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Power and Energy Monitoring MIB  
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## Abstract

This document defines a subset of the Management Information Base (MIB) for power and energy monitoring of devices.

## Conventions used in this document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED" "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC 2119](#) [[RFC2119](#)].

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## [1.](#) Introduction

This document defines a subset of the Management Information Base (MIB) for use in energy management of devices within or connected to communication networks. The MIB modules in this document are designed to provide a model for energy management, which includes monitoring for Power State and energy consumption of networked elements. This MIB takes into account the Energy Management Framework [[EMAN-FMWK](#)], which in turn, is based on the Requirements for Energy Management [[RFC6988](#)].

Energy management is applicable to devices in communication networks. Target devices for this specification include (but are not limited to): routers, switches, Power over Ethernet (PoE) endpoints, protocol gateways for building management systems,

intelligent meters, home energy gateways, hosts and servers, sensor proxies, etc. Target devices and the use cases for Energy Management are discussed in Energy Management Applicability Statement [[EMAN-AS](#)].

Where applicable, device monitoring extends to the individual components of the device and to any attached dependent devices. For example: A device can contain components that are independent from a power-state point of view, such as line cards, processor cards, hard drives. A device can also have

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dependent attached devices, such as a switch with PoE endpoints or a power distribution unit with attached endpoints.

## [2.](#) The Internet-Standard Management Framework

For a detailed overview of the documents that describe the current Internet-Standard Management Framework, please refer to [section 7 of RFC 3410](#) [[RFC3410](#)].

Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. MIB objects are generally accessed through the Simple Network Management Protocol (SNMP). Objects in the MIB are defined using the mechanisms defined in the Structure of Management Information (SMI). This memo specifies MIB modules that are compliant to SMIV2, which is described in STD 58, [RFC 2578](#) [[RFC2578](#)], STD 58, [RFC 2579](#) [[RFC2579](#)] and STD 58, [RFC 2580](#) [[RFC2580](#)].

## [3.](#) Use Cases

Requirements for power and energy monitoring for networking devices are specified in [[RFC6988](#)]. The requirements in [[RFC6988](#)] cover devices typically found in communications networks, such as switches, routers, and various connected endpoints. For a power monitoring architecture to be useful, it should also apply to facility meters, power distribution units, gateway proxies for commercial building control, home automation devices, and devices that interface with the utility and/or smart grid. Accordingly, the scope of the MIB modules in this

document is broader than that specified in [[RFC6988](#)]. Several use cases for Energy Management have been identified in the "Energy Management (EMAN) Applicability Statement" [[EMAN-AS](#)]. An illustrative example scenario is presented in [Section 8](#).

#### [4](#). Terminology

Please refer to [[EMAN-FMWK](#)] for the definitions of the following terminology used in this draft.

Energy Management

Energy Management System (EnMS)

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Energy Monitoring

Energy Control

electrical equipment

non-electrical equipment (mechanical equipment)

device

component

power inlet

power outlet

energy

power

demand

provide energy

receive energy

meter (energy meter)

battery

Power Interface

Nameplate Power

Power Attributes

Power Quality

Power State

Power State Set

## [5.](#) Architecture Concepts Applied to the MIB Modules

This section describes the concepts specified in the Energy Management Framework [[EMAN-FMWK](#)] that pertain to power usage, with specific information related to the MIB module specified in

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this document. This subsection maps to the different concepts developed in the Energy Management Framework [[EMAN-FMWK](#)].

The Energy Monitoring MIB has 2 independent MIB modules ENERGY-OBJECT-MIB and POWER-ATTRIBUTES-MIB. The first MIB module ENERGY-OBJECT-MIB is focused on measurement of power and energy. The second MIB module POWER-ATTRIBUTES-MIB is focused on Power Attributes measurements for Energy Objects.

Devices and their sub-components can be modeled using the containment tree of the ENTITY-MIB [[RFC6933](#)]. In addition, ENERGY-OBJECT-CONTEXT-MIB MIB module [[EMAN-AWARE-MIB](#)] provides a framework for modeling the relationship between Energy Objects. It is conceivable to have implementations of ENERGY-OBJECT-CONTEXT-MIB and ENERGY-OBJECT-MIB for modeling the relationships between Energy Objects and also monitoring the Energy consumption of those Energy Objects. In some situations, it is possible to have implementation of ENERGY-OBJECT-MIB along ENTITY-MIB V4 [[RFC6933](#)] with the Module compliance of entity4CRCompliance. This compliance requires that the following 3 MIB objects from ENTITY-MIB [[RFC6933](#)] (entPhysicalIndex, entPhysicalName and entPhysicalUUID) MUST be implemented.

The ENERGY-OBJECT-MIB MIB module consists of five tables.

The first table is the eoMeterCapabilitiesTable. It indicates the instrumentation available for each Energy Object. Thus, the entries in this table indicate to the EnMS which other tables from the ENERGY-OBJECT-MIB and POWER-ATTRIBUTES-MIB are available for each Energy Object. The eoMeterCapabilitiesTable is indexed by entPhysicalIndex [[RFC6933](#)].

The second table is the eoPowerTable. It returns the power consumption of each Energy Object, as well as the units, sign, measurement accuracy, and related objects. The eoPowerTable is indexed by entPhysicalIndex.

The third table is the eoPowerStateTable. For each Energy Object, it provides information and statistics about the supported Power States. The eoPowerStateTable is indexed by entPhysicalIndex and eoPowerStateIndex.

The fourth table is the eoEnergyParametersTable. The entries in this table configure the parameters of energy and demand measurement collection. This table is indexed by eoEnergyParametersIndex.

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The fifth table is the eoEnergyTable. The entries in this table provide the log the energy and demand information. This table is indexed by eoEnergyParametersIndex.

```
eoMeterCapabilitiesTable(1)
|
+---eoMeterCapabilitiesEntry(1)[entPhysicalIndex]
|   |
|   +---r-n BITS          eoMeterCapability
|
eoPowerTable(2)
|
+---eoPowerEntry(1) [entPhysicalIndex]
|   |
|   +---r-n Integer32      eoPower(1)
|   +--- r-n Integer32     eoPowerNamePlate(2)
```

```

|   +-- r-n UnitMultiplier      eoPowerUnitMultiplier(3)
|   +-- r-n Integer32          eoPowerAccuracy(4)
|   +-- r-n INTEGER            eoMeasurementCaliber(5)
|   +-- r-n INTEGER            eoPowerCurrentType(6)
|   +-- r-n INTEGER            eoPowerOrigin(7)
|   +-- rwn IANAPowerStateSet  eoPowerAdminState(8)
|   +-- r-n IANAPowerStateSet  eoPowerOperState(9)
|   +-- r-n OwnerString        eoPowerStateEnterReason(10)
|
|
+---eoPowerStateTable(3)
|   +---eoPowerStateEntry(1)
|   |       [entPhysicalIndex, eoPowerStateIndex]
|   |
|   +-- --n IANAPowerStateSet  eoPowerStateIndex(1)
|   +-- r-n Integer32          eoPowerStateMaxPower(2)
|   +-- r-n UnitMultiplier
|   |                               eoPowerStatePowerUnitMultiplier(3)
|   +-- r-n TimeTicks          eoPowerStateTotalTime(4)
|   +-- r-n Counter32          eoPowerStateEnterCount(5)
|
|
+eoEnergyParametersTable(4)
+---eoEnergyParametersEntry(1) [eoEnergyParametersIndex]
|
|   +-- --n PhysicalIndex      eoEnergyObjectIndex(1)
|   +  r-n Integer32           eoEnergyParametersIndex(2)
|   +-- r-n TimeInterval      eoEnergyParametersIntervalLength(3)
|   +-- r-n Integer32         eoEnergyParametersIntervalNumber(4)
|   +-- r-n Integer32         eoEnergyParametersIntervalMode(5)

```

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```

|   +-- r-n TimeInterval      eoEnergyParametersIntervalWindow(6)
|   +-- r-n Integer32         eoEnergyParametersSampleRate(7)
|   +-- r-n RowStatus         eoEnergyParametersStatus(8)
|
+eoEnergyTable(5)
+---eoEnergyEntry(1)
|   [eoEnergyParametersIndex, eoEnergyCollectionStartTime]
|
|   +-- r-n TimeTicks         eoEnergyCollectionStartTime(1)
|   +-- r-n Integer32         eoEnergyConsumed(2)
|   +-- r-n Integer32         eoEnergyProvided(3)
|   +-- r-n Integer32         eoEnergyStored(4)
|   +-- r-n UnitMultiplier   eoEnergyUnitMultiplier(5)

```



```

|   +-- r-n Integer32      eoEnergyAccuracy(6)
|   +-- r-n Integer32      eoEnergyMaxConsumed(7)
|   +-- r-n Integer32      eoEnergyMaxProduced(8)
|   +-- r-n TimeTicks      eoEnergyDiscontinuityTime(9)

```

The powerAttributesMIB consists of four tables.  
 eoACPwrAttributesTable is indexed by entPhysicalIndex.  
 eoACPwrAttributesPhaseTable is indexed by entPhysicalIndex and  
 eoPhaseIndex. eoACPwrAttributesWyePhaseTable and  
 eoACPwrAttributesDelPhaseTable are indexed by entPhysicalIndex  
 and eoPhaseIndex.

```

eoACPwrAttributesTable(1)
|
|+---eoACPwrAttributesEntry(1) [ entPhysicalIndex]
|   |
|   |   +---r-n INTEGER      eoACPwrAttributesConfiguration(1)
|   |   +-- r-n Integer32    eoACPwrAttributesAvgVoltage(2)
|   |   +-- r-n Integer32    eoACPwrAttributesAvgCurrent(3)
|   |   +-- r-n Integer32    eoACPwrAttributesFrequency(4)
|   |   +-- r-n UnitMultiplier
|   |       eoACPwrAttributesPowerUnitMultiplier(5)
|   |   +-- r-n Integer32    eoACPwrAttributesPowerAccuracy(6)
|   |   +-- r-n Integer32
|   |       eoACPwrAttributesTotalActivePower(7)
|   |   +-- r-n Integer32
|   |       eoACPwrAttributesTotalReactivePower(8)
|   |   +-- r-n Integer32
|   |       eoACPwrAttributesTotalApparentPower(9)
|   |   +-- r-n Integer32
|   |       eoACPwrAttributesTotalPowerFactor(10)
|   |   +-- r-n Integer32    eoACPwrAttributesThdAmperes(11)
|   |
|   +eoACPwrAttributesPhaseTable(2)

```

```

+---EoACPwrAttributesPhaseEntry(1)
|   | [ entPhysicalIndex, eoPhaseIndex]
|   |
|   |   +-- r-n Integer32    eoPhaseIndex(1)
|   |   +-- r-n Integer32
|   |       eoACPwrAttributesPhaseAvgCurrent(2)
|   |   +-- r-n Integer32
|   |       eoACPwrAttributesPhaseActivePower(3)

```

```

|      +-- r-n Integer32
|      |          eoACPwrAttributesPhaseReactivePower(4)
|      +-- r-n Integer32
|      |          eoACPwrAttributesPhaseApparentPower(5)
|      +-- r-n Integer32
|      |          eoACPwrAttributesPhasePowerFactor(6)
|      +-- r-n Integer32
|      |          eoACPwrAttributesPhaseImpedance(7)
|      |
+eoACPwrAttributesDelPhaseTable(3)
+-- eoACPwrAttributesDelPhaseEntry(1)
|   |   [entPhysicalIndex, eoPhaseIndex]
|   |
|   +-- r-n Integer32
|   |   eoACPwrAttributesDelPhaseToNextPhaseVoltage(1)
|   +-- r-n Integer32
|   |   eoACPwrAttributesDelThdPhaseToNextPhaseVoltage(2)
|   +-- r-n Integer32
|       eoACPwrAttributesDelThdCurrent(3)
|
+eoACPwrAttributesWyePhaseTable(4)
+-- eoACPwrAttributesWyePhaseEntry(1)
|   |   [entPhysicalIndex, eoPhaseIndex]
|   |
|   +-- r-n Integer32
|   |   eoACPwrAttributesWyePhaseToNeutralVoltage(1)
|   +-- r-n Integer32
|   |   eoACPwrAttributesWyePhaseCurrent(2)
|   +-- r-n Integer32
|   |   eoACPwrAttributesWyeThdPhaseToNeutralVoltage(3)
|   .

```

A UML representation of the MIB objects in the two MIB modules ENERGY-OBJECT-MIB and POWER-ATTRIBUTES-MIB are presented.

```

+-----+
| Energy Object State |
+-----+

```

```

| eoPowerAdminState      |
| eoPowerOperState       |
| eoPowerStateEnterReason |

```

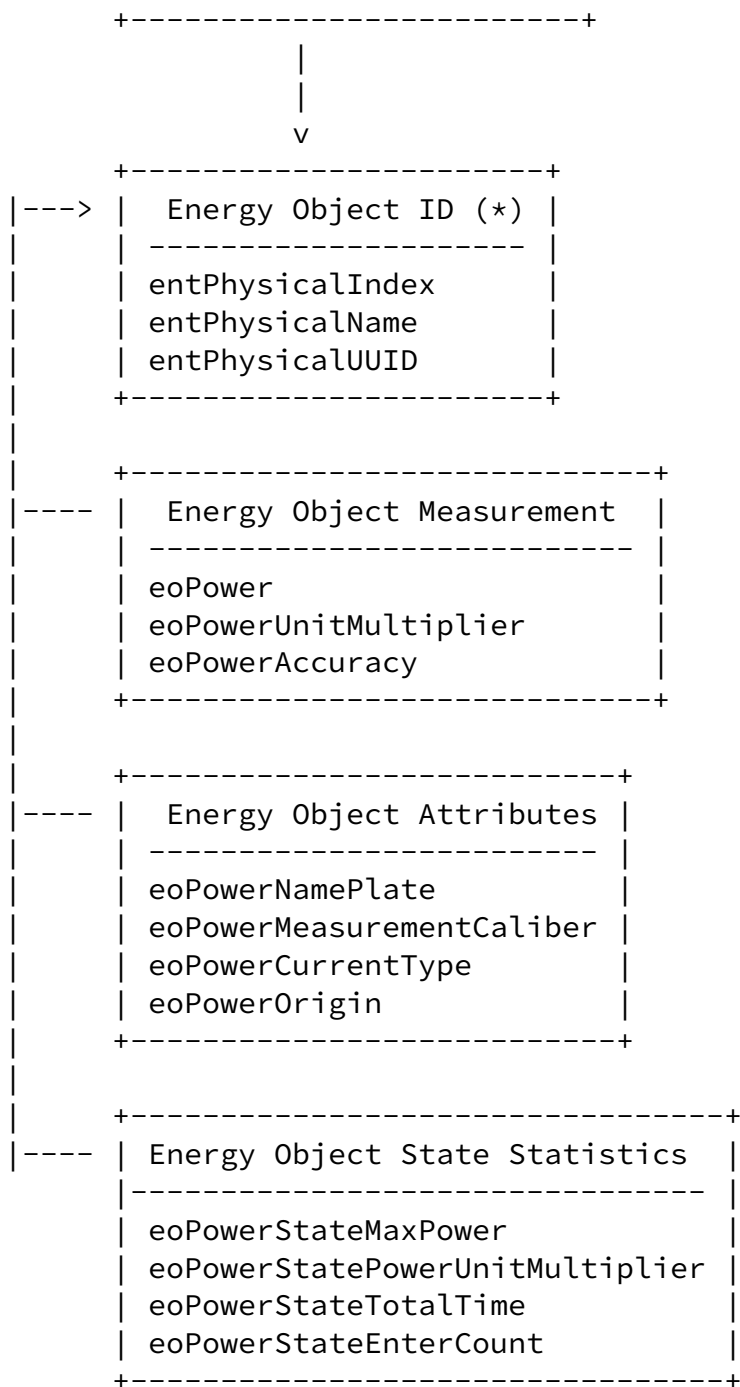


Figure 1:UML diagram for energyObjectMIB

(\*) Compliance with the ENERGY-OBJECT-CONTEXT-MIB

