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Energy Object Context MIB

Abstract

This document defines a subset of a Management Information Base (MIB) for energy management of devices. The module addresses device identification, context information, and the energy relationships between devices.

Status of This Memo

This is an Internet Standards Track document.

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1. Introduction

The Energy Management (EMAN) standards provide a specification for Energy Management. This document defines a subset of a Management Information Base (MIB) for use with network management protocols for Energy monitoring of network devices and devices attached to the network and possibly extending to devices in the industrial automation setting with a network interface.

The focus of the MIB module specified in this document is on the identification of Energy Objects and reporting the context and relationships of Energy Objects as defined in [RFC7326]. The module addresses Energy Object identification, Energy Object context, and Energy Object relationships.

1.1. Energy Management Document Overview

This document specifies the Energy Object Context (ENERGY-OBJECT-CONTEXT-MIB) and IANA Energy Relationship (IANA-ENERGY-RELATION-MIB) modules. The Energy Object Context MIB module specifies MIB objects for identification of Energy Objects, and reporting context and relationship of an Energy Object. The IANA Energy Relationship MIB module specifies the first version of the IANA-maintained definitions of relationships between Energy Objects.

Firstly, to illustrate the importance of energy monitoring in networks and, secondly, to list some of the important areas to be addressed by the Energy Management Framework [RFC7326], several use cases and network scenarios are presented in the EMAN applicability statement document [EMAN-AS]. In addition, for each scenario, the target devices for energy management, and how those devices powered and metered are also presented. To address the network scenarios, requirements for power and energy monitoring for networking devices are specified in [RFC6988]. Based on the requirements in [RFC6988], [RFC7326] presents a solution approach.

Accordingly, the scope of the MIB modules in this document is in accordance to the requirements specified in [RFC6988] and the concepts from [RFC7326].

This document is based on the Energy Management Framework [RFC7326] and meets the requirements on identification of Energy Objects and their context and relationships as specified in the Energy Management requirements document [RFC6988].

A second MIB module meeting the EMAN requirements [RFC6988] the Monitoring and Control MIB for Power and Energy [RFC7460], monitors the Energy Objects for Power States, for the Power and Energy consumption. Power State monitoring includes: retrieving Power States, Power State properties, current Power State, Power State transitions, and Power State statistics. In addition, this MIB module provides the Power Characteristics properties of the Power and Energy, along with optional characteristics.

The applicability statement document [EMAN-AS] provides the list of use cases, describes the common aspects between existing Energy standards and the EMAN standard, and shows how the EMAN framework relates to other frameworks.

1.2. 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 [RFC2119].

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 with SMIv2, which is described in STD 58, RFC 2578 [RFC2578], STD 58, RFC 2579 [RFC2579] and STD 58, RFC 2580 [RFC2580].

3. Terminology

Please refer to [RFC7326] for the definitions of the following terminology used in this document.

Energy Management
Energy Management System (EnMS)
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

4. Architecture Concepts Applied to the MIB Module

This section describes the basic concepts specified in the Energy Management Framework [RFC7326], with specific information related to the MIB modules specified in this document.

The Energy Object Context (ENERGY-OBJECT-CONTEXT-MIB) MIB module in this document specifies MIB objects for the identification of Energy Objects and reporting context and relationship of an Energy Object. The managed objects are contained in two tables: eoTable and eoRelationTable.

The first table, eoTable, focuses on the link to the other MIB modules, on identification, and on the context of the Energy Object. The second table, eoRelationTable, specifies the relationships between Energy Objects. This is a simplified representation of the relationship between Energy Objects.

