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Facility smart grid information model

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National foreword

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INTERNATIONAL STANDARD

ISO 17800

First edition
2017-12

Facility smart grid information model

Modèle d'informations des réseaux électriques intelligents des installations

Reference number
ISO 17800:2017(E)

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INTRODUCTION

The effort to substantially modernize and transform the national electric grid and create what has become known as a "smart grid" is an enormous undertaking that reflects both the size and importance of the electric grid. Viewed in its entirety, it is an international effort involving hundreds of organizations and companies, and it will impact billions of people. The standards infrastructure that will be needed to support this transformation may include over one hundred standards by the time that it is fully in place. This standard is one part of that infrastructure.

Almost all electricity is consumed in a building of some kind – homes, retail establishments, offices, schools, factories, hospitals – the list goes on. This standard attempts to capture the breadth and diversity of these consumers by using the term "facility." A facility is any kind of building or collection of buildings, and all of the electrical loads or local generation sources contained within them or controlled by the facility owner.

Historically, electricity consumption has been viewed as a collection of dumb loads at the end of a distribution system. There has been almost no interaction between the "loads" and those responsible for electricity generations and distribution. The vision of the smart grid changes this picture radically. In a smart grid world, facilities become full partners in supporting and managing the electric grid. Facilities become generators using local renewable or other generation capacity. Facilities moderate electrical demand in response to fluctuations in the price or availably of electricity. Facilities communicate and negotiate with energy providers, sharing information about the facility's projected electrical demand or ability to respond to the energy provider's needs for maintaining grid stability and reliability.

In some respects all facilities have common characteristics and needs with respect to interactions with a smart grid, regardless of whether the facility is a commercial, institutional, or industrial building, or a private home. The Facility Smart Grid Information Model (FSGIM) standard attempts to capture this commonality and standardize the content of the information that a facility manager needs to have, or, in some cases, needs to exchange with the energy provider, in order to manage the facility. Energy providers benefit from the FSGIM standard because it enables interaction with all different types of facilities in a common way. Facility owners benefit because products can be designed for use in multiple facility types and products designed primarily for one type of facility, a home for example, can more easily be used in another, say a commercial building.

An information model is an abstraction, not an implementation. This abstract representation is a way to account for the reality that the technology used to manage a facility may be quite different depending on the type of facility. It is intended that the FSGIM will be used to develop or enhance other standards that define technology and communication protocol specific implementations of the model for particular markets.

The FSGIM was developed in the context of a much larger framework of smart grid standards. It builds on some of those standards in a way that is intended to maintain consistency and harmony with established and developing standards that impact the information needed to managing the facility, while at the same time capturing all of the key information needed in one place.

If the smart grid is to become a reality there must be smart facilities of all types that interact with it. The considerable time and talent that went into developing the FSGIM was invested in order to lay a solid foundation upon which to fulfill this vision.

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1. PURPOSE

The purpose of this standard is to define an abstract, object-oriented information model to enable appliances and control systems in homes, buildings, and industrial facilities to manage electrical loads and generation sources in response to communication with a "smart" electrical grid and to communicate information about those electrical loads to utility and other electrical service providers.

2. SCOPE

This model provides the basis for common information exchange between control systems and end use devices found in single - and multi-family homes, commercial and institutional buildings, and industrial facilities that is independent of the communication protocol in use. It provides a common basis for electrical energy consumers to describe, manage, and communicate about electrical energy consumption and forecasts.

The model defines a comprehensive set of data objects and actions that support a wide range of energy management applications and electrical service provider interactions including:

a) on-site generation,
b) demand response,
c) electrical storage,
d) peak demand management,
e) forward power usage estimation,
f) load shedding capability estimation,
g) end load monitoring (sub metering),
h) power quality of service monitoring,
i) utilization of historical energy consumption data, and
j) direct load control.

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3. DEFINITIONS

See Clause 8 for external standards that are referenced by this standard.

3.1. Terms Adopted from External Sources

The following terms used in this standard are drawn from other standards or published reference sources. The definitions are repeated here and a reference to the appropriate standard or document is provided. Words or phrases in italics refer to terms defined elsewhere in this clause.

asset
A logical entity with measurable and reportable consumption, e.g., an *asset* may be a physical device with its own meter, or the main meter at the *service delivery point* of a service location.
(NAESB 2010a).

baseline
A method of estimating the electricity that would have been consumed by a customer or *demand resource* in the absence of a *demand response event*. It may be calculated using interval metering and/or statistical sampling techniques.
(NAESB 2010a).

combined heat and power
Combined heat and power (CHP), also known as cogeneration, is the simultaneous production of electricity and heat from a single fuel source, such as: natural gas, biomass, biogas, coal, waste heat, or oil.
(http://www.epa.gov/chp/basic/index.html).

electrical coupling point
Point of electrical connection between the DER source of energy (generation or storage) and any electric power system (EPS). Each DER (generation or storage) unit has an ECP connecting it to its local power system; groups of DER units have an ECP where they interconnect to the power system at a specific site or plant; a group of DER units plus local loads have an ECP where they are interconnected to the utility power system.
(IEC 61850 Part 7-420).

energy management system
A system used to monitor and control the energy consuming devices in a building. Within this standard, "energy management system" always refers to a customer/facility energy management system and not a utility energy management system.
(EIS Alliance Use-Cases).

non-spinning reserve
1. That generating reserve not connected to the system but capable of serving demand within a specified time.
2. Interruptible load that can be removed from the system in a specified time.
(NERC Glossary).

peak load
The maximum amount of power delivered (*load*) for a given time period.
(NEMA glossary (http://www.nema.org/gov/energy/glossary/)).

power quality
Characteristics of the electricity at a given point on an electrical system, evaluated against a set of reference technical parameters.
NOTE: These parameters might, in some cases, relate to the compatibility between electricity supplied on a network and the loads connected to that network.
(IEC 61000-4-30 (2008)).

pricing node (Pnode)
A single network Node or subset of networked Nodes where a physical injection or withdrawal is modeled and for which a Locational Marginal Price is calculated and used for financial settlements.
(CAISO Tariff).

program administrator
An investor-owned, governmental or cooperative distribution company with the responsibility for developing and operating specific programs.
(NAESB REQ.0.2.179).

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spinning reserve
Unloaded generation that is synchronized and ready to serve additional demand.
(NERC Glossary).

3.2. Terms Defined for this Standard

aggregated pricing node
An *aggregated pricing node* is a location in the electric grid where the locational marginal price is calculated by a weighted average of one or more underlying *pricing nodes*.

capacity restraint
A limitation in the generating capacity or transmission capacity of an energy supplier that constrains the amount of electricity that is available to be bought or sold.

Commercial Buildings Energy Consumption Survey
A national sample survey that collects information on the stock of U.S. commercial buildings.

control system
A device or set of devices used to manage, command, direct, or regulate the behavior of other devices or systems.

critical loads
Individual *loads* deemed to be critical to the operation of the facility or process.

critical peak period
A time period during which a special high price for electricity is applied as a way to reduce demand.

curtailable load
Loads whose power consumption can be increased or decreased for the purpose of increasing or decreasing the total electrical demand on the grid.

demand
The rate at which energy is delivered to or used by a system or part of a system at a given instant in time or averaged over any designated interval of time.

demand forecast
Predictions regarding future electrical demand.

demand interval
The period of time over which an energy supplier calculates demand. Typical values range from five minutes to 60 minutes.

demand resource
A *load*, aggregation of loads, behind-the-meter generator, electrical storage system, or thermal storage system capable of providing measurable and verifiable *demand response*.

demand response
A temporary change in electricity usage by a *demand resource* in response to market or reliability conditions.

demand response event
A period of time defined by the *program administrator*, including notifications, deadlines, and transitions, during which *demand resources* provide *demand response*. All notifications, deadlines, and transitions may not be applicable to all *demand response* products or services.

demand target
Target in *demand* management; *peak demand* is a key factor in contract charges for electricity use.

direct load control
A d*emand response* activity by which the *program administrator* remotely shuts down or cycles a customer's electrical equipment (e.g., air conditioner, water heater). Direct load control programs are primarily offered to residential or small commercial retail customers.

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dispatchable generator
Generators whose power supply may be increased or decreased for the purpose of decreasing or increasing the total electrical demand on the grid.

distributed energy resource
A small, modular, energy generation or storage device located within the electrical distribution system at or near the end user. Distributed energy resources may be connected to the local electrical power grid (e.g., for voltage support) or isolated from the grid in standalone applications, such as part of a micro grid.

emergency standby generation
The provision of capacity deployed by the balancing authority to meet NERC and regional reliability organization contingency requirements.

end device
A physical end-use device that consumes or supplies electricity.

energy consumption
A measure of the quantity of electricity used in a given time period, measured in kilowatt hours.

energy cost
That portion of the charge for electric service based upon the electric energy (kWh) consumed or billed.

energy emissions
The pollution emissions associated with generating a quantity of electrical energy.

energy information provider
A business that provide energy supply or *demand* information to customers or authorized third parties.

energy services company
A business providing *energy* savings, efficiency, and *generation* solutions.

energy services interface
An abstract representation of a bi-directional communication interface between devices within a facility and an external electric *service provider*. This interface enables exchange of information including pricing, energy consumption, demand response interactions, load forecasts, energy production forecasts, and weather information.

energy supplier
An entity that delivers electricity to end use customers. Examples include investor-owned utilities, municipal utilities, and private companies.

forward pricing forecast
The compilation of prices of actual transactions for forward (future) delivery periods that are executed today.

independent system operator
An independent system operator maintains balance of the grid system by controlling the dispatch of plants and ensuring that loads match system resources. As such, the operator must be neutral and independent.

intelligent end point
A system that internally measures, collects, and analyzes its *energy cost*/consumption.

load
A device, system or process that consumes electrical energy.

local codes
Local laws, regulations, and building codes that determine building operation and capabilities.

measurement and verification
Energy measurements that can be determined to a degree of accuracy and trust that is acceptable to all stakeholders.

net demand
Total demand minus total supply. Net demand is determined at the facility interconnection point, billing meter, or internal location, and may be positive or negative.

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peak demand
The highest measured *demand* encountered during a specified period of time (e.g., month, year, or finite set of time intervals).

plug load
A device that is powered by means of an electrical plug and matching socket or receptacle. This excludes devices that are accounted for as part of major building end uses such as HVAC, lighting systems, and water heating.

present demand
Demand occurring during the present *demand interval* or subinterval (e.g., Watts or VA).

present subinterval demand
Average rate of energy used over a small portion of a *demand interval*.

present subinterval net demand
Average net rate of energy used over a small portion of a *demand interval*.

present subinterval supply
Average rate of energy supplied over a small portion of a *demand interval*.

ramp rate
The rate at which a generator changes its output or a *demand resource* changes its demand.

service delivery point
The location where electric service is delivered to the facility.

service level agreement
A part of a service contract where the level of service is formally agreed upon.

smart power distribution unit
A device that measures and distributes electric power to an electrical circuit.

smart power strip
A power strip that measures electrical power being drawn by the connected equipment.

supply
The rate of energy generation or storage output that is used to serve facility load and possibly provided to the grid as a generation resource.

time of use pricing
A rate structure characterized by different prices for electricity use in a 24-hour time frame. Time of use pricing is generally used to encourage electricity use during periods of lower demand and discourage electricity use during periods of high demand.

use case
A story, told in structured and detailed steps, about how participants in an Application collaborate to reach a goal.

variable generation
Variable generation comprises any power generating device in which the source of the energy is not dispatchable and that the resource does not have control over its net power output. Variable generating devices include those powered by wind, solar, run of river hydro, tidal, wave, ocean thermal and other renewable resources.

3.3. Abbreviations and Acronyms Used in this Standard

ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
CBECS	*Commercial Buildings Energy Consumption Survey*
CHP	combined heat and power
DER	distributed energy resource
ECP	electrical coupling point
EIP	Energy Information Provider
EM	Energy Manager
EMS	energy management system
ESCO	energy services company

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ESI	Energy Services Interface
ESI EM	Energy Services Interface Energy Manager
ESP	Energy Service Provider
HMI	human machine interface
HVAC	Heating, ventilating, and air conditioning
IEP	Intelligent End Point
ISO	International Organization for Standardization
kW	kilowatt
M&V	Measurement and Verification
OASIS	(Organization for the Advancement of Structured Information Standards) is a not-for-profit consortium that drives the development, convergence and adoption of open standards for the global information society.
RTO	Regional Transmission Operator
SCADA	supervisory control and data acquisition
SLA	Service Level Agreement
SP	Service Provider
SPDU	Smart Power Distribution Unit
SPS	Smart Power Strip

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4. FSGIM STRUCTURE AND USAGE

4.1. Overview

The Facility Smart Grid Information Model (FSGIM) defines an abstract representation of the energy consuming, producing, and storage systems found in residential, commercial, and industrial facilities. By modeling the energy characteristics of this equipment, the characteristics of a facility's energy needs can be determined. When this information is included in equipment and communicated with a protocol, a facility owner can understand what factors influence the facility's energy consumption; energy consultants can determine how to effectively reduce the energy profile of a facility; architects and engineers can design facilities that optimize the energy profile; controls manufacturers can create products that monitor and manage the facility energy profile; and energy providers can more accurately forecast energy demand as well as the reactions to energy supply constraints.

A key concept in the FSGIM is a "facility." A facility is any kind of building or collection of buildings, and all of the electrical loads or local generation sources contained within them or controlled by the facility owner. Examples of facilities include homes, retail establishments, offices, schools, factories, hospitals, and college campuses.