```

+-----+
| Energy ParametersTable |
+-----+

```

eoEnergyObjectIndex
eoEnergyParametersIndex
eoEnergyParametersIntervalLength
eoEnergyParametersIntervalNumber
eoEnergyParametersIntervalMode
eoEnergyParametersIntervalWindow
eoEnergyParametersSampleRate
eoEnergyParametersStatus

|  
V

Energy Table
eoEnergyCollectionStartTime
eoEnergyConsumed
eoEnergyProvided
eoEnergyStored
eoEnergyUnitMultiplier
eoEnergyAccuracy
eoEnergyMaxConsumed
eoEnergyMaxProduced
eoDiscontinuityTime

Energy Object ID (*)
entPhysicalIndex
entPhysicalName
entPhysicalUUID

Power Attributes
eoACPwrAttributesConfiguration
eoACPwrAttributesAvgVoltage
eoACPwrAttributesAvgCurrent
eoACPwrAttributesFrequency
eoACPwrAttributesPowerUnitMultiplier
eoACPwrAttributesPowerAccuracy
eoACPwrAttributesTotalActivePower
eoACPwrAttributesTotalReactivePower

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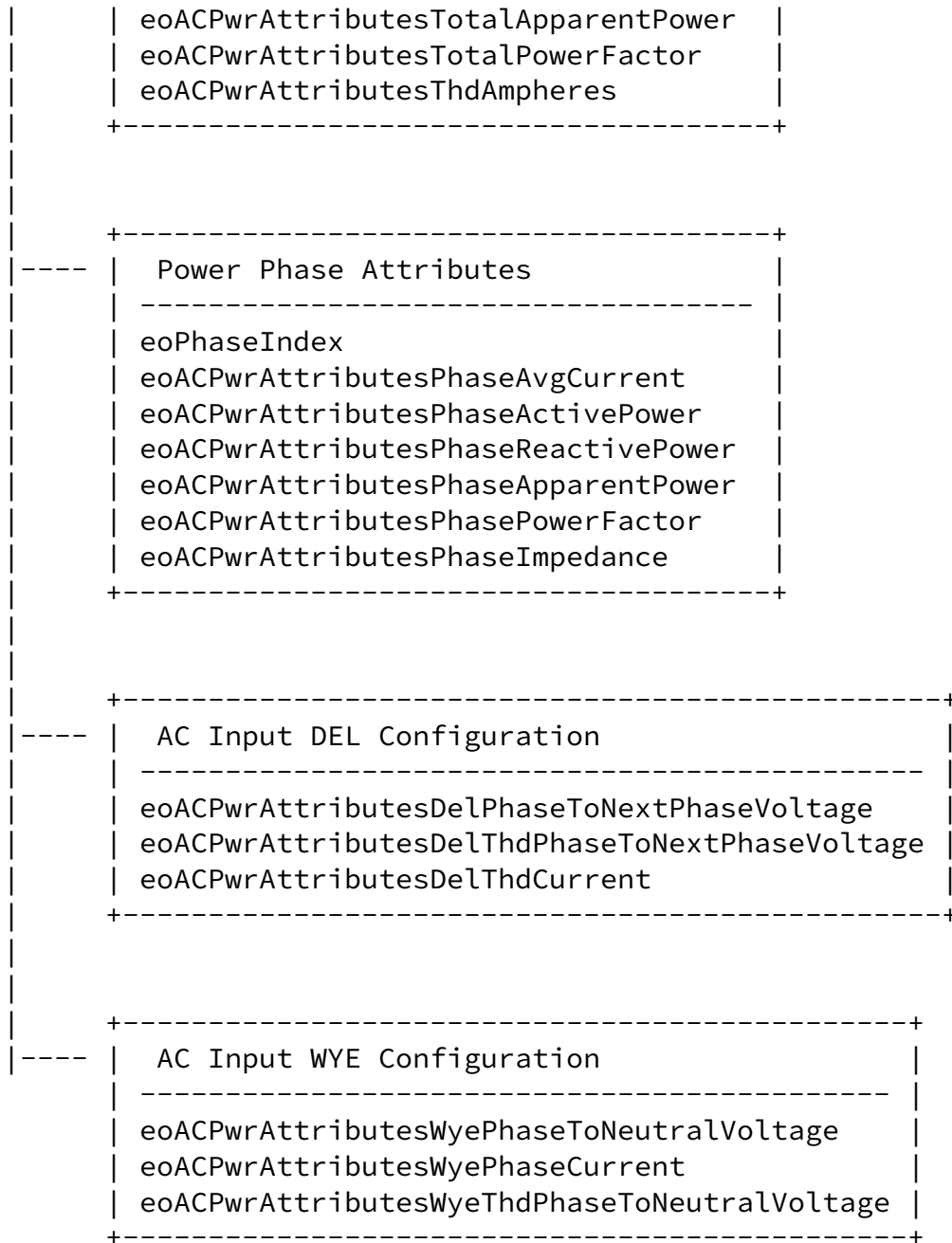


Figure 2: UML diagram for the powerAttributesMIB

(\*) Compliance with the ENERGY-OBJECT-CONTEXT-MIB

### [5.1.](#) Energy Object Information

The Energy Object identity information is specified in the ENERGY-OBJECT-CONTEXT-MIB MIB module [[EMAN-AWARE-MIB](#)] primary table, i.e. the eoTable. In this table, the context of the Energy Object such as domain, role description, importance are specified. In addition, the ENERGY-OBJECT-CONTEXT-MIB module

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specifies the relationship between Energy Objects. There are several possible relationships between Energy Objects such as meteredBy, metering, poweredBy, powering, aggregatedBy, and aggregating as defined in the IANA-ENERGY-RELATION-MIB MIB module [[EMAN-AWARE-MIB](#)].

## [5.2](#). Power State

An Energy Object may have energy conservation modes called Power States. Between the ON and OFF states of a device, there can be several intermediate energy saving modes. Those energy saving modes are called as Power States.

Power States, which represent universal states of power management of an Energy Object, are specified by the eoPowerState MIB object. The actual Power State is specified by the eoPowerOperState MIB object, while the eoPowerAdminState MIB object specifies the Power State requested for the Energy Object. The difference between the values of eoPowerOperState and eoPowerAdminState can be attributed that the Energy Object is busy transitioning from eoPowerAdminState into the eoPowerOperState, at which point it will update the content of eoPowerOperState. In addition, the possible reason for change in Power State is reported in eoPowerStateEnterReason. Regarding eoPowerStateEnterReason, management stations and Energy Objects should support any format of the owner string dictated by the local policy of the organization. It is suggested that this name contain at least the reason for the transition change, and one or more of the following: IP address, management station name, network manager's name, location, or phone number.

The MIB objects eoPowerOperState, eoPowerAdminState , and eoPowerStateEnterReason are contained in the eoPowerTable MIB table.

The eoPowerStateTable table enumerates the maximum power usage

in watts, for every single supported Power State of each Power State Set supported by the Energy Object. In addition, PowerStateTable provides additional statistics: eoPowerStateEnterCount, the number of times an entity has visited a particular Power State, and eoPowerStateTotalTime, the total time spent in a particular Power State of an Energy Object.

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#### [5.2.1](#). Power State Set

There are several standards and implementations of Power State Sets. An Energy Object can support one or multiple Power State Set implementation(s) concurrently.

There are currently three Power State Sets advocated:

IEEE1621	-	<a href="#">[IEEE1621]</a>
DMTF	-	<a href="#">[DMTF]</a>
EMAN	-	<a href="#">[EMAN-FMWK]</a>

The Power State Sets, along with each Power State within the Power Set are listed in [\[EMAN-FMWK\]](#).

#### [5.3](#). Energy Object Usage Information

For an Energy Object, power usage is reported using eoPower. The magnitude of measurement is based on the eoPowerUnitMultiplier MIB variable, based on the UnitMultiplier Textual Convention (TC). Power measurement magnitude should conform to the IEC 62053-21 [\[IEC.62053-21\]](#) and IEC 62053-22 [\[IEC.62053-22\]](#) definition of unit multiplier for the SI (System International) units of measure. Measured values are represented in SI units obtained by BaseValue \* 10 raised to the power of the scale.

For example, if current power usage of an Energy Object is 3, it could be 3 W, 3 mW, 3 KW, or 3 MW, depending on the value of eoPowerUnitMultiplier. Note that other measurements throughout the two MIB modules in this document use the same mechanism, including eoPowerStatePowerUnitMultiplier, eoEnergyUnitMultiplier, and

eoACPwrAttributesPowerUnitMultiplier.

In addition to knowing the usage and magnitude, it is useful to know how a eoPower measurement was obtained. An NMS can use this to account for the accuracy and nature of the reading between different implementations. For this eoPowerOrigin describes whether the measurements were made at the device itself or from a remote source. The eoPowerMeasurementCaliber describes the method that was used to measure the power and can distinguish actual or estimated values. There may be devices in the network, which may not be able to measure or report power consumption. For those devices, the object eoPowerMeasurementCaliber shall report that measurement mechanism is "unavailable" and the eoPower measurement shall be "0".

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The nameplate power rating of an Energy Object is specified in eoPowerNameplate MIB object.

#### [5.4](#). Optional Power Usage Attributes

The optional powerAttributesMIB MIB module can be implemented to further describe power usage attributes measurement. The powerAttributesMIB MIB module adheres closely to the IEC 61850 7-2 standard to describe AC measurements.

The powerAttributesMIB MIB module contains a primary table, the eoACPwrAttributesTable table, that defines power attributes measurements for supported entPhysicalIndex entities, as a sparse extension of the eoPowerTable (with entPhysicalIndex as primary index). This eoACPwrAttributesTable table contains such information as the configuration (single phase, DEL 3 phases, WYE 3 phases), voltage, frequency, power accuracy, total active/reactive power/apparent power, amperage, and voltage.

In case of 3-phase power, the eoACPwrAttributesPhaseTable additional table is populated with Power Attributes measurements per phase (so double indexed by the entPhysicalIndex and eoPhaseIndex). This table, which describes attributes common to both WYE and DEL configurations, contains the average current, active/reactive/apparent power, power factor, and impedance.



In case of 3-phase power with a DEL configuration, the eoACPwrAttributesDelPhaseTable table describes the phase-to-phase power attributes measurements, i.e., voltage and current.

In case of 3-phase power with a WYE configuration, the eoACPwrAttributesWyePhaseTable table describes the phase-to-neutral power attributes measurements, i.e., voltage and current.

### [5.5](#). Optional Energy Measurement

It is relevant to measure energy and demand only when there are actual power measurements obtained from measurement hardware. If the eoPowerMeasurementCaliber MIB object has values of unavailable, unknown, estimated, or presumed, then the energy and demand values are not useful.

Two tables are introduced to characterize energy measurement of an Energy Object: eoEnergyTable and eoEnergyParametersTable. Both energy and demand information can be represented via the

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eoEnergyTable. Energy information will be an accumulation with no interval. Demand information can be represented.

The eoEnergyParametersTable consists of the parameters defining eoEnergyParametersIndex an index of that specifies the setting for collection of energy measurements for an Energy Object, eoEnergyObjectIndex linked to the entPhysicalIndex of the Energy Object, the duration of measurement intervals in seconds, (eoEnergyParametersIntervalLength), the number of successive intervals to be stored in the eoEnergyTable, (eoEnergyParametersIntervalNumber), the type of measurement technique (eoEnergyParametersIntervalMode), and a sample rate used to calculate the average (eoEnergyParametersSampleRate). Judicious choice of the sampling rate will ensure accurate measurement of energy while not imposing an excessive polling burden.

There are three eoEnergyParametersIntervalMode types used for energy measurement collection: period, sliding, and total. The choices of the three different modes of collection are based on IEC standard 61850-7-4. Note that multiple eoEnergyParametersIntervalMode types MAY be configured simultaneously. It is important to note that for a given Energy Object, multiple modes (periodic, total, sliding window) of

energy measurement collection can be configured with the use of `eoEnergyParametersIndex`. However, simultaneous measurement in multiple modes for a given Energy Object depends on the Energy Object capability.

These three `eoEnergyParametersIntervalMode` types are illustrated by the following three figures, for which:

- The horizontal axis represents the current time, with the symbol `<--- L --->` expressing the `eoEnergyParametersIntervalLength`, and the `eoEnergyCollectionStartTime` is represented by `S1`, `S2`, `S3`, `S4`, ..., `Sx` where `x` is the value of `eoEnergyParametersIntervalNumber`.
- The vertical axis represents the time interval of sampling and the value of `eoEnergyConsumed` can be obtained at the end of the sampling period. The symbol `=====` denotes the duration of the sampling period.

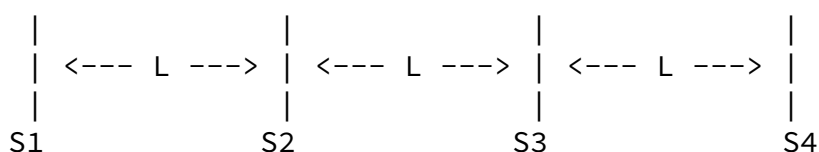
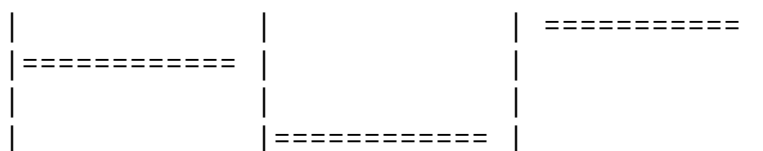
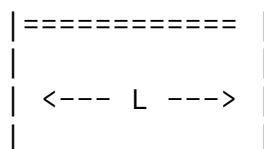


Figure 3 : Period `eoEnergyParametersIntervalMode`

A `eoEnergyParametersIntervalMode` type of 'period' specifies non-overlapping periodic measurements. Therefore, the next `eoEnergyCollectionStartTime` is equal to the previous `eoEnergyCollectionStartTime` plus `eoEnergyParametersIntervalLength`.  $S2=S1+L$ ;  $S3=S2+L$ , ...



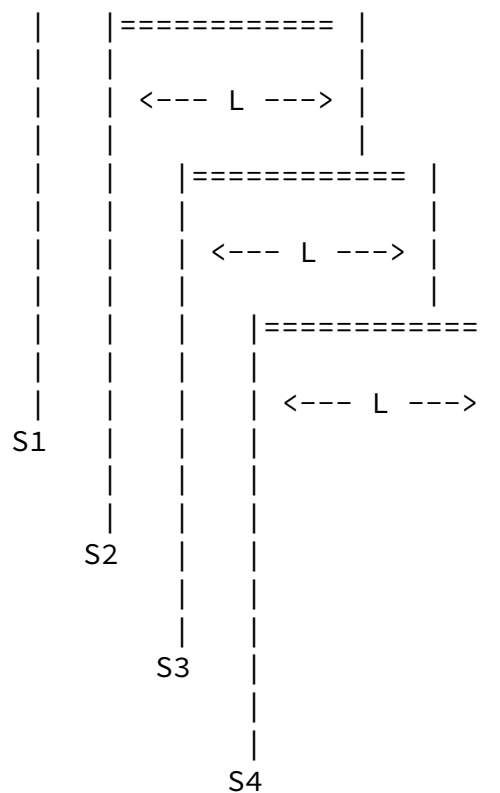


Figure 4 : Sliding eoEnergyParametersIntervalMode

A eoEnergyParametersIntervalMode type of 'sliding' specifies overlapping periodic measurements.

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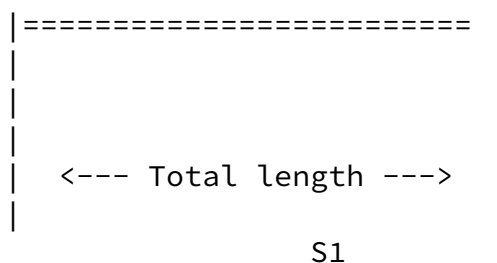


Figure 5 : Total eoEnergyParametersIntervalMode

A eoEnergyParametersIntervalMode type of 'total' specifies a continuous measurement since the last reset. The value of eoEnergyParametersIntervalNumber should be (1) one and

eoEnergyParametersIntervalLength is ignored.

The eoEnergyParametersStatus is used to start and stop energy usage logging. The status of this variable is "active" when all the objects in eoEnergyParametersTable are appropriate which in turn indicates if eoEnergyTable entries exist or not.

The eoEnergyTable consists of energy measurements in eoEnergyConsumed, eoEnergyProvided and eoEnergyStored, the units of the measured energy eoEnergyUnitMultiplier, and the maximum observed energy within a window eoEnergyMaxConsumed, eoEnergyMaxProduced.

Measurements of the total energy consumed by an Energy Object may suffer from interruptions in the continuous measurement of energy consumption. In order to indicate such interruptions, the object eoEnergyDiscontinuityTime is provided for indicating the time of the last interruption of total energy measurement. eoEnergyDiscontinuityTime shall indicate the sysUpTime [[RFC3418](#)] when the device was reset.

The following example illustrates the eoEnergyTable and eoEnergyParametersTable:

First, in order to estimate energy, a time interval to sample energy should be specified, i.e. eoEnergyParametersIntervalLength can be set to "900 seconds" or 15 minutes and the number of consecutive intervals over which the maximum energy is calculated (eoEnergyParametersIntervalNumber) as "10". The sampling rate internal to the Energy Object for measurement of power usage (eoEnergyParametersSampleRate) can be "1000 milliseconds", as set by the Energy Object as a reasonable value. Then, the eoEnergyParametersStatus is set to active (value 1) to indicate

that the Energy Object should start monitoring the usage per the eoEnergyTable.

The indices for the eoEnergyTable are eoEnergyParametersIndex which identifies the index for the setting of energy measurement collection Energy Object, and eoEnergyCollectionStartTime, which denotes the start time of the energy measurement interval based on sysUpTime [[RFC3418](#)]. The value of eoEnergyComsumed is the

measured energy consumption over the time interval specified (eoEnergyParametersIntervalLength) based on the Energy Object internal sampling rate (eoEnergyParametersSampleRate). While choosing the values for the eoEnergyParametersIntervalLength and eoEnergyParametersSampleRate, it is recommended to take into consideration either the network element resources adequate to process and store the sample values, and the mechanism used to calculate the eoEnergyConsumed. The units are derived from eoEnergyUnitMultiplier. For example, eoEnergyConsumed can be "100" with eoEnergyUnitMultiplier equal to 0, the measured energy consumption of the Energy Object is 100 watt-hours. The eoEnergyMaxConsumed is the maximum energy observed and that can be "150 watt-hours".

The eoEnergyTable has a buffer to retain a certain number of intervals, as defined by eoEnergyParametersIntervalNumber. If the default value of "10" is kept, then the eoEnergyTable contains 10 energy measurements, including the maximum.

Here is a brief explanation of how the maximum energy can be calculated. The first observed energy measurement value is taken to be the initial maximum. With each subsequent measurement, based on numerical comparison, maximum energy may be updated. The maximum value is retained as long as the measurements are taking place. Based on periodic polling of this table, an NMS could compute the maximum over a longer period, i.e. a month, 3 months, or a year.

#### [5.6](#). Fault Management

[RFC6988] specifies requirements about Power States such as "the current Power State" , "the time of the last state change", "the total time spent in each state", "the number of transitions to each state" etc. Some of these requirements are fulfilled explicitly by MIB objects such as eoPowerOperState, eoPowerStateTotalTime and eoPowerStateEnterCount. Some of the other requirements are met via the SNMP NOTIFICATION mechanism. eoPowerStateChange SNMP notification which is generated when the

value(s) of ,eoPowerStateIndex, eoPowerOperState, eoPowerAdminState have changed.

## 6. Discovery

It is foreseen that most Energy Objects will require the implementation of the ENERGY-OBJECT-CONTEXT-MIB MIB [[EMAN-AWARE-MIB](#)] as a prerequisite for this MIB module. In such a case, eoPowerTable of the EMAN-MON-MIB is a sparse extension of the eoTable of ENERGY-OBJECT-CONTEXT-MIB. Every Energy Object MUST implement entPhysicalIndex, entPhysicalUUID and entPhysicalName from the ENTITY-MIB [[RFC6933](#)]. As the primary index for the Energy Object, entPhysicalIndex is used: It characterizes the Energy Object in the ENERGY-OBJECT-MIB and the POWER-ATTRIBUTES-MIB MIB modules (this document).

