [02468] [048] | [02468] [1235679] (0) [48] | [02468] [1235679] [2468] [048] | [0-
433 9] [0-9] [13579] [26]) [\-] (02) [\-] (0[1-9]|1[0-9]|2[0-9]) T(( [01] [0-9] |2 [0-3]) : [0-5] [0-
434 9]) Z) | ((([13579] [26] [02468] [1235679] | [13579] [01345789] (0) [01235679] | [13579] [01345789] [
435 2468] [1235679] | [02468] [048] [02468] [1235679] | [02468] [1235679] (0) [01235679] | [02468] [123
436 5679] [2468] [1235679] | [0-9] [0-9] [13579] [01345789]) [\-] (02) [\-] (0[1-9]|1[0-9]|2[0-
437 8]) T(( [01] [0-9] |2 [0-3]) : [0-5] [0-9]) Z)" />
438     </xs:restriction>
439 </xs:simpleType>
440 <xs:complexType name="ESMP_DateTimeInterval"
441 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#DateTimeInterval">
442     <xs:sequence>
443         <xs:element minOccurs="1" maxOccurs="1" name="start" type="YMDHM_DateTime"
444 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-
445 cim16#DateTimeInterval.start">
446     </xs:element>
447         <xs:element minOccurs="1" maxOccurs="1" name="end" type="YMDHM_DateTime"
448 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-
449 cim16#DateTimeInterval.end">
450     </xs:element>
451 </xs:sequence>
452 </xs:complexType>
453 <xs:complexType name="HVDCLink_MarketDocument"
454 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#MarketDocument">
455     <xs:sequence>
456         <xs:element minOccurs="1" maxOccurs="1" name="mRID" type="ID_String"
457 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-
458 cim16#IdentifiedObject.mRID">
459     </xs:element>
460         <xs:element minOccurs="1" maxOccurs="1" name="revisionNumber"
461 type="ESMPVersion_String" sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-
462 cim16#Document.revisionNumber">
463     </xs:element>
464         <xs:element minOccurs="1" maxOccurs="1" name="type" type="MessageKind_String"
465 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#Document.type">
466     </xs:element>

```



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467     <xs:element minOccurs="1" maxOccurs="1" name="process.processType"
468 type="ProcessKind_String" sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-
469 cim16#Process.processType">
470     </xs:element>
471     <xs:element minOccurs="1" maxOccurs="1" name="sender_MarketParticipant.mRID"
472 type="PartyID_String" sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-
473 cim16#IdentifiedObject.mRID">
474     </xs:element>
475     <xs:element minOccurs="1" maxOccurs="1"
476 name="sender_MarketParticipant.marketRole.type" type="MarketRoleKind_String"
477 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#MarketRole.type">
478     </xs:element>
479     <xs:element minOccurs="1" maxOccurs="1" name="receiver_MarketParticipant.mRID"
480 type="PartyID_String" sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-
481 cim16#IdentifiedObject.mRID">
482     </xs:element>
483     <xs:element minOccurs="1" maxOccurs="1"
484 name="receiver_MarketParticipant.marketRole.type" type="MarketRoleKind_String"
485 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#MarketRole.type">
486     </xs:element>
487     <xs:element minOccurs="1" maxOccurs="1" name="createdDateTime"
488 type="ESMP_DateTime" sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-
489 cim16#Document.createdDateTime">
490     </xs:element>
491     <xs:element minOccurs="1" maxOccurs="1" name="schedule_Period.timeInterval"
492 type="ESMP_DateTimeInterval" sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-
493 schema-cim16#Period.timeInterval">
494     </xs:element>
495     <xs:element minOccurs="1" maxOccurs="1" name="docStatus" type="Action_Status"
496 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#Document.docStatus">
497     </xs:element>
498     <xs:element minOccurs="1" maxOccurs="1" name="domain.mRID" type="AreaID_String"
499 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-
500 cim16#IdentifiedObject.mRID">
501     </xs:element>
502     <xs:element minOccurs="1" maxOccurs="unbounded" name="TimeSeries"
503 type="TimeSeries" sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-
504 cim16#MarketDocument.TimeSeries">
505     </xs:element>
506 </xs:sequence>
507 </xs:complexType>
508 <xs:simpleType name="Position_Integer"
509 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#Integer">
510     <xs:restriction base="xs:integer">
511         <xs:minInclusive value="1" />
512         <xs:maxInclusive value="999999" />
513     </xs:restriction>
514 </xs:simpleType>
515 <xs:complexType name="Point" sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-
516 schema-cim16#Point">
517     <xs:sequence>
518         <xs:element minOccurs="1" maxOccurs="1" name="position" type="Position_Integer"
519 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#Point.position">
520         </xs:element>
521         <xs:element minOccurs="0" maxOccurs="1" name="quantity" type="xs:decimal"
522 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#Point.quantity">
523         </xs:element>
524         <xs:element minOccurs="0" maxOccurs="1" name="minimum_Quantity.quantity"
525 type="xs:decimal" sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-
526 cim16#Quantity.quantity">
527         </xs:element>
528         <xs:element minOccurs="0" maxOccurs="1" name="maximum_Quantity.quantity"
529 type="xs:decimal" sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-
530 cim16#Quantity.quantity">
531         </xs:element>
532         <xs:element minOccurs="0" maxOccurs="1" name="optimum_Quantity.quantity"
533 type="xs:decimal" sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-
534 cim16#Quantity.quantity">
535         </xs:element>