In some respects all facilities have common characteristics and needs with respect to interactions with a smart grid. The FSGIM attempts to capture this commonality and standardize the content of the information that a facility manager needs to have, or, in some cases, needs to exchange with the energy provider, in order to manage the facility. The FSGIM encompasses detailed information about systems inside the facility that can be thought of as tightly coupled in the sense that they are directly managed and controlled within the facility. Examples include HVAC, lighting, security, facility management systems, and industrial automation systems. The FSGIM also includes details about external systems that can be thought of as loosely coupled in the sense that the facility interacts with them but does not have any direct control over them. Examples of this include sources of weather information, real-time energy pricing information, demand response signals, and sources of energy usage information.

Energy providers benefit from the FSGIM standard because it enables interaction with all different types of facilities in a common way. Facility owners benefit because products can be designed for use in multiple facility types and products designed primarily for one type of facility can more easily be used in another.

In order to guide the content of the FSGIM a set of use cases was developed and vetted with a broad array of industry experts. These use cases define a wide range of scenarios for interaction between a facility and an energy provider. They define specific actors for the transactions and the information that needs to be exchanged to carry out the scenario. In addition to these interactions between the facility and energy provider, the information model also addresses information that is needed within the facility to make control decisions when managing loads and to develop load forecasts.

An information model is an abstraction, not an implementation. This abstract representation is a way to account for the reality that the technology used to manage a facility may be quite different depending on the type of facility. It is intended that the FSGIM will be used to develop or enhance other standards that define technology and communication protocol specific implementations of the model for particular markets. By supporting the same FSGIM, a level of interoperability is ensured since the semantic meaning of the information is standardized. A protocol translator may still be needed to translate between different message syntaxes and signaling but the information content is understood. In this way, the FSGIM will provide the basis for interoperable extensions to new and existing facility information communications protocols. Figure 4.1 illustrates the types of information standardized in the FSGIM and how that relates to the additional details that will be provided by protocol specific implementations.

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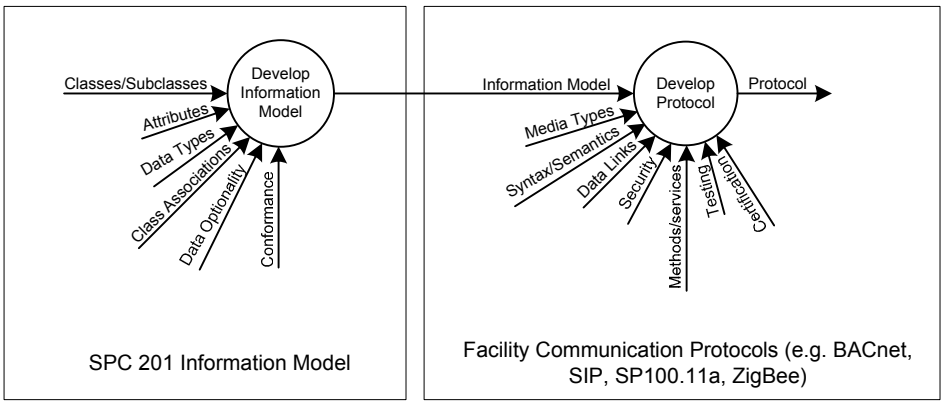

Figure 4.1 - The Facility Smart Grid Information Model will be implemented through modifications to existing facility communications protocols.

In order to fulfill the needs of diverse kinds of facilities described above, it is necessary to structure the FSGIM in a way that enables considerable flexibility and scalability. The approach taken was to define an information model that consists of four major components or building blocks. Those components are a Generator Component, a Meter Component, a Load Component, and an Energy Manager Component. These building blocks can be arranged and combined as needed to represent physical devices, systems, or functions. For example, storage can be represented by combining characteristics of the Load Component (when charging) and the Generator Component (when discharging). A meter might simply be a measuring device or, under some circumstances it might be a "smart meter" that plays a role in controlling loads in addition to its measurement function. Such a smart meter would be represented in the FSGIM as a combination of the Meter Component and the Energy Manager Component. The FSGIM components can also represent aggregations. For example the Load Component can represent characteristics of an individual device or the combined demand of a collection of devices or other loads. With this kind of flexibility it is expected that the information model components can provide all of the needed functionality and flexibility. Note: In a facility, there may be many real-world devices contributing to the computation of an aggregated value. As such, the details of these contributing values and how they are obtained may vary. Thus, judgments must be made in determining how well they can be aggregated. For additional information about aggregation in the FSGIM see Clause 5.6.3.1.

The structure and semantics of the FSGIM are defined using the Unified Modeling Language (UML) [http://www.omg.org/spec/UML/2.3/]. An electronic version of the standard suitable for use with UML software tools accompanies the printed standard. The text of most portions of the standard was generated from documentation included in the UML files. UML diagrammatic conventions are used in the figures contained in this standard and define normative relationships and multiplicity details of the FSGIM. A summary of UML conventions is contained in Annex B.

To avoid possible confusion over similar terms used in the model definition a special effort is made to fully qualify terms used to describe portions of the model described in the text of the standard. The four model component are all always referred to as a Generator Component, a Load Component, a Meter Component, and an Energy Manager Component. In each case there is an information model class defined with a similar name. These are the Generator Class, Load Class, Meter Class, and Energy Manager Class. In cases where a physical device represented by the information model is intended it is referred to as the normal English noun without special qualification. For example, a device that measures electrical energy consumption is a meter. The attributes of this meter can be represented using the details of the Meter Class and other related classes defined in the Meter Component of the FSGIM.

The FSGIM was developed in the context of a much larger framework of smart grid standards. It builds on some of those standards in a way that is intended to maintain consistency and harmony with established and developing standards that impact the information needed to manage the facility, while at the same time capturing all of the key information needed in one place. These standards include several IEC standards developed and used by the electricity generation and distribution industry, OASIS WS-Calendar [OASIS WS-Calendar v1.0 (see http://www.oasis-open.org/committees/ws-calendar/)], and OASIS Energy Market Information Exchange [(EMIX) v1.0 (see http://www.oasis-open.org/committees/emix/)].

The FSGIM defines the datatypes of the attributes used in the model. A convention has been adopted to define the datatype in the broadest sense appropriate to the attribute. For example a measurement would have a datatype of Real, meaning the mathematical concept of a Real number. A protocol specific implementation would map this Real value to something that can actually be represented in a computer, e.g. a Float, that has constraints on the precision and size that can be represented which are not part of the mathematical definition of a Real number. This was done to be more faithful to the meaning of the information being represented while not imposing constraints on the computer hardware and communication protocols that will be used to implement the FSGIM. In cases where

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portions of the FSGIM are derived from other standards, datatypes are mapped as needed to be consistent with this convention.

4.2. How the FSGIM Component Model can be Applied to Real-World Examples

Imagine an owner-occupied commercial building in a major metropolitan area that is served by a single retail electric provider. Assume that building is used for commercial office space. In this type of building, the main energy consuming systems are lighting, heating ventilation and air conditioning (HVAC), and information and communications technology (ICT) systems. To protect the company's data center, there is a battery powered uninterruptible power supply for the ICT system. To reduce daytime energy consumption, the building owner has installed solar photovoltaic panels on the building's roof. To ensure business continuity in case of a power failure, the owner has also installed a backup generator system. A drawing of this building is shown in Figure 4.2. This example will illustrate how the FSGIM components can be used to represent these physical devices and their function. Individual subsystems will be modeled and then combined to show the overall results.

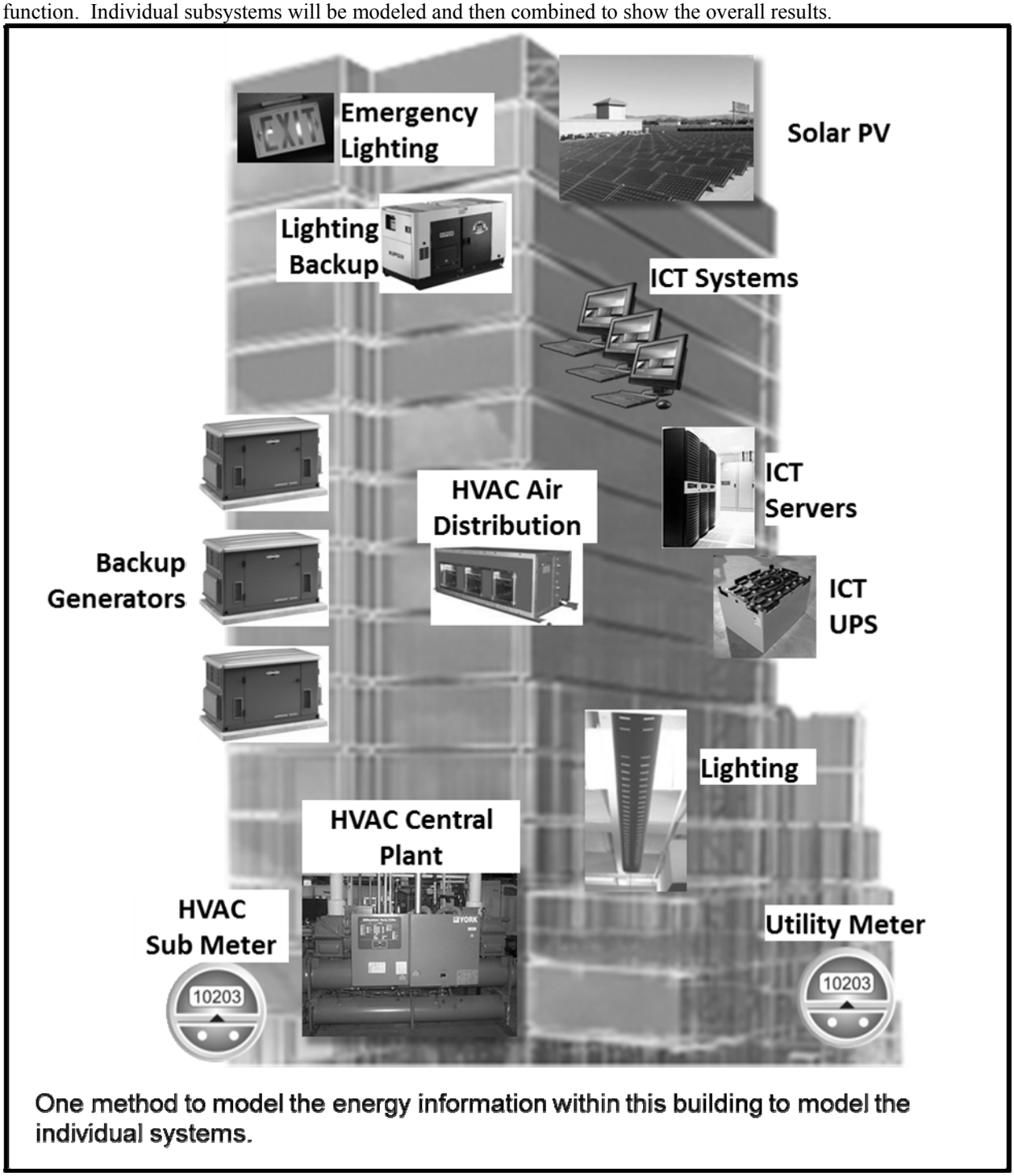

Figure 4.2 - Example Customer Facility Showing Major Energy Components

4.2.1. Modeling the Backup Generators

The facility's backup generator system consists of three separate generators controlled by a generator control system. Since this equipment could be used by the facility to provide services to the grid (e.g., demand response) we have

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chosen to model each generator individually instead of as a single composite generator resource. In this case, the generator control system is modeled as an instance of an EM Class while each generator is modeled as an instance of a Generator Class. The FSGIM representation of this sub-system is shown in Figure 4.3.

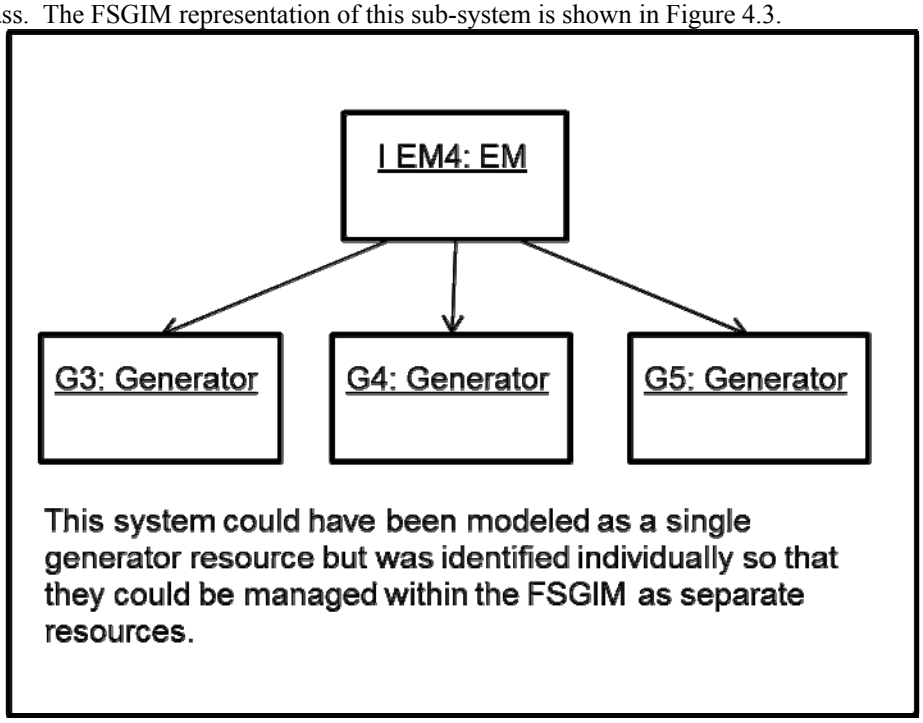

Figure 4.3 - Example of an FSGIM Model for a Generator System of Three Generators

4.2.2. Modeling the ICT System

The ICT system provides the internet, telecommunications, security, personal computers, and servers for the facility. A network management system provides the intelligence for monitoring and managing the energy consumption of this equipment and is therefore modeled as an instance of an EM Class. The equipment (PCs, servers, cameras, phones) managed by the sub-system are modeled as instances of the Load Class and the UPS is modeled as a combination of an instance of a Generator Class (when producing power) and an instance of a Load Class (when being recharged). The FSGIM representation of this sub-system is shown in Figure 4.4.