The NMS must first poll the ENERGY-OBJECT-CONTEXT-MIB MIB module [[EMAN-AWARE-MIB](#)], if available, in order to discover all the Energy Objects and the relationships between those Energy Objects. In the ENERGY-OBJECT-CONTEXT-MIB module tables, the Energy Objects are indexed by the entPhysicalIndex.

From there, the NMS must poll the eoPowerStateTable (specified in the ENERGY-OBJECT-MIB module in this document), which enumerates, amongst other things, the maximum power usage. As the entries in eoPowerStateTable table are indexed by the Energy Object ( entPhysicalIndex), by the Power State Set (eoPowerStateIndex), the maximum power usage is discovered per Energy Object, and the power usage per Power State of the Power State Set. In other words, polling the eoPowerStateTable allows the discovery of each Power State within every Power State Set supported by the Energy Object.

If the Energy Object has an Aggregation Relationship with another Energy Object, the MIB module would be populated with the Energy Object relationship information, which have their own Energy Object index value (entPhysicalIndex). However, the Energy Object relationship must be discovered thanks to the ENERGY-OBJECT-CONTEXT-MIB module.

Finally, the NMS can monitor the power attributes thanks to the powerAttributesMIB MIB module, which reuses the entPhysicalIndex to index the Energy Object.

## [7](#). Link with the other IETF MIBs

### [7.1](#). Link with the ENTITY-MIB and the ENTITY-SENSOR MIB

[RFC 4133](#) [[RFC4133](#)] defines the ENTITY-MIB module that lists the physical entities of a networking device (router, switch, etc.) and those physical entities indexed by entPhysicalIndex. From an energy-management standpoint, the physical entities that consume or produce energy are of interest.

[RFC 3433](#) [[RFC3433](#)] defines the ENTITY-SENSOR MIB module that provides a standardized way of obtaining information (current value of the sensor, operational status of the sensor, and the data units precision) from sensors embedded in networking devices. Sensors are associated with each index of entPhysicalIndex of the ENTITY-MIB [[RFC4133](#)]. While the focus of the Power and Energy Monitoring MIB is on measurement of power usage of networking equipment indexed by the ENTITY-MIB, this MIB proposes a customized power scale for power measurement and different Power States of networking equipment, and functionality to configure the Power States.

The Energy Objects are modeled by the entPhysicalIndex through the entPhysicalEntity MIB object specified in the eoTable in the ENERGY-OBJECT-CONTEXT-MIB MIB module [[EMAN-AWARE-MIB](#)].

The ENTITY-SENSOR MIB [[RFC3433](#)] does not have the ANSI C12.x accuracy classes required for electricity (i.e., 1%, 2%, 0.5% accuracy classes). Indeed, entPhySensorPrecision [[RFC3433](#)] represents "The number of decimal places of precision in fixed-point sensor values returned by the associated entPhySensorValue object". The ANSI and IEC Standards are used for power measurement and these standards require that we use an accuracy class, not the scientific-number precision model specified in [RFC3433](#). The eoPowerAccuracy MIB object models this accuracy. Note that eoPowerUnitMultiplier represents the scale factor per IEC 62053-21 [[IEC.62053-21](#)] and IEC 62053-22 [[IEC.62053-22](#)], which is a more logical representation for power measurements (compared to entPhySensorScale), with the mantissa and the exponent values  $X * 10 ^ Y$ .

Power measurements specifying the qualifier 'UNITS' for each measured value in watts are used in the LLDP-EXT-MED-MIB, POE [[RFC3621](#)], and UPS [[RFC1628](#)] MIBs. The same 'UNITS' qualifier is used for the power measurement values.

---

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One cannot assume that the ENTITY-MIB and ENTITY-SENSOR MIB are implemented for all Energy Objects that need to be monitored. A typical example is a converged building gateway, monitoring several other devices in the building, doing the proxy between SNMP and a protocol like BACNET. Another example is the home energy controller. In such cases, the eoPhysicalEntity value contains the zero value, thanks to PhysicalIndexOrZero textual convention.

The eoPower is similar to entPhySensorValue [[RFC3433](#)] and the eoPowerUnitMultiplier is similar to entPhySensorScale.

## [7.2.](#) Link with the ENTITY-STATE MIB

For each entity in the ENTITY-MIB [[RFC4133](#)], the ENTITY-STATE MIB [[RFC4268](#)] specifies the operational states (entStateOper: unknown, enabled, disabled, testing), the alarm (entStateAlarm: unknown, underRepair, critical, major, minor, warning, indeterminate) and the possible values of standby states (entStateStandby: unknown, hotStandby, coldStandby, providingService).

From a power monitoring point of view, in contrast to the entity operational states of entities, Power States are required, as proposed in the Power and Energy Monitoring MIB module. Those Power States can be mapped to the different operational states in the ENTITY-STATE MIB, if a formal mapping is required. For example, the entStateStandby "unknown", "hotStandby", "coldStandby", states could map to the Power State "unknown", "ready", "standby", respectively, while the entStateStandby "providingService" could map to any "low" to "high" Power State.

## [7.3.](#) Link with the POWER-OVER-ETHERNET MIB

Power-over-Ethernet MIB [[RFC3621](#)] provides an energy monitoring and configuration framework for power over Ethernet devices. The RFC introduces a concept of a port group on a switch to define power monitoring and management policy and does not use the entPhysicalIndex as the index. Indeed, the pethMainPseConsumptionPower is indexed by the pethMainPseGroupIndex, which has no mapping with the



entPhysicalIndex.

One cannot assume that the Power-over-Ethernet MIB is implemented for all Energy Objects that need to be monitored.

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A typical example is a converged building gateway, monitoring several other devices in the building, doing the proxy between SNMP and a protocol like BACNET. Another example is the home energy controller. In such cases, the eoethPortIndex and eoethPortGrpIndex values contain the zero value, thanks to new PethPsePortIndexOrZero and textual PethPsePortGroupIndexOrZero conventions.

However, if the Power-over-Ethernet MIB [[RFC3621](#)] is supported, the Energy Object eoethPortIndex and eoethPortGrpIndex contain the pethPsePortIndex and pethPsePortGroupIndex, respectively.

As a consequence, the entPhysicalIndex MIB object has been kept as the unique Energy Object index.

Note that, even though the Power-over-Ethernet MIB [[RFC3621](#)] was created after the ENTITY-SENSOR MIB [[RFC3433](#)], it does not reuse the precision notion from the ENTITY-SENSOR MIB, i.e. the entPhySensorPrecision MIB object.

#### [7.4](#). Link with the UPS MIB

To protect against unexpected power disruption, data centers and buildings make use of Uninterruptible Power Supplies (UPS). To protect critical assets, a UPS can be restricted to a particular subset or domain of the network. UPS usage typically lasts only for a finite period of time, until normal power supply is restored. Planning is required to decide on the capacity of the UPS based on output power and duration of probable power outage. To properly provision UPS power in a data center or building, it is important to first understand the total demand required to support all the entities in the site. This demand can be assessed and monitored via the Power and Energy Monitoring MIB.

UPS MIB [[RFC1628](#)] provides information on the state of the UPS network. Implementation of the UPS MIB is useful at the aggregate level of a data center or a building. The MIB module

contains several groups of variables:

- upsIdent: Identifies the UPS entity (name, model, etc.).
- upsBattery group: Indicates the battery state (upsbatteryStatus, upsEstimatedMinutesRemaining, etc.)
- upsInput group: Characterizes the input load to the UPS (number of input lines, voltage, current, etc.).

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- upsOutput: Characterizes the output from the UPS (number of output lines, voltage, current, etc.)
- upsAlarms: Indicates the various alarm events.

The measurement of power in the UPS MIB is in Volts, Amperes and Watts. The units of power measurement are RMS volts and RMS Amperes. They are not based on the EntitySensorDataScale and EntitySensorDataPrecision of ENTITY-SENSOR-MIB.

Both the Power and Energy Monitoring MIB and the UPS MIB may be implemented on the same UPS SNMP agent, without conflict. In this case, the UPS device itself is the Energy Object and any of the UPS meters or submeters are the Energy Objects with a possible relationship as defined in [[EMAN-FMWK](#)].

#### [7.5](#). Link with the LLDP and LLDP-MED MIBs

The LLDP Protocol is a Data Link Layer protocol used by network devices to advertise their identities, capabilities, and interconnections on a LAN network.

The Media Endpoint Discovery is an enhancement of LLDP, known as LLDP-MED. The LLDP-MED enhancements specifically address voice applications. LLDP-MED covers 6 basic areas: capability discovery, LAN speed and duplex discovery, network policy discovery, location identification discovery, inventory discovery, and power discovery.

Of particular interest to the current MIB module is the power discovery, which allows the endpoint device (such as a PoE phone) to convey power requirements to the switch. In power discovery, LLDP-MED has four Type Length Values (TLVs): power

type, power source, power priority and power value. Respectively, those TLVs provide information related to the type of power (power sourcing entity versus powered device), how the device is powered (from the line, from a backup source, from external power source, etc.), the power priority (how important is it that this device has power?), and how much power the device needs.

The power priority specified in the LLDP-MED MIB [[LLDP-MED-MIB](#)] actually comes from the Power-over-Ethernet MIB [[RFC3621](#)]. If the Power-over-Ethernet MIB [[RFC3621](#)] is supported, the exact value from the pethPsePortPowerPriority [[RFC3621](#)] is copied over in the lldpXMedRemXPoEPDPPowerPriority [[LLDP-MED-MIB](#)]; otherwise the value in lldpXMedRemXPoEPDPPowerPriority is "unknown". From the Power and Energy Monitoring MIB, it is possible to identify

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the pethPsePortPowerPriority [[RFC3621](#)], thanks to the eoethPortIndex and eoethPortGrpIndex.

The lldpXMedLocXPoEPDPPowerSource [[LLDP-MED-MIB](#)] is similar to eoPowerOrigin in indicating if the power for an attached device is local or from a remote device. If the LLDP-MED MIB is supported, the following mapping can be applied to the eoPowerOrigin: lldpXMedLocXPoEPDPPowerSource fromPSE(2) and local(3) can be mapped to remote(2) and self(1), respectively.

## [8.](#) Implementation Scenario

This section provides an illustrative example scenario for the implementation of the Energy Object, including Energy Object relationships.

Example Scenario of a campus network: Switch with PoE Endpoints with further connected devices.

The campus network consists of switches that provide LAN connectivity. The switch with PoE ports is located in wiring closet. PoE IP phones are connected to the switch. The IP phones draw power from the PoE ports of the switch. In addition, a PC is daisy-chained from the IP phone for LAN connectivity.

The IP phone consumes power from the PoE switch, while the PC

consumes power from the wall outlet.

The switch has implementations of ENTITY-MIB [[RFC6933](#)] and ENERGY-OBJECT-CONTEXT-MIB MIB [[EMAN-AWARE-MIB](#)]. while the PC has an implementation of the ENTITY-MIB with entity4CRCompliance, and an implementation of ENERGY-OBJECT-CONTEXT-MIB MIB [[EMAN-AWARE-MIB](#)]. The switch has the following attributes, entPhysicalIndex "1", and entPhysicalUUID "UUID 1000". The power usage of the switch is "440 Watts".

The PoE switch port has the following attributes: The switch port has entPhysicalIndex "3", and entPhysicalUUID is "UUID 1000:3". The power metered at the POE switch port is "12 watts". In this example, the POE switch port has an Energy Object relationship with the switch with Energy Object index "1000".

The attributes of the PC are given below. The PC has an entPhysicalIndex "7" and its entPhysicalUUID is "UUID 1000:57 ". The PC has an Energy Object relationship with the switch port

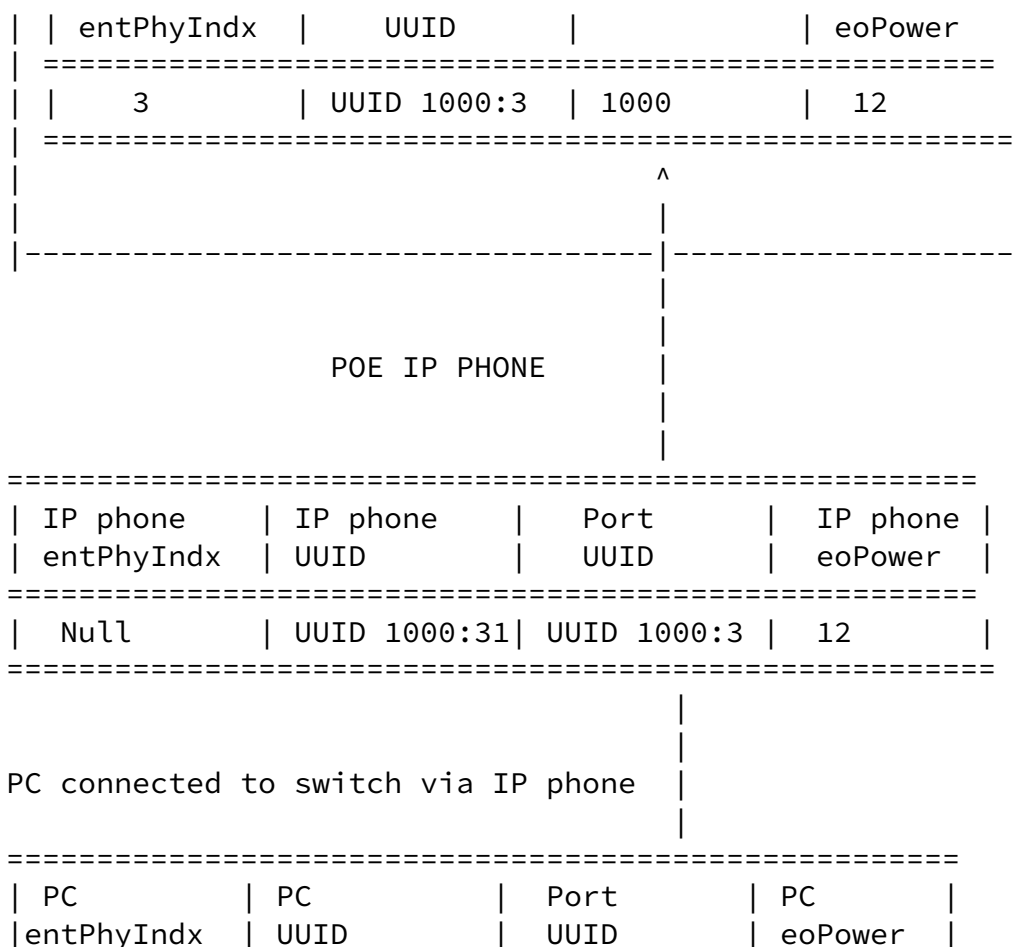
---

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whose entPhysicalUUID is "UUID 1000:3". The power usage of the PC is "120 Watts" and is communicated to the switch port.

The IP phone draws power from the switch, while the PC has LAN connectivity from the phone, but is powered from the wall outlet. However, the Energy Object switch sends power control messages to both the Energy Object (IP phone and PC) and the attached remote Energy Objects react to those messages.

Switch			
Switch entPhyIndx	Switch UUID		Switch eoPower
1	UUID 1000	null	440
SWITCH PORT			
Switch Port	Switch Port	Switch UUID	Switch Port



7	UUID 1000:57	UUID 1000:3	120
---	--------------	-------------	-----

Figure 6: Example scenario

## 9. Structure of the MIB

The primary MIB object in this MIB module is the energyObjectMIBObject. The eoPowerTable table of energyObjectMIBObject describes the power measurement attributes of an Energy Object entity. The notion of identity of the device in terms of uniquely identification of the Energy Object and its relationship to other entities in the network are addressed in [EMAN-AWARE-MIB].

Logically, this MIB module is a sparse extension of the ENERGY-OBJECT-CONTEXT-MIB module [[EMAN-AWARE-MIB](#)]. Thus the following requirements which are applied to [[EMAN-AWARE-MIB](#)] are also applicable. As a requirement for this MIB module, [[EMAN-AWARE-MIB](#)] should be implemented and as Module Compliance of ENTITY-MIB V4 [[RFC6933](#)] with respect to entity4CRCompliance should be supported which requires 3 MIB objects (entPhysicalIndex, entPhysicalName and entPhysicalUUID ) MUST be implemented.

eoMeterCapabilitiesTable is useful to enable applications to determine the capabilities supported by the local management agent. This table indicates the energy monitoring MIB groups that are supported by the local management system. By reading the value of this object, it is possible for applications to know which tables contain the information and are usable without walking through the table and querying every element which involves a trial-and-error process.

The power measurement of an Energy Object contains information describing its power usage (eoPower) and its current Power State (eoPowerOperState). In addition to power usage, additional information describing the units of measurement (eoPowerAccuracy, eoPowerUnitMultiplier), how power usage measurement was obtained (eoPowerMeasurementCaliber), the source of power (eoPowerOrigin) and the type of power (eoPowerCurrentTtype) are described.

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An Energy Object may contain an optional eoPowerAttributes table that describes the electrical characteristics associated with the current Power State and usage.

An Energy Object may contain an optional eoEnergyTable to describe energy measurement information over time.

An Energy Object may also contain optional battery information associated with this entity.