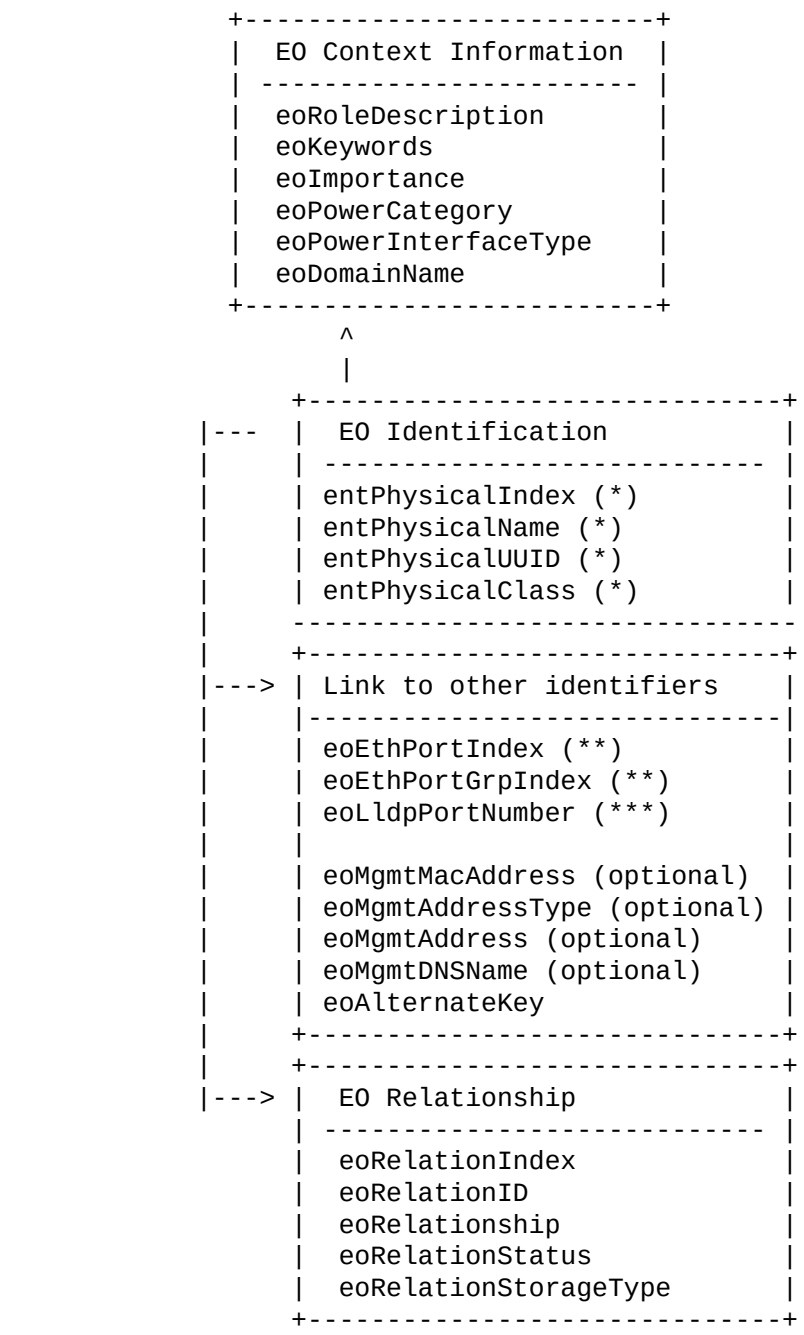
A "smidump-style" tree presentation of the MIB modules contained in the document is presented. The meaning of the three symbols in is a compressed representation of the object's MAX-ACCESS clause, which may have the following values:

```
    "not-accessible"->"---"
    "accessible-for-notify"->"--n"
    "read-only"->"r-n"
    "read-write"->"rwn"
```

```
+- eoTable(1)
   |
   +- eoEntry(1) [entPhysicalIndex]
      |
      +-- r-n PethPsePortIndexOrZero       eoEthPortIndex(1)
      +-- r-n PethPsePortGroupIndexOrZero  eoEthPortGrpIndex(2)
      +-- r-n LldpPortNumberOrZero         eoLldpPortNumber(3)
      +-- rwn MacAddress                   eoMgmtMacAddress(4)
      +-- r-n InetAddressType              eoMgmtAddressType(5)
      +-- r-n InetAddress                  eoMgmtAddress(6)
      +-- r-n OCTET STRING                 eoMgmtDNSName(7)
      +-- rwn SnmpAdminString              eoDomainName(8)
      +-- rwn SnmpAdminString              eoRoleDescription(9)
      +-- rwn EnergyObjectKeywordList      eoKeywords(10)
      +-- rwn Integer32                    eoImportance(11)
      +-- r-n INTEGER                      eoPowerCategory(12)
      +-- rwn SnmpAdminString              eoAlternateKey(13)
      +-- r-n INTEGER                      eoPowerInterfaceType(14)
```

```
+- eoRelationTable(2)
   |
   +- eoRelationEntry(1) [entPhysicalIndex, eoRelationIndex]
      |
      +-- --n Integer32                   eoRelationIndex(1)
      +-- rwn UUIDorZero                  eoRelationID(2)
      +-- rwn IANAEnergyRelationship      eoRelationship(3)
      +-- rwn RowStatus                   eoRelationStatus(4)
      +-- rwn StorageType                 eoRelationStorageType(5)
```