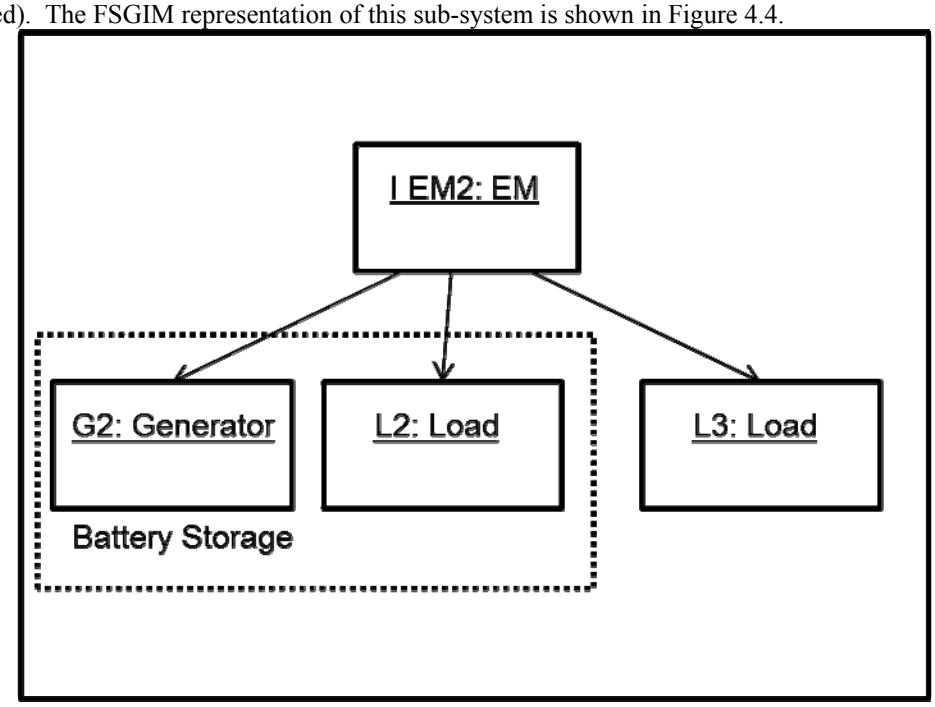

Figure 4.4 - Example of an FSGIM Model for an ICT system that contains a network manager, equipment, and a UPS.

4.2.3. Modeling the Lighting System

The lighting system provides floor, outdoor, and emergency lighting. A lighting control system manages the floor and outdoor lighting while an emergency lighting panel manages the exit lighting. A small generator is used to illuminate the emergency lighting in case of power failure. The lighting control system and emergency lighting control panel are modeled as instances of the EM Class. The indoor/outdoor and emergency lights are modeled as

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instances of the Load Class. The FSGIM representation of this sub-system is shown in Figure 4.5. Note that for simplicity the indoor/outdoor lighting is represented as a single Load Class instance, but it could have been represented as several Load Class instances.

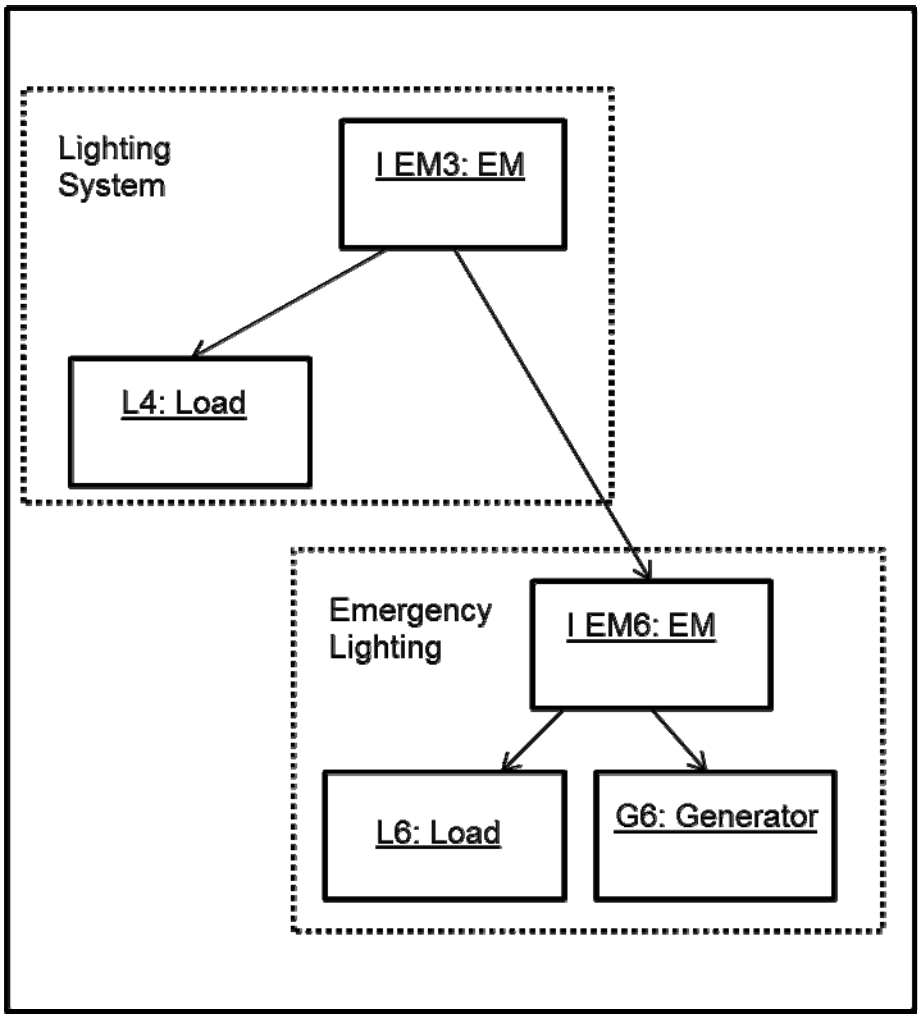

Figure 4.5 - Example of an FSGIM Model for a Lighting System

4.2.4. Modeling the HVAC System

The HVAC system in this example consists of a central plant and an air distribution system. The central plant contains a chiller and pumps, central plant controller, and a sub-meter. For simplicity in this example, the chiller and pump system are modeled as a single instance of the Load Class. The central plant controller is modeled as an instance of an EM Class, and the sub-meter is modeled as an instance of a Meter Class. The air distribution system contains a number of constant volume air handlers. For simplicity in this example, they are modeled as a single instance of the Load Class since there is a single sub-meter that monitors their consumption. The air handler controllers are modeled as an instance of the EM Class. The FSGIM representation of this sub-system is shown in Figure 4.6.

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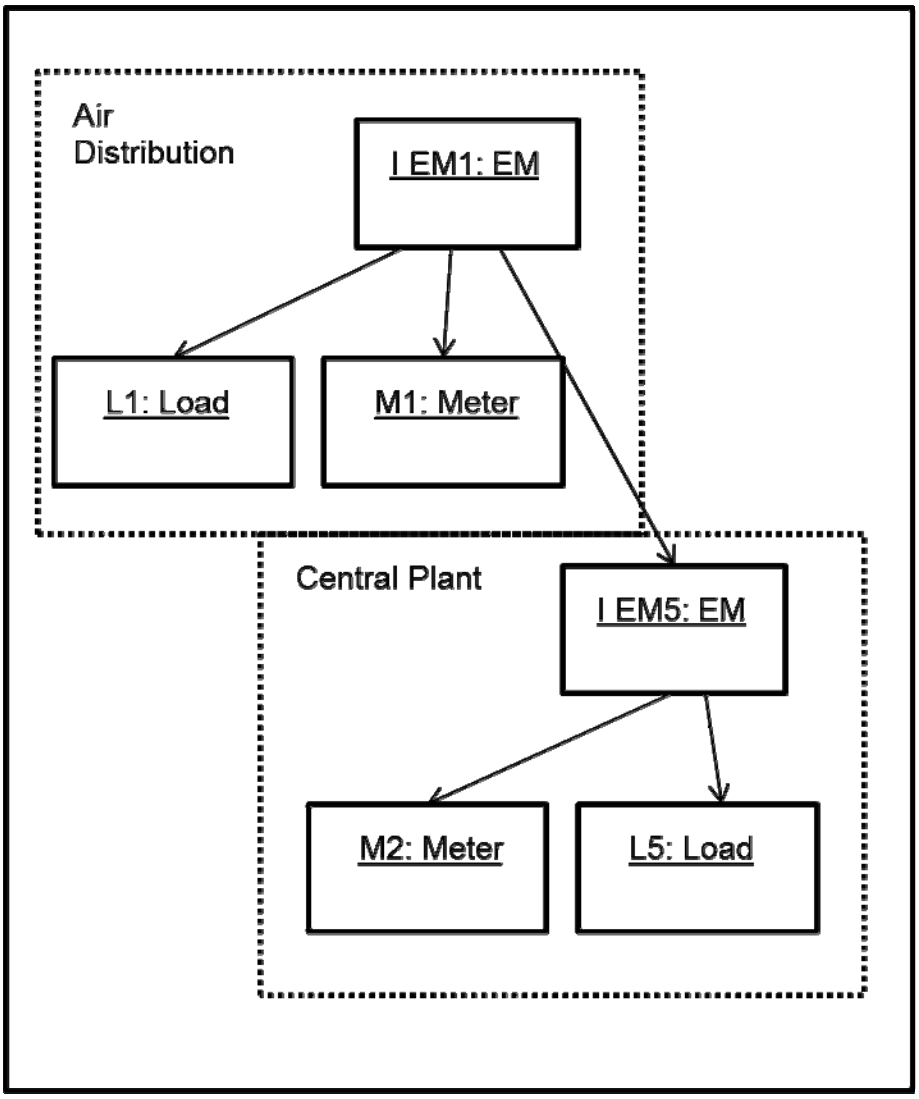

Figure 4.6 - Example of an FSGIM Model for an HVAC System that contains a central plant and air distribution system.

4.2.5. Modeling the Photovoltaic Array and Grid Interface

Electricity enters the facility at a service delivery point through the utility meter. In order to interact with the smart electric grid, energy information is exchanged between the electric delivery system, external energy information providers, and the facility. This interface is called the Energy Services Interface (ESI). This is where consumption information, rate schedules, demand response requests/responses, energy forecasts, and weather information are exchanged. For simplicity in this example, it is assumed that the ESI is connected through the utility meter and is interfaced to the energy management system. In the FSGIM, a specialized form of an EM Class called an ESI EM Class is used to model the facility side of the ESI. In this example, the energy manager represented by an instance of the ESI EM Class also performs an internal energy management function to control the photovoltaic array system. The photovoltaic array system is modeled as an instance of a Generator Class. The FSGIM representation of this sub-system is shown in Figure 4.7.

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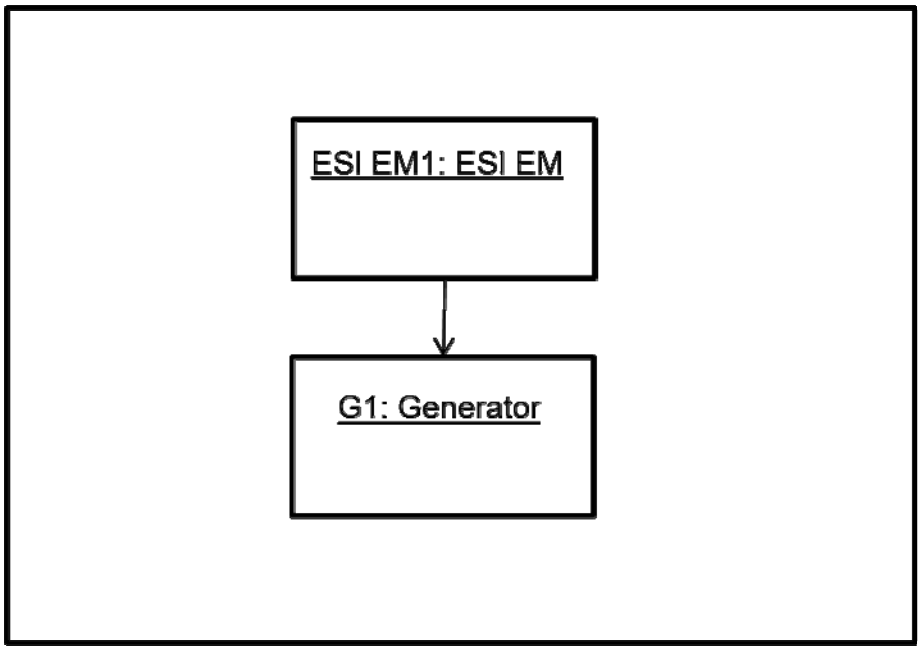

Figure 4.7 - Example of an FSGIM Model of a System that Contains an Energy Manager and a Generator.

4.2.6. Combining All of the Subsystems

To create a model of an entire facility the subsystems are interconnected together as shown in Figure 4.8 in a topology diagram. Once all of the subsystems are connected together, the energy information of the entire system can be collected and disseminated. The FSGIM provides the energy information semantics that are needed to be communicated without limiting the communications methodologies used. The energy managers are responsible for aggregating energy information provided by other energy managers farther down the topology. In this way, a facility can contain many energy managers that cooperate to meet energy goals and provide energy information.

