Energy Market Information Exchange (EMIX) Version 1.0

Committee Specification Draft ~~02~~03 / Public Review Draft ~~02~~03

~~28 April~~23 June 2011

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http://docs.oasis-open.org/emix/emix/v1.0/emix-v1.0.html

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Technical Committee:

OASIS Energy Market Information Exchange (eMIX) TC

~~**Chair(s):**~~

Chairs:

William Cox, Individual
Edward Cazalet, Individual

Editor~~(s)~~:

Toby Considine, University of North Carolina at Chapel Hill

Related work:

This specification is related to:

- OASIS Specification WS-Calendar V1.0, in process
- OASIS Specification Energy Interoperation V1.0, in process
- XML ~~schema(s):~~schemas: emix/v1.0/csprd03/xsd/

Declared XML ~~namespace(s):~~namespaces:

http://docs.oasis-open.org/ns/emix/2011/06

http://docs.oasis-open.org/ns/emix/2011/06/power
http://docs.oasis-open.org/ns/emix/2011/06/power/resource
http://docs.oasis-open.org/ns/emix/2011/06/siscale

Abstract:

~~The data models and XML vocabularies defined by this TC will address issues in energy markets and the Smart Grid, but are defined so as to support requirements for other markets. The TC will develop~~This specification defines an information model and XML vocabulary ~~to~~for the interoperable and standard exchange of prices and product definitions ~~for~~ in transactive energy markets~~.~~:

- Price information
- Bid information
- Time for use or availability
- Units and quantity to be traded
- Characteristics of what is traded

~~The definition of a price and of other market information exchanged depends on the market context in which it exists. It is not in scope for this TC to define specifications for markets, nor how prices are determined, nor the mechanisms for interoperation.~~

Status:

This document was last revised or approved by the OASIS Energy Market Information Exchange (~~EMIX~~eMIX) TC on the above date. The level of approval is also listed above. Check the "Latest ~~Version~~version" location noted above for possible later revisions of this document.

Technical Committee members should send comments on this specification to the Technical Committee's email list. Others should send comments to the Technical Committee by using the "Send A Comment" button on the Technical Committee's web page at http://www.oasis-open.org/committees/emix/.

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When referencing this specification the following citation format should be used:

[EMIX~~-v1.0~~]

Energy Market Information Exchange (EMIX) Version 1.0. ~~28 April,~~23 June 2011. OASIS Committee Specification Draft ~~02~~03 / Public Review Draft ~~02.~~03. http://docs.oasis-open.org/emix/emix/v1.0/csprd03/emix-v1.0-csprd03.html~~-~~.

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1 Introduction

This ~~document~~specification defines an information model to exchange Price and Product information for power and energy markets. Product definition includes quantity and quality of supply as well as attributes of interest to consumers distinguishing between power and energy sources. ~~Energy Market Information Exchange (EMIX) is not intended as a stand-alone signal; rather, it~~It is anticipated to be used for information exchange in a variety of market-oriented interactions.

The EMIX Technical Committee (TC) is developing this specification in support of the US Department of Commerce National Institute of Standards and Technology (NIST) ~~NIST~~ Framework and Roadmap for Smart Grid Interoperability Standards **[NIST Roadmap]** and in support of the US Department of Energy (DOE) as described in the Energy Independence and Security Act of 2007 (EISA 2007) **[EISA]**.

~~This specification defines the following:~~

- ~~The characteristics of power and energy that along with price define a product~~
- ~~An **[XML Schema]** for Price and Product definition for products whose value varies with time of delivery.~~
- ~~An **[XML Schema]** for Price and Product definition for Power-related products and services.~~
- ~~An **[XML Schema]** describing the capabilities of resources that are being offered to the market.~~

Key to reading ~~the~~this document:

- **BOLD** terms are the names of referenced standards
- Italic phrases are quotes from external material.
- **[bracketed]** are references to the standards listed in listed in the normative or non-normative ~~sections~~ references sections.
- All examples and all Appendices are non-normative.

1.1 Terminology

The key words “MUST”, “MUST NOT”, “REQUIRED”, “SHALL”, “SHALL NOT”, “SHOULD”, “SHOULD NOT”, “RECOMMENDED”, “MAY”, and “OPTIONAL” in this document are to be interpreted as described in [**RFC2119**].

1.2 Process

This information ~~exchange~~model was developed primarily by integrating requirements and use cases for Price and Product definition developed by the North American Energy Standards Board (NAESB) as part of its response to NIST Priority Action Plan 03 (PAP03), “Develop Common Specification for Price and Product Definition” **[NIST PAP03]**, which was driven by NIST, Federal Energy Regulatory Commission (FERC), and DOE priority items.

Where appropriate, semantic elements from the International Electrotechnical Commission (IEC) Technical Committee (TC) 57 Power ~~systems management~~Systems Management and ~~associated information exchange~~Associated Information Exchange Common Information Model (CIM) are used **[IEC TC57]**. Business and market information was borrowed from the financial instruments Common Information Models as described in International Standards Organization (ISO) **[ISO20022]** standard and in the financial trading protocol, **[FIX]** (Financial Information eXchange).

Both the supply and the use of energy ~~products~~, and therefore the market value, are time dependent, so precise communication of time of delivery is a significant component of product definition. EMIX incorporates schedule and interval communication interfaces from Web Services Calendar (**[WS-Calendar]**) to communicate schedule-related information. Practitioners should read the **[WS-Calendar]** specification or the **[WS-Calendar Note]**.

Additional guidance was drawn from subject matter experts familiar with the design and implementation of enterprise and other systems that may interact with smart grids.

1.3 Normative References

RFC2119 S. Bradner, *Key words for use in RFCs to Indicate Requirement Levels*, http://www.ietf.org/rfc/rfc2119.txt, IETF RFC 2119, March 1997.

~~CEFACT~~ISO42173 *United Nations Centre for Trade Facilitation and Electronic Business*, Currency codes, ISO ~~4217 3A~~42173A - Code List Schema Module http://www.unece.org/uncefact/codelist/standard/ISO_ISO3AlphaCurrencyCode_20100407.xsd

GML L van den Brink, C Portele, P. Vretanos *Geography Markup Language (GML) simple features profile*, OpenGIS® Implementation Standard, GML 3.2 Profile, Version 2.0, October 2010, http://schemas.opengis.net/gml/3.2.1/gml.xsd

~~**SOA-RM** M MacKenzie, K Laskey, F McCabe, P Brown, R Metz~~**SI Units** Bureau International des Poids et Mesures (BIPM), The International System of Units, 8th Edition, May 2006. http://www.bipm.org/en/si/si_brochure/general.html

SOA-RM OASIS Standard, *OASIS Reference Model for Service Oriented Architecture 1.0*, October 2006 http://docs.oasis-open.org/soa-rm/v1.0/

~~**UML** *Unified Modeling Language (UML), Version 2.2*, Object Management Group, February, 2009,~~

URI T. Berners-Lee, R. Fielding, L. Masinter, *Uniform Resource Identifier (URI): Generic Syntax,* http://www.ietf.org/rfc/rfc3986.txt, January 2005

WS-Calendar ~~T. Considine, M. Douglas,~~ OASIS Committee Specification Draft 03, *WS-Calendar ~~Public Review Draft 02~~*, ~~April~~, May 2011, http://docs.oasis-open.org/ws-calendar/ws-calendar-spec/v1.0/csprd02/ws-calendar-spec-v1.0-csprd02.pdf~~specification in progress,~~

XML Schema H. Thompson, D Beech, M Maloney, N Mendelsohn, *XML Schema Part 1: Structures Second Edition*, http://www.w3.org/TR/xmlschema-1/ October 2004 PV Biron, A Malhotra, *XML Schema Part 2: Datatypes Second Edition*, http://www.w3.org/TR/xmlschema-2/ October 2004.

1.4 Non-Normative References

Budeanu C.I. Budeanu, *The different options and conceptions regarding active power in nonsinusoidal systems.* Rumanian National Institute, 1927

Caramia P Caramia, G. Carpinelli, P Verde, *Power Quality Indices in Liberalized Markets,* Wiley 2009

EISA Energy Independence and Security Act (EISA 2007) http://www.gpo.gov/fdsys/pkg/PLAW-110publ140/content-detail.html

EN50160 EN50160-2000 (2003) Electromagnetic Compatibility (EMC) – Part 4-30: Testing and Measurement Techniques – Power Quality Measurement Methods, Edition 2, June.

FIX Financial Information eXchange (FIX) Protocol, http://www.fixprotocol.org/specifications/FIX.5.0SP2

IEC TC57 IEC TC 57 Power Systems Management and Associated Information Exchange, IEC 61968-9 Application integration at electric utilities - System interfaces for distribution management - Part 9: Interfaces for meter reading and control http://webstore.iec.ch/preview/info_iec61968-9%7Bed1.0%7Den.pdf IEC 61970-301, Energy management system application program interface (EMS-API) - Part 301: Common information model (CIM) base http://webstore.iec.ch/Webstore/webstore.nsf/Artnum_PK/42807

IEC61000-4-30 IEC 61000-4-30–2003, *Electromagnetic compatibility (EMC) – Part 4-30: Testing and measurement techniques – Power quality measurement methods*

IEEE1519 IEEE1159-2009, *IEEE Recommended Practice for Monitoring Electric Power Quality*, ieee.org

IEEE1547 IEEE 1547, *Standard for Interconnecting Distributed Resources with Electric Power Systems,* ieee.org

IEEEv15#3 Pretorius, van Wyk, Swart. *An Evaluation of Some Alternative Methods of Power Resolution in a Large Industrial Plant*, 1990 IEEE Transactions on Power Delivery, VOL. 15, NO. 3, JULY 2000.

ISO 20022 ISO Standards, Financial Services - Universal financial industry message scheme, http://www.iso20022.org/UNIFI_ISO20022_standard.page

Kingham Brian Kingham**,** *Quality of Supply Standards: Is EN 50160 the Answer?,* 17th Conference of Electrical Power Supply Industry, Macau, 2008; also EPRI Power Quality Conference, 2008; Also available at http://www.oasis-open.org/committees/download.php/37248/Power%20Quality%20White%20Paper%20from%20Schneider.pdf

NAESB PAP03 Requirements Specification for Common Electricity Product and Pricing Definition, North American Energy Standards Board [NAESB], March, 2010
NAESB Wholesale Electrical Quadrant Business Practice
http://www.naesb.org/member_login_check.asp?doc=fa_2010_weq_api_6_a_ii.doc
NAESB Retail Electrical Quadrant Business Practice,
http://www.naesb.org/member_login_check.asp?doc=fa_2010_retail_api_9_a.doc

NAESB MDL Wholesale Electrical Quadrant Business Practice Master Data Element List,
http://www.naesb.org/member_login_check.asp?doc=fa_2010_weq_api_6_a-c.doc
Retail Electrical Quadrant Business Practice Master Data Element List,
http://www.naesb.org/member_login_check.asp?doc=fa_2010_retail_api_9_a-c.doc

NAESB PAP10 NAESB Wholesale Electrical Quadrant Business Practice Standard PAP10
http://www.naesb.org/member_login_check.asp?doc=fa_weq_2010_ap_6d.doc
NAESB Retail Electrical Quadrant Business Practice Standard PAP10
http://www.naesb.org/member_login_check.asp?doc=fa_req_2010_retail_ap_9d.doc
Energy Usage Model (freely available):
http://www.naesb.org/pdf4/naesb_energy_usage_information_model.pdf

NAESB M&V Measurement and Verification Standards
Wholesale Electrical Quadrant Business Practice Standard:
http://www.naesb.org/member_login_check.asp?doc=fa_2010_weq_api_4a_4b.doc~~**IEC TC57** IEC TC 57 Power and Load Management,~~
Retail Electrical Quadrant Business Practice Standard:
http://www.naesb.org/member_login_check.asp?doc=fa_2010_retail_api_3_c.doc

NIEM NIEM Technical Architecture Committee (NTAC), *National Information Exchange Model Naming and Design Rules v1.3*, October 2008, http://www.niem.gov/pdf/NIEM-NDR-1-3.pdf

OpenADR Mary Ann Piette, Girish Ghatikar, Sila Kiliccote, Ed Koch, Dan Hennage, Peter Palensky, and Charles McParland. 2009. Open Automated Demand Response Communications Specification (Version 1.0). California Energy Commission, PIER Program. CEC-500-2009-063. http://openadr.lbl.gov/pdf/cec-500-2009-063.pdf

TeMIX	~~Transactional~~Transactive Energy Market Information Exchange [TeMIX] an approved ~~White Paper~~Note of the EMIX TC. Ed Cazalet et al. http://www.oasis-open.org/committees/download.php/37954/TeMIX-20100523.pdf
~~NAESB 03~~	~~*Requirements Specification for Common Electricity Product and Pricing Definition*, North American Energy Standards Board [NAESB], March, 2010 (Public Review Draft).~~
NIST Roadmap	NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 1.0, http://www.nist.gov/public_affairs/releases/upload/smartgrid_interoperability_final.pdf~~online.~~
NIST PAP03	Details of PAP03 ~~may~~can be found at http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/PAP03PriceProduct ~~(link retrieved 06/23/2010)~~
RFC5545	B. ~~**RFC5545** B.~~ Desruisseaux *Internet Calendaring and Scheduling Core Object Specification (iCalendar)*, http://www.ietf.org/rfc/rfc5545.txt, IETF RFC 5545, September 2009.
RDDL	J Borden, T Bray, *Resource Directory Description Language (RDDL) Version 2.0*, October, 2002, http://www.rddl.org/RDDL2
UML	*Unified Modeling Language (UML), Version 2.2*, Object Management Group, February, 2009, http://www.omg.org/spec/UML/2.2/**~~White Paper on WS-Calendar~~**
WS-Calendar Note	OASIS Committee Note Public Review Draft, *WS-Calendar Conceptual Overview*, http://docs.oasis-open.org/ws-calendar/ws-calendar/v1.0/CD01/WS-Calendar-Conceptual-Overview-CD01.pdf

1.5 Namespace

XML namespaces and prefixes used in this specification are shown in Table 1-1~~standard:~~.

Table 1-1: XML Namespaces in this standard

Prefix	Namespace
emix~~:~~	http://docs.oasis-open.org/ns/emix/2011/06
scale~~power:~~	http://docs.oasis-open.org/ns/emix/2011/06/siscale
power~~resource:~~	http://docs.oasis-open.org/ns/emix/2011/06/power
resource~~xs~~	http://docs.oasis-open.org/ns/emix/2011/06/power/resource
~~gml:~~xs	http://www.w3.org/2001/XMLSchema
gml~~xcal:~~	http://www.opengis.net/gml/3.2~~urn:ietf:params:xml:ns:icalendar-2.0~~
xcal~~clm5ISO42173A:~~	urn:ietf:params:xml:ns:icalendar-2.0 ~~urn:un:unece:uncefact:codelist:standard:5:ISO42173A:2010-04-07~~

All OASIS Schemas are permanently accessible through directory structures that include major and minor version numbers. They are also accessible through RDDL files that describe these structures and version in directories below http://docs.oasis-open.org/emix/emix.

The schema document at that URI may however change in the future, in order to remain compatible with the latest version of EMIX Specification. In other words, if the schemas namespaces change, the version of this document at http://docs.oasis-open.org/ns/emix/2011/ will change accordingly.

In keeping with OASIS standard policy, a RDDL document locating the schemas defined in this specification will persist in http://docs.oasis-open.org/ns/emix.

The EMIX schema versioning policy is that namespaces reflect the year and month in which they were released. For this version, this rule results namespaces as indicated in the first four namespaces listed in Table 1-1.

Namespace maintenance as described above also addresses the need for schema versioning; such information is already contained in the directory structures found at http://docs.oasis-open.org/emix/emix/~~Namespace URIs resolve to a Resource Directory Description Language [] document describing the namespace.~~

. Versioning beyond that which is required by the namespace maintenance policy is not specified.

1.6 Naming Conventions

~~This specification generally follows the follows the National Information Exchange Model **[NIEM]** naming and design rules for artifacts defining the specification, as follows:~~

~~For the~~The names of ~~elements and the names of attributes within~~EMIX XSD ~~files, the names~~Elements and Attributes follow ~~the lower camelCase~~Lower Camel Case convention~~, with all names starting with a lower case letter. For example,~~.

Example:

```
<element name="componentService" type="emix:ComponentServiceType"/>
```

~~For the~~The names of ~~types within XSD files, the names~~ EMIX Types follow ~~the~~ Upper ~~CamelCase~~Camel Case convention ~~with all~~and Type names ~~starting with an upper case letter~~are postfixed with "Type". ~~For example,~~

Example:

```
<complexType name="ComponentServiceType">
```

1.7 Editing Conventions

For readability, ~~element~~Element names in tables appear as separate words. ~~The actual names are lowerCamelCase, as specified above, and as~~In the Schemas, they ~~appear in the XML schemas.~~

~~The cardinality of each element can vary by transactive state. For clarity, cardinality for each element is not indicated in~~follow the ~~tables in the specification. Note: because of EMIX Inheritance (see section), a :"missing" required element may be supplied through inheritance~~rules as described in Section 1.6.

~~Information in the "Specification" column of the tables is normative. Information appearing in the note column is explanatory and non-normative.~~

Terms defined in this specification or used from specific cited references are capitalized; the same term not capitalized has its normal English meaning.

All sections explicitly noted as examples are informational and ~~are not to~~SHALL NOT be considered normative.

All UML and figures are illustrative and SHALL NOT be considered normative.

~~1.8 Semantics from WS-Calendar~~

~~Time semantics are critical to EMIX. An overview of EMIX semantics is in Appendix C for easy reference. Practitioners should read that specification or the [**White Paper on WS-Calendar].**~~

~~1.9 Market Semantics~~

~~Different energy markets have specific market terms and interaction patterns. This specification endorses none of them, but still needs to discuss the various stages of a market transaction. Without mandating the terminology used in any particular market, the EMIX specification uses the common market terms as defined in .~~

~~You may want to turn ahead to have these definitions in mind as you read this document.~~

~~1.10~~1.8 Security Approaches

~~EMIX is an information model, and thus security per se is out of scope for this specification.~~ EMIX will normally be conveyed in messages as part of business processes. Each business process will have its own security needs, including different consequences for failure of security. EMIX relies on the business processes using the standard to ensure secure exchange of Price and Product information in energy market transactions.

2 Overview

2.1 Introduction

Energy markets have been characterized by tariffs and embedded knowledge that ~~make~~makes decision automation difficult. Different market segments use conflicting terms for similar attributes. Smart grids introduce rapidly changing products and product availability, with associated dynamic prices. A lack of a widely understood model conveying market information has been a barrier to development and deployment of technology to respond to changing market ~~circumstances~~conditions.

Price and ~~product definition~~Product Descriptions are *actionable information.* When presented with standard messages conveying price and product information, automated systems can make decisions to optimize energy and economic results. In regulated electricity markets, price and products often are defined by complex tariffs, derived through not strictly economic processes. These tariffs convey the price and product information to make buying and selling decisions easier. The same information can be derived from market operations in non-tariffed markets. EMIX defines ~~the~~an information ~~for use in messages that~~model to convey this actionable information.

An essential distinction between energy and other markets is that price is strongly influenced by time of delivery. Energy for sale at 2:00 AM, when energy use is low, ~~is~~may not have the same ~~product~~value as energy for sale at the same location at 2:00 PM, during the working day. EMIX conveys time and ~~interval~~Interval by incorporating WS-Calendar into tenders, transactions, and ~~performance calls.~~ delivery. Not all market information is available in real time. Present day markets, particularly wholesale markets, may have deferred charges (e.g. balancing charges) that cannot be determined at point of sale. Other markets may require additional purchases to allow the use of the energy purchased (e.g. same-time transmission rights or pipeline fees when accepting delivery on a forward contract). EMIX is useful for representing available price and product information.

2.1.1 Product Terminology

This specification uses a definition of Product that is inclusive of attributes including schedule, location, and source. Some markets define products in a more restricted or general manner. We combine the various attributes of a thing bought or sold, shown graphically in FIGURE 2-1. In this specification we define a product to include both the type of product (e.g., Energy), the response time (e.g. fast enough to qualify as Regulation), and the delivery time as shown by the black arrow. Others (e.g., ISO Wholesale markets) define products at a higher level (e.g. Energy) which is considered the same product regardless of delivery time, as indicated by the gray arrow.

Figure 2-1is illustrative, not normative; the order of significance is not defined in this specification. Moreover, there are attributes such as Source or Power Quality that do not easily fit in a single dimension—and a renewable source typically makes a different Product with different value.

Fortunately, this is often a distinction without moment, as the information needed for a transaction involves the more detailed characteristics as indicated by the black arrow, and the specific definition of a Product is part of the Market Context.

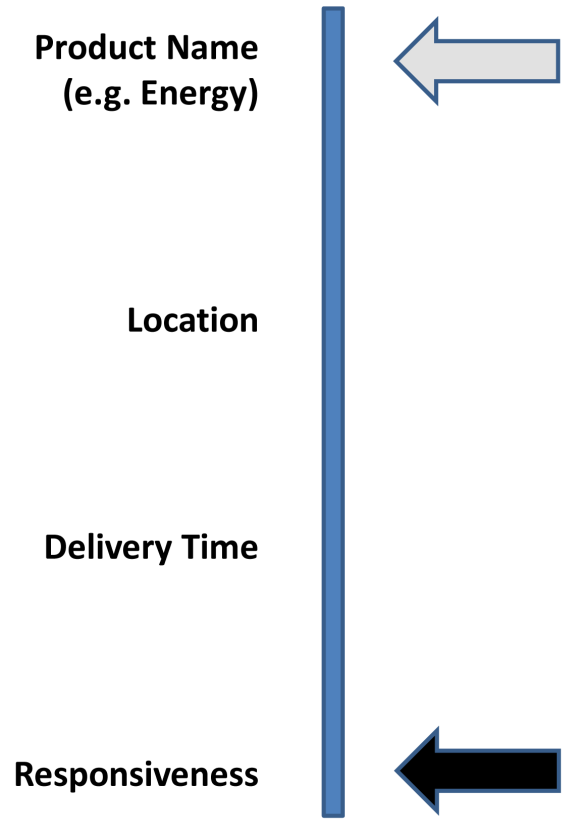

Figure 2-1: Attributes of a Product

2.2 Approach

The EMIX TC has prepared a white paper ~~which~~that provides a context for discussing the use of transactions in ~~retail~~forward and futures wholesale energy markets~~.~~ and financial markets. The ~~Transactional~~Transactive Energy Market Information Exchange ~~({~~**[TeMIX~~}~~]]** white paper can be found in the non-normative references.

~~Transactive Energy Market Information Exchange (~~ Users of EMIX are strongly encouraged to become familiar with TeMIX~~) was developed as~~ when considering this standard.

Transactive Energy Market Information Exchange **([TeMIX])** is a specialization of work within the EMIX TC to address retail and wholesale transactions using approaches common in energy wholesale and financial ~~transactions. The Energy Interoperation TC~~markets. This specification defines a TeMIX profile ~~which is~~as a restricted subset of the EMIX information model ~~and the Energy Interoperation TC services.~~ .

The TeMIX ~~profile~~approach allows only specific tenders and transactions for block power on defined ~~intervals~~Intervals of time. Any party can be a buyer, seller, or both. Tenders may be offered by any party to any other party, as market rules and regulations may allow. ~~Any party can be a buyer, seller or both.~~ Transactions may include call and put options. TeMIX also describes transport products for transmission and distribution.

The restricted information model and services of the TeMIX profile also support increased automation of transactions using the computer and communications technology of the smart grid. Tenders and Transactions can support dynamic tariffs by retail providers to retail customers. Options perform a similar function to demand response contracts or ancillary service contracts ~~where~~wherein an operator has dispatch control over the exercise of the option. The TeMIX ~~products also include transmission and~~

~~distribution (transport) products.~~ approach assumes interval metering where delivery can be accurately measured.

~~TeMIX tenders and transactions can support dynamic tariffs by retail providers to retail customers. TeMIX is designed for interval metering where delivery can be accurately measured. The simplified information model and services of the TeMIX profile also support increased automation of transactions using the computer and communications technology of the smart grid.~~

EMIX has adopted ~~the~~ much of ~~the~~ TeMIX terminology. EMIX supports current operating models of market operators, utilities, and ~~demand response~~Demand Response providers while at the same time supporting the TeMIX model and future transitions among the models.

Power is a commodity good whose market value may be different based upon how it is produced or generated. After production, though, the commodity is commingled with production from other sources with which it is fully fungible. Even so, some energy purchasers distinguish between sources of this product even as they consume the commingled commodity. EMIX assumes this product differentiation and defines multiple products based on the underlying good.

Throughout this work, ~~we refer~~the specification refers to the intrinsic and extrinsic properties of an energy product. An intrinsic property is one *"belonging to a thing by its very nature."* An extrinsic property is one *"not forming an essential part of a thing or arising or originating from the outside."* In EMIX, the term intrinsic properties refers to those that can be measured and / or ~~-~~verified at the point of delivery, ~~i.e.,~~such as electric power and price. The term extrinsic properties refers to those that can only be known with prior knowledge, such as the carbon cost, the energy source, or the sulfate load from generation.

EMIX ~~artifacts~~Artifacts can communicate both intrinsic and extrinsic properties~~;~~. EMIX is designed to support arrange of markets from those in which extrinsic properties must ~~be able to~~ clear ~~in the market~~ just as do intrinsic properties~~.~~

~~EMIX is~~ , to markets may not be concerned with the ~~processes whereby an actor provides the products and resources it describes.~~ extrinsic properties.

EMIX is an information model that assumes conveyance within a service-based environment~~. As~~, as defined in the OASIS Reference Model for Service Oriented Architecture 1.0 **[SOA-RM]**~~, service requests access the capability of a remote system.~~**].**

~~2.3 The purpose of using a capability is to realize one or more real world effects. At its core, an interaction is "an act" as opposed to "an object" and the result of an interaction is an effect (or a set/series of effects). This effect may be the return of information or the change in the state of entities (known or unknown) that~~2.3 Time Semantics

Time semantics are ~~*involved in the interaction.*~~

~~*We are careful to distinguish between public actions and private actions; private actions are inherently unknowable by other parties. On the other hand, public actions result in changes to the state that is shared between at least those involved in the current execution context and possibly shared by others. Real world effects are, then, couched in terms of changes to this shared state*~~

~~A request for the delivery of a product is a request for specific real world effects. For~~ critical to EMIX~~,~~ ~~these effects are expected to occur during a given period.~~. Consider two sellers that offer the same product. ~~One~~ For the first, one must start planning an hour or more in advance. The second may be able to deliver the product ~~in~~within five minutes~~.~~ of a request. The service start time is the time when product delivery begins. Because this service start time and service period are all that matters to product delivery, different providers using quite different technologies can provide equivalent product as specified in EMIX if each is given adequate notice. For other products, timeliness of notice is of the essence, and the first may not be able to provide the service.

~~Time semantics are critical to EMIX. EMIX uses semantics from **[WS-Calendar]** to describe time, duration, and schedule. WS-Calendar also defines an information model wherein services or products that vary over time can be efficiently and unambiguously communicated using inheritance. Lastly, WS-Calendar describes an approach wherein an incompletely specified sequence of information can be completed using minimal re-definition and remote invocation. EMIX uses these semantic and conformance rules throughout this specification.~~

EMIX uses semantics from **[WS-Calendar]** to describe Time, Duration, and Schedule. An overview of **[WS-Calendar]** semantics is provided in Appendix E.

~~2.3~~2.4 Information Structure

As a conceptual aid, ~~we discuss~~consider the information structure using the metaphor of an *envelope containing ~~warrants~~.Warrants*. The intrinsic properties and the price are on the face of the envelope, easy to read by all. The contents of the envelope are the supporting information and various ~~warrants~~Warrants about the extrinsic qualities.

On the face of the envelope, EMIX lists the intrinsic qualities of the energy product. In the simplest model, the intrinsic qualities are limited to the price and the information a meter can provide. In a market of homogenous energy sources and commodity energy, only the intrinsic qualities are actionable. In postal handling, information on the face of the envelope is meant for high-speed automated processing. The simplest devices, including the proverbial smart toaster, may understand only the intrinsic qualities. The phrase “prices to devices” is used in energy policy discussions to describe a market model in which energy use decisions are distributed to each device that uses energy. Under this model, decisions about whether to use energy ~~now~~immediately or delay energy use until a later time are best made where the value is received for that energy use, that is, at the end device. The smart toaster is shorthand for the smallest, least capable end device that can receive such a message. ~~The Committee anticipates~~It is anticipated that the information on the face of the envelope will be sufficient for many, if not most, energy decisions.

The envelope contents are the supporting documents that explain and support the price for the intrinsic qualities on the face of the envelope. These extrinsic qualities are separable from the intrinsic transaction and perhaps can be traded in secondary markets. The contents can include Warrants about the source and the environmental attributes which provide information about the energy, but they are not the energy. The extrinsic qualities enable traceability and auditing, increasing public trust in energy markets and on energy differentiation. The simplest gateways and devices may ignore the ~~warrants,~~Warrants; that is, they can forward or process messages without opening the envelope.

The extrinsic information within the envelope may contain information that supports the price among the Extrinsic information conveyed within the envelope ~~includes supporting information.~~ For example, a purchaser may opt to buy energy from a particular supplier with advertised rates. Transport loss may reduce the quantity delivered. Markets may add congestion charges along the way.

Such supporting information can explain why the delivered cost, on the face of the envelope, is different than the purchase cost.

~~2.4 EMIX Time and Schedules~~

~~Time is an important component of energy products. An energy product produced in one Interval of time may or may not be able to be stored for delivery at a later Interval of time. Thus the same product in different Intervals of time may have different prices. EMIX uses **[WS-Calendar]** to apply prices and products to time Intervals.~~

~~WS-Calendar defines a mechanism to apply a schedule to a Sequence of time Intervals. WS-Calendar further defines how to use a process analogous to inheritance to apply a single information artifact to each Interval in the Sequence, allowing elements of that artifact to be over-ridden within any given Interval. WS-Calendar also defines a schedule entry point, defining how specific performance can be contracted and scheduled.~~

~~This document assumes that the reader has a clear understanding of WS-Calendar and its interfaces. The non-normative white paper on the use of the WS-Calendar specification published by that committee is a good place to start.~~

2.5 Tenders and Transactions for Power Products and Resource Capabilities

The focus of EMIX is on ~~price~~a Price and ~~product~~Product information model for communication in support of commercial transactions. The messaging and interaction patterns for commercial transactions are out of scope for EMIX but worth a brief discussion here to provide context.

EMIX is intended for commercial transactions in all types of markets including ISO/RTO markets, exchange markets, regulated markets, regulated retail tariffs, open markets, and wholesale and retail bilateral markets. *(ISO refers to Independent System Operators. ISOs provide non-discriminatory access to transmission, operate spot markets and maintain grid reliability. RTO refers to Regional Transmission Organizations. RTOs perform the ISO functions on a regional basis.)* The commercial practices that determine prices vary in these markets but all markets can benefit from interoperable communication of ~~price~~Price and ~~product~~Product information.

Transactions in most markets begin with ~~Tenders~~tenders (offers to buy or sell) by ~~a Party~~one party to another ~~Party.~~party. Once an agreement among ~~Parties~~ parties is reached, the parties ~~Agree~~agree to a ~~Transaction~~transaction (contract or award). The parties to the ~~Transaction~~transaction then must perform on the transaction~~Transaction~~ by arranging for supply, transport, consumption, settlement and payment. At every stage in this process, clear communication of the terms -(price, quantity, delivery schedule and other attributes) of the tender or transaction is essential. Section 1.1, *"Envelopes: EMIX Base and its Derivatives"* describes EMIX Base Type, the core of EMIX information models.

In many electricity markets, Operators are offered electrical products based on specific resources~~, i.e.,~~ such as generators, load curtailment, and other energy resources. EMIX uses EMIX Resource Descriptions to describe the responsiveness, capacity, and other aspects of these Resources. EMIX Resource Offers combine an EMIX Resource Description with a multi-part offer. A Party can use EMIX Resource Offers to tender to an Operator one or more EMIX Products. Similarly, an EMIX Load Curtailment Offer combines a Load Curtailment Resource Description with a multi-part offer.

2.6 Transport

Product transport ~~costs vary over time. Delivery~~from a point of injection to a grid to a point of takeout to a grid is also described by the EMIX information model. Product transport can be characterized by (1) the quantity transported and price, or (2) the quantity transported and cost detail.

Transport costs come in two general forms. Congestion charges apply to each unit of product that passes through a particular point in the distribution system. Congestion charges increase the cost of the Product delivered in a particular Interval. Loss reduces the product delivered as it passes from the purchase point to the delivery point. Loss may reduce the amount of product received or a loss charge may be applied to purchase replacement energy for the energy loss.

If the Product is priced for ~~Delivery~~delivery to the consumer, transport charges may not apply. Product descriptions for ~~Transport charges~~transport services are discussed in Section 11, *"Power Transport Product Description~~,~~."*

2.7 Verification of Response

Many products, ~~particularly~~e.g. those transacted for Demand Response, ~~are distinguished by particular Verification Methods. In a pure transactive energy market, the meter would be the only Verification mechanism.~~have detailed verification methods. In today's markets, ~~Verification~~ verification can be ~~more~~quite complex.

Verification is out of scope for this ~~document.~~specification. Measurement and Verification is fully specified ~~under~~ by NAESB Business Practices for Measurement and Verification~~.~~ **[NAESB M&V]**. This specification does not ~~describe~~define verification.

3 Guide to the Schema Structures

~~The EMIX information exchange model defines common structures that can be used to define products whose value varies with the time of delivery. Because the future of smart energy markets its not known, there is an emphasis on extensibility and composition to allow EMIX to be suitable for markets known and unknown, and for easy evolution.~~

The EMIX 1.0 Specification consists of ~~three~~four schemas~~.~~:

- The EMIX schema defines the framework and extensibility as well as agreement types common to many markets. The EMIX schema consists of three files—emix.xsd, emix-terms.xsd, and emix-warrants.xsd
- The SI Scale schema, defines a code list enumerating the characters indicating the decadic scale for measurements defined by the System International (SI).
- The Power schema defines the specific information exchanges, based on the EMIX framework, needed for markets in power and energy. The Power schema consists of three files—power.xsd, power-product.xsd, and power-quality.xsd.
- The Resource schema ~~defines how load and generation,~~describes specific capabilities of devices and systems ~~to affect power and energy markets, can be described,~~ irrespective of the underlying technologies that affect power and energy markets.

Note that EMIX and Power schemas are broken into multiple files for convenience of human readers and editors.

The Power and Resource schemas are, in effect, the first extensions to the EMIX Schema. The Power schema extends the EMIX schema to define products for Power markets. ~~Other markets, particularly other products for energy markets, share the characteristic that value is closely linked to time of delivery. Power and Resource provide examples of extension and conformance with the EMIX model. Specifications that wish to claim conformance with EMIX use should follow the same approaches. Information exchanges based on specifications that conform to the EMIX specification, can be used within any business process or specification that uses or exchanges EMIX payloads.~~

~~*Table -: EMIX Schemas*~~

~~Schema~~	~~Definition~~
~~**EMIX**~~	~~The EMIX schema has target namespace http://docs.oasis-open.org/ns/emix and consists of three files—emix.xsd, emix-requirements.xsd, and emix-warrants.xsd~~
~~**Power**~~	~~The Power schema as target namespace http://docs.oasis-open.org/ns/emix/power consists of three files—power.xsd, power-product.xsd, and power-quality.xsd.~~
~~**Resource**~~	~~The Resource schema has target namespace http://docs.oasis-open.org/ns/emix/power and consists of one file—resource.xsd~~

The Resource schema extends the Power schema to provide information on the capabilities and the responsiveness of devices and systems in support of decisions regarding tenders and transactions for products that can be provided by or consumed by Resources.

3.1 Use of Core Type Extension ~~Elements~~to define EMIX

The core ~~extension~~ elements ~~are the Product Description Type and the EMIX Base Type. These types include the~~ of EMIX are abstract types ~~Item (Item Base), and the Interface (EMIX Interface). Almost all of~~

EMIX using these four. The concrete types used in exchangeable information models are built by extending those abstract types.

The abstract Product Description Type is the basis for all static descriptions of EMIX products. to create the information exchanges for energy markets. Product Descriptions are static in that they refer to a particular instance in time. Most of the elements in the Power and Resource schemas are creating built out of lower-level Items. Schedules are populated with Product Descriptions for Power Markets. Top level models, derived from EMIX Base, incorporate Schedules. Top level models can be exchanged at an Interface between systems or owners.

3.1.1 Core Abstract Types

The abstract EMIX Base Type defines a Product Description Type toconveyed by a Schedule. That Schedule may be as simple as a single 5 minute interval on a particular day, or as complex and repeating as you can find in your own personal calendar. Any type derived from the EMIX Base Type contains a Sequence that can holdcontain any Product Description. Information elements derived from the EMIX Base include Products, Options, TEMIXTeMIX, and Delivery (Metered Information). The definitions in Table 3-1 assume that the reader is familiar with terms defined in **[WS-Calendar]**; as a convenience to the reader, these are summarized in section 3.2.

Table 3-1: EMIX Core Abstract Types

Type	Description
Item Base	Abstract base type for units for EMIX Products. Item Base does not include Quantity or Price, because a single Product may have multiple quantities or prices associated with each Interval.
Schedule	EMIX Products are delivered for a Duration, at a particular time. EMIX relies on the Interval and the Gluon as defined in **[WS-Calendar]** to communicate Schedules. The Schedule names a collection, but is not itself a type.
Product Description	Product Description is derived from an abstract Artifact type that resides within **[WS-Calendar]** Components, and all Product Description-derived types can therefore reside within those Components as well. The Product Description is placed in Components of the Schedule.
EMIX Base	The EMIX Base conveys a Schedule populated with Product Descriptions and is extended to express additional market information sufficient to define Products. All EMIX Products are derived from EMIX Base, but not all derived types are Products. Along with the Schedule, EMIX Base includes an optional Envelope (see 3.1.5).

Conforming specifications can extend the EMIX specification for use in their own domain by extending the core types of EMIX. Within this specification, Electrical Power is a specific extension of EMIX for power markets. Specifications to support energy markets can be created through extension in an analogous manner.

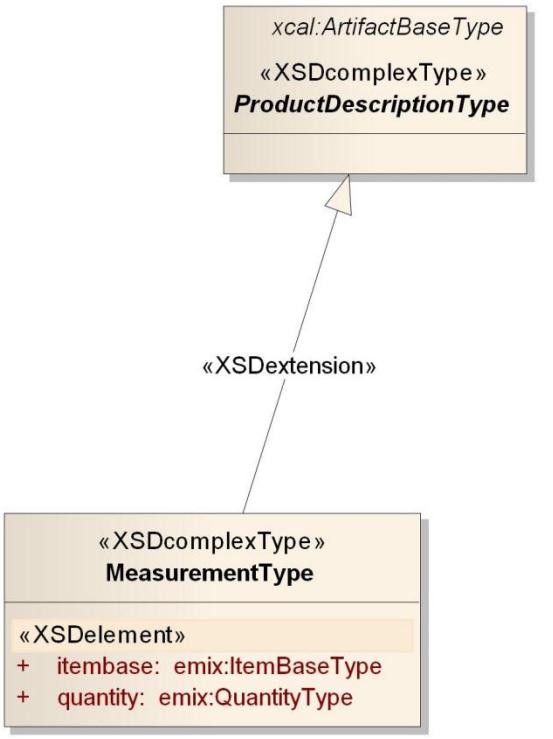

Figure 3-1: The Abstract Product Description Base Type

3.1.2 Price Base and its extensions

Prices in today's power markets may be communicated other than as a simple price. The Price Base is a low level abstract type which is an element in many other types. Price Base is an extensible type whose extensions include not only a simple or absolute price, but other types that rely on foreknowledge and computation. Unless otherwise specified (as it is in TeMIX which is restricted to only the simple price), wherever an information model requires a Price Base, any type derived from Price Base is supported.

Table 3-2: Elements derived from Price Base

Element	Description
Price	This is the number that quantifies the actual price per unit of the product.
Price Multiplier	A Price Multiplier applied to a reference price produces the actual price. Optionally includes a Market Context for the reference price.
Price Relative	A Price Relative is added to a reference price to compute the actual price. Price Relative may be positive or negative. Optionally includes a Market Context for the reference price.

For extension purposes, a conforming specification can define a new price type that can be used in any EMIX type by extending the abstract Price Base.

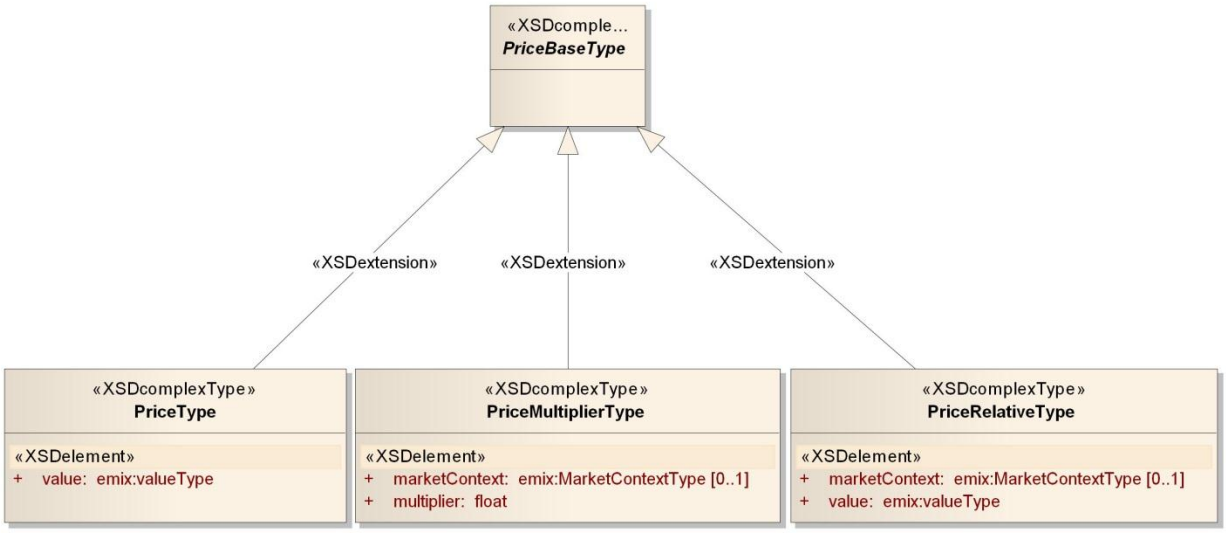

Figure 3-2: Price Base and Extensions

3.1.3 The EMIX Interface

EMIX describes Products whose value is tied to an exchange of ownership or control at a particular location at a particular time. EMIX expresses this locality using the EMIX Interface.

The EMIX Interface is where something transfers ownership. In power, this may be a node or meter, an aggregation of nodes or meters, a pair of nodes, or a geographic area. Other specifications can derive from the base type to support their own needs.

The EMIX Interface is an abstract type. The EMIX Interface can represent a meter or a computation; the EMIX Interface can be real or virtual, the EMIX Interface can be a collection or a singlet.

Table 3-3: The EMIX Interface.

Type	Description
EMIX Interface	Abstract base class for the interfaces for EMIX Product delivery, measurement, and/or pricing
Service Area	The Service Area is the only Interface defined for all derived schemas. The Service Area expresses locations or geographic regions relevant to price communication. For example, a change in price for a power product could apply to all customers in an urban area. Service Areas are defined using **[GML]** in its simplest profile, i.e., level 0.

EMIX interfaces for specific products have product-specific requirements or have characteristics already defined in specific markets. Within this specification, the EMIX Interface has specific extensions for Power markets defined in Section 8.1 *"EMIX Interfaces for Power"*. Other markets can extend the EMIX Interface to support their specific needs.

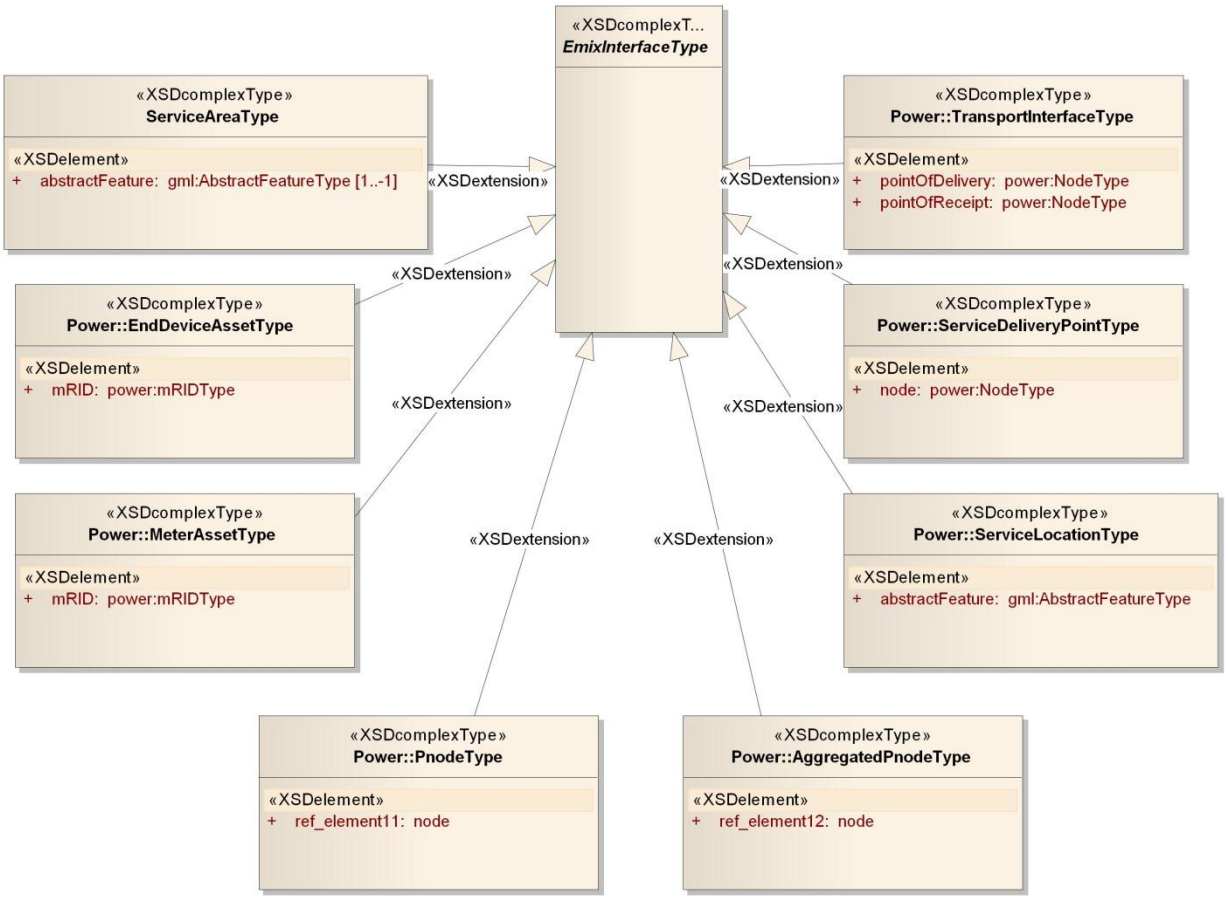

Figure 3-3: Summary of EMIX Interfaces including both Emix and Power

3.1.4 The Item Base

The Item Base is the basis for the lowest level description of each Product and its aspects. The term Item is in common business use for that thing on a line of a purchase order, or of a receipt, or on a bill of lading. Item Base derived types have at least a name, a unit of measure, and a scale factor. The ~~Power~~ power schema (see 0 See Figure 3-3: Summary of EMIX Interfaces including both Emix and Power for all Interfaces defined in this specification.

Power Items derived from Item Base~~defines 3 power types and three energy types derived from the Item Base Type.~~

) defines three power types derived from the Item Base Type.

Items, i.e., types derived from Item Base, reference the International System of Units (SI) to specify a set of alphabetic prefixes known as SI prefixes or metric prefixes. An SI prefix is a name that precedes a basic unit of measure to indicate a decadic multiple or fraction of the unit **[SI Units].**

EMIX requires that conforming specifications use the SI Scale to indicate the size of the unit of measure. The SI Scale is in the external code list siscale.xsd.

3.1.5 The Envelope Contents

While energy markets actually deliver a blended commodity, the customer may value the product differently based upon extrinsic characteristics of the commodity. This distinction may be based, for example, upon the origin of the product or upon its means of production. The product may come with

attached credits that may have re-sale value. The buyer may contract for, and the supplier may need to report specific quality of product delivery. In other circumstances, it may be necessary to deliver supporting detail to explain the prices delivered.

In EMIX, the assertions that distinguish the commodity product are called EMIX Warrants. A common definition of a warrant is a written assurance that some product or service will be provided or will meet certain specifications. Sellers may use EMIX Warrants to provide information about the source of the energy or about its environmental characteristics. Buyers may use EMIX Warrants to indicate what they wish to purchase. It seems a fundamental market rule that a middleman cannot sell more wind power than he has bought. ~~All product descriptions include~~Such rules are beyond the scope of EMIX~~ Interface. The~~ , but EMIX ~~Interface is where something transfers ownership for the~~ information models, including EMIX Warrants, can support such market rules.