The following Unified Modeling Language (UML) diagram illustrates the relationship of the MIB objects in the eoTable, eoRelationTable, and ENTITY-MIB. The MIB objects describe the identity, context, and relationship of an Energy Object. The UML diagram, furthermore, contains objects from the ENTITY-MIB [RFC6933].



(*) Compliance with entity4CRCompliance ENTITY-MIB [RFC6933]
(**) Link with the Power over Ethernet MIB [RFC3621]
(***) Link with LLDP MIBs [LLDP-MIB] [LLDP-MED-MIB]

Figure 1: MIB Objects Grouping

As displayed in Figure 1, the MIB objects can be classified in different logical grouping of MIB objects.

1) The Energy Object Identification. See Section 5.1 "Energy Object Identification". Devices and their sub-components are characterized by the power-related attributes of a physical entity present in the ENTITY-MIB [RFC6933].

2) The Context Information. See Section 4.1 "Energy Object Context".

3) The links to other MIB modules. See Section 4.3 "Links to Other Identifiers".

4) The Energy Object Relationships specific information. See Section 4.4 "Energy Object Relationships".

5) The Energy Object Identity Persistence. See Section 4.5 "Energy Object Identity Persistence".

4.1. Energy Object Identification

Refer to the "Identification" section in [RFC7326] for background information about Energy Objects.

Every Energy Object MUST implement the unique index, entPhysicalIndex, entPhysicalName, entPhysicalClass, and entPhysicalUUID from the ENTITY-MIB [RFC6933]. Module Compliance with respect to entity4CRCompliance of ENTITY-MIB MUST be supported, which requires a limited number of objects supported (entPhysicalIndex, entPhysicalName, entPhysicalClass, and entPhysicalUUID). entPhysicalIndex is used as index for the Energy Object in the ENERGY-OBJECT-CONTEXT-MIB module. Every Energy Object MUST have a printable name assigned to it. Energy Objects MUST implement the entPhysicalName object specified in the ENTITY-MIB [RFC6933], which must contain the Energy Object name.

For the ENERGY-OBJECT-CONTEXT-MIB compliance, every Energy Object instance MUST implement the entPhysicalUUID from the ENTITY-MIB [RFC6933].

As displayed in [RFC4122], the following is an example of the string representation of a Universally Unique Identifier (UUID) as a URN: urn:uuid:f81d4fae-7dec-11d0-a765-00a0c91e6bf6.

For example, to understand the relationship between Energy Object Components and Energy Objects, the ENTITY-MIB physical containment tree [RFC6933] MUST be implemented.