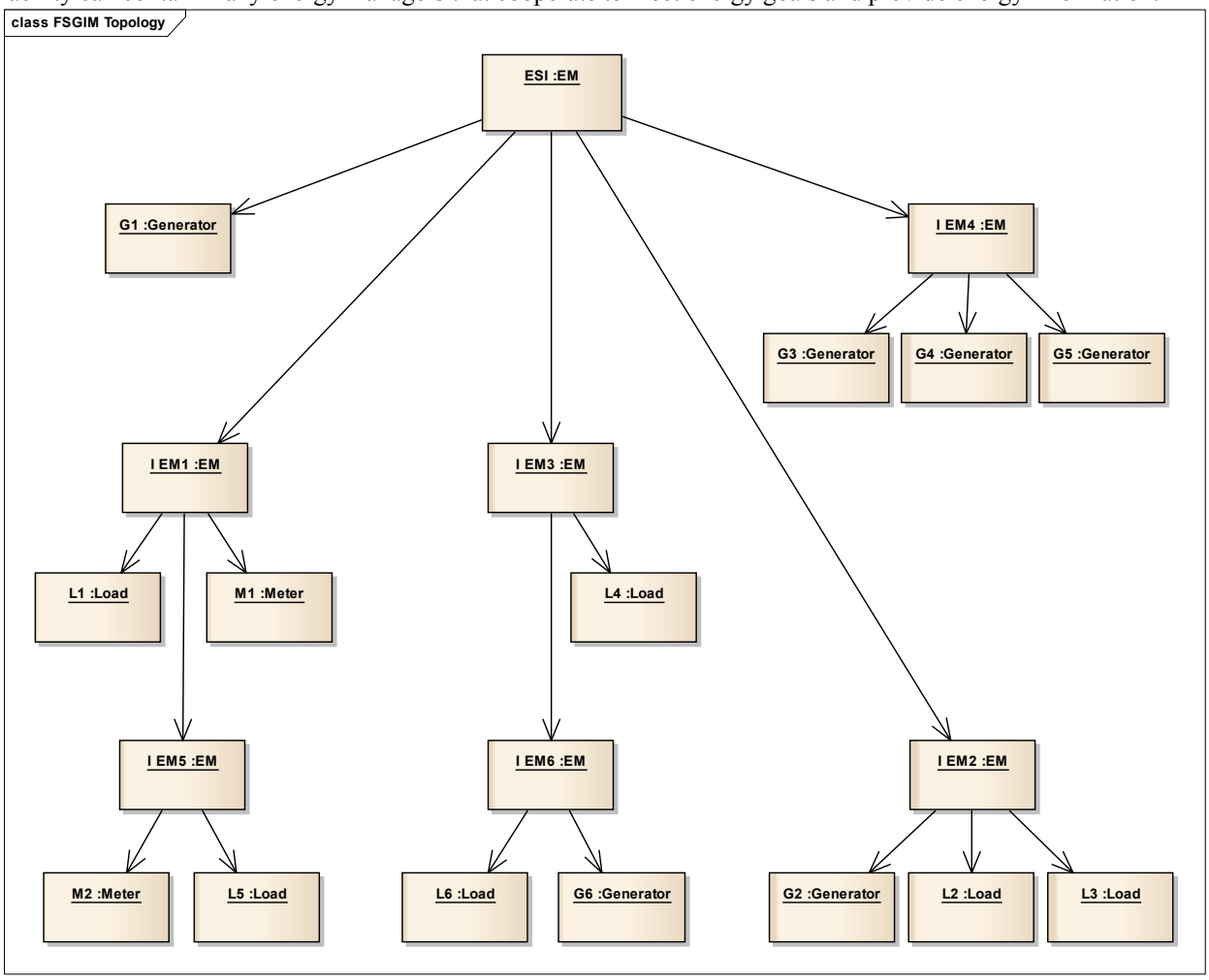

Figure 4.8 - Example Topology Diagram Based on the FSGIM

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5. DEVICE AND MODEL COMPONENTS

The FSGIM is comprised of four distinct components. These modeling components can be arranged and combined as needed to represent physical devices, systems, or functions.

The model components are:

- Meter Component -- an abstract representation of any device that measures electricity or emissions;
- Load Component -- an abstract representation of any device that consumes electricity;
- Generator Component -- an abstract representation of any device that produces electricity; and
- Energy Manager Component -- an abstract representation of any device that makes control decisions about energy generation or consumption.

The components are defined and described using UML class diagrams and detailed descriptions of class attributes and enumerations. For each model component the overall structure is displayed in a series of class diagrams. Each class diagram is followed by a summary description of the elements in the diagram, including a cross-reference to the subclause that provides all of the element details.

UML Package Location: *Model\Device and Model Components*

5.1. Facility Model Overview Diagram

This diagram shows the major elements within the Facility Smart Grid Information Model and where they fit within an architecturally layered interface view of a facility.

- Layer 1 represents data primarily coming from sources outside of the facility where these sources are loosely coupled with the systems in the facility.
- Layer 2 shows how the ESI EMs represent the information that is exchanged between the facility and the external world. The package symbols show the external standards that have been used by the FSGIM.
- Layer 3 describes how energy managers represent the information used within the facility for monitoring, control, and analysis.
- Layer 4 represents protocols used within the facility.

As one moves down through the layers tighter coupling among systems is expected. The scope of FSGIM stops short of providing for the representation of local control categories as indicated in the bottom boundary of the diagram.

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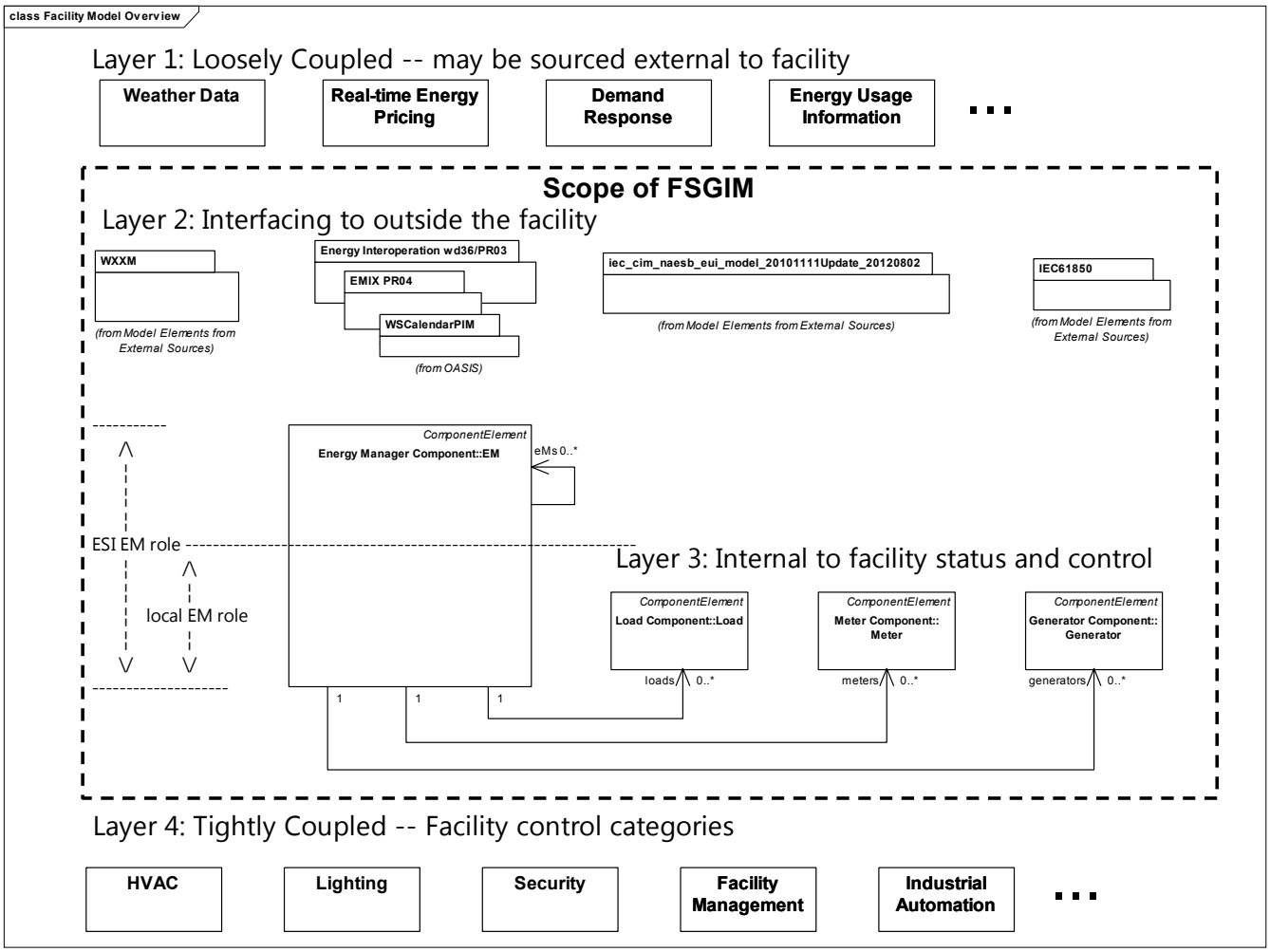

Figure 5.1 - Facility Model Overview

The Facility Model Overview Diagram makes use of the following elements:

EM (Class)
The EM Class is the central class of the Energy Manager Component. It contains indirectly through its associations the information elements that support the functionality of an energy manager. An energy manager reports on and makes decisions involving meters, loads, generators, storage devices, other energy managers, and external information.

UML Element Location: *Model\Device and Model Components\Energy Manager Component\EM.* See Clause 5.6.7.2 for the complete definition of this element.

EMIX PR04 (Package)
The Energy Market Information Exchange (EMIX) Component is the portion of the FSGIM that provides an abstract representation of information needed 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.

UML Element Location: *Model\Model Elements from External Sources\OASIS\EMIX PR04.* See Clause 5.7.2 for the complete definition of this element.

Energy Interoperation wd36/PR03 (Package)
The Energy Interoperation Component is the portion of the FSGIM that provides an abstract representation of information needed for collaborative and transactive use of energy. It defines information used to coordinate energy supply and use, including power and ancillary services, between two parties such as energy suppliers and facilities.

UML Element Location: *Model\Model Elements from External Sources\OASIS\Energy Interoperation wd36/PR03.* See Clause 5.7.1 for the complete definition of this element.

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Generator (Class)
The Generator Class is the central class of the Generator Component. It contains, directly through its attributes and indirectly through its associations, the information elements that support the functionality of a generator. A generator produces energy or retrieves it from storage.

UML Element Location: *Model\Device and Model Components\Generator Component\Generator.* See Clause 5.5.6.2 for the complete definition of this element.

iec_cim_naesb_eui_model_20101111Update_20120802 (Package)
This package, derived from NAESB REQ.18/WEQ.19, contains information elements used in the Meter Component, Energy Manager Component, FSGIM measurements, and exchange of energy usage information with external parties.

UML Element Location: *Model\Model Elements from External Sources\iec_cim_naesb_eui_model_20101111Update_20120802.* See Clause 5.7.5 for the complete definition of this element.

IEC61850 (Package)
IEC 61850 is the international standard for communications with electric power and related system intelligent electric devices (IED). There are many parts to this standard.

FSGIM adopts parts of the information model from IEC61850-7-2,3,4 and 420. The latter part deals with the modeling of distributed energy resources (DER). It contains a set of model classes that allow for the nameplate, status, and control of DERs.

These model elements were extracted from the corresponding 61850 parts and were modified to use the primitives of FSGIM where there was a one to one correspondence. LogicalNode class names were expanded to make them more "human readable". No semantic changes were made to the imported model elements.

UML Element Location: *Model\Model Elements from External Sources\IEC61850.* See Clause 5.7.4 for the complete definition of this element.

Load (Class)
The Load Class is the central class of the Load Component. It contains, directly through its attributes and indirectly through its associations, the information elements that support the functionality of a load.

UML Element Location: *Model\Device and Model Components\Load Component\Load.* See Clause 5.4.2.5 for the complete definition of this element.

Meter (Class)
The Meter Class is the central class of the Meter Component. It contains, directly through its attributes and indirectly through its associations, the information elements that support the functionality of a meter. A meter measures electricity or pollution emissions.

UML Element Location: *Model\Device and Model Components\Meter Component\Meter.* See Clause 5.3.2.1 for the complete definition of this element.

WSCalendarPIM (Package)
This is a tailored version of the WSCalendard PIM for use in FSGIM.

A PIM is a model of a system designed to be independent of the details needed for particular implementation technologies.

UML Element Location: *Model\Model Elements from External Sources\OASIS\WSCalendarPIM.* See Clause 5.7.3 for the complete definition of this element.

WXXM (Package)
This package, derived from the Weather Exchange Model (WXXM), contains information elements used in the Energy Manager Component to represent weather observations, hazards, and forecasts.

FSGIM has imported this UML Model, Version 1.1.1., and tailored it as follows:
1. A subset of classes needed for FSGIMWeather were selected.
2. Primitive data types were normalized to FSGIM common primitive types.

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3. The inheritance hierarchy was abbreviated while preserving all inherited attributes and relationships. Local versions of deeply nested inheritance were simplified by hand-assembling equivalent classes.
4. Enumerations were coerced to the enumeration style and stereotypes of FSGIM.

These modifications were designed to capture the desired subset of functionality, improve consistency, and preserve all semantics of the base WXXM standard. In each case, the FSGIM class retains the name of the WXXM class and additionally, the XMI identifier of the original to provide traceability back to the original class.