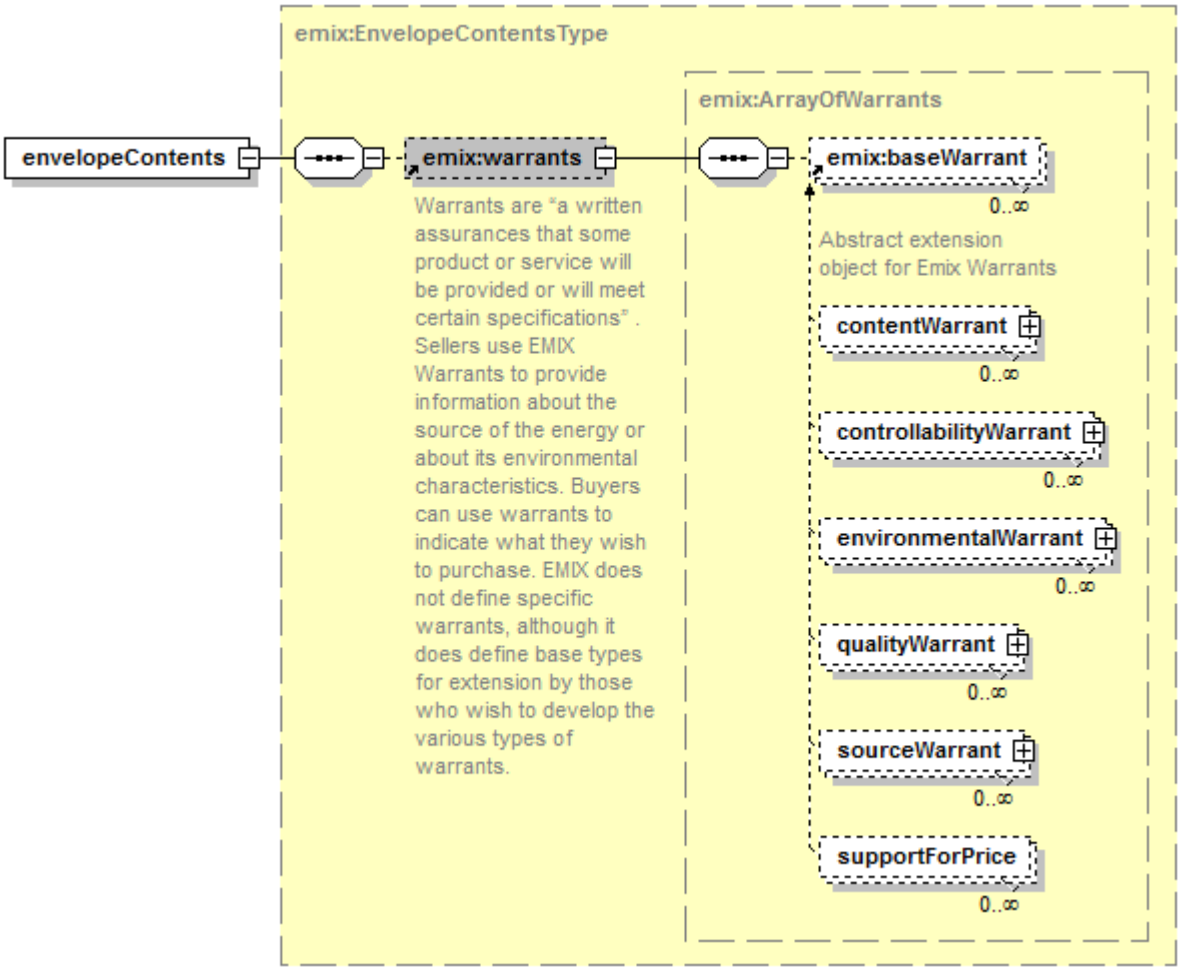

Figure 3-4: Envelope Contents

EMIX Warrants are described in section 15~~. In Power~~. For now, it ~~can be a node or meter,~~is sufficient to know that EMIX Warrants are delivered as Envelope Contents.

3.2 WS-Calendar Terms and ~~aggregation of nodes or meters, a pair~~Descriptions (Non-Normative)

The communication of ~~nodes, or a geographic area. Other specifications can derive from the base type to support their own needs. Any type derived from~~a commonly understood Schedule is essential to EMIX. EMIX is conformant with the **[WS-Calendar]** specification for communicating duration and time to define a Schedule. **[WS-Calendar]** itself extends the well-known semantics **[RFC5545]**.

Without an understanding of certain terms defined in **[WS-Calendar]**, the reader may have difficulty achieving complete understanding of their use in this standard. The table below provides summary descriptions of certain key terms from that specification. EMIX does not redefine these terms; they are here solely as a convenience to the reader.

Table 3-4~~Interface can be~~: WS-Calendar defined Terms used in EMIX

WS-Calendar Term	Description
Component	In **[iCalendar]**, the primary information structure is a Component, also known as "vcomponent." A Component is refined by Parameters and can itself contain Components. Several RFCs have extended iCalendar by defining new components using the common semantics defined in that specification. In the list below, Interval, Gluon, and Availability (Vavailability) are Components. Duration, Link, and Relationship are Parameters. A Sequence is set of Components, primarily Intervals and Gluons, but is not itself a Type.
Duration	Duration is the length of an event scheduled using iCalendar or any of its derivatives. The **[XCAL]** duration is a data type using the string representation defined in the iCalendar (**[RFC5545]**) Duration.
Interval	The Interval is a single Duration derived from the common calendar Components as defined in iCalendar (**[RFC5545]**). An Interval is part of a Sequence.
Sequence	A set of Intervals with defined temporal relationships. Sequences may have gaps between Intervals, or even simultaneous activities. A Sequence is re-locatable, i.e., it does not have a specific date and time. A Sequence may consist of a single Interval, and can be scheduled by scheduling that single Interval in that sequence.
Gluon	A Gluon influences the serialization of Intervals in a Sequence, through inheritance and through schedule setting. The Gluon is similar to the Interval, but has no service or schedule effects until applied to an Interval or Sequence.
Artifact	The thing that occurs during an Interval. **[WS-Calendar]** uses the Artifact as a placeholder. EMIX Product Descriptions populate Schedules as Artifacts inside Intervals.
Link	A reference to an internal object within the same calendar, or an external object in a remote system. The Link is used by one **[WS-Calendar]** Component to reference another.
Relationship	Links between Components.
Availability	Availability in this specification refers to the Vavailability Component, itself a collection of recurring Availability parameters each of which expresses set of Availability Windows. In this specification, these Windows may indicate when an Interval or Sequence can be Scheduled, or when a partner can be notified, or even when it is cannot be Scheduled.
Inheritance	A pattern by which information in Sequence is completed or modified by information in a Gluon.

Normative descriptions of the terms in the table above are in **[WS-Calendar]**.

Using the relation between Gluon and Sequence in WS-Calendar, external information can be applied to an existing Sequence. For example, a resource representing a responsive load may state that 15 minutes lead time is required between notification and load reduction. This characteristic may hold true whether

the response requested is for a run-time of 10 minutes or for one of 10 hours. EMIX specifies invariant characteristics as part of a product description or resource, while offering the variable run-time to the market.

A Sequence populated with product descriptions is referred to as a Schedule. Because Schedules embody the same calendaring standards used by most business and personal calendaring systems, there is a base of compatibility between EMIX communications and business and personal systems. For example, the Power Product (see section 10 *Power Product Descriptions*~~any of the~~), an EMIX Base~~-~~ derived type, may convey a Product Description for a constant rate of delivery power product over a single Interval comprises a (1) start time, (2) duration, (3) rate of delivery, (4) price and (5) location. If the rate of delivery (kW) and price ($/kWh) have been exchanged in advance, the information exchanged to deliver the product is simply "start (reference **[URI]** to product) at 3:00 AM for 0.75 hours."

3.3 Simple Semantic Elements of EMIX

A number of simple semantic types appear throughout this specification. These are defined here.

Table 3-5: Simple Semantic Elements of EMIX

Element	Definition
Market Context	A URI uniquely identifying a source for market terms, market rules, market prices, etc. The URI may or may not resolve.
Transactive State	An indicator included in an EMIX Base derived types to aid in processing. The enumerated Transactive States are: Indication Of Interest, Tender, Transaction, Exercise, Delivery, Transport Commitment, and Publication.
Currency	Market expressions of price are in the context of a particular currency. Currency is always expressed as the **[ISO 42173]** Alpha Currency Code.
Side	An indicator of the interest of the party originating the artifact. Possible enumerations are Buy and Sell.
Integral Only	An indication that the element described is [tendered] as an all or nothing product. It may apply to an (amount, response, ramp) that is all (true) or nothing (false).
Autonomous	An indicator that the tendering party is able to detect a need and self-dispatch to meet or correct that need.
Envelope	A generic name for all of the EMIX-Base derived types.

Normative descriptions of the terms in the table above are in **[WS-Calendar]**.

~~3.2~~3.4 Extensibility of EMIX Framework

EMIX ~~supports a~~ is modular ~~model in which extensions to~~ by design. EMIX can ~~easily~~ be ~~propagated into~~extended in conforming standards ~~that communicate~~. Information models from EMIX~~. There are multiple~~ conforming standards can be exchanged in any interaction designed to exchange EMIX ~~envelopes to participate in different roles; each includes a set of EMIX Base Types that describe what is tendered or transacted.~~ information models.

New efforts ~~could~~ can specify novel Product Descriptions by extending ~~-~~the EMIX Product Description Type. ~~These new Product Descriptions would~~For example, district energy systems distribute and transact thermal energy products. A district energy group could define ~~new conformant~~an EMIX ~~Products merely by application the EMIX Base Type. Such conforming Products~~-compliant product definition. These definitions could ~~then be transported on any EMIX Envelope. Any Specification that communicates EMIX Products can exchange market information about these new Product Descriptions. A new committee can extend EMIX into new products~~be used to populate the Schedule of an EMIX Product or EMIX Option

without re-considering any aspects of the EMIX specification itself. A specification used to exchange EMIX information could exchange these new information models without change.

~~A similar logic applies to the warrants, which outside the scope of this specification. If the warrant information varies over time, the warrant information can be applied to a WS-Calendar Sequence just as if it were a Product Description.~~

Warrants can evolve in a similar way. Some postulate that water costs of energy sources may be of more future interest than the Warrants anticipated in this specification. A water Warrant can be defined that extends the Base Warrant type. This water Warrant can accompany EMIX information models inside the envelope without any change to the underlying specification.

The Power and Resource schemas are, in effect, the first extensions to the EMIX Schema.

Extensibility mechanisms supported in EMIX are discussed in Appendix B.

~~3.3 Power and Resource Schemas~~

~~The Power and Resource schemas are, in effect, the first extensions to the EMIX Schema. This specification includes two schemas that extend EMIX. The Power schema extends the EMIX schema to define products for Power markets. The Resource schema extends the EMIX schema to define the capabilities of systems in ways that allow market participants to make buying decisions.~~

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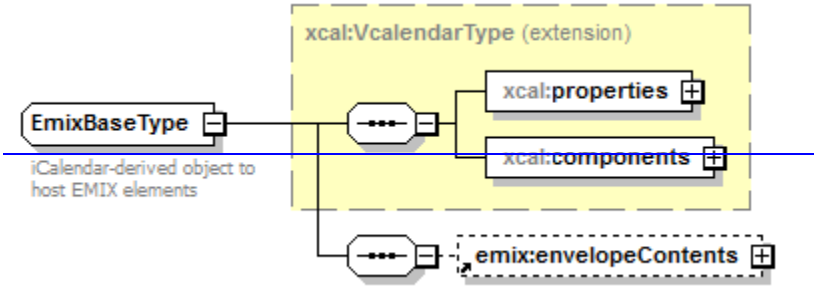
4 Overview of the Information Elements

4 Envelopes: EMIX Base and its Derivatives

EMIX describes the market communications ~~(EMIX Base type)~~ of tenders and transactions for products whose market value varies with time~~ of delivery~~. An energy product ~~typically~~ is delivered over time at a specific location. Five kW at 2:00 AM does not ~~provide~~have the same ~~energy services~~value as five kW at 2:00 PM~~.~~ due to differences in its composition and potential usage by individual consumers. EMIX describes the terms of tenders and transactions for which time and location are essential characteristics. For example, the price and quantity (rate of delivery) of energy in each time Interval of a Sequence of Intervals may vary for energy transactions made in a Sequence of Intervals.

~~EMIX Base derived types are created by applying Product Descriptions to WS-Calendar Sequences. WS-Calendar Sequences embody the same calendaring standards used by most business and personal calendaring systems. This enables greater interoperation between grid systems and business and personal systems. An EMIX Product Description describes the elements of an energy product at a location for a one Interval or a Sequence of Intervals. An EMIX Product Description for a constant rate of delivery power product over a single Interval comprises a (1) start time, (2) duration, (3) rate of delivery, (4) price and (5) location. If the rate of delivery (kW) and price ($/kWh) have been exchanged in advance, the information exchanged to deliver the product is simply "start (reference **[URI]** to product) at 3:00 AM for 0.75 hours."~~



~~*Figure -: EMIX Base Type*~~

A Product Description included in each Interval in a Sequence could describe ~~the same~~similar elements ~~again and again.~~repeatedly. Only a few elements, perhaps only price, or quantity, may change per Interval. EMIX uses the WS-Calendar Sequence to specify product elements once, and then specifies which elements may vary by the time Intervals of a Sequence. A Sequence populated with product descriptions is referred to as a Schedule.

4.1 ~~For example, a resource representing a responsive load may state that 15 minutes lead time is required between notification and load reduction. This characteristic may hold true whether the response requested is for a run-time of 10 minutes or for one of 10 hours. EMIX specifies invariant characteristics as part of a product description or resource, while offering the variable run-time to the market.~~UML Summary of the EMIX Base and Extensions

Figure 4-1

: UML of EMIX Base ~~types using~~ and its Extensions

4.2 The EMIX Base

The EMIX Base, as defined in *Table 3-1: EMIX Core Abstract Types* and shown in Figure 4-1: UML of EMIX Base and its Extensions is the foundation for the Envelopes. The EMIX Base conveys a **[WS-Calendar]** Sequence populated with Product Descriptions ~~applied to WS-Calendar Sequence provide~~.

This populated Sequence, sometimes referred to as the Schedule, provides a flexible information model for describing any energy tender or transaction.

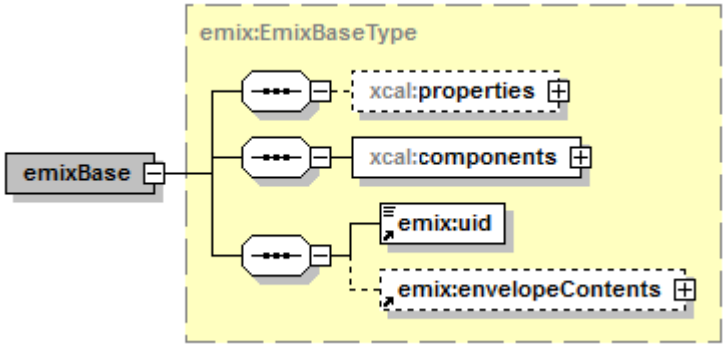


Figure 4-2: EMIX Base Type

There are three types of Envelopes defined in EMIX: the Product, the Option, and the Delivery. Sections 0-4.5 define the information on the "face of the envelope", also referred to as the Intrinsic Information. The Envelope Contents, also referred to as the Extrinsic Information, are discussed in Section 15.

Table 4-1-: Elements of the EMIX Base.

Element	Definition
UID	A unique identifier for an EMIX element. Note: different markets and specifications that use EMIX may have their own rules for specifying a UID.
Schedule	A **[WS-Calendar]** Sequence populated with a Product Description. See Table 3-1.
Envelope Contents	The extrinsic information that may distinguish the product from being a pure commodity. See Section 3.1.5.

New or specialized ~~energy~~ products can be offered and transacted without changing the EMIX standard. A new Type can be derived from the Product Description, be applied to a Schedule, and conveyed with EMIX Envelope.

~~EMIX Base types minimize the size of information exchanged by efficiently describing how information elements of a tender or a transaction may or may not vary over time. This reduces communication overhead.~~

4.3 The ~~Intrinsic Elements:~~ EMIX Product

The EMIX Product is derived from the EMIX Base type and conveys a Schedule as described in Section 4.2~~Products~~. Section 2.1.1 discusses terminology and characteristics of a Product as defined in this specification.

~~The following table specifies the Intrinsic Elements in the EMIX information model. Intrinsic elements make up the face of the envelope. EMIX-based transactions are based on the exchange of these envelopes. There are four types of envelopes defined in EMIX. These are Product, Option, TeMIX, and Delivery, each envelope with its own requirements.~~

~~Central to each is the Base Product Description Type. The Base Product Description Type is the abstract class from which all Product Descriptions are derived. A Product is a description of the product or service applied to a delivery schedule. Product Descriptions as concrete classes, make up most of the sections after this one. However, as no envelope is complete without a Product Description, we define them here.~~

4.1.1 Intrinsic Elements of the EMIX Product Type

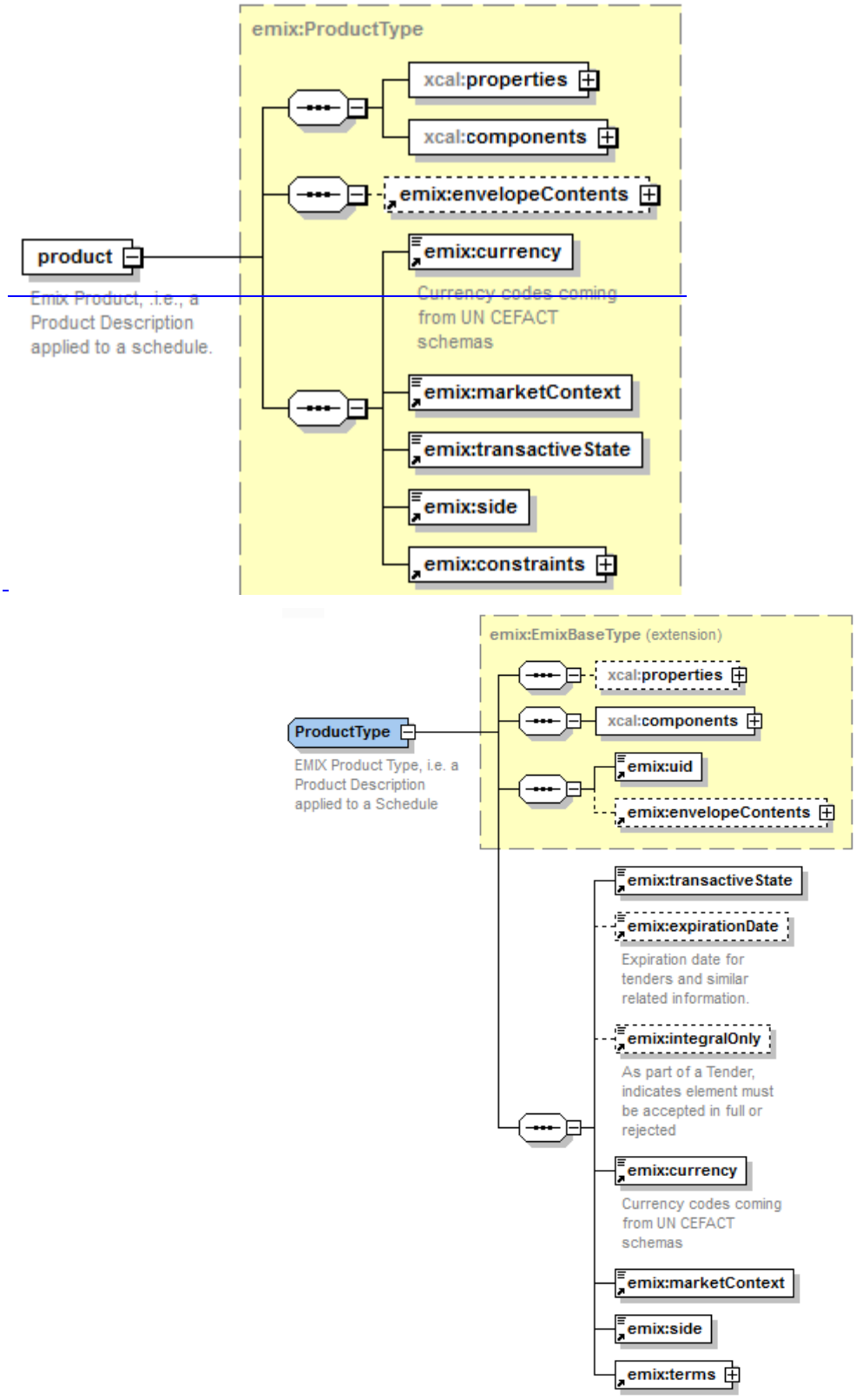


Figure 4-3: EMIX Product ~~Type~~

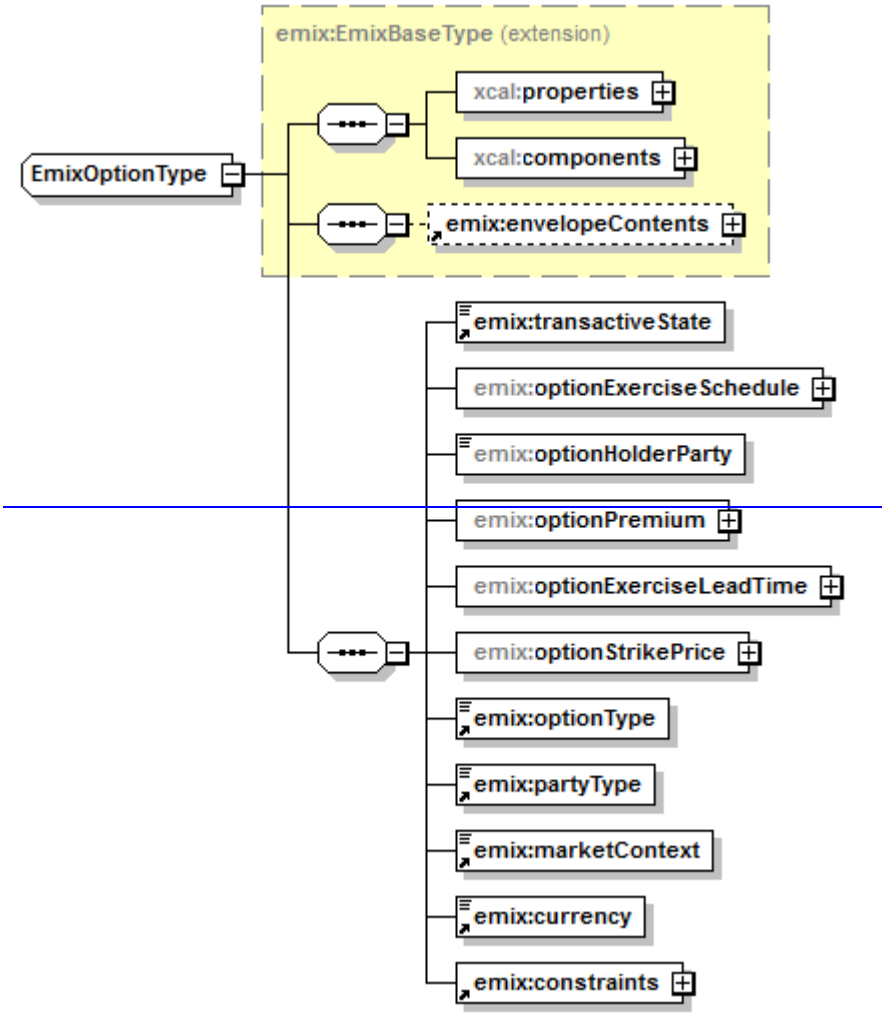
678 The EMIX Product is the ~~commonest~~most common of the envelopes. It is used for simple tenders~~,~~ and
679 agreements. It describes specific product delivery.

680 *Table 4-2: Elements of the EMIX Product*

Product Element	~~Definition~~Description
~~EMIX Base~~UID	~~Identifier of this artifact. In many (if not most) markets the UID is required to be globally unique.~~Incorporated EMIX Base Type. See *Table 4-1: Elements of the EMIX Base*.
Transactive State	As defined in *Table 3-5: Simple Semantic Elements of EMIX*~~Used to aid parsing and conformance, e.g., to distinguish between different purposes for EMIX communications~~ ~~See~~ .
~~EMIX Product~~Tender Expiration Date	~~EMIX Products are created by applying a Product Description to a Schedule using the Base Product abstract class.~~The date and time when a Tender expires. Meaningful only when the value of Transactive State is Tender.
~~Market Context~~Integral Only	~~An identification of the market in which the Product is offered. This may include standard financial and energy exchanges, markets managed by system operators, markets managed by or for aggregators and distributors, or an identification of the microgrid in which the Product is priced~~Indicates that Schedule is accepted entirely or not at all. Meaningful only when the value of Transactive State is Tender.
~~Party Type~~Market Context	As defined in *Table 3-5: Simple Semantic Elements of EMIX*~~Identifies whether information originator is Buyer or Seller~~.
~~Currency~~Side	~~A code that indicates the currency used, as specified in **[CEFACT]**~~Buyer or Seller.
~~Constraints~~Currency	Currency denominating product, *Table 3-5: Simple Semantic Elements of EMIX*~~A collection of business and performance rules that constrain the option agreement. See Constraints at Section~~ .
~~Envelope Contents~~Terms	A collection of business and performance rules that define the product offering. See Section 0, "EMIX Terms~~As defined in section~~ ".

681 ## ~~4.2~~4.4 ~~Intrinsic Elements of the~~The EMIX Option

682 The EMIX Option is an elaboration of the EMIX Product described above. An option is ~~a financial~~an
683 instrument that gives the buyer the right, but not the obligation, to buy or sell a product at a set price
684 during given time windows. Many typical energy agreements, including demand response and reserves,
685 include elements that would give them the name ~~Option~~option in any other market.



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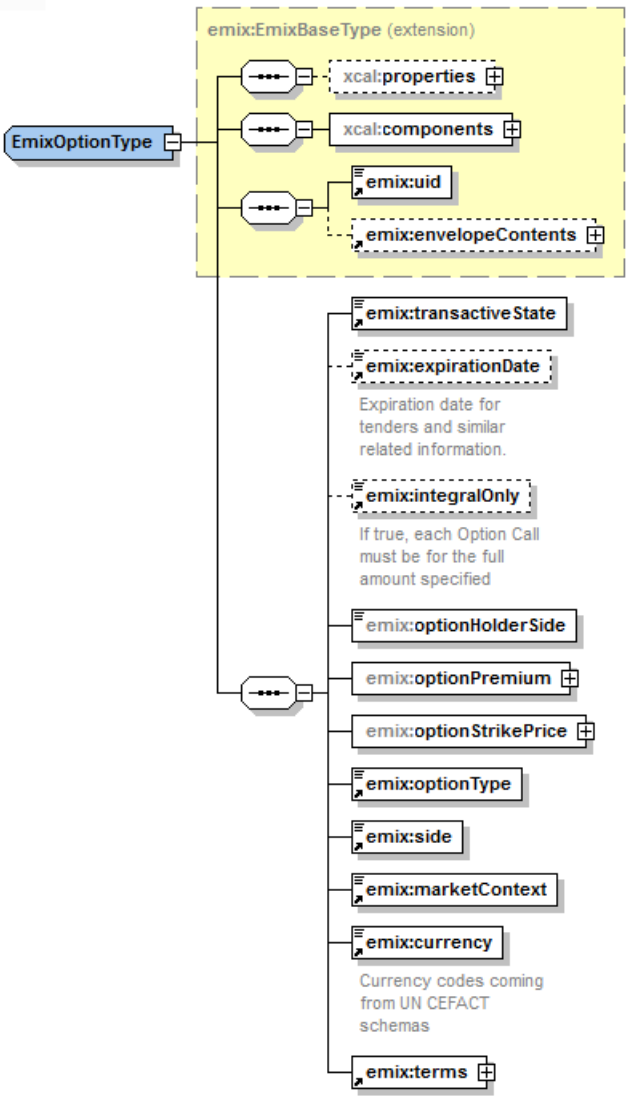


Figure 4-4: EMIX Option Type

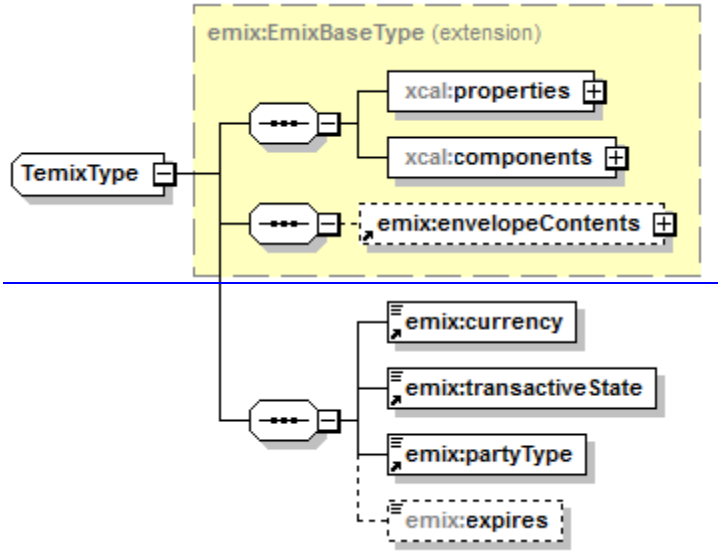
The EMIX ~~option~~ Option also ~~specifies~~conveys specific availability and performance. The "face of the ~~envelope" displays~~Envelope" contains additional information to support these requirements.

Table 4-3~~:~~: EMIX Option Elements – another "Face of the Envelope"

Option Element	~~Description~~**Specification**
~~**UID**~~**EMIX Base**	~~Identifier of this artifact. In many (if not most) markets the UID is required to be globally unique.~~Incorporated EMIX Base Type. See *Table 4-1: Elements of the EMIX Base*.
Transactive State	As defined in *Table 3-5: Simple Semantic Elements of EMIX*~~Used to aid parsing and conformance, e.g., to distinguish between different purposes for EMIX communications.~~
~~**EMIX Product**~~**Tender Expiration Date**	~~EMIX Products are created by applying a Product Description to a Schedule using the Base Product abstract class.~~The date and time when a Tender expires. Meaningful only when the value of Transactive State is Tender.

Option Element	DescriptionSpecification
Market Context	As defined in *Table 3-5: Simple Semantic Elements of EMIX*An identification of the market in which the Product is offered. This may include standard financial and energy exchanges, markets managed by system operators, markets managed by or for aggregators and distributors, or an identification of the microgrid in which the Product is priced.
Currency	Currency denominating product, *Table 3-5: Simple Semantic Elements of EMIX*A code that indicates the currency used, as specified in **[CEFACT]**.
Envelope ContentsTerms	A collection of business and performance rules that define the product offering. See Section 0, "EMIX TermsAs defined in section ".
Option Exercise ScheduleIntegral Only	Uses the Availability Schedule Constraint to specify the period or periods in which the option is available for exercise. For example, a reserve power option could specify a schedule of afternoons in July excluding the 4th.Indicates that a Schedule is accepted entirely or not at all. Meaningful only when the value of Transactive State is Tender.
Option Holder SideExercise Schedule	The side which enjoys the benefit of choosing whether or not to exercise the terms specified in the option. Sometimes referred to as the PromiseeThe schedule of time windows for the option expressed using the "Availability Schedule" in Terms. See Section 5.2.
Option PremiumHolder Side	The price paid to the Promisor for the rights involvedThe side which enjoys the benefit of choosing whether to exercise the terms specified in the option.
Option Strike PricePremium	The price at which an option holder (Promisee) has the right to require the option writer (Promisor) to deliverThe Price paid by the Option Holder Side for the rights involved.
Option Strike PriceExercise Lead Time	The minimum notification time required by the Promisor to to be able to perform. Uses the Minimum Notification Duration Constraint. The Promisor is not responsible for performance in less than the Exercise Lead Time.The Price that the Option Holder Side pays to exercise the option.
Exercise Lead TimeStrike Price	The price the Promisee will pay the Promisor delivery of Product under the option. May be fixed or relative to a specified market.The minimum Duration in advance of a proposed response that a notification will be accepted for the exercise of the option. Expressed using the "Minimum Notification Duration" in Terms. See Section 5.1.
Side	Identifies whether information originator is on the Buy or Sell side.
Option Type	An enumerated list of Option types.
Constraints	A collection of business and performance rules that constrain the option agreement. See Constraints at Section 16

692 ## 4.2.1 Intrinsic Elements of the TeMIX



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694 *Figure -: The TEMIX Product*

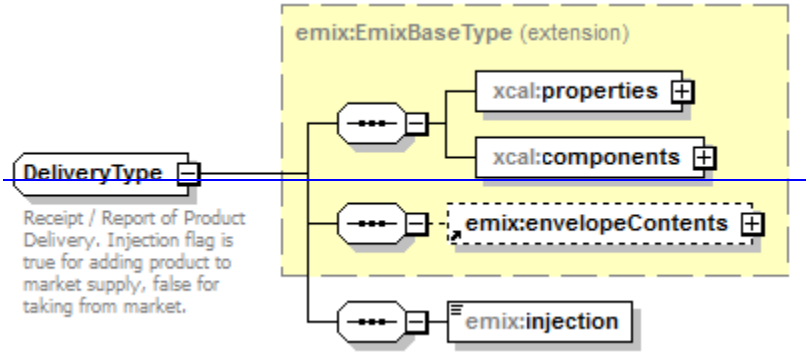
695 The TEMIX (Transactional Energy Market Information Exchange) is a model for balancing energy markets
696 with pure economic trading. As such, it is the simplest of the EMIX Envelopes.

697 *Table -: Elements of the TeMIX*

TEMIX Element	Specification
UID	Identifier of this artifact. In many (if not most) markets the UID is required to be globally unique.
Transactive State	Used to aid parsing and conformance, e.g., to distinguish between different purposes for EMIX communications See *Table 4-5: Transactive States Enumeration*
EMIX Product	EMIX Products are created by applying a Product Description to a Schedule using the Base Product abstract class.
Currency	A code that indicates the currency used, as specified in **[CEFACT]**
Constraints	A collection of business and performance rules that constrain the option transaction. See Constraints at Section 16. The permitted list of constraints for TeMIX is constrained to those discussed in section 11.
Expiration Date	For Tenders only, the date and time when this Tender expires.
Envelope Contents	As defined in section 4.3 *Inside the Envelope – the Extrinsic Items*

698 See Section for a discussion putting TeMIX products in context.

~~4.2.2 Intrinsic Elements of Delivery~~



4.5 EMIX Delivery

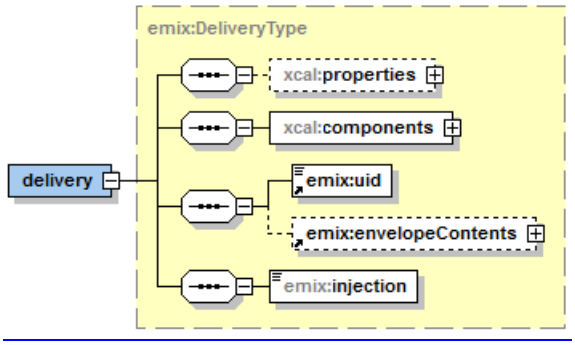


Figure 4-5: Delivery

In any market, order must be matched to delivery. EMIX Delivery reports the historical delivery of product over time.

Table 4-4: Elements of the EMIX Delivery

Delivery Element	Description~~Specification~~
~~**UID**~~	~~Identifier of this artifact. In many (if not most) markets the UID is required to be globally unique.~~
EMIX ~~Product~~Base	~~EMIX Products are created by applying a Product Description to a Schedule using the Base Product abstract class.~~Incorporated EMIX Base Type. See *Table 4-1: Elements of the EMIX Base*.
Injection	True means positive Delivery is injection into the grid. False means positive Delivery is extraction from Grid
~~**Envelope Contents**~~	~~As defined in section 4.3 *Inside the Envelope – the Extrinsic Items*~~

~~4.2.3 Other Envelopes and Information Elements~~

~~EMIX anticipates that further elements will be defined, and an EMIX envelope containing elements not defined herein is fully compliant.~~

~~4.3 Transactive States~~

~~As parties use EMIX to come to an agreement and transact energy, the information required changes. An initial offer may not have a price. An agreement may not yet have a performance date. It is necessary for~~

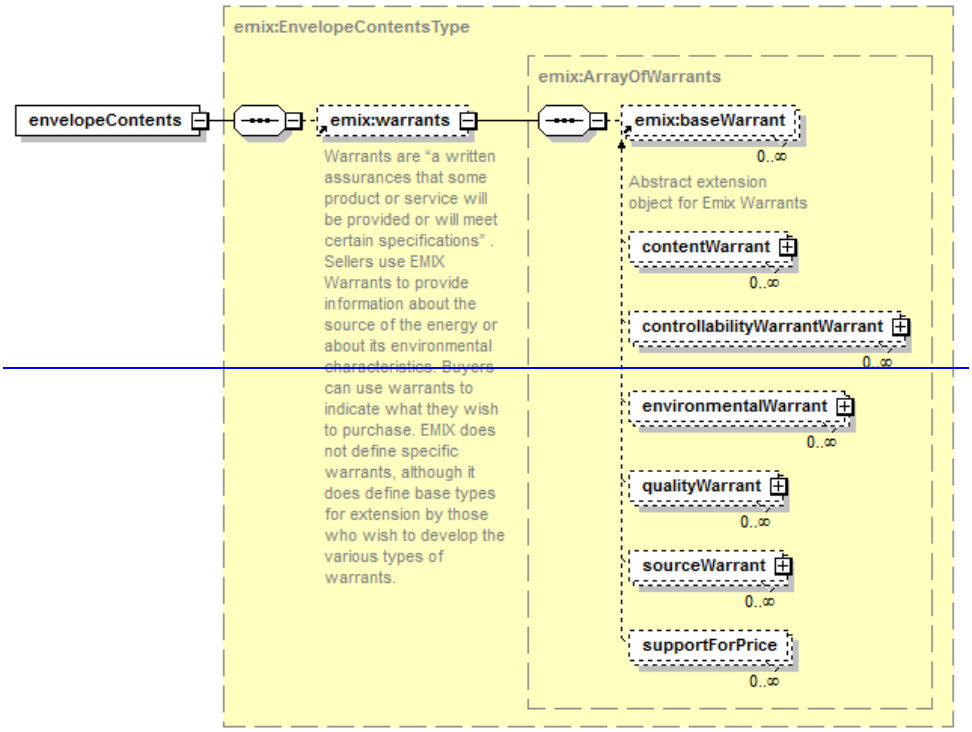
both parties in any communication to understand the Transactive State, i.e. what level of agreement defines the current communication.

Table : Transactive States Enumeration

Transactive State	Description
Indication of Interest	Indication of Interest is a non-binding offer or request for offer for a transaction that may or may not indicate price and quantity and other terms.
Tender	A Tender is a binding offer or bid for a Transaction by a party that when accepted by a counter party will result in a binding Transaction. ISOs use the term Bids to describe offers and bids into their markets.
Transaction	A Transaction between two parties is a binding agreement
Exercise	Exercise applies to two-part Transactions such as Ancillary Services Dispatch by ISOs, Call and Put Options and DR event dispatch that have an initial agreement that includes a second step to that results in another Transaction.
Transport Commitment	Transport Commitment is what the ISOs call "Transmission Scheduling" which is a Transport product and not an energy product transaction. Since the distribution grid may require such transactions or schedules in the future we use the term "Transport"
Delivery	Delivery, which includes both Production and Usage, is the act of actually generating and consuming power that is measured by meters and reported for settlement to the parties. Delivery also names the enumeration of the Delivery.
Publication	Publication is the act of general announcement or posting of appropriate prices and other information concerning products. Publications are not Tenders or Indications of Interest.

4.4 Inside the Envelope – the Extrinsic Items

While energy markets deliver a blended commodity, the customer may value the product differently based upon indistinguishable characteristics of the commodity. Often this distinction is based upon the origin of the product. The product may come with attached credits that may have re-sale value. The buyer may contract for, and the supplier may need to report specific quality of product delivery. In other circumstances, it may be necessary to deliver supporting detail to explain the prices delivered.



~~Figure -: Envelope Contents~~

~~The definition of a warrant is "a written assurance that some product or service will be provided or will meet certain specifications". Sellers use EMIX Warrants to provide information about the source of the energy or about its environmental characteristics. Buyers can use warrants to indicate what they wish to purchase. It seems a fundamental market rule that a middleman cannot sell more wind power than he has bought. Such rules are beyond the scope of EMIX, but EMIX-based information exchanges support such market rules.~~

~~EMIX Warrants are assertions about the EMIX Product.~~

4.5 Summary of the EMIX Base Derivations

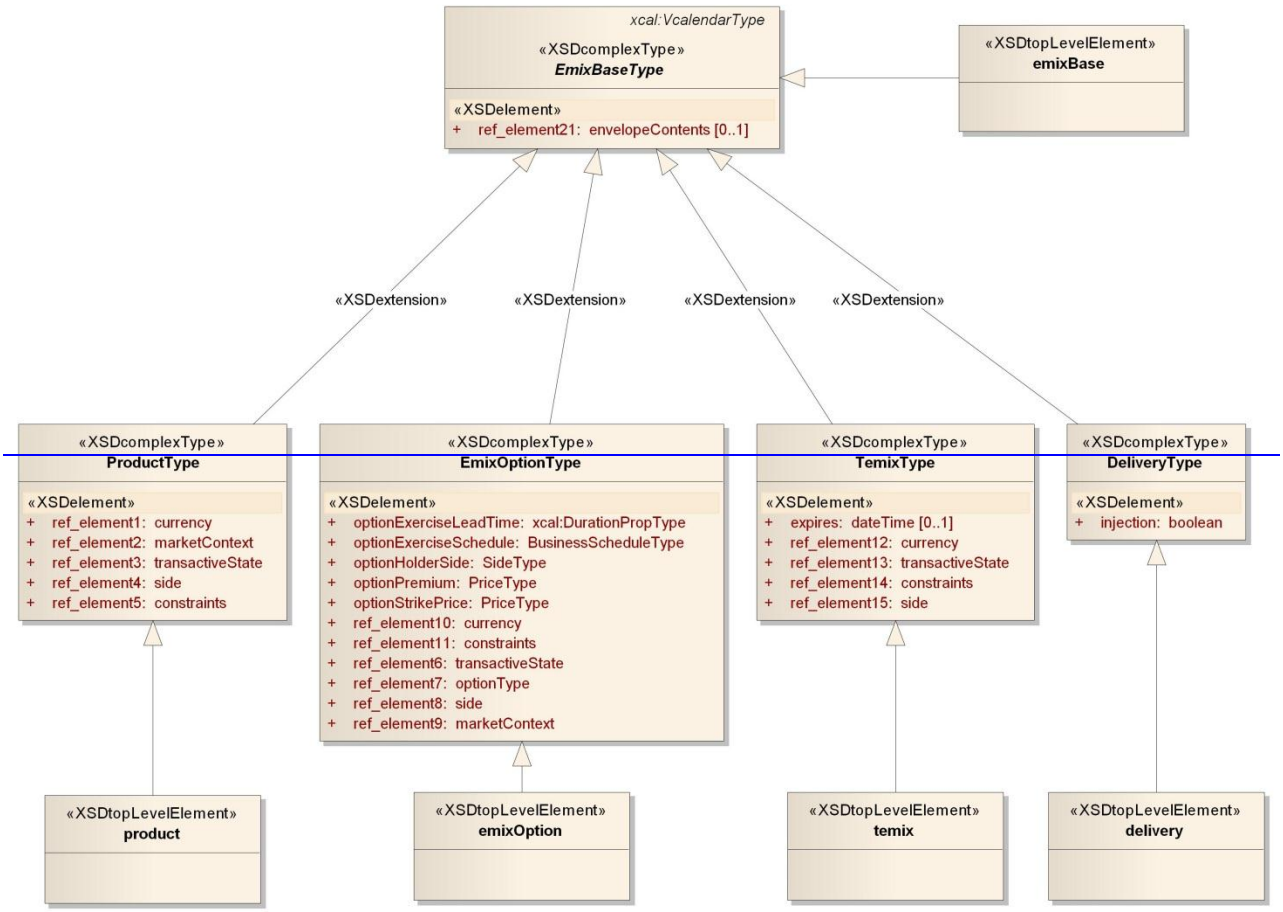


Figure - : UML of EMIX Base and its Extensions

5 Constraints and Market Requirements

5 As noted on each of the elements above, EMIX Terms

EMIX Products can be subject to a number of ConstraintsTerms and Market Requirements. These Constraints and RequirementsTerms can apply at each transactive state. Both Constraints and RequirementsTerms are extensible, so additional schemas, specifications, and standards can extend the listslist while remaining in conformance.

Neither the EMIX Constraints nor Requirements are tied to any particular kind of Product or Resource (See section for a discussion of Resources).

5.1 EMIX Constraints

ConstraintsTerms are extrinsic to the product delivery but affect how a partner may request performance of a service. Performance constraintsTerms may originate in the basic mechanical needs of the Resource or toin the business needs of the source. These constraintsTerms can affect the market value of the resource or the repeated invocation of a resource. It is possible for a given underlying resource to be offered to the market with different constraintsterms and thereforetherefore different values.

5.1 EMIX Performance Oriented Terms

Some terms indicate the ability of a side to perform. As many market interactions may have a penalty for non-performance or for performance that is not timely, it is essential for parties using EMIX information to negotiate services to be able to define performance.

Table 5-1: ConstraintsPerformance-Oriented Terms

ConstraintTerm	DescriptionDefinition
Minimum Response Duration	The shortest Duration for which the resource will accept a request to maintain a response before returning to pre-request levels.will be accepted.
Maximum Response Duration	The longest Duration for which the resource will accept a request. will be accepted.
Minimum Recovery Duration	The minimum Duration that the Resource requires after the endcompletion of a response the resource has is ready to respond tobefore a new request.response can be begun.
Minimum Duration Between Invocations	The minimum Duration between successive responses that the Resource requires after receiving a request before the resource has is ready to respond to a new request.will be accepted.
Minimum Notification Duration	The minimum Duration that the Resource requires for Notification before initiatingin advance of a proposed response to that a request. notification will be accepted.
Maximum Notification Duration	The maximum Duration in advance of a proposed response that the Resourcea notification will accept a Notificationbe accepted.
Response Time	Duration required from receipt of a request to supplying the full requested level of response by the resource; i.e., notification time plus response time.
Maximum Invocations Per Duration	Maximum number of invocations of servicerequests for response that will be accepted during a given durationDuration.

~~Constraint~~Term	~~Description~~Definition
Maximum Consecutive Durations	Maximum consecutive ~~durations~~Durations in which ~~service can~~ a notification will be ~~invoked,~~accepted; e.g., it will not accept requests on more than ~~3~~three consecutive days.
~~**Minimum Starts Per Duration**~~	~~The fewest Requests that the resource will accept during any duration. This constraint is typically used in market rather than in resource descriptions~~
Maximum Run Duration	~~The~~ Maximum ~~duration~~acceptable Duration for ~~which~~ a ~~resource will accept a request~~proposed response
Minimum Run Duration	~~The~~ Minimum ~~duration~~acceptable Duration for ~~which~~ a ~~resource will accept a request~~proposed response
~~**Availability Schedule**~~	~~A schedule of time for which a resource will accept requests. The schedule may include multiple availability windows, i.e., an availability in May, can include weekday mornings and Thursday afternoons. The scheduled duration must be entirely within a single instance of an availability window.~~
~~**Notification Schedule**~~	~~A schedule of time during which a resource will accept requests. The schedule may include multiple availability windows which may be tied to business process, i.e., must receive notifications between 8:00 and 9:30 on business days. The notification must be received within a notification window.~~
~~**Unavailability Schedule**~~	~~A schedule of time during which a resource will accept requests. The schedule may include multiple availability windows, i.e., an availability in May, can include weekday mornings and Thursday afternoons. The scheduled duration must be entirely within a single instance of an availability window.~~

5.2 EMIX Schedule Oriented Terms

Schedule related terms indicate schedules when a product may be available or when an interaction may occur. A product may only be available on weekends, or a party may not be able to respond outside of normal office hours.

Table 5-2: Schedule-Oriented Terms

Term	Description
Availability Schedule	A schedule of time windows during which a response may be scheduled. A scheduled Duration must be entirely within a single instance of an availability window.
Unavailability Schedule	A schedule of time windows for which no request for response will be accepted. No part of a requested Duration must coincide with an unavailability window.
Notification Schedule	A schedule of time windows during which requests can be made.

~~5.2~~5.3 Market Requirements

Market Requirements are terms tied to the economic expectations expressed in certain market tenders. Market Requirements are the market portion of ~~Constraints~~Terms, i.e., they are used to state the offeror's expectations about a tender. It is possible for a given underlying resource to be offered to the market with different Requirements and therefore different values.

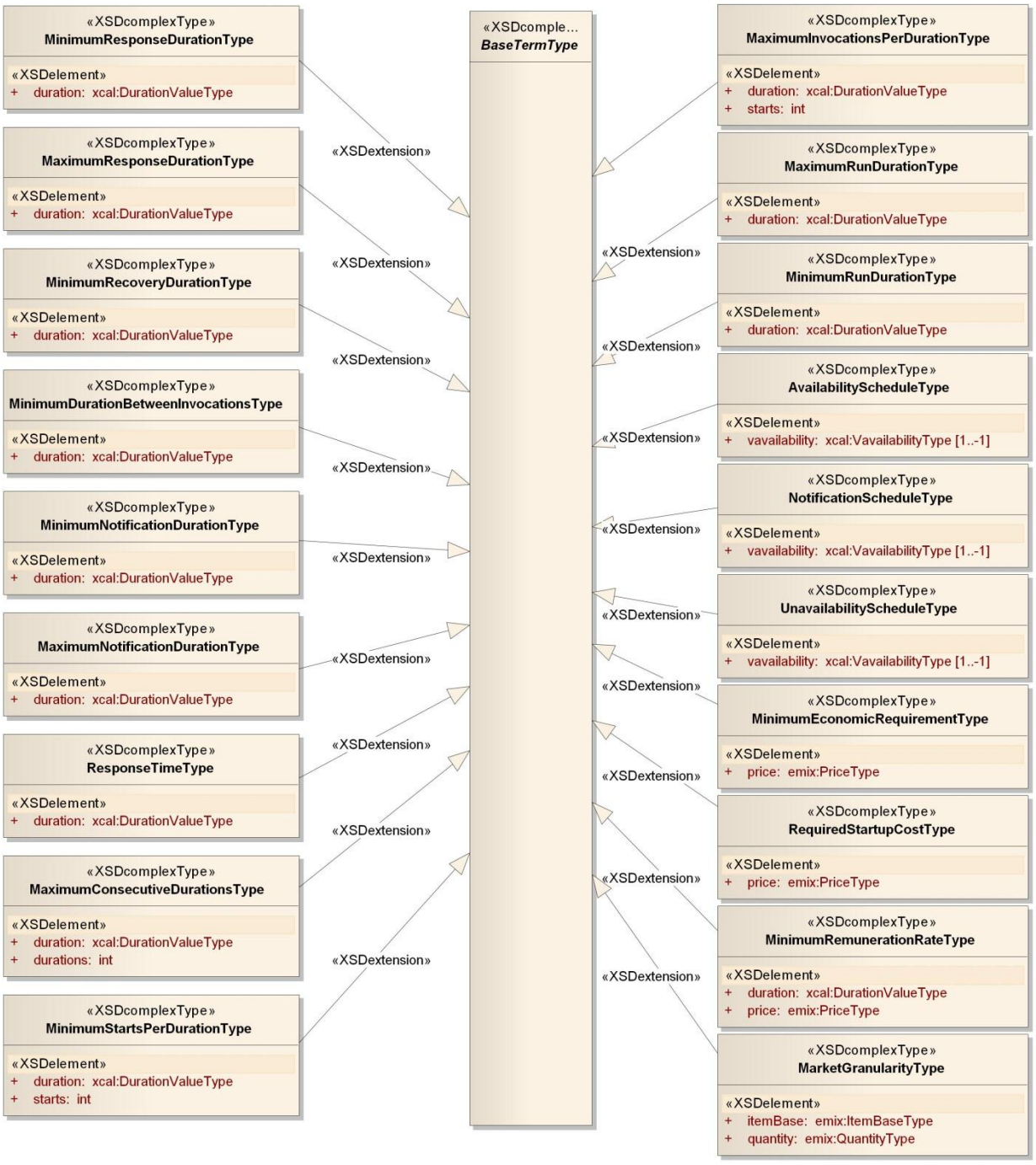
764 *Table 5-3: Market Requirements for EMIX Products*

Market Requirement	Description~~Definition~~
Market Granularity	The size of a market "bundle". For example, a Market with a granularity of 10 MW, will only accept tenders, process transactions, and pay for delivery of Power in multiples of 10MW.
Minimum Economic Requirement	Minimum net remuneration ~~this resource requires from a total~~for any single response
Required Startup ~~Cost~~Remuneration	Minimum remuneration required ~~from start-up of this service.~~for initiating a response.
Minimum Starts Per Duration	The fewest requests that the resource will accept during any Duration.
Minimum ~~Resource Cost~~Remuneration Rate	~~Resource requires this amount~~Minimum remuneration acceptable per ~~period, i.e.,~~stated Duration of response. For example, a minimum ~~requirement for~~remuneration of $100 ~~/~~per hour ~~at whatever rate~~.