```
-- *****
--
--
-- This MIB is used to monitor power usage of network
-- devices
--
-- *****
```

ENERGY-OBJECT-MIB DEFINITIONS ::= BEGIN

IMPORTS

```
    MODULE-IDENTITY,
    OBJECT-TYPE,
    NOTIFICATION-TYPE,
    mib-2,
    Integer32, Counter32, TimeTicks
        FROM SNMPv2-SMI
    TEXTUAL-CONVENTION, DisplayString, RowStatus, TimeInterval,
    TimeStamp, TruthValue
        FROM SNMPv2-TC
    MODULE-COMPLIANCE, NOTIFICATION-GROUP, OBJECT-GROUP
        FROM SNMPv2-CONF
    OwnerString
        FROM RMON-MIB
    entPhysicalIndex, PhysicalIndex
        FROM ENTITY-MIB
    IANAPowerStateSet
        FROM IANA-POWERSTATE-SET-MIB;
```

energyObjectMIB MODULE-IDENTITY

LAST-UPDATED "201312130000Z" -- 13 December 2013

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#### DESCRIPTION

"This MIB is used to monitor power and energy in devices.

This table sparse extension of the eoTable from the ENERGY-OBJECT-CONTEXT-MIB. As a requirement [[EMAN-AWARE-MIB](#)] must be implemented.

Module Compliance of ENTITY-MIB v4 with respect to entity4CRCompliance should be supported which requires implementation of 3 MIB objects (entPhysicalIndex, entPhysicalName and entPhysicalUUID)."

#### REVISION

"201312130000Z" -- 13 December 2013

#### DESCRIPTION

"Initial version, published as RFC YYY."

::= { energyMIB 3 }

energyObjectMIBNotifs OBJECT IDENTIFIER  
::= { energyObjectMIB 0 }

energyObjectMIBObjects OBJECT IDENTIFIER  
::= { energyObjectMIB 1 }

energyObjectMIBConform OBJECT IDENTIFIER  
::= { energyObjectMIB 2 }

-- Textual Conventions

UnitMultiplier ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION

"The Unit Multiplier is an integer value that represents the IEEE 61850 Annex A units multiplier associated with the integer units used to measure the power or energy.

For example, when used with eoPowerUnitMultiplier, -3 represents  $10^{-3}$  or milliwatts."

REFERENCE

"The International System of Units (SI),  
National Institute of Standards and Technology,  
Spec. Publ. 330, August 1991."

SYNTAX INTEGER {

yocto(-24),	-- $10^{-24}$
zepto(-21),	-- $10^{-21}$
atto(-18),	-- $10^{-18}$
femto(-15),	-- $10^{-15}$
pico(-12),	-- $10^{-12}$
nano(-9),	-- $10^{-9}$
micro(-6),	-- $10^{-6}$
milli(-3),	-- $10^{-3}$
units(0),	-- $10^0$
kilo(3),	-- $10^3$
mega(6),	-- $10^6$
giga(9),	-- $10^9$
tera(12),	-- $10^{12}$
peta(15),	-- $10^{15}$
exa(18),	-- $10^{18}$
zetta(21),	-- $10^{21}$
yotta(24)	-- $10^{24}$

}

-- Objects

eoMeterCapabilitiesTable OBJECT-TYPE

SYNTAX SEQUENCE OF EoMeterCapabilitiesEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This table is useful for helping applications determine the monitoring capabilities supported by the local management agents. It is possible for applications to know which tables are usable without going through a trial-and-error process."

::= { energyObjectMIBObjects 1 }

---

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eoMeterCapabilitiesEntry OBJECT-TYPE

SYNTAX                EoMeterCapabilitiesEntry

MAX-ACCESS           not-accessible

STATUS                current

DESCRIPTION

"An entry describes the metering capability of an Energy Object."

INDEX                { entPhysicalIndex }

::= { eoMeterCapabilitiesTable 1 }

EoMeterCapabilitiesEntry ::= SEQUENCE {

    eoMeterCapability                BITS

    }

eoMeterCapability OBJECT-TYPE

SYNTAX    BITS {

    none(0),

    powermetering(1),                -- power measurement

    energymetering(2),                -- energy measurement

    powerattributes(3)    -- power attributes

    }

MAX-ACCESS           read-only

STATUS                current

DESCRIPTION

"An indication of the Energy monitoring capabilities supported by this agent. This object use a BITS syntax and indicate the MIB groups supported by the probe. By reading the value of this object, it is possible to determine the MIB tables supported. "

::= { eoMeterCapabilitiesEntry 1 }

eoPowerTable OBJECT-TYPE

SYNTAX                SEQUENCE OF EoPowerEntry

MAX-ACCESS           not-accessible

STATUS                current

DESCRIPTION

    "This table lists Energy Objects."

::= { energyObjectMIBObjects 2 }

eoPowerEntry OBJECT-TYPE

SYNTAX                EoPowerEntry

MAX-ACCESS       not-accessible  
STATUS            current  
DESCRIPTION

"An entry describes the power usage of an Energy Object."

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INDEX            { entPhysicalIndex }  
::= { eoPowerTable 1 }

EoPowerEntry ::= SEQUENCE {

eoPower	Integer32,
eoPowerNameplate	Integer32,
eoPowerUnitMultiplier	UnitMultiplier,
eoPowerAccuracy	Integer32,
eoPowerMeasurementCaliber	INTEGER,
eoPowerCurrentType	INTEGER,
eoPowerOrigin	INTEGER,
eoPowerAdminState	IANAPowerStateSet,
eoPowerOperState	IANAPowerStateSet,
eoPowerStateEnterReason	OwnerString

}

eoPower OBJECT-TYPE

SYNTAX           Integer32  
UNITS            "Watts"  
MAX-ACCESS       read-only  
STATUS           current  
DESCRIPTION

"This object indicates the power measured for the Energy Object. For alternating current, this value is obtained as an average over fixed number of AC cycles. . This value is specified in SI units of watts with the magnitude of watts (milliwatts, kilowatts, etc.) indicated separately in eoPowerUnitMultiplier. The accuracy of the measurement is specified in eoPowerAccuracy. The direction of power flow is indicated by the sign on eoPower. If the Energy Object is consuming power, the eoPower value will be positive. If the Energy Object is producing power, the eoPower value will be negative."

The eoPower MUST be less than or equal to the maximum power that can be consumed at the power state specified by eoPowerState.

The eoPowerMeasurementCaliber object specifies how the usage value reported by eoPower was obtained. The eoPower value must report 0 if the eoPowerMeasurementCaliber is 'unavailable'. For devices that can not measure or report power, this option can be used."

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::= { eoPowerEntry 1 }

eoPowerNameplate OBJECT-TYPE

SYNTAX Integer32

UNITS "Watts"

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"This object indicates the rated maximum consumption for the fully populated Energy Object. The nameplate power requirements are the maximum power numbers and, in almost all cases, are well above the expected operational consumption. The eoPowerNameplate is widely used for power provisioning. This value is specified in either units of watts or voltage and current. The units are therefore SI watts or equivalent Volt-Amperes with the magnitude (milliwatts, kilowatts, etc.) indicated separately in eoPowerUnitMultiplier."

::= { eoPowerEntry 2 }

eoPowerUnitMultiplier OBJECT-TYPE

SYNTAX UnitMultiplier

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The magnitude of watts for the usage value in eoPower and eoPowerNameplate."

::= { eoPowerEntry 3 }

eoPowerAccuracy OBJECT-TYPE

SYNTAX Integer32 (0..10000)

UNITS "hundredths of percent"

MAX-ACCESS        read-only  
STATUS            current  
DESCRIPTION

"This object indicates a percentage value, in 100ths of a percent, representing the assumed accuracy of the usage reported by eoPower. For example: The value 1010 means the reported usage is accurate to +/- 10.1 percent. This value is zero if the accuracy is unknown or not applicable based upon the measurement method.

ANSI and IEC define the following accuracy classes for power measurement:

IEC 62053-22    60044-1 class 0.1, 0.2, 0.5, 1    3.

ANSI C12.20 class 0.2, 0.5"

::= { eoPowerEntry 4    }

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eoPowerMeasurementCaliber    OBJECT-TYPE  
SYNTAX            INTEGER {  
                    unavailable(1) ,  
                    unknown(2),  
                    actual(3) ,  
                    estimated(4),  
                    static(5)                                }

MAX-ACCESS        read-only  
STATUS            current

DESCRIPTION

"This object specifies how the usage value reported by eoPower was obtained:

- unavailable(1): Indicates that the usage is not available. In such a case, the eoPower value must be 0 for devices that can not measure or report power this option can be used.

- unknown(2): Indicates that the way the usage was determined is unknown. In some cases, entities report aggregate power on behalf of another device. In such cases it is not known whether the usage reported is actual(2), estimated(3) or presumed (4).

- actual(3): Indicates that the reported usage was measured by the entity through some hardware or direct

physical means. The usage data reported is not presumed (4) or estimated (3) but is the measured consumption rate.

- estimated(4): Indicates that the usage was not determined by physical measurement. The value is a derivation based upon the device type, state, and/or current utilization using some algorithm or heuristic. It is presumed that the entity's state and current configuration were used to compute the value.

- static(5): Indicates that the usage was not determined by physical measurement, algorithm or derivation. The usage was reported based upon external tables, specifications, and/or model information. For example, a PC Model X draws 200W, while a PC Model Y draws 210W"

```
::= { eoPowerEntry 5 }
```

eoPowerCurrentType OBJECT-TYPE

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```
SYNTAX      INTEGER {
                ac(1),
                dc(2),
                unknown(3)
            }
```

```
MAX-ACCESS  read-only
```

```
STATUS      current
```

DESCRIPTION

"This object indicates whether the eoPower for the Energy Object reports alternating current AC(1), direct current DC(2), or that the current type is unknown(3)."

```
::= { eoPowerEntry 6 }
```

eoPowerOrigin OBJECT-TYPE

```
SYNTAX      INTEGER {
                self (1),
                remote (2)
            }
```

```
MAX-ACCESS  read-only
```

```
STATUS      current
```

DESCRIPTION

"This object indicates the source of power measurement and can be useful when modeling the power usage of

attached devices. The power measurement can be performed by the entity itself or the power measurement of the entity can be reported by another trusted entity using a protocol extension. A value of self(1) indicates the measurement is performed by the entity, whereas remote(2) indicates that the measurement was performed by another entity."