A second example deals with one of the ENTITY-MIB extensions: if the Energy Object temperature is required, the managed objects from the ENTITY-SENSOR-MIB [RFC3433] should be supported.

Each Energy Object MUST belong to a single Energy Management Domain or in other words, an Energy Object cannot belong to more than one Energy Management Domain. Refer to the "Context: Domain" section in [RFC7326] for background information. The eoDomainName, which is an element of the eoTable, is a read-write MIB object. The Energy Management Domain should map 1:1 with a metered or sub-metered portion of the network. The Energy Management Domain MUST be configured on the Energy Object. The Energy Object MAY inherit some of the domain parameters (possibly domain name, some of the context information such as role or keywords, importance) from the Energy Object or the Energy Management Domain MAY be configured directly in an Energy Object.

When an Energy Object acts as a Power Aggregator, the Energy Objects for which Power should be aggregated MUST be members of the same Energy Management Domain, specified by the eoDomainName MIB Object.

4.2. Energy Object Context

Refer to the "Context: Domain" section in [RFC7326] for background information.

An Energy Object must provide a value for eoImportance in the range of 1-100 to help differentiate the use or relative value of the device. The importance range is from 1 (least important) to 100 (most important). The default importance value is 1.

An Energy Object can provide a set of eoKeywords. These keywords are a list of tags that can be used for grouping and summary reporting within or between Energy Management Domains.

An Energy Object can have Power Interfaces and those interfaces can be classified as Power Inlet, Power Outlet, or both.

An Energy Object can be classified based on the physical properties of the Energy Object. That Energy Object can be classified as consuming power or supplying power to other devices or that Energy Object can perform both of those functions and finally, an Energy Object can be a passive meter.

Additionally, an Energy Object can provide an eoRoleDescription string that indicates the purpose the Energy Object serves in the network.

4.3. Links to Other Identifiers

While the entPhysicalIndex is the primary index for all MIB objects in the ENERGY-OBJECT-CONTEXT-MIB module, the Energy Management Systems (EnMS) must be able to make the link with the identifier(s) in other supported MIB modules.

If the Energy Object is a Power over Ethernet (PoE) port, and if the Power over Ethernet MIB [RFC3621] is supported by the SNMP agent managing the Energy Object, then the Energy Objects eoethPortIndex and eoethPortGrpIndex MUST contain the corresponding values of pethPsePortIndex and pethPsePortGroupIndex [RFC3621].

If the LLDP-MED MIB [LLDP-MIB] is supported by the Energy Object SNMP agent, then the Energy Object eoLldpPortNumber MUST contain the corresponding lldpLocPortNum from the LLDP MIB.

The intent behind the links to the other MIB module identifier(s) is to correlate the instances in the different MIB modules. This will allow the ENERGY-OBJECT-CONTEXT-MIB module to reference other MIB modules in cases where the Power over Ethernet and the LLDP MIB modules are supported by the SNMP agent. Some use cases may not implement either of these two MIB modules for the Energy Objects. However, in situations where either of these two MIB modules are implemented, the EnMS must be able to correlate the instances in the different MIB modules.

The eoAlternateKey object specifies an alternate key string that can be used to identify the Energy Object. Since an EnMS may need to correlate objects across management systems, this alternate key is provided to facilitate such a link. This optional value is intended as a foreign key or alternate identifier for a manufacturer or EnMS to use to correlate the unique Energy Object Id in other systems or namespaces. If an alternate key is not available or is not applicable, then the value is the zero-length string.

An Energy Object can have additional MIB objects that can be used for easier identification by the EnMS. The optional objects eoMgmtMacAddress, eoMgmtAddressType, and eoMgmtDNSName can be used to help identify the relationship between the Energy Objects and other NMS objects. These objects can be used as an alternate key to help link the Energy Object with other keyed information that may be stored within the EnMS(s). For the optional objects that may not be included in some vendor implementations, the expected behavior when those objects are polled is a response noSuchInstance.