UML Element Location: *Model\Model Elements from External Sources\WXXM.* See Clause 5.7.6 for the complete definition of this element.

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5.2. Device

The Device represents a physical entity that is then modeled using the remaining classes within the FSGIM. This portion of the model also includes classes that are used to name and tag these physical devices and the logical roles that these physical devices assume.

UML Package Location: *Model\Device and Model Components\Device*

5.2.1. Device Diagram

This diagram shows the basic composition of the FSGIM model. It shows how a physical device is decomposed into one or more of its logical components.

Components represent the various roles played by an actual device as viewed by the FSGIM.

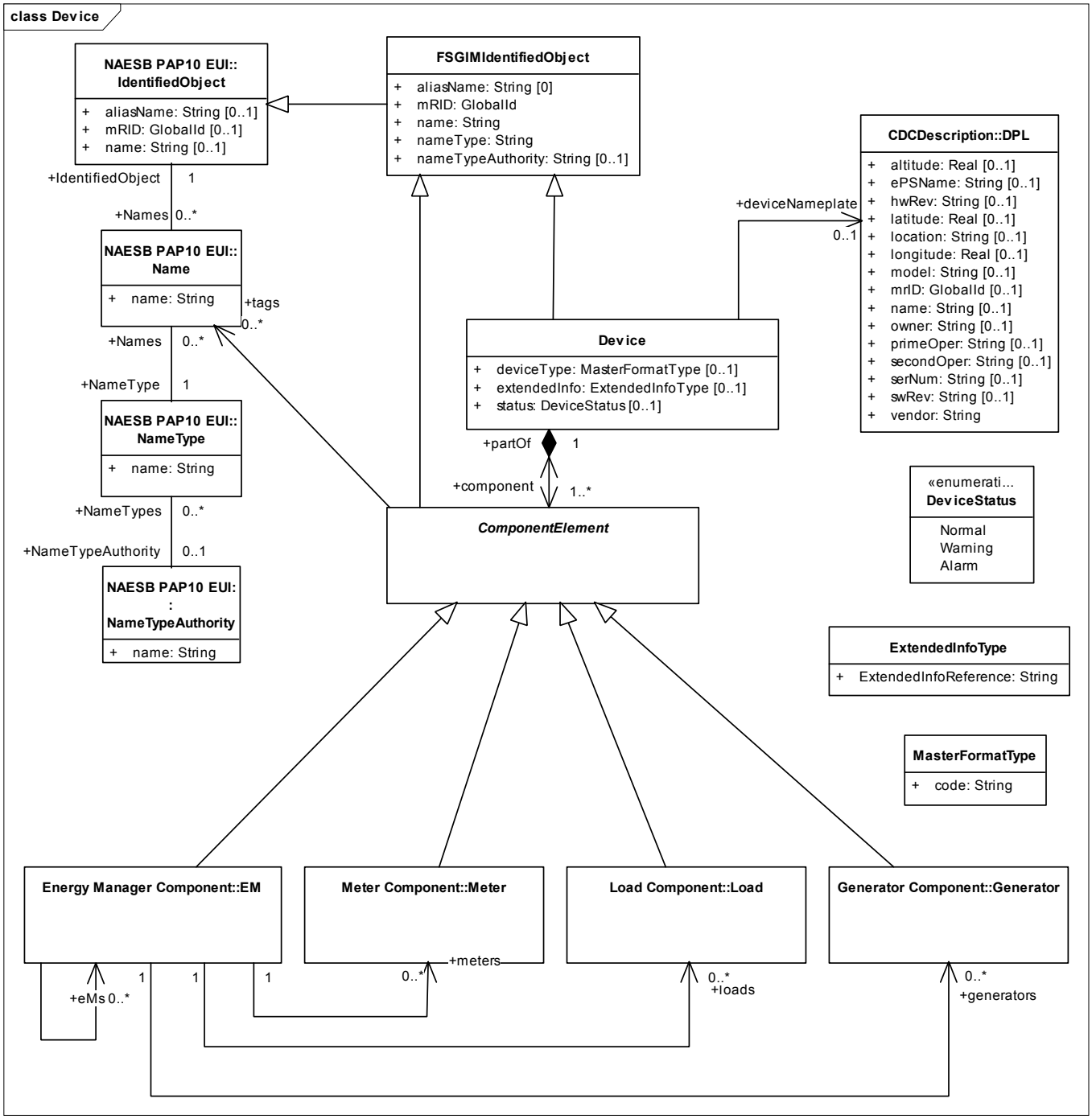

Figure 5.2 - Device

The Device Diagram makes use of the following elements:

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ComponentElement (Abstract Class)
This class is an abstract class representing the top level class of one of the four FSGIM model components or a Collection of these top level classes. Note that the parts of a Collection instance inherit the tag attribute values of its parent collection ComponentElement instance.

UML Element Location: *Model\Device and Model Components\Device\ComponentElement.* See Clause 5.2.3.1 for the complete definition of this element.

Device (Class)
This is the class that represents a physical device in the facility

UML Element Location: *Model\Device and Model Components\Device\Device.* See Clause 5.2.3.2 for the complete definition of this element.

DeviceStatus (Enumeration)
The general indication of the health of a Device.

UML Element Location: *Model\Device and Model Components\Device\DeviceStatus.* See Clause 5.2.3.6 for the complete definition of this element.

DPL (Class)
This common data class is used to identify entities like primary equipment or physical devices.

UML Element Location: *Model\Model Elements from External Sources\IEC61850\IEC61850_7_3\CommonDataClasses\CDCDescription\DPL.* See Clause 5.7.4.5.3.1.18 for the complete definition of this element.

EM (Class)
The EM Class is the central class of the Energy Manager Component. It contains indirectly through its associations the information elements that support the functionality of an energy manager. An energy manager reports on and makes decisions involving meters, loads, generators, storage devices, other energy managers, and external information.

UML Element Location: *Model\Device and Model Components\Energy Manager Component\EM.* See Clause 5.6.7.2 for the complete definition of this element.

ExtendedInfoType (Class)
This class defines an reference external from this model that can be used to gain additional information about the device.

UML Element Location: *Model\Device and Model Components\Device\ExtendedInfoType.* See Clause 5.2.3.3 for the complete definition of this element.

FSGIMIdentifiedObject (Class)
A standard representation of the identifier used to distinguish key object instances in the FSGIM.

UML Element Location: *Model\Device and Model Components\Device\FSGIMIdentifiedObject.* See Clause 5.2.3.4 for the complete definition of this element.

Generator (Class)
The Generator Class is the central class of the Generator Component. It contains, directly through its attributes and indirectly through its associations, the information elements that support the functionality of a generator. A generator produces energy or retrieves it from storage.

UML Element Location: *Model\Device and Model Components\Generator Component\Generator.* See Clause 5.5.6.2 for the complete definition of this element.

IdentifiedObject (Class)
This is a root class to provide common identification for all classes needing identification and naming attributes

UML Element Location: *Model\Model Elements from External Sources\iec_cim_naesb_eui_model_20101111Update_20120802\NAESB PAP10 EUI\IdentifiedObject.* See Clause 5.7.5.2.1.8 for the complete definition of this element.

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Load (Class)
The Load Class is the central class of the Load Component. It contains, directly through its attributes and indirectly through its associations, the information elements that support the functionality of a load.

UML Element Location: *Model\Device and Model Components\Load Component\Load.* See Clause 5.4.2.5 for the complete definition of this element.

MasterFormatType (Class)
This class defines a string attribute with specific constraints to map into the Master Format 2012 numbering system.

UML Element Location: *Model\Device and Model Components\Device\MasterFormatType.* See Clause 5.2.3.5 for the complete definition of this element.

Meter (Class)
The Meter Class is the central class of the Meter Component. It contains, directly through its attributes and indirectly through its associations, the information elements that support the functionality of a meter. A meter measures electricity or pollution emissions.

UML Element Location: *Model\Device and Model Components\Meter Component\Meter.* See Clause 5.3.2.1 for the complete definition of this element.

Name (Class)
The Name class provides the means to define any number of human readable names for an object.

UML Element Location: *Model\Model Elements from External Sources\iec_cim_naesb_eui_model_20101111Update_20120802\NAESB PAP10 EUI\Name.* See Clause 5.7.5.2.1.14 for the complete definition of this element.

NameType (Class)
Type of name. Possible values for attribute 'name' are implementation dependent but standard profiles may specify types. An enterprise may have multiple information technology systems each having its own local name for the same object, e.g., a planning system may have different names from an energy management system. An object may also have different names within the same system.

UML Element Location: *Model\Model Elements from External Sources\iec_cim_naesb_eui_model_20101111Update_20120802\NAESB PAP10 EUI\NameType.* See Clause 5.7.5.2.1.15 for the complete definition of this element.

NameTypeAuthority (Class)
Authority responsible for creation and management of names of a given type; typically an organization or an enterprise system.

UML Element Location: *Model\Model Elements from External Sources\iec_cim_naesb_eui_model_20101111Update_20120802\NAESB PAP10 EUI\NameTypeAuthority.* See Clause 5.7.5.2.1.16 for the complete definition of this element.

5.2.2. Object Identification Diagram

This diagram illustrates the correspondence between the NAESB standard use of IdentifiedObject and the FSGIM profile of that class and the associated Name class.

In the FSGIM, the mRID becomes a required globally unique identifier. This makes instances of objects that inherit from IdentifiedObject recognizeable regardless of the protocol transformations that may occur as information is exchanged via FSGIM-implementing protocol standards. That is, while the syntactical encoding of the identifier may be different, there is a canonical form to which the identifiers can be transformed such that the same object is recognized as the same.

Additionally, the aliasName has been profiled out of the IdentifiedObject class. Finally, the name attribute has been modified to allow NameType and NameTypeAuthority attribution.

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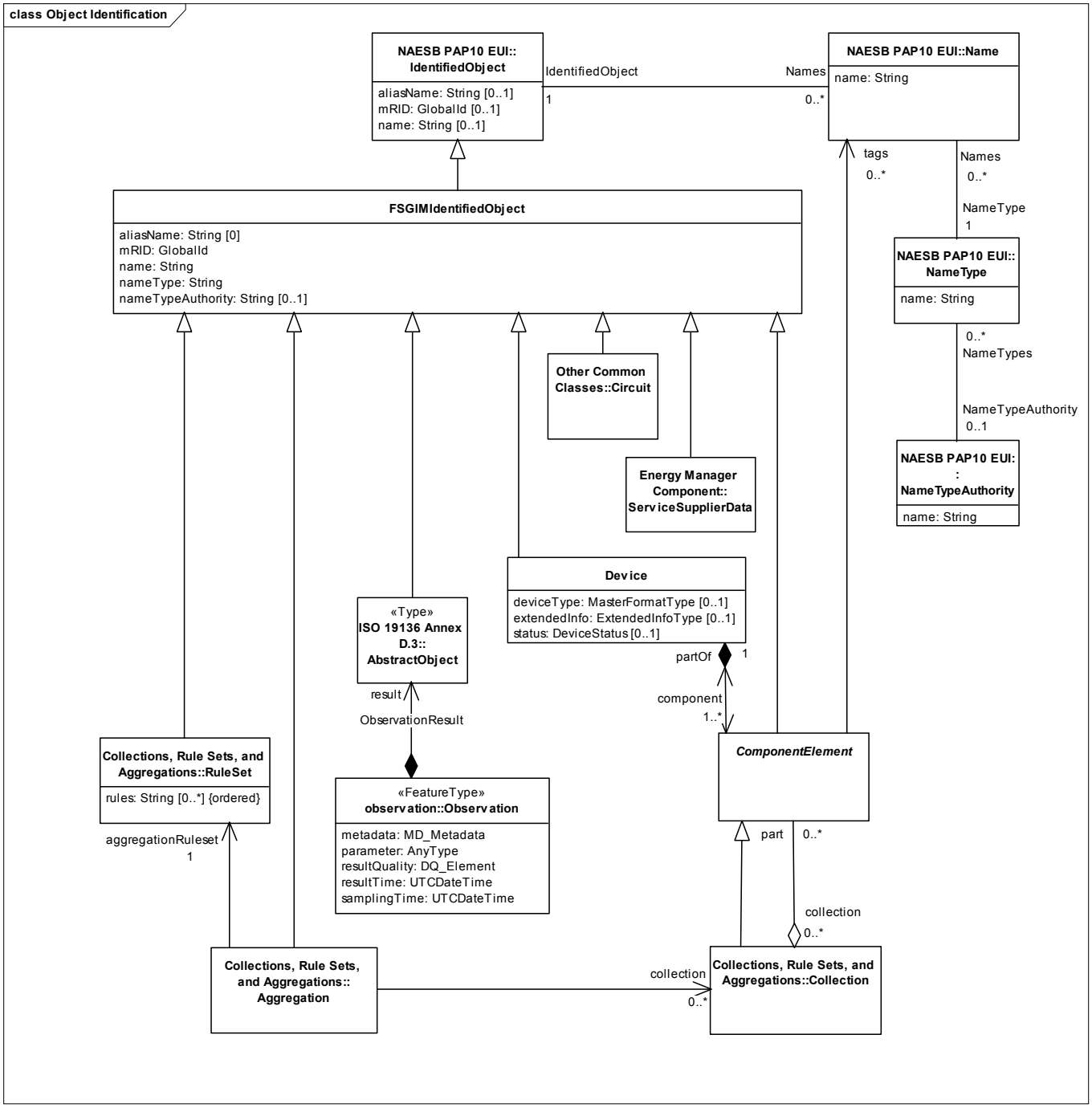

Figure 5.3 - Object Identification

The Object Identification Diagram makes use of the following elements:

AbstractObject (Class)
Abstract object class.