765 # 5.4 Extensibility of Terms

766 The EMIX Terms above are not tied to any particular kind of Product or Resource. All are based on the
767 abstract Base Term type. Specifications that require additional terms can create them by extending the
768 Base Term Type to create new terms.

769 Specific Terms for use with Power Products created by extending the Base Term Type are found in *Table*
770 *13-2: Terms unique to Power Resources*.



771

772 *Figure 5-1: Summary of EMIX Terms*

6 Schedules in EMIX: Intervals, Gluons, and WS-Calendar

This section discusses how EMIX uses **[WS-Calendar]** to create Schedules. EMIX does not "schedule". EMIX includes information to communicate Schedules. Algorithms and methods are completely outside the scope of EMIX. EMIX uses **[WS-Calendar]** to create information models that describe schedules and that are populated with Product Descriptions. The Semantics drawn from **[WS-Calendar]** are summarized in *Table 3-4: WS-Calendar defined Terms used in EMIX*. This section describes how EMIX uses the recombination and conformance rules from **[WS-Calendar]** to create Schedules.

6.1 Intervals, Gluons, and Sequences

Types derived from the abstract EMIX Base contain a Schedule created by populating a Sequence with Product Descriptions. The terms Duration, Interval, Sequence, and Gluon are defined in **[WS-Calendar]**. **[WS-Calendar]** defines a model for inheritance wherein a fixed description of a product is refined with additional information as it becomes actionable. The Intervals in a Sequence can inherit information from a Gluon related to that Sequence.

The iCalendar standard, with which **[WS-Calendar]** conforms, is an information model of a "bag of Components". Each Component can include an attachment for passing some kind of information. Intervals and Gluons are two of the **[WS-Calendar]** Components. The schema type for Product Descriptions is derived from the attachment so Product Description-derived types are valid contents of these Components.

In **[WS-Calendar]**, a Gluon relates to a Sequence by relating to a specific Designated Interval within that sequence. All other Intervals have defined temporal relationships, directly or indirectly, to the Designated Interval. If a Gluon contains a start date and time, that start date and time is inherited only by the Designated Interval; the start dates and times for all other Intervals in the Sequence can be computed from that single date and time. In this way, a set of Intervals containing EMIX Product Descriptions can define what is in effect a schedule sub-routine, invoked by starting the Designated Interval.

In EMIX, when a Gluon contains a Product Description, it can then be inherited by each of the Intervals. If an Interval already contains a Product Description, then it refuses the Inheritance from the Gluon. This model of inheritance mimics that defined in **[WS-Calendar]** for inheriting Duration.

Duration, Product Description, Price, and Quantity for each Interval in a Sequence can each be inherited from a Gluon in EMIX. The Start Date and Time can be inherited only by the Designated Interval. This follows and extends the rules of inheritance defined in **[WS-Calendar]**.

There is no requirement for the Designated Interval to be the "first" interval. If a Sequence describes a ramp-up, peak operation (of whatever service), and ramp down, it may be more useful to designate the Interval containing peak operation. In this scenario, the Durations of all Intervals other than the Designated Interval may be fixed, that is encoded in each interval. A communication to "start" the Sequence, then, could contain the start date and time and the run Duration.

The rules of inheritance are described in *Section 17.1 EMIX Conformance with [*WS-Calendar. Inheritance in **[WS-Calendar]** is described in that specification.

6.2 Availability (Vavailability) and Temporal Granularity

[WS-Calendar] defines the expression of the Vavailability information model for repeating instances of time (Availability Windows) within a period that may or may not have an end date. Vavailability is a Component of iCalendar. EMIX uses Vavailability primarily in Terms.

One party MAY use Vavailability to indicate to another party when a service can be requested. This may be a contracted part of an EMIX Option or it may define the Demand Response window (afternoons

during summer months) of a regulated tariff. EMIX does not define the interactions or negotiations that lead to either of those circumstances.

Availability communicates acceptable schedule times for Sequences. The semantics of scheduling a Sequence to comply with previously stated Availability in **[WS-Calendar]** is that the Designated Interval must be inside one of the Availability Windows. While it is possible that not all information regarding Intervals in a Sequence may be exposed in interactions, a party requesting an EMIX product does know the Duration and Start Date and Time of the Designated Interval.

WS-Calendar EMIX are information models, and do not create market rules or define interactions. The specification makes no statement about how a market, or even how a market participant handles receipt of a Schedule which does not comply with a stated availability. Such an Availability and Schedule are likely in separate communications, each containing valid informational artifacts. The word “comply” in the previous paragraph describes the meaning of the information exchanged, and not any behavior or market rule.

Again, see **[WS-Calendar]** for a complete description.

6.3 Temporal Granularity

[WS-Calendar] defines temporal Granularity which is expressed as a Duration. When Granularity is applied to a Vavailability object, then:

1) The valid start times are offsets from the start of the availability window that are integral multiples of that duration. For an Availability of 14:00 to 16:00, with a granularity of fifteen minutes *“PT15M”*, there are 8 valid starting times (14:00, 14:15, 14:30, 14:45, 15:00, 15:15, 15:30, 15:45).
2) If duration is specified by the requestor, it must be an integral multiple of the Granularity. In the example above, “PT15M”, “PT30M”, “PT45M”, “PT1H”, PT1H15M”, etc. are valid Durations.
3) The Start Date and Time plus the Duration must complete no later than the end of the Availability window.

6.4 Illustration of WS-Calendar and EMIX

The illustration below provides a model demonstrating a sequence of three Intervals, and the successive application of Gluons to bring them to market.

1. **Party defines sequence offering Power to market.**
2. **Gluon references Interval, private Intervals described in Terms**
3. **Tender uses gluon to reference existing Schedule and Terms, using Availability to indicate a time window, and stating the asking price.**
4. **External reference to Tender executes contract. Start date and time (9:00) and Duration (6 hours, 30 minutes) are set in Sequence (1) as per WS-Calendar inheritance rules**

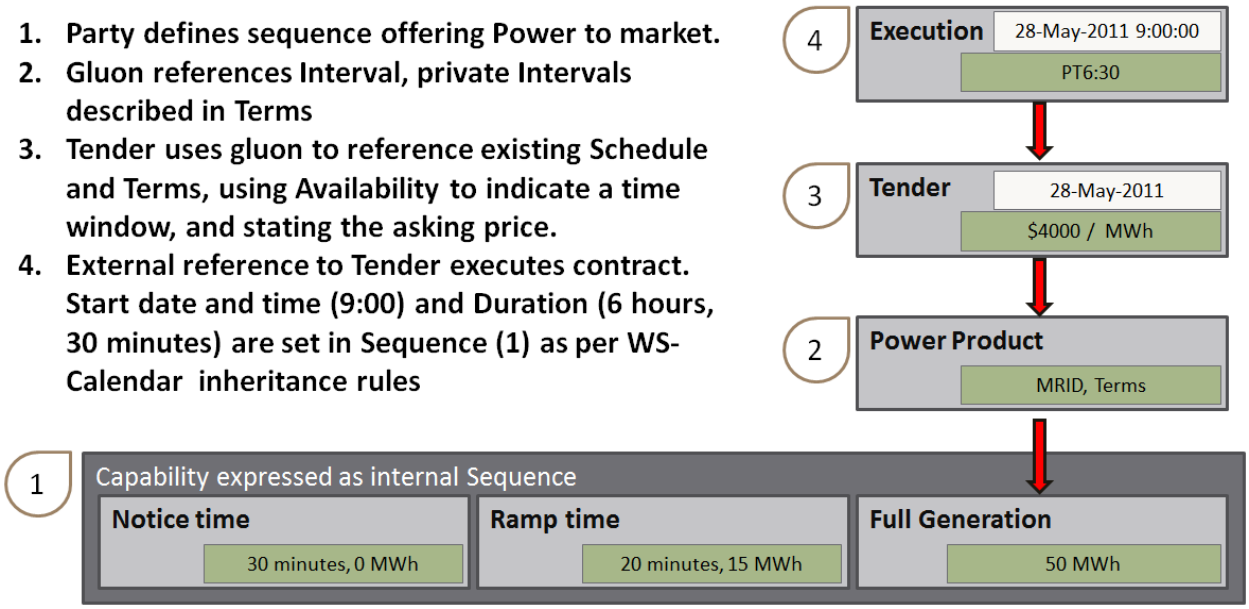


Figure 6-1: EMIX Schedule and Building a Product

7 Standardizing Terms for Market Context

In any market context, there are standing terms and expectations about product offerings. If these standing terms and expectations are not known, many exchanges need to occur of products that do not meet those expectations. If those expectations are only known by local knowledge, then then national and international products need to be re-configured for each local market that they enter. If all market information is transmitted in every information exchange, messages based on EMIX would be repetitious.

As defined in *Table 3-5: Simple Semantic Elements of EMIX*, a Market Context is no more than a URI uniquely identifying a source for market terms, market rules, market prices, etc. This section defines an information model for the common rules and expectations for all interactions within a single Market Context.

7.1 Overview of Standard Terms

Standard Terms defines an information model for exchanging these common expectations outside of any single product-related artifact. The TC acknowledges that these can be only a small portion the total market rules.

The basis of Standard Terms is the Standard Terms Set shown in the following table.

Table 7-1: Elements of the Standard Term Set

Component	Description
Terms	A collection of Terms as defined in Section 0: *EMIX Terms.*
Availability	**[WS-Calendar]** Vavailability (see Table 3-4: WS-Calendar defined Terms used in EMIX) indicating when this Market Term Set is valid, i.e., weekdays from 11:00 AM to 6:00 PM.. If absent, the Market Term Set is valid at all times.
Non-Standard Terms Handling	A string enumeration indicating how to handle terms received that are different than those in the Market Term Set. Permissible values are: Reject (the information artifact), Ignore (the terms), Must Understand, Must Accept.
Side	"Buy" or "Sell". Note: Some Terms can have different interpretations based on who is offering them. A Buyer may indicate "meet or exceed" while a seller expressing the same term may indicate "no worse than".

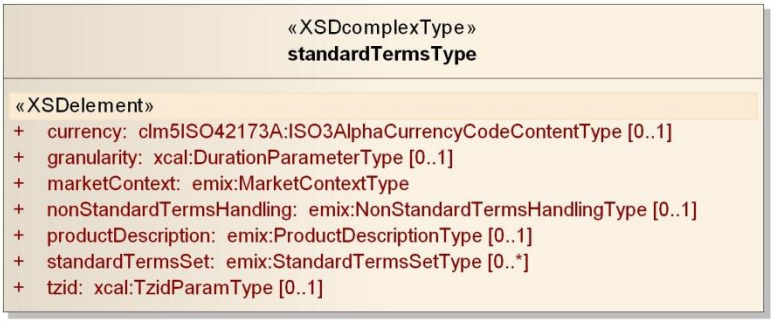
Standard Terms Sets can be assembled with other information to create the Standard Terms shown in the following table.

Table 7-2: Elements of Standard Terms

Element	Description
Market Context	URI uniquely identifying context, per Table 3-5: Simple Semantic Elements of EMIX.
Standard Terms Set	Zero (0) to many. As defined in Table 1-1
Product Description	As defined in *Table 10-1: Summary of Power Product Description Types*. If present, this is the only Product Description in this market context. If Product Quantity is included, it SHALL be ignored.

Element	Description
Temporal Granularity	As defined in **[WS-Calendar]**. For example, this may be the temporal granularity of market; i.e., a 5-minute market operates in 5-minute chunks, with a fixed offset from the beginning of the Availability time window.
Time Zone	TZID as defined in **[WS-Calendar].** Time Zone for communications in this market. Note: this applies to "floating" time, that is expressions of time that are not in UTC or do not have a Time Zone indicated.
Currency	Currency for all information models. If present, becomes the default for all information models. As defined in Table 3-5: Simple Semantic Elements of EMIX.
Non-Standard Terms Handling	As defined in *Table 7-1: Elements of the Standard Term Set*

Specifications that claim conformance with EMIX MAY define inheritance patterns by which EMIX compliant information models inherit certain information from the Standard Terms.



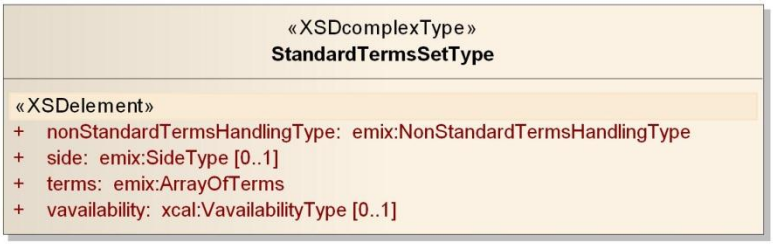


Figure 7-1~~There is a wide variety of warrant types, issuing authorities, and characteristics described by warrants. For bilateral agreements, there may be self-issued warrants. In larger markets, there may be a requirement that Warrants be traceable through multiple levels of transactions.~~

~~Warrants are discussed in Section .~~

6 Interfaces and Items – Components for Constructing Product Descriptions

EMIX Product Descriptions applied to business schedules define EMIX Products. The EMIX Products were defined in section , including Products, Options, TEMIX, and Delivery. All product descriptions include an EMIX Interface and one or more elements derived from the EMIX Item Base.

6.1 EMIX Interfaces

: Standard Terms

8 Extending EMIX for Electrical Power

EMIX provides an abstract information model that can be extended to convey Price and Product information for commodities whose value varies with the time and location of delivery.

The EMIX Power schema (POWER.XSD) can be viewed as the first extension of EMIX into a particular domain. The schema extends the Base EMIX Product Descriptions to define a variety of power products, in particular extending the Item Base to create Items for Real Power, Apparent Power, and Reactive Power among others. The schema derives new Product Descriptions products with ways to describe levels and tiers.

Electrical power markets have their own definitions for where the transaction occurs. The EMIX Power schema (POWER.XSD) extends the EMIX Interface to accommodate these definitions.

The resulting extensions can populate a Schedule and define EMIX Products, Options, and Delivery.

8.1 EMIX Interfaces for Power

Every market transaction occurs at an interface, where beneficial rights to or use of a product are transferred between buyer and seller. This is often the point at which the flow of product is measured although it may not be.

In power ~~Markets~~markets, described in the sections below, ~~it~~the Interface can be a node or meter, ~~and~~an aggregation of nodes or meters, a pair of nodes, or a geographic area. ~~Only the geographic~~The Service area ~~is~~ defined ~~within~~ in the underlying EMIX.XSD schema~~.~~ is also available for use by power-based products.

Table 8-1~~Other specifications can derive from the base type to support their own needs. Any type derived from the Interface can be used in any of the EMIX Base derived Product Descriptions.~~

~~6.2 Item Base~~

~~In common business usage, the item is that thing on each line of the Purchase Order, n each line of the Invoice, and on each line of the Shipping Document. Common aspects of the item is the name and the unit of measure. For general use, EMIX also defines the~~

~~EMIX references the International System of Units (SI) to specify a set of unit prefixes known as SI prefixes or metric prefixes. An SI prefix is a name that precedes a basic unit of measure to indicate a decadic multiple or fraction of the unit. The SI prefixes are standardized by the International Bureau of Weights and Measures (IBWM)in resolutions dating from 1960 to 1991. EMIX enumerates the Si prefixes in the SiScale enumeration. EMIX requires that conforming specifications use the SiScale to indicate the size of the unit of measure.~~

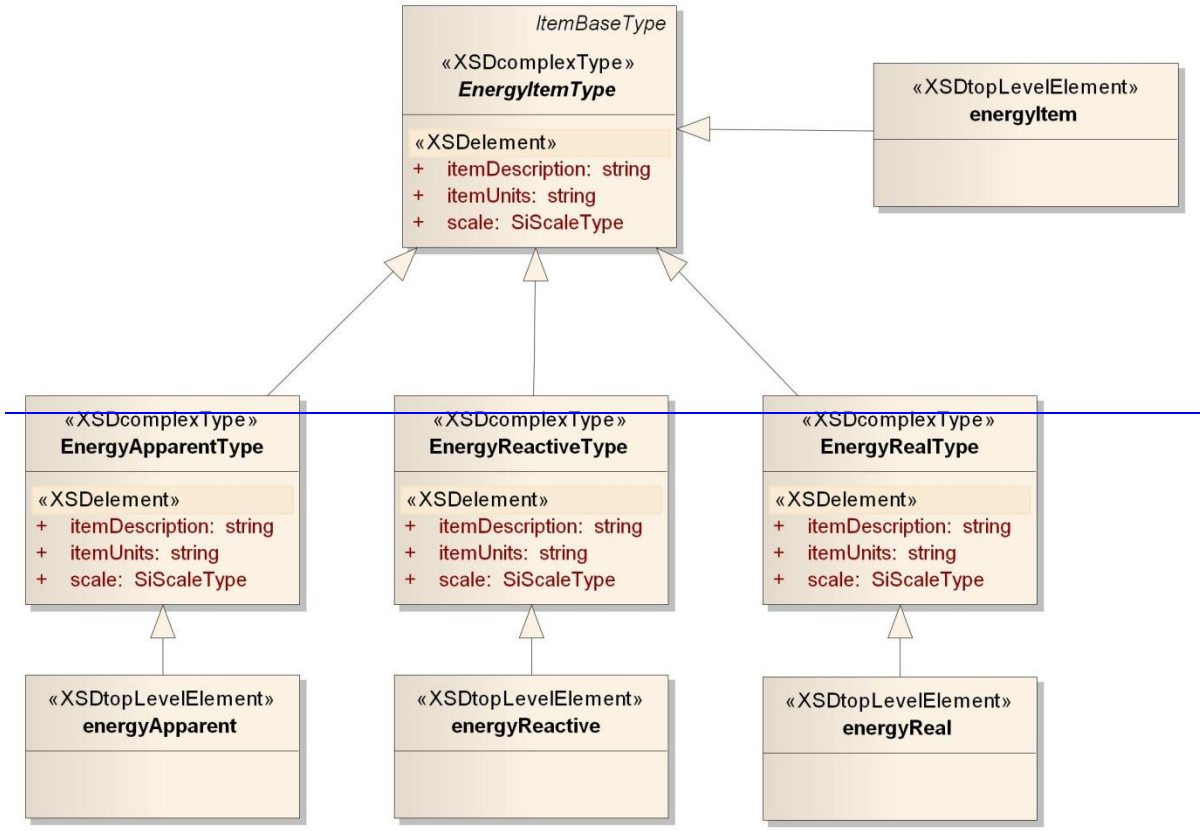
: Elemental types of EMIX Interfaces defined in POWER

~~The Item Base~~ ~~is used not only to quantify the Item, but potential attributes of the Item as well.~~

~~Items do not include quantity or precise. The same Item definition may be used in every transactive state, and prices and quantities are not known for all.~~

~~6.2.1 Example of use of Item Base~~

~~The Item Base is used in many derived types. This illustration shows the POWER Energy Item Type, from which Real, Apparent, and Reactive Energy are derived.~~



~~Figure –: UML showing use of Item Base in Energy Types~~

7 The Schedule in the EMIX Product: Gluons and Intervals.

The EMIX Base Product is an abstract class that defines how all Product Descriptions are assembled with a schedule to be brought to market. The Base Product also defines an inheritance model whereby a fixed description of a product is refined with additional information as it becomes actionable.

While a product can be fully defined within an Interval, energy markets often consist of many consecutive intervals throughout the day. The intervals can be as short as minutes, or even seconds. A day's worth of intervals, each described separately, would consist of much duplicate information. For this reason, it is desirable to define product information in the Gluon, and place only those bits of information that change over time in each interval. Sometimes, the information in a particular interval takes precedence over the inherited information. The rules of inheritance are discussed below in ,

7.1 The EMIX Gluon

The Base Product incorporates structures and inheritance patterns from **[WS-Calendar]** that are applied to and through the schedule. and describe the key elements of the semantics of the Base Product. **[WS-Calendar]** defines the Gluon as a way to convey information relating to an entire Schedule. Those unfamiliar with WS-Calendar may wish to refer to Appendix C for an overview.

Table -: EMIX Base Product – the Gluon

Gluon ElementElemental Type	DescriptionDefinition
Product DescriptionMRID	An EMIX ProductDescription describes the energy or services, the location and the price and quantity variables that can be set as a default in the Gluon and inherited by the Intervals in the Sequence. With the possibility of lineage of multiple gluons, product description in the interval, this is nor required.As defined in the **[IEC TC57]**, can identify a physical device that may be a Customer Meter or other types of End Devices."
Gluon Duration	A Duration set in a Gluon can be inherited by a Sequence of Intervals, subject to the inheritance rules. Not present in all Gluons.
Gluon Quantity	A Quantity set in a Gluon can be inherited by a Sequence of Intervals, subject to the inheritance rules. Not present in all Gluons.
Gluon Unit Price	A Price set in a Gluon can be inherited by a Sequence of Intervals, subject to the inheritance rules. Not present in all Gluons.
Sequence Node	A sequence is a set of intervals and the Gluons associated with them. A Gluon influences a Sequence through Inheritance.As defined in the **[IEC TC57]**, a place where something changes (often ownership) or connects on the grid. Many nodes are associated with meters, but not all are.
Starting Date-Time	A Price set in a Gluon can be inherited by the Designated Interval in the Sequence to define the schedule for all Intervals in the Sequence. Not present in all Gluons
Designated Interval	The Interval in a sequence which has a direct relation with a Gluon (or chain of Gluons).

Gluon ElementElemental Type	DescriptionDefinition
Availability	When present in a tender, defines when the product is available for delivery.

7.2 The EMIX Sequence and Intervals

[WS-Calendar] defines a Sequence is a temporally related set of Intervals. An interval is a period when something is done or delivered. Because of the temporal relation, Scheduling one Interval in the Sequence schedules them all. For this reason, EMIX Intervals are normally brought to market through one or more Gluons, each able to schedule its Sequence.

Power Interfaces are, for the most part, named instances of one of the elements above included in the EMIX Interface.

Table 1-1: EMIX Base Product - the IntervalInterfaces defined in POWER

Interval ElementPower Interface	DefinitionDescription
EMIX Interface	Each of the interfaces below derives from the abstract class as defined in . *Table 3-3: The EMIX* Interface.
Service Area	Inherited from EMIX schema. See . *Table 3-3: The EMIX* Interface.
ProductEnd Device Asset	Elements of the Product Description that can be inherited without change from the Gluon need not be expressed in the Interval. Physical device or devices, which could be meters or other types of devices that may be of interest. Examples of End Device Assets include a Meter Asset that can perform metering, load management, connect/disconnect, accounting functions, etc. Some End Device Assets may be connected to a Meter Asset.
DurationMeter Asset	Can be inherited from the Gluon Lineage. Local expression supersedes inheritance. Physical device or devices that perform the role of the meter.
QuantityPricing Node (PNode)	Can be inherited from the Gluon Lineage. Local expression supersedes inheritance.Pricing location for which market participants submit their bids, offers, buy/sell CRRs, and settle. Note: a pricing node is directly associated with a connectivity node.
Unit PriceAggregated Pricing Node	Can be inherited from the Gluon Lineage. Local expression supersedes inheritance.Specialized type of Pricing Node used to model items such as system zone, default price zone, custom price zone, control area, aggregated generation, aggregated participating load, aggregated non-participating load, trading hub, or DCA zone.
Starting Date-TimeService Location	Within a Sequence, is computed from the Starting Date Time of a single member of the Sequence. The Designated Interval can inherit this from the Gluon Lineage. Local expression supersedes inheritance. A location on the network where the ownership of the service changes hands, expressed as a **[GML]** Abstract Feature. Note: it potentially has many Service Delivery Points, delivering service in accordance with a Customer Agreement. Each Service Location may have zero to many Meter Assets.

~~Interval Element~~Power Interface	~~Definition~~Description
~~Relation~~Service Delivery Point	Logical point on the network where the ownership of the service changes hands. ~~Link from one Interval to other that specifies the relationship in time between Intervals in a Sequence.~~There is only one Service Location for each Service Delivery Point, delivering service in accordance with a Customer Agreement. Used at the place where a meter may be installed. Each Service Delivery Point may have zero to many Meter Assets.
Transport Interface	Delineates the edges at either end of a transport segment. Note: unique among Interfaces in that it names two Nodes rather than one: point of receipt and point of delivery.

See Figure 3-3: Summary of EMIX Interfaces including both Emix and Power for all Interfaces defined in this specification.

8.2 Power Items derived from Item Base

Types derived from the abstract Item Base type are used not only to quantify the items, but potential attributes of items as well.

8.2.1 Power Items

The POWER.XSD schema defines a number of items to define the exchange of POWER. These Power Items are derived from the abstract Power Item, itself derived from Item Base.

Table 1-2: Elements of the Power Item

Power Element	Description
Item Base	Abstract Item as defined in *Table 4-1: Elements of the EMIX Base*.
Item Description	Name of the Power Item.
Item Units	String representation of Units.
Scale Code	Alphabetic representations of Scale from the SI Scale code list; e.g., M for Mega, K for Kilo, etc.
Power Attributes	Gross attributes of Power: AC/DC, Hertz, nominal Voltage.

The named Items derived from the Power Item type are shown in the table below.

Table 1-3: Defined Power Items

Item Name	Units	Description
Real Power	W or J/s	Real power, expressed in Watts (W) or Joules/second (J/s).
Reactive Power	VAR	Reactive power, expressed in volt-amperes reactive (VAR).
Apparent Power	VA	Apparent power, expressed in volt-amperes (VA).

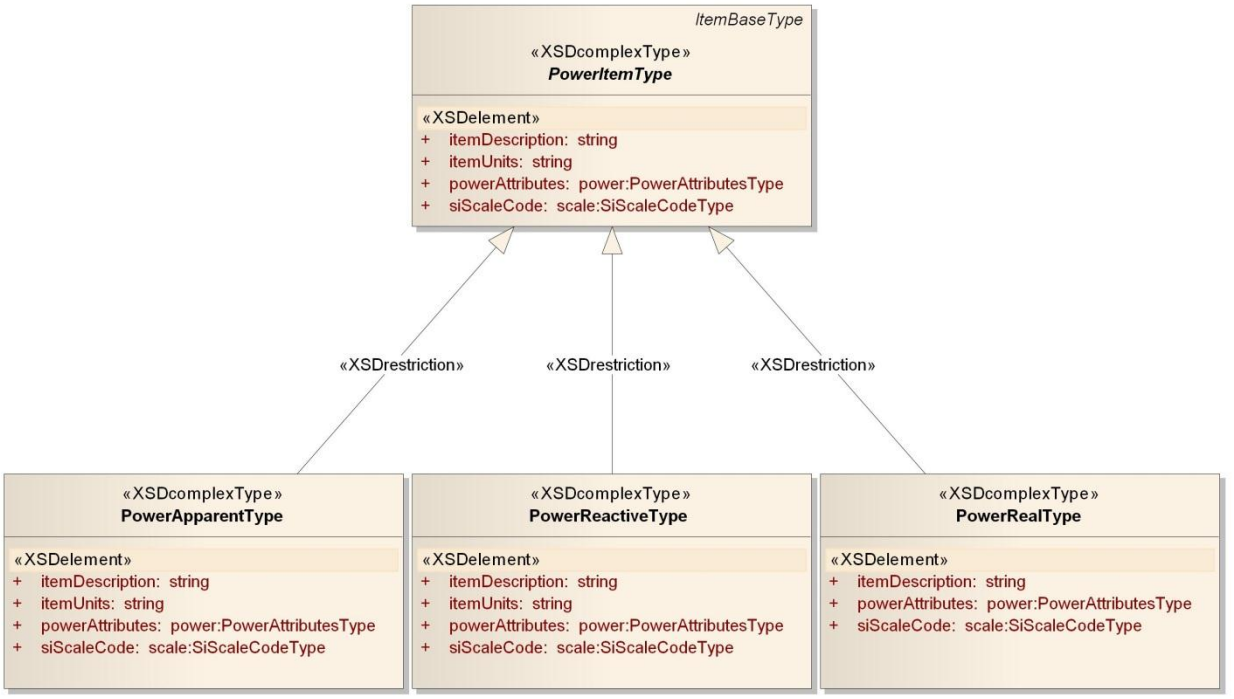


Figure 1-1: UML Summary of Power Items

8.3 Energy Items derived from Item Base

Types derived from the abstract Item Base type are used not only to quantify the items, but potential attributes of Energy as well.

8.3.1 Energy Items

The POWER.XSD schema defines a number of items to define the exchange of electrical energy. These Energy Items are derived from the abstract Energy Item, itself derived from Item Base. The following table enumerates the Energy Elements.

Table 1-4: Elements of the Energy Item

Energy Element	Description
Item Base	Abstract Item as defined in *Table 4-1: Elements of the EMIX Base*.
Item Description	Name of the Energy Item.
Item Units	String representation of Units.
Scale Code	Alphabetic representations of Scale from the SI Scale code list; e.g., M for Mega, K for Kilo, etc.

The named Items derived from the Energy Item type are shown in the following table.

Table 1-5: Defined Energy Items

Item Name	Units	Description
Real Energy	Wh or J	Real energy, expressed in Watt Hours (Wh) or Joules (J).

Item Name	Units	Description
Reactive Energy	VARh	Reactive energy, expressed in volt-amperes reactive hours (VARh).
Apparent Energy	VAh	Apparent energy, expressed in volt-ampere hours (VAh).

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8.3.2 Illustrative Diagram of Energy Items

Many types in POWER.XSD derive from the Item Base. Figure 1-2 shows the Energy Item Type, from which Real Energy, Apparent Energy, and Reactive Energy are derived.

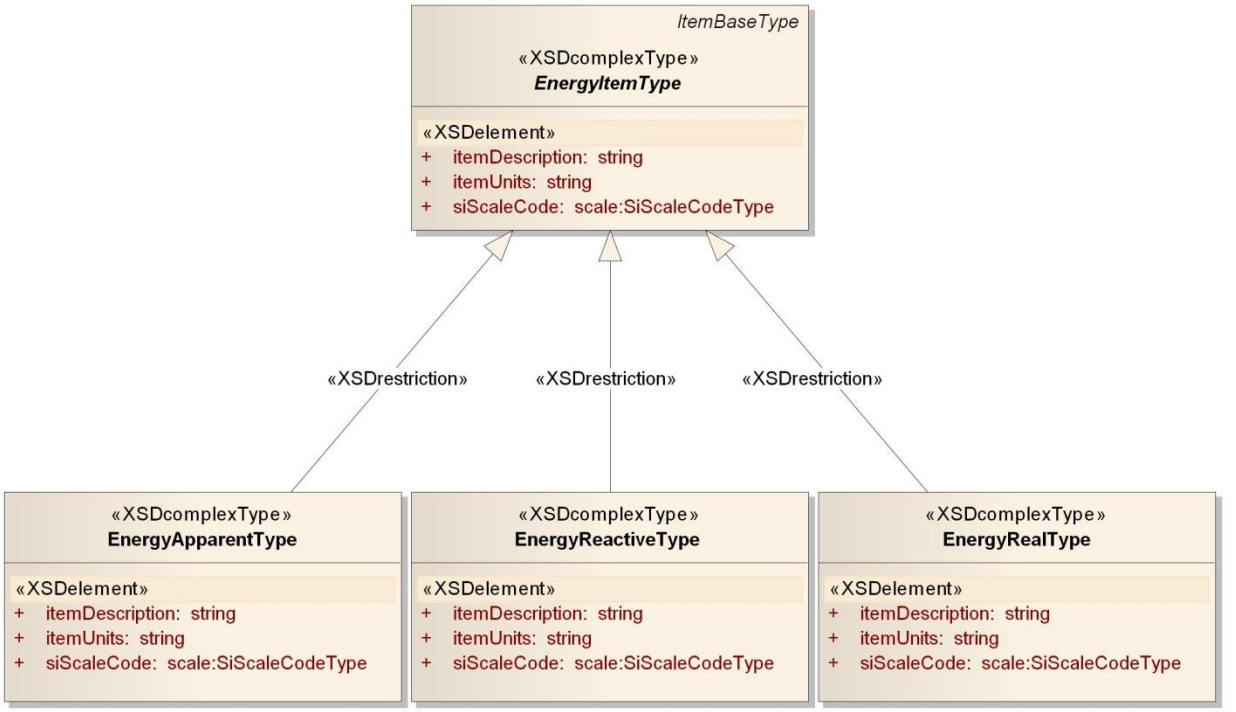


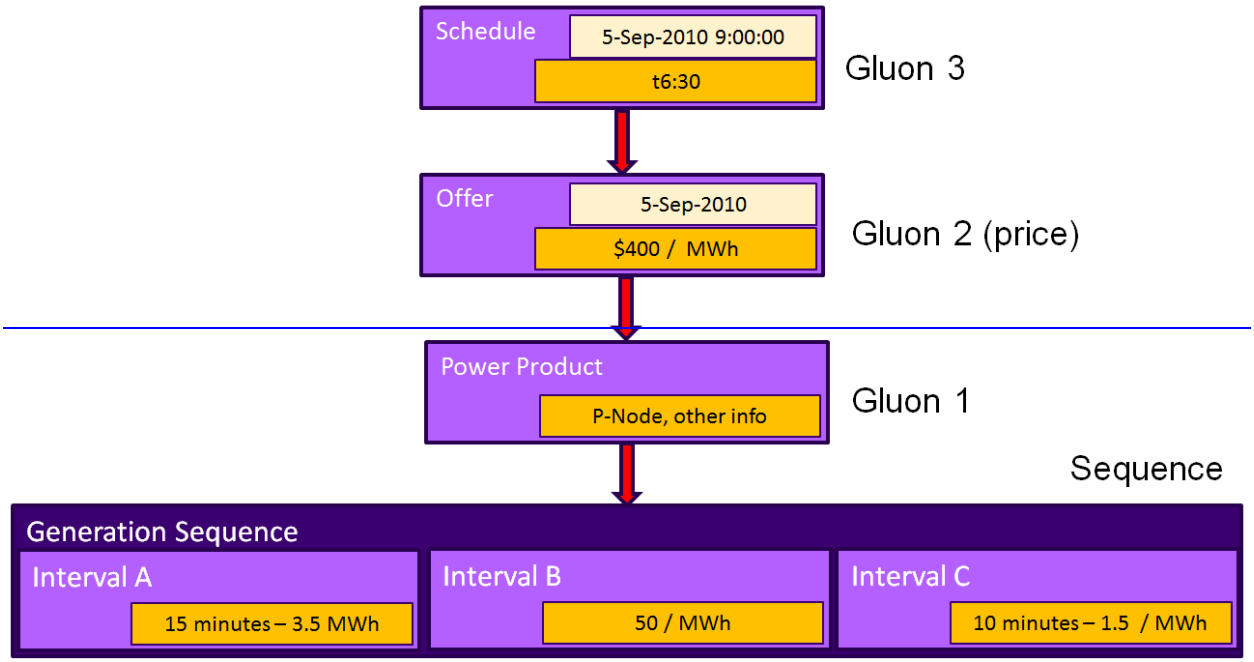
Figure 1-2: UML summary of Energy Item Types

8.4 Other Item-derived types

Voltage is another type in POWER.XSD derived directly from the underlying Item Base. The Elements of Voltage are shown in the table below.

~~7.3~~ Table 1-6~~EMIX Product Model~~

~~The illustration below provides a model demonstrating a sequence of three intervals, and the successive application of Gluons to bring them to market.~~



~~*Figure -: EMIX Model*~~

1. ~~*Power source defines product to market (Sequence and Gluon 1).*~~
2. ~~*Product is offered to market on a particular day ([1] and Gluon 2) (Date but not time, required price specified)*~~

~~Transaction specifies start time (9:00) and duration (6:30) (Gluon 3), inherited by Sequence through Gluons 2 and 1. Interval B (linked to Gluon 1) is the Interval that starts at 9:00.~~*: Voltage as an Item*

Voltage Element	**Description**
Item Base	Abstract Item as defined in *Table 4-1: Elements of the EMIX Base*.
Item Description	Voltage
Item Units	V
Scale Code	Alphabetic representations of Scale from the SI Scale code list; e.g., M for Mega, K for Kilo, etc.

~~8~~9 EMIX Power Product Descriptions

This section provides a guide to the rest of the Specification.

Electrical ~~Energy~~power and energy must be described precisely as it comes to market. Different products can provide total power, real power, or reactive power. Products delivering the same Power at a different voltage, or in DC rather than AC, may be valued differently. For the convenience of the readers, terms associated with electrical power and energy, and the relationships between them, are reviewed in Appendix E.

EMIX ~~Provides a general~~ provides an information model for exchanging ~~product~~Price and ~~market~~Product information ~~about products whose~~for power and energy markets, where the value of the Products is tied closely to the time of delivery. EMIX Power defines specific EMIX Products for Power delivery. EMIX Resources define capabilities that could be brought to market and the performance characteristics those resources will have, and thus enable a buyer to determine with which resources to seek agreements ~~with~~.

EMIX Products consist of Product Descriptions applied to the EMIX Base Product. ~~The sections ahead discuss~~There are three classes of Product Description defined as:

1) Power Product Descriptions
2) Resource Offer Descriptions
3) Transport Product Descriptions

EMIX ~~Electrical~~ Power Products are defined using standard attribute definitions from ~~the Power and Load Management Common Information Model (CIM). The~~ **[IEC TC57],** where the canonical definitions ~~are in the IEC TC57 CIM~~also reside.

~~8.1~~9.1 Power Product Descriptions

~~Power can be bought under terms that~~

~~a) Specify the rate of delivery over a duration of an interval. Duration times power = energy~~

~~b) Specify the amount of energy over an interval with no restrictions on the rate of delivery at any instant with in the interval.~~

~~c) Made available as Full Requirements Power (the same as b) except that the amount of energy transacted is measured after delivery.~~

~~Power Products are the subject of tenders and transactions, i.e., they are what is actually bought and sold. Depending upon the market,~~ Power can be bought under terms that specify the energy and its rate of delivery (power), or made available for use up to the maximum amount deliverable by the in-place infrastructure (also known as "Full~~-requirements Power") Power Products in Section , .~~ Requirements Power"). While the underlying commodity good is identical, the Product is differentiated based on how it is purchased. Common distinctions include:

a) Specify the rate of delivery over a Duration.

b) Specify the amount of energy over an Interval with no restrictions on the rate of delivery at any instant within the Interval.

c) Made available as Full Requirements Power, the same as b, except that the amount of energy transacted is measured after delivery.

Product Descriptions for transacting Power are found in Section 10 *"Power Product Descriptions"*

~~8.2~~9.2 Resource Offer Descriptions

Resources include generators that can produce power and other services, storage devices that can consume, store and then produce power, and ~~load~~loads that produce ~~a~~ power through load curtailment.

A Resource Offer describes both the characteristics of the resource and the prices and quantities of products and services offered as described in Section 0~~,~~: *Energy Resources*.

~~8.3~~9.3 Transport Product Descriptions

Product ~~transport incurs specific costs that vary over time.~~ Transport ~~costs include congestion charges that apply to each unit of Product that passes through a particular point in the~~ provides for the transport of a product from one Interface location to another generally using transmission and distribution ~~system, and loss, .which reduces the Product delivered. If the Product is priced for Delivery to the consumer,~~facilities. Transport prices may cover recovery of investment and energy loses incurred during transport ~~charges may not apply.~~as well as congestion prices. A single price may characterize a Transport Product or a set of charges. Product descriptions for Transport ~~charges~~ are discussed in Section 11~~,~~ *Power Transport Product Description ~~Descriptions.~~*.

910 Power Product Descriptions

The information model in this section is described in POWER-PRODUCTS.XSD

AllAlmost all Power Products are based on core abstract class, the Power Product Description. The Power Products also share core semantic elements, used throughout the Descriptions and their associated charges. Several of these were described in *Section 8: Extending EMIX for Electrical Power*Not all elements are in all classes; these are the recurring elements..

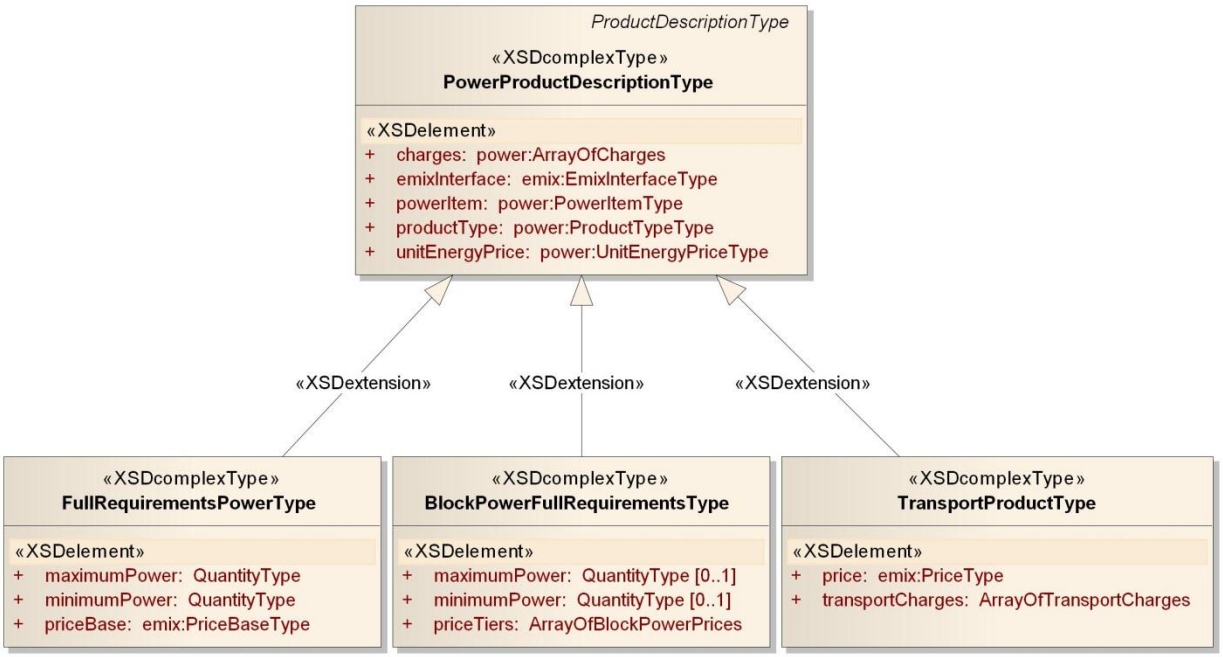


Figure 10-1: UML Summary of Power Product Descriptions

10.1 Overview of Power Product Descriptions

The following sections define the Power Product Descriptions. A summary of those descriptions is provided in the following table..

Table 10-1: Semantic Elements common to MultipleSummary of Power ProductsProduct Description Types

Name	DefinitionDescription
EMIX Interface	An EMIX Interface is any of a number of metering points (as defined below), an aggregate point, or a geographic area at which a product exchanges ownership
Attributes	Essential characteristics (Voltage, Hz, AC or DC) of delivered electricity.
VoltageProduct Description	All Power Product Descriptions are derived from the EMIX base Product Description type See *Table 3-1: EMIX Core Abstract Types*One of three elements hereafter referred to as the Power Attributes..
Hertz	One of three elements hereafter referred to as the Power Attributes. Always 0 for DC

Name	~~Definition~~Description
~~AC~~	~~One of three elements hereafter referred to as the Power Attributes.~~
~~Power Units~~	~~Enumeration of Power Units, e.g., total power (VA), real power (W), and reactive power (VAR)~~
~~Energy Units~~Power Product Description	~~Enumeration of Energy Units, e.g., including real energy (Wh), reactive energy, (VARh), and apparent energy (VAh)~~Used for simple power transactions; also used as template for other Power Product Description Types. After a specified duration, energy has been delivered at a price per unit of energy.
~~Voltage Units~~Full Requirements Power	~~Enumeration of Voltage Units, e.g., MV~~Used to provide for full requirements of buyer. Simple price, will supply all used. Demand Charges optional. Often used in retail residential rates.
~~VAR Units~~Block Power Full Requirements	Used to provide for full requirements of buyer in "blocks". Price is constant within a block, but changes as each block is used during a period. Demand Charges MAY be included. Often used in retail residential rates~~Enumeration of volt amperes reactive (var) units, e.g., Kvar~~.
~~Meter Asset~~	~~Identifier for an actual or virtual meter~~
~~Node~~	~~Grid Location identifier~~
~~Price~~	~~A fixed price.~~
~~Price Multiplier~~Transport Product	Used for charges and revenue related to Transport Services for a Power Product; i.e., the movement of Power through Transmission and Distribution. The Interface used matches a segment of the transport infrastructure, usually identified by an injection node and a delivery node. Transport Products are discussed in Section 11~~A multipler relative to a market. It consists of a multiplier, which could be more or less than 1.0 and of a reference to a market context. PriceMultiplier can also be used to set a price now to match market at a forward period in time~~.
~~Price Relative~~TeMIX Power	~~A price to add or subtract from the pre-existing market price. It consists of a price, which could be positive or negative, and of a reference to a market context.~~Used for a specific sized block of Power at a constant rate of delivery. Derived directly from EMIX Product Description rather than Power Product Description because only Price and Quantity are required.

~~9.1.1~~10.1.1 ~~Base~~ Enumerated Power Contract Types

Because different Power Product Descriptions use the same informational elements, and because different transaction states may not require all elements be present in every exchange, each Power Product Description includes a Power Contract Type. Different Power Contract Types MAY have different conformance requirements in different market contexts.

Table 10-2: Power Contract Types

Power Contract Type	Note
Energy	Used in TeMIX for simple block of Energy agreement.

Power Contract Type	Note
Transport	Used in TeMIX for simple transport agreement.
Energy Option	Used in TeMIX for Option to transact simple block of Energy.
Transport Option	Used in TeMIX for Option to acquire rights to Transport.
Full Requirements Power	Used for supplier to provide for full requirements of buyer. Simple price, will supply all used. Often used in retail residential rates.
Full Requirements Power with Demand Charge	Similar to Full Requirements except specific and perhaps recurring Demand Charges are incurred for exceeding set demand limit(s).
Full Requirements Power with Maximum and Minimum	Customer must draw power at no less than the minimum rate and no more than the maximum rate during any measurement Interval.
Hourly Day Ahead Pricing	Same as Full Requirements Power but prices potentially change each hour.
Ex-Ante Real Time Price	Used to report prices after the fact.
Time of Use Pricing	Strategy where the price may change based on time of day on a schedule set by the provider. The provider may define schedule and pricing differences depending upon day of week, holiday or not, month of year and season.
Transport Service	Used to acquire Transport including factors for congestion, loss, charges, fees, etc.
Congestion Revenue Rights	Used to hedge against future Transport / Congestion costs.

The Power Contract Type MAY be extended per the extensibility rules. See Appendix B-1 for a discussion of extending string enumerations.

10.1.2 Power Product Charges

Power Products are often encumbered with a number of special charges. Some charges may be intrinsic to the product, and specifically incorporated into the Power Product Descriptions below. Others arise from specific market conditions and can be applied through a generic charges collection.

Each of the products from Table 10-2, with the exception of TeMIX, can be subject to one or more Power Charges. All Charges are based on the Base Charge abstract type, meaning markets that require non-standard Charges have the means to define extensions to the set of Power Charges.

Table 10-3 summarizes the Power Product Charges.

Table 10-3: Power Product Charges

Charge Type	Description
Base Charge	Null abstract type from which all charges are derived.
Block Power Price	A Price and a Maximum Energy Quantity. When arranged in order by Maximum Energy Quantity, they represent a set or prices for different levels of Energy.
Demand Charge	Charges meant to offset infrastructure needed to support peak use. The structure that describes a Demand Charge is described in Section 10.1.2.1.

10.1.2.1 Demand Charges

The Demand Charge as defined above has a more complex structure than the other Charges. The Demand Charge is defined in *Table 10-4: Elements of Demand Charges*.