::= { eoPowerEntry 7 }

eoPowerAdminState OBJECT-TYPE

SYNTAX IANAPowerStateSet

MAX-ACCESS read-write

STATUS current

DESCRIPTION

"This object specifies the desired Power State and the Power State Set for the Energy Object. Note that other(0) is not a Power State Set and unknown(255) is not a Power State as such, but simply an indication that the Power State of the Energy Object is unknown. Possible values of eoPowerAdminState within the Power State Set are registered at IANA.

A current list of assignments can be found at

<<http://www.iana.org/assignments/eman>>

RFC-EDITOR: please check the location after IANA"

::= { eoPowerEntry 8 }

eoPowerOperState OBJECT-TYPE

SYNTAX IANAPowerStateSet

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"This object specifies the current operational Power State and the Power State Set for the Energy Object. other(0) is not a Power State Set and unknown(255) is not a Power State as such, but simply an indication that the Power State of the Energy Object is unknown.

Possible values of eoPowerAdminState within the Power State Set are registered at IANA.

A current list of assignments can be found at

<<http://www.iana.org/assignments/eman>>



RFC-EDITOR: please check the location after IANA"

::= { eoPowerEntry 9 }

eoPowerStateEnterReason OBJECT-TYPE

SYNTAX OwnerString

MAX-ACCESS read-write

STATUS current

DESCRIPTION

"This string object describes the reason for the eoPowerAdminState transition. Alternatively, this string may contain with the entity that configured this Energy Object to this Power State."

DEFVAL { "" }

::= { eoPowerEntry 10 }

eoPowerStateTable OBJECT-TYPE

SYNTAX SEQUENCE OF EoPowerStateEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This table enumerates the maximum power usage, in watts, for every single supported Power State of each Energy Object."

This table has an expansion-dependent relationship on the eoPowerTable, containing rows describing each Power State for the corresponding Energy Object. For every Energy

Object in the eoPowerTable, there is a corresponding entry in this table."

::= { energyObjectMIBObjects 3 }

eoPowerStateEntry OBJECT-TYPE

SYNTAX EoPowerStateEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"A eoPowerStateEntry extends a corresponding eoPowerEntry. This entry displays max usage values at every single possible Power State supported by the Energy Object."

For example, given the values of a Energy Object corresponding to a maximum usage of 0 W at the state 1 (mechhoff), 8 W at state 6 (ready), 11 W at state 9 (mediumMinus), and 11 W at state 12 (high):

State	MaxUsage	Units
1 (mechhoff)	0	W
2 (softoff)	0	W
3 (hibernate)	0	W
4 (sleep)	0	W
5 (standby)	0	W
6 (ready)	8	W
7 (lowMinus)	8	W
8 (low)	11	W
9 (mediumMinus)	11	W
10 (medium)	11	W
11 (highMinus)	11	W
12 (high)	11	W

Furthermore, this table extends to return the total time in each Power State, along with the number of times a particular Power State was entered."

```

INDEX { entPhysicalIndex,
        eoPowerStateIndex
      }
 ::= { eoPowerStateTable 1 }

EoPowerStateEntry ::= SEQUENCE {
    eoPowerStateIndex          IANAPowerStateSet,
    eoPowerStateMaxPower      Integer32,
    eoPowerStatePowerUnitMultiplier UnitMultiplier,
    eoPowerStateTotalTime     TimeTicks,
    eoPowerStateEnterCount    Counter32
}

```

```

eoPowerStateIndex OBJECT-TYPE
    SYNTAX          IANAPowerStateSet
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION
        "
        This object specifies the index of the Power State of

```

the Energy Object within a Power State Set. The semantics of the specific Power State can be obtained from the Power State Set definition."  
 ::= { eoPowerStateEntry 1 }

eoPowerStateMaxPower OBJECT-TYPE

SYNTAX Integer32  
UNITS "Watts"  
MAX-ACCESS read-only  
STATUS current

DESCRIPTION

"This object indicates the maximum power for the Energy Object at the particular Power State. This value is specified in SI units of watts with the magnitude of the units (milliwatts, kilowatts, etc.) indicated separately in eoPowerStatePowerUnitMultiplier. If the maximum power is not known for a certain Power State, then the value is encoded as 0xFFFF.

For Power States not enumerated, the value of eoPowerStateMaxPower might be interpolated by using the next highest supported Power State."

::= { eoPowerStateEntry 2 }

eoPowerStatePowerUnitMultiplier OBJECT-TYPE

SYNTAX UnitMultiplier  
MAX-ACCESS read-only  
STATUS current

DESCRIPTION

"The magnitude of watts for the usage value in eoPowerStateMaxPower."

::= { eoPowerStateEntry 3 }

eoPowerStateTotalTime OBJECT-TYPE

SYNTAX TimeTicks  
MAX-ACCESS read-only  
STATUS current

DESCRIPTION

"This object indicates the total time in hundredth

of second that the Energy Object has been in this power state since the last reset, as specified in the sysUpTime."

```
::= { eoPowerStateEntry 4 }
```

eoPowerStateEnterCount OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"This object indicates how often the Energy Object has entered this power state, since the last reset of the device as specified in the sysUpTime."

```
::= { eoPowerStateEntry 5 }
```

eoEnergyParametersTable OBJECT-TYPE

SYNTAX SEQUENCE OF EoEnergyParametersEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This table is used to configure the parameters for Energy measurement collection in the table eoEnergyTable. This table allows the configuration of different measurement settings on the same Energy Object. Implementation of this table only sense for Energy Objects that an eoPowerMeasurementCaliber of actual(3)."

```
::= { energyObjectMIBObjects 4 }
```

eoEnergyParametersEntry OBJECT-TYPE

SYNTAX EoEnergyParametersEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An entry controls an energy measurement in eoEnergyTable."

INDEX { eoEnergyObjectIndex, eoEnergyParametersIndex }

```
::= { eoEnergyParametersTable 1 }
```

EoEnergyParametersEntry ::= SEQUENCE {

eoEnergyObjectIndex	PhysicalIndex,
eoEnergyParametersIndex	Integer32,
eoEnergyParametersIntervalLength	TimeInterval,
eoEnergyParametersIntervalNumber	Integer32,
eoEnergyParametersIntervalMode	INTEGER,
eoEnergyParametersIntervalWindow	TimeInterval,
eoEnergyParametersSampleRate	Integer32,

```

        eoEnergyParametersStatus          RowStatus
    }

eoEnergyObjectIndex OBJECT-TYPE
    SYNTAX          PhysicalIndex
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION
        "The unique value, to identify the specific Energy Object
        on which the measurement is applied, the same index used
        in the eoPowerTable to identify the Energy Object."
    ::= { eoEnergyParametersEntry 1 }

eoEnergyParametersIndex OBJECT-TYPE
    SYNTAX          Integer32 (0..2147483647)
    MAX-ACCESS      read-create
    STATUS          current
    DESCRIPTION
        "This object specifies the index of the Energy
        Parameters setting for collection of energy measurements
        for an Energy Object. An Energy Object can have multiple
        eoEnergyParametersIndex, depending on the capability of
        the Energy Object"
    ::= { eoEnergyParametersEntry 2 }

eoEnergyParametersIntervalLength OBJECT-TYPE
    SYNTAX          TimeInterval
    MAX-ACCESS      read-create
    STATUS          current
    DESCRIPTION
        "This object indicates the length of time in hundredth of
        seconds over which to compute the average
        eoEnergyConsumed measurement in the eoEnergyTable table.
        The computation is based on the Energy Object's internal
        sampling rate of power consumed or produced by the Energy
        Object. The sampling rate is the rate at which the Energy
        Object can read the power usage and may differ based on
        device capabilities. The average energy consumption is
        then computed over the length of the interval."
    DEFVAL { 90000 }
    ::= { eoEnergyParametersEntry 3 }

eoEnergyParametersIntervalNumber OBJECT-TYPE
    SYNTAX          Integer32
    MAX-ACCESS      read-create
    STATUS          current
    DESCRIPTION
```

---

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"The number of intervals maintained in the eoEnergyTable. Each interval is characterized by a specific eoEnergyCollectionStartTime, used as an index to the table eoEnergyTable. Whenever the maximum number of entries is reached, the measurement over the new interval replaces the oldest measurement. There is one exception to this rule: when the eoEnergyMaxConsumed and/or eoEnergyMaxProduced are in (one of) the two oldest measurement(s), they are left untouched and the next oldest measurement is replaced."

DEFVAL { 10 }

::= { eoEnergyParametersEntry 4 }

eoEnergyParametersIntervalMode OBJECT-TYPE

SYNTAX                INTEGER {  
                         period(1),  
                         sliding(2),  
                         total(3)  
                         }

MAX-ACCESS            read-create

STATUS                current

DESCRIPTION

"A control object to define the mode of interval calculation for the computation of the average eoEnergyConsumed or eoEnergyProvided measurement in the eoEnergyTable table.

A mode of period(1) specifies non-overlapping periodic measurements.

A mode of sliding(2) specifies overlapping sliding windows where the interval between the start of one interval and the next is defined in eoEnergyParametersIntervalWindow.

A mode of total(3) specifies non-periodic measurement. In this mode only one interval is used as this is a continuous measurement since the last reset. The value of eoEnergyParametersIntervalNumber should be (1) one and eoEnergyParametersIntervalLength is ignored. "

::= { eoEnergyParametersEntry 5 }

eoEnergyParametersIntervalWindow OBJECT-TYPE

SYNTAX                TimeInterval

MAX-ACCESS            read-create

STATUS current

DESCRIPTION

"The length of the duration window between the starting time of one sliding window and the next starting time in

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hundredth of seconds, in order to compute the average of eoEnergyConsumed, eoEnergyProvided measurements in the eoEnergyTable table. This is valid only when the eoEnergyParametersIntervalMode is sliding(2). The eoEnergyParametersIntervalWindow value should be a multiple of eoEnergyParametersSampleRate."

::= { eoEnergyParametersEntry 6 }

eoEnergyParametersSampleRate OBJECT-TYPE

SYNTAX Integer32

UNITS "Milliseconds"

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"The sampling rate, in milliseconds, at which the Energy Object should poll power usage in order to compute the average eoEnergyConsumed, eoEnergyProvided measurements in the table eoEnergyTable. The Energy Object should initially set this sampling rate to a reasonable value, i.e., a compromise between intervals that will provide good accuracy by not being too long, but not so short that they affect the Energy Object performance by requesting continuous polling. If the sampling rate is unknown, the value 0 is reported. The sampling rate should be selected so that eoEnergyParametersIntervalWindow is a multiple of eoEnergyParametersSampleRate."

DEFVAL { 1000 }

::= { eoEnergyParametersEntry 7 }

eoEnergyParametersStatus OBJECT-TYPE

SYNTAX RowStatus

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"The status of this row. The eoEnergyParametersStatus is used to start or stop energy usage logging. An entry status may not be active(1) unless all objects in the entry have an appropriate value. If this object is not

equal to active(1), all associated usage-data logged into the eoEnergyTable will be deleted. The data can be destroyed by setting up the eoEnergyParametersStatus to destroy(2)."

::= {eoEnergyParametersEntry 8 }

eoEnergyTable OBJECT-TYPE

---

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SYNTAX SEQUENCE OF EoEnergyEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This table lists Energy Object energy measurements.

Entries in this table are only created if the corresponding value of object eoPowerMeasurementCaliber is active(3), i.e., if the power is actually metered."

::= { energyObjectMIBObjects 5 }

eoEnergyEntry OBJECT-TYPE

SYNTAX EoEnergyEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An entry describing energy measurements."

INDEX { eoEnergyParametersIndex,

eoEnergyCollectionStartTime }

::= { eoEnergyTable 1 }

EoEnergyEntry ::= SEQUENCE {

eoEnergyCollectionStartTime TimeTicks,

eoEnergyConsumed Integer32,

eoEnergyProvided Integer32,

eoEnergyStored Integer32,

eoEnergyUnitMultiplier UnitMultiplier,

eoEnergyAccuracy Integer32,

eoEnergyMaxConsumed Integer32,

eoEnergyMaxProduced Integer32,

eoEnergyDiscontinuityTime TimeStamp

}

eoEnergyCollectionStartTime OBJECT-TYPE

SYNTAX TimeTicks

UNITS "hundredths of seconds"



MAX-ACCESS not-accessible  
 STATUS current  
 DESCRIPTION  
 "The time (in hundredths of a second) since the network management portion of the system was last re-initialized, as specified in the sysUpTime [[RFC3418](#)]. This object specifies the start time of the energy measurement sample. "  
 ::= { eoEnergyEntry 1 }

eoEnergyConsumed OBJECT-TYPE  
 SYNTAX Integer32

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UNITS "Watt-hours"  
 MAX-ACCESS read-only  
 STATUS current  
 DESCRIPTION  
 "This object indicates the energy consumed in units of watt-hours for the Energy Object over the defined interval. This value is specified in the common billing units of watt-hours with the magnitude of watt-hours (kW-Hr, MW-Hr, etc.) indicated separately in eoEnergyUnitMultiplier."  
 ::= { eoEnergyEntry 2 }

eoEnergyProvided OBJECT-TYPE  
 SYNTAX Integer32  
 UNITS "Watt-hours"  
 MAX-ACCESS read-only  
 STATUS current  
 DESCRIPTION  
 "This object indicates the energy produced in units of watt-hours for the Energy Object over the defined interval. This value is specified in the common billing units of watt-hours with the magnitude of watt-hours (kW-Hr, MW-Hr, etc.) indicated separately in eoEnergyUnitMultiplier."  
 ::= { eoEnergyEntry 3 }

eoEnergyStored OBJECT-TYPE  
 SYNTAX Integer32  
 UNITS "Watt-hours"  
 MAX-ACCESS read-only  
 STATUS current  
 DESCRIPTION

"This object indicates the resultant of the energy consumed and energy produced for an Energy Object in units of watt-hours for the Energy Object over the defined interval. This value is specified in the common billing units of watt-hours with the magnitude of watt-hours (kW-Hr, MW-Hr, etc.) indicated separately in eoEnergyUnitMultiplier."

::= { eoEnergyEntry 4 }

eoEnergyUnitMultiplier OBJECT-TYPE

SYNTAX UnitMultiplier

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"This object is the magnitude of watt-hours for the energy field in eoEnergyConsumed, eoEnergyProvided, eoEnergyStored, eoEnergyMaxConsumed, and eoEnergyMaxProduced ."