4.4. Energy Object Relationships

Refer to the "Relationships" section in [RFC7326] for the definition and background information. In order to link two Energy Objects, a separate table (eoRelationTable) has been introduced in this MIB module.

Each Energy Object can have one or more Energy Object relationships with other Energy Objects. The relationship between Energy Objects is specified in eoRelationTable. The relationship between the Energy Objects is specified with the entPhysicalIndex of the Energy Object and the UUID of the remote Energy Object. The UUID MUST comply to the RFC 4122 specifications. It is important to note that it is possible that an Energy Object may not have an Energy Object relationship with other Energy Objects.

The following relationships between Energy Objects have been considered in the eoRelationTable.

```
Metering Relationship     -> meteredBy / metering

Power Source Relationship -> poweredBy / powering

Aggregation Relationship  -> aggregatedBy / aggregating
```

Energy Object B has a "meteredBy" relationship with Energy Object A, if the energy consumption of Energy Object B is measured by Energy Object A. Equivalently, it is possible to indicate that Energy Object A has a "metering" relationship with Energy Object B.

Energy Object B has a "poweredBy" relationship with Energy Object A, if the power source of Energy Object B is Energy Object A. Equivalently, it is possible to indicate that Energy Object A has a "powering" relationship with Energy Object B.

Energy Object B has "aggregatedBy" relationship with Energy Object A, if Energy Object A is an aggregation point for energy usage of Energy Object B. Equivalently, it is possible to indicate that Energy Object A has "aggregating" relationship with Energy Object B.

The IANA-ENERGY-RELATION-MIB module in Section 5 below specifies the first version of the IANA-maintained definitions of relationships. This way, for Energy Relationships, new textual conventions can be specified, without updating the primary Energy Object Context MIB module.

4.5. Energy Object Identity Persistence

In some situations, the Energy Object identity information should be persistent even after a device reload. For example, in a static setup where a switch monitors a series of connected PoE phones, there is a clear benefit for the EnMS if the Energy Object Identification and all associated information persist, as it saves a network discovery. However, in other situations, such as a wireless access point monitoring the mobile user PCs, there is not much advantage to persist the Energy Object Information. The identity information of an Energy Object should be persisted and there is value in the writable MIB objects persisted.