UML Element Location: *Model\Model Elements from External Sources\WXXM\CommonUsagePackages\ISO 19136 Annex D.3\AbstractObject.* See Clause 5.7.6.6.3.1.3 for the complete definition of this element.

Aggregation (Class)
An aggregation allows the assembly of statistics of interest arrived at through defined algorithms applied to other parts of the model. The description of an aggregation includes all of the inputs that comprise the algorithms as well as the outputs of the algorithm. An aggregation instance represents one or more aggregateQuantities that are computed by applying aggregation rules for each quantity against a Collection or FilteredCollection of Components.

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UML Element Location: *Model\Device and Model Components\Energy Manager Component\Collections, Rule Sets, and Aggregations\Aggregation.* See Clause 5.6.7.11.1 for the complete definition of this element.

Circuit (Class)
This class is used to model electrical circuits. All ConnectionPoints that are electrically tied together will point to the same instance of this class.

UML Element Location: *Model\Common Primitive Types, Classes, and Enumerations\Other Common Classes\Circuit.* See Clause 6.6.5.1 for the complete definition of this element.

Collection (Class)
This class defines a set of entities that is identified as a group because the members share some trait. A Collection can contain other Collections.

UML Element Location: *Model\Device and Model Components\Energy Manager Component\Collections, Rule Sets, and Aggregations\Collection.* See Clause 5.6.7.11.3 for the complete definition of this element.

ComponentElement (Abstract Class)
This class is an abstract class representing the top level class of one of the four FSGIM model components or a Collection of these top level classes. Note that the parts of a Collection instance inherit the tag attribute values of its parent collection ComponentElement instance.

UML Element Location: *Model\Device and Model Components\Device\ComponentElement.* See Clause 5.2.3.1 for the complete definition of this element.

Device (Class)
This is the class that represents a physical device in the facility

UML Element Location: *Model\Device and Model Components\Device\Device.* See Clause 5.2.3.2 for the complete definition of this element.

FSGIMIdentifiedObject (Class)
A standard representation of the identifier used to distinguish key object instances in the FSGIM.

UML Element Location: *Model\Device and Model Components\Device\FSGIMIdentifiedObject.* See Clause 5.2.3.4 for the complete definition of this element.

IdentifiedObject (Class)
This is a root class to provide common identification for all classes needing identification and naming attributes

UML Element Location: *Model\Model Elements from External Sources\iec_cim_naesb_eui_model_20101111Update_20120802\NAESB PAP10 EUI\IdentifiedObject.* See Clause 5.7.5.2.1.8 for the complete definition of this element.

Name (Class)
The Name class provides the means to define any number of human readable names for an object.

UML Element Location: *Model\Model Elements from External Sources\iec_cim_naesb_eui_model_20101111Update_20120802\NAESB PAP10 EUI\Name.* See Clause 5.7.5.2.1.14 for the complete definition of this element.

NameType (Class)
Type of name. Possible values for attribute 'name' are implementation dependent but standard profiles may specify types. An enterprise may have multiple information technology systems each having its own local name for the same object, e.g., a planning system may have different names from an energy management system. An object may also have different names within the same system.

UML Element Location: *Model\Model Elements from External Sources\iec_cim_naesb_eui_model_20101111Update_20120802\NAESB PAP10 EUI\NameType.* See Clause 5.7.5.2.1.15 for the complete definition of this element.

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NameTypeAuthority (Class)
Authority responsible for creation and management of names of a given type; typically an organization or an enterprise system.

UML Element Location: *Model\Model Elements from External Sources\iec_cim_naesb_eui_model_20101111Update_20120802\NAESB PAP10 EUI\NameTypeAuthority.* See Clause 5.7.5.2.1.16 for the complete definition of this element.

Observation (Class)
Weather observation. This class comprises the measurements and observed phenomena at a point in time and for a given weather area.

UML Element Location: *Model\Model Elements from External Sources\WXXM\SWE\OM1_Observation\observation\Observation.* See Clause 5.7.6.6.5.1.2 for the complete definition of this element.

RuleSet (Class)
A Ruleset contains a set of ordered rules that defines how the value of an AggregateQuantity is derived or how the members of a FilteredCollection are selected. The text in Ruleset.rules is meant to convey the intent of the set of rules. It is not meant to imply requirements for a parsable Ruleset language. The exact format used for the rules in the Ruleset is a local matter.

UML Element Location: *Model\Device and Model Components\Energy Manager Component\Collections, Rule Sets, and Aggregations\RuleSet.* See Clause 5.6.7.11.5 for the complete definition of this element.

ServiceSupplierData (Class)
This class contains information associated with the generated emissions, quality of power, and energy-price units associated with an identified supplier of energy.

UML Element Location: *Model\Device and Model Components\Energy Manager Component\ServiceSupplierData.* See Clause 5.6.7.9 for the complete definition of this element.

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5.2.3. Elements Defined in the Device Model

The following elements are defined in this model.

5.2.3.1. ComponentElement (Abstract Class)

This class is an abstract class representing the top level class of one of the four FSGIM model components or a Collection of these top level classes. Note that the parts of a Collection instance inherit the tag attribute values of its parent collection ComponentElement instance.

Parent Class: FSGIMIdentifiedObject (See Clause 5.2.3.4.)

UML Element Location: *Model\Device and Model Components\Device\ComponentElement.*
This element has the following connections to other elements:

Table 5.1 - Class Connections

Connection Type	Role Name	Description	Role Type	Multiplicity
Composition (with bi-directional navigation)	partOf	The physical device that houses the functionality of the EM Class, Meter Class, Load Class, and/or Generator Class.	Device See Clause 5.2.3.2.	[1]
Association	tags	This attribute may contain a set of strings to be used at the configuration phase of installation such as "hallway", "3rd Floor", "Critical", ... These strings may be optionally qualified with a NameType and NameTypeAuthority.	Name See Clause 5.7.5.2.1.14.	[0..*]

5.2.3.2. Device (Class)

This is the class that represents a physical device in the facility

Parent Class: FSGIMIdentifiedObject (See Clause 5.2.3.4.)

UML Element Location: *Model\Device and Model Components\Device\Device.*

Table 5.2 - Class Attributes

Attribute Name	Description	Attribute Type	Multiplicity
deviceType	This attribute defines an unique code (as specified in Master Format 2012) that uniquely identifies the device installed.	MasterFormatType See Clause 5.2.3.5.	[0..1]
extendedInfo	This attribute references extended information about the device.	ExtendedInfoType See Clause 5.2.3.3.	[0..1]
status	Operational state of a device within a facility.	DeviceStatus See Clause 5.2.3.6.	[0..1]

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This element has the following connections to other elements:

Table 5.3 - Class Connections

Connection Type	Role Name	Description	Role Type	Multiplicity
Composition	component	The logical building blocks that are combined to represent the physical device.	ComponentElement See Clause 5.2.3.1.	[1..*]
Association	deviceNameplate	The nameplate associated with this device.	DPL See Clause 5.7.4.5.3.1.18.	[0..1]

5.2.3.3. ExtendedInfoType (Class)

This class defines an reference external from this model that can be used to gain additional information about the device.

UML Element Location: *Model\Device and Model Components\Device\ExtendedInfoType.*

Table 5.4 - Class Attributes

Attribute Name	Description	Attribute Type	Multiplicity
ExtendedInfoReference	This attribute defines a string reference to additional information about the device. This reference may be any string reference such as a URL, URI, or other identifying information. This attribute is only the reference to the extended information, it shall not hold the extended information directly.	String See Clause 6.6.3.7.	[1]

5.2.3.4. FSGIMIdentifiedObject (Class)

A standard representation of the identifier used to distinguish key object instances in the FSGIM.

Parent Class: IdentifiedObject (See Clause 5.7.5.2.1.8.)

UML Element Location: *Model\Device and Model Components\Device\FSGIMIdentifiedObject.*

Table 5.5 - Class Attributes

Attribute Name	Description	Attribute Type	Multiplicity
aliasName	This attribute redefines the NAESB IdentifiedObject and sets its multiplicity to 0 to profile it out of the model since aliases are handled through the Name/NameType/NameTypeAuthority construct in the FSGIM. (This attribute redefines the aliasName attribute of the IdentifiedObject Class. See Clause 5.7.5.2.1.8.)	String See Clause 6.6.3.7.	[0]

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Attribute Name	Description	Attribute Type	Multiplicity
mRID	Master resource identifier issued by a model authority. The mRID is globally unique within an exchange context. This attribute redefines the mRID attribute of the NAESB IdentifiedObject to force the attribute to be of type GlobalId. (This attribute redefines the mRID attribute of the IdentifiedObject Class. See Clause 5.7.5.2.1.8.)	GlobalId See Clause 6.6.3.4.	[1]
name	Any free text that names the object. This attribute redefines the NAESB IdentifiedObject attribute to force the multiplicity to be 1. (This attribute redefines the name attribute of the IdentifiedObject Class. See Clause 5.7.5.2.1.8.)	String See Clause 6.6.3.7.	[1]
nameType	Name of the name type.	String See Clause 6.6.3.7.	[1]
nameTypeAuthority	Name of the name type authority.	String See Clause 6.6.3.7.	[0..1]

5.2.3.5. MasterFormatType (Class)

This class defines a string attribute with specific constraints to map into the Master Format 2012 numbering system.

UML Element Location: *Model\Device and Model Components\Device\MasterFormatType.*

Table 5.6 - Class Attributes

Attribute Name	Description	Attribute Type	Multiplicity
code	This attribute is an eleven character string that defines a coded identifier for the device defined. The identifier is defined in the Master Format (2012) Numbers and Titles document. The Master Format is a near exhaustive list of building components maintained by the construction industry. Each component has an assigned unique immutable identifier taking the form of NNSNNSNNPXX where: space = ' ' period = '.' number = '0','1','2','3','4','5','6','7','8','9' N = number S = space P = (period, space) X = (0..9, space) For example, a portable dehumidifier uses code '23 84 13.33'; a room air-conditioner uses code '23 81 16 '. A value of "99 99 99 99" shall be used to model an unknown load.	String See Clause 6.6.3.7.	[1]

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5.2.3.6. DeviceStatus (Enumeration)

The general indication of the health of a Device.

UML Element Location: *Model\Device and Model Components\Device\DeviceStatus*.

Table 5.7 - DeviceStatus Enumerated Values

Enumerated Value	Definition
Normal	Device is in a normal operating condition.
Warning	Some type of abnormal condition that does not constitute an alarm has been detected.
Alarm	A serious abnormal condition has been detected.

5.2.3.7. EFacilitySystem (Enumeration)

This enumeration is used to define the subsystem to which the ComponentElement is associated within the facility. ComponentElements that cross subsystems should use the 'general' category.

UML Element Location: *Model\Device and Model Components\Device\EFacilitySystem.*

Table 5.8 - EFacilitySystem Enumerated Values

Enumerated Value	Definition
athletic	The load is associated with athletic equipment including exercise equipment, gymnasium equipment, pool heaters, saunas, steam rooms and scoreboards.
audioVisual	The load is associated with Audio-Visual equipment including projection screens, fixed projection screens, portable projection screens, rear projection screens, projectors, movie projectors, slide projectors, overhead projectors, opaque projectors, video projectors, players, recorders and information centers (kiosks).
banking	The load is associated with a banking subsystem including safe deposit boxes, safes vault ventilators, teller equipment, automatic banking systems, money handling equipment, detention pass-thru doors and depositories.
disposal	The load is associated with a disposal subsystem including packaged incinerators, recycling equipment, facility waste compactors, composting equipment, facility waste shredders, and facility waste balers.
elevators	The load is associated with an elevator or escalator subsystem.
entertainment	The load is associated with an entertainment subsystem including lighting rigging systems, scenery rigging systems, curtain systems, and voice amplifiers.
exterior	The load is associated with exterior equipment including automatic flagpoles, fountains, decorative lighting, pest control devices, deicers and signage.
fire	This load is associated with Fire subsystem including fire panels, smoke detection devices, strobes, evacuation equipment, fire fighter control panels, smoke control and automatic sprinkler systems.
foodservice	The load is associated with Foodservice equipment including refrigerated food storage cases, walk-In coolers, walk-In freezers, food preparation appliances, food preparation surfaces, food delivery carts, food delivery conveyors, commercial ranges, commercial ovens, bar equipment, service line equipment, soda fountain equipment, coffee and espresso equipment, ice machines, disposal equipment and commercial dishwashers.