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::= { eoEnergyEntry 5 }

eoEnergyAccuracy OBJECT-TYPE

SYNTAX Integer32 (0..10000)

UNITS "hundredths of percent"

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"This object indicates a percentage value, in 100ths of a percent, representing the presumed accuracy of Energy usage reporting. eoEnergyAccuracy is applicable to all Energy measurements in the eoEnergyTable.

For example: 1010 means the reported usage is accurate to +/- 10.1 percent.

This value is zero if the accuracy is unknown."

::= { eoEnergyEntry 6 }

eoEnergyMaxConsumed OBJECT-TYPE

SYNTAX Integer32

UNITS "Watt-hours"

MAX-ACCESS read-only

STATUS current

#### DESCRIPTION

"This object is the maximum energy ever observed in eoEnergyConsumed since the monitoring started. This value is specified in the common billing units of watt-hours with the magnitude of watt-hours (kW-Hr, MW-Hr, etc.) indicated separately in eoEnergyUnitMultiplier."  
::= { eoEnergyEntry 7 }

#### eoEnergyMaxProduced OBJECT-TYPE

SYNTAX Integer32  
UNITS "Watt-hours"  
MAX-ACCESS read-only  
STATUS current

#### DESCRIPTION

"This object is the maximum energy ever observed in eoEnergyEnergyProduced since the monitoring started. This value is specified in the units of watt-hours with the magnitude of watt-hours (kW-Hr, MW-Hr, etc.) indicated separately in eoEnergyEnergyUnitMultiplier."  
::= { eoEnergyEntry 8 }

#### eoEnergyDiscontinuityTime OBJECT-TYPE

SYNTAX TimeStamp  
MAX-ACCESS read-only  
STATUS current

#### DESCRIPTION

"The value of sysUpTime [[RFC3418](#)] on the most recent occasion at which any one or more of this entity's energy counters in this table suffered a discontinuity: eoEnergyConsumed, eoEnergyProvided or eoEnergyStored. If no such discontinuities have occurred since the last re-initialization of the local management subsystem, then this object contains a zero value."  
::= { eoEnergyEntry 9 }

#### -- Notifications

#### eoPowerEnableStatusNotification OBJECT-TYPE

SYNTAX TruthValue

```
MAX-ACCESS      read-write
STATUS          current
DESCRIPTION      "This variable indicates whether the
system produces the following notifications:
    eoPowerStateChange.
```

```
    A false value will prevent these notifications
    from being generated."
DEFVAL          { false }
::= { energyObjectMIBNotifs 1 }
```

```
eoPowerStateChange NOTIFICATION-TYPE
    OBJECTS      {eoPowerAdminState, eoPowerOperState,
eoPowerStateEnterReason}
    STATUS      current
    DESCRIPTION
        "The SNMP entity generates the eoPowerStateChange when
        the value(s) of eoPowerAdminState or eoPowerOperState,
        in the context of the Power State Set, have changed for
        the Energy Object represented by the entPhysicalIndex."
    ::= { energyObjectMIBNotifs 2 }
```

-- Conformance

```
energyObjectMIBCompliances OBJECT IDENTIFIER
    ::= { energyObjectMIBConform 1 }
```

```
energyObjectMIBGroups OBJECT IDENTIFIER
    ::= { energyObjectMIBConform 2 }
```

```
energyObjectMIBFullCompliance MODULE-COMPLIANCE
    STATUS      current
    DESCRIPTION
        "When this MIB is implemented with support for
        read-create, then such an implementation can
        claim full compliance. Such devices can then
        be both monitored and configured with this MIB.
```

```
    Module Compliance of [RFC6933]
    with respect to entity4CRCompliance should
    be supported which requires implementation
```

of 3 MIB objects (entPhysicalIndex,  
entPhysicalName and entPhysicalUUID)."

```
MODULE          -- this module
MANDATORY-GROUPS {
    energyObjectMIBTableGroup,
    energyObjectMIBStateTableGroup,
    eoPowerEnableStatusNotificationGroup,
    energyObjectMIBNotifGroup
}

GROUP          energyObjectMIBEnergyTableGroup

DESCRIPTION "A compliant implementation does not
have to implement.

Module Compliance of [RFC6933]
with respect to entity4CRCompliance should
be supported which requires implementation
of 3 MIB objects (entPhysicalIndex,
entPhysicalName and entPhysicalUUID)."
```

```
GROUP          energyObjectMIBEnergyParametersTableGroup

DESCRIPTION "A compliant implementation does not
have to implement.

Module Compliance of [RFC6933]
with respect to entity4CRCompliance should
be supported which requires implementation
of 3 MIB objects (entPhysicalIndex,
```

entPhysicalName and entPhysicalUUID)."

```
GROUP          energyObjectMIBMeterCapabilitiesTableGroup

DESCRIPTION "A compliant implementation does not
have to implement.

Module Compliance of [RFC6933]
with respect to entity4CRCompliance should
be supported which requires implementation
```

of 3 MIB objects (entPhysicalIndex,  
entPhysicalName and entPhysicalUUID)."

::= { energyObjectMIBCompliances 1 }

energyObjectMIBReadOnlyCompliance MODULE-COMPLIANCE

STATUS current

DESCRIPTION

"When this MIB is implemented without support for read-create (i.e. in read-only mode), then such an implementation can claim read-only compliance. Such a device can then be monitored but cannot be configured with this MIB.

Module Compliance of [[RFC6933](#)]  
with respect to entity4CRCompliance should be supported which requires implementation of 3 MIB objects (entPhysicalIndex, entPhysicalName and entPhysicalUUID)."

MODULE -- this module

MANDATORY-GROUPS {  
energyObjectMIBTableGroup,  
energyObjectMIBStateTableGroup,  
energyObjectMIBNotifGroup  
}

OBJECT eoPowerOperState

MIN-ACCESS read-only

DESCRIPTION

"Write access is not required."

::= { energyObjectMIBCompliances 2 }

-- Units of Conformance

energyObjectMIBTableGroup OBJECT-GROUP

OBJECTS {  
eoPower,  
eoPowerNameplate,  
eoPowerUnitMultiplier,  
eoPowerAccuracy,  
eoPowerMeasurementCaliber,

```

        eoPowerCurrentType,
        eoPowerOrigin,
        eoPowerAdminState,
        eoPowerOperState,
        eoPowerStateEnterReason
    }
    STATUS          current
DESCRIPTION
    "This group contains the collection of all the objects
    related to the Energy Object."
 ::= { energyObjectMIBGroups 1 }

energyObjectMIBStateTableGroup OBJECT-GROUP
    OBJECTS      {
        eoPowerStateMaxPower,
        eoPowerStatePowerUnitMultiplier,
        eoPowerStateTotalTime,
        eoPowerStateEnterCount
    }
    STATUS          current
DESCRIPTION
    "This group contains the collection of all the
    objects related to the Power State."
 ::= { energyObjectMIBGroups 2 }

energyObjectMIBEnergyParametersTableGroup OBJECT-GROUP
    OBJECTS      {
        eoEnergyParametersIndex,
        eoEnergyParametersIntervalLength,
        eoEnergyParametersIntervalNumber,
        eoEnergyParametersIntervalMode,
        eoEnergyParametersIntervalWindow,
        eoEnergyParametersSampleRate,
        eoEnergyParametersStatus
    }
    STATUS          current
DESCRIPTION
    "This group contains the collection of all the objects
    related to the configuration of the Energy Table."

```

```

energyObjectMIBEnergyTableGroup OBJECT-GROUP
    OBJECTS          {
        -- Note that object
        -- eoEnergyCollectionStartTime is not
        -- included since it is not-accessible

        eoEnergyConsumed,
        eoEnergyProvided,
        eoEnergyStored,
        eoEnergyUnitMultiplier,
        eoEnergyAccuracy,
        eoEnergyMaxConsumed,
        eoEnergyMaxProduced,
        eoEnergyDiscontinuityTime
    }
    STATUS            current
    DESCRIPTION
        "This group contains the collection of all the objects
        related to the Energy Table."
    ::= { energyObjectMIBGroups 4 }

energyObjectMIBMeterCapabilitiesTableGroup OBJECT-GROUP
    OBJECTS          {
        eoMeterCapability
    }
    STATUS            current
    DESCRIPTION
        "This group contains the object indicating the
        capability of the Energy Object"
    ::= { energyObjectMIBGroups 5 }

eoPowerEnableStatusNotificationGroup OBJECT-GROUP
    OBJECTS          { eoPowerEnableStatusNotification }
    STATUS            current
    DESCRIPTION
        "The collection of objects which are used
        to enable notification."
    ::= { energyObjectMIBGroups 6 }

energyObjectMIBNotifGroup NOTIFICATION-GROUP
    NOTIFICATIONS    {
        eoPowerStateChange
    }
    STATUS            current
    DESCRIPTION
        "This group contains the notifications for

```



```
        the power and energy monitoring MIB Module."
 ::= { energyObjectMIBGroups 7 }
```

END

```
-- *****
--
-- This MIB module is used to monitor power attributes of
-- networked devices with measurements.
--
-- This MIB module is an extension of energyObjectMIB module.
--
-- *****
```

POWER-ATTRIBUTES-MIB DEFINITIONS ::= BEGIN

```
IMPORTS
    MODULE-IDENTITY,
    OBJECT-TYPE,
    mib-2,
    Integer32
        FROM SNMPv2-SMI
    MODULE-COMPLIANCE,
    OBJECT-GROUP
        FROM SNMPv2-CONF
    UnitMultiplier
        FROM ENERGY-OBJECT-MIB
    OwnerString
        FROM RMON-MIB
    entPhysicalIndex
        FROM ENTITY-MIB;
```

powerAttributesMIB MODULE-IDENTITY

```
    LAST-UPDATED      "201312130000Z"    -- 13 December 2013
```

```
    ORGANIZATION      "IETF EMAN Working Group"
```

```
    CONTACT-INFO
```

```
        "WG charter:
```

```
        http://datatracker.ietf.org/wg/eman/charter/
```

```
    Mailing Lists:
```

```
        General Discussion: eman@ietf.org
```

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Expires June 13, 2014

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Internet-Draft <Power and Energy Monitoring MIB> December 2013

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#### DESCRIPTION

"This MIB is used to report AC power attributes in devices. The table is a sparse augmentation of the eoPowerTable table from the energyObjectMIB module. Both three-phase and single-phase power configurations are supported.

As a requirement for this MIB module,  
[[EMAN-AWARE-MIB](#)] should be implemented.

Module Compliance of ENTITY-MIB v4  
with respect to entity4CRCompliance should  
be supported which requires implementation  
of 3 MIB objects (entPhysicalIndex,  
entPhysicalName and entPhysicalUUID)."

#### REVISION

"201312130000Z" -- 13 December 2013

#### DESCRIPTION

"Initial version, published as RFC YYY."

::= { energyMIB 4 }

powerAttributesMIBConform OBJECT IDENTIFIER  
::= { powerAttributesMIB 0 }

powerAttributesMIBObjects OBJECT IDENTIFIER  
::= { powerAttributesMIB 1 }

-- Objects

```

eoACPwrAttributesTable OBJECT-TYPE
    SYNTAX          SEQUENCE OF EoACPwrAttributesEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION
        "This table defines power attributes measurements for
        supported entPhysicalIndex entities. It is a sparse
        extension of the eoPowerTable."
    ::= { powerAttributesMIBObjects 1 }

```

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```

eoACPwrAttributesEntry OBJECT-TYPE
    SYNTAX          EoACPwrAttributesEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION
        "This is a sparse extension of the eoPowerTable with
        entries for power attributes measurements or
        configuration. Each measured value corresponds to an
        attribute in IEC 61850-7-4 for non-phase measurements
        within the object MMUX."

```

```

INDEX {entPhysicalIndex }
    ::= { eoACPwrAttributesTable 1 }

```

```

EoACPwrAttributesEntry ::= SEQUENCE {
    eoACPwrAttributesConfiguration      INTEGER,
    eoACPwrAttributesAvgVoltage        Integer32,
    eoACPwrAttributesAvgCurrent        Integer32,
    eoACPwrAttributesFrequency         Integer32,
    eoACPwrAttributesPowerUnitMultiplier UnitMultiplier,
    eoACPwrAttributesPowerAccuracy     Integer32,
    eoACPwrAttributesTotalActivePower  Integer32,
    eoACPwrAttributesTotalReactivePower Integer32,
    eoACPwrAttributesTotalApparentPower Integer32,
    eoACPwrAttributesTotalPowerFactor  Integer32,
    eoACPwrAttributesThdAmperes        Integer32,
    eoACPwrAttributesThdVoltage        Integer32
}

```

```

eoACPwrAttributesConfiguration OBJECT-TYPE
    SYNTAX INTEGER {
        sngl(1),

```

```

        del(2),
        wye(3)
    }
MAX-ACCESS      read-only
STATUS          current
DESCRIPTION
    "Configuration describes the physical configurations
    of the power supply lines:

    * alternating current, single phase (SNGL)
    * alternating current, three phase delta (DEL)
    * alternating current, three phase Y (WYE)

```

Three-phase configurations can be either connected in a triangular delta (DEL) or star Y (WYE) system. WYE

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systems have a shared neutral voltage, while DEL systems do not. Each phase is offset 120 degrees to each other."

```
 ::= { eoACPwrAttributesEntry 1 }
```

eoACPwrAttributesAvgVoltage OBJECT-TYPE

```

SYNTAX          Integer32
UNITS           "0.1 Volt AC"
MAX-ACCESS      read-only
STATUS          current
DESCRIPTION
    "A measured value for average of the voltage measured
    over an integral number of AC cycles For a 3-phase
    system, this is the average voltage (V1+V2+V3)/3. IEC
    61850-7-4 measured value attribute 'Vol'"
 ::= { eoACPwrAttributesEntry 2 }

```

eoACPwrAttributesAvgCurrent OBJECT-TYPE

```

SYNTAX          Integer32
UNITS           "Amperes"
MAX-ACCESS      read-only
STATUS          current
DESCRIPTION
    "A measured value of the current per phase. IEC 61850-
    7-4 attribute 'Amp'"
 ::= { eoACPwrAttributesEntry 3 }

```

eoACPwrAttributesFrequency OBJECT-TYPE

```

SYNTAX      Integer32 (4500..6500) -- UNITS 0.01 Hertz
UNITS       "hertz"
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
    "A measured value for the basic frequency of the AC
    circuit. IEC 61850-7-4 attribute 'Hz'."
 ::= { eoACPwrAttributesEntry 4 }

```

#### eoACPwrAttributesPowerUnitMultiplier OBJECT-TYPE

```

SYNTAX      UnitMultiplier
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
    "The magnitude of watts for the usage value in
    eoACPwrAttributesTotalActivePower,
    eoACPwrAttributesTotalReactivePower
    and eoACPwrAttributesTotalApparentPower measurements.
    For 3-phase power systems, this will also include

```

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```

    eoACPwrAttributesPhaseActivePower,
    eoACPwrAttributesPhaseReactivePower and
    eoACPwrAttributesPhaseApparentPower"
 ::= { eoACPwrAttributesEntry 5 }

```

#### eoACPwrAttributesPowerAccuracy OBJECT-TYPE

```

SYNTAX      Integer32 (0..10000)
UNITS       "hundredths of percent"
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
    "This object indicates a percentage value, in 100ths of
    a percent, representing the presumed accuracy of
    active, reactive, and apparent power usage reporting.
    For example: 1010 means the reported usage is accurate
    to +/- 10.1 percent. This value is zero if the
    accuracy is unknown.