5. MIB Definitions

```
-- ************************************************************
--
--
-- This MIB is used for describing the identity and the
-- context information of Energy Objects in network
--
--
-- ************************************************************

ENERGY-OBJECT-CONTEXT-MIB DEFINITIONS ::= BEGIN

IMPORTS
    MODULE-IDENTITY,
    OBJECT-TYPE,
    mib-2, Integer32
        FROM SNMPv2-SMI                              -- RFC 2578
    TEXTUAL-CONVENTION, MacAddress, TruthValue,
       RowStatus, StorageType
        FROM SNMPv2-TC                               -- RFC 2579
    MODULE-COMPLIANCE,  OBJECT-GROUP
        FROM SNMPv2-CONF                             -- RFC 2580
    SnmpAdminString
        FROM SNMP-FRAMEWORK-MIB                      -- RFC 3411
    InetAddressType, InetAddress
       FROM INET-ADDRESS-MIB                         -- RFC 4001
    entPhysicalIndex
       FROM ENTITY-MIB                               -- RFC 6933
    UUIDorZero
       FROM UUID-TC-MIB                              -- RFC 6933
    IANAEnergyRelationship
       FROM IANA-ENERGY-RELATION-MIB;
```

```
   energyObjectContextMIB MODULE-IDENTITY
       LAST-UPDATED    "201502090000Z"

       ORGANIZATION    "IETF EMAN Working Group"
       CONTACT-INFO
          "WG Charter:
           http://datatracker.ietf.org/wg/eman/charter/

          Mailing Lists:
           General Discussion: eman@ietf.org
           To Subscribe: https://www.ietf.org/mailman/listinfo/eman
           Archive: http://www.ietf.org/mail-archive/web/eman

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       DESCRIPTION
          "Copyright (c) 2015 IETF Trust and the persons identified as
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           (http://trustee.ietf.org/license-info).
```

```
            This MIB is used for describing the identity and the
            context information of Energy Objects."
        REVISION
            "201502090000Z"
        DESCRIPTION
           "Initial version, published as RFC 7461."

       ::= { mib-2 231 }

   energyObjectContextMIBNotifs OBJECT IDENTIFIER
       ::= { energyObjectContextMIB 0 }

   energyObjectContextMIBObjects OBJECT IDENTIFIER
       ::= { energyObjectContextMIB 1 }

   energyObjectContextMIBConform  OBJECT IDENTIFIER
       ::= { energyObjectContextMIB 2 }

   -- Textual Conventions

   PethPsePortIndexOrZero ::= TEXTUAL-CONVENTION
      DISPLAY-HINT "d"
      STATUS            current
      DESCRIPTION
          "This textual convention is an extension of the
          pethPsePortIndex convention, which defines a greater-
          than-zero value used to identify a power Ethernet Power
          Sourcing Equipment (PSE) port.

          This extension permits the additional value of zero.  The
          semantics of the value zero are object-specific and must,
          therefore, be defined as part of the description of any
          object that uses this syntax.  Examples of the usage of
          this extension are situations where none or all physical
          entities need to be referenced."
      SYNTAX Integer32 (0..2147483647)

   PethPsePortGroupIndexOrZero ::= TEXTUAL-CONVENTION
       DISPLAY-HINT "d"
       STATUS            current
       DESCRIPTION
           "This textual convention is an extension of the
           pethPsePortGroupIndex convention from the Power Over
           Ethernet MIB in RFC 3621, which defines a greater-than-zero
           value used to identify the group containing the port to which
           a power Ethernet PSE is connected.  This extension
           permits the additional value of zero.  The semantics of
           the value zero are object-specific and must, therefore,
```

```
          be defined as part of the description of any object that
          uses this syntax.  Examples of the usage of this
          extension are situations where none or all physical
          entities need to be referenced."
       SYNTAX Integer32 (0..2147483647)

   LldpPortNumberOrZero ::= TEXTUAL-CONVENTION
        DISPLAY-HINT "d"
        STATUS     current
        DESCRIPTION
           "This textual convention is an extension of the
           LldpPortNumber convention specified in the LLDP MIB,
           which defines a greater than zero value used to uniquely
           identify each port contained in the chassis (that is
           known to the LLDP agent) by a port number.  This
           extension permits the additional value of zero.  The
           semantics of the value zero are object-specific and must,
           therefore, be defined as part of the description of any
           object that uses this syntax.  Examples of the usage of
           this extension are situations where none or all physical
           entities need to be referenced."
      SYNTAX Integer32(0..4096)

    EnergyObjectKeywordList ::= TEXTUAL-CONVENTION
       STATUS          current