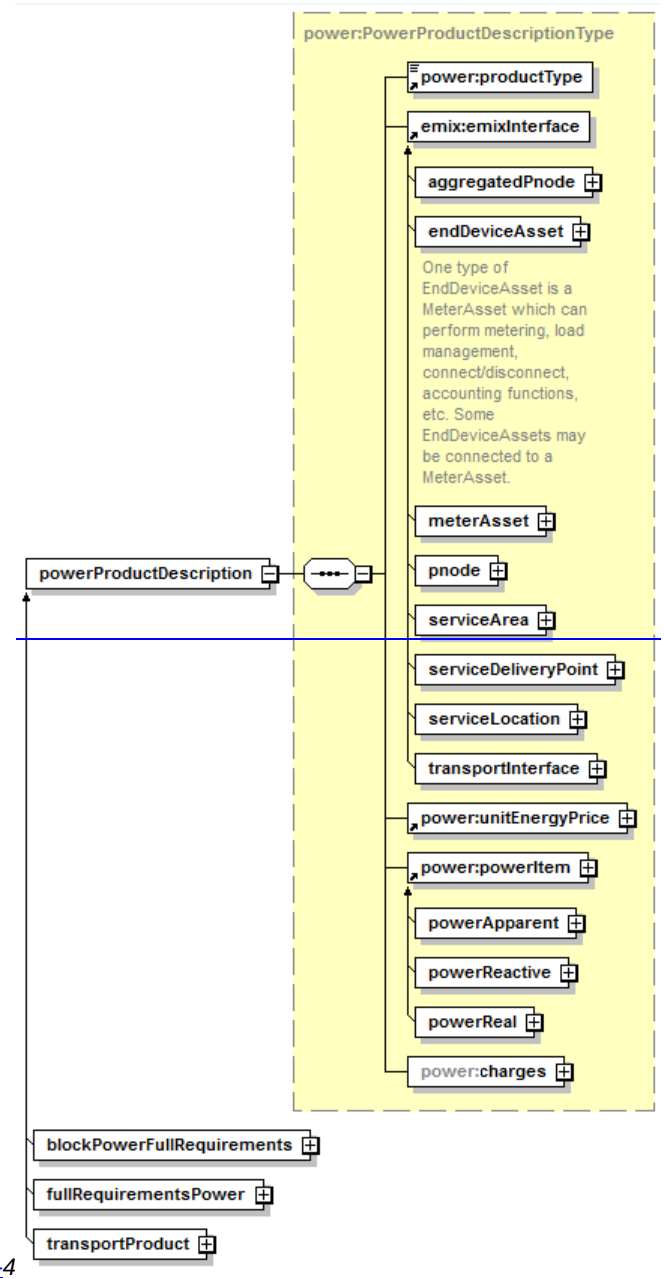


Table 10-4: Elements of Demand Charges

Demand Charge Element	Description
Consumption Units	Units of product consumed upon which Demand Charges will be computed.
Consumption Ceiling	Below this quantity, a Consumption Penalty is not applied.
Consumption Penalty	Incremental charge applied if Consumption Ceiling Floor is exceeded.

Demand Charge Element	Description
Measurement Interval	Duration over which average peak demand is measured (e.g., 15 minutes, 30 minutes...)
Collection Interval	Collection of Measurement Intervals. Consumption Penalty is based on single highest average peak demand taken from all the Measurement Intervals contained in the Collection Interval.
Penalty Period	Duration to which the Penalty applies, often a billing cycle.
Penalty Duration	Duration during which consecutive Consumption Penalties will continue to be applied after incurred.

10.1.2.2 Summary of Power Product Charges

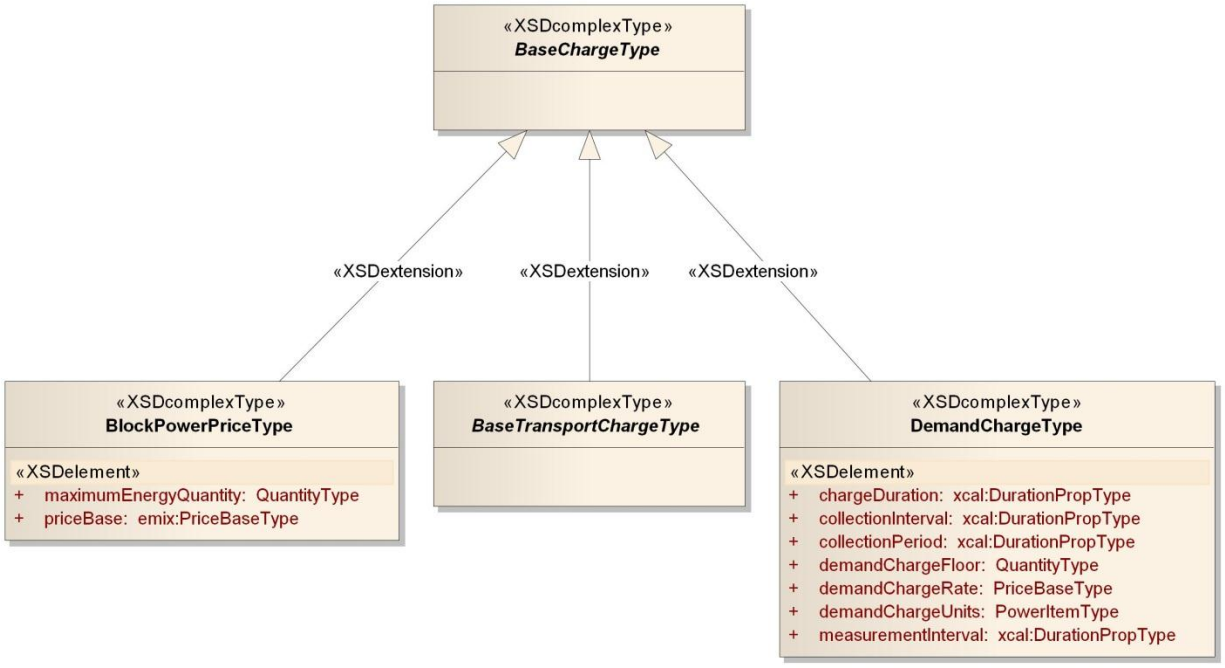


Figure 10-2~~: Base~~: UML Summary of Power Product Charges

10.2 The Power Product Description

The Base Power Contract is the foundation for all the other Power Contracts. Each of them has the characteristics of the Base Power Contract plus their own additional elements:

Table 10-5: Base Power Product Description

Name	~~Definition~~Description
Product Description	Base type for derivation. See *Table 3-1: EMIX Core Abstract Types*.
Power Product Type	~~Enumerated type of Power Product.~~ Used to determine conformance ~~requirements.~~ and processing. See Table 10-2

Name	~~Definition~~Description
EMIX Interface	See Table 1-1: *EMIX Interfaces defined in POWER*~~An EMIX Interface is any of a number of market exchange points including a point, an aggregate point, or a geographic area at which a product exchanges ownership~~.
Unit Energy Price	Price Base, see *Table 3-2: Elements derived from Price Base*~~per Unit of Energy~~.
Power Item	See *Table 1-3: Defined Power Items*~~Can indicate Real, Apparent, or Reactive Power~~.
Charges	Any number of Charges ~~affect the power product in addition to the cost of the product delivered. Charges are~~as defined ~~below.~~in *Table 10-3: Power Product Charges*

Each Power Product is applied to the EMIX Base Product before it is fully described. Because each element can be set for the ~~while~~whole Sequence, or applied to individual ~~intervals~~Intervals, each can vary over time.

~~9.2~~10.3 Full Requirements Power

Full Requirements Power products are the traditional “all-you-can-eat” electrical contract. Maximum delivery is limited by the physical infrastructure. Demand Charges may apply. This type of product often appears in Residential markets.

As well as the attributes in the base Power Contract, the Full Requirements Product has~~:~~ the elements defined below.

Table 10-6: Full Requirements Power Product Description

Name	~~Definition~~Description
~~**Price**~~**Power Product Description**	As described in *Table 10-5: Base Power Product Description*~~EMIX Price is a choice one of a Price, a Price Multiplier, or a Price Relative.~~.
~~**Energy Units**~~	~~Denominates the units that the Price applies to.~~
~~**Attributes**~~	~~Essential characteristics (Voltage, Hz, AC or DC) of delivered electricity.~~
Maximum Power	~~Denominates the~~The most power available for transacting during the period. Often determined by physical limits.
Minimum Power	~~Denominates the~~The least power that must be transacted during the Interval. Buyer is responsible for making up the difference if the stated value is not ~~reached.~~consumed.

~~9.3~~10.4 Block Power Full Requirements

Block Power Full Requirements products provide for full buyer requirement, but prices the power in “blocks”. Price is constant within a block, but ~~changes as~~ each block ~~is used during~~may have a different price within a period. Demand Charges MAY be included. ~~Often~~This type of Product is often used in retail residential rates.

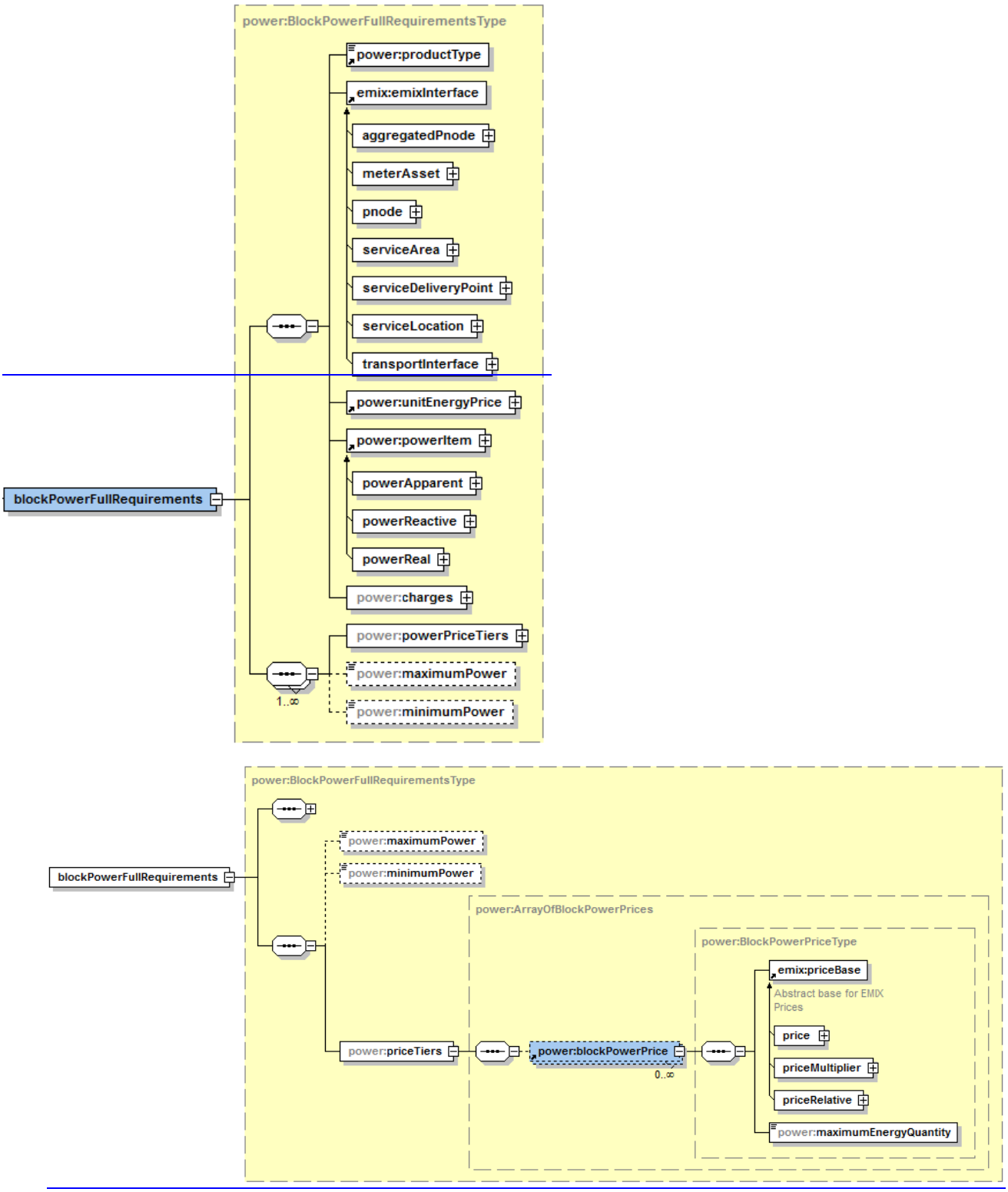


Figure 10-3: Block Power Full Requirements

As well as the attributes in the base Power Contract, the Block Power Full Requirements Product has these additional elements:

Table 10-7: Block Power Full Requirements

Block Power Element	~~Definition~~Description
~~Block Energy Price~~Power Product Description	As described in *Table 10-5: Base Power Product Description*~~Blocks are sorted in order of Maximum Energy Quantity and price for next block starts when last block is used. Blocks can be confined within an interval to create different tiers at different times of day.~~.
~~Energy Units~~Maximum Power	Denominates the ~~units that~~most power available for transacting during the ~~Price applies to.~~period.
~~Attributes~~	~~For residential, usually 60 Hz, 220V AC~~
~~Maximum~~Minimum **Power**	Denominates the ~~most~~least power ~~available for transacting~~that must be transacted during the ~~period.~~Interval. Buyer is responsible for making up the difference if the stated value is not consumed.
~~Minimum Power~~Price Tiers	Any number of Block Power Prices as described in *Table 10-3: Power Product Charges*~~Denominates the least power that must be transacted during the Interval. Buyer is responsible for making up the difference if the stated value is not reached.~~.

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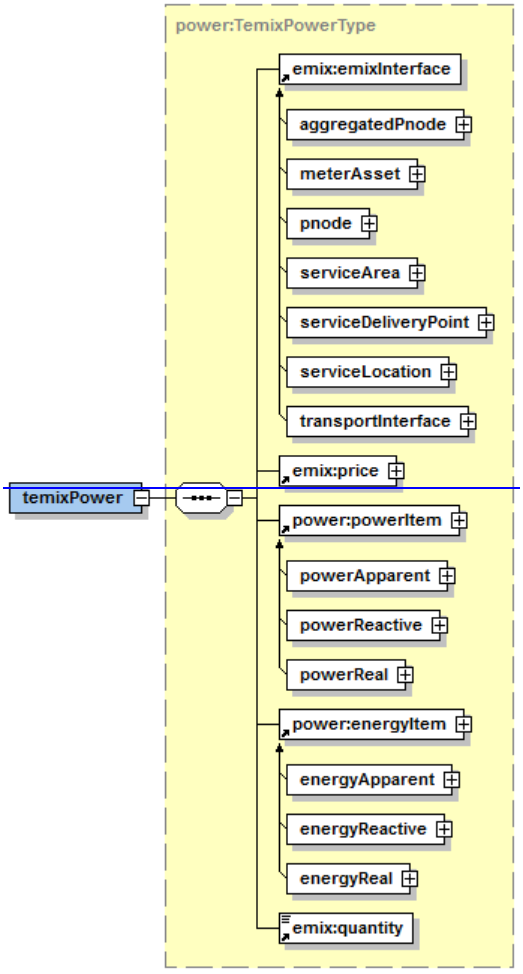
~~9.4 TEMIX Power Product~~



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9.510.5 Figure -: TeMIX Power Product

TEMIXThe TeMIX (Transactive Energy Market Information Exchange) is a model for balancing power markets with pure economic trading. It uses the simplest of the Power Product Descriptions.

The TeMIX profile allows only specific tenders and transactions for block power on defined Intervals of time. Tenders may be offered by any party to any other party, as market rules and regulations may allow. Any party can be a buyer, seller, or both. Transactions may include call and put options. TeMIX Options perform a similar function to demand response contracts or ancillary service contracts where an operator has dispatch control over the exercise of the option. TeMIX products also include transmission and distribution (transport) products.

TeMIX tenders and transactions can support dynamic tariffs by retail providers to retail customers. TeMIX is designed for interval metering where delivery can be accurately measured. The simplified information model and services of the TeMIX profile also support increased automation of transactions using the computer and communications technology of the smart grid.

TeMIX Products are specified by the power Power (rate of delivery of energy) over an interval. . TEMIXInterval. TeMIX Products are obligations in that a TeMIX Product is a commitment by the seller to deliver and the buyer to take the power (energyPower (Energy) over the interval.,Interval. When the intervalInterval includes more than one measurement or metering intervalInterval, the TeMIX product is defined as a constant rate over each of those metering intervals.Intervals. An example is the sale of 1 MW tomorrow between 3 and 5 PM that may be measured every 15 minutes (-The energy is 1 MWh-). The power in each 15 minute intervalsInterval is 1 MW and the energyEnergy in each 15 minute intervalInterval is 0.25 MWh. A position in a TEMIXTeMIX product may be resoldsold or added to. Depending on local market rules, differences between the powerPower purchased and the actual delivery may be delivered from or to spot markets at spot market prices-.

TeMIX is derived directly from the base Product Description because TeMIX is simpler and with less optionality than other Power Product Descriptions.

Table 10-8: TEMIX: TeMIX Power Product Description

TEMIXTeMIX Element	DefinitionDescription
Product Description	Base type for derivation. See *Table 3-1: EMIX Core Abstract Types*.
Power Product Type	Enumerated type of Power Product. Used to determine conformance requirements. and processing. See Table 10-2
EMIX Interface	An EMIX Interface is any of a number of market exchange points including a point, an aggregate point, or a geographic area at which a product exchanges ownership
Price	Price per Unit of Energy. For TeMIX, this is always the actual price and not an offset.
Energy Item	Total Energy (Power * Time), being transacted. Energy Type (Real, Apparent, or Reactive, in the block purchase) must match Energy Type of Power Item.
Power Item	Rate of Delivery of Energy. Can be Power Type (Real, Apparent, or Reactive Power, and) must match type of Energy Item.

TeMIX Product-based information exchanges are a little different thanfrom those for other products; they are discussed by themselves in Section 12 *Transactive Energy (TeMIX) Products.*

~~10~~11 Power Transport Product ~~Charges~~Description

The information model in this section is described in POWER-PRODUCTS.XSD

Transport costs affect the delivery of energy in all markets. Today's electrical power markets use different terms in transmission and delivery, but the underlying elements are the same. Future markets, including those for microgrids and virtual service providers, may not make the same distinctions between transmission and distribution as have been made in the past. Distributed Energy Resources (DER) may create new business models for use of the existing distribution networks.

11.1 Power Transport Elements

The information model below merges the charges and approaches used in the respective transmission and distribution networks today. It anticipates that potential source selection markets may result in passage through multiple networks. ~~Each of the products above, with the exception of TEMIX, can be subject to one or more Power Market Charges. All charges are based on the BasePowerCharge abstract interface, meaning markets the define new charges have the means to define new compliant charges. See the Appendices for a discussion of extensibility in EMIX.~~

~~Many of the charges defined are specific to Transport Products, although they can be applied to each of the Product herein. See Section , , for a discussion of those charges.~~

~~One charge can be applied to each of the Products as above, so is defined here. That charge is the Demand Charge.~~

The resulting Schedule can either stand-alone in transport products, or be conveyed inside the Envelope as price support information, in support of Locational Marginal Pricing (LMP).

Table 11-1~~: Elements of Power Demand Charges~~: Transport Description

~~Demand Charge~~Transport Product Element	~~Definition~~Description
~~Demand Charge Units~~	~~Units upon which Demand Charges will be computed~~
~~Demand Charge Floor~~	~~Below this floor, demand charges are not applied~~
~~Demand Charge Rate~~	~~Incremental charge applied if floor is exceeded.~~
~~Measurement Interval~~Point of Receipt	~~Granularity or Power Use readings. For example the demand charge may be incurred of the Power is above the floor for 5 minutes.~~Where power enters a network or changes ownership.
~~Collection Interval~~Point of Delivery	~~Period during which power usage is summed for comparison to Demand Floor.~~ Where power exits a network or changes ownership.
Price~~Collection Period~~	As defined in Table 3-2: Elements derived from Price Base~~Period during which the Demand Charge applies~~.
~~Charge Duration~~Transport Charges	An array of Transport Charges, as defined in . Table 11-2: Transport Product Charges~~Period during which Demand Charges will be applied after incurred.~~.

~~10.1 Enumerated Power Product Types~~

~~Because different Power Product Descriptions use the same informational elements, and because different transaction states may not require all elements be present in every exchange, each Power Product Description includes a Power Contract Type. Different Power Contract Types MAY have different conformance requirements in different market contexts.~~There MAY be multiple instances of the above

Artifacts in a single Price instance. For example, in a given transaction, power may pass through multiple distribution nodes and congestion points.

The items listed in the table above are each derived from the base charge type. All other charges, previously described, are available for inclusion within a Transport Product. ~~The Power Contract Type MAY be extended per the extensibility rules.~~

~~The following Power Product Types are enumerated:~~

Table 11-2: Transport Product Charges

Charge Type	Description
Base Transport Charge	A sub-set of Charges for Transport-related Charges. Derived from Base Charge.
Congestion Revenue Rights	A financial hedge for congestion; i.e., a forward contract for congestion revenues potentially to offset congestion charges. Also known as financial transmission rights. (Transport Charge)
Congestion Charge	The cost of purchasing the right to transfer power over a given segment of the grid. (Transport Charge)
Transport Access Fee	A simple charge (not dependent on congestion) to access transport system. (Transport Charge)
Transport Congestion Fee	Assessment per unit of energy for energy flowing from receipt to delivery point. Can be a positive or negative price. (Transport Charge)
Marginal Loss Fee	A Marginal Loss Fee is assessed per unit of energy to pay to replace Power lost during transport. (Transport Charge)
Transport Loss Factor	A multiplier applied to a transacted quantity of energy to reduce delivery quantity due to loss during transport. (Transport Charge)
Conversion Loss Factor	A multiplier applied to a transacted quantity of energy to reduce delivery quantity due to loss as product voltage is changed or as converted from AC to DC or DC to AC. (Transport Charge)

11.2 UML Summary of Transport Charges

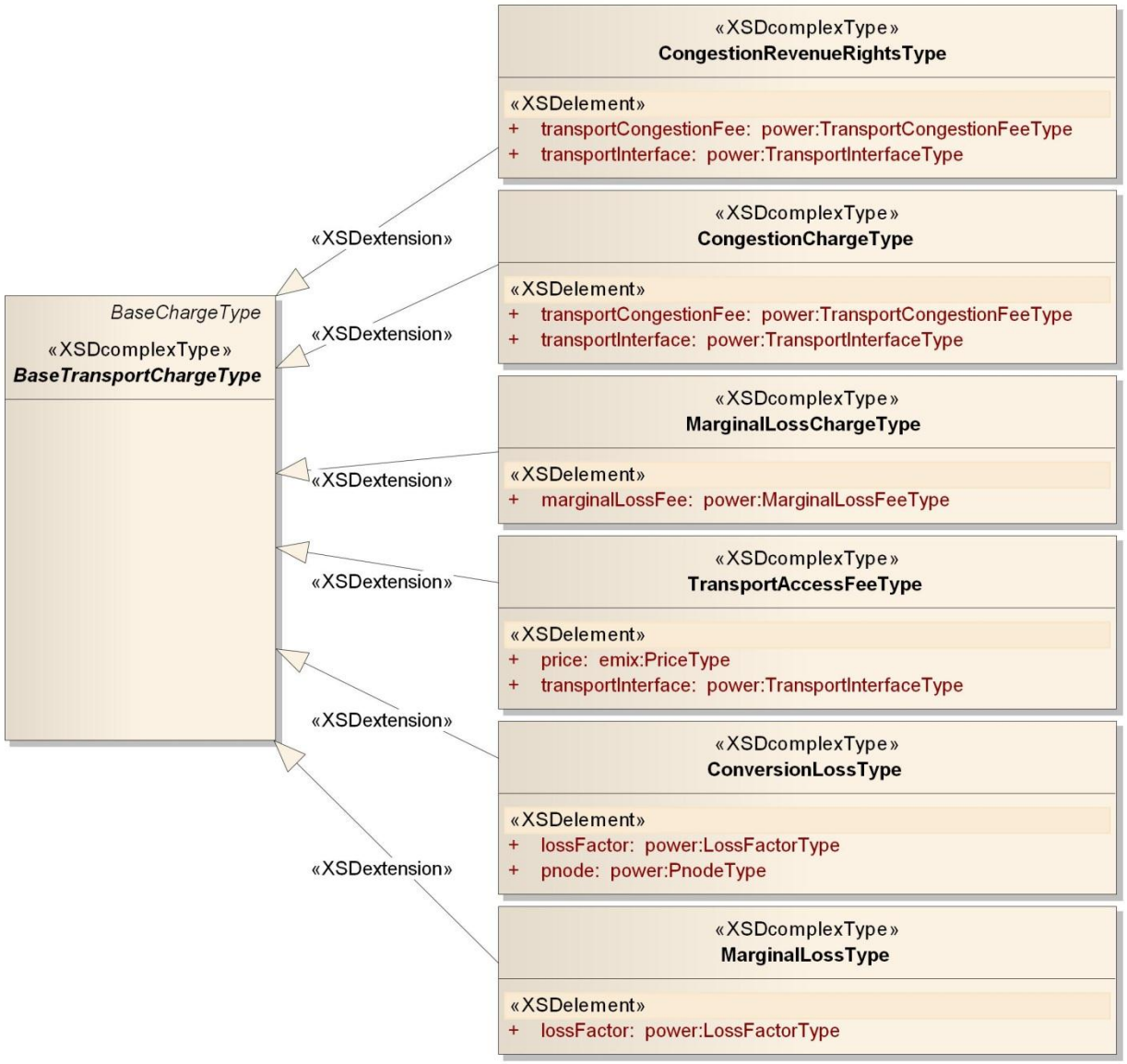


Figure 11-1: Requirements Power : UML Summary of Transport Charges

~~11~~12 Transactive Energy (TeMIX) Products

TeMIX is a subset or profile of the EMIX Power Products. This section describes the TeMIX profile of EMIX.

The TeMIX model is based on blocks of Power with a constant rate of delivery (subscription) over a single Interval. All TeMIX Products are transactions for Power delivered over the course of a single Interval. Each transaction imposes an obligation on the buyer to purchase and the seller to deliver a TeMIX Power Product. This simplicity reduces the number of products and interactions.

There are only four types of TeMIX Products:

1. TeMIX Power Product
2. TeMIX Transport Product
3. TeMIX Option Power Product
4. TeMIX Option Transport Product

The Transactive States for a TeMIX Product are:

- Indication of Interest
- Tender
- Transaction
- Delivery
- Price Publishing

A TeMIX Delivery Interval is specified by a Duration and Start Time. When a TeMIX Product specifies a set of Delivery Intervals, then the elements that do not vary by Delivery Interval may be specified in a Gluon or the Standard Terms. Each TeMIX Delivery Interval is transacted independently of the others.

12.1 TeMIX Overview

The rate of delivery of a TeMIX Power Product is constant over all measured (metered) Intervals within a TeMIX Delivery Interval. For example the transaction could be for 1 hour, but the meter reads every 5 minutes. These market rules are outside the scope of this specification/

For example, 1 MW of power transacted for delivery tomorrow for two hours between 3 and 5 PM provides 1 MWh of energy over each hour and 2 MWh over the two hours. If delivery is measured every 15-minutes, then the power transacted in each 15 minute Interval is 1 MW. The energy transacted in each 15-minute Interval is 0.25 MWh. If the energy delivered in each 15-minute Interval is greater or less than 0.25 MWh then the balance (positive or negative) will be sold or purchased in a subsequent balancing transaction.

The Price of a TeMIX Product is expressed in energy units. For the example above, when the price is $80 per MWh of energy, the extended price (cost) of 1 MW of Power for two hours between 3 and 5 PM is $160; the extended price for 1 MW of Power in each 15-minute Interval of the two hours is $20.

A TeMIX Transport Product is a subscription for Transport (transmission or distribution) to transport a TeMIX Power Product from one EMIX Interface to another. A TeMIX Transport Product is a subscription for power transport at a constant power over the interval.

A TeMIX Option Product provides the Option Holder the right to instruct the option writer to deliver (call) or take (put) a TeMIX Power or Transport Product up to the transacted quantity (rate of delivery) of the Option at a Strike Price.

TeMIX Options are either Call or Put Options on TeMIX Power and Transport Products. A TeMIX Option can be exercised during the Delivery Interval of the Option for any sub-Interval not smaller than the Option Interval Granularity.

For example, a TeMIX Option for 10 MW for a Day and an Option Interval Granularly of 1-hour and an Option Lead Time of 30 minutes would allow the Holder to exercise the option for any or all hours of the Day at the Strike Price by giving notice 30 minutes before each hour.

12.2 TeMIX Products

The elements of a TeMIX Power and Transport Product are shown in Table 11-1: Transport Description. When the Product Description (from the Section *Power Product Descriptions*) is applied to the EMIX Base types, the TeMIX elements are as shown in that table.

Table 12-1: TeMIX Product Description

TeMIX Element	Description
Power Product Type	Enumerated type of Power Product. Used to determine conformance requirements.
EMIX Interface	The Interface where the transaction occurs. Generally, the Interface for a Power Product has one node and the Interface for a Transport Product has two nodes.
Start Date and Time	When the Interval begins.
Duration	The extent of time of the Interval.
Price	The Unit Energy Price for the Interval. TeMIX does not allow Relative Prices or Price Multipliers.
Energy Item	Total Energy (Power * Time), Real, Apparent, or Reactive, delivered over the Interval.
Power Item	Units for the Rate of Delivery of Energy for the Delivery Interval. Includes Power Attributes.
Power Quantity	Rate of Delivery of Energy for the Delivery Interval.
Transactive State	TeMIX Transactive state is conformed to Indication of Interest, Tender, Transaction, Delivery or Publish.
Currency	Currency for the exchange.
Side	Indicates which side of the agreement the information originator is on. Buy or Sell.
Expires Date	Date and Time Tender expires. Not present if the Transactive State is anything other than Tender.
Envelope	As defined in Section 3.1.5: *The Envelope Contents*.

The TeMIX Option extends the TeMIX Product by adding these additional elements:

Table 12-2: TeMIX Power Option Product Description

TeMIX Element	Description
Option Holder Side	The side (buy or sell side of the option) which enjoys the benefit of choosing whether or not to exercise the option. The other side is the option writer.
Option Strike Price	The price at which the Option Holder can require option writer to deliver.
Exercise Lead Time	(Term) The Minimum Notification Duration expressed as an EMIX Term.

TeMIX Element	Description
Option Exercise Schedule	(Term) The Availability Schedule expressed as an EMIX Term.
Temporal Granularity	If present, expresses the temporal granularity of requests as a Duration. For example, if the Duration is 15 Minutes, the option can be called at 10:00, 10:15, 10:30, or 10:45. Granularity is a Property of the Option Schedule.

In TeMIX, very few terms are used, and they are homogenous for the entire market. See 7 *Standardizing Terms for Market Context* for a discussion of exchanging market-wide information.

12.3 Conformance Rules for TeMIX

The following comprise the conformance rules for TeMIX:

1. All allowed TeMIX Product Elements are named in Tables 7-1, 7-2, 12-1 and 12-2.
2. For a given Market Context, all Product Elements MUST be Defined in Standard Terms EXCEPT FOR
   - Starting Date and Time
   - Quantity
   - Price
   - Side
   - Tender Expiration Date and Time
3. All TeMIX Product Elements MUST BE UNDERSTOOD
4. All Elements NOT in the TeMIX Product Elements MUST BE IGNORED
5. All TeMIX Intervals are transacted separately MUST NOT have Links to other Intervals.
6. TeMIX MUST conform to all EMIX Conformance Requirements

12.3.1 Valid TeMIX Product Types

The allowed TeMIX Products are:

- TeMIX Power Product
- TeMIX Transport Product
- TeMIX Option Power Product
- TeMIX Option Transport Product

12.3.2 Transactive States for TeMIX

The Transactive States for a TeMIX are:

- Indication of Interest (IOI)
- Tender
- Transaction
- Delivery

~~Power Contract Type~~	~~Note~~
~~**Energy**~~	~~Used in TeMIX for simple block of Energy agreement~~
~~**Transport**~~	~~Used in TeMIX for simple transport agreement~~
~~**Energy Option**~~	~~Used in TeMIX for Option to transact simple block of Energy~~
~~**Transport Option**~~	~~Used in TeMIX for Option to acquire rights to Transport~~
~~**Full Requirements Power**~~	~~Traditional power Product to provide all power used. Often used in retail residential rates. Demand Charges~~

Power Contract Type	Note
Full Requirements Power with Demand Charge	Similar to Full Requirements except specific and perhaps recurring charges are incurred for exceeding set limit(s)
Full Requirements Power with Maximum and Minimum	Customer must draw energy at least the minimum rate (power) and no more than the maximum rate during any measurement Interval.
Hourly Day Ahead Pricing	Same Full requirements power but prices potentially change each day.

1258 •
1259 • Publish
1260

Ex-Ante Real Time Price	Used to report prices after the fact.
Time of Use Pricing	Similar to Hourly day-ahead pricing but prices may change seasonally and not be at hourly Intervals
Transport Service	Product to acquire Transport including factors for congestion, loss, charges, fees, etc.
Congestion Revenue Rights	Hedge product against future Transport / Congestion costs

1261 Power products such as these can be described using the Power Product Descriptions

~~12~~13 Energy Resources

The information model in this section is described in RESOURCE.XSD

~~Resources describe potential services to offer to others in a smart grid. Resource tenders are either requesting services or offering services. In a pure transactive market, these tenders might be identical to the services provided, i.e., they could be fully described using the same language used to transact execution and performance.~~

~~Resources often enter or are called to enter the market to meet specific needs. These needs can include a range of performance requirements; Resources might be able to perform a range of capabilities. These performance capabilities are described using the information in Resource Offers. Resource Offers are less specific than a single transactive request, and may thereby present the Resource to more than a single market.~~

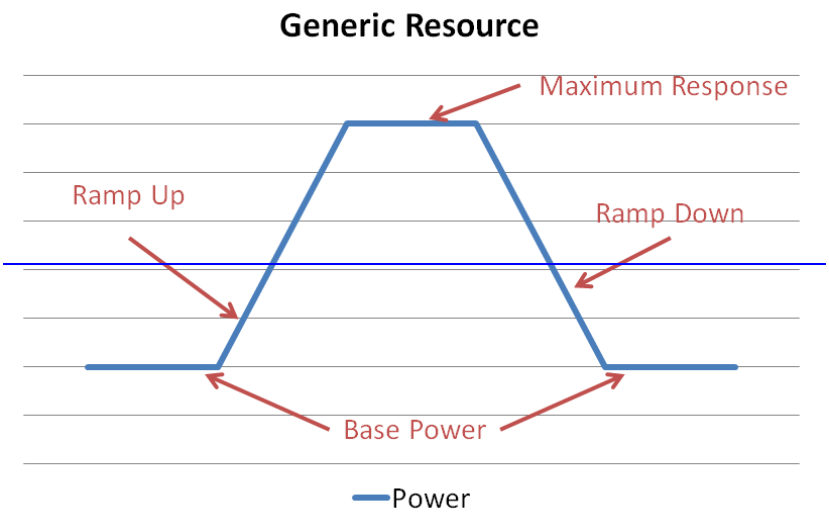
The Resource information model describes information that MAY be used to offer product(s) in a market. The Resource model describes a range of potential operational responses. The model allows parties to describe a wide range operations, both generation and curtailment. Resource descriptions are used tenders either to buy or tenders to sell Energy or Power products.

When making a tender for products and services, it is useful to describe the ~~capabilities~~operational characteristics of a resource~~,~~ so the counter party can determine if a resource can meet the requirements. A notice of interest MAY specify performance expectations. A Resource MAY compare its own capabilities to those requirements before submitting a bid.

~~Resource Capabilities may describe a ramp rate, or maximum run time, or any number of elements useful to energy schedulers. A Resource Offer associates offers for power produces with a Resource Capability.~~

~~12.1 Resource Capabilities~~

~~Resources have capabilities rather than schedules. Resource descriptions describe what could be done, as distinguished from a transaction in which specific performance is requested or agreed to.~~



Parties can potentially exchange these models, until they come to an agreement. The rules for exchanging these models are outside the scope of this specification. Resource tenders are less specific than a single transactive request, and one Resource tender may be able offer the Resource to more than one market.

Resources may represent a generator or a load responses or aggregations. In interactions involving Resources it may be useful to describe either (1) the proposed or actual operation of a Resources, or (2) the range of capability of a Resource.

13.1 Resource Capabilities

The following curve characterizes the a schedule for operation of a generic Resource

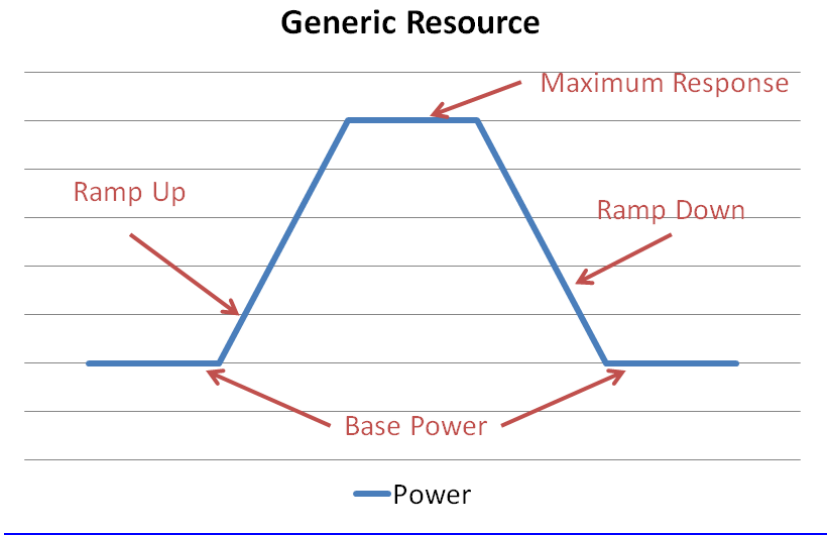
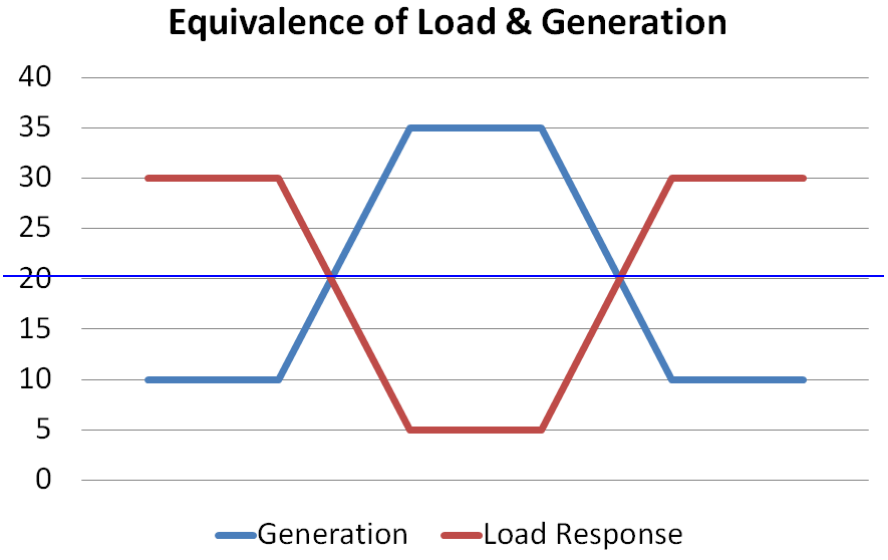


Figure 13-1: ~~Attributes~~Operational Profile of a Generic Resource

In the Resource illustration above, there is some base level of ~~energy~~power, a *status quo ante*. When invoked, the resource takes ~~some~~a period of time to change to a different level. If the response is binary, then it can only go up to the maximum response, and that ramp rate takes a fixed time. If a resource is able to provide several layers of response, then the ramp time also varies. The ramp time can be computed from the ramp rate and the difference between the base power and the maximum response.

As electricity is fungible, a critical key element of ~~power resources~~the information model in Power Resources is that generation, that is the production of power, and load shedding, the reduction of power use are similar products ~~with similar value.~~ .



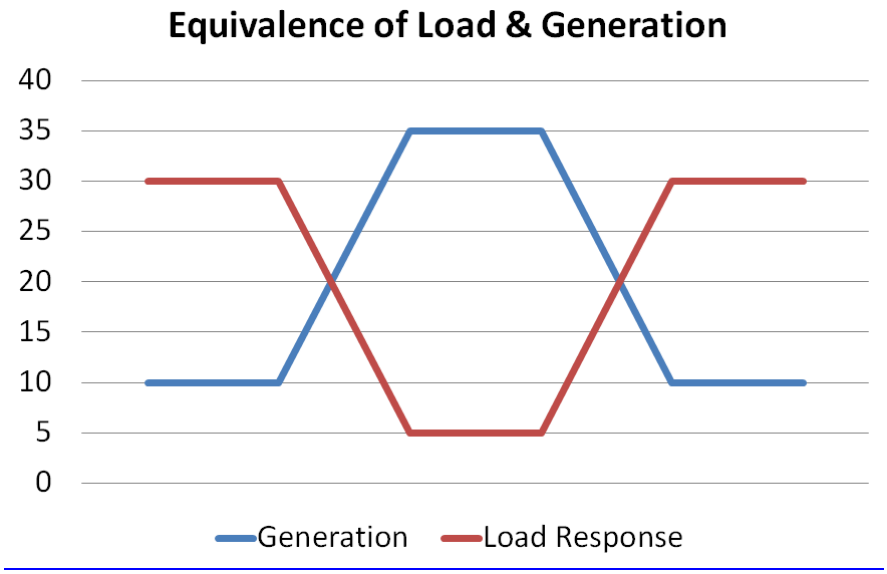
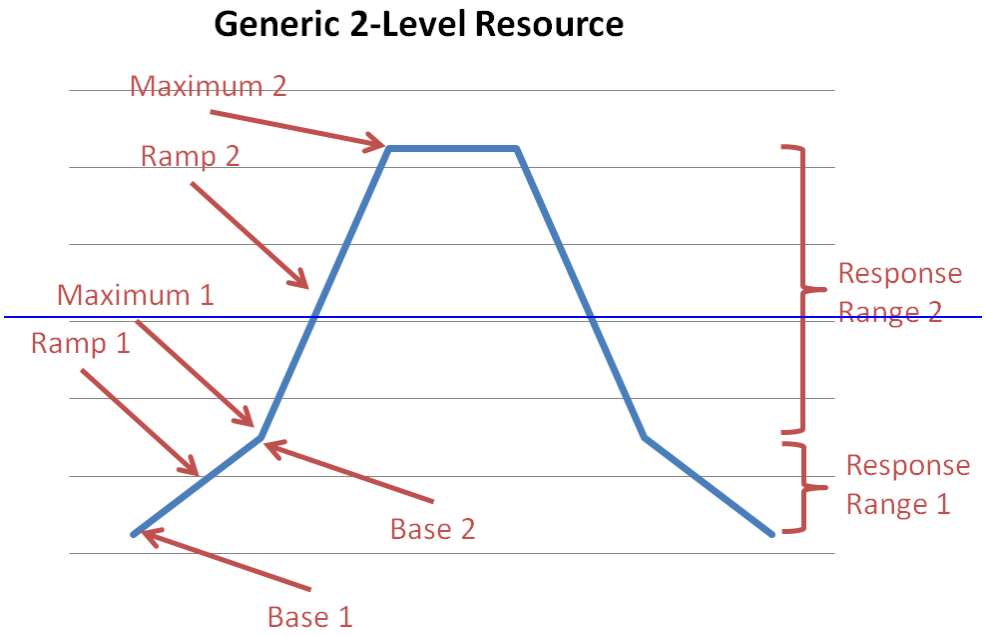


Figure 13-2: Equivalence of Load Shed and Generation

As shown in the example above, generation and load response are similar and can be described using the same ~~language~~information model.

Many Resources have capabilities that change over the range of response. A generator may have one ramp ~~speed~~rate until it gets up to half speed, and then another as it goes to full speed. Load response can have similar characteristics. Such resources can be described by combining simple response characteristics.

~~. Load response can have similar characteristics. Such resources can be described by combining simple response characteristics.~~



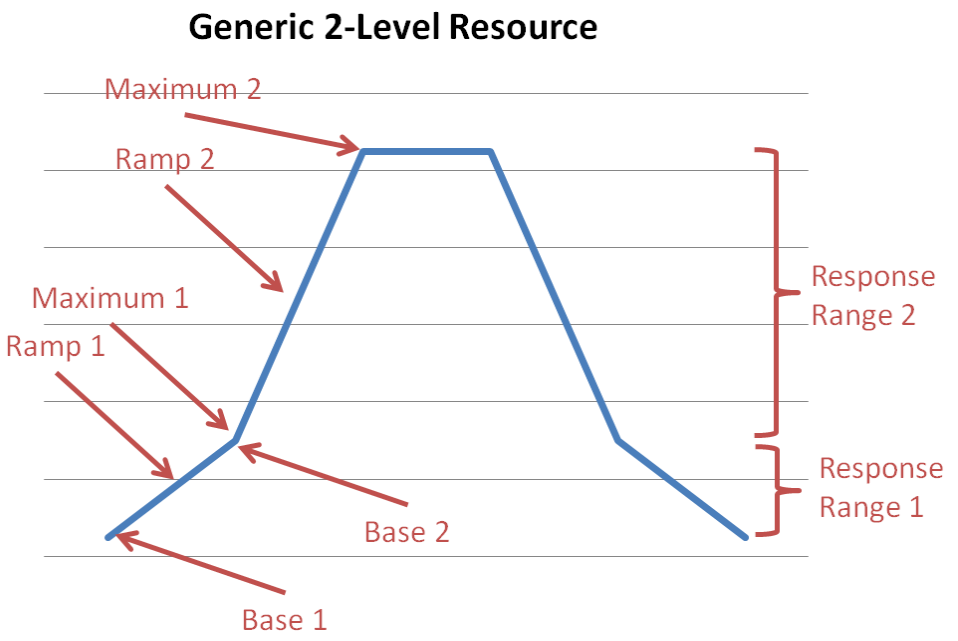


Figure 13-3: Combining ~~Response Capabilities~~Resource Operational Responses

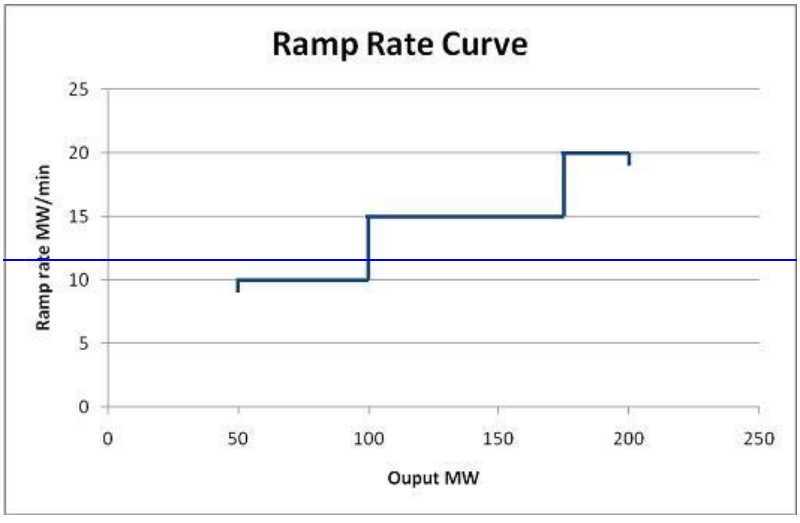
13.2 Resource Capability Description

Resource capability descriptions describe what could be done, as distinguished from a transaction in which specific performance is requested or agreed to.

Resources ~~as in can~~capabilities may be communicated as an array of ramp up rates, a maximum power offered, and an array of ramp down rates. Between the Base 1 and Maximum 1, expressed in MW, the resource ~~can ramp~~ramps up at Ramp 1 expressed in MW/~~min.~~minute. Between the Base 2 and Maximum 2, expressed in MW, the resource can ramp up at Ramp ~~1~~2 expressed in MW/~~min.~~ minute.

~~With capabilities expressed as above, to capabilities of a Resource can be found by the time indicated (moving along the X axis) between Base 1 and wherever the ramp up line passes through desired output level.~~

~~Users of the IEC TC57 CIM express this with a Ramp Rate Curve. expresses similar information as does , showing Base1 at 50 MW of power and Maximum 1 at 100 MW with a ramp rate of 10 MW/minute. Ramp 2, at 15 MW/minute goes from 100MW to 180 MW.~~



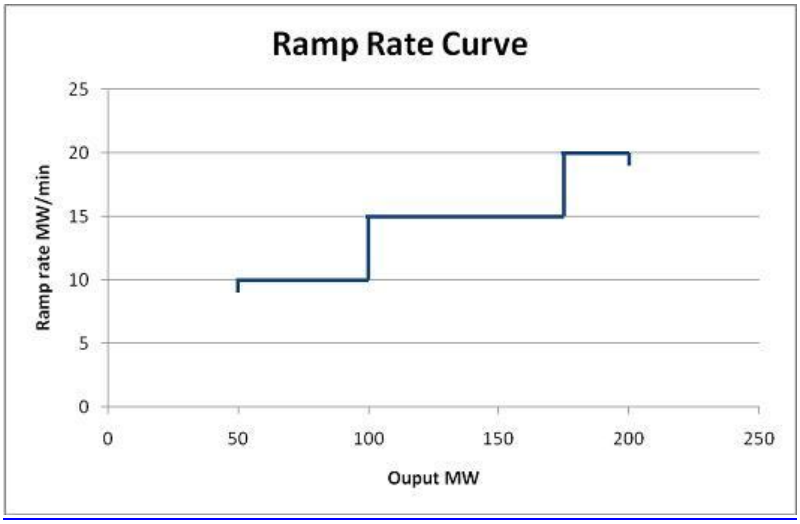


Figure 13-4: Ramp Rate Curve—CIM Style

By expressing ResourcesAs described in terms of capabilities**[IEC 62325-301],** a given resource may publish multiple ramp rate curves for different circumstances. This resource capability description may be preferred to the resource operation description in some interactions.

13.3 Contrasting Operation and Capability Descriptions

Assume the Resource is operated at the ramp rates as in Figure 13-4 then an operation as described in Figure 13-1, a potential purchaser. A capability description is generally used to guide resource dispatch. Once the dispatch is computed, an operational description can determine if a Resource meets hisbe used to tender or her needs, tenderingtransact the power that is the result of the dispatch from the market.

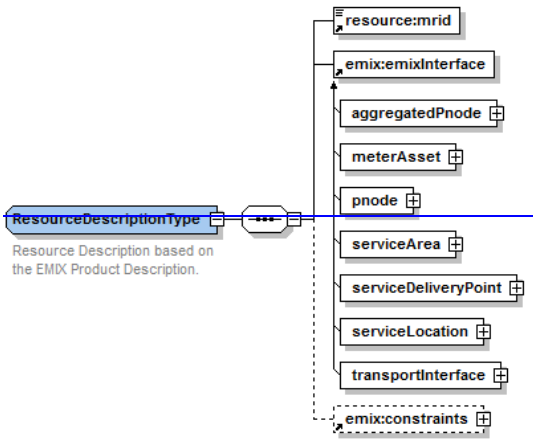
This specification describes market interactions, i.e., the operational profiles. Only the description in Section 13.1 is in this specification. When a single resource to a variety of purchase scenarios.offers different ramp rates for different circumstances, this specification considers the resulting operational profiles to be distinct products.

The description in Section 13.2Picture several Resources each able to generate 10 MW of additional power. One can increase power at 1 MW/minute, one at 2 MW/minute, one at 5 MW/minute. The latter two each can enter into an Agreement to supply 10 MW in 5 minutes. Only the last can Agree to supply an increase of 10 MW within 2 minutes. All three can Agree to supply an increase of 10 MW within 15 minutes.

may be considered at a later date by the committee.