```

ANSI and IEC define the following accuracy classes for power measurement: IEC 62053-22 & 60044-1 class 0.1, 0.2, 0.5, 1 & 3.

ANSI C12.20 class 0.2 & 0.5"

```

 ::= { eoACPwrAttributesEntry 6 }

```

eoACPwrAttributesTotalActivePower OBJECT-TYPE

SYNTAX Integer32

UNITS " watts"

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"A measured value of the actual power delivered to or consumed by the load. IEC 61850-7-4 attribute 'TotW'."

::= { eoACPwrAttributesEntry 7 }

eoACPwrAttributesTotalReactivePower OBJECT-TYPE

SYNTAX Integer32

UNITS "volt-amperes reactive"

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"A measured value of the reactive portion of the apparent power. IEC 61850-7-4 attribute 'TotVAR'."

::= { eoACPwrAttributesEntry 8 }

eoACPwrAttributesTotalApparentPower OBJECT-TYPE

SYNTAX Integer32

UNITS "volt-amperes"

MAX-ACCESS read-only

---

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STATUS current

DESCRIPTION

"A measured value of the voltage and current which determines the apparent power. The apparent power is the vector sum of real and reactive power.

Note: watts and volt-amperes are equivalent units and may be combined. IEC 61850-7-4 attribute 'TotVA'."

::= { eoACPwrAttributesEntry 9 }

eoACPwrAttributesTotalPowerFactor OBJECT-TYPE

SYNTAX Integer32 (-10000..10000)

UNITS "hundredths of percent"

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"A measured value ratio of the real power flowing to the load versus the apparent power. It is dimensionless

and expressed here as a percentage value in 100ths of a percent. A power factor of 100% indicates there is no inductance load and thus no reactive power. Power Factor can be positive or negative, where the sign should be in lead/lag (IEEE) form. IEC 61850-7-4 attribute 'TotPF'."

::= { eoACPwrAttributesEntry 10 }

eoACPwrAttributesThdAmperes OBJECT-TYPE

SYNTAX Integer32 (0..10000)  
UNITS "hundredths of percent"  
MAX-ACCESS read-only  
STATUS current

DESCRIPTION

"A calculated value for the current total harmonic distortion (THD). Method of calculation is not specified. IEC 61850-7-4 attribute 'ThdAmp'."

::= { eoACPwrAttributesEntry 11 }

eoACPwrAttributesThdVoltage OBJECT-TYPE

SYNTAX Integer32 (0..10000)  
UNITS "hundredths of percent"  
MAX-ACCESS read-only  
STATUS current

DESCRIPTION

"A calculated value for the voltage total harmonic distortion (THD). Method of calculation is not specified. IEC 61850-7-4 attribute 'ThdVol'."

::= { eoACPwrAttributesEntry 12 }

eoACPwrAttributesPhaseTable OBJECT-TYPE

SYNTAX SEQUENCE OF EoACPwrAttributesPhaseEntry  
MAX-ACCESS not-accessible  
STATUS current

DESCRIPTION

"This table describes 3-phase power attributes measurements. It is a sparse extension of the eoACPwrAttributesTable."

::= { powerAttributesMIBObjects 2 }

eoACPwrAttributesPhaseEntry OBJECT-TYPE

SYNTAX EoACPwrAttributesPhaseEntry



MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An entry describes common 3-phase power attributes measurements.

This optional table describes 3-phase power attributes measurements, with three entries for each supported entPhysicalIndex entity. Entities having single phase power shall not have any entities.

This table describes attributes common to both WYE and DEL. Entities having single phase power shall not have any entries here. It is a sparse extension of the eoACPwrAttributesTable.

These attributes correspond to IEC 61850-7.4 MMXU phase measurements."

INDEX { entPhysicalIndex, eoPhaseIndex }

::= { eoACPwrAttributesPhaseTable 1 }

EoACPwrAttributesPhaseEntry ::= SEQUENCE {  
    eoPhaseIndex Integer32,  
    eoACPwrAttributesPhaseAvgCurrent Integer32,  
    eoACPwrAttributesPhaseActivePower Integer32,  
    eoACPwrAttributesPhaseReactivePower Integer32,  
    eoACPwrAttributesPhaseApparentPower Integer32,  
    eoACPwrAttributesPhasePowerFactor Integer32,  
    eoACPwrAttributesPhaseImpedance Integer32  
}

eoPhaseIndex OBJECT-TYPE

SYNTAX Integer32 (0..359)

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"A phase angle typically corresponding to 0, 120, 240."

::= { eoACPwrAttributesPhaseEntry 1 }

eoACPwrAttributesPhaseAvgCurrent OBJECT-TYPE

SYNTAX Integer32

UNITS "Amperes"

MAX-ACCESS read-only

STATUS current  
 DESCRIPTION  
 "A measured value of the current per phase. IEC 61850-7-4 attribute 'A'"  
 ::= { eoACPwrAttributesPhaseEntry 2 }

eoACPwrAttributesPhaseActivePower OBJECT-TYPE

SYNTAX Integer32  
 UNITS " watts"  
 MAX-ACCESS read-only  
 STATUS current  
 DESCRIPTION  
 "A measured value of the actual power delivered to or consumed by the load. IEC 61850-7-4 attribute 'W'"  
 ::= { eoACPwrAttributesPhaseEntry 3 }

eoACPwrAttributesPhaseReactivePower OBJECT-TYPE

SYNTAX Integer32  
 UNITS "volt-amperes reactive"  
 MAX-ACCESS read-only  
 STATUS current  
 DESCRIPTION  
 "A measured value of the reactive portion of the apparent power. IEC 61850-7-4 attribute 'VAR'"  
 ::= { eoACPwrAttributesPhaseEntry 4 }

eoACPwrAttributesPhaseApparentPower OBJECT-TYPE

SYNTAX Integer32  
 UNITS "volt-amperes"  
 MAX-ACCESS read-only  
 STATUS current  
 DESCRIPTION  
 "A measured value of the voltage and current determines the apparent power. Active plus reactive power equals the total apparent power.

Note: Watts and volt-amperes are equivalent units and may be combined. IEC 61850-7-4 attribute 'VA'."

::= { eoACPwrAttributesPhaseEntry 5 }

eoACPwrAttributesPhasePowerFactor OBJECT-TYPE

SYNTAX Integer32 (-10000..10000)  
 UNITS "hundredths of percent"

MAX-ACCESS read-only  
 STATUS current  
 DESCRIPTION  
     "A measured value ratio of the real power flowing to the load versus the apparent power for this phase. IEC 61850-7-4 attribute 'PF'. Power Factor can be positive or negative where the sign should be in lead/lag (IEEE) form."  
 ::= { eoACPwrAttributesPhaseEntry 6 }

eoACPwrAttributesPhaseImpedance OBJECT-TYPE

SYNTAX Integer32  
 UNITS "volt-amperes"  
 MAX-ACCESS read-only  
 STATUS current  
 DESCRIPTION  
     "A measured value of the impedance. IEC 61850-7-4 attribute 'Z'."  
 ::= { eoACPwrAttributesPhaseEntry 7 }

eoACPwrAttributesDelPhaseTable OBJECT-TYPE

SYNTAX SEQUENCE OF EoACPwrAttributesDelPhaseEntry  
 MAX-ACCESS not-accessible  
 STATUS current  
 DESCRIPTION  
     "This table describes DEL configuration phase-to-phase power attributes measurements. This is a sparse extension of the eoACPwrAttributesPhaseTable."  
 ::= { powerAttributesMIBObjects 3 }

eoACPwrAttributesDelPhaseEntry OBJECT-TYPE

SYNTAX EoACPwrAttributesDelPhaseEntry  
 MAX-ACCESS not-accessible  
 STATUS current  
 DESCRIPTION  
     "An entry describes power attributes attributes of a phase in a DEL 3-phase power system. Voltage measurements are provided both relative to each other and zero.  
  
     Measured values are from IEC 61850-7-2 MMUX and THD from MHAI objects.

For phase-to-phase measurements, the eoPhaseIndex is compared against the following phase at +120 degrees. Thus, the possible values are:

eoPhaseIndex	Next Phase Angle
0	120
120	240
240	0

"

```
INDEX { entPhysicalIndex, eoPhaseIndex}
 ::= { eoACPwrAttributesDelPhaseTable 1}
```

```
EoACPwrAttributesDelPhaseEntry ::= SEQUENCE {
    eoACPwrAttributesDelPhaseToNextPhaseVoltage      Integer32,
    eoACPwrAttributesDelThdPhaseToNextPhaseVoltage   Integer32,
    eoACPwrAttributesDelThdCurrent                   Integer32
}
```

eoACPwrAttributesDelPhaseToNextPhaseVoltage OBJECT-TYPE

```
SYNTAX      Integer32
UNITS       "0.1 Volt AC"
MAX-ACCESS  read-only
STATUS      current
```

DESCRIPTION

"A measured value of phase to next phase voltages, where the next phase is IEC 61850-7-4 attribute 'PPV'."

```
::= { eoACPwrAttributesDelPhaseEntry 2 }
```

eoACPwrAttributesDelThdPhaseToNextPhaseVoltage OBJECT-TYPE

```
SYNTAX      Integer32 (0..10000)
UNITS       "hundredths of percent"
MAX-ACCESS  read-only
STATUS      current
```

DESCRIPTION

"A calculated value for the voltage total harmonic distortion for phase to next phase. Method of calculation is not specified. IEC 61850-7-4 attribute 'ThdPPV'."

```
::= { eoACPwrAttributesDelPhaseEntry 3 }
```

eoACPwrAttributesDelThdCurrent OBJECT-TYPE

```
SYNTAX      Integer32 (0..10000)
UNITS       "hundredths of percent"
MAX-ACCESS  read-only
STATUS      current
```

DESCRIPTION

"A calculated value for the voltage total harmonic distortion (THD) for phase to phase. Method of calculation is not specified."

---

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IEC 61850-7-4 attribute 'ThdPPV'.  
::= { eoACPwrAttributesDelPhaseEntry 4 }

eoACPwrAttributesWyePhaseTable OBJECT-TYPE  
SYNTAX SEQUENCE OF EoACPwrAttributesWyePhaseEntry  
MAX-ACCESS not-accessible  
STATUS current  
DESCRIPTION  
"This table describes WYE configuration phase-to-neutral  
power attributes measurements. This is a sparse  
extension of the eoACPwrAttributesPhaseTable."  
::= { powerAttributesMIBObjects 4 }

eoACPwrAttributesWyePhaseEntry OBJECT-TYPE  
SYNTAX EoACPwrAttributesWyePhaseEntry  
MAX-ACCESS not-accessible  
STATUS current  
DESCRIPTION  
"This table describes measurements of WYE configuration  
with phase to neutral power attributes attributes. Three  
entries are required for each supported entPhysicalIndex  
entry. Voltage measurements are relative to neutral.

This is a sparse extension of the  
eoACPwrAttributesPhaseTable.

Each entry describes power attributes attributes of one  
phase of a WYE 3-phase power system.

Measured values are from IEC 61850-7-2 MMUX and THD from  
MHAI objects."

INDEX { entPhysicalIndex, eoPhaseIndex }  
::= { eoACPwrAttributesWyePhaseTable 1}

EoACPwrAttributesWyePhaseEntry ::= SEQUENCE {  
    eoACPwrAttributesWyePhaseToNeutralVoltage Integer32,  
    eoACPwrAttributesWyePhaseCurrent Integer32,  
    eoACPwrAttributesWyeThdPhaseToNeutralVoltage Integer32  
}

eoACPwrAttributesWyePhaseToNeutralVoltage OBJECT-TYPE  
SYNTAX Integer32  
UNITS "0.1 Volt AC"

MAX-ACCESS	read-only
STATUS	current
DESCRIPTION	"A measured value of phase to neutral voltage. IEC 61850-7-4 attribute 'PhV'."

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```
::= { eoACPwrAttributesWyePhaseEntry 1 }
```

eoACPwrAttributesWyePhaseCurrent OBJECT-TYPE

SYNTAX	Integer32
UNITS	"0.1 ampheres AC"
MAX-ACCESS	read-only
STATUS	current
DESCRIPTION	"A measured value of phase currents. IEC 61850-7-4 attribute 'A'."

```
::= { eoACPwrAttributesWyePhaseEntry 2 }
```

eoACPwrAttributesWyeThdPhaseToNeutralVoltage OBJECT-TYPE

SYNTAX	Integer32 (0..10000)
UNITS	"hundredths of percent"
MAX-ACCESS	read-only
STATUS	current
DESCRIPTION	"A calculated value of the voltage total harmonic distortion (THD) for phase to neutral. IEC 61850-7-4 attribute 'ThdPhV'."

```
::= { eoACPwrAttributesWyePhaseEntry 3 }
```

-- Conformance

powerAttributesMIBCompliances OBJECT IDENTIFIER

```
::= { powerAttributesMIB 2 }
```

powerAttributesMIBGroups OBJECT IDENTIFIER

```
::= { powerAttributesMIB 3 }
```

powerAttributesMIBFullCompliance MODULE-COMPLIANCE

STATUS	current
DESCRIPTION	"When this MIB is implemented with support for read-create, then such an implementation can claim full compliance."

Such devices can then be both monitored and configured with this MIB.

Module Compliance of [[RFC6933](#)] with respect to entity4CRCompliance should be supported which requires implementation of 3 MIB objects (entPhysicalIndex, entPhysicalName and entPhysicalUUID)."

MODULE                   -- this module

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---

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```
MANDATORY-GROUPS {  
    powerACPwrAttributesMIBTableGroup  
}
```

```
GROUP           powerACPwrAttributesOptionalMIBTableGroup  
DESCRIPTION  
    "A compliant implementation does not have  
    to implement."
```

```
GROUP           powerACPwrAttributesPhaseMIBTableGroup  
DESCRIPTION  
    "A compliant implementation does not have to  
    implement."
```

```
GROUP           powerACPwrAttributesDelPhaseMIBTableGroup  
DESCRIPTION  
    "A compliant implementation does not have to  
    implement."
```

```
GROUP           powerACPwrAttributesWyePhaseMIBTableGroup  
DESCRIPTION  
    "A compliant implementation does not have to  
    implement."
```

```
::= { powerAttributesMIBCompliances 1 }
```

-- Units of Conformance

```

powerACPwrAttributesMIBTableGroup OBJECT-GROUP
    OBJECTS
        {
            -- Note that object entPhysicalIndex is NOT
            -- included since it is not-accessible

            eoACPwrAttributesAvgVoltage,
            eoACPwrAttributesAvgCurrent,
            eoACPwrAttributesFrequency,
            eoACPwrAttributesPowerUnitMultiplier,
            eoACPwrAttributesPowerAccuracy,
            eoACPwrAttributesTotalActivePower,
            eoACPwrAttributesTotalReactivePower,
            eoACPwrAttributesTotalApparentPower,
            eoACPwrAttributesTotalPowerFactor
        }

```

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STATUS current

DESCRIPTION

"This group contains the collection of all the power  
attributes objects related to the Energy Object."

::= { powerAttributesMIBGroups 1 }

powerACPwrAttributesOptionalMIBTableGroup OBJECT-GROUP

```

OBJECTS
    {
        eoACPwrAttributesConfiguration,
        eoACPwrAttributesThdAmperes,
        eoACPwrAttributesThdVoltage
    }

```

STATUS current

DESCRIPTION

"This group contains the collection of all the power  
attributes objects related to the Energy Object."