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Enumerated Value	Definition
general	This load is associated to multiple subsystems none of which is primary.
healthcare	The load is associated with healthcare equipment including medical sterilizing equipment, refrigeration units, examination equipment, treatment equipment, patient care equipment, dental equipment, optical equipment, operating room equipment, radiology equipment and mortuary equipment.
hospitality	The load is associated with Hospitality equipment including registration equipment.
HVAC	The load is associated with a heating ventilation and air conditioning (HVAC) subsystem including chillers, ice storage, boilers, electric heaters, heat pumps, air handlers, packaged units, pumps, air distribution systems, air handlers, air compressors, variable air volume controllers, fan coils, humidifiers, dehumidifiers, thermostats, humidistats and facility management systems (FMS).
IT	The load is associated with information technology (IT) equipment including servers, CRAC units, network switches, hubs, routers, firewalls, access points, telephone switches and other MDF/IDF closet equipment.
laboratory	The load is associated with Laboratory equipment including fume hoods, incubators, equipment washers, sterilizers, environment cabinets, emergency safety appliances, service fittings and accessories biological safety cabinets.
laundry	The load is associated with Laundry equipment including dry cleaning equipment; drying and conditioning equipment; finishing equipment; commercial ironing equipment; commercial washers; driers; coin-operated laundry equipment and hanging garment conveyors.
lighting	The load is associated with a lighting subsystem including lighting panels; lighting circuits; floor and task lighting; emergency lighting; lava lamps; and shade control.
maintenance	The load is associated with Maintenance equipment including; floor and wall cleaning equipment; housekeeping carts; vacuum cleaning systems; façade access equipment; window washing systems; welders; drill presses and lathes.
merchantile	The load is associated with Mercantile equipment including cash registers; checking equipment; vending machines; checkroom equipment; weighing and wrapping equipment; barbering and beauty equipment.
office	The load is associated with Office equipment including telephones, computers, printers, copiers, facsimile machines and white noise generators.
pedestrian	The load is associated to a pedestrian equipment, including pedestrian gates, rotary gates turnstiles, money changing machines, fare collection equipment, pedestrian detection equipment, electronic detection and counting systems and pedestrian security equipment.
parking	The load is associated with parking equipment including parking card control units; parking ticket dispensers, parking meters, parking fee collection equipment and parking gates.
production	The load is associated with a production subsystems including assembly line equipment, robots, part picking equipment, stocking equipment, inventory control equipment, assembly, quality testing and production control equipment.
recreational	The load is associated with recreational equipment including game room equipment, video games, and pinball machines.
residential	The load is associated with Residential equipment including lights, bathroom appliances, kitchen appliances, laundry appliances, televisions, stereo equipment and fans.
security	The load is associated with a physical security subsystem including video surveillance, door control, building access, tamper monitoring, terrorist activity monitoring, radio communications, asset tracking, personnel tracking and video analytics.
shipping	The load is associated with Shipping equipment including airport luggage handlers, conveyor belts, packaging, dock levelers, forklifts and postal equipment.
vehicle	The load is associated to a vehicle, including servicing, lubrication, tire changing, battery charging and washing equipment.
other	The load is associated to a subsystem that is not listed in this enumeration.

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5.3. Meter Component

The Meter Component is the portion of the FSGIM that provides an abstract representation of the function of measuring power, energy, and emissions.

UML Package Location: *Model\Device and Model Components\Meter Component*

5.3.1. FSGIM Meter Model Diagram

The FSGIM Meter Model incorporates a subset of the full NAESB model for a meter. The subset mirrors the NAESB model from the UsagePoint "down" with two exceptions. (1) It does not include a UsageSummary because the Meter Component in the FSGIM does not retain long-term historical data. (2) It does not include the IntervalBlock because interval blocks are handled by the Energy Manager Component in the FSGIM. In summary, the FSGIM Meter Model translates the NAESB presentation of measurements into the FSGIM presentation of measurements for power, energy, and emissions.

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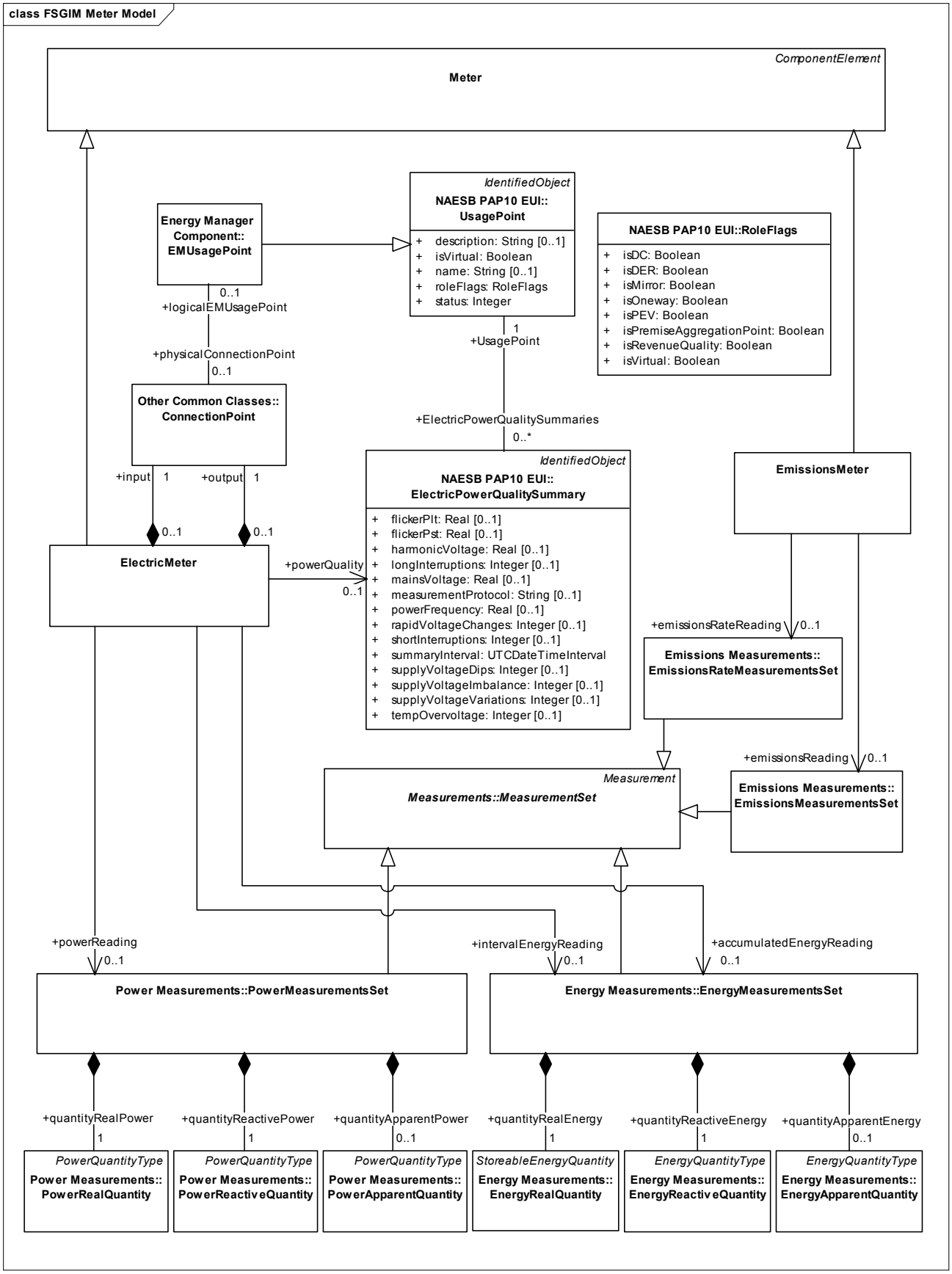

Figure 5.4 - FSGIM Meter Model

The FSGIM Meter Model Diagram makes use of the following elements:

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ConnectionPoint (Class)
This class is used to model the physical connections from Generators, Loads, Meters, and Energy Routers to sources or sinks of energy.

UML Element Location: *Model\Common Primitive Types, Classes, and Enumerations\Other Common Classes\ConnectionPoint.* See Clause 6.6.5.2 for the complete definition of this element.

ElectricMeter (Class)
The ElectricMeter Class is a subclass of the Meter Class. It is an abstract representation of devices that measure real and reactive power or energy. These devices optionally measure other electrical parameters such as apparent power, apparent energy, present subinterval demand or power quality.

UML Element Location: *Model\Device and Model Components\Meter Component\ElectricMeter.* See Clause 5.3.2.2 for the complete definition of this element.

ElectricPowerQualitySummary (Class)
A summary of power quality events. This information represents a summary of power quality information typically required by energy management systems. It is not intended to satisfy the detailed requirements of power quality monitoring. All values are as defined by measurementProtocol during the period. The standards typically also give ranges of allowed values. See referenced standards for definition, measurement protocol and period.

UML Element Location: *Model\Model Elements from External Sources\iec_cim_naesb_eui_model_20101111Update_20120802\NAESB PAP10 EUI\ElectricPowerQualitySummary.* See Clause 5.7.5.2.1.5 for the complete definition of this element.

EmissionsMeasurementsSet (Class)
A container class used to hold zero to one of each type of emissions quantity measurement that could be made for a given location and time.

UML Element Location: *Model\Common Primitive Types, Classes, and Enumerations\Measurements\Emissions Measurements\EmissionsMeasurementsSet.* See Clause 6.6.4.8.12 for the complete definition of this element.

EmissionsMeter (Class)
The EmissionsMeter Class is a subclass of the Meter Class which is used to represent devices that are capable of measuring pollution emissions.

UML Element Location: *Model\Device and Model Components\Meter Component\EmissionsMeter.* See Clause 5.3.2.3 for the complete definition of this element.

EmissionsRateMeasurementsSet (Class)
A container class used to hold zero to one of each type of emissions rate measurement that could be made for a given location and time.

UML Element Location: *Model\Common Primitive Types, Classes, and Enumerations\Measurements\Emissions Measurements\EmissionsRateMeasurementsSet.* See Clause 6.6.4.8.15 for the complete definition of this element.

EMUsagePoint (Class)
Logical point on a network at which consumption or production is either measured (e.g., metered) or estimated (e.g., unmetered street lights).

UML Element Location: *Model\Device and Model Components\Energy Manager Component\EMUsagePoint.* See Clause 5.6.7.8 for the complete definition of this element.

EnergyApparentQuantity (Class)
Quantity/metadata pair used to represent apparent energy measurements.

UML Element Location: *Model\Common Primitive Types, Classes, and Enumerations\Measurements\Energy Measurements\EnergyApparentQuantity.* See Clause 6.6.4.7.6 for the complete definition of this element.

EnergyMeasurementsSet (Class)
A container class used to hold zero to one of each type of energy measurement that could be made for a given location and time.

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UML Element Location: *Model\Common Primitive Types, Classes, and Enumerations\Measurements\Energy Measurements\EnergyMeasurementsSet.* See Clause 6.6.4.7.9 for the complete definition of this element.

EnergyReactiveQuantity (Class)
Quantity/metadata pair used to represent reactive energy measurements.

UML Element Location: *Model\Common Primitive Types, Classes, and Enumerations\Measurements\Energy Measurements\EnergyReactiveQuantity.* See Clause 6.6.4.7.11 for the complete definition of this element.

EnergyRealQuantity (Class)
Quantity/metadata pair used to represent real energy measurements.

UML Element Location: *Model\Common Primitive Types, Classes, and Enumerations\Measurements\Energy Measurements\EnergyRealQuantity.* See Clause 6.6.4.7.13 for the complete definition of this element.

MeasurementSet (Abstract Class)
An abstract container class used to hold either the power measurements, energy measurements, or emissions measurements that could be made for a given EMUsagePoint and time reference.

UML Element Location: *Model\Common Primitive Types, Classes, and Enumerations\Measurements\MeasurementSet.* See Clause 6.6.4.2 for the complete definition of this element.

Meter (Class)
The Meter Class is the central class of the Meter Component. It contains, directly through its attributes and indirectly through its associations, the information elements that support the functionality of a meter. A meter measures electricity or pollution emissions.

UML Element Location: *Model\Device and Model Components\Meter Component\Meter.* See Clause 5.3.2.1 for the complete definition of this element.

PowerApparentQuantity (Class)
Quantity and pair used to represent apparent power measurements.

UML Element Location: *Model\Common Primitive Types, Classes, and Enumerations\Measurements\Power Measurements\PowerApparentQuantity.* See Clause 6.6.4.6.8 for the complete definition of this element.

PowerMeasurementsSet (Class)
A container class used to hold one of each type of power measurement made at a given physical location and time.

UML Element Location: *Model\Common Primitive Types, Classes, and Enumerations\Measurements\Power Measurements\PowerMeasurementsSet.* See Clause 6.6.4.6.11 for the complete definition of this element.

PowerReactiveQuantity (Class)
Quantity and pair used to represent reactive power measurements.

UML Element Location: *Model\Common Primitive Types, Classes, and Enumerations\Measurements\Power Measurements\PowerReactiveQuantity.* See Clause 6.6.4.6.13 for the complete definition of this element.

PowerRealQuantity (Class)
Quantity and metadata pair used to represent real power measurements.

UML Element Location: *Model\Common Primitive Types, Classes, and Enumerations\Measurements\Power Measurements\PowerRealQuantity.* See Clause 6.6.4.6.15 for the complete definition of this element.

RoleFlags (Class)
Describes a set of specific communication or physical attributes that the associated UsagePoint has. The term RoleFlags in this specific case pertains to the application-specific nature of the UsagePoint. More than one of these flags can be true for any UsagePoint.

UML Element Location: *Model\Model Elements from External Sources\iec_cim_naesb_eui_model_20101111Update_20120802\NAESB PAP10 EUI\RoleFlags.* See Clause 5.7.5.2.1.28 for the complete definition of this element.

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UsagePoint (Class)
Logical point on a network at which consumption or production is either physically measured (e.g., metered) or estimated (e.g., unmetered street lights).

UML Element Location: *Model\Model Elements from External Sources\iec_cim_naesb_eui_model_20101111Update_20120802\NAESB PAP10 EUI\UsagePoint.* See Clause 5.7.5.2.1.26 for the complete definition of this element.

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5.3.2. Elements Defined in the Meter Component Model

The following elements are defined in this model.

5.3.2.1. Meter (Class)

The Meter Class is the central class of the Meter Component. It contains, directly through its attributes and indirectly through its associations, the information elements that support the functionality of a meter. A meter measures electricity or pollution emissions.

Parent Class: ComponentElement (See Clause 5.2.3.1.)

UML Element Location: *Model\Device and Model Components\Meter Component\Meter*.

5.3.2.2. ElectricMeter (Class)

The ElectricMeter Class is a subclass of the Meter Class. It is an abstract representation of devices that measure real and reactive power or energy. These devices optionally measure other electrical parameters such as apparent power, apparent energy, present subinterval demand or power quality.

Parent Class: Meter (See Clause 5.3.2.1.)