12.213.4 Resource Description Semantics

EMIX Resource Descriptions are an extension of the EMIX Product Description. As an extension of the Product Description, resources can be applied inside any EMIX schedule.



~~*Figure -: Resource Description base*~~

The only aspects of a Resource that ~~matters~~matter to the energy market are the effects it can provide, the likelihood it will be able adequately to provide what it promises, and the financial incentives required to acquire them. The technology and process control details are many, and new ones may be required for each new power technology. Unless the market for the Resource requires direct control, such details are irrelevant. ~~The limited semantic set herein is sufficient to describe the capabilities of a Resource.~~

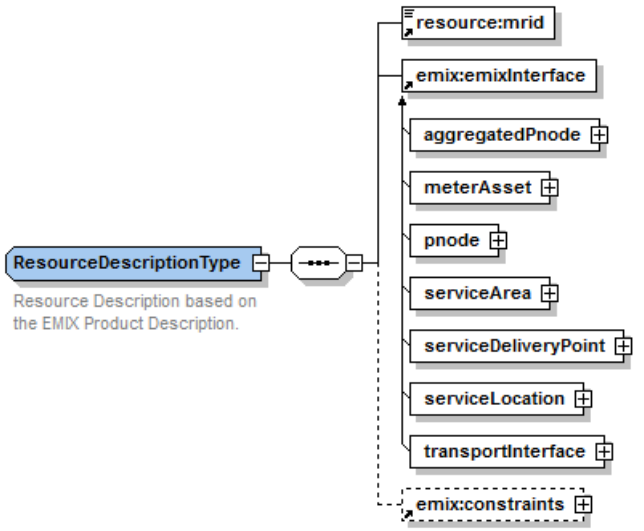


Figure 13-5: Resource Description base

The EMIX Resource Description base consists of~~:~~ the elements shown in the table below.

Table 13-1: Resource Description Elements

Resource Description Element	Note
MRID	The ~~Multi-part resource id~~Master Resource ID as defined in the [**IEC TC57**] ~~CIM uniquely identifies each resource.~~IEC 61970-301.
EMIX Interface	The Interface is where the Resource injects or extracts power. Note: for many transactions, reduced extraction is equivalent to injection.
~~Constraints~~Terms	~~As well as all of~~In addition to the ~~constraints~~Terms listed for Product performance, Resources have additional ~~constraints~~Terms, listed ~~below.~~in Table 10-2.

Power Resources descriptions can use any of the ~~constraints~~Terms or requirements defined in EMIX. Power Resource descriptions can also use additional ~~constraints~~Terms that are specific to Power:

Table 13-2: ~~Constraints~~Terms unique to Power Resources

Power ~~Constraint~~Term	Note
Minimum Load	~~Constraint on~~ Minimum Load that a Resource can maintain.
Maximum Power	~~Constraint on~~ Maximum Power available from a resource.
Maximum Energy	~~Constraint on~~ Maximum Energy available from a resource.
Minimum Load Reduction	~~Constraint on~~ Minimum Load Reduction resource can make.

13.5 UML Summary of Resource Descriptions

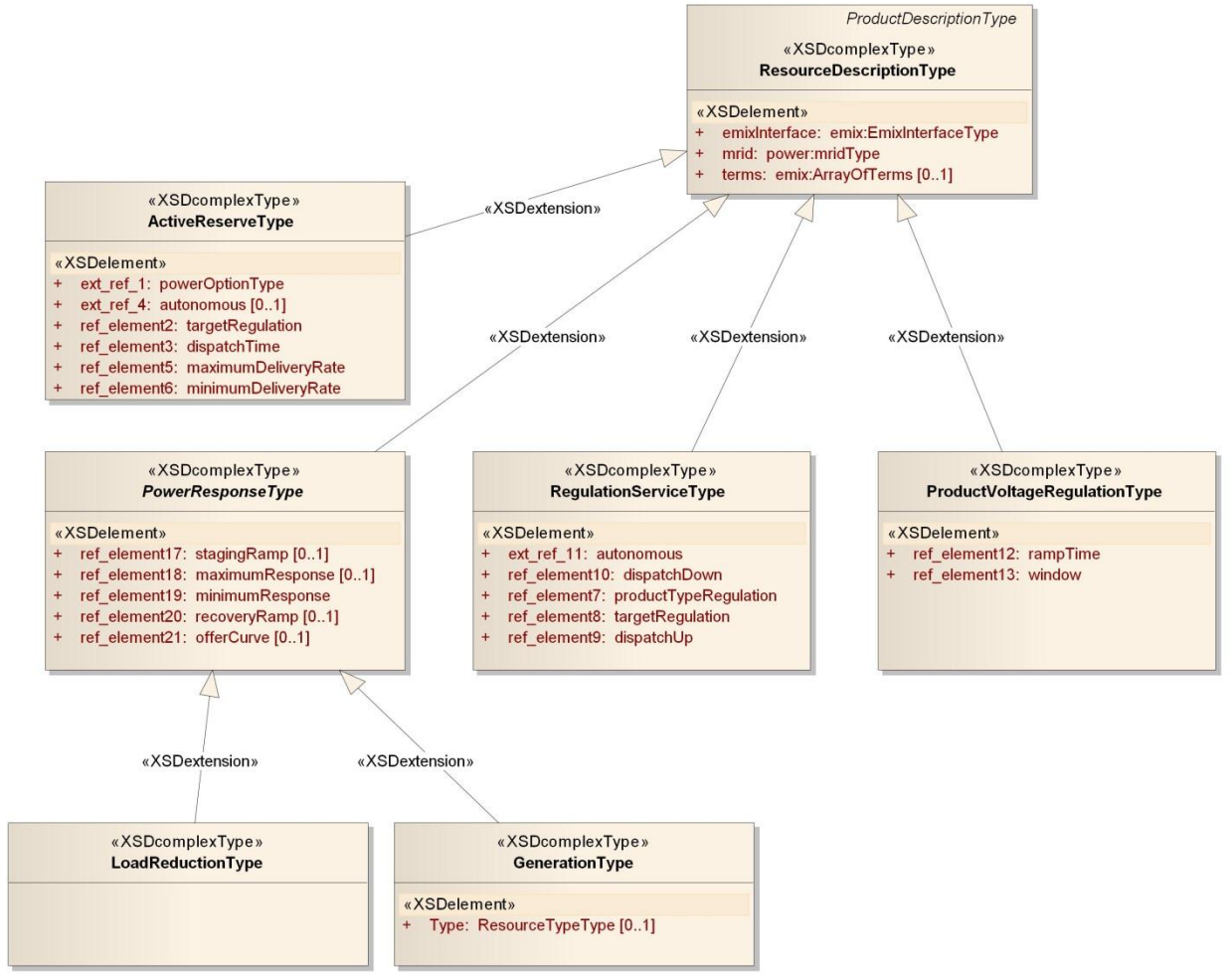


Figure 13-6: UML Summary of Resource Descriptions

~~12.3~~13.6 Generic Power Resource

The Generic Power Resource description is used both for generation and for load Resources. The common Resource model is ~~as follows:~~shown in the following table.

Table 13-3: Generic Power Response Resource

Generic Resource Element	Note
Staging Ramp	An array of Power Ramp Segments describing a Resource's ability to change level at the initiation of a Response.
Minimum Response	The least Response for which this resource will accept a request.
Maximum Response	The greatest Response for which this resource will accept a request.
Recovery Ramp	An array Power Ramp Segments describing how a Resource's returns to its original state following a response.

A Power Response Description MAY be accompanied by an Offer Curve *(described in section 13.6.2* Offer Curves*). Each Ramp consists of zero to many Power Ramp Segments (see Figure 13-3: Combining Resource Operational Responses~~).~~).*

Power Ramp Segments~~Each Ramp consists of zero to many Power Ramp Segments (see figure). Each Power Ramp Segment Rate describes a change up or down in units/duration, from the Power Quantity of the Begin Ramp to the Power Quantity of the End Ramp. The rate of change is assumed to be constant between the Begin Ramp and the End Ramp.~~

13.6.1

Power Ramp Segments consist of the following elements~~:~~ shown in the table below.

Table 13-4: Power Ramp

Power Ramp Element	Note
Rate	Power Units for the Ramp.
Begin Ramp Quantiyu	Power Quantity at the beginning of the Segment.
End Ramp Quantity	Power Quantity at the end of the Segment.
Duration	The time ~~to get~~ between the begin ramp and the end ramp.
Integral Only	If true, one can't stop between the begin and end rates.

While Power Ramps are generic, specific instances within derived Resource Descriptions are subject to different conformance rules.

For a Generation Resource, Staging Ramps are processed in order of increasing End Power. The quantity of End Power MUST be greater than the quantity of the Begin Power for each Ramp in the Staging Ramp. Recovery Ramps are processed in order of decreasing End Power. The quantity of End Power MUST be less than the quantity of Begin Power for each Ramp in the Recovery Ramp.

For a Load Resource, Staging Ramps are processed in order of decreasing End Power. The quantity of End Power MUST be less than the quantity of Begin Power for each Ramp in the Staging Ramp. Recovery Ramps are processed in order of increasing End Power. The quantity of End Power MUST be greater than the quantity of the Begin Power for each Ramp in the Recovery Ramp.

Load Resources and Power Resources are conformed instances of the Generic Power Resource.

~~12.3.1~~13.6.2 Offer Curves

When ~~a~~the capability of Power Resource ~~is offered to the market~~tendered, it may be accompanied by an Offer Curve. An Offer Curve is comprised of a number of Offer Segments. An Offer Segment defines the ~~minimum requirements~~offer price (as expressed in EMIX Requirements) ~~of the Offeror~~ for the quantity offered in each ~~block of response without which~~segment. A sequence number indicates the ~~Offeror will~~

withdraw the Resource from the market. order of the segments. Each segment may be offered in any partial amount or all-or-none.

Table 13-5: Resource Offer Segment

Resource Offer Element	Note
Price	Energy Price required for this Segment.
QuantityMaximum Response	Enumerator for the Power rate at the beginning of this RampaximumPower change in this segmentPower Quantity for this Segment.
Duration	Duration of the Segments.
Units	Power Units inQuantity at which the Ramp EndsSegment is denominated.
Units	Energy Units in which Segment is denominated.
Integral Only	If true, offer is all or none; no partial acceptance of this segment.

Because an Offer Curve is always figured in terms of the block size of the response, it is always sorted in order of increasing response. In many markets, they Offer Curves are then processed as a series of bids.

Reactive Power

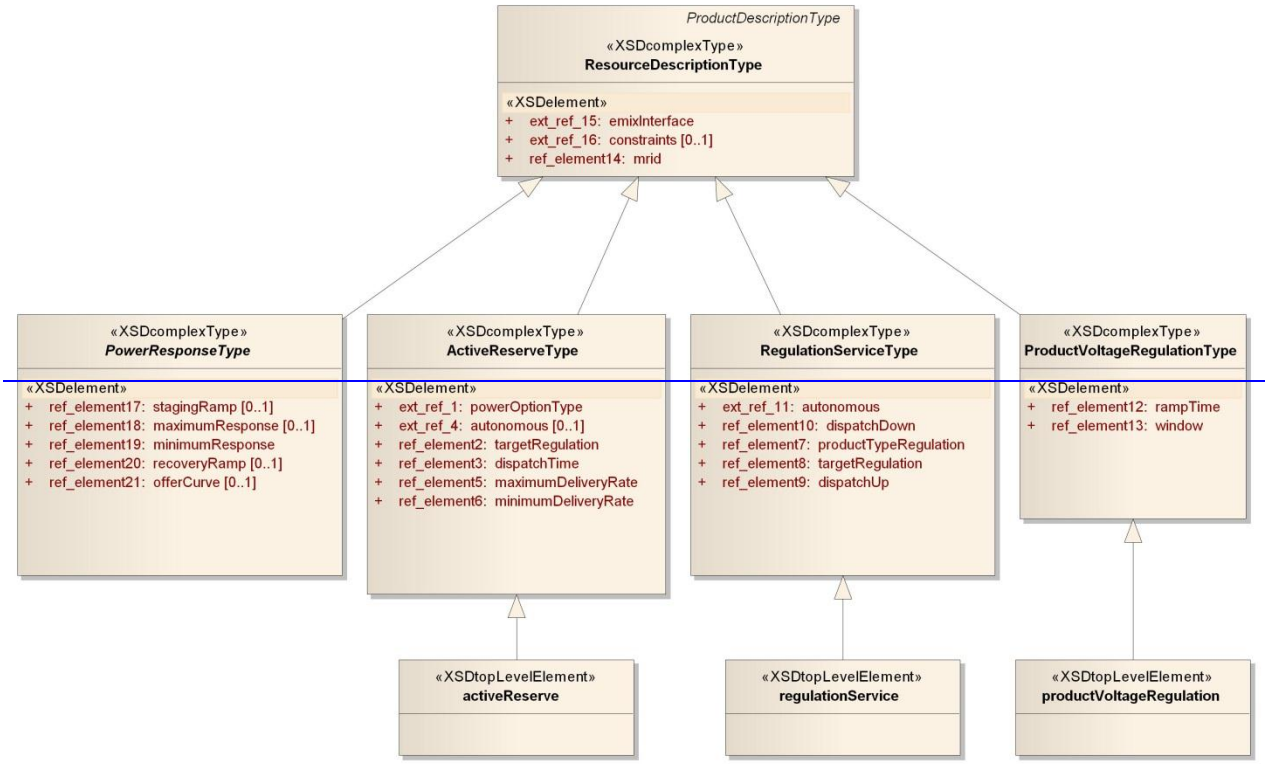
12.413.7 Voltage Regulation Resources

In addition, voltageVoltage regulation services have their own particular semantics as described in the following table.

Table 13-6: Semantics for Voltage Regulation Services

Voltage Regulation Element	Note
VMin	VMin is the IEEE 1547 minimum voltage level of 88% of nominal voltage where the photovoltaic (PV) inverter must disconnect. Also , as defined as the minimum Reactive Power of the Resource.in **[IEE1547]**.
VMax	VMax is the IEEE 1547 maximum voltage level of 110% of nominal voltage where the photovoltaic (PV) inverter must disconnect. Also , as defined as the Maximum reactive power of the Resourcein **[IEE1547]**.
QMax	QmaxQMax is the inverter's current varpresent reactive power (VAR) capability and may be positive (capacitive) or negative (inductive). It isIt can also be considered as the apparent power (VA) capability left after supporting the real power (W) demand. See **[Budeanu]** and **[IEEEv15#3]**.
voltVar	Reactive Power

1415 # ~~12.5 Summary of Resource Types~~



1416

1417 *~~Figure -: UML Summary of Resource Types~~*

13 Transactive Energy (TeMIX) Products

TeMIX products use transactive interactions to acquire blocks of power. It emphasizes simple interactions and requires minimal knowledge of one's trading partner. All TeMIX Products are subscriptions for power over a single Delivery Interval. Subscriptions impose an obligation on the buyer to purchase and the seller to deliver a TeMIX Power Product. This simplicity reduces the number of products and interactions.

There are only four types of TeMIX Products:

1. TeMIX Power Product
2. TeMIX Transport Product
3. TeMIX Option Power Product
4. TeMIX Option Transport Product

The Transactive States for a TeMIX Product are:

- Indication of Interest
- Tender
- Transaction
- Delivery
- Price Publishing

A TeMIX Delivery Interval is specified by a Duration and Start Time. When TeMIX Product is specified for a set of Delivery Intervals, then elements that do not vary by Delivery Interval may be specified in a Gluon. However each TeMIX Delivery Interval is transacted independently of the others in the set.

A TeMIX Power Product defines a subscription for Power (energy = power * duration) over a Delivery Interval. The subscribed power of TeMIX Power Product is constant over all measured (metered) intervals within a TeMIX Delivery Interval.

For example, 1 MW of power subscribed for delivery tomorrow for 2-hours between 3 and 5 PM provides 1 MWh of energy over each hour and 2-MWh over the two hours. If delivery is measured every 15-minutes, then the power subscribed in each 15 minute interval is 1 MW. The energy subscribed in each 15-minute interval is 0.25 MWh. If the energy delivered in each 15-minute interval is greater or less than 0.25 MWh then the balance (positive or negative) will typically be sold or purchased in a subsequent balancing transaction.

The Price of a TeMIX Product is expressed in energy units. For the example above, when the price is $80 per MWh of energy, the extended price (cost) of 1 MW of Power for 2- hours between 3 and 5 PM is $160 and the extended price for 1 MW of Power in each 15-minute interval of the 2-hours is $20.

A TeMIX Transport Product is a subscription for Transport (transmission or distribution) to transport a TeMIX Power Product from one EMIX Interface to another. A TeMIX Transport Product is a subscription for power transport at a constant rate over the delivery interval.

A TeMIX Option Product is a subscription for optionality applied to a TeMIX Power or Transport Product. A TeMIX Option Product is a subscription that provides the Option Holder a right to instruct the Option Writer to deliver (call) or take (put) a TeMIX Power or Transport Product up to the subscribed quantity (rate of delivery) of the Option at a Strike Price.

TeMIX Options are either Call or Put Options on TeMIX Power and Transport Products. A TeMIX Option can be exercised during the Delivery Interval of the Option for any subinterval not smaller than the Option Interval Granularity.

For example a TeMIX Option for 10 MW for a Day and an Option Interval Granularly of 1-hour and an Option Lead Time of 30 minutes would allow the Holder to exercise the option for any or all hours of the Day at the Strike Price by giving notice 30 minutes before each hour.

The elements of a TeMIX Power and Transport Product are shown in . When the Product Description (from section) is applied to the EMIX Base types, the TeMIX elements are:

Table -: TeMIX Power Product Description

TeMIX Element	Definition
Power Product Type	Enumerated type of Power Product. Used to determine conformance requirements.
EMIX Interface	The TeMIX Interface where the transaction occurs. Generally the Interface for a Power Product has one node and the Interface for a Transport Product has two nodes.
Price	Price per Unit of Energy. For TeMIX, this is always the actual price and not an offset.
Start Date and Time	When the Interval begins
Duration	The length of time of the Interval
Price	The Unit Energy Price for the interval. TeMIX does not allow Relative Prices or Price Multipliers.
Energy Item	Total Energy (Power * Time), Real, Apparent, or Reactive, in the block purchase
Power Item	Units for the Rate of Delivery of Energy for the Delivery Interval. Includes Power Attributes.
Power Quantity	Rate of Delivery of Energy for the Delivery Interval.
Transactive State	TeMIX Transactive state is conformed to Indication of Interest, Tender, Transaction, Delivery or Publish.
Currency	Currency for the exchange
Side	Indicates which side of the agreement the information originator is on. Buy or Sell
Expires Date	Date and Time Tender expires. Not present if the Transactive State is anything other than Tender.
Envelope	As defined in Section 4.1.5

The TeMIX Option extends the TeMIX Product by adding these additional elements:

*Table -: TeMIX Power Option Product **Description***

TeMIX Element	Definition
Option Holder	The side (buy or sell side of the option) which enjoys the benefit of choosing whether or not to exercise the option. The other side is the Option Writer
Strike Price	The price at which the Option Holder can require Option Writer to deliver.
Option Lead Time	The Minimum Notification Duration constraint
Option Schedule	The Availability Schedule constraint

~~EnMIX Element~~	~~Definition~~
~~**Minimum Option Call**~~	~~The shortest duration for which the Option can be called. Uses the Minimum Run Duration constraint~~
~~**Granularity**~~	~~If present, expresses the temporal granularity of requests as a duration. For example, if the Duration is 15 Minutes, the option can be called at10:00, 10:15, 10:30, or 10:45.~~

14 Ancillary Services Products

Ancillary Services are typically products provided by a Resource Capability, and historically ~~were~~are contracted to stand by for a request to deliver changes in power to balance the grid on very short notice. Ancillary services include Regulation Up, Regulation Down, Spinning Reserve, ~~and~~ Non-Spinning Reserve~~.~~ and Volt/Var support (Reactive Power). These Ancillary services are different from other power products in that they are paid for availability, whether or not they ~~perform.~~are dispatched. Of course, if dispatched, they must ~~also~~ perform ~~when called~~.

~~In general, Ancillary services are a promise to perform, usually within tight constraints, i.e., within five minutes of notification in one market, or within one minute of notification for another. The promisee pays for this offer to perform, whether or not the promise is called. When the performance call comes, the promisor is then paid again, often at a premium over the market rate at the time of the performance call.~~

In general, Ancillary services support grid stability by stabilizing specific aspects of grid power attributes. There are several types of ancillary services, each defined by local market rules or utility tariffs. Ancillary services tend to be used frequently but for short durations. Common characteristics are that the Resource must have a secure, often dedicated, link to the dispatcher, must be able to respond very quickly (sub second to ten minutes), respond with accuracy, and provide rapid and accurate performance reporting. Because of the specialized and critical nature of Ancillary Services, this type of Resource Capability is tightly integrated with grid operations. Dispatch must be completely automated and utterly reliable. Failure in this area will result in a range of issues from equipment malfunction to widespread outage. For these reasons, Ancillary Services historically have been performed by specialized generators or capacitor banks. More recently, wholesale markets have piloted the origination of Ancillary Services from Demand Side Resources.

Each market or local utility will define Ancillary Services it will buy from third parties as well as the compensation mechanism for those service and the tests Resource Providers must pass to become certified, “ready to perform”. General types of Ancillary Services are Frequency Regulation, Load Following, Reactive Power (Volt/VAR), Contingency Reserves (Spin and Non-Spin), and Black Start.

Frequency Regulation/Load Following services are fast acting continuously performing resources that respond nearly instantly to compensate for fluctuations in grid power. In contrast, Contingency Reserves (Spin or Non Spin) are off-line until needed, but must be able to react quickly to a dispatch signal (usually ten minutes or less depending on type) sent when another resource suddenly stops performing.

Black Start Resources are generator based sub-grids that can start independently and produce reference grade power without relying on integration with the wider grid. These are used to restore service after outages because they can provide a reference signal required by non-black start resources.

Reactive Power offsets certain types of loads (coils or capacitors) that are capable of sending power back to the grid from what normally would be a load. Uncompensated, this potentially can be damaging to neighboring loads on the grid.

In EMIX, Reserves are ~~modeled as simple Options~~ described using the market semantics of Options within the EMIX Option type~~, which is one of the EMIX Base-derived types.~~. Performance expectations are expressed using ~~constraints, which can appear on either side of a Tender.~~terms. Strike prices and the penalty for non-performance are part of the option agreement.

Because it is useful to have a short-hand to refer to these services, they are enumerated in the Power Option Type enumeration which is incorporated into the Power Product Types.

The enumerated Power Option Types are: Spinning Reserve, Non Spinning Reserve, Operating Reserve, ~~and Demand Response.~~Black Start Recovery, and Reactive Power. The enumerated list is extensible as described in Appendix B.1: *“Extensibility in Enumerated Values”.* Because the exact definitions vary from

market to market, and will continue to vary over time, EMIX does not define these terms. All definitions and performance requirements SHALL be expressed through the ~~constraints.~~

15 Power Quality

The information model in this section is described in POWER-QUALITY.XSD

Terms. Higher quality power can obtain a market premium. A buyer willing to accept lower quality power may be able to obtain inexpensive power. Power Qualities must be measurable, discrete, and on a spectrum allowing the buyers to make choices. They must also be verifiable, measurable by defined protocols, so performance can be compared to promise.

15.1 Electrical Power Quality

Table - : AC Power Quality

Name	Specification
Measurement Protocol	A string containing an identification of the standard or other protocol used to measure power quality
Power Frequency	A floating point number describing the measured Power frequency. Users who wish to describe how the frequency varies over time will need to derive their own measure from the base Powr Quality type.
Supply Voltage Variations	An unsigned integer count of Supply Voltage Variations during the period
Rapid Voltage Changes	An unsigned integer count of Rapid Voltage Change events during the period
Flicker	An unsigned integer count of Flicker events during the period
Supply Voltage Dips	An unsigned integer count of Supply Voltage Dip events during the period
Short Interruptions	An unsigned integer count of Short Interruption events during the period
Long Interruptions	An unsigned integer count of Long Interruption events during the period
Temp Overvoltage	An unsigned integer count of Temporary Overvoltage events during the period
Supply Voltage Imbalance	An unsigned integer count of Supply Voltage Imbalance events during the period. Not meaningful for DC.
Harmonic Voltage	A floating point number for the Harmonic Voltage during the period. For DC, distortion is with respect to a signal of 0 Hz
Mains Voltage	A floating point number Mains [Signaling] Voltage

16 Power Transport Product Descriptions

The information model in this section is described in POWER-PRODUCTS.XSD

Transport costs affect the delivery of energy in all markets. Today's electrical power markets use different terms in transmission and delivery, but the underlying elements are the same. Future markets, including those for microgrids and virtual service providers, may not make the same distinctions between transmission and distribution as have been made in the past. Distributed Energy Resources (DER) may create new business models for use of the existing distribution networks.

The information model below merges the charges and approaches used in the respective transmission and distribution networks today. It anticipates that potential source selection markets may result in passage through multiple networks. The resulting EMIX Base can support either stand-alone transport products, or price support information conveyed within the Envelope, in support of Locational Marginal Pricing (LMP).

Table -: Transport ***Description***

Transport Product Element	Definition
Point of Receipt	Where power enters a network or changes ownership
Point of Delivery	Where power exits a network or changes ownership
Transport Access Fee	Fixed Charge (not dependent on congestion) to access transport system
Transport Congestion Fee	Congestion fee per unit of energy for energy flowing from receipt to delivery point. Can be a positive or negative price.
Marginal Loss Fee	Marginal Loss Fee
Transport Loss Factor	Reduction in amount delivered due to loss during transport. (Loss Factor * purchase amount) = delivered amount
Conversion Loss Factor	Reduction in amount delivered as product voltage is changed or as converted from AC to DC or DC to AC. (Loss Factor * purchase amount = delivered amount)

There MAY be multiple instances of the above Artifacts in a single Price instance. For example, in a given transaction, power may pass through multiple distribution nodes and congestion points.

The items listed in the table above are each derived from the base charge type. All other charges, previously described, are available for inclusion within a Transport Product.

~~17~~15 EMIX Warrants

The information model in this section is described in EMIX-WARRANTS.XSD

Warrants are specific assertions about the extrinsic characteristics of EMIX Products that may affect market pricing. Warrants are in effect Product ~~artifacts~~Artifacts as defined in EMIX. Warrants are extensions of the Product Descriptions type that are applied the Intervals in a Schedule. There may be zero Intervals in a Product if the unchanged product description applies to all.

The Intervals in a ~~warrant~~Warrant may differ from those of the Product on the outside of the envelope.

Some ~~warrants~~Warrants may be applicable only in certain jurisdictions. For example, in ~~today's energy markets (~~2011~~)~~ energy warranted as renewable in the Pacific Northwest can include hydropower. Energy markets in California exclude hydropower from their definition of renewable power. Credits or mandates for renewable energy in California are not met by Products warranted as renewable in the Pacific Northwest.

Some ~~warrants~~Warrants may be separable from the underlying energy. For example, a Warrant that energy is generated by a source that is certified as "green" by an authority, may be issued a "green certificate". In some markets, such a certificate can be traded separately. ~~warrant that energy is generated by a source that is certified as "green" by an authority, may be issued a "green certificate". In some markets, such a certificate can be traded separately.~~ The detailed specification of ~~warrants~~Warrants is not part of version 1.0 of this specification.

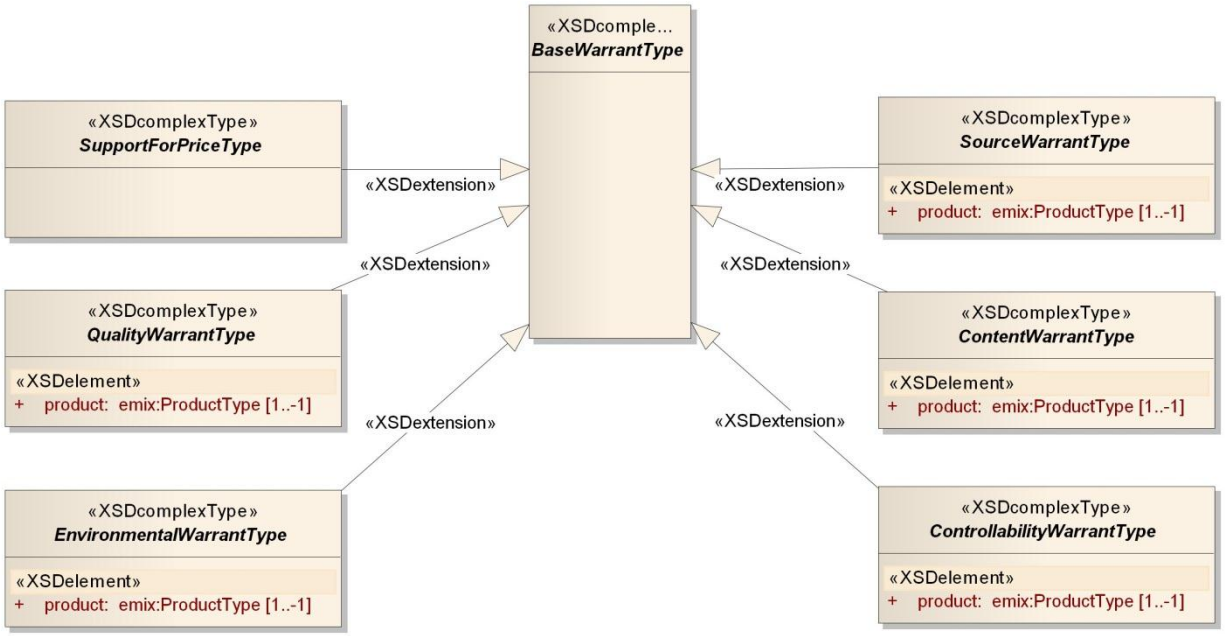


Figure 15-1: UML Summary of Warrants

15.1 Warrants Described

~~17.1~~ Warrant Types are abstract types defined in this specification for extension and definition elsewhere. Conforming information exchanges can include schema types derived from these types.~~Warrant List Definition~~

~~Warrant Types are abstract types defined in this specification for extension and definition elsewhere. Conforming information exchanges can include schema types derived from these types.~~

Table 15-1: Warrant Types

~~Warrant Type~~	~~Note~~
~~**Product Quality**~~	~~If during an offer, can be a promise of quality. If during verification, and be actual measurements. If during an indication of interest, might be a minimum standard.~~

Warrant Type	Descriptions
Product Quality	Assertion of quality. Examples include: If during an offer, can be a promise of quality. If during verification, can be actual measurements. If during an indication of interest, might be a minimum standard.
Environmental Warrant	Quantifies the environmental burden created during the generation of the electric power.
Content Warrant	The proportion of the product defined that is from non-fossil fuel sources, including but not limited to “hydroelectric”, “nuclear”, “solar”, and “wind”.
Source Warrant	The product source. In aggregate may be the same as a Content Warrant.
Controllability Warrant	Assertion that a Resource referenced on the face of the envelope can be controlled and/or operated by or to some standard.

~~**Content Warrant**~~	~~The proportion of the product defined that is from non-fossil fuel sources, including but not limited to “hydroelectric”, “nuclear”, “solar”, and “wind”.~~
~~**Source Warrant**~~	~~In aggregate may be the same as a Warrant Content~~
~~**Controllability Warrant**~~	~~Assertion that a Resource referenced on the face of the envelope can be controlled and/or operated by or to some standard.~~

16 Power Quality

The information model in this section is described in POWER-QUALITY.XSD.

Higher quality power can obtain a market premium. A buyer willing to accept lower quality power may be able to obtain it at lower expense. Power qualities must be measurable, discrete, and allow buyers and sellers to make choices. They must also be auditable and measurable by a specific defined protocol, so performance can be compared to promise.

16.1 Power Quality Warrant

There are numerous protocols for determining power quantity, and often more than one name for the same quality. Assertions about Power Quality must be qualified with what protocol is being used, and must be able to specify the period or periods to which they refer.

The Power Quality Warrant is similar to the EMIX Base. As an extension to the EMIX Base, it holds a schedule, which can be populated with Quality Assertions. A Quality Assertion is a collection of Quality Statements that apply for an Interval.

Table 16-1: Elements of the Power Quality Warrant

Product Element	Description
Quality Warrant	See Table 15-1: Warrant Types
Power Quality Type	An enumerated string that about the origins of the Warrant. Defined enumerations are Guaranteed, Measured, Projected, Average.
Measurement Protocol	A string containing an identification of the standard or other protocol used to measure power quality.
Schedule	Sequence populated by a Power Quality Description.
Side	Buy or Sell, as defined in *Table 3-5: Simple Semantic Elements of EMIX.*

The Schedule is populated by Quality Measures. A Quality Measure is a collection of Power Quality Indicators. The Power Quality indicators MUST be recorded as per the requirements and definitions in the Measurement Protocol. The defined Power Quality indicators are in Table 16-3: Power Quality Indicators.

The terminology for characteristics is largely that of **[IEC61000-4-30]** and the generally similar **[Caramia]**. Table 16-2 defines strings for Measurement Protocol in Table 15-3; others may be added by prefixing "x-" as described in Appendix B *"Extensibility in EMIX"*.

Table 16-2: Named Power Quality Protocols

Protocol	Reference
EN 50160	As described in **[EN50160]**
IEEE 1519-2008	As described in **[IEEE1519]**
IEC 61000+2003	A described in **[IEC61000-4-30]**

The power quality indicators are described in Table 16-3. Other Quality Indicators can be defined by deriving from the base Quality Indicator type.

1599 *Table 16-3: Power Quality Indicators*

Name	Description
Measurement Protocol	A string containing an identification of the standard or other protocol used to measure power quality.
Power Frequency	A floating point number describing the measured Power Frequency. Note: users who wish to describe how the frequency varies over time will need to derive their own measure from the base Power Quality type.
Supply Voltage Variations	An unsigned integer count of Supply Voltage Variations during the period.
Rapid Voltage Changes	An unsigned integer count of Rapid Voltage Change events during the period.
Flicker ST	An unsigned integer count of Flicker Short Term events during the period.
Flicker LT	An unsigned integer count of Flicker Long Term events during the period.
Supply Voltage Dips	An unsigned integer count of Supply Voltage Dip events (called Sags in some protocols) during the period.
Short Interruptions	An unsigned integer count of Short Interruption events during the period.
Long Interruptions	An unsigned integer count of Long Interruption events during the period.
Temp Overvoltage	An unsigned integer count of Temporary Overvoltage events during the period.
Supply Voltage Imbalance	An unsigned integer count of Supply Voltage Imbalance events during the period. Not meaningful for DC.
Harmonic Voltage	A floating point number for the Harmonic Voltage during the period. For DC, distortion is with respect to a signal of zero (0) Hz.
Mains Voltage	A floating point number indicating Mains Voltage.
Mains Signaling Voltage	A floating point number indicating Mains Signaling Voltage, relating generally to power line communications systems.

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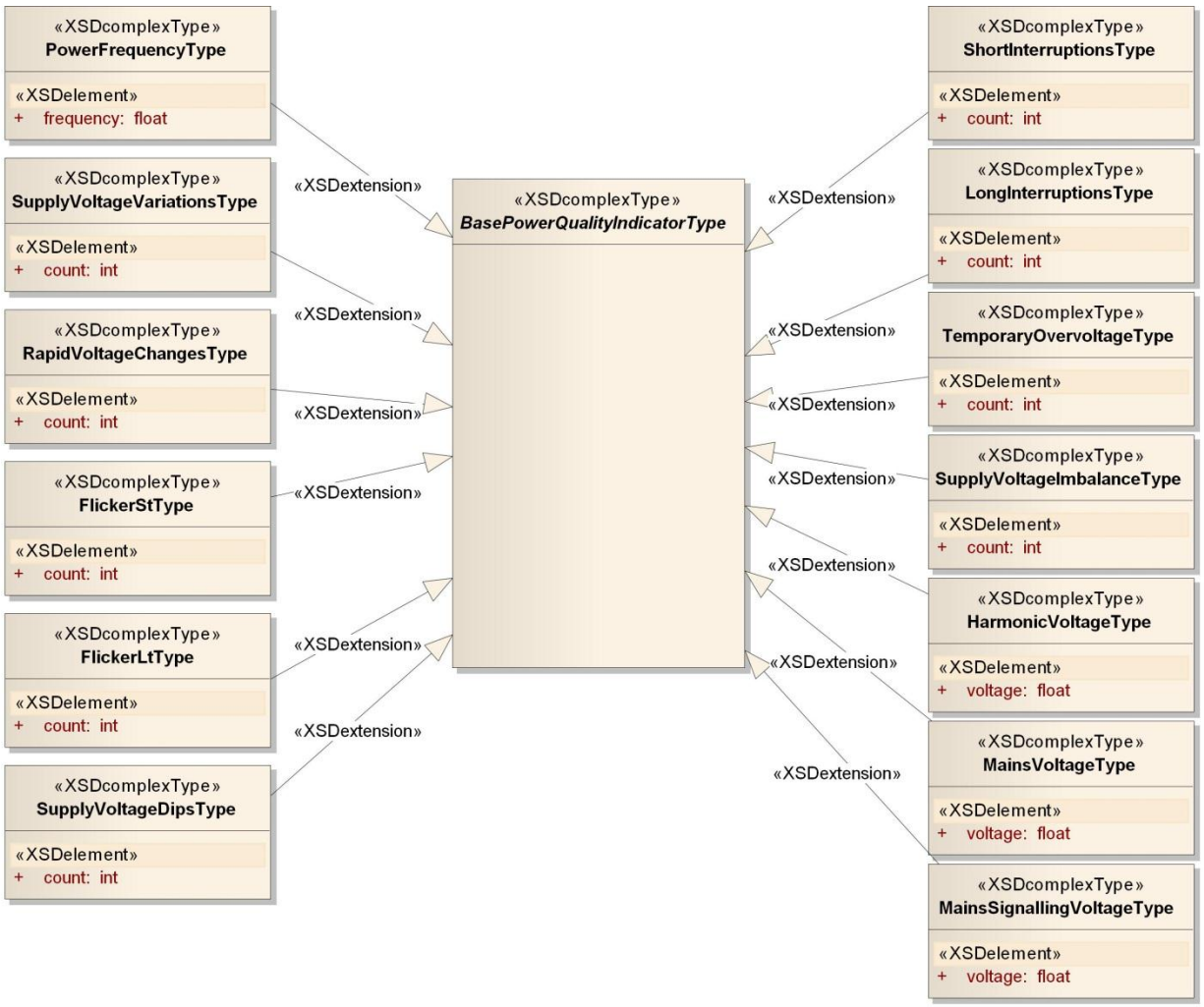
16.2 UML Summary of Power Quality Indicators



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1603 *Figure 16-1: UML Summary of Power Quality Indicators*

~~18~~17 Conformance and Rules for EMIX and Referencing Specifications

This section specifies conformance related to the semantic model of EMIX. EMIX is heavily dependent upon **[WS-Calendar~~,~~]**, and repeatedly incorporates **[WS-Calendar~~-~~]**-based information models.

EMIX ~~artifacts~~Artifacts can be exchanged at any of several stages of a transaction. Necessarily, a tender must be able to accept an incomplete information model while a call for execution must fully define the performance expected. Specifications referencing EMIX SHALL define conformance rules by transaction type and market context.

EMIX ~~Conformance~~ conformance necessarily occurs in two stages. EMIX uses **[WS-Calendar]** to communicate similar ~~intervals~~Intervals that occur over time, each containing an EMIX ~~artifact.~~Artifact. Portions of that ~~artifact~~Artifact may be expressed within the Lineage of the sequence. Applications MUST apply **[WS-Calendar]** Inheritance and then EMIX Inheritance to Compose the information exchange for each ~~interval.~~Interval. Only after Composition, can the EMIX ~~artifact~~Artifact within each Interval of the Sequence be evaluated for conformance and completeness.

~~18.1~~17.1 EMIX Conformance with [WS-Calendar]

EMIX Base are EMIX Products and Resources instantiated through the schedule model of **[WS-Calendar~~,~~]**. As such, EMIX Base SHALL follow **[WS-Calendar]** Conformance rules. These rules include the following conformance types:

- Conformance to the ***inheritance rules*** in **[WS-Calendar~~,~~]**, including the direction of inheritance
- ***Specific attributes*** for each type that MUST or MUST NOT be inherited.
- ***Conformance rules*** that Referencing Specifications MUST follow
- Description of ***Covarying attributes*** with respect to the Reference Specification
- ***Semantic Conformance*** for the information within the ~~artifacts~~Artifacts exchanged.

EMIX Products and Resources also extend the Inheritance patterns of **[WS-Calendar]** to include the EMIX information model. We address each of these in the following sections.

~~18.1.1~~17.1.1 Inheritance in EMIX Base

~~In this section we recapitulate the~~The rules that define inheritance, including direction in **[WS-Calendar]**, are recapitulated.

I1: Proximity Rule Within a given lineage, inheritance is evaluated though each Parent to the Child before what the Child bequeaths is evaluated.

I2: Direction Rule Intervals MAY inherit attributes from the nearest ~~gluon~~Gluon subject to the Proximity Rule and Override Rule, provided those attributes are defined as Inheritable.

I3: Override Rule If and only if there is no value for a given attribute of a Gluon or Interval, that Gluon or Interval SHALL inherit the value for that attribute from its nearest Ancestor in conformance to the Proximity Rule.

I4: Comparison Rule Two Sequences are equivalent if a comparison of the respective Intervals succeeds as if each Sequence were fully Bound and redundant Gluons are removed.

I5: Designated Interval Inheritance [To facilitate composition of Sequences] the Designated Interval in the ultimate Ancestor of a Gluon is the Designated Interval of the composed Sequence. Special conformance rules for Designated Intervals apply only to the Interval linked from the Designator Gluon.

I6: Start Time Inheritance When a start time is specified through inheritance, that start time is inherited only by the Designated Interval; the start time of all other Intervals are computed through the durations and temporal; relationships within the Sequence. The designated Interval is the Interval whose parent is at the end of the lineage.

~~18.1.2~~17.1.2 Specific Attribute Inheritance ~~in~~within EMIX Envelopes

This section refers to EMIX Products, agreements, and Resources as Artifacts. In general, ~~if~~ an ~~artifact~~Artifact of a particular type blocks inheritance of a complete ~~artifact~~Artifact of that type down the lineage.

~~If an Artifacts of the same type exist in both the parent and in the child, the prototypical argument can be discussed two-dimensional tree with branches. Blended inheritance consists of deciding when to graft a branch onto the root.~~

The root node of parent and the child must match for blended inheritance to occur, that is, the roots must be of the same type. The exception is if there are no roots in the child's Artifact, then the root and all its branches are inherited by the child.

If matching roots for the model are found in both the parent and in the child, then each tree should be navigated to determine blended inheritance. The child's artifact may be mostly unpopulated. Within any branch in the child, the first node that is populated blocks all further inheritance on that branch. All nodes deeper ~~in~~into the Artifact than that populated node~~,~~ are determined by the child. When a branch is inherited from the child, it blocks the inheritance of any deeper nodes within that branch.

Specific artifacts may declare rules that break this inheritance pattern. As of now, the exceptions are:

- There are no exceptions.

Inheritance creates a virtual artifact at each level of processing. That virtual ~~artifact~~Artifact is the basis for inheritance for any child ~~artifact~~Artifact.

In EMIX the following attributes MUST NOT be inherited

- UID (Gluons and Intervals)
- Temporal Relationships

Some elements of EMIX are may be ~~**covarying**~~**covariant**, meaning that they change together. Such elements are treated as a single element for inheritance, they ~~are~~ either are inherited together or the child keeps its current values intact. This becomes important if one or more of a ~~covarying~~covariant set have default values. In that case, if any are present, then inheritance should deem they are all present, albeit some perhaps in their default values.

17.2 Time Zone Specification

The time zone MUST be explicitly expressed in any conforming EMIX Artifact.

This may be accomplished in two ways:

- The time, date, or date and time MUST be specified using **[ISO8601]** utc-time (also called *zulu time*)
- The **[WS-Calendar]** Time Zone Identifier, TZID, MUST be in the Lineage of the artifact, as extended by the Standard Terms. See 17.3 below.

If neither expression is included, the Artifact does not conform to this specification and its attempted use in information exchanges MUST result in an error condition.

17.3 Inheritance from Standard Terms

If an Artifact exists within the context of Standard Terms, the artifact inherits from the Standard Terms. Elements that can be inherited from Standard Terms include Product Type, TZID, Currency, and Measurement Units.

~~18.2~~ Inheritance MUST be determined in the manner of Section 17.1.1~~Miscellaneous Business Rules not yet dealt with.~~

~~If the first~~. Rules I1, I2, and I3, that is, that the attribute definition be determined by going to the nearest Gluon in the Lineage containing that attribute, with the addition that if no such Gluon is present then the search continues in the associated Standard Terms.

17.4 Specific Rules for Optimizing Inheritance

1. If the Designated Interval in a ~~series~~Series has a ~~price~~ Price only, all Intervals in the Sequence have a ~~price~~ Price only and there is no ~~price~~Price in the Product.
2. If the ~~first~~Designated Interval in a ~~series~~Series has a ~~quantity~~ Quantity only, all Intervals in the Sequence have a ~~quantity~~ Quantity only and there is no quantity in the Product.
3. If the ~~first~~Designated Interval in a ~~series~~Series has a ~~price & quantity~~Price & Quantity, all Intervals in the Sequence MUST have a Price and Quantity and there is neither Price not Quantity in the Product.

~~All Intervals in a Sequence may be restricted to single service location. What are the rules?~~

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B. Extensibility and EMIX

Extensibility was a critical design constraint for EMIX. Extensibility allows the EMIX specification to be used in markets and in interactions that were not represented on the Technical Committee. Formal extensibility rules also create a set of complaint extensions for incorporation into later versions that are already compliant.

B.1 Extensibility in Enumerated values

EMIX defines a number of enumerations. Some of these, such as measurements of power, are predictably stable. Others, such as market contracts or energy sources, may well have new elements added. In general, these accept any string beginning ~~-~~with "x-" as a legal extension. In particular, these are defined using the following mechanism in the formal schemas (XSD's).

In emix.xsd, the extensibility pattern is~~ defined. This pattern looks like:~~:

```
<xs:simpleType name="EMIXExtensionType">
   <xs:annotation>
         <xs:documentation>Pattern used for extending string enumeration,
where allowed</xs:documentation>
   </xs:annotation>
   <xs:restriction base="xs:string">
         <xs:pattern value="x-\S.*"/>
   </xs:restriction>
</xs:simpleType>
```

~~Non~~An example of non-extensible enumerated types ~~look like this~~is:

```
<xs:simpleType name="PowerOptionTypeEnumeratedType">
   <xs:annotation>
         <xs:documentation>Power Reserve Options</xs:documentation>
   </xs:annotation>
   <xs:restriction base="xs:string">
         <xs:enumeration value="SpinningReserve"/>
         <xs:enumeration value="NonSpinningReserve"/>
         <xs:enumeration value="OperatingReserve"/>
         <xs:enumeration value="DemandResponse"/>
   </xs:restriction>
</xs:simpleType>
```

The enumerations used in the ~~specifications look like~~specification follow this~~.~~ pattern:.

```
   <xs:element name="powerOptionType" type="power:PowerOptionTypeType"/>
   <xs:simpleType name="PowerOptionTypeType">
         <xs:union memberTypes="power:PowerOptionTypeEnumeratedType
emix:EmixExtensionType"/>
   </xs:simpleType>
```

This pattern has been followed throughout EMIX, allowing any string beginning "~~X~~x-" to be a legal extension ~~numeration~~enumeration for EMIX enumerated strings.

Some extensible enumerated types ~~are planned~~assume they will be used for extension. For example, the means of ~~measurement~~measurements for power quality ~~are defined~~enumerate specific testing protocols. As of this writing, there are only two testing protocols in the specification.

```
   <xs:simpleType name="MeasurementProtocolEnumeratedType">
         <xs:restriction base="xs:string">
               <xs:enumeration value="EN 50160"/>
               <xs:enumeration value="IEEE 1549-2009"/>
         </xs:restriction>
```

```
   </xs:simpleType>
```

We anticipateIt is anticipated that other protocols will be used. In this case, we use the suffix ""EnumeratedType""is used to allow for the possibility of other Measurement Protocols that are not enumerated. Actual compliance, though, is based upon the type:

```
   <xs:simpleType name="MeasurementProtocolType">
         <xs:union memberTypes="power:MeasurementProtocolEnumeratedType
emix:EMIXExtensionType"/>
   </xs:simpleType>
```

That is, valid values for the measurement protocol are the enumerated values, and any that match the extension pattern "x-*"

EMIX defines extensibility for the following values:

- [Quality] Measurement Protocol
- Contract Type
- Option Type
- Power Option Type
- Resource Type

B.2 Extension of Structured Information Collective Items

EMIX anticipates adding some information structures that are more complex than simple strings that can also be extended as well. A challenge for these items is that they are more complicated and so require formal definition. Formal definitions, expressed as additions to schema, could require changes to the specification. Without formal definition, it is difficult for trading partners to agree on valid information exchanges.

EMIX uses abstract classes for many information exchanges. For example, trading partners could agree on the exchange of larger or smaller lists of quality measures. Many measures of power quality are defined in power-quality.xsd. Quality consists of an array of elements that are derived from the abstract base quality element.

```
<xs:complexType name="PowerQualityType">
   <xs:annotation>
         <xs:documentation>Power Quality consists of a number of measures,
based on contract, negotiation, and local regulation. Extend Power Quality to
incorporate new elements by creating additional elements based on
PowerQualityBaseType</xs:documentation>
   </xs:annotation>
   <xs:sequence>
   <xs:element name="measurementProtocol"
type="power:MeasurementProtocolType"/>
         <xs:element name="constraints" type="power:ArrayOfPowerQualities"/>
   </xs:sequence>
</xs:complexType>
```

A practitioner who wanted to add an additional quality type would need to develop a description and instantiation of that type based on the abstract base, similar to that used below. The implementation refers to the substitution group:

```
<xs:element name="supplyVoltageVariations"
type="power:SupplyVoltageVariationsType"
substitutionGroup="power:basePowerQualityMeasurement"/>
```

and the type extends the abstract base class BasePowerQualityMeaurementType:

```
<xs:complexType name="SupplyVoltageVariationsType" mixed="false">
   <xs:complexContent mixed="false">
```

```
        <xs:extension base="power:BasePowerQualityMeasurementType">
              <xs:sequence>
                    <xs:element name="count" type="xs:int"/>
              </xs:sequence>
        </xs:extension>
   </xs:complexContent>
</xs:complexType>
```

The resulting schema, which references the approved EMIX schemas, but does not change them, can then be distributed to business partners to validate the resulting information exchanges. The core EMIX types, which are used throughout the specifications herein, can be extended this way, including:

- **EMIX Base Type**: iCalendar-derived object to host EMIX Product Descriptions
- **Product Description Type**: In EMIX, the Product Description is the basis for all Resources and Product Descriptions.
- **Item Base**: Abstract base class for units for EMIX Product delivery, measurement, and ~~warrants.~~Warrants. Item does not include Quantity or Price, because a single product description or transaction may have multiple quantities or prices associated with a single item.
- **EMIX Interface**: Abstract base class for the interfaces for EMIX Product delivery, measurement, and/or pricing.