       DESCRIPTION
           "A list of keywords that can be used to group Energy
           Objects for reporting or searching.  If multiple keywords
           are present, then this string will contain all the
           keywords separated by the ',' character.  All alphanumeric
           characters and symbols (other than a comma), such as #,
           (, $, !, and &, are allowed.  White spaces before and
           after the commas are ignored, as well as within a keyword
           itself.

           For example, if an Energy Object were to be tagged with
           the keyword values 'hospitality' and 'guest', then the
           keyword list will be 'hospitality,guest'."
       SYNTAX OCTET STRING (SIZE (0..2048))

    -- Objects

    eoTable OBJECT-TYPE
        SYNTAX          SEQUENCE OF EoEntry
        MAX-ACCESS      not-accessible
        STATUS          current
        DESCRIPTION
           "This table lists Energy Objects."
```

```
        ::= { energyObjectContextMIBObjects 1 }

    eoEntry OBJECT-TYPE
        SYNTAX          EoEntry
        MAX-ACCESS      not-accessible
        STATUS          current
        DESCRIPTION
           "An entry describes the attributes of an Energy Object.
           Whenever a new Energy Object is added or an existing
           Energy Object is deleted, a row in the eoTable is added
           or deleted."

         INDEX      {entPhysicalIndex }
        ::= { eoTable 1 }

    EoEntry ::= SEQUENCE {
            eoEthPortIndex              PethPsePortIndexOrZero,
            eoEthPortGrpIndex           PethPsePortGroupIndexOrZero,
            eoLldpPortNumber            LldpPortNumberOrZero,
            eoMgmtMacAddress            MacAddress,
            eoMgmtAddressType           InetAddressType,
            eoMgmtAddress               InetAddress,
            eoMgmtDNSName               OCTET STRING,
            eoDomainName                SnmpAdminString,
            eoRoleDescription           SnmpAdminString,
            eoKeywords                  EnergyObjectKeywordList,
            eoImportance                Integer32,
            eoPowerCategory             INTEGER,
            eoAlternateKey              SnmpAdminString,
            eoPowerInterfaceType        INTEGER
           }

    eoEthPortIndex   OBJECT-TYPE
        SYNTAX      PethPsePortIndexOrZero
        MAX-ACCESS   read-only
        STATUS       current
        DESCRIPTION
           "This variable uniquely identifies the power Ethernet
           port to which a Power over Ethernet device is connected.
           If the Power over Ethernet MIB in RFC 3621 is supported by
           the SNMP agent managing the Energy Object, then the
           Energy Object eoethPortIndex MUST contain the
           corresponding value of pethPsePortIndex.  If such a power
           Ethernet port cannot be specified or is not known, then
           the object is zero."
        REFERENCE
           "RFC 3621: Power Ethernet MIB"
        DEFVAL { 0 }
```

```
        ::= { eoEntry 1 }

    eoEthPortGrpIndex   OBJECT-TYPE
        SYNTAX      PethPsePortGroupIndexOrZero
        MAX-ACCESS   read-only
        STATUS       current
        DESCRIPTION
           "This variable uniquely identifies the group containing
           the port to which a power over Ethernet device PSE is
           connected (RFC 3621).  If the Power over Ethernet MIB (RFC
           3621) is supported by the SNMP agent managing the Energy
           Object, then the Energy Object eoEthPortGrpIndex MUST
           contain the corresponding value of eoethPortGrpIndex.  If
           such a power Ethernet port cannot be specified or is not
           known, then the object is zero."
        REFERENCE
           "RFC 3621: Power Ethernet MIB"
        DEFVAL { 0 }
        ::= { eoEntry 2 }

    eoLldpPortNumber   OBJECT-TYPE
        SYNTAX      LldpPortNumberOrZero
        MAX-ACCESS   read-only
        STATUS       current
        DESCRIPTION
           "This variable uniquely identifies the port component
           (contained in the local chassis with the LLDP agent) as
           defined by the lldpLocPortNum in the LLDP-MIB and
           LLDP-MED-MIB.  If the LLDP-MIB is supported by the
           SNMP agent managing the Energy Object, then the Energy
           Object eoLldpPortNumber MUST contain the corresponding
           value of lldpLocPortNum from the LLDP-MIB.  If such a
           port number cannot be specified or is not known, then the
           object is zero."
        REFERENCE
           "LLDP MIB, IEEE 802.1AB-2005; LLDP-MED-MIB, ANSI/TIA-1057"
        DEFVAL { 0 }

        ::= { eoEntry 3 }

    eoMgmtMacAddress OBJECT-TYPE
        SYNTAX          MacAddress
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
           "This object specifies a Media Access Control (MAC) address
           of the Energy Object."