```

```

536     </xs:sequence>
537 </xs:complexType>
538 <xs:complexType name="Series_Period"
539 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#Period">
540 <xs:sequence>
541 <xs:element minOccurs="1" maxOccurs="1" name="timeInterval"
542 type="ESMP_DateTimeInterval" sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-
543 schema-cim16#Period.timeInterval">
544 </xs:element>
545 <xs:element minOccurs="1" maxOccurs="1" name="resolution" type="xs:duration"
546 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#Period.resolution">
547 </xs:element>
548 <xs:element minOccurs="1" maxOccurs="unbounded" name="Point" type="Point"
549 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#Period.Point">
550 </xs:element>
551 </xs:sequence>
552 </xs:complexType>
553 <xs:simpleType name="BusinessKind_String"
554 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#String">
555 <xs:restriction base="cl:BusinessTypeList" />
556 </xs:simpleType>
557 <xs:simpleType name="EnergyProductKind_String"
558 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#String">
559 <xs:restriction base="cl:EnergyProductTypeList" />
560 </xs:simpleType>
561 <xs:simpleType name="ObjectAggregationKind_String"
562 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#String">
563 <xs:restriction base="cl:ObjectAggregationTypeList" />
564 </xs:simpleType>
565 <xs:simpleType name="ResourceID_String-base"
566 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#String">
567 <xs:restriction base="xs:string">
568 <xs:maxLength value="18" />
569 </xs:restriction>
570 </xs:simpleType>
571 <xs:complexType name="ResourceID_String"
572 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#String">
573 <xs:simpleContent>
574 <xs:extension base="ResourceID_String-base">
575 <xs:attribute name="codingScheme" type="cl:CodingSchemeTypeList"
576 use="required" />
577 </xs:extension>
578 </xs:simpleContent>
579 </xs:complexType>
580 <xs:simpleType name="HVDCMode_String"
581 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#String">
582 <xs:restriction base="cl:HVDCModeTypeList" />
583 </xs:simpleType>
584 <xs:simpleType name="MeasurementUnitKind_String"
585 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#String">
586 <xs:restriction base="cl:UnitOfMeasureTypeList" />
587 </xs:simpleType>
588 <xs:simpleType name="CurveType_String"
589 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#String">
590 <xs:restriction base="cl:CurveTypeList" />
591 </xs:simpleType>
592 <xs:complexType name="TimeSeries"
593 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#TimeSeries">
594 <xs:sequence>
595 <xs:element minOccurs="1" maxOccurs="1" name="mRID" type="ID_String"
596 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-
597 cim16#IdentifiedObject.mRID">
598 </xs:element>
599 <xs:element minOccurs="1" maxOccurs="1" name="businessType"
600 type="BusinessKind_String" sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-
601 cim16#TimeSeries.businessType">
602 </xs:element>

```

```

603         <xs:element minOccurs="1" maxOccurs="1" name="product"
604 type="EnergyProductKind_String" sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-
605 schema-cim16#TimeSeries.product">
606         </xs:element>
607         <xs:element minOccurs="1" maxOccurs="1" name="objectAggregation"
608 type="ObjectAggregationKind_String"
609 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-
610 cim16#TimeSeries.objectAggregation">
611         </xs:element>
612         <xs:element minOccurs="1" maxOccurs="1"
613 name="connectingLine_RegisteredResource.mRID" type="ResourceID_String"
614 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-
615 cim16#IdentifiedObject.mRID">
616         </xs:element>
617         <xs:element minOccurs="0" maxOccurs="1"
618 name="hVDCMode_AttributeInstanceComponent.attribute" type="HVDCMode_String"
619 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-
620 cim16#AttributeInstanceComponent.attribute">
621         </xs:element>
622         <xs:element minOccurs="1" maxOccurs="1" name="out_Domain.mRID"
623 type="AreaID_String" sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-
624 cim16#IdentifiedObject.mRID">
625         </xs:element>
626         <xs:element minOccurs="1" maxOccurs="1" name="in_Domain.mRID"
627 type="AreaID_String" sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-
628 cim16#IdentifiedObject.mRID">
629         </xs:element>
630         <xs:element minOccurs="1" maxOccurs="1" name="measurement_Unit.name"
631 type="MeasurementUnitKind_String" sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-
632 schema-cim16#Unit.name">
633         </xs:element>
634         <xs:element minOccurs="0" maxOccurs="1" name="curveType"
635 type="CurveType_String" sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-
636 cim16#TimeSeries.curveType">
637         </xs:element>
638         <xs:element minOccurs="0" maxOccurs="1"
639 name="minimumExchange_Quantity.quantity" type="xs:decimal"
640 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#Quantity.quantity">
641         </xs:element>
642         <xs:element minOccurs="0" maxOccurs="1"
643 name="maximumExchange_Quantity.quantity" type="xs:decimal"
644 sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#Quantity.quantity">
645         </xs:element>
646         <xs:element minOccurs="1" maxOccurs="unbounded" name="Series_Period"
647 type="Series_Period" sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-
648 cim16#TimeSeries.Series_Period">
649         </xs:element>
650     </xs:sequence>
651 </xs:complexType>
652 </xs:schema>

```