The following additional abstract types are among those designed with extension by practitioners in mind:

- **BasePowerQualityMeauremementType**: the basis for exchanging measurements of power quality
- ~~**BaseConstraintType**~~**BaseTermType**: used to express ~~constraints~~Terms on the performance of equipment exposed to the market as Resources
- **BaseRequirementType**: used to express the market or business requirements of a trading partner.
- **BaseWarrantType**: the root for all ~~warrants~~Warrants delivered with the energy product.

C. Semantics from WS-Calendar

Certain terms appear throughout this document that are defined in **[WS-Calendar]**. This section provides summary definitions for the convenience of the reader and reviewer. Nothing in this table replaces or over-rides the normative definitions in that specification.

Table C--: WS-Calendar Foundational Semantics

Time Segment	Definition
Duration	Duration is the length of an event scheduled using iCalendar or any of its derivatives.
Interval	The Interval is the core component of duration and sequence. Parties make Agreements for delivery of EMIX-described products during an Interval.
Sequence	A Sequence is a set of Intervals with defined temporal relationships. Sequences may have gaps between Intervals, or even simultaneous activities. A Sequence may be re-locatable, i.e., it does not require a specific date and time. A Sequence may consist of a single Interval. A Sequence MAY include a Lineage.
Partition	A Partition is a set of consecutive Intervals. The Partition includes the trivial case of a single Interval. Many energy negotiations apply an EMIX product to a partition, e.g., consecutive fifteen minute Intervals.
Gluon	A Gluon is influences the serialization of Intervals in a Sequence, though inheritance and through schedule setting. The Gluon is similar to the Interval, but has no service or schedule effects until applied to an Interval or Sequence. A Gluon also defines a handle for invoking a sequence within a service.
Artifact	An Artifact is the thing that occurs during an Interval. The contents of the Artifact are not specified in WS-Calendar, rather the Artifact provides an extension base for the use of WS-Calendar in other specifications. EMIX product and performance Artifacts may inherit elements as do Intervals within a Sequence.

Much of EMIX defines the payloads that are delivered in the artifact. WS-Calendar defines how schedule-related information, although incomplete in an Interval and Sequence can be modified and completed. WS-Calendar calls this process Inheritance and specifies a number of rules that govern Inheritance. EMIX artifacts define Inheritance in manner compliant with WS-Calendar. defines the terms used to describe inheritance.

Table C--: WS-Calendar Semantics of Inheritance

Term	Definition
Parent	A Gluon that points to a sequence is known as the sequence's Parent. A Gluon may alternately reference another Gluon, i.e., it is that other Gluon's Parent.
Lineage	Lineage refers to the full ordered set of Parents of a Sequence

Term	Definition
Inheritance	Parents bequeath information to Children that inherit them. If a child does not already possess that information, then it accepts the inheritance. Information specified in one informational object is considered present in another that is itself lacking expression of that information. This information is termed the Inheritance of that object.
Bequeath	A Parent Bequeaths attributes (Inheritance) to its Children
Inherit	A Child Inherits attributes (Inheritance) from its Parent
Availability	Availability expresses the range of times in which an Interval or Sequence can be Scheduled. Availability can overlay or be overlaid by Busy. Availability can be Inherited
Busy	Busy expresses the range of times in which an Interval or Sequence cannot be Scheduled. Busy can overlay or be overlaid by Availability. Busy can be Inherited

As Intervals are processed, as Intervals are assembled, and as inheritance is processed, the information conveyed about each element changes. EMIX artifacts may pass through several stages in which the information is not yet complete or actionable, but is still a conforming expression of time and Sequence. defines the terms used when discussing the processing or processability of Intervals and Sequences.

Table -: WS-Calendar Semantics of Information Processing

Term	Definition
Bound	As in mathematical logic where a metasyntactic variable is called "bound", an Interval, Sequence, or Partition is said to be Bound when the values necessary to execute it (as a service) are completely filled in.
Partially Bound	A Partially Bound Interval is one that is still not Bound after receiving its Inheritance. A Sequences or Partitions is Partially Bound if it contains at least one Interval that is Partially Bound.
Unbound	An Unbound Interval or Sequence is not itself complete, but must still receive inheritance to be fully specified. A Sequences or Partitions is Unbound if it contains at least one Interval that is Unbound.
Fully Bound	A synonym for Bound
Scheduled	A Sequence or Partition is said to be Scheduled when it is Anchored, Fully Bound, and service performance has been requested.
Unscheduled	An Interval is Unscheduled if its neither its begin date and time nor its end date and time have been set. A Sequence or Partition is Unscheduled if none of its Intervals, after when Fully Bound, is Scheduled.
Designated Interval	In a Sequence the Designated `Interval` is either (a) (if there are no Gluons related to the Sequence) one of the Earliest Interval(s), or (b) (if there is at least one Gluon related to the Sequence) the single Interval referenced by a Gluon as Parent.
Composed Interval	A Composed Interval is the virtual Interval specified by applying inheritance through the entire lineage and into the Sequence in accord with the inheritance rules. A Composed Interval may be Bound or Unbound.

Term	Definition
Composed Sequence	A Composed Sequence is the virtual Sequence specified by applying inheritance through the entire lineage and into the Sequence in accord with the inheritance rules. A Composed Sequence may be Bound or Unbound.

The WS-Calendar defines more terms, and in greater detail, but the tables above are sufficient to be able to discuss schedule, sequence, and inheritance in EMIX.

~~D.~~C. Electrical Power and Energy

Each type of Electrical Power and Energy Product has its own definitions and its own descriptive parameters. These ~~artifacts~~Artifacts are the specific descriptions relevant to defining the potential utility of the power and energy Product. The Power and Energy Artifacts describe the intrinsic information. There may be cases when an Artifact is held in the envelope contents, perhaps as informational support for the intrinsic prices.

To put the terms "Power" and "Energy" into the proper context for this specification, the following definitions will be used:

- Apparent Energy: the production or consumption of Apparent Power over time; unit: volt-ampere hours~~,~~; abbreviation: VAh
- Apparent Power (S): mathematical product of root-mean-square voltage and root-mean-square current, vector sum of Real Power and Reactive Power, square root of sum of squares of Real Power and Reactive Power; unit: volt-ampere~~,~~; abbreviation: VA
- Current: flow of electric charge, or rate of flow of electric charge; unit: ampere~~,~~; abbreviation: A
- Energy: the production or consumption of Power over time.
- Power Factor ~~(p.f.):~~: ratio of Real Power to Complex Power, cosine of the phase angle between Current and Voltage, expressed as a number between 0 and 1, expressed as a percentage (i.e., 50% = 0.5); unit: dimensionless; abbreviation: p.f.
- Power Triangle: the mathematic relationship between the Apparent Power (S), the Real Power (P) and the Reactive Power (Q) where S = sqrt(P*P + Q*Q).
- Reactive Energy: the production or consumption of Reactive Power over time; unit: volt-ampere-reactive hours~~,~~; abbreviations: VARh, VArh, VA-rh, varh
- Reactive Power (Q): mathematical product of the root-mean-square voltage and root-mean-square current multiplied by the sine of the angle between the voltage and current; unit: volt-amperes reactive~~,~~; abbreviations: VAR, VAr, VA-r, var
- Real Energy: the production or consumption of Real Power over time; unit: Watt-hour~~,~~; abbreviation: Wh
- Real Power (P): rate at which electricity is produced or consumed, mathematical product of Voltage and Current; unit: Watt~~,~~; abbreviation: W
- Voltage: difference in electric potential between two points; unit: volt, ~~V~~abbreviation: V

Generically, the use of the term "Power" refers to "Real Power" and is expressed in Watts. Otherwise, one talks of Apparent Power in VA, or Reactive Power in VARs. Generically, the use of the term "Energy" refers to "Real Energy" and is expressed in Watt-hours. Otherwise, ~~on~~one talks of Apparent Energy in ~~VAh~~VArh, or Reactive Energy in ~~VARh~~VArh.

~~Generically, the use of the term “Power” refers to “Real Power” and is expressed in Watts. Otherwise, one talks of Apparent Power or Complex Power in VA, or Reactive Power in VARs.~~

~~E.~~D. Mapping between NAESB PAP03 work and this specification

Under the **[NIST]**-led smart grid interoperability process, the North American Energy Standards Board (NAESB) provided a minimal scope and requirements for this specification, specifically in its work to address the Priority Action Plan 03 (PA03), Price and Product definition. This section maps the specific requirements from NAESB to the work in this specification.

Table E-1

: Mapping between NAESB PAP03 and this work

Tariff Rate Type	Description
block rate	In ~~Power-Contracts.xsd~~POWER-CONTRACTS.XSD, addressed by the Block Power Full Requirements Contract.
critical peak price	Addressed by both Price Relative and Price Multiplier when applies to a business schedule.
demand rate	Demand charges can be applied to all Product types in EMIX.
day ahead market rate	Either ~~TEMIX~~TeMIX or a Block Power agreement applied to a day-ahead schedule addresses this need.
market clearing price for energy	~~TEMIX~~TeMIX addresses this use case directly.
peak time rebate	Peak Time Rebates can be handled by TeMIX Transactions
real time price rate	Either ~~TEMIX~~TeMIX or a Block Power agreement applied to a day-ahead schedule addresses this need.
time of use rate	Either ~~TEMIX~~TeMIX or a Block Power agreement applied to a day-ahead schedule addresses this need. EMIX applied alongside any of the standard agreements can support variable peak pricing.
variable peak pricing	~~TEMIX~~TeMIX applied alongside any of the standard products can support variable peak pricing.

F. Schemas (Non-Normative)

In OASIS, when there are external, machine-readable artifacts, they are always normative. These are placed here as a convenience to the reviewer.

If you are tracing inheritance, and the construction of EMIX information through the schemas, recall that every EMIX Product is derived from **EMIX Base** which is a Business Schedule applied to a Product **Description**. All transactions occur at the EMIX Interface. Products are described and enumerated using extensions of the Item Base.

F.1 EMIX Schemas

The EMIX Schema is in three parts

F.1.1 EMIX.XSD

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- emix.xsd
Schema Set for OASIS EMIX 1.0 WD23 (20110411)
Set includes:
   EMIX, EMIX-Requirements, EMIX-Warrants (emix)
   Power, Power-Contracts, Power-Quality (power)
   Resource (resource)

This set built on the WS-Calendar v1.0 PRD02 Schemas.
-->
<!-- 1.0 EMIX: Energy Market Information Exchange-->
<xs:schema xmlns:emix="http://docs.oasis-open.org/ns/emix"
xmlns:xcal="urn:ietf:params:xml:ns:icalendar-2.0"
xmlns:clm5ISO42173A="urn:un:unece:uncefact:codelist:standard:5:ISO42173A:2010-04-07"
xmlns:gml="http://www.opengis.net/gml/3.2"
xmlns:gmlsf="http://www.opengis.net/gmlsf/2.0"
xmlns:xs="http://www.w3.org/2001/XMLSchema" targetNamespace="http://docs.oasis-
open.org/ns/emix" elementFormDefault="qualified" attributeFormDefault="unqualified">
   <xs:include schemaLocation="emix-requirements.xsd"/>
   <xs:include schemaLocation="emix-warrants.xsd"/>
   <xs:import namespace="urn:ietf:params:xml:ns:icalendar-2.0"
schemaLocation="http://docs.oasis-open.org/ws-calendar/ws-calendar-
spec/v1.0/csprd02/xsd/iCalendar.xsd"/>
   <xs:import namespace="urn:ietf:params:xml:ns:icalendar-2.0"
schemaLocation="http://docs.oasis-open.org/ws-calendar/ws-calendar-
spec/v1.0/csprd02/xsd/iCalendar-wscal-extensions.xsd"/>
   <xs:import namespace="urn:ietf:params:xml:ns:icalendar-2.0"
schemaLocation="http://docs.oasis-open.org/ws-calendar/ws-calendar-
spec/v1.0/csprd02/xsd/iCalendar-availability-extension.xsd"/>
   <xs:import namespace="urn:un:unece:uncefact:codelist:standard:5:ISO42173A:2010-04-07"
schemaLocation="http://www.unece.org/uncefact/codelist/standard/ISO_ISO3AlphaCurrencyCod
e_20100407.xsd"/>
   <xs:import namespace="http://www.opengis.net/gml/3.2"
schemaLocation="http://schemas.opengis.net/gml/3.2.1/gml.xsd"/>
   <!-- 1.0 Core EMIX objects-->
   <xs:annotation>
      <xs:appinfo
source="http://schemas.opengis.net/gml/3.2.1/profiles/gmlsfProfile/2.0/gmlsfLevels.xsd">
         <gmlsf:ComplianceLevel>0</gmlsf:ComplianceLevel>
      
   <gmlsf:GMLProfileSchema>http://schemas.opengis.net/gml/3.2.1/profiles/gmlsfProfile/2.
0/gmlsf.xsd</gmlsf:GMLProfileSchema>
      </xs:appinfo>
   </xs:annotation>
   <!-- 1.1 EMIX Product -->
   <xs:element name="product" type="emix:ProductType">
      <xs:annotation>
         <xs:documentation>Emix Product, .i.e., a Product Description applied
to a schedule.</xs:documentation>
```

```
            </xs:annotation>
    </xs:element>
    <xs:complexType name="ProductType" mixed="false">
            <xs:annotation>
                    <xs:documentation>EMIX Product Type, i.e. a Product Description
applied to a Schedule</xs:documentation>
            </xs:annotation>
            <xs:complexContent mixed="false">
                    <xs:extension base="emix:EmixBaseType">
                            <xs:sequence>
                                    <xs:element ref="emix:currency"/>
                                    <xs:element ref="emix:marketContext"/>
                                    <xs:element ref="emix:transactiveState"/>
                                    <xs:element ref="emix:side"/>
                                    <xs:element ref="emix:constraints"/>
                            </xs:sequence>
                    </xs:extension>
            </xs:complexContent>
    </xs:complexType>
    <!-- 1.2 EMIX Option -->
    <xs:element name="emixOption" type="emix:EmixOptionType">
            <xs:annotation>
                    <xs:documentation>Option to buy an Emix Product</xs:documentation>
            </xs:annotation>
    </xs:element>
    <xs:complexType name="EmixOptionType" mixed="false">
            <xs:complexContent mixed="false">
                    <xs:extension base="emix:EmixBaseType">
                            <xs:sequence>
                                    <xs:element ref="emix:transactiveState"/>
                                    <xs:element name="optionExerciseSchedule"
type="emix:BusinessScheduleType"/>
                                    <xs:element name="optionHolderSide"
type="emix:SideType"/>
                                    <xs:element name="optionPremium"
type="emix:PriceType"/>
                                    <xs:element name="optionExerciseLeadTime"
type="xcal:DurationPropType"/>
                                    <xs:element name="optionStrikePrice"
type="emix:PriceType"/>
                                    <xs:element ref="emix:optionType"/>
                                    <xs:element ref="emix:side"/>
                                    <xs:element ref="emix:marketContext"/>
                                    <xs:element ref="emix:currency"/>
                                    <xs:element ref="emix:constraints"/>
                            </xs:sequence>
                    </xs:extension>
            </xs:complexContent>
    </xs:complexType>
    <!-- 1.3 EMIX TEMIX -->
    <xs:element name="temix" type="emix:TemixType">
            <xs:annotation>
                    <xs:documentation>minimalist Energy Market Information Exchange (EMIX)
Type</xs:documentation>
            </xs:annotation>
    </xs:element>
    <xs:complexType name="TemixType" mixed="false">
            <xs:complexContent mixed="false">
                    <xs:extension base="emix:EmixBaseType">
                            <xs:sequence>
                                    <xs:element ref="emix:currency"/>
                                    <xs:element ref="emix:transactiveState"/>
                                    <xs:element ref="emix:constraints"/>
                                    <xs:element ref="emix:side"/>
                                    <xs:element name="expires" type="xs:dateTime"
minOccurs="0" maxOccurs="1"/>
                            </xs:sequence>
                    </xs:extension>
            </xs:complexContent>
    </xs:complexType>
    <!-- 1.4 Delivery -->
```

```
    <xs:element name="delivery" type="emix:DeliveryType"/>
    <xs:complexType name="DeliveryType" mixed="false">
          <xs:annotation>
                <xs:documentation>Receipt / Report of Product Delivery. Injection flag
is true for adding product to market supply, false for taking from
market.</xs:documentation>
          </xs:annotation>
          <xs:complexContent mixed="false">
                <xs:extension base="emix:EmixBaseType">
                      <xs:sequence>
                            <xs:element name="injection" type="xs:boolean"/>
                      </xs:sequence>
                </xs:extension>
          </xs:complexContent>
    </xs:complexType>
    <!-- 2.0 EMIX Components-->
    <!-- 2.1 Envelope -->
    <xs:element name="envelopeContents" type="emix:EnvelopeContentsType"/>
    <xs:complexType name="EnvelopeContentsType">
          <xs:sequence>
                <xs:element ref="emix:warrants" minOccurs="0" maxOccurs="1"/>
          </xs:sequence>
    </xs:complexType>
    <!-- 8.0 Supporting Information Structures-->
    <!-- 8.2 Market defintions -->
    <!-- 8.2.1 Market Context -->
    <xs:element name="marketContext" type="emix:MarketContextType"/>
    <xs:simpleType name="MarketContextType">
          <xs:restriction base="xs:anyURI"/>
    </xs:simpleType>
    <!-- 8.2.2 Transactive State -->
    <xs:element name="transactiveState" type="emix:TransactiveStateType"/>
    <xs:simpleType name="TransactiveStateType">
          <xs:restriction base="xs:string">
                <xs:enumeration value="IndicationOfInterest"/>
                <xs:enumeration value="Tender"/>
                <xs:enumeration value="Transaction"/>
                <xs:enumeration value="Exercise"/>
                <xs:enumeration value="Delivery"/>
                <xs:enumeration value="TransportCommitment"/>
                <xs:enumeration value="Publication"/>
          </xs:restriction>
    </xs:simpleType>
    <!-- 8.2.3 Currency -->
    <xs:element name="currency" type="clm5ISO42173A:ISO3AlphaCurrencyCodeContentType">
          <xs:annotation>
                <xs:documentation>Currency codes coming from UN CEFACT
schemas</xs:documentation>
          </xs:annotation>
    </xs:element>
    <!-- 8.2.4 Enumeration for Side -->
    <xs:element name="side" type="emix:SideType"/>
    <xs:simpleType name="SideType">
          <xs:restriction base="xs:string">
                <xs:enumeration value="Buy"/>
                <xs:enumeration value="Sell"/>
          </xs:restriction>
    </xs:simpleType>
    <!-- 8.3 Price -->
    <xs:element name="priceBase" type="emix:PriceBaseType" abstract="true">
          <xs:annotation>
                <xs:documentation>Abstract base for EMIX Prices</xs:documentation>
          </xs:annotation>
    </xs:element>
    <xs:complexType name="PriceBaseType" abstract="true">
          <xs:annotation>
                <xs:documentation>Type of Abstract base for EMIX
Prices</xs:documentation>
          </xs:annotation>
    </xs:complexType>
    <!-- 8.3.1 Absolute Price -->
```

```
    <xs:element name="price" type="emix:PriceType" substitutionGroup="emix:priceBase"/>
    <xs:complexType name="PriceType" mixed="false">
        <xs:annotation>
            <xs:documentation>Simple Price</xs:documentation>
        </xs:annotation>
        <xs:complexContent mixed="false">
            <xs:extension base="emix:PriceBaseType">
                <xs:sequence>
                    <xs:element ref="emix:value" minOccurs="1"
maxOccurs="1"/>
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
    <!-- 8.3.2 Multiplier Price - multiplier on base amount  -->
    <xs:element name="priceMultiplier" type="emix:PriceMultiplierType"
substitutionGroup="emix:priceBase"/>
    <xs:complexType name="PriceMultiplierType" mixed="false">
        <xs:annotation>
            <xs:documentation>Multiplier times market price, 1 for same as
market</xs:documentation>
        </xs:annotation>
        <xs:complexContent mixed="false">
            <xs:extension base="emix:PriceBaseType">
                <xs:sequence>
                    <xs:element name="multiplier" type="xs:float"
minOccurs="1" maxOccurs="1"/>
                    <xs:element ref="emix:marketContext" minOccurs="0"
maxOccurs="1">
                        <xs:annotation>
                            <xs:documentation>Market Context for
base price. If blank, Market Context from hosting artifact.</xs:documentation>
                        </xs:annotation>
                    </xs:element>
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
    <!-- 8.3.4 Price Offset (additive or subtractive) over base amount  -->
    <xs:element name="priceRelative" type="emix:PriceRelativeType"
substitutionGroup="emix:priceBase"/>
    <xs:complexType name="PriceRelativeType" mixed="false">
        <xs:annotation>
            <xs:documentation>Price Relative is a fixed charge (positive or
negative) apllied to base price</xs:documentation>
        </xs:annotation>
        <xs:complexContent mixed="false">
            <xs:extension base="emix:PriceBaseType">
                <xs:sequence>
                    <xs:element ref="emix:value" minOccurs="1"
maxOccurs="1"/>
                    <xs:element ref="emix:marketContext" minOccurs="0"
maxOccurs="1">
                        <xs:annotation>
                            <xs:documentation>Market Context for
base price. If blank, Market Context from hosting artifact.</xs:documentation>
                        </xs:annotation>
                    </xs:element>
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
    <!-- 8.3.6 Simple Price  -->
    <xs:element name="value" type="emix:valueType"/>
    <xs:simpleType name="valueType">
        <xs:restriction base="xs:decimal"/>
    </xs:simpleType>
    <!-- 8.5 Quantity -->
    <xs:element name="integralOnly" type="emix:IntegralOnlyType"/>
    <xs:simpleType name="IntegralOnlyType">
        <xs:annotation>
```

```
                    <xs:documentation>integralOnly is an element used in many EMIX objects
distinguishing between an (amount, response, ramp) that is all (true) or nothing
(false)</xs:documentation>
          </xs:annotation>
          <xs:restriction base="xs:boolean"/>
    </xs:simpleType>
    <xs:element name="autonomous" type="emix:AutonomousType"/>
    <xs:simpleType name="AutonomousType">
          <xs:annotation>
                    <xs:documentation>An autonomous resource or service (true) is able to
respond or maintain service independently. A non autonomous service (false) must await
dispatch.</xs:documentation>
          </xs:annotation>
          <xs:restriction base="xs:boolean"/>
    </xs:simpleType>
    <!-- 8.7 Enumeration for Option Types -->
    <xs:element name="optionType" type="emix:OptionTypeType"/>
    <xs:simpleType name="OptionTypeType">
          <xs:union memberTypes="emix:OptionTypeEnumeratedType
emix:EmixExtensionType"/>
    </xs:simpleType>
    <xs:simpleType name="OptionTypeEnumeratedType">
          <xs:annotation>
                    <xs:documentation>Enumerated Option Types</xs:documentation>
          </xs:annotation>
          <xs:restriction base="xs:string"/>
    </xs:simpleType>
    <!-- 8.8 Performance Constraints -->
    <!-- 9.2 Abstract EMIX Base(product applied to a schedule) -->
    <xs:element name="emixBase" type="emix:EmixBaseType"/>
    <xs:complexType name="EmixBaseType" abstract="true">
          <xs:annotation>
                    <xs:documentation>iCalendar-derived object to host EMIX
elements</xs:documentation>
          </xs:annotation>
          <xs:complexContent>
                    <xs:extension base="xcal:VcalendarType">
                              <xs:sequence>
                                        <xs:element ref="emix:envelopeContents" minOccurs="0"
maxOccurs="1"/>
                              </xs:sequence>
                    </xs:extension>
          </xs:complexContent>
    </xs:complexType>
    <!-- 9.3 Abstract Product  Description -->
    <xs:element name="productDescription" type="emix:ProductDescriptionType"
substitutionGroup="xcal:artifactBase"/>
    <xs:complexType name="ProductDescriptionType" abstract="true">
          <xs:annotation>
                    <xs:documentation>In EMIX, the Product Description is placed in the
Interval or Gluon attachment. The respective product schemas extend this abstract
class.</xs:documentation>
          </xs:annotation>
          <xs:complexContent>
                    <xs:extension base="xcal:ArtifactBaseType"/>
          </xs:complexContent>
    </xs:complexType>
    <!-- 9.4 Interfaces  -->
    <xs:element name="serviceArea" type="emix:ServiceAreaType"
substitutionGroup="emix:emixInterface"/>
    <xs:complexType name="ServiceAreaType">
          <xs:annotation>
                    <xs:documentation>The Service Area is the geographic region that is
affected by the EMIX market condition</xs:documentation>
          </xs:annotation>
          <xs:complexContent>
                    <xs:extension base="emix:EmixInterfaceType">
                              <xs:sequence>
                                        <xs:element ref="emix:geographicArea"/>
                              </xs:sequence>
                    </xs:extension>
```

```
          </xs:complexContent>
    </xs:complexType>
    <xs:element name="emixInterface" type="emix:EmixInterfaceType"/>
    <xs:complexType name="EmixInterfaceType" abstract="true" mixed="false">
          <xs:annotation>
                <xs:documentation>Abstract base class for the interfaces for EMIX
Product delivery, measurement, and/or pricing</xs:documentation>
          </xs:annotation>
    </xs:complexType>
    <!-- 9.5 Geographic Area -->
    <xs:element name="geographicArea" type="emix:GeographicAreaType"
substitutionGroup="gml:AbstractFeature"/>
    <xs:complexType name="GeographicAreaType" mixed="false">
          <xs:annotation>
                <xs:documentation>A service area is a geographic region that may be
affected by the same EMIX market condition.</xs:documentation>
          </xs:annotation>
          <xs:complexContent mixed="false">
                <xs:extension base="gml:AbstractFeatureType">
                      <xs:sequence>
                            <xs:element name="foo"
type="gml:GeometryPropertyType"/>
                      </xs:sequence>
                </xs:extension>
          </xs:complexContent>
    </xs:complexType>
    <!-- 9.6 Business Schedule  -->
    <xs:element name="businessSchedule" type="emix:BusinessScheduleType"/>
    <xs:complexType name="BusinessScheduleType" mixed="false">
          <xs:annotation>
                <xs:documentation>iCalendar-derived business schedule, more variant
than allowed in sequences</xs:documentation>
          </xs:annotation>
          <xs:complexContent mixed="false">
                <xs:extension base="xcal:VavailabilityType"/>
          </xs:complexContent>
    </xs:complexType>
    <xs:element name="duration" type="emix:DurationType"/>
    <xs:complexType name="DurationType" mixed="false">
          <xs:annotation>
                <xs:documentation>iCalendar-derived duration. THis brings in
xcal:duration and xcal:parameters. </xs:documentation>
          </xs:annotation>
          <xs:complexContent mixed="false">
                <xs:extension base="xcal:DurationPropType"/>
          </xs:complexContent>
    </xs:complexType>
    <!-- 9.7 emix Items -->
    <xs:element name="measurement" type="emix:MeasurementType"
substitutionGroup="emix:productDescription"/>
    <xs:complexType name="MeasurementType">
          <xs:annotation>
                <xs:documentation>Type of Measurement</xs:documentation>
          </xs:annotation>
          <xs:complexContent>
                <xs:extension base="emix:ProductDescriptionType">
                      <xs:sequence>
                            <xs:element ref="emix:quantity"/>
                            <xs:element ref="emix:itemBase"/>
                      </xs:sequence>
                </xs:extension>
          </xs:complexContent>
    </xs:complexType>
    <xs:element name="emixGranularity" type="emix:EmixGranularityType"/>
    <xs:complexType name="EmixGranularityType" mixed="false">
          <xs:annotation>
                <xs:documentation>Abstract base class used for graularity of market
indications of interest and tenders</xs:documentation>
          </xs:annotation>
          <xs:sequence>
                <xs:element ref="emix:quantity"/>
```

```
                    <xs:element ref="emix:itemBase"/>
                </xs:sequence>
            </xs:complexType>
            <xs:element name="itemBase" type="emix:ItemBaseType" abstract="true"/>
            <xs:complexType name="ItemBaseType" abstract="true" mixed="false">
                <xs:annotation>
                    <xs:documentation>Abstract base class for units for EMIX Product
delivery, measurement, and warrants. Item as in PO Item, Requisition Item, Invoice Item,
Lading Item. Item does not include Quantity or Price, because a single product
description or transaction may have multiple quantities or prices associated with a
single item.</xs:documentation>
                </xs:annotation>
            </xs:complexType>
            <!-- 9.8 Units and Measurement Abstractions -->
            <xs:element name="quantity" type="emix:QuantityType"/>
            <xs:simpleType name="QuantityType">
                <xs:annotation>
                    <xs:documentation>Base type for all quanties in
EMIX.</xs:documentation>
                </xs:annotation>
                <xs:restriction base="xs:float"/>
            </xs:simpleType>
            <xs:element name="scale" type="emix:SiScaleType"/>
            <xs:simpleType name="SiScaleType">
                <xs:annotation>
                    <xs:documentation>Scale based on representations of SI scale as
expressed in the unit multipliers defined for the CIM</xs:documentation>
                    <xs:documentation xml:lang="en">enumeration</xs:documentation>
                </xs:annotation>
                <xs:restriction base="xs:string">
                    <xs:enumeration value="n">
                        <xs:annotation>
                            <xs:documentation>Nano 10**-9</xs:documentation>
                            <xs:documentation xml:lang="en">enum</xs:documentation>
                        </xs:annotation>
                    </xs:enumeration>
                    <xs:enumeration value="micro">
                        <xs:annotation>
                            <xs:documentation>Micro 10**-6</xs:documentation>
                            <xs:documentation xml:lang="en">enum</xs:documentation>
                        </xs:annotation>
                    </xs:enumeration>
                    <xs:enumeration value="m">
                        <xs:annotation>
                            <xs:documentation>Milli 10**-3</xs:documentation>
                            <xs:documentation xml:lang="en">enum</xs:documentation>
                        </xs:annotation>
                    </xs:enumeration>
                    <xs:enumeration value="c">
                        <xs:annotation>
                            <xs:documentation>Centi 10**-2</xs:documentation>
                            <xs:documentation xml:lang="en">enum</xs:documentation>
                        </xs:annotation>
                    </xs:enumeration>
                    <xs:enumeration value="d">
                        <xs:annotation>
                            <xs:documentation>Deci 10**-1</xs:documentation>
                            <xs:documentation xml:lang="en">enum</xs:documentation>
                        </xs:annotation>
                    </xs:enumeration>
                    <xs:enumeration value="k">
                        <xs:annotation>
                            <xs:documentation>Kilo 10**3</xs:documentation>
                            <xs:documentation xml:lang="en">enum</xs:documentation>
                        </xs:annotation>
                    </xs:enumeration>
                    <xs:enumeration value="M">
                        <xs:annotation>
                            <xs:documentation>Mega 10**6</xs:documentation>
                            <xs:documentation xml:lang="en">enum</xs:documentation>
                        </xs:annotation>
```

```
                </xs:enumeration>
                <xs:enumeration value="G">
                    <xs:annotation>
                        <xs:documentation>Giga 10**9</xs:documentation>
                        <xs:documentation xml:lang="en">enum</xs:documentation>
                    </xs:annotation>
                </xs:enumeration>
                <xs:enumeration value="T">
                    <xs:annotation>
                        <xs:documentation>Tera 10**12</xs:documentation>
                        <xs:documentation xml:lang="en">enum</xs:documentation>
                    </xs:annotation>
                </xs:enumeration>
                <xs:enumeration value="none">
                    <xs:annotation>
                        <xs:documentation xml:lang="en">enum</xs:documentation>
                    </xs:annotation>
                </xs:enumeration>
                <xs:enumeration value="p">
                    <xs:annotation>
                        <xs:documentation>Pico 10**-12</xs:documentation>
                        <xs:documentation xml:lang="en">enum</xs:documentation>
                    </xs:annotation>
                </xs:enumeration>
            </xs:restriction>
    </xs:simpleType>
    <!-- 9.9 Extension Type  -->
    <xs:simpleType name="EmixExtensionType">
            <xs:annotation>
                <xs:documentation>Pattern used for extending string enumeration, where
allowed</xs:documentation>
            </xs:annotation>
            <xs:restriction base="xs:string">
                <xs:pattern value="x-\S.*"/>
            </xs:restriction>
    </xs:simpleType>
</xs:schema>
```

F.1.2 EMIX-Requirements

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- emix.xsd
Schema Set for OASIS EMIX 1.0 WD23 (20110411)
Set includes:
    EMIX, EMIX-Requirements, EMIX-Warrants (emix)
    Power, Power-Contracts, Power-Quality (power)
    Resource (resource)

This set built on the WS-Calendar v1.0 PRD02 Schemas.
-->
<!-- 8.9 Constraints & Requirements -->
<xs:schema xmlns:emix="http://docs.oasis-open.org/ns/emix"
xmlns:xs="http://www.w3.org/2001/XMLSchema"
xmlns:xcal="urn:ietf:params:xml:ns:icalendar-2.0"
xmlns:clm5ISO42173A="urn:un:unece:uncefact:codelist:standard:5:ISO42173A:2010-04-07"
xmlns:gml="http://www.opengis.net/gml/3.2" targetNamespace="http://docs.oasis-
open.org/ns/emix" elementFormDefault="qualified" attributeFormDefault="unqualified">
    <xs:include schemaLocation="emix.xsd"/>
    <xs:element name="constraints" type="emix:ConstraintsType"/>
    <xs:complexType name="ConstraintsType">
            <xs:annotation>
                <xs:documentation>Constraints are extrinsic to the product delivery
but effect how a partner may request performance of a service. Performance constraints
may be tied to the basic mechanical needs of the resource or to the business needs of
the source. These constraints can affect the market value of the resource or the
repeated invocation of a resource. It is possible for a given underlying resource to be
offered to the market with different constraints and therefor different values. It is
possible for a given underlying resource to be offered to the market with different
constraints and therefor different values.</xs:documentation>
            </xs:annotation>
```

```
            <xs:sequence>
                <xs:element name="constraints" type="emix:ArrayOfConstraints"/>
                <xs:element name="requirements" type="emix:ArrayOfRequirements"/>
            </xs:sequence>
        </xs:complexType>
        <!-- 8.9.1 Core EMIX Constraints-->
        <xs:element name="baseConstraint" type="emix:BaseConstraintType" abstract="true">
            <xs:annotation>
                <xs:documentation>Abstract extension object for Emix
Constraints</xs:documentation>
            </xs:annotation>
        </xs:element>
        <xs:complexType name="ArrayOfConstraints">
            <xs:annotation>
                <xs:documentation>Collection of Emix Constraints</xs:documentation>
            </xs:annotation>
            <xs:sequence>
                <xs:element ref="emix:baseConstraint" minOccurs="0"
maxOccurs="unbounded"/>
            </xs:sequence>
        </xs:complexType>
        <xs:complexType name="BaseConstraintType" abstract="true">
            <xs:annotation>
                <xs:documentation>Type of Abstract extension object for Emix
Constraints</xs:documentation>
            </xs:annotation>
        </xs:complexType>
        <xs:element name="minimumResponseDuration" type="emix:MinimumResponseDurationType"
substitutionGroup="emix:baseConstraint">
            <xs:annotation>
                <xs:documentation>The shortest Duration for which the resource will
accept a request  to maintain a response before returning to pre-request
levels.</xs:documentation>
            </xs:annotation>
        </xs:element>
        <xs:element name="maximumResponseDuration" type="emix:MaximumResponseDurationType"
substitutionGroup="emix:baseConstraint">
            <xs:annotation>
                <xs:documentation>The longest Duration for which the resource will
accept a request.</xs:documentation>
            </xs:annotation>
        </xs:element>
        <xs:element name="minimumRecoveryDuration" type="emix:MinimumRecoveryDurationType"
substitutionGroup="emix:baseConstraint">
            <xs:annotation>
                <xs:documentation>The minimum Duration that the Resource requires
after the end of a response the resource has is ready to respond to a new
request.</xs:documentation>
            </xs:annotation>
        </xs:element>
        <xs:element name="minimumDurationBetweenInvocations"
type="emix:MinimumDurationBetweenInvocationsType"
substitutionGroup="emix:baseConstraint">
            <xs:annotation>
                <xs:documentation>The minimum Duration that the Resource requires
after receiving a request before the resource has is ready to respond to a new
request.</xs:documentation>
            </xs:annotation>
        </xs:element>
        <xs:element name="minimumNotificationDuration"
type="emix:MinimumNotificationDurationType" substitutionGroup="emix:baseConstraint">
            <xs:annotation>
                <xs:documentation>The minimum Duration that the Resource requires for
Notification before initiating a response to a request.</xs:documentation>
            </xs:annotation>
        </xs:element>
        <xs:element name="maximumNotificationDuration"
type="emix:MaximumNotificationDurationType" substitutionGroup="emix:baseConstraint">
            <xs:annotation>
                <xs:documentation>The maximum Duration in advance of a requested
response that the resource is willing to accept a request.</xs:documentation>
```

```
            </xs:annotation>
    </xs:element>
    <xs:element name="responseTime" type="emix:ResponseTimeType"
substitutionGroup="emix:baseConstraint">
            <xs:annotation>
                <xs:documentation>Duration required from receipt of a request to
initiation of a response by the resource</xs:documentation>
            </xs:annotation>
    </xs:element>
    <xs:element name="maximumInvocationsPerDuration"
type="emix:MaximumInvocationsPerDurationType" substitutionGroup="emix:baseConstraint">
            <xs:annotation>
                <xs:documentation>Maximum number of invocations of service during a
given duration</xs:documentation>
            </xs:annotation>
    </xs:element>
    <xs:element name="maximumConsecutiveDurations"
type="emix:MaximumConsecutiveDurationsType" substitutionGroup-"emix:baseConstraint">
            <xs:annotation>
                <xs:documentation>Maximim consecutive durations in which service can
be invoked, e.g., it will not accept requests on more than 3 consecutive
days.</xs:documentation>
            </xs:annotation>
    </xs:element>
    <xs:element name="minimumStartsPerDuration" type="emix:MinimumStartsPerDurationType"
substitutionGroup="emix:baseConstraint">
            <xs:annotation>
                <xs:documentation>The fewest Requests that the resource will accept
during any duration. This constraint is typically used in market rather than in resource
descriptions.</xs:documentation>
            </xs:annotation>
    </xs:element>
    <xs:element name="maximumRunDuration" type="emix:MaximumRunDurationType"
substitutionGroup="emix:baseConstraint">
            <xs:annotation>
                <xs:documentation>The Maximum duration for which a resource will
accept a request</xs:documentation>
            </xs:annotation>
    </xs:element>
    <xs:element name="minimumRunDuration" type="emix:MinimumRunDurationType"
substitutionGroup-"emix:baseConstraint">
            <xs:annotation>
                <xs:documentation>The Minimum duration for which a resource will
accept a request</xs:documentation>
            </xs:annotation>
    </xs:element>
    <xs:element name="availabilitySchedule" type-"emix:AvailabilityScheduleType"
substitutionGroup-"emix:baseConstraint">
            <xs:annotation>
                <xs:documentation>A schedule of times for which which a resource will
accept requests. The schedule may include multiple availability windows. The scheduled
duration must be entirely within an availability window.</xs:documentation>
            </xs:annotation>
    </xs:element>
    <xs:element name="notificationSchedule" type-"emix:NotificationScheduleType"
substitutionGroup="emix:baseConstraint">
            <xs:annotation>
                <xs:documentation>A schedule of time during which a resource will
accept requests. The schedule may include multiple availability windows. THe
notification must occur within an availability window.</xs:documentation>
            </xs:annotation>
    </xs:element>
    <xs:element name="unavailabilitySchedule" type="emix:UnavailabilityScheduleType"
substitutionGroup-"emix:baseConstraint">
            <xs:annotation>
                <xs:documentation>A schedule of times for which which a resource will
not accept requests. The schedule may include multiple unavailability windows. The
scheduled duration must not occur within or overlap an unavailability
window.</xs:documentation>
            </xs:annotation>
    </xs:element>
```

```
    <!-- 8.9.1.1 Minimum Response-->
    <xs:complexType name="MinimumResponseDurationType" mixed="false">
          <xs:annotation>
                <xs:documentation>Type of the shortest Duration for which the resource
will accept a request  to maintain a response before returning to pre-request
levels.</xs:documentation>
          </xs:annotation>
          <xs:complexContent mixed="false">
                <xs:extension base="emix:BaseConstraintType">
                      <xs:sequence>
                            <xs:element ref="emix:duration" minOccurs="1"
maxOccurs="1"/>
                      </xs:sequence>
                </xs:extension>
          </xs:complexContent>
    </xs:complexType>
    <!-- 8.9.1.2 Maximum Response-->
    <xs:complexType name="MaximumResponseDurationType" mixed="false">
          <xs:annotation>
                <xs:documentation>Type of the longest Duration for which the resource
will accept a request.</xs:documentation>
          </xs:annotation>
          <xs:complexContent mixed="false">
                <xs:extension base="emix:BaseConstraintType">
                      <xs:sequence>
                            <xs:element ref="emix:duration" minOccurs="1"
maxOccurs="1"/>
                      </xs:sequence>
                </xs:extension>
          </xs:complexContent>
    </xs:complexType>
    <xs:complexType name="MinimumRecoveryDurationType" mixed="false">
          <xs:annotation>
                <xs:documentation>Type of the minimum Duration that the Resource
requires after the end of a response the resource has is ready to respond to a new
request.</xs:documentation>
          </xs:annotation>
          <xs:complexContent mixed="false">
                <xs:extension base="emix:BaseConstraintType">
                      <xs:sequence>
                            <xs:element ref="emix:duration" minOccurs="1"
maxOccurs="1"/>
                      </xs:sequence>
                </xs:extension>
          </xs:complexContent>
    </xs:complexType>
    <xs:complexType name="MinimumDurationBetweenInvocationsType" mixed="false">
          <xs:annotation>
                <xs:documentation>Type of the minimum Duration that the Resource
requires after receiving a request before the resource has is ready to respond to a new
request.</xs:documentation>
          </xs:annotation>
          <xs:complexContent mixed="false">
                <xs:extension base="emix:BaseConstraintType">
                      <xs:sequence>
                            <xs:element ref="emix:duration" minOccurs="1"
maxOccurs="1"/>
                      </xs:sequence>
                </xs:extension>
          </xs:complexContent>
    </xs:complexType>
    <xs:complexType name="MinimumNotificationDurationType" mixed="false">
          <xs:annotation>
                <xs:documentation>Type of the minimum Duration that the Resource
requires for Notification before initiating a response to a request.</xs:documentation>
          </xs:annotation>
          <xs:complexContent mixed="false">
                <xs:extension base="emix:BaseConstraintType">
                      <xs:sequence>
                            <xs:element ref="emix:duration" minOccurs="1"
maxOccurs="1"/>
```

```
                    </xs:sequence>
                </xs:extension>
            </xs:complexContent>
        </xs:complexType>
        <xs:complexType name="MaximumNotificationDurationType" mixed="false">
            <xs:annotation>
                <xs:documentation>Type of the maximum Duration in advance that a
Resource is willing to accept a request for a response.</xs:documentation>
            </xs:annotation>
            <xs:complexContent mixed="false">
                <xs:extension base="emix:BaseConstraintType">
                    <xs:sequence>
                        <xs:element ref="emix:duration" minOccurs="1"
maxOccurs="1"/>
                    </xs:sequence>
                </xs:extension>
            </xs:complexContent>
        </xs:complexType>
        <xs:complexType name="ResponseTimeType" mixed="false">
            <xs:annotation>
                <xs:documentation>Type of the Duration required from receipt of a
request to initiation of a response by the resource</xs:documentation>
            </xs:annotation>
            <xs:complexContent mixed="false">
                <xs:extension base="emix:BaseConstraintType">
                    <xs:sequence>
                        <xs:element ref="emix:duration" minOccurs="1"
maxOccurs="1"/>
                    </xs:sequence>
                </xs:extension>
            </xs:complexContent>
        </xs:complexType>
        <xs:complexType name="MaximumInvocationsPerDurationType" mixed="false">
            <xs:annotation>
                <xs:documentation>Type of the Maximum number of invocations of service
during a given duration</xs:documentation>
            </xs:annotation>
            <xs:complexContent mixed="false">
                <xs:annotation>
                    <xs:documentation>The resource will only accept a given number
of requests for performance during a given interval.</xs:documentation>
                </xs:annotation>
                <xs:extension base="emix:BaseConstraintType">
                    <xs:sequence>
                        <xs:element name="starts" type="xs:int" minOccurs="1"
maxOccurs="1"/>
                        <xs:element ref="emix:duration" minOccurs="1"
maxOccurs="1"/>
                    </xs:sequence>
                </xs:extension>
            </xs:complexContent>
        </xs:complexType>
        <xs:complexType name="MaximumConsecutiveDurationsType" mixed="false">
            <xs:annotation>
                <xs:documentation>Type of Maximim consecutive durations in which
service can be invoked, e.g., it will not accept requests on more than 3 consecutive
days.</xs:documentation>
            </xs:annotation>
            <xs:complexContent mixed="false">
                <xs:extension base="emix:BaseConstraintType">
                    <xs:sequence>
                        <xs:element name="durations" type="xs:int"/>
                        <xs:element ref="emix:duration" minOccurs="1"
maxOccurs="1"/>
                    </xs:sequence>
                </xs:extension>
            </xs:complexContent>
        </xs:complexType>
        <xs:complexType name="MinimumStartsPerDurationType" mixed="false">
            <xs:annotation>
```

```
                <xs:documentation>Type of the fewest Requests that the resource will
accept during any duration. This constraint is typically used in market rather than in
resource descriptions.</xs:documentation>
            </xs:annotation>
            <xs:complexContent mixed="false">
                <xs:extension base="emix:BaseConstraintType">
                    <xs:sequence>
                        <xs:element name="starts" type="xs:int" minOccurs="1"
maxOccurs="1"/>
                        <xs:element ref="emix:duration" minOccurs="1"
maxOccurs="1"/>
                    </xs:sequence>
                </xs:extension>
            </xs:complexContent>
        </xs:complexType>
        <xs:complexType name="MaximumRunDurationType" mixed="false">
            <xs:annotation>
                <xs:documentation>Type of the Maximum duration for which a resource
will accept a request</xs:documentation>
            </xs:annotation>
            <xs:complexContent mixed="false">
                <xs:extension base="emix:BaseConstraintType">
                    <xs:sequence>
                        <xs:element ref="emix:duration" minOccurs="1"
maxOccurs="1"/>
                    </xs:sequence>
                </xs:extension>
            </xs:complexContent>
        </xs:complexType>
        <xs:complexType name="MinimumRunDurationType" mixed="false">
            <xs:annotation>
                <xs:documentation>Type of the Minimum duration for which a resource
will accept a request</xs:documentation>
            </xs:annotation>
            <xs:complexContent mixed="false">
                <xs:extension base="emix:BaseConstraintType">
                    <xs:sequence>
                        <xs:element ref="emix:duration" minOccurs="1"
maxOccurs="1"/>
                    </xs:sequence>
                </xs:extension>
            </xs:complexContent>
        </xs:complexType>
        <!-- Business Schedules -->
        <xs:complexType name="AvailabilityScheduleType" mixed="false">
            <xs:annotation>
                <xs:documentation>Type of the schedule of time for which a resource
will accept requests. The schedule may include multiple availability windows. The
scheduled duration must be entirely within an availability window.</xs:documentation>
            </xs:annotation>
            <xs:complexContent mixed="false">
                <xs:extension base="emix:BaseConstraintType">
                    <xs:sequence>
                        <xs:element ref="emix:businessSchedule"
maxOccurs="unbounded"/>
                    </xs:sequence>
                </xs:extension>
            </xs:complexContent>
        </xs:complexType>
        <xs:complexType name="NotificationScheduleType" mixed="false">
            <xs:annotation>
                <xs:documentation>Type of the schedule of time during which a resource
will accept requests. The schedule may include multiple notofication windows. The
request must occur within a notification window.</xs:documentation>
            </xs:annotation>
            <xs:complexContent mixed="false">
                <xs:extension base="emix:BaseConstraintType">
                    <xs:sequence>
                        <xs:element ref="emix:businessSchedule"
maxOccurs="unbounded"/>
                    </xs:sequence>
```

```
                    </xs:extension>
                </xs:complexContent>
            </xs:complexType>
            <xs:complexType name="UnavailabilityScheduleType" mixed="false">
                <xs:annotation>
                    <xs:documentation>Type of the schedule of time for which a resource
will not accept requests. The schedule may include multiple unavailability windows. The
scheduled duration must not occur within or overlap an unavailability
window.</xs:documentation>

                </xs:annotation>
                <xs:complexContent mixed="false">
                    <xs:extension base="emix:BaseConstraintType">
                        <xs:sequence>
                            <xs:element ref="emix:businessSchedule"
maxOccurs="unbounded"/>
                        </xs:sequence>
                    </xs:extension>
                </xs:complexContent>
            </xs:complexType>
            <!-- 8.2 EMIX Requirements-->
            <xs:element name="marketRequirements" type="emix:MarketRequirementsType">
                <xs:annotation>
                    <xs:documentation>Market Requirements are the market portion of
Constraints, i.e., they are used to state the offeror's expectations about a tender.It
is possible for a given underlying resource to be offered to the market with different
Requirements and therefor different values.</xs:documentation>
                </xs:annotation>
            </xs:element>
            <xs:complexType name="MarketRequirementsType">
                <xs:annotation>
                    <xs:documentation>Market Requirements are the market portion of
Constraints, i.e., they are used to state the offeror's expectations about a tender.It
is possible for a given underlying resource to be offered to the market with different
Requirements and therefor different values.</xs:documentation>
                </xs:annotation>
                <xs:sequence>
                    <xs:element name="requirements" type="emix:ArrayOfRequirements"/>
                </xs:sequence>
            </xs:complexType>
            <xs:complexType name="BaseRequirementType" abstract="true">
                <xs:annotation>
                    <xs:documentation>Abstract base for all
Requirements</xs:documentation>
                </xs:annotation>
            </xs:complexType>
            <xs:element name="baseRequirement" type="emix:BaseRequirementType">
                <xs:annotation>
                    <xs:documentation>Abstract base for all
Requirements</xs:documentation>
                </xs:annotation>
            </xs:element>
            <xs:complexType name="ArrayOfRequirements">
                <xs:annotation>
                    <xs:documentation>Abstract base for a collection of
requirements</xs:documentation>
                </xs:annotation>
                <xs:sequence>
                    <xs:element ref="emix:baseRequirement" minOccurs="0"
maxOccurs="unbounded"/>
                </xs:sequence>
            </xs:complexType>
            <xs:element name="minimumEconomicRequirement"
type="emix:MinimumEconomicRequirementType" substitutionGroup="emix:baseRequirement">
                <xs:annotation>
                    <xs:documentation> Minimum net remuneration this resource requires
from a total response</xs:documentation>
                </xs:annotation>
            </xs:element>
            <xs:element name="requiredStartupCost" type="emix:RequiredStartupCostType"
substitutionGroup="emix:baseRequirement">
```

```
          <xs:annotation>
                    <xs:documentation>Minimum remunuration required from start-up of this
service. </xs:documentation>
          </xs:annotation>
    </xs:element>
    <xs:element name="minimumResourceCost" type="emix:MinimumResourceCostType"
substitutionGroup="emix:baseRequirement">
          <xs:annotation>
                    <xs:documentation>Resource requires this amount per period, i.e., a
minimum requirement for $100 / hour at whatever rate</xs:documentation>
          </xs:annotation>
    </xs:element>
    <xs:complexType name="MinimumEconomicRequirementType" mixed="false">
          <xs:annotation>
                    <xs:documentation>Minimum net remuneration this resource requires from
a total response</xs:documentation>
          </xs:annotation>
          <xs:complexContent mixed="false">
                    <xs:extension base="emix:BaseRequirementType">
                              <xs:sequence>
                                        <xs:element ref="emix:price"/>
                              </xs:sequence>
                    </xs:extension>
          </xs:complexContent>
    </xs:complexType>
    <xs:complexType name="RequiredStartupCostType" mixed="false">
          <xs:annotation>
                    <xs:documentation> Minimum remunuration required from start-up of this
service. </xs:documentation>
          </xs:annotation>
          <xs:complexContent mixed="false">
                    <xs:extension base="emix:BaseRequirementType">
                              <xs:sequence>
                                        <xs:element ref="emix:price" minOccurs="1"
maxOccurs="1"/>
                              </xs:sequence>
                    </xs:extension>
          </xs:complexContent>
    </xs:complexType>
    <!-- 4.3.2 Minimum Resource Cost  -->
    <xs:complexType name="MinimumResourceCostType" mixed="false">
          <xs:annotation>
                    <xs:documentation>Resource requires this amount per period, i.e., a
minimum requirement for $100 / hour at whatever rate</xs:documentation>
          </xs:annotation>
          <xs:complexContent mixed="false">
                    <xs:extension base="emix:BaseRequirementType">
                              <xs:sequence>
                                        <xs:element ref="emix:price"/>
                                        <xs:element ref="emix:duration"/>
                              </xs:sequence>
                    </xs:extension>
          </xs:complexContent>
    </xs:complexType>
</xs:schema>
```