UML Element Location: *Model\Device and Model Components\Meter Component\ElectricMeter*.
This element has the following connections to other elements:

Table 5.9 - Class Connections

Connection Type	Role Name	Description	Role Type	Multiplicity
Association	accumulatedEnergyReading	The accumulated energy measurement set for a given location at the timestamp defined by Measurement.timeReference.	EnergyMeasurementsSet See Clause 6.6.4.7.9.	[0..1]
Composition	input	The connection point associated with the input of this ElectricMeter. The input side of a Meter is defined as the connection point nearer to the GridCircuit.	ConnectionPoint See Clause 6.6.5.2.	[1]
Association	intervalEnergyReading	The energy measurement set for a given location over the interval defined by Measurement.timeReference.	EnergyMeasurementsSet See Clause 6.6.4.7.9.	[0..1]
Composition	output	The connection point associated with the output of this ElectricMeter. The output side of a Meter is defined as the connection point farther from the GridCircuit.	ConnectionPoint See Clause 6.6.5.2.	[1]
Association	powerQuality	The power quality statistical data set for a given location.	ElectricPowerQualitySummary See Clause 5.7.5.2.1.5.	[0..1]
Association	powerReading	The power measurement set for a given location.	PowerMeasurementsSet See Clause 6.6.4.6.11.	[0..1]

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5.3.2.3. EmissionsMeter (Class)

The EmissionsMeter Class is a subclass of the Meter Class which is used to represent devices that are capable of measuring pollution emissions.
Constraint: An EmissionsMeter must have either an emissionsReading or an emissionsRateReading and may have both.

Parent Class: Meter (See Clause 5.3.2.1.)

UML Element Location: *Model\Device and Model Components\Meter Component\EmissionsMeter*.
This element has the following connections to other elements:

Table 5.10 - Class Connections

Connection Type	Role Name	Description	Role Type	Multiplicity
Association	emissionsRateReading	The emissions rate measurement set for a given location.	EmissionsRateMeasurementsSet See Clause 6.6.4.8.15.	[0..1]
Association	emissionsReading	The emissions measurement set for a given location.	EmissionsMeasurementsSet See Clause 6.6.4.8.12.	[0..1]

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5.4. Load Component

The Load Component is the portion of the FSGIM that provides an abstract representation of all devices that consume electricity. This includes devices powered from the electrical grid, powered from an alternate source, or battery powered devices. Some loads can only be switched on and off. Other loads can be modified to manage peaks or in response to pricing or other grid interactions.

The Load Component contains classes that support the ability to forecast demand, energy consumption, or both. It also contains classes that support some types of protection to prevent damage of physical equipment, however real devices may need additional safety constraints that are not captured in the model.

UML Package Location: *Model\Device and Model Components\Load Component*

5.4.1. Load Classes and Elements Diagram

The Load Classes and Elements figure describes the Load and CurtailableLoad Classes. All devices that use electricity will support the Load class. Those that can be curtailed will also support the CurtailableLoad class.

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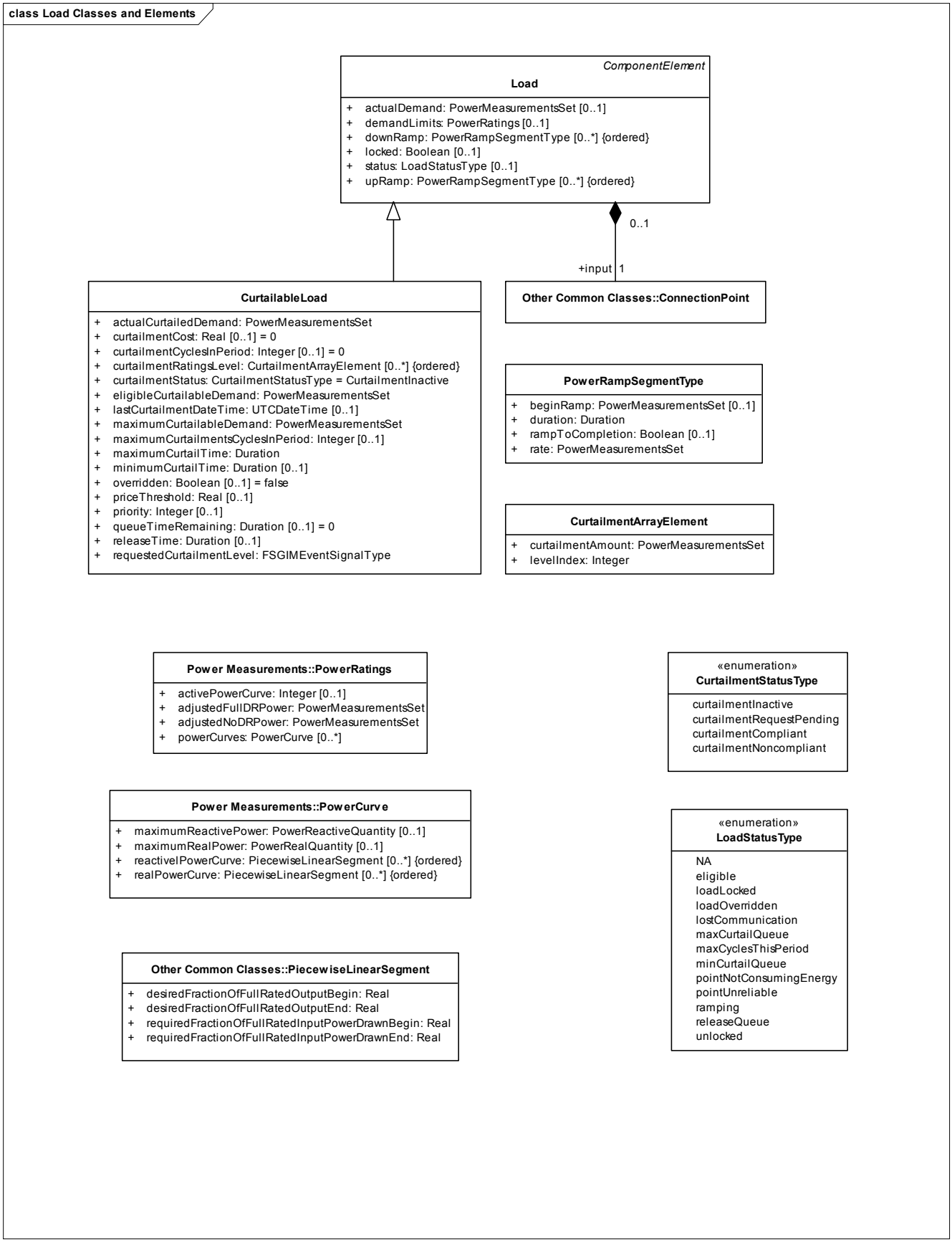

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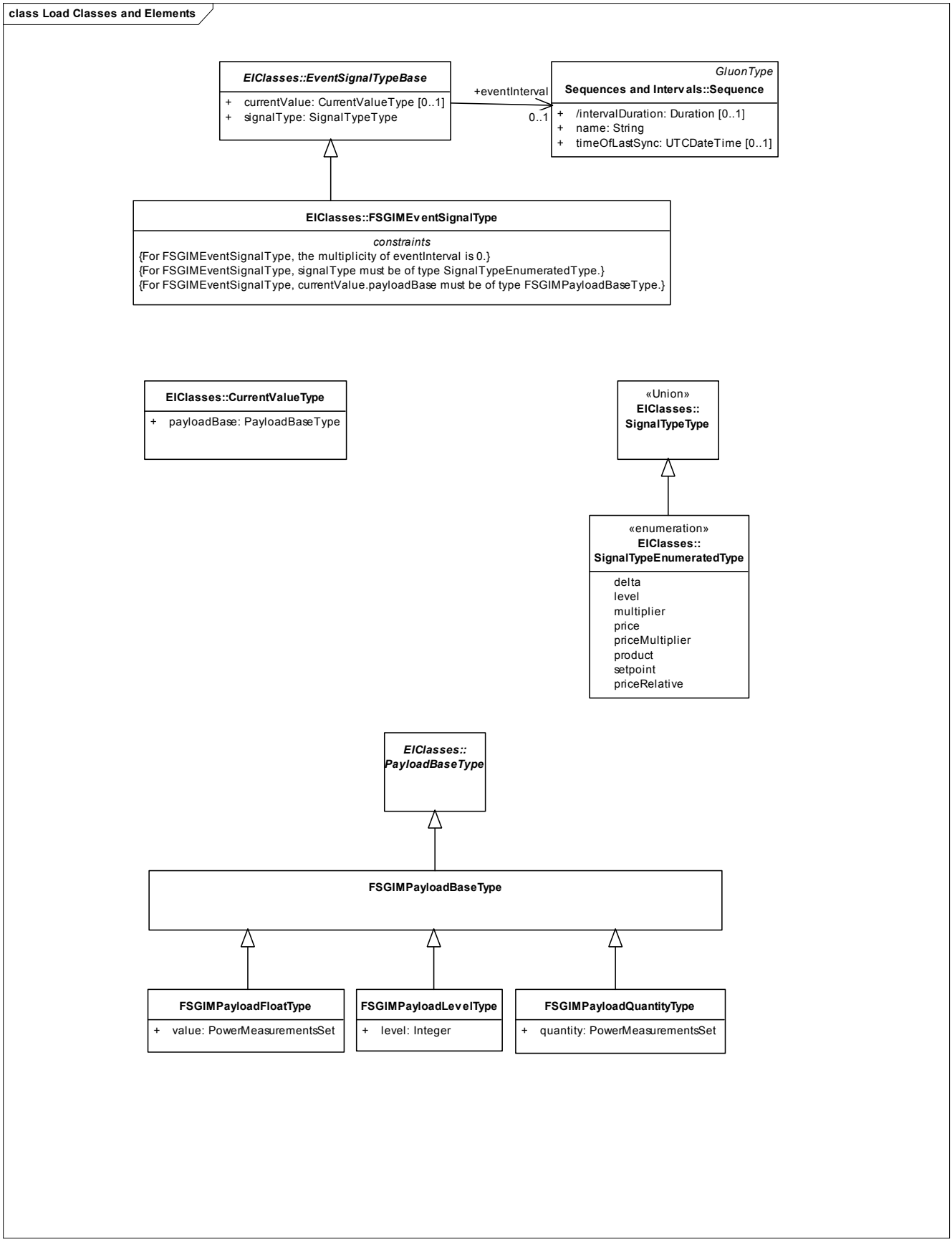

Figure 5.5 - Load Classes and Elements

The Load Classes and Elements Diagram makes use of the following elements:

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ConnectionPoint (Class)
This class is used to model the physical connections from Generators, Loads, Meters, and Energy Routers to sources or sinks of energy.

UML Element Location: *Model\Common Primitive Types, Classes, and Enumerations\Other Common Classes\ConnectionPoint.* See Clause 6.6.5.2 for the complete definition of this element.

CurrentValueType (Class)
This class contains the common information, at the time of an event, in an Energy Interoperation signal.

UML Element Location: *Model\Model Elements from External Sources\OASIS\Energy Interoperation wd36/PR03\EIClasses\CurrentValueType.* See Clause 5.7.1.2.1.5 for the complete definition of this element.

CurtailableLoad (Class)
The CurtailableLoad class defines the attributes that are unique to devices whose electrical consumption can be curtailed. The attributes define the information needed to represent curtailment policies based on criteria including load priorities, cost constraints, protection of physical equipment, and safety considerations. The CurtailableLoad class also provides attributes for restoration of curtailed loads.

UML Element Location: *Model\Device and Model Components\Load Component\CurtailableLoad.* See Clause 5.4.2.2 for the complete definition of this element.

CurtailmentArrayElement (Class)
This class defines a single array element of the curtailmentRatingsLevel attribute. Each array element defines the fixed demand to which the load shall be controlled as a function of the stated level. The array is ordered by the curtailmentRatingsLevel.levelIndex attribute.

UML Element Location: *Model\Device and Model Components\Load Component\CurtailmentArrayElement.* See Clause 5.4.2.3 for the complete definition of this element.

CurtailmentStatusType (Enumeration)
This enumeration indicates if the load is presently curtailed and if curtailed is in compliance with the curtailment request received.

UML Element Location: *Model\Device and Model Components\Load Component\CurtailmentStatusType.* See Clause 5.4.2.10 for the complete definition of this element.

EventSignalTypeBase (Abstract Class)
This class conveys the kind of demand response event being signaled and the desired resulting load or generation.

UML Element Location: *Model\Model Elements from External Sources\OASIS\Energy Interoperation wd36/PR03\EIClasses\EventSignalTypeBase.* See Clause 5.7.1.2.1.13 for the complete definition of this element.

FSGIMEventSignalType (Class)
This class conveys the kind of demand response event being signaled from an energy manager to a curtailable load or a dispatchable generator. The signal indicates the desired resulting load or generation.

For FSGIMEventSignalType, the multiplicity of eventInterval is 0.

UML Element Location: *Model\Model Elements from External Sources\OASIS\Energy Interoperation wd36/PR03\EIClasses\FSGIMEventSignalType.* See Clause 5.7.1.2.1.15 for the complete definition of this element.

FSGIMPayloadBaseType (Class)
This class is the union of the different classes used to define the needed curtailment of an individual load.

UML Element Location: *Model\Device and Model Components\Load Component\FSGIMPayloadBaseType.* See Clause 5.4.2.9 for the complete definition of this element.

FSGIMPayloadFloatType (Class)
The curtailment request is of the form of either an absolute or relative demand curtailment value from the present baseline demand. This class requires the use of a 'setpoint' or 'delta' signal type. This class is based on the EIClasses::PayloadFloatType Class but includes metadata that the Energy Interoperation model captures elsewhere.

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