::= { powerAttributesMIBGroups 2 }

powerACPwrAttributesPhaseMIBTableGroup OBJECT-GROUP

```

OBJECTS
    {
        -- Note that object entPhysicalIndex is
        -- NOT included since it is
        -- not-accessible
        eoACPwrAttributesPhaseAvgCurrent,
        eoACPwrAttributesPhaseActivePower,
        eoACPwrAttributesPhaseReactivePower,
        eoACPwrAttributesPhaseApparentPower,
    }

```



```

        eoACPwrAttributesPhasePowerFactor,
        eoACPwrAttributesPhaseImpedance
    }
    STATUS          current
    DESCRIPTION
        "This group contains the collection of all 3-phase power
        attributes objects related to the Power State."
    ::= { powerAttributesMIBGroups 3 }

powerACPwrAttributesDelPhaseMIBTableGroup OBJECT-GROUP
    OBJECTS
        {
            -- Note that object entPhysicalIndex and
            -- eoPhaseIndex are NOT included
            -- since they are not-accessible
            eoACPwrAttributesDelPhaseToNextPhaseVoltage ,
            eoACPwrAttributesDelThdPhaseToNextPhaseVoltage,
            eoACPwrAttributesDelThdCurrent
        }
    STATUS          current
    DESCRIPTION

```

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```

        "This group contains the collection of all power
        characteristic attributes of a phase in a DEL 3-phase
        power system."
    ::= { powerAttributesMIBGroups 4 }

powerACPwrAttributesWyePhaseMIBTableGroup OBJECT-GROUP
    OBJECTS
        {
            -- Note that object entPhysicalIndex and
            -- eoPhaseIndex are NOT included
            -- since they are not-accessible
            eoACPwrAttributesWyePhaseToNeutralVoltage,
            eoACPwrAttributesWyePhaseCurrent,
            eoACPwrAttributesWyeThdPhaseToNeutralVoltage
        }
    STATUS          current
    DESCRIPTION
        "This group contains the collection of all WYE
        configuration phase-to-neutral power attributes
        measurements."
    ::= { powerAttributesMIBGroups 5 }

```

END

```

IANA-POWERSTATE-SET-MIB DEFINITIONS ::= BEGIN
    IMPORTS
        MODULE-IDENTITY, mib-2
            FROM SNMPv2-SMI
        TEXTUAL-CONVENTION
            FROM SNMPv2-TC;

    ianaPowerStateSetMIB MODULE-IDENTITY
        LAST-UPDATED "201312130000Z" -- December 13, 2013
        ORGANIZATION "IANA"
        CONTACT-INFO "
            Internet Assigned Numbers Authority
            Postal: ICANN
            4676 Admiralty Way, Suite 330
            Marina del Rey, CA 90292
            Tel: +1-310-823-9358
            EMail: iana@iana.org"

```

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#### DESCRIPTION

"This MIB module defines a TEXTUAL-CONVENTION that describes the relationships between Energy Objects.

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The initial version of this MIB module was published in RFC YYY; for full legal notices see the RFC itself. Supplementary information may be available at <http://www.ietf.org/copyrights/ianamib.html>"

REVISION "201312130000Z" -- December 13, 2013

DESCRIPTION "Initial version of this MIB as published in RFC YYY."

::= { energyMIB 5 }

-- RFC Editor, please replace YYY with the IANA allocation

```
-- for this MIB module and YYY with the number of the
-- approved RFC

-- Textual Conventions
```

```
IANAPowerStateSet ::= TEXTUAL-CONVENTION
    STATUS      current
    DESCRIPTION
```

"IANAPowerState is a textual convention that describes Power State Sets and Power State Set Values an Energy Object supports. IANA has created a registry of Power State supported by an Energy Object and IANA shall administer the list of Power State Sets and Power States.

The textual convention assumes that Power States in a power state set are limited to 255 distinct values. For a Power State Set S, the named number with the value  $S * 256$  is allocated to indicate the Power State set. For a Power State X in the Power State S, the named number with the value  $S * 256 + X + 1$  is allocated to represent the Power State."

#### REFERENCE

"<http://www.iana.org/assignments/eman>

RFC EDITOR NOTE: please change the previous URL if this is not the correct one after IANA assigned it."

```
SYNTAX      INTEGER {
```

```
    other(0),          -- indicates other set
    unknown(255),      -- unknown
```

```
    ieee1621(256), -- indicates IEEE1621 set
    ieee16210n(257),
    ieee16210ff(258),
    ieee1621Sleep(259),
```

```
    dmtf(512),  -- indicates DMTF set
    dmtf0n(513),
    dmtfSleepLight(514),
    dmtfSleepDeep(515),
```

```

    dmtfOffHard(516),
    dmtfOffSoft(517),
    dmtfHibernate(518),
    dmtfPowerOffSoft(519),
    dmtfPowerOffHard(520),
    dmtfMasterBusReset(521),
    dmtfDiagnosticInterrupt(522),
    dmtfOffSoftGraceful(523),
    dmtfOffHardGraceful(524),
    dmtfMasterBusResetGraceful(525),
    dmtfPowerCycleOffSoftGraceful(526),
    dmtfPowerCycleHardGraceful(527),

    eman(1024),          -- indicates EMAN set
    emanmechoff(1025),
    emansoftoff(1026),
    emanhibernate(1027),
    emansleep(1028),
    emanstandby(1029),
    emanready(1030),
    emanlowMinus(1031),
    emanlow(1032),
    emanmediumMinus(1033),
    emanmedium(1034),
    emanhighMinus(1035),
    emanhigh(1036)
}

```

END

## 11. Implementation Status

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[Note to RFC Editor: Please remove this section and the reference to [\[RFC6982\]](#) before publication.]

This section records the status of known implementations of the EMAN-Monitoring MIB at the time of posting of this Internet-Draft, and is based on a proposal described in [\[RFC6982\]](#).

The description of implementations in this section is intended

to assist the IETF in its decision processes in progressing drafts to RFCs.

#### 11.1. SNMP Research

Organization: SNMP Research, Inc.

Maturity: Prototype based upon early drafts of the MIBs. We anticipate updating it to more recent documents as development schedules allow.

Coverage: Code was generated to implement all MIB objects in ENTITY-MIB (Version 4), ENERGY-OBJECT-CONTEXT-MIB, ENERGY-OBJECT-MIB, POWER-ATTRIBUTES-MIB, and BATTERY-MIB.

Implementation experience: The documents are implementable.

Comments: Technical comments about the ENERGY-OBJECT-CONTEXT-MIB, ENERGY-OBJECT-MIB, and BATTERY-MIB were submitted to the EMAN Working Group E-mail list.

Licensing: Proprietary, royalty licensing

Contact: Alan Luchuk, luchuk at snmp.com

URL: <http://www.snmp.com/>

#### 11.2. Cisco Systems

Organization: Cisco Systems, Inc.

Maturity: Prototype based upon early version drafts of the MIBs. We anticipate updating the MIB modules as when the drafts are updated.

Coverage: Code was generated to implement all MIB objects in the ENTITY-MIB (Version 4), and ENERGY-OBJECT-MIB.

Implementation experience: The MIB modules are implemented on Cisco router platforms to measure and report router energy measurements. The documents are implementable.

Licensing: Proprietary

URL: <http://www.cisco.com>

## 12. Security Considerations

Some of the readable objects in these MIB modules (i.e., objects with a MAX-ACCESS other than not-accessible) may be considered sensitive or vulnerable in some network environments. It is thus important to control even GET and/or NOTIFY access to these objects and possibly to even encrypt the values of these objects when sending them over the network via SNMP.

There are a number of management objects defined in these MIB modules with a MAX-ACCESS clause of read-write and/or read-create. Such objects MAY be considered sensitive or vulnerable in some network environments. The support for SET operations in a non-secure environment without proper protection can have a negative effect on network operations. The following are the tables and objects and their sensitivity/vulnerability:

- Unauthorized changes to the eoPowerOperState (via theeoPowerAdminState ) MAY disrupt the power settings of the differentEnergy Objects, and therefore the state of functionality of the respective Energy Objects.
- Unauthorized changes to the eoEnergyParametersTable MAY disrupt energy measurement in the eoEnergyTable table.

SNMP versions prior to SNMPv3 did not include adequate security. Even if the network itself is secure (for example, by using IPsec), there is still no secure control over who on the secure network is allowed to access and GET/SET (read/change/create/delete) the objects in these MIB modules.

It is RECOMMENDED that implementers consider the security features as provided by the SNMPv3 framework (see [\[RFC3410\]](#), [section 8](#)), including full support for the SNMPv3 cryptographic mechanisms (for authentication and privacy).

Further, deployment of SNMP versions prior to SNMPv3 is NOT RECOMMENDED. Instead, it is RECOMMENDED to deploy SNMPv3 and to enable cryptographic security. It is then a customer/operator responsibility to ensure that the SNMP entity giving access to an instance of these MIB modules is properly configured to give access to the objects only to those principals (users) that have legitimate rights to GET or SET (change/create/delete) them.

### [13.](#) IANA Considerations

Additions to the ENERGY-OBJECT-MIB MIB and POWER-ATTRIBUTES-MIB MIB modules are subject to Expert Review [\[RFC5226\]](#), i.e., review by one of a group of experts designated by an IETF Area Director. The group of experts MUST check the requested MIB objects for completeness and accuracy of the description. Requests for MIB objects that duplicate the functionality of existing objects SHOULD be declined. The smallest available OIDs SHOULD be assigned to the new MIB objects. The specification of new MIB objects SHOULD follow the structure specified in [Section 10](#). and MUST be published using a well-established and persistent publication medium.

#### [13.1.](#) IANA Registration of new Power State Set

The initial set of Power State Sets are specified in [\[EMAN-FMWK\]](#). IANA maintains a Textual Convention IANAPowerStateSet with the initial set of Power State Sets and the Power States within those Power State Sets as proposed in the [\[EMAN-FMWK\]](#). The current version of IANAPowerStateSet Textual convention can be accessed <http://www.iana.org/assignments/IANAPowerStateSet>.

New Assignments (and potential deprecation) to Power State Sets shall be administered by IANA and the guidelines and procedures are specified in [\[EMAN-FMWK\]](#), and will, as a consequence, the IANAPowerStateSet Textual Convention should be updated.

##### [13.1.1.](#) IANA Registration of the IEEE1621 Power State Set

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The Internet Assigned Numbers Authority (IANA) has created a new registry for IEEE1621 Power State Set identifiers and filled it with the initial list in the Textual Convention IANAPowerStateSet.

Guidelines for new assignments (or potentially deprecation) for IEEE1621 Power State Set are specified in [[EMAN-FMWK](#)].

#### [13.1.2](#). IANA Registration of the DMTF Power State Set

The Internet Assigned Numbers Authority (IANA) has created a new registry for DMTF Power State Set identifiers and filled it in the Textual Convention IANAPowerStateSet.

Guidelines for new assignments (or potentially deprecation) for DMTF Power State Set are specified in [[EMAN-FMWK](#)].

#### [13.1.3](#). IANA Registration of the EMAN Power State Set

The Internet Assigned Numbers Authority (IANA) has created a new registry for EMAN Power State Set identifiers and filled it in the Textual Convention IANAPowerStateSet.

Guidelines for new assignments (or potentially deprecation) for EMAN Power State Set are specified in [[EMAN-FMWK](#)].

### [14](#). Contributors

This document results from the merger of two initial proposals. The following persons made significant contributions either in one of the initial proposals or in this document.

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### [12](#). Acknowledgment



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## [13.](#) References

### 13.1. Normative References

[RFC2119] S. Bradner, Key words for use in RFCs to Indicate Requirement Levels, [BCP 14](#), [RFC 2119](#), March 1997.

[RFC2578] McCloghrie, K., Ed., Perkins, D., Ed., and J. Schoenwaelder, Ed., "Structure of Management Information Version 2 (SMIv2)", STD 58, [RFC 2578](#), April 1999.

[RFC2579] McCloghrie, K., Ed., Perkins, D., Ed., and J. Schoenwaelder, Ed., "Textual Conventions for SMIv2", STD 58, [RFC 2579](#), April 1999.

[RFC2580] McCloghrie, K., Perkins, D., and J. Schoenwaelder, "Conformance Statements for SMIv2", STD 58, [RFC 2580](#), April 1999.

[RFC3621] Berger, A., and D. Romascanu, "Power Ethernet MIB", [RFC3621](#), December 2003.

[RFC4133] Bierman, A. and K. McCloghrie, "Entity MIB (Version 3)", [RFC 4133](#), August 2005.

[EMAN-AWARE-MIB] J. Parello, B. Claise and M. Chandramoili, "[draft-ietf-eman-energy-aware-mib-11](#)", work in progress, November 2013.

[LLDP-MED-MIB] ANSI/TIA-1057, "The LLDP Management Information Base extension module for TIA-TR41.4 media endpoint discovery information", July 2005.

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---

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## 13.2. Informative References

[RFC1628] S. Bradner, "UPS Management Information Base", [RFC 1628](#), May 1994

[RFC3410] Case, J., Mundy, R., Partain, D., and B. Stewart, "Introduction and Applicability Statements for Internet Standard Management Framework ", [RFC 3410](#), December 2002.

[RFC3418] Presun, R., Case, J., McCloghrie, K., Rose, M, and S. Waldbusser, "Management Information Base (MIB) for the Simple Network Management Protocol (SNMP)", [RFC3418](#), December 2002.

[RFC3433] Bierman, A., Romascanu, D., and K. Norseth, "Entity Sensor Management Information Base", [RFC 3433](#), December 2002.

[RFC4268] Chisholm, S. and D. Perkins, "Entity State MIB", [RFC 4268](#), November 2005.

[RFC5226] Narten, T. Alverstrand, H., A. and K. McCloghrie, "Guidelines for Writing an IANA Considerations Section in RFCs ", [BCP 26](#), [RFC 5226](#), May 2008.

[RFC6933] A. Bierman, D. Romascanu, J. Quittek and M. Chandramouli " Entity MIB (Version 4)", [RFC 6933](#), May 2013.

[RFC6982] Sheffer, Y. and A. Farrel, "Improving Awareness of

Running Code: The Implementation Status Section", [RFC 6982](#), July 2013.

[RFC6988] Quittek, J., Winter, R., Dietz, T., Claise, B., and M. Chandramouli, "Requirements for Energy Management", [RFC 6988](#), September 2013.

[EMAN-FMWK] Parello, J. Claise, B., Schoening, B. and Quittek, J., "Energy Management Framework", [draft-ietf-eman-framework-11](#), October 2013.

[EMAN-AS] Schoening, B., Chandramouli, M. and Nordman, B. "Energy Management (EMAN) Applicability Statement", [draft-ietf-eman-applicability-statement-04](#), October 2013.

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---

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[ACPI] "Advanced Configuration and Power Interface Specification", <http://www.acpi.info/DOWNLOADS/ACPIspec30b.pdf>

[DMTF] "Power State Management Profile DMTF DSP1027 Version 2.0" December 2009  
[http://www.dmtf.org/sites/default/files/standards/documents/DSP1027\\_2.0.0.pdf](http://www.dmtf.org/sites/default/files/standards/documents/DSP1027_2.0.0.pdf)

[IEEE1621] "Standard for User Interface Elements in Power Control of Electronic Devices Employed in Office/Consumer Environments", IEEE 1621, December 2004.

[IEC.61850-7-4] International Electrotechnical Commission, "Communication networks and systems for power utility automation Part 7-4: Basic communication structure Compatible logical node classes and data object classes", 2010.

[IEC.62053-21] International Electrotechnical Commission, "Electricity metering equipment (a.c.) Particular requirements Part 22: Static meters for active energy (classes 1 and 2)", 2003.

[IEC.62053-22] International Electrotechnical Commission, "Electricity metering equipment (a.c.) Particular

requirements Part 22: Static meters for active energy  
(classes 0,2 S and 0,5 S)", 2003.

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