F.1.3 EMIX Warrants

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- emix.xsd
Schema Set for OASIS EMIX 1.0 WD23 (20110411)
Set includes:
   EMIX, EMIX-Requirements, EMIX-Warrants (emix)
   Power, Power-Contracts, Power-Quality (power)
   Resource (resource)

This set built on the WS-Calendar v1.0 PRD02 Schemas.
-->
```

```
<xs:schema xmlns:emix="http://docs.oasis-open.org/ns/emix"
xmlns:xcal="urn:ietf:params:xml:ns:icalendar-2.0"
xmlns:clm5ISO42173A="urn:un:unece:uncefact:codelist:standard:5:ISO42173A:2010-04-07"
xmlns:gml="http://www.opengis.net/gml/3.2" xmlns:xs="http://www.w3.org/2001/XMLSchema"
targetNamespace="http://docs.oasis-open.org/ns/emix" elementFormDefault="qualified"
attributeFormDefault="unqualified">
   <xs:include schemaLocation="emix.xsd"/>
   <!-- 8.8 EMIX Warrants-->
   <xs:element name="warrants" type="emix:ArrayOfWarrants">
      <xs:annotation>
         <xs:documentation>Warrants are “a written assurances that some product
or service will be provided or will meet certain specifications” . Sellers use EMIX
Warrants to provide information about the source of the energy or about its
environmental characteristics. Buyers can use warrants to indicate what they wish to
purchase. EMIX does not define specific warrants, although it does define base types for
extension by those who wish to develop the various types of warrants.</xs:documentation>
      </xs:annotation>
   </xs:element>
   <xs:element name="baseWarrant" type="emix:BaseWarrantType">
      <xs:annotation>
         <xs:documentation>Abstract extension object for Emix
Warrants</xs:documentation>
      </xs:annotation>
   </xs:element>
   <xs:complexType name="ArrayOfWarrants">
      <xs:annotation>
         <xs:documentation>Collection of Emix Warrants</xs:documentation>
      </xs:annotation>
      <xs:sequence>
         <xs:element ref="emix:baseWarrant" minOccurs="0"
maxOccurs="unbounded"/>
      </xs:sequence>
   </xs:complexType>
   <xs:complexType name="BaseWarrantType" abstract="true">
      <xs:annotation>
         <xs:documentation>Type of Abstract extension object for Emix
Warrants</xs:documentation>
      </xs:annotation>
   </xs:complexType>
   <xs:element name="supportForPrice" type="emix:SupportForPriceType"
substitutionGroup="emix:baseWarrant"/>
   <xs:element name="qualityWarrant" type="emix:QualityWarrantType"
substitutionGroup="emix:baseWarrant"/>
   <xs:element name="environmentalWarrant" type="emix:EnvironmentalWarrantType"
substitutionGroup="emix:baseWarrant"/>
   <xs:element name="sourceWarrant" type="emix:SourceWarrantType"
substitutionGroup="emix:baseWarrant"/>
   <xs:element name="contentWarrant" type="emix:ContentWarrantType"
substitutionGroup="emix:baseWarrant"/>
   <xs:element name="controllabilityWarrant" type="emix:ControllabilityWarrantType"
substitutionGroup="emix:baseWarrant"/>
   <!-- 8.8.1 Core EMIX Warrants-->
   <xs:complexType name="SupportForPriceType" abstract="true" mixed="false">
      <xs:annotation>
         <xs:documentation>Price Support products may be needed to justify the
price. An example would be a transport product that support the difference between a
product price at a point of delivery and a product price at a point of
receipt.</xs:documentation>
      </xs:annotation>
      <xs:complexContent mixed="false">
         <xs:extension base="emix:BaseWarrantType"/>
      </xs:complexContent>
   </xs:complexType>
   <xs:complexType name="QualityWarrantType" abstract="true" mixed="false">
      <xs:annotation>
         <xs:documentation>A Quality Warrant asserts or requires that the power
be of a certain quality or better.</xs:documentation>
      </xs:annotation>
      <xs:complexContent mixed="false">
         <xs:extension base="emix:BaseWarrantType">
            <xs:sequence>
```

```
                    <xs:element ref="emix:product" minOccurs="1"
maxOccurs="unbounded"/>
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
    <xs:complexType name="EnvironmentalWarrantType" abstract="true" mixed="false">
        <xs:annotation>
            <xs:documentation>An Environmental Warrant asserts what environmental
cost was created by the product.</xs:documentation>
        </xs:annotation>
        <xs:complexContent mixed="false">
            <xs:extension base="emix:BaseWarrantType">
                <xs:sequence>
                    <xs:element ref="emix:product" minOccurs="1"
maxOccurs="unbounded"/>
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
    <xs:complexType name="SourceWarrantType" abstract="true" mixed="false">
        <xs:annotation>
            <xs:documentation>A source warrant consists of assertions about
through what proces energy originated. </xs:documentation>
        </xs:annotation>
        <xs:complexContent mixed="false">
            <xs:extension base="emix:BaseWarrantType">
                <xs:sequence>
                    <xs:element ref="emix:product" minOccurs="1"
maxOccurs="unbounded"/>
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
    <xs:complexType name="ContentWarrantType" abstract="true" mixed="false">
        <xs:annotation>
            <xs:documentation>A content warrant consists of assertions about where
energy originated. </xs:documentation>
        </xs:annotation>
        <xs:complexContent mixed="false">
            <xs:extension base="emix:BaseWarrantType">
                <xs:sequence>
                    <xs:element ref="emix:product" minOccurs="1"
maxOccurs="unbounded"/>
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
    <xs:complexType name="ControllabilityWarrantType" abstract="true" mixed="false">
        <xs:annotation>
            <xs:documentation>A Controllability Warrant makes certifies that the
resource is controolable byt the market buyer. </xs:documentation>
        </xs:annotation>
        <xs:complexContent mixed="false">
            <xs:extension base="emix:BaseWarrantType">
                <xs:sequence>
                    <xs:element ref="emix:product" minOccurs="1"
maxOccurs="unbounded"/>
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
</xs:schema>
```

F.2 Power Schemas

The Power Schema is in 3 parts

F.2.1 Power.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- power-quality.xsd - Power Products for OASIS EMIX 1.0 WD23 (20110411)

Set includes:
   EMIX, EMIX-Requirements, EMIX-Warrants (emix)
   Power, Power-Contracts, Power-Quality (power)
   Resource (resource)

This set built on the WS-Calendar v1.0 PRD02 Schemas.
-->
<xs:schema xmlns:power="http://docs.oasis-open.org/ns/emix/power"
xmlns:emix="http://docs.oasis-open.org/ns/emix"
xmlns:xcal="urn:ietf:params:xml:ns:icalendar-2.0"
xmlns:clm5ISO42173A="urn:un:unece:uncefact:codelist:standard:5:ISO42173A:2010-04-07"
xmlns:gml="http://www.opengis.net/gml/3.2" xmlns:xs="http://www.w3.org/2001/XMLSchema"
targetNamespace="http://docs.oasis-open.org/ns/emix/power"
elementFormDefault="unqualified" attributeFormDefault="unqualified">
   <xs:include schemaLocation="power-products.xsd"/>
   <xs:include schemaLocation="power-quality.xsd"/>
   <xs:import namespace="http://docs.oasis-open.org/ns/emix" schemaLocation="emix.xsd"/>
   <!-- 1.0 Core EMIX Power objects-->
   <!-- 1.1 Power Product-->
   <!-- 1.2 Reserves and Power Options-->
   <!-- 2.0  Contract Power Products -->
   <!-- 4.0 Resource Semantics -->
   <!-- 6.0 Power Quality -->
   <!-- 9.1.2 Unit Energy Price -->
   <xs:element name="unitEnergyPrice" type="power:UnitEnergyPriceType"/>
   <xs:complexType name="UnitEnergyPriceType">
      <xs:annotation>
         <xs:documentation>Price per Unit of Energy, i.e., Power times
Duration</xs:documentation>
      </xs:annotation>
      <xs:sequence>
         <xs:element ref="emix:priceBase"/>
         <xs:element ref="power:energyItem"/>
      </xs:sequence>
   </xs:complexType>
   <xs:element name="energyQuantity" type="power:EnergyQuantityType"/>
   <xs:complexType name="EnergyQuantityType">
      <xs:annotation>
         <xs:documentation>Level of Energy</xs:documentation>
      </xs:annotation>
      <xs:sequence>
         <xs:element ref="emix:quantity"/>
         <xs:element ref="power:energyItem"/>
      </xs:sequence>
   </xs:complexType>
   <!-- 9.1.3 Power Delivery Rate -->
   <xs:element name="powerQuantity" type="power:PowerQuantityType"/>
   <xs:complexType name="PowerQuantityType">
      <xs:annotation>
         <xs:documentation>Quantity of Power</xs:documentation>
      </xs:annotation>
      <xs:sequence>
         <xs:element ref="emix:quantity"/>
         <xs:element ref="power:powerItem"/>
      </xs:sequence>
   </xs:complexType>
   <!-- 9.1.5 Reactive Power -->
   <xs:element name="varQuantity" type="power:VarQuantityType"/>
   <xs:complexType name="VarQuantityType">
      <xs:sequence>
         <xs:element ref="emix:quantity"/>
         <xs:element ref="power:powerReactive"/>
      </xs:sequence>
   </xs:complexType>
   <!-- 9.8 Interface Types -->
   <!-- 9.8.1 EndDevices -->
```

```
    <!-- updated name of this section to reflect the more generic EndDevice rather than
Meters specifically -->
    <xs:element name="endDeviceAsset" type="power:EndDeviceAssetType"
substitutionGroup="emix:emixInterface">
          <xs:annotation>
                <xs:documentation>One type of EndDeviceAsset is a MeterAsset which can
perform metering, load management, connect/disconnect, accounting functions, etc. Some
EndDeviceAssets may be connected to a MeterAsset.</xs:documentation>
          </xs:annotation>
    </xs:element>
    <xs:complexType name="EndDeviceAssetType">
          <xs:annotation>
                <xs:documentation>The EndDeviceAssets are the physical device or
devices which could be meters or other types of devices that may be of
interest</xs:documentation>
          </xs:annotation>
          <xs:complexContent>
                <xs:extension base="emix:EmixInterfaceType">
                      <xs:sequence>
                            <xs:element ref="power:mRID"/>
                      </xs:sequence>
                </xs:extension>
          </xs:complexContent>
    </xs:complexType>
    <!-- 9.8.1.1 Meters -->
    <xs:element name="meterAsset" type="power:MeterAssetType"
substitutionGroup="emix:emixInterface"/>
    <xs:complexType name="MeterAssetType">
          <xs:annotation>
                <xs:documentation>The MeterAsset is the physical device or devices
that performs the role of the meter</xs:documentation>
          </xs:annotation>
          <xs:complexContent>
                <xs:extension base="emix:EmixInterfaceType">
                      <xs:sequence>
                            <xs:element ref="power:mRID"/>
                      </xs:sequence>
                </xs:extension>
          </xs:complexContent>
    </xs:complexType>
    <!-- 9.8.2 Nodes -->
    <xs:element name="pnode" type="power:PnodeType"
substitutionGroup="emix:emixInterface"/>
    <xs:complexType name="PnodeType" mixed="false">
          <xs:annotation>
                <xs:documentation>A pricing node is directly associated with a
connectivity node.  It is a pricing location for which market participants submit their
bids, offers, buy/sell CRRs, and settle.</xs:documentation>
          </xs:annotation>
          <xs:complexContent mixed="false">
                <xs:extension base="emix:EmixInterfaceType">
                      <xs:sequence>
                            <xs:element ref="power:node"/>
                      </xs:sequence>
                </xs:extension>
          </xs:complexContent>
    </xs:complexType>
    <xs:element name="aggregatedPnode" type="power:AggregatedPnodeType"
substitutionGroup="emix:emixInterface"/>
    <xs:complexType name="AggregatedPnodeType" mixed="false">
          <xs:annotation>
                <xs:documentation>An aggregated pricing node is a specialized type of
pricing node used to model items such as System Zone, Default Price Zone, Custom Price
Zone, Control Area, Aggregated Generation, Aggregated Particpating Load, Aggregated Non-
Participating Load, Trading Hub, DCA Zone</xs:documentation>
          </xs:annotation>
          <xs:complexContent mixed="false">
                <xs:extension base="emix:EmixInterfaceType">
                      <xs:sequence>
                            <xs:element ref="power:node"/>
                      </xs:sequence>
```

```
                    </xs:extension>
                </xs:complexContent>
            </xs:complexType>
            <xs:element name="serviceLocation" type="power:ServiceLocationType"
substitutionGroup="emix:emixInterface"/>
            <xs:complexType name="ServiceLocationType" mixed="false">
                <xs:annotation>
                    <xs:documentation>A customer ServiceLocation has one or more
ServiceDeliveryPoint(s), which in turn relate to Meters. The location may be a point or
a polygon, depending on the specific circumstances. For distribution, the
ServiceLocation is typically the location of the utility customer's premise.
</xs:documentation>
                </xs:annotation>
                <xs:complexContent mixed="false">
                    <xs:extension base="emix:EmixInterfaceType">
                        <xs:sequence>
                            <xs:element ref="emix:geographicArea"/>
                        </xs:sequence>
                    </xs:extension>
                </xs:complexContent>
            </xs:complexType>
            <xs:element name="serviceDeliveryPoint" type="power:ServiceDeliveryPointType"
substitutionGroup="emix:emixInterface"/>
            <xs:complexType name="ServiceDeliveryPointType" mixed="false">
                <xs:annotation>
                    <xs:documentation>Logical point on the network where the ownership of
the service changes hands. It is one of potentially many service points within a
ServiceLocation, delivering service in accordance with a CustomerAgreement. Used at the
place where a meter may be installed.</xs:documentation>
                </xs:annotation>
                <xs:complexContent mixed="false">
                    <xs:extension base="emix:EmixInterfaceType">
                        <xs:sequence>
                            <xs:element ref="power:node" maxOccurs="1"/>
                        </xs:sequence>
                    </xs:extension>
                </xs:complexContent>
            </xs:complexType>
            <!-- 9.8.3 Transport Interface -->
            <xs:element name="transportInterface" type="power:TransportInterfaceType"
substitutionGroup="emix:emixInterface"/>
            <xs:complexType name="TransportInterfaceType" mixed="false">
                <xs:annotation>
                    <xs:documentation>The Transport Interface delineates the edges at
either end of a transport segment.</xs:documentation>
                </xs:annotation>
                <xs:complexContent mixed="false">
                    <xs:extension base="emix:EmixInterfaceType">
                        <xs:sequence>
                            <xs:element name="pointOfReceipt"
type="power:NodeType"/>
                            <xs:element name="pointOfDelivery"
type="power:NodeType"/>
                        </xs:sequence>
                    </xs:extension>
                </xs:complexContent>
            </xs:complexType>
            <!-- 9.8.9 Base Elements for Interfaces -->
            <xs:element name="node" type="power:NodeType"/>
            <xs:simpleType name="NodeType">
                <xs:annotation>
                    <xs:documentation>The Node is a place where something changes (often
ownership) or connects on the grid. Many nodes are associated with meters, but not all
are.</xs:documentation>
                </xs:annotation>
                <xs:restriction base="xs:string"/>
            </xs:simpleType>
            <!-- 9.8.9.1 Base Elements for Interfaces -->
            <!--    The identifier for a EndDevice (meter or other), is mRID from IEC61968-->
            <xs:element name="mRID" type="power:mRIDType"/>
            <xs:simpleType name="mRIDType">
```

```
          <xs:annotation>
                    <xs:documentation>The mRID identifies the physical device that may be
a CustomerMeter or other types of EndDevices.</xs:documentation>
          </xs:annotation>
          <xs:restriction base="xs:string"/>
    </xs:simpleType>
    <!-- 9.9 Enumerations -->
    <!--  9.9.1 Voltage  -->
    <xs:element name="voltage" type="power:VoltageType"
substitutionGroup="emix:itemBase"/>
    <xs:complexType name="VoltageType" mixed="false">
          <xs:annotation>
                    <xs:documentation>Voltage</xs:documentation>
          </xs:annotation>
          <xs:complexContent mixed="false">
                    <xs:extension base="emix:ItemBaseType">
                              <xs:sequence>
                                        <xs:element name="itemDescription" type="xs:string"
fixed="Voltage"/>
                                        <xs:element name="itemUnits" type="xs:string"
fixed="V"/>
                                        <xs:element ref="emix:scale"/>
                              </xs:sequence>
                    </xs:extension>
          </xs:complexContent>
    </xs:complexType>
    <!-- 9.9.2 Energy Units -->
    <xs:element name="energyApparent" type="power:EnergyApparentType"
substitutionGroup="power:energyItem"/>
    <xs:complexType name="EnergyApparentType" mixed="false">
          <xs:annotation>
                    <xs:documentation>Apparent Energy, measured in volt-ampere hours
(VAh)</xs:documentation>
          </xs:annotation>
          <xs:complexContent mixed="false">
                    <xs:restriction base="power:EnergyItemType">
                              <xs:sequence>
                                        <xs:element name="itemDescription" type="xs:string"
fixed="ApparentEnergy"/>
                                        <xs:element name="itemUnits" type="xs:string"
fixed="VAh"/>
                                        <xs:element name="scale" type="emix:SiScaleType"/>
                              </xs:sequence>
                    </xs:restriction>
          </xs:complexContent>
    </xs:complexType>
    <xs:element name="energyReactive" type="power:EnergyReactiveType"
substitutionGroup="power:energyItem"/>
    <xs:complexType name="EnergyReactiveType" mixed="false">
          <xs:annotation>
                    <xs:documentation>Reactive Energy, volt-amperes reactive hours
(VARh)</xs:documentation>
          </xs:annotation>
          <xs:complexContent mixed="false">
                    <xs:restriction base="power:EnergyItemType">
                              <xs:sequence>
                                        <xs:element name="itemDescription" type="xs:string"
fixed="ReactiveEnergy"/>
                                        <xs:element name="itemUnits" type="xs:string"
fixed="VARh"/>
                                        <xs:element name="scale" type="emix:SiScaleType"/>
                              </xs:sequence>
                    </xs:restriction>
          </xs:complexContent>
    </xs:complexType>
    <xs:element name="energyReal" type="power:EnergyRealType"
substitutionGroup="power:energyItem"/>
    <xs:complexType name="EnergyRealType" mixed="false">
          <xs:annotation>
                    <xs:documentation>Real Energy, Watt Hours (Wh)</xs:documentation>
          </xs:annotation>
```

```
            <xs:complexContent mixed="false">
                <xs:restriction base="power:EnergyItemType">
                    <xs:sequence>
                        <xs:element name="itemDescription" type="xs:string"
fixed="RealEnergy"/>
                        <xs:element name="itemUnits" type="xs:string"
fixed="Wh"/>
                        <xs:element name="scale" type="emix:SiScaleType"/>
                    </xs:sequence>
                </xs:restriction>
            </xs:complexContent>
    </xs:complexType>
    <!-- ================================================== -->
    <!-- 9.9.5 Base Energy Item Type -->
    <!-- ================================================== -->
    <xs:element name="energyItem" type="power:EnergyItemType"
substitutionGroup="emix:itemBase"/>
    <xs:complexType name="EnergyItemType" abstract="true" mixed="false">
            <xs:annotation>
                <xs:documentation>Base for the measurement of
Energy</xs:documentation>
            </xs:annotation>
            <xs:complexContent mixed="false">
                <xs:extension base="emix:ItemBaseType">
                    <xs:sequence>
                        <xs:element name="itemDescription" type="xs:string"/>
                        <xs:element name="itemUnits" type="xs:string"/>
                        <xs:element name="scale" type="emix:SiScaleType"/>
                    </xs:sequence>
                </xs:extension>
            </xs:complexContent>
    </xs:complexType>
    <!-- ================================================== -->
    <!-- 9.9.4 Power Units -->
    <!-- ================================================== -->
    <!-- ================================================== -->
    <xs:element name="powerApparent" type="power:PowerApparentType"
substitutionGroup="power:powerItem"/>
    <xs:complexType name="PowerApparentType" mixed="false">
            <xs:annotation>
                <xs:documentation>Apparent Power measured in volt-amperes
(VA)</xs:documentation>
            </xs:annotation>
            <xs:complexContent mixed="false">
                <xs:restriction base="power:PowerItemType">
                    <xs:sequence>
                        <xs:element name="itemDescription" type="xs:string"
fixed="ApparentPower"/>
                        <xs:element name="itemUnits" type="xs:string"
fixed="VA"/>
                        <xs:element name="scale" type="emix:SiScaleType"/>
                        <xs:element ref="power:powerAttributes"/>
                    </xs:sequence>
                </xs:restriction>
            </xs:complexContent>
    </xs:complexType>
    <!-- ================================================== -->
    <xs:element name="powerReactive" type="power:PowerReactiveType"
substitutionGroup="power:powerItem"/>
    <xs:complexType name="PowerReactiveType" mixed="false">
            <xs:annotation>
                <xs:documentation>Reactive power, measured in volt-amperes reactive
(VAR)</xs:documentation>
            </xs:annotation>
            <xs:complexContent mixed="false">
                <xs:restriction base="power:PowerItemType">
                    <xs:sequence>
                        <xs:element name="itemDescription" type="xs:string"
fixed="ReactivePower"/>
                        <xs:element name="itemUnits" type="xs:string"
fixed="VAR"/>
```

```
                                        <xs:element name="scale" type="emix:SiScaleType"/>
                                        <xs:element ref="power:powerAttributes"/>
                                    </xs:sequence>
                                </xs:restriction>
                            </xs:complexContent>
                        </xs:complexType>
                        <!-- ========================================================= -->
                        <xs:element name="powerReal" type="power:PowerRealType"
                    substitutionGroup="power:powerItem"/>
                        <xs:complexType name="PowerRealType" mixed="false">
                            <xs:annotation>
                                <xs:documentation>Real power measured in Watts (W) or Joules/second
                    (J/s)</xs:documentation>
                            </xs:annotation>
                            <xs:complexContent mixed="false">
                                <xs:restriction base="power:PowerItemType">
                                    <xs:sequence>
                                        <xs:element name="itemDescription" type="xs:string"
                    fixed="RealPower"/>
                                        <xs:element name="itemUnits">
                                            <xs:simpleType>
                                                <xs:restriction base="xs:token">
                                                    <xs:enumeration value="W"/>
                                                    <xs:enumeration value="J/s"/>
                                                </xs:restriction>
                                            </xs:simpleType>
                                        </xs:element>
                                        <xs:element name="scale" type="emix:SiScaleType"/>
                                        <xs:element ref="power:powerAttributes"/>
                                    </xs:sequence>
                                </xs:restriction>
                            </xs:complexContent>
                        </xs:complexType>
                        <!-- ========================================================= -->
                        <!-- 9.9.5 Base Power Item Type -->
                        <!-- ========================================================= -->
                        <xs:element name="powerItem" type="power:PowerItemType"
                    substitutionGroup="emix:itemBase"/>
                        <xs:complexType name="PowerItemType" abstract="true" mixed="false">
                            <xs:annotation>
                                <xs:documentation>Base for the measurement of Power</xs:documentation>
                            </xs:annotation>
                            <xs:complexContent mixed="false">
                                <xs:extension base="emix:ItemBaseType">
                                    <xs:sequence>
                                        <xs:element name="itemDescription" type="xs:string"/>
                                        <xs:element name="itemUnits" type="xs:string"/>
                                        <xs:element name="scale" type="emix:SiScaleType"/>
                                        <xs:element ref="power:powerAttributes"/>
                                    </xs:sequence>
                                </xs:extension>
                            </xs:complexContent>
                        </xs:complexType>
                        <!-- ========================================================= -->
                        <xs:element name="powerAttributes" type="power:PowerAttributesType"/>
                        <xs:complexType name="PowerAttributesType">
                            <xs:sequence>
                                <xs:element name="hertz" type="xs:decimal"/>
                                <xs:element name="voltage" type="xs:decimal"/>
                                <xs:element name="ac" type="xs:boolean"/>
                            </xs:sequence>
                        </xs:complexType>
                        <!-- 9.9.5 Enumeration for Reserves and other Power Options -->
                        <xs:element name="powerOptionType" type="power:PowerOptionTypeType"/>
                        <xs:simpleType name="PowerOptionTypeType">
                            <xs:union memberTypes="power:PowerOptionTypeEnumeratedType
                    emix:EmixExtensionType"/>
                        </xs:simpleType>
                        <xs:simpleType name="PowerOptionTypeEnumeratedType">
                            <xs:annotation>
                                <xs:documentation>Power Reserve Options</xs:documentation>
```

```
          </xs:annotation>
          <xs:restriction base="xs:string">
                    <xs:enumeration value="SpinningReserve"/>
                    <xs:enumeration value="NonSpinningReserve"/>
                    <xs:enumeration value="OperatingReserve"/>
                    <xs:enumeration value="DemandResponse"/>
          </xs:restriction>
    </xs:simpleType>
</xs:schema>
```

F.2.2 Power Quality

Demonstrates extensibility of base Warrant classes, as well.

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- power-quality.xsd - Power Products for OASIS EMIX 1.0 WD23 (20110411)

Set includes:
    EMIX, EMIX-Requirements, EMIX-Warrants (emix)
    Power, Power-Contracts, Power-Quality (power)
    Resource (resource)

This set built on the WS-Calendar v1.0 PRD02 Schemas.
-->
<xs:schema xmlns:power="http://docs.oasis-open.org/ns/emix/power"
xmlns:emix="http://docs.oasis-open.org/ns/emix"
xmlns:xcal="urn:ietf:params:xml:ns:icalendar-2.0"
xmlns:clm5ISO42173A="urn:un:unece:uncefact:codelist:standard:5:ISO42173A:2010-04-07"
xmlns:gml="http://www.opengis.net/gml/3.2" xmlns:xs="http://www.w3.org/2001/XMLSchema"
targetNamespace="http://docs.oasis-open.org/ns/emix/power"
elementFormDefault="qualified" attributeFormDefault="unqualified">
    <xs:include schemaLocation="power.xsd"/>
    <xs:import namespace="http://docs.oasis-open.org/ns/emix" schemaLocation="emix.xsd"/>
    <!-- 6.0 Quality Warrants -->
    <xs:element name="powerQualityWarrant" type="power:PowerQualityWarrantType"
substitutionGroup="emix:baseWarrant"/>
    <xs:complexType name="PowerQualityWarrantType" mixed="false">
          <xs:annotation>
                    <xs:documentation>A Power Quality Warrant asserts or requires that the
power be of a certain quality or better.</xs:documentation>
          </xs:annotation>
          <xs:complexContent mixed="false">
                    <xs:extension base="emix:BaseWarrantType">
                              <xs:sequence>
                                        <xs:element name="measurementProtocol"
type="power:MeasurementProtocolType"/>
                                        <xs:element name="constraints"
type="power:ArrayOfPowerQualities"/>
                              </xs:sequence>
                    </xs:extension>
          </xs:complexContent>
    </xs:complexType>
    <!-- 6.1 Power Quality -->
    <xs:element name="powerQuality" type="power:PowerQualityType">
          <xs:annotation>
                    <xs:documentation>Power Quality warrant</xs:documentation>
          </xs:annotation>
    </xs:element>
    <xs:complexType name="PowerQualityType">
          <xs:annotation>
                    <xs:documentation>Power Quality consists of a number of measures,
based on contract, negotiation, and local regulation. Extend Power Qulity to incorporate
new elements by creating additional elements based on
PowerQualityBaseType</xs:documentation>
          </xs:annotation>
          <xs:sequence>
                    <xs:element name="measurementProtocol"
type="power:MeasurementProtocolType"/>
                    <xs:element name="constraints" type="power:ArrayOfPowerQualities"/>
          </xs:sequence>
    </xs:complexType>
```

```
    <xs:element name="basePowerQualityMeasurement"
type="power:BasePowerQualityMeasurementType" abstract="true">
          <xs:annotation>
               <xs:documentation>Abstract extension object for Power
Qualities</xs:documentation>
          </xs:annotation>
    </xs:element>
    <xs:complexType name="ArrayOfPowerQualities">
          <xs:annotation>
               <xs:documentation>Collection of Power Qualities</xs:documentation>
          </xs:annotation>
          <xs:sequence>
               <xs:element ref="power:basePowerQualityMeasurement" minOccurs="0"
maxOccurs="unbounded"/>
          </xs:sequence>
    </xs:complexType>
    <xs:complexType name="BasePowerQualityMeasurementType" abstract="true">
          <xs:annotation>
               <xs:documentation>An identification of the standard or other protocol
used to measure power quality. Sets definition for all other power attributes. Type of
Abstract extension object  for Power Qualities</xs:documentation>
          </xs:annotation>
    </xs:complexType>
    <!-- 6.1 Defined Power Qualities -->
    <xs:element name="powerFrequency" type="power:PowerFrequencyType"
substitutionGroup="power:basePowerQualityMeasurement"/>
    <xs:element name="supplyVoltageVariations" type="power:SupplyVoltageVariationsType"
substitutionGroup="power:basePowerQualityMeasurement"/>
    <xs:element name="rapidVoltageChanges" type="power:RapidVoltageChangesType"
substitutionGroup="power:basePowerQualityMeasurement"/>
    <xs:element name="flicker" type="power:FlickerType"
substitutionGroup="power:basePowerQualityMeasurement"/>
    <xs:element name="supplyVoltageDips" type="power:SupplyVoltageDipsType"
substitutionGroup="power:basePowerQualityMeasurement"/>
    <xs:element name="shortInterruptions" type="power:ShortInterruptionsType"
substitutionGroup="power:basePowerQualityMeasurement"/>
    <xs:element name="longInterruptions" type="power:LongInterruptionsType"
substitutionGroup="power:basePowerQualityMeasurement"/>
    <xs:element name="temporaryOvervoltage" type="power:TemporaryOvervoltageType"
substitutionGroup="power:basePowerQualityMeasurement"/>
    <xs:element name="supplyVoltageImbalance" type="power:SupplyVoltageImbalanceType"
substitutionGroup="power:basePowerQualityMeasurement"/>
    <xs:element name="harmonicVoltage" type="power:HarmonicVoltageType"
substitutionGroup="power:basePowerQualityMeasurement"/>
    <xs:element name="mainsVoltage" type="power:MainsVoltageType"
substitutionGroup="power:basePowerQualityMeasurement"/>
    <!-- 6.2 Defines Power Quality Measuress -->
    <xs:complexType name="PowerFrequencyType" mixed="false">
          <xs:annotation>
               <xs:documentation>measured Power frequency, e.g. 50.4, 59.9, ,
measured as per referenced measurement protocol. 0 for DC
                    </xs:documentation>
          </xs:annotation>
          <xs:complexContent mixed="false">
               <xs:extension base="power:BasePowerQualityMeasurementType">
                    <xs:sequence>
                         <xs:element name="frequency" type="xs:float"/>
                    </xs:sequence>
               </xs:extension>
          </xs:complexContent>
    </xs:complexType>
    <xs:complexType name="SupplyVoltageVariationsType" mixed="false">
          <xs:annotation>
               <xs:documentation>count of Supply Voltage Variations during the
period, measured as per referenced measurement protocol
          </xs:documentation>
          </xs:annotation>
          <xs:complexContent mixed="false">
               <xs:extension base="power:BasePowerQualityMeasurementType">
                    <xs:sequence>
                         <xs:element name="count" type="xs:int"/>
```

```
                    </xs:sequence>
                </xs:extension>
            </xs:complexContent>
        </xs:complexType>
        <xs:complexType name="RapidVoltageChangesType" mixed="false">
            <xs:annotation>
                <xs:documentation>count of Rapid Voltage Changes during the period,
measured as per referenced measurement protocol
            </xs:documentation>
            </xs:annotation>
            <xs:complexContent mixed="false">
                <xs:extension base="power:BasePowerQualityMeasurementType">
                    <xs:sequence>
                        <xs:element name="count" type="xs:int"/>
                    </xs:sequence>
                </xs:extension>
            </xs:complexContent>
        </xs:complexType>
        <xs:complexType name="FlickerType" mixed="false">
            <xs:annotation>
                <xs:documentation>count of Flicker during the period, measured as per
referenced measurement protocol
            </xs:documentation>
            </xs:annotation>
            <xs:complexContent mixed="false">
                <xs:extension base="power:BasePowerQualityMeasurementType">
                    <xs:sequence>
                        <xs:element name="count" type="xs:int"/>
                    </xs:sequence>
                </xs:extension>
            </xs:complexContent>
        </xs:complexType>
        <xs:complexType name="SupplyVoltageDipsType" mixed="false">
            <xs:annotation>
                <xs:documentation>count of Supply Voltage Dips during the period,
measured as per referenced measurement protocol
            </xs:documentation>
            </xs:annotation>
            <xs:complexContent mixed="false">
                <xs:extension base="power:BasePowerQualityMeasurementType">
                    <xs:sequence>
                        <xs:element name="count" type="xs:int"/>
                    </xs:sequence>
                </xs:extension>
            </xs:complexContent>
        </xs:complexType>
        <xs:complexType name="ShortInterruptionsType" mixed="false">
            <xs:annotation>
                <xs:documentation>count of Short Interruptions during the period,
measured as per referenced measurement protocol
            </xs:documentation>
            </xs:annotation>
            <xs:complexContent mixed="false">
                <xs:extension base="power:BasePowerQualityMeasurementType">
                    <xs:sequence>
                        <xs:element name="count" type="xs:int"/>
                    </xs:sequence>
                </xs:extension>
            </xs:complexContent>
        </xs:complexType>
        <xs:complexType name="LongInterruptionsType" mixed="false">
            <xs:annotation>
                <xs:documentation>count of Long Interuptions during the period,
measured as per referenced measurement protocol
            </xs:documentation>
            </xs:annotation>
            <xs:complexContent mixed="false">
                <xs:extension base="power:BasePowerQualityMeasurementType">
                    <xs:sequence>
                        <xs:element name="count" type="xs:int"/>
                    </xs:sequence>
```

```
                    </xs:extension>
                </xs:complexContent>
            </xs:complexType>
            <xs:complexType name="TemporaryOvervoltageType" mixed="false">
                <xs:annotation>
                    <xs:documentation>count of Temporary Overvoltage Events during the
period, measured as per referenced measurement protocol
                </xs:documentation>
                </xs:annotation>
                <xs:complexContent mixed="false">
                    <xs:extension base="power:BasePowerQualityMeasurementType">
                        <xs:sequence>
                            <xs:element name="count" type="xs:int"/>
                        </xs:sequence>
                    </xs:extension>
                </xs:complexContent>
            </xs:complexType>
            <xs:complexType name="SupplyVoltageImbalanceType" mixed="false">
                <xs:annotation>
                    <xs:documentation>count of Supply Voltage Imbalance events during the
period,  measured as per referenced measurement protocol. Not meaningful for DC.
                </xs:documentation>
                </xs:annotation>
                <xs:complexContent mixed="false">
                    <xs:extension base="power:BasePowerQualityMeasurementType">
                        <xs:sequence>
                            <xs:element name="count" type="xs:int"/>
                        </xs:sequence>
                    </xs:extension>
                </xs:complexContent>
            </xs:complexType>
            <xs:complexType name="HarmonicVoltageType" mixed="false">
                <xs:annotation>
                    <xs:documentation>Harmonic Voltage during the period, measured as per
referenced measurement protocol. For DC, distortion is with respect to a signal of 0 Hz,
    The period is usually much shorter than other power quality measures.
                </xs:documentation>
                </xs:annotation>
                <xs:complexContent mixed="false">
                    <xs:extension base="power:BasePowerQualityMeasurementType">
                        <xs:sequence>
                            <xs:element name="voltage" type="xs:float"/>
                        </xs:sequence>
                    </xs:extension>
                </xs:complexContent>
            </xs:complexType>
            <xs:complexType name="MainsVoltageType" mixed="false">
                <xs:annotation>
                    <xs:documentation>Mains [Signaling] Voltage. Nominal value, e.g, 110,
130, 220, 208. See referenced measurement protocol for definition.
                </xs:documentation>
                </xs:annotation>
                <xs:complexContent mixed="false">
                    <xs:extension base="power:BasePowerQualityMeasurementType">
                        <xs:sequence>
                            <xs:element name="voltage" type="xs:float"/>
                        </xs:sequence>
                    </xs:extension>
                </xs:complexContent>
            </xs:complexType>
            <xs:simpleType name="MeasurementProtocolType">
                <xs:union memberTypes="power:MeasurementProtocolEnumeratedType
emix:EmixExtensionType"/>
            </xs:simpleType>
            <xs:simpleType name="MeasurementProtocolEnumeratedType">
                <xs:annotation>
                    <xs:documentation>An identification of the standard or other protocol
used to measure power quality. Sets definition for all other power
attributes</xs:documentation>
                </xs:annotation>
                <xs:restriction base="xs:string">
```

```
                    <xs:enumeration value="EN 50160"/>
                    <xs:enumeration value="IEEE 1549-2009"/>
                </xs:restriction>
            </xs:simpleType>
        </xs:schema>
```

F.2.3 Power Products.xsd

```
        <?xml version="1.0" encoding="UTF-8"?>
        <!-- power-quality.xsd - Power Products for OASIS EMIX 1.0 WD23 (20110411)

        Set includes:
            EMIX, EMIX-Requirements, EMIX-Warrants (emix)
            Power, Power-Contracts, Power-Quality (power)
            Resource (resource)

        This set built on the WS-Calendar v1.0 PRD02 Schemas.
        -->
        <xs:schema xmlns:power="http://docs.oasis-open.org/ns/emix/power"
        xmlns:emix="http://docs.oasis-open.org/ns/emix"
        xmlns:xcal="urn:ietf:params:xml:ns:icalendar-2.0"
        xmlns:clm5ISO42173A="urn:un:unece:uncefact:codelist:standard:5:ISO42173A:2010-04-07"
        xmlns:gml="http://www.opengis.net/gml/3.2" xmlns:xs="http://www.w3.org/2001/XMLSchema"
        targetNamespace="http://docs.oasis-open.org/ns/emix/power"
        elementFormDefault="qualified" attributeFormDefault="unqualified">
            <xs:include schemaLocation="power.xsd"/>
            <xs:import namespace="http://docs.oasis-open.org/ns/emix" schemaLocation="emix.xsd"/>
            <!-- 2.0 Power Products -->
            <xs:element name="powerProductDescription" type="power:PowerProductDescriptionType"
        substitutionGroup="emix:productDescription"/>
            <xs:complexType name="PowerProductDescriptionType" abstract="true">
                <xs:annotation>
                    <xs:documentation>Type of Product Description for simple transactions.
        Also used as template for other Power Product Description Types. A product is advertised
        (or bought) with a constant power, which dictates the rate of delivery. After a
        specified duration, energy has been delivered, at a price per energy, price per unit
        energy</xs:documentation>
                </xs:annotation>
                <xs:complexContent>
                    <xs:extension base="emix:ProductDescriptionType">
                        <xs:sequence>
                            <xs:element ref="power:productType"/>
                            <xs:element ref="emix:emixInterface"/>
                            <xs:element ref="power:unitEnergyPrice"/>
                            <xs:element ref="power:powerItem"/>
                            <xs:element name="charges"
        type="power:ArrayOfCharges"/>
                        </xs:sequence>
                    </xs:extension>
                </xs:complexContent>
            </xs:complexType>
            <!-- 2.1 Full Requirements Power -->
            <xs:element name="fullRequirementsPower" type="power:FullRequirementsPowerType"
        substitutionGroup="power:powerProductDescription"/>
            <xs:complexType name="FullRequirementsPowerType">
                <xs:annotation>
                    <xs:documentation>Type of Product Description for Supplier to provide
        for full requirements of buyer. Simple prices, will supply all used. Demand Charges
        Optional. Often used in retail residential rates.</xs:documentation>
                </xs:annotation>
                <xs:complexContent>
                    <xs:extension base="power:PowerProductDescriptionType">
                        <xs:sequence>
                            <xs:element ref="emix:priceBase"/>
                            <xs:element name="maximumPower"
        type="emix:QuantityType"/>
                            <xs:element name="minimumPower"
        type="emix:QuantityType"/>
                        </xs:sequence>
                    </xs:extension>
```

```
            </xs:complexContent>
    </xs:complexType>
    <!-- 2.2 Block Power Full Requirements -->
    <xs:element name="blockPowerFullRequirements"
type="power:BlockPowerFullRequirementsType"
substitutionGroup="power:powerProductDescription"/>
    <xs:complexType name="BlockPowerFullRequirementsType">
            <xs:annotation>
                    <xs:documentation>Type of Product Description for Supplier to provide
for full requirements of buyer in "blocks". Price is constant within a block, but
changes as each block is used during a period. Demand Charges MAY be included. Often
used in retail residential rates.</xs:documentation>
            </xs:annotation>
            <xs:complexContent>
                    <xs:extension base="power:PowerProductDescriptionType">
                            <xs:sequence minOccurs="1" maxOccurs="unbounded">
                                    <xs:element name="powerPriceTiers"
type="power:ArrayOfBlockPowerPrices" minOccurs="1" maxOccurs="1"/>
                                    <xs:element name="maximumPower"
type="emix:QuantityType" minOccurs="0" maxOccurs="1"/>
                                    <xs:element name="minimumPower"
type="emix:QuantityType" minOccurs="0" maxOccurs="1"/>
                            </xs:sequence>
                    </xs:extension>
            </xs:complexContent>
    </xs:complexType>
    <!-- 2.3 Transport Service -->
    <xs:element name="transportProduct" type="power:TransportProductType"
substitutionGroup="power:powerProductDescription"/>
    <xs:complexType name="TransportProductType">
            <xs:annotation>
                    <xs:documentation>Type of Product Description for charges and revenue
related to Transport Services for a Power Product, i.e., the movement of Power through
Transmission and Distribution. The Interface used matches a segment of the transport
infrastructure, usually idetifed by an injection node and a delivery
node.</xs:documentation>
            </xs:annotation>
            <xs:complexContent>
                    <xs:extension base="power:PowerProductDescriptionType">
                            <xs:sequence>
                                    <xs:element name="transportCharges"
type="power:ArrayOfTransportCharges"/>
                            </xs:sequence>
                    </xs:extension>
            </xs:complexContent>
    </xs:complexType>
    <!-- 2.1 TEMIX Power -->
    <xs:element name="temixPower" type="power:TemixPowerType"
substitutionGroup="emix:productDescription"/>
    <xs:complexType name="TemixPowerType">
            <xs:annotation>
                    <xs:documentation>Type of contract Product Description for Supplier to
a specific sized block of power to buyer. Simple prices, will supply fixed block.
Derived directly from emix:ProductDescriptionType rather than
power:PowerProductDescriptionType because optionality stripped out.</xs:documentation>
            </xs:annotation>
            <xs:complexContent>
                    <xs:extension base="emix:ProductDescriptionType">
                            <xs:sequence>
                                    <xs:element ref="emix:emixInterface"/>
                                    <xs:element ref="emix:price" minOccurs="1"
maxOccurs="1"/>
                                    <xs:element ref="power:powerItem" minOccurs="1"
maxOccurs="1"/>
                                    <xs:element ref="power:energyItem" minOccurs="1"
maxOccurs="1"/>
                                    <xs:element ref="emix:quantity" minOccurs="1"
maxOccurs="1"/>
                            </xs:sequence>
                    </xs:extension>
            </xs:complexContent>
```

```
    </xs:complexType>
    <!--
================================================================================
====== -->
    <!-- Charge Defintions -->
    <!--
================================================================================
====== -->
    <!-- 2.5 Charge Abstractions -->
    <xs:element name="baseCharge" type="power:BaseChargeType" abstract="true">
        <xs:annotation>
            <xs:documentation>Abstract extension object for Emix Power Product
Charges</xs:documentation>
        </xs:annotation>
    </xs:element>
    <xs:complexType name="ArrayOfCharges">
        <xs:annotation>
            <xs:documentation>Collection of Emix Power Product
Charges</xs:documentation>
        </xs:annotation>
        <xs:sequence>
            <xs:element ref="power:baseCharge" minOccurs="0"
maxOccurs="unbounded"/>
        </xs:sequence>
    </xs:complexType>
    <xs:complexType name="BaseChargeType" abstract="true">
        <xs:annotation>
            <xs:documentation>Type of Abstract extension object for  Emix Power
Product Charges</xs:documentation>
        </xs:annotation>
    </xs:complexType>
    <!--
================================================================================
====== -->
    <!-- 2.6 General Charges -->
    <!-- 2.6.1 Blocks for use in Block Power -->
    <xs:element name="blockPowerPrice" type="power:BlockPowerPriceType"
substitutionGroup="power:baseCharge"/>
    <xs:complexType name="BlockPowerPriceType" mixed="false">
        <xs:complexContent mixed="false">
            <xs:extension base="power:BaseChargeType">
                <xs:sequence>
                    <xs:element ref="emix:priceBase"/>
                    <xs:element name="maximumEnergyQuantity"
type="emix:QuantityType"/>
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
    <xs:complexType name="ArrayOfBlockPowerPrices">
        <xs:annotation>
            <xs:documentation>Collection of Emix Block Power
Prices</xs:documentation>
        </xs:annotation>
        <xs:sequence>
            <xs:element ref="power:blockPowerPrice" minOccurs="0"
maxOccurs="unbounded"/>
        </xs:sequence>
    </xs:complexType>
    <!--
================================================================================
====== -->
    <!-- 2.6.2 Demand Charges -->
    <xs:element name="demandCharge" type="power:DemandChargeType"
substitutionGroup="power:baseCharge"/>
    <xs:complexType name="DemandChargeType" mixed="false">
        <xs:complexContent mixed="false">
            <xs:extension base="power:BaseChargeType">
                <xs:sequence>
                    <xs:element name="demandChargeUnits"
type="power:PowerItemType"/>
```

```
                                    <xs:element name="demandChargeFloor"
type="emix:QuantityType"/>
                                    <xs:element name="demandChargeRate"
type="emix:PriceBaseType"/>
                                    <xs:element name="measurementInterval"
type="emix:DurationType"/>
                                    <xs:element name="collectionInterval"
type="emix:DurationType"/>
                                    <xs:element name="collectionPeriod"
type="emix:DurationType"/>
                                    <xs:element name="chargeDuration"
type="emix:DurationType"/>
                                </xs:sequence>
                            </xs:extension>
                        </xs:complexContent>
                    </xs:complexType>
                    <!--
------------------------------------------------------------------------------------
------ -->
                    <!-- Transport Charges and Losses Types -->
                    <!--
------------------------------------------------------------------------------------
------ -->
                    <!-- 2.7 Transport Abstract Types -->
                    <xs:element name="baseTransportCharge" type="power:BaseTransportChargeType"
abstract="true" substitutionGroup="power:baseCharge">
                        <xs:annotation>
                            <xs:documentation>Abstract extension object for Emix Power Product
Charges</xs:documentation>
                        </xs:annotation>
                    </xs:element>
                    <xs:complexType name="ArrayOfTransportCharges">
                        <xs:annotation>
                            <xs:documentation>Collection of Emix Power Transport Product
Charges</xs:documentation>
                        </xs:annotation>
                        <xs:sequence>
                            <xs:element ref="power:baseTransportCharge" minOccurs="0"
maxOccurs="unbounded"/>
                        </xs:sequence>
                    </xs:complexType>
                    <xs:complexType name="BaseTransportChargeType" abstract="true" mixed="false">
                        <xs:annotation>
                            <xs:documentation>Type of Abstract extension object for  Emix
Transport Charges</xs:documentation>
                        </xs:annotation>
                        <xs:complexContent mixed="false">
                            <xs:extension base="power:BaseChargeType"/>
                        </xs:complexContent>
                    </xs:complexType>
                    <!--
------------------------------------------------------------------------------------
------ -->
                    <!-- 2.8 Congestion and Loss Charges -->
                    <!-- 2.8.1 Congestion Revenue Rights Charge-->
                    <xs:element name="congestionRevenueRights" type="power:CongestionRevenueRightsType"
substitutionGroup="power:baseTransportCharge"/>
                    <xs:complexType name="CongestionRevenueRightsType" mixed="false">
                        <xs:annotation>
                            <xs:documentation>Financial Hedge for Congestion, a forward contract
for congestion revenues to potentially offset congestion charges. Also known as
Financial Transmission Rights or Congestion Revenue Rights</xs:documentation>
                        </xs:annotation>
                        <xs:complexContent mixed="false">
                            <xs:extension base="power:BaseTransportChargeType">
                                <xs:sequence>
                                    <xs:element ref="power:transportInterface"/>
                                    <xs:element ref="power:transportCongestionFee"/>
                                </xs:sequence>
                            </xs:extension>
                        </xs:complexContent>
```

```
    </xs:complexType>
    <!-- 2.8.2 Congestion Charge-->
    <xs:element name="congestionCharge" type="power:CongestionChargeType"
substitutionGroup="power:baseTransportCharge"/>
    <xs:complexType name="CongestionChargeType" mixed="false">
        <xs:annotation>
            <xs:documentation>Congestion Charge is the cost of purchasing the
right to transfer power over a given segment of the grid.</xs:documentation>
        </xs:annotation>
        <xs:complexContent mixed="false">
            <xs:extension base="power:BaseTransportChargeType">
                <xs:sequence>
                    <xs:element ref="power:transportInterface"/>
                    <xs:element ref="power:transportCongestionFee"/>
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
    <!-- 2.8.3 Marginal Loss Charge -->
    <xs:element name="marginalLossCharge" type="power:MarginalLossChargeType"
substitutionGroup="power:baseTransportCharge"/>
    <xs:complexType name="MarginalLossChargeType" mixed="false">
        <xs:complexContent mixed="false">
            <xs:extension base="power:BaseTransportChargeType">
                <xs:sequence>
                    <xs:element ref="power:marginalLossFee"/>
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
    <!-- 2.8.4 Marginal Loss -->
    <xs:element name="marginalLoss" type="power:MarginalLossType"
substitutionGroup="power:baseTransportCharge"/>
    <xs:complexType name="MarginalLossType" mixed="false">
        <xs:complexContent mixed="false">
            <xs:extension base="power:BaseTransportChargeType">
                <xs:sequence>
                    <xs:element ref="power:lossFactor"/>
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
    <!-- 2.8.5 Conversion Loss -->
    <xs:element name="conversionLoss" type="power:ConversionLossType"
substitutionGroup="power:baseTransportCharge"/>
    <xs:complexType name="ConversionLossType" mixed="false">
        <xs:complexContent mixed="false">
            <xs:extension base="power:BaseTransportChargeType">
                <xs:sequence>
                    <xs:element ref="power:pnode"/>
                    <xs:element ref="power:lossFactor"/>
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
    <xs:element name="transportAccessFee" type="power:TransportAccessFeeType"
substitutionGroup="power:baseTransportCharge"/>
    <xs:complexType name="TransportAccessFeeType" mixed="false">
        <xs:annotation>
            <xs:documentation>Transport Access Fee is a Fixed Charge (not
dependent on congestion or quantity) to access a transport system.</xs:documentation>
        </xs:annotation>
        <xs:complexContent mixed="false">
            <xs:extension base="power:BaseTransportChargeType">
                <xs:sequence>
                    <xs:element ref="power:transportInterface"/>
                    <xs:element ref="emix:price"/>
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
```

```
    <!--
    ================================================================================================
    ====== -->
    <!-- 2.9 Elemental Charge and Loss Types -->
    <!--
    ================================================================================================
    ====== -->
    <!-- 2.9.3 Loss Fee -->
    <xs:element name="marginalLossFee" type="power:MarginalLossFeeType"/>
    <xs:simpleType name="MarginalLossFeeType">
        <xs:annotation>
            <xs:documentation>Marginal Loss Fee</xs:documentation>
        </xs:annotation>
        <xs:restriction base="xs:decimal"/>
    </xs:simpleType>
    <!-- 2.9.4 Transport Congestion Fee -->
    <xs:element name="transportCongestionFee" type="power:TransportCongestionFeeType"/>
    <xs:simpleType name="TransportCongestionFeeType">
        <xs:annotation>
            <xs:documentation>Financial Transmission Rights (FTR) regarding
transmission capacity.</xs:documentation>
        </xs:annotation>
        <xs:restriction base="xs:decimal"/>
    </xs:simpleType>
    <!-- 2.9.5 Loss Factor -->
    <xs:element name="lossFactor" type="power:LossFactorType"/>
    <xs:simpleType name="LossFactorType">
        <xs:annotation>
            <xs:documentation>Reduction in amount delivered as product travels.
(lossFactor * purchase amount) = delivered amount</xs:documentation>
        </xs:annotation>
        <xs:restriction base="xs:float">
            <xs:maxInclusive value="1"/>
        </xs:restriction>
    </xs:simpleType>
    <!-- 2.9.6 Enumeration & Simple Types for Products -->
    <xs:element name="productType" type="power:ProductTypeType"/>
    <xs:simpleType name="ProductTypeType">
        <xs:union memberTypes="power:ProductTypeEnumeratedType emix:EmixExtensionType
power:PowerOptionTypeType"/>
    </xs:simpleType>
    <xs:simpleType name="ProductTypeEnumeratedType">
        <xs:restriction base="xs:string">
            <xs:enumeration value="Energy"/>
            <xs:enumeration value="Transport"/>
            <xs:enumeration value="EnergyOption"/>
            <xs:enumeration value="TransportOption"/>
            <xs:enumeration value="FullRequirementsPower"/>
            <xs:enumeration value="FullRequirementsPowerWithDemandCharge"/>
            <xs:enumeration value="FullRequirementsPowerWithMaximumAndMinimum"/>
            <xs:enumeration value="HourlyDayAhead"/>
            <xs:enumeration value="Ex-AnteRealTimePrice"/>
            <xs:enumeration value="TimeOfUsePricing"/>
            <xs:enumeration value="Transport"/>
            <xs:enumeration value="CongestionRevenueRights"/>
        </xs:restriction>
    </xs:simpleType>
</xs:schema>
```

F.3 Resource.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- edited with XMLSpy v2011 rel. 2 (x64) (http://www.altova.com) by Toby Considine
(TC9, Inc) -->
<!-- resource.xsd – Resource Descriptions for OASIS EMIX 1.0 WD23 (20110411)

Set includes:
    EMIX, EMIX-Requirements, EMIX-Warrants (emix)
    Power, Power-Contracts, Power-Quality (power)
    Resource (resource)
```

```
This set built on the WS-Calendar v1.0 PRD02 Schemas.
-->
<xs:schema xmlns:resource="http://docs.oasis-open.org/ns/emix/power/resource"
xmlns:power="http://docs.oasis-open.org/ns/emix/power" xmlns:emix="http://docs.oasis-
open.org/ns/emix" xmlns:xcal="urn:ietf:params:xml:ns:icalendar-2.0"
xmlns:clm5ISO42173A="urn:un:unece:uncefact:codelist:standard:5:ISO42173A:2010-04-07"
xmlns:gml="http://www.opengis.net/gml/3.2" xmlns:xs="http://www.w3.org/2001/XMLSchema"
targetNamespace="http://docs.oasis-open.org/ns/emix/power/resource"
elementFormDefault="qualified" attributeFormDefault="unqualified">
   <xs:import namespace="http://docs.oasis-open.org/ns/emix" schemaLocation="emix.xsd"/>
   <xs:import namespace="http://docs.oasis-open.org/ns/emix/power"
schemaLocation="power.xsd"/>
   <!-- 3.0 Resource are described in terms of their capabilities Capabilities to aid in
the matching of need and supplier -->
   <xs:element name="loadReduction" type="resource:LoadReductionType"
substitutionGroup="emix:productDescription"/>
   <xs:element name="generation" type="resource:GenerationType"
substitutionGroup="emix:productDescription"/>
   <xs:element name="activeReserve" type="resource:ActiveReserveType"
substitutionGroup="emix:productDescription"/>
   <xs:element name="regulationService" type="resource:RegulationServiceType"
substitutionGroup="emix:productDescription"/>
   <xs:element name="productVoltageRegulation"
type="resource:ProductVoltageRegulationType"
substitutionGroup="emix:productDescription"/>
   <!-- 3.1 Load resource -->
   <xs:complexType name="LoadReductionType">
      <xs:annotation>
         <xs:documentation>A Load Reduction Resource ramps down, stays down,
and then ramps up. For stagingRamps, endRamp is less than beginRamp. For recoveryRamps,
endRamp is greater than beginRamp.</xs:documentation>
      </xs:annotation>
      <xs:complexContent>
         <xs:extension base="resource:PowerResponseType"/>
      </xs:complexContent>
   </xs:complexType>
   <!-- 3.2 Generation Resource -->
   <xs:complexType name="GenerationType">
      <xs:annotation>
         <xs:documentation>A Generation Resource ramps up, stays up, and then
ramps down. For stagingRamps, endRamp is greater than beginRamp. For recoveryRamps,
endRamp is less than beginRamp.</xs:documentation>
      </xs:annotation>
      <xs:complexContent>
         <xs:extension base="resource:PowerResponseType">
            <xs:sequence>
               <xs:element name="Type"
type="resource:ResourceTypeType" minOccurs="0" maxOccurs="1"/>
            </xs:sequence>
         </xs:extension>
      </xs:complexContent>
   </xs:complexType>
   <!-- 3.5 Active Reserve -->
   <xs:complexType name="ActiveReserveType">
      <xs:annotation>
         <xs:documentation>Active Reserve</xs:documentation>
      </xs:annotation>
      <xs:complexContent>
         <xs:extension base="resource:ResourceDescriptionType">
            <xs:sequence>
               <xs:element ref="power:powerOptionType"/>
               <xs:element ref="resource:targetRegulation"/>
               <xs:element ref="resource:dispatchTime"/>
               <xs:element ref="emix:autonomous" minOccurs="0">
                  <xs:annotation>
                     <xs:documentation>Resource provides
autonomous management of its local circuits. If true, service notes local conditions and
dispatches itself. If false, it waits for dispatch request from VTN.</xs:documentation>
                  </xs:annotation>
               </xs:element>
```

```
                                        <xs:element ref="resource:maximumDeliveryRate"/>
                                        <xs:element ref="resource:minimumDeliveryRate"/>
                                    </xs:sequence>
                                </xs:extension>
                            </xs:complexContent>
                        </xs:complexType>
                        <!-- 3.6 Regulation Service Product -->
                        <xs:complexType name="RegulationServiceType">
                            <xs:annotation>
                                <xs:documentation>Regulation Service</xs:documentation>
                            </xs:annotation>
                            <xs:complexContent>
                                <xs:extension base="resource:ResourceDescriptionType">
                                    <xs:sequence>
                                        <xs:element ref="resource:productTypeRegulation"/>
                                        <xs:element ref="resource:targetRegulation"/>
                                        <xs:element ref="resource:dispatchUp"/>
                                        <xs:element ref="resource:dispatchDown"/>
                                        <xs:element ref="emix:autonomous"/>
                                        <!-- frequency response faster than freq regulation -->
                                    </xs:sequence>
                                </xs:extension>
                            </xs:complexContent>
                        </xs:complexType>
                        <!-- 3.6 Voltage Regulation -->
                        <xs:complexType name="ProductVoltageRegulationType">
                            <xs:annotation>
                                <xs:documentation>Voltage Regulation</xs:documentation>
                                <xs:appinfo>At the end of the scheduled interval, VAR resources should
return to their original state</xs:appinfo>
                            </xs:annotation>
                            <xs:complexContent>
                                <xs:extension base="resource:ResourceDescriptionType">
                                    <xs:sequence>
                                        <!-- *** <xs:element name="voltVar"
type="resource:VoltVarType" maxOccurs="unbounded"/> -->
                                        <xs:element ref="resource:rampTime">
                                            <xs:annotation>
                                                <xs:documentation>Requested ramp time to
move from the current setpoint to the new setpoint</xs:documentation>
                                            </xs:annotation>
                                        </xs:element>
                                        <xs:element ref="resource:window">
                                            <xs:annotation>
                                                <xs:documentation>Time window within
which to randomly execute the command. If the time window is zero, the command will be
executed immediately, (if not included, then default time window for this function will
be used)</xs:documentation>
                                            </xs:annotation>
                                        </xs:element>
                                    </xs:sequence>
                                </xs:extension>
                            </xs:complexContent>
                        </xs:complexType>
                        <!-- 3.9 Resource Description -->
                        <xs:complexType name="ResourceDescriptionType">
                            <xs:annotation>
                                <xs:documentation>Resource Description based on the EMIX Product
Description.</xs:documentation>
                            </xs:annotation>
                            <xs:complexContent>
                                <xs:extension base="emix:ProductDescriptionType">
                                    <xs:sequence>
                                        <xs:element ref="resource:mrid"/>
                                        <xs:element ref="emix:emixInterface"/>
                                        <xs:element ref="emix:constraints" minOccurs="0"
maxOccurs="1"/>
                                    </xs:sequence>
                                </xs:extension>
                            </xs:complexContent>
                        </xs:complexType>
```

```
    <!-- 3.9.1 Resource Types -->
    <xs:element name="resourceType" type="resource:ResourceTypeType"/>
    <xs:simpleType name="ResourceTypeType">
        <xs:union memberTypes="resource:ResourceTypeEnumeratedType
emix:EmixExtensionType"/>
    </xs:simpleType>
    <xs:simpleType name="ResourceTypeEnumeratedType">
        <xs:annotation>
            <xs:documentation>Resource types share common responsiveness and
predictability characteristics, sometimes covarying across resources in the same class.
(Example: Solar in the same region failing at the same time)</xs:documentation>
        </xs:annotation>
        <xs:restriction base="xs:token">
            <xs:enumeration value="DispatchableHydro"/>
            <xs:enumeration value="NonDispatchableHydro"/>
            <xs:enumeration value="WindGeneration"/>
            <xs:enumeration value="SolarGeneration"/>
            <xs:enumeration value="TollingContract"/>
            <xs:enumeration value="AggregateResource"/>
            <xs:enumeration value="DispatchableStorage"/>
        </xs:restriction>
    </xs:simpleType>
    <!-- 3.9.2 Regulation Products -->
    <xs:element name="productTypeRegulation" type="resource:ProductTypeRegulationType"/>
    <xs:simpleType name="ProductTypeRegulationType">
        <xs:annotation>
            <xs:documentation>enumerates the Voltage Regulation
Products</xs:documentation>
        </xs:annotation>
        <xs:restriction base="xs:string">
            <xs:enumeration value="RegulationUp"/>
            <xs:enumeration value="RegulationDn"/>
            <xs:enumeration value="RegulationUp-Dn"/>
        </xs:restriction>
    </xs:simpleType>
    <!-- 4.0 Resource Semantics -->
    <!-- 4.1 Resource Capability -->
    <xs:element name="powerResponse" type="resource:PowerResponseType"/>
    <xs:complexType name="PowerResponseType" abstract="true">
        <xs:annotation>
            <xs:documentation>Generic model describing the power response
capabilities of a resource</xs:documentation>
        </xs:annotation>
        <xs:complexContent>
            <xs:extension base="resource:ResourceDescriptionType">
                <xs:sequence>
                    <xs:element ref="resource:stagingRamp" minOccurs="0"
maxOccurs="1"/>
                    <xs:element ref="resource:maximumResponse"
minOccurs="0" maxOccurs="1"/>
                    <xs:element ref="resource:minimumResponse"
maxOccurs="1"/>
                    <xs:element ref="resource:recoveryRamp" minOccurs="0"
maxOccurs="1"/>
                    <xs:element ref="resource:offerCurve" minOccurs="0"
maxOccurs="1"/>
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
    <!-- 4.1 Ramp Rates -->
    <!-- 4.1.3 Power Ramp Rate -->
    <xs:element name="stagingRamp" type="resource:ArrayOfRampSegments"/>
    <xs:element name="recoveryRamp" type="resource:ArrayOfRampSegments"/>
    <xs:element name="powerRamp" type="resource:ArrayOfRampSegments"/>
    <xs:complexType name="PowerRampType">
        <xs:annotation>
            <xs:documentation>A Power Ramp is an Array of of Ramp Segments that
describing a Resource's ability to change level. A Power Ramp is either monotonically
increasing or monotonically decreasing.</xs:documentation>
        </xs:annotation>
```

```
            <xs:sequence>
                <xs:element ref="resource:rampSegments"/>
            </xs:sequence>
        </xs:complexType>
        <xs:element name="rampSegments" type="resource:ArrayOfRampSegments"/>
        <xs:complexType name="ArrayOfRampSegments">
            <xs:annotation>
                <xs:documentation>Collection of Power Ramp Segments</xs:documentation>
            </xs:annotation>
            <xs:sequence>
                <xs:element ref="resource:powerRampSegment" minOccurs="0"
maxOccurs="unbounded"/>
            </xs:sequence>
        </xs:complexType>
        <xs:element name="powerRampSegment" type="resource:PowerRampSegmentType"/>
        <xs:complexType name="PowerRampSegmentType">
            <xs:annotation>
                <xs:documentation>A Power Ramp Segment describes a change up or down
in units/duration. A ramp rate holds for the duration between beginRamp to
endRamp</xs:documentation>
            </xs:annotation>
            <xs:sequence>
                <xs:element name="rate" type="power:PowerQuantityType"/>
                <xs:element ref="emix:duration"/>
                <xs:element ref="resource:beginRamp"/>
                <xs:element ref="resource:endRamp"/>
                <xs:element ref="emix:integralOnly"/>
            </xs:sequence>
        </xs:complexType>
        <xs:element name="beginRamp" type="xs:int"/>
        <xs:element name="endRamp" type="xs:int"/>
        <!-- 4.1.4 Power Ramp Rate -->
        <xs:element name="percentRampRate" type="resource:PercentRampRateType"/>
        <xs:complexType name="PercentRampRateType">
            <xs:annotation>
                <xs:documentation>Change up or down in percent of total
response.</xs:documentation>
            </xs:annotation>
            <xs:sequence>
                <xs:element ref="resource:rate"/>
                <xs:element ref="emix:duration"/>
            </xs:sequence>
        </xs:complexType>
        <!-- 4.2 Constraints and Requirements unique to Power Resources-->
        <xs:element name="minimumLoad" type="resource:MinimumLoadType"
substitutionGroup="emix:baseConstraint">
            <xs:annotation>
                <xs:documentation>Constraint on Minimum Load that a Resource can
maintain</xs:documentation>
            </xs:annotation>
        </xs:element>
        <xs:element name="maximumPower" type="resource:MaximumPowerType"
substitutionGroup="emix:baseConstraint">
            <xs:annotation>
                <xs:documentation>Constraint on Maximum Power available from a
resource</xs:documentation>
            </xs:annotation>
        </xs:element>
        <xs:element name="maximumEnergy" type="resource:MaximumEnergyType"
substitutionGroup="emix:baseConstraint">
            <xs:annotation>
                <xs:documentation>Constraint on Maximum Energy available from a
resource</xs:documentation>
            </xs:annotation>
        </xs:element>
        <xs:element name="minimumLoadReduction" type="resource:MinimumLoadReductionType"
substitutionGroup="emix:baseConstraint">
            <xs:annotation>
                <xs:documentation>Constraint on Minimum Load Reduction resource can
make</xs:documentation>
            </xs:annotation>
```

```
    </xs:element>
    <xs:complexType name="MinimumLoadType" mixed="false">
        <xs:annotation>
            <xs:documentation>ype of Constraint on Minimum Load that a Resource
can maintain</xs:documentation>
        </xs:annotation>
        <xs:complexContent mixed="false">
            <xs:extension base="emix:BaseConstraintType">
                <xs:sequence>
                    <xs:element ref="power:powerQuantity"/>
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
    <xs:complexType name="MaximumPowerType" mixed="false">
        <xs:annotation>
            <xs:documentation>Type of Constraint on Maximum Power available from a
resource</xs:documentation>
        </xs:annotation>
        <xs:complexContent mixed="false">
            <xs:extension base="emix:BaseConstraintType">
                <xs:sequence>
                    <xs:element ref="power:powerQuantity" minOccurs="1"
maxOccurs="1"/>
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
    <xs:complexType name="MaximumEnergyType" mixed="false">
        <xs:annotation>
            <xs:documentation> Type of Constraint on Maximum Energy available from
a resource</xs:documentation>
        </xs:annotation>
        <xs:complexContent mixed="false">
            <xs:extension base="emix:BaseConstraintType">
                <xs:sequence>
                    <xs:element ref="power:energyQuantity"/>
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
    <!-- 4.2.5 Minimum Load Reduction -->
    <xs:complexType name="MinimumLoadReductionType" mixed="false">
        <xs:annotation>
            <xs:documentation>Minimum units for a load reduction (e.g., MW rating
of a discrete pump)</xs:documentation>
        </xs:annotation>
        <xs:complexContent mixed="false">
            <xs:extension base="emix:BaseConstraintType">
                <xs:sequence>
                    <xs:element ref="power:powerQuantity" minOccurs="1"
maxOccurs="1"/>
                </xs:sequence>
            </xs:extension>
        </xs:complexContent>
    </xs:complexType>
    <!-- 4.3.1 Offer Segment elements  -->
    <xs:element name="offerCurve" type="resource:OfferCurveType"
substitutionGroup="emix:baseRequirement"/>
    <xs:complexType name="OfferCurveType" mixed="false">
        <xs:annotation>
            <xs:documentation>Type of a collection of Offer Segments used to
compute cost requirements across a range of power.</xs:documentation>
        </xs:annotation>
        <xs:complexContent mixed="false">
            <xs:extension base="emix:BaseRequirementType">
                <xs:sequence>
                    <xs:element name="offerSegment"
type="resource:OfferSegmentType" maxOccurs="unbounded"/>
                </xs:sequence>
            </xs:extension>
```

```
            </xs:complexContent>
    </xs:complexType>
    <xs:element name="offerSegment" type="resource:OfferSegmentType"/>
    <xs:complexType name="OfferSegmentType">
            <xs:annotation>
                    <xs:documentation> Type of Marginal offer for Power within a range.
Marginal costs must be computed within the context of a range of segments as conformed
by the Offer Type</xs:documentation>
            </xs:annotation>
            <xs:sequence>
                    <xs:element ref="emix:price"/>
                    <xs:element ref="emix:quantity"/>
                    <xs:element ref="power:powerItem"/>
                    <xs:element ref="emix:integralOnly"/>
            </xs:sequence>
    </xs:complexType>
    <!-- 4.3.9 Resource ID -->
    <xs:element name="mrid" type="resource:MridType"/>
    <xs:simpleType name="MridType">
            <xs:annotation>
                    <xs:documentation>multi-part resource  id from the ISO TC57
CIM.</xs:documentation>
            </xs:annotation>
            <xs:restriction base="xs:string"/>
    </xs:simpleType>
    <!-- 4.4  Volt-Var Elements -->
    <!-- 4.4.1 VMin -->
    <!-- These are the 4 parts of an inverter.. -->
    <xs:element name="vMin" type="resource:VMinType"/>
    <xs:complexType name="VMinType">
            <xs:annotation>
                    <xs:documentation>The minimum voltage level of the Voltage Regulation
Service. In IEEE 1547, this represents a voltage level of 88% of nominal voltage for a
photovoltaic (PV) inverter.</xs:documentation>
            </xs:annotation>
            <xs:sequence>
                    <xs:element ref="power:voltage"/>
            </xs:sequence>
    </xs:complexType>
    <!-- 4.4.2 VMax -->
    <xs:element name="vMax" type="resource:VMaxType"/>
    <xs:complexType name="VMaxType">
            <xs:annotation>
                    <xs:documentation>VMax is the IEEE 1547 maximum voltage level of 110%
of nominal voltage where the PV inverter must disconnect.</xs:documentation>
            </xs:annotation>
            <xs:sequence>
                    <xs:element ref="power:voltage"/>
            </xs:sequence>
    </xs:complexType>
    <!-- 4.4.3 QMax -->
    <xs:element name="qMax" type="resource:QMaxType"/>
    <xs:complexType name="QMaxType">
            <xs:annotation>
                    <xs:documentation>Qmax is the inverter's var capability and may be
positive (capacitive) or negative (inductive).</xs:documentation>
            </xs:annotation>
            <xs:sequence>
                    <xs:element ref="power:varQuantity"/>
            </xs:sequence>
    </xs:complexType>
    <!-- 4.4.4 volt-var -->
    <xs:element name="pMax" type="resource:PMaxType"/>
    <xs:complexType name="PMaxType">
            <xs:annotation>
                    <xs:documentation>PMax is the inverter's watt capability and may be
positive or negative. </xs:documentation>
            </xs:annotation>
            <xs:sequence>
                    <xs:element ref="power:powerQuantity"/>
            </xs:sequence>
```

```
    </xs:complexType>
    <!-- 4.9 Miscelenous Semantic elementsvolt-var -->
    <xs:element name="dispatchTime" type="emix:DurationType"/>
    <xs:element name="maximumDeliveryRate" type="emix:QuantityType"/>
    <xs:element name="minimumDeliveryRate" type="emix:QuantityType"/>
    <xs:element name="maximumResponse" type="emix:QuantityType"/>
    <xs:element name="minimumResponse" type="emix:QuantityType"/>
    <xs:element name="rate" type="emix:QuantityType"/>
    <xs:element name="targetRegulation" type="power:PowerAttributesType"/>
    <xs:element name="dispatchUp" type="emix:DurationType">
          <xs:annotation>
                <xs:documentation>Time in which resource can respond to a request to
increase energy provided. If zero, no dispatchUp available. Can also be startup delay
for non-spinning reserve.</xs:documentation>
          </xs:annotation>
    </xs:element>
    <xs:element name="dispatchDown" type="emix:DurationType">
          <xs:annotation>
                <xs:documentation>Time in which resource can respond to a request to
decrease energy provided. If zero, no dispatch Down available.</xs:documentation>
          </xs:annotation>
    </xs:element>
    <xs:element name="rampTime" type="emix:DurationType">
          <xs:annotation>
                <xs:documentation>Requested ramp time to move from the current
setpoint to the new setpoint</xs:documentation>
          </xs:annotation>
    </xs:element>
    <xs:element name="window" type="emix:DurationType">
          <xs:annotation>
                <xs:documentation>Time window within which to randomly execute the
command. If the time window is zero, the command will be executed immediately, (If not
included, then default time window for this function will be used)</xs:documentation>
          </xs:annotation>
    </xs:element>
</xs:schema>
```

G. An Example

24 Hours of pricing on a full requirements contract.

```
<?xml version="1.0" encoding="utf-16"?>
<!--
Jira 274 Price Publication
    emix = EMIXType
    createdDateTime = 2-12-2011 14:00
    transactive State = Tender
    currency = USD

    terms:
    PriceType = absolutePrice

    Gluon: StartTime = 2-13-2001 00:00, Duration = 3600 seconds
    Intervals (0.71,0.21,-0.13, 0.15,0.70,0.86,0.90,1.01,1.12,1.14,1.15,2.74,
                    1.25,1.20,1.29,1.31,1.00,0.99,0.89,0.86,0.79,0.88,0.87,0.76)
-->
<emix:product xmlns:power="http://docs.oasis-open.org/ns/emix/power"
xmlns:emix="http://docs.oasis-open.org/ns/emix" xmlns:xcal="http://docs.oasis-
open.org/ns/ws-calendar/201103" xmlns:xs="http://www.w3.org/2001/XMLSchema-
instance">
    <xcal:properties>
        <xcal:created>
            <xcal:utc-date-time>20110328</xcal:utc-date-time>
        </xcal:created>
    </xcal:properties>
    <xcal:components>
        <xcal:gluon>
            <xcal:properties>
                <xcal:uid>
                    <xcal:text>b375a906-64bc-4573-9971-
045b52c30a56@examples.oasis-open.org</xcal:text>
                </xcal:uid>
                <xcal:related-to>
                    <xcal:parameters>
                        <xcal:reltype>
                            <xcal:text>CHILD</xcal:text>
                        </xcal:reltype>
                    </xcal:parameters>
                    <xcal:uid>cd6dc037-1c39-481d-87ef-
8c587df56dfb@examples.oasis-open.org</xcal:uid>
                </xcal:related-to>
                <xcal:dtstart>
                    <xcal:parameters>
                        <xcal:tzid>
                            <xcal:text>America/New_York</xcal:text>
                        </xcal:tzid>
                    </xcal:parameters>
                    <xcal:date-time>20110330T00000000</xcal:date-time>
                </xcal:dtstart>
                <xcal:duration>
                </xcal:duration>
                <xcal:x-wsCalendar-attach>
                    <emix:productDescription
xs:type="power:PowerProductDescription">
                        <power:unitEnergyPrice>
```

```
                                <emix:priceAbsolute>

<emix:priceEnumeration>0.111</emix:priceEnumeration>
                                </emix:priceAbsolute>
                                <power:wattHours>
                                    <emix:scale>#k</emix:scale>
                                </power:wattHours>
                            </power:unitEnergyPrice>
                            <power:Watts>
                                <emix:scale>#M</emix:scale>
                                <power:powerAttributes>
                                    <power:hertz>60</power:hertz>
                                    <power:voltage>220</power:voltage>
                                    <power:ac>true</power:ac>
                                </power:powerAttributes>
                            </power:Watts>
                            <power:serviceLocation>
                                <power:node>xxNode.IDxx</power:node>
                            </power:serviceLocation>
                        </emix:productDescription>
                    </xcal:x-wsCalendar-attach>
                </xcal:properties>
            </xcal:gluon>
            <xcal:interval>
                <xcal:properties>
                    <xcal:uid>
                        <xcal:text>ed6de037-1c39-481d-87cf-
8c587df56dfb@examples.oasis-open.org</xcal:text>
                    </xcal:uid>
                    <xcal:x-wsCalendar-attach>
                        <emix:productDescription
xs:type="power:PowerProductDescription">
                            <power:unitEnergyPrice>
                                <emix:priceAbsolute>

<emix:priceEnumeration>0.71</emix:priceEnumeration>
                                </emix:priceAbsolute>
                            </power:unitEnergyPrice>
                        </emix:productDescription>
                    </xcal:x-wsCalendar-attach>
                </xcal:properties>
            </xcal:interval>
            <xcal:interval>
                <xcal:properties>
                    <xcal:uid>
                        <xcal:text>78839070-98bc-42c4-b216-
3665efdeacf4@examples.oasis-open.org</xcal:text>
                    </xcal:uid>
                    <xcal:related-to>
                        <xcal:parameters>
                            <xcal:reltype>
                            </xcal:reltype>
                        </xcal:parameters>
                        <xcal:uid>ed6de037-1c39-481d-87cf-
8c587df56dfb@examples.oasis-open.org</xcal:uid>
                    </xcal:related-to>
                    <xcal:x-wsCalendar-attach>
                        <emix:productDescription
xs:type="power:PowerProductDescription">
                            <power:unitEnergyPrice>
                                <emix:priceAbsolute>

<emix:priceEnumeration>0.21</emix:priceEnumeration>
```

```
                                    </emix:priceAbsolute>
                                </power:unitEnergyPrice>
                            </emix:productDescription>
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                    </xcal:properties>
                </xcal:interval>
                <xcal:interval>
                    <xcal:properties>
                        <xcal:uid>
                            <xcal:text>3fbb3ccb-a38c-43b2-968b-
0117c57a1d24@examples.oasis-open.org</xcal:text>
                        </xcal:uid>
                        <xcal:related-to>
                            <xcal:parameters>
                                <xcal:reltype>
                                </xcal:reltype>
                            </xcal:parameters>
                            <xcal:uid>78839070-98bc-42c4-b216-
3665efdeacf4@examples.oasis-open.org</xcal:uid>
                        </xcal:related-to>
                        <xcal:x-wsCalendar-attach>
                            <emix:productDescription
xs:type="power:PowerProductDescription">
                                <power:unitEnergyPrice>
                                    <emix:priceAbsolute>
                                        <emix:priceEnumeration>-
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                                    </emix:priceAbsolute>
                                </power:unitEnergyPrice>
                            </emix:productDescription>
                        </xcal:x-wsCalendar-attach>
                    </xcal:properties>
                </xcal:interval>
                <xcal:interval>
                    <xcal:properties>
                        <xcal:uid>
                            <xcal:text>6a5d23b2-0aa9-4309-b2d3-
b04f630add99@examples.oasis-open.org</xcal:text>
                        </xcal:uid>
                        <xcal:related-to>
                            <xcal:parameters>
                                <xcal:reltype>
                                </xcal:reltype>
                            </xcal:parameters>
                            <xcal:uid>3fbb3ccb-a38c-43b2-968b-
0117c57a1d24@examples.oasis-open.org</xcal:uid>
                        </xcal:related-to>
                        <xcal:x-wsCalendar-attach>
                            <emix:productDescription
xs:type="power:PowerProductDescription">
                                <power:unitEnergyPrice>
                                    <emix:priceAbsolute>

<emix:priceEnumeration>0.15</emix:priceEnumeration>
                                    </emix:priceAbsolute>
                                </power:unitEnergyPrice>
                            </emix:productDescription>
                        </xcal:x-wsCalendar-attach>
                    </xcal:properties>
                </xcal:interval>
                <xcal:interval>
                    <xcal:properties>
                        <xcal:uid>
```

```
                    <xcal:text>5b0b2104-f2bd-4b7b-819c-
ab970b29f668@examples.oasis-open.org</xcal:text>
                </xcal:uid>
                <xcal:related-to>
                    <xcal:parameters>
                        <xcal:reltype>
                        </xcal:reltype>
                    </xcal:parameters>
                    <xcal:uid>6a5d23b2-0aa9-4309-b2d3-
b04f630add99@examples.oasis-open.org</xcal:uid>
                </xcal:related-to>
                <xcal:x-wsCalendar-attach>
                    <emix:productDescription
xs:type="power:PowerProductDescription">
                        <power:unitEnergyPrice>
                            <emix:priceAbsolute>

<emix:priceEnumeration>0.70</emix:priceEnumeration>
                            </emix:priceAbsolute>
                        </power:unitEnergyPrice>
                    </emix:productDescription>
                </xcal:x-wsCalendar-attach>
            </xcal:properties>
        </xcal:interval>
        <xcal:interval>
            <xcal:properties>
                <xcal:uid>
                    <xcal:text>0270f6af-56bc-4d9c-a7e2-
bebcfe3bc0ca@examples.oasis-open.org</xcal:text>
                </xcal:uid>
                <xcal:related-to>
                    <xcal:parameters>
                        <xcal:reltype>
                        </xcal:reltype>
                    </xcal:parameters>
                    <xcal:uid>5b0b2104-f2bd-4b7b-819c-
ab970b29f668@examples.oasis-open.org</xcal:uid>
                </xcal:related-to>
                <xcal:x-wsCalendar-attach>
                    <emix:productDescription
xs:type="power:PowerProductDescription">
                        <power:unitEnergyPrice>
                            <emix:priceAbsolute>

<emix:priceEnumeration>0.86</emix:priceEnumeration>
                            </emix:priceAbsolute>
                        </power:unitEnergyPrice>
                    </emix:productDescription>
                </xcal:x-wsCalendar-attach>
            </xcal:properties>
        </xcal:interval>
        <xcal:interval>
            <xcal:properties>
                <xcal:uid>
                    <xcal:text>3e36a01d-1229-4f7f-86dc-
31728bfaba6d@examples.oasis-open.org</xcal:text>
                </xcal:uid>
                <xcal:related-to>
                    <xcal:parameters>
                        <xcal:reltype>
                        </xcal:reltype>
                    </xcal:parameters>
```

```
                    <xcal:uid>0270f6af-56bc-4d9c-a7e2-
bebcfc3bc0ca@examples.oasis-open.org</xcal:uid>
                </xcal:related-to>
                <xcal:x-wsCalendar-attach>
                    <emix:productDescription
xs:type="power:PowerProductDescription">
                        <power:unitEnergyPrice>
                            <emix:priceAbsolute>

<emix:priceEnumeration>0.90</emix:priceEnumeration>
                            </emix:priceAbsolute>
                        </power:unitEnergyPrice>
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                </xcal:x-wsCalendar-attach>
            </xcal:properties>
        </xcal:interval>
        <xcal:interval>
            <xcal:properties>
                <xcal:uid>
                    <xcal:text>0d96802b-bf0f-41c6-8d55-
804598879bc0@examples.oasis-open.org</xcal:text>
                </xcal:uid>
                <xcal:related-to>
                    <xcal:parameters>
                        <xcal:reltype>
                        </xcal:reltype>
                    </xcal:parameters>
                    <xcal:uid>3c36a01d-1229-4f7f-86dc-
31728bfaba6d@examples.oasis-open.org</xcal:uid>
                </xcal:related-to>
                <xcal:x-wsCalendar-attach>
                    <emix:productDescription
xs:type="power:PowerProductDescription">
                        <power:unitEnergyPrice>
                            <emix:priceAbsolute>

<emix:priceEnumeration>1.01</emix:priceEnumeration>
                            </emix:priceAbsolute>
                        </power:unitEnergyPrice>
                    </emix:productDescription>
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            </xcal:properties>
        </xcal:interval>
        <xcal:interval>
            <xcal:properties>
                <xcal:uid>
                    <xcal:text>a843d8d0-28f8-4a31-a7cc-
25b14e701036@examples.oasis-open.org</xcal:text>
                </xcal:uid>
                <xcal:related-to>
                    <xcal:parameters>
                        <xcal:reltype>
                        </xcal:reltype>
                    </xcal:parameters>
                    <xcal:uid>0d96802b-bf0f-41c6-8d55-
804598879bc0@examples.oasis-open.org</xcal:uid>
                </xcal:related-to>
                <xcal:x-wsCalendar-attach>
                    <emix:productDescription
xs:type="power:PowerProductDescription">
                        <power:unitEnergyPrice>
                            <emix:priceAbsolute>
```

```
5008
5009        <emix:priceEnumeration>1.12</emix:priceEnumeration>
5010                                    </emix:priceAbsolute>
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5012                            </emix:productDescription>
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5020        9eb8551c086d@examples.oasis-open.org</xcal:text>
5021                        </xcal:uid>
5022                        <xcal:related-to>
5023                            <xcal:parameters>
5024                                <xcal:reltype>
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5026                            </xcal:parameters>
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5028        25b14c701036@examples.oasis-open.org</xcal:uid>
5029                        </xcal:related-to>
5030                        <xcal:x-wsCalendar-attach>
5031                            <emix:productDescription
5032        xs:type="power:PowerProductDescription">
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5035
5036        <emix:priceEnumeration>1.14</emix:priceEnumeration>
5037                                    </emix:priceAbsolute>
5038                                </power:unitEnergyPrice>
5039                            </emix:productDescription>
5040                        </xcal:x-wsCalendar-attach>
5041                    </xcal:properties>
5042                </xcal:interval>
5043                <xcal:interval>
5044                    <xcal:properties>
5045                        <xcal:uid>
5046                            <xcal:text>f2f630f6-f673-47ac-8a89-
5047        3d2b23f379c6@examples.oasis-open.org</xcal:text>
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5049                        <xcal:related-to>
5050                            <xcal:parameters>
5051                                <xcal:reltype>
5052                                </xcal:reltype>
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5055        9eb8551c086d@examples.oasis-open.org</xcal:uid>
5056                        </xcal:related-to>
5057                        <xcal:x-wsCalendar-attach>
5058                            <emix:productDescription
5059        xs:type="power:PowerProductDescription">
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5061                                    <emix:priceAbsolute>
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5063        <emix:priceEnumeration>1.15</emix:priceEnumeration>
5064                                    </emix:priceAbsolute>
5065                                </power:unitEnergyPrice>
5066                            </emix:productDescription>
5067                        </xcal:x-wsCalendar-attach>
5068                    </xcal:properties>
5069                </xcal:interval>
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```

```
            <xcal:properties>
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05a8df1d1f20@examples.oasis-open.org</xcal:text>
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                <xcal:related-to>
                    <xcal:parameters>
                        <xcal:reltype>
                        </xcal:reltype>
                    </xcal:parameters>
                    <xcal:uid>f2f630f6-f673-47ac-8a89-
3d2b23f379c6@examples.oasis-open.org</xcal:uid>
                </xcal:related-to>
                <xcal:x-wsCalendar-attach>
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xs:type="power:PowerProductDescription">
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<emix:priceEnumeration>2.74</emix:priceEnumeration>
                            </emix:priceAbsolute>
                        </power:unitEnergyPrice>
                    </emix:productDescription>
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        <xcal:interval>
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0f7dbc0cc99c@examples.oasis-open.org</xcal:text>
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                <xcal:related-to>
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                        <xcal:reltype>
                        </xcal:reltype>
                    </xcal:parameters>
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                </xcal:related-to>
                <xcal:x-wsCalendar-attach>
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<emix:priceEnumeration>1.25</emix:priceEnumeration>
                            </emix:priceAbsolute>
                        </power:unitEnergyPrice>
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        <xcal:interval>
            <xcal:properties>
                <xcal:uid>
                    <xcal:text>920c3e26-cea2-4456-84a7-
9f5f369cf491@examples.oasis-open.org</xcal:text>
                </xcal:uid>
                <xcal:related-to>
                    <xcal:parameters>
                        <xcal:reltype>
                        </xcal:reltype>
```

```
                    </xcal:parameters>
                    <xcal:uid>f65aa213-3176-47e3-88e3-
0f7dbe0ee99e@examples.oasis-open.org</xcal:uid>
                </xcal:related-to>
                <xcal:x-wsCalendar-attach>
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                        <power:unitEnergyPrice>
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<emix:priceEnumeration>1.20</emix:priceEnumeration>
                            </emix:priceAbsolute>
                        </power:unitEnergyPrice>
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                    <xcal:text>bd51713d-c84e-4a18-b641-
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                </xcal:uid>
                <xcal:related-to>
                    <xcal:parameters>
                        <xcal:reltype>
                        </xcal:reltype>
                    </xcal:parameters>
                    <xcal:uid>920e3e26-eea2-4456-84a7-
9f5f369cf491@examples.oasis-open.org</xcal:uid>
                </xcal:related-to>
                <xcal:x-wsCalendar-attach>
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xs:type="power:PowerProductDescription">
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<emix:priceEnumeration>1.29</emix:priceEnumeration>
                            </emix:priceAbsolute>
                        </power:unitEnergyPrice>
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                <xcal:uid>
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cf89d637d1b8@examples.oasis-open.org</xcal:text>
                </xcal:uid>
                <xcal:related-to>
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                <xcal:x-wsCalendar-attach>
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xs:type="power:PowerProductDescription">
                        <power:unitEnergyPrice>
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```

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                            </emix:productDescription>
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                        </xcal:uid>
                        <xcal:related-to>
                            <xcal:parameters>
                                <xcal:reltype>
                                </xcal:reltype>
                            </xcal:parameters>
                            <xcal:uid>2482a65e-bd0e-4a33-b777-
cf89d637d1b8@examples.oasis-open.org</xcal:uid>
                        </xcal:related-to>
                        <xcal:x-wsCalendar-attach>
                            <emix:productDescription
xs:type="power:PowerProductDescription">
                                <power:unitEnergyPrice>
                                    <emix:priceAbsolute>

                    <emix:priceEnumeration>1.00</emix:priceEnumeration>
                                    </emix:priceAbsolute>
                                </power:unitEnergyPrice>
                            </emix:productDescription>
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                    </xcal:properties>
                </xcal:interval>
                <xcal:interval>
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                        <xcal:uid>
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395e25b35674@examples.oasis-open.org</xcal:text>
                        </xcal:uid>
                        <xcal:related-to>
                            <xcal:parameters>
                                <xcal:reltype>
                                </xcal:reltype>
                            </xcal:parameters>
                            <xcal:uid>01063041-4d93-46a6-9fd6-
7b4f92a938e0@examples.oasis-open.org</xcal:uid>
                        </xcal:related-to>
                        <xcal:x-wsCalendar-attach>
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xs:type="power:PowerProductDescription">
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                                    <emix:priceAbsolute>

                    <emix:priceEnumeration>0.99</emix:priceEnumeration>
                                    </emix:priceAbsolute>
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                            </emix:productDescription>
                        </xcal:x-wsCalendar-attach>
                    </xcal:properties>
                </xcal:interval>
                <xcal:interval>
```

```
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f730ccfa76b4@examples.oasis-open.org</xcal:text>
                </xcal:uid>
                <xcal:related-to>
                    <xcal:parameters>
                        <xcal:reltype>
                        </xcal:reltype>
                    </xcal:parameters>
                    <xcal:uid>2bb61d4e-a3ca-423a-98cf-
395e25b35674@examples.oasis-open.org</xcal:uid>
                </xcal:related-to>
                <xcal:x-wsCalendar-attach>
                    <emix:productDescription
xs:type="power:PowerProductDescription">
                        <power:unitEnergyPrice>
                            <emix:priceAbsolute>

<emix:priceEnumeration>0.89</emix:priceEnumeration>
                            </emix:priceAbsolute>
                        </power:unitEnergyPrice>
                    </emix:productDescription>
                </xcal:x-wsCalendar-attach>
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~~H.~~E. Revision History

Revision	Date	Editor	Changes Made
WD01	2009-12-08	Toby Considine	Initial Draft from templates and outline
WD02	2010-01-12	William Cox	Inserted information model details from TC discussions
WD03	2010-03-10	William Cox	Change to envelope and certificate metaphor. Changes in mandatory and optional definitions.
WD04	2010-03-24	William Cox	Updates based on TC comments and corrections. Additional open issues in TC agenda.
WD05	2010-05-18	Toby Considine	Aligned elements with current draft if WS-Calendar, cleaned up some language to align with the last two months of conversation. Extended envelop and intrinsic/extrinsic language
WD06	2010-05-21	Toby Considine	Began incorporating TeMIX language. Changed Certificates to Warrants. Fleshed out Energy Artifacts
WD07	2010-07-07	Toby Considine	Incorporated Aaron Snyder's extensive re-write into Power & Energy section
WD08	2010-08-10	Toby Considine	Extensive re-write for narrative quality, responded to first 52 comments, Updated to include WS-Calendar WD08 language, added tables of table, examples
WD09	2010-08-18	Toby Considine	Incorporated recent WS-Calendar changes to update Products. Added explanation of WS-Calendar. Cleaned up double entry of Partitions.
WD10	2010-08-30	Toby Considine	Reduced argumentation in intro, excluded WS-Calendar re-writes, pointed to WS-Calendar appendices. Merged AC and DC
WD11	2010-09-05	Toby Considine	Distinguished between Intrinsic elements and Generic Product, incorporated inheritance language into GP, Re-created T&D as a much smaller Transport Artifact, changed envelope language to face and contents.
WD12	2010-10-26	Toby Considine	Responded to many Jira comments. Re-created T&D as a much smaller Transport Artifact, changed envelope language to face and contents. Responded to many Jira comments. Descriptions now based on WD12

Revision	Date	Editor	Changes Made
			Schema.
WD13	2010-11-01	Toby Considine Ed Cazalet Dave Holmberg	Removed repetitive discussion of WS-Calendar objects. Reflect new use of WS-Calendar Sequence in Schema. Recast Options to describe reserves.
WD14	2010-11-09	Toby Considine Ed Cazalet	Changes to resources, block power, misc. tightening of document
WD15	2010-11-14	Toby Considine Ed Cazalet Sean Crimmins	EMIX Sequence changed to EMIX Base. General tightening. Addition of Load and Power Offers, including 3-part bids for each.
CSD01	2010-11-15	Toby Considine	Minor changes as per comments
WD16	2011-01-15	Toby Considine	46 Minor issues from PR01 Adopted new WD format Moved namespaces into section 1 Adjusted duplicate table names Fixed section numbering anomalies
WD17	2011-02-08	Toby Considine	Issue Resolution. See Release Notes from Jira
WD18	2011-03-07	Toby Considine	Numerous Jira Issues, (see release notes), Significant Schema work: Resources as ~~dicussed~~discussed, General EMIX constraints and requirements now in Core EMIX namespace, but isolated in requirements.xsd. Added schedule constraints as optional constraint
WD19	2011-03-17	Toby Considine	Tightened language, some egregious errors and references not found removed
WD20	2011-03022	Toby Considine	Simplified Tables, Added NAESB appendix, updated schemas in appendix
WD21	2011-0323	Toby Considine	Quick Pass for show-stoppers, Purged last 16 uses of ~~EMIXTerms~~EMIX Terms for EMIX Base,
WD22	2011-0329	Toby Considine	Minor edits and comments from Jira. Made explicit relations between Base, Product Description, Items, Interfaces, and all derived extensions
WD23	2011-0411	Toby Considine	Extensive review and re-write to consolidate changes as logged in Jira
WD24	2011-05-29	Anne Hendry	Reorganization, underbrush of PR02
WD25	2011-05-31	Toby Considine	Paul Knight comments, related
WD26	2011-06-01	Toby Considine	Most Aclara comments, Gerry Gray comments, Cox comments, others from Jira

Revision	Date	Editor	Changes Made
WD27	2011-06-05	Anne Hendry Dave Holmberg Ed Cazalet Toby Considine	Tightened spec, formalized many definitions earlier, incorporated many suggestions for improving definitions, moved base class, non-normative ref to WS-Calendar to Section 2, Changes made up only though Section 5 (6 and 7 may require complete re-write)
WD28	2011-06-07	Toby Considine	Completed run though from WD27 Added Market Rules section
WD29	2011-06-14	Toby Considine	Jira issues from PR02 Added Plenty-O-UML Propagated Envelope language Removed top level TEMIX Base type Moved Temix toward Profile
WD30	2011-06-15	Toby Considine, Aaron Snyder	Too numerous to list here, almost 100% editorial.
WD31	2011-06019	Toby Considine	Many Editorial issues, Updates to Resource Introduction, TeMIX, Offer Curves
WD32	20110620	Toby Considine	Editorial final pass, esp Offer Segments
WD33	2011-06-21	Toby Considine	More editorial, moves some references to non-normative *Integral Only* in Product and Option
WD34	2011-06-22	Toby Considine	Mino changes (Josh Phillips in Jira) in intro material in sections 2, 4, 13

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