        ::= { eoEntry 4  }
```

```
    eoMgmtAddressType OBJECT-TYPE
        SYNTAX          InetAddressType
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
           "This object specifies the eoMgmtAddress type, i.e., an
           IPv4 or IPv6 address.  This object MUST be
           populated when eoMgmtAddress is populated."
        ::= { eoEntry 5  }

    eoMgmtAddress OBJECT-TYPE
        SYNTAX          InetAddress
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
           "This object specifies the management address as an IPv4
           address or IPv6 address of Energy Object.  The IP address
           type, i.e. IPv4 or IPv6, is determined by the
           eoMgmtAddressType value.  This object can be used as an
           alternate key to help link the Energy Object with other
           keyed information that may be stored within the EnMS(s)."
        ::= { eoEntry 6  }

    eoMgmtDNSName OBJECT-TYPE
        SYNTAX          OCTET STRING
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
           "This object specifies a DNS name of the eoMgmtAddress.
           This object can be used as an alternate key to help link
           the Energy Object with other keyed information that may
           be stored within the EnMS(s).  A DNS Name must always be a
           fully qualified name.  This MIB uses the same encoding as
           the DNS protocol."
         REFERENCE
           "RFC 1034: Domain names - concepts and facilities,
            Section 3.1."
        ::= { eoEntry 7  }

    eoDomainName OBJECT-TYPE
        SYNTAX          SnmpAdminString
        MAX-ACCESS      read-write
        STATUS          current
        DESCRIPTION
           "This object specifies the name of an Energy Management
           Domain for the Energy Object.  By default, this object
           should be an empty string.  The value of eoDomainName must
           remain constant at least from one re-initialization of
```

```
            the entity local management system to the next re-
            initialization."
        ::= { eoEntry 8   }

    eoRoleDescription OBJECT-TYPE
        SYNTAX          SnmpAdminString
        MAX-ACCESS      read-write
        STATUS          current
        DESCRIPTION
            "This object specifies an administratively assigned name
            to indicate the purpose an Energy Object serves in the
            network.

            For example, we can have a phone deployed to a lobby with
            eoRoleDescription as 'Lobby phone'.

            This object specifies that the value is the zero-length
            string value if no role description is configured.
            The value of eoRoleDescription must remain constant at
            least from one re-initialization of the entity local
            management system to the next re-initialization."
        ::= { eoEntry 9   }

    eoKeywords OBJECT-TYPE
        SYNTAX          EnergyObjectKeywordList
        MAX-ACCESS      read-write
        STATUS          current
        DESCRIPTION
            "This object specifies a list of keywords that can be
            used to group Energy Objects for reporting or searching.
            The value is the zero-length string if no keywords have
            been configured.  If multiple keywords are present, then
            this string will contain all the keywords separated by
            the ',' character.  For example, if an Energy Object were
            to be tagged with the keyword values 'hospitality' and
            'guest', then the keyword list will be
            'hospitality,guest'.

            If write access is implemented and a value is written
            into the instance, the agent must retain the supplied
            value in the eoKeywords instance associated with
            the same physical entity for as long as that entity
            remains instantiated.  This includes instantiations
            across all re-initializations/reboots of the local
            management agent."
        ::= { eoEntry 10     }

    eoImportance OBJECT-TYPE
```

```
        SYNTAX          Integer32 (1..100)
        MAX-ACCESS      read-write
        STATUS          current
        DESCRIPTION
           "This object specifies a ranking of how important the
           Energy Object is (on a scale of 1 to 100) compared with
           other Energy Objects in the same Energy Management
           Domain.  The ranking should provide a business or
           operational context for the Energy Object as compared to
           other similar Energy Objects.  This ranking could be used
           as input for policy-based network management.

           Although network managers must establish their own
           ranking, the following is a broad recommendation:

           90 to 100 Emergency response
           80 to 89  Executive or business critical
           70 to 79  General or average
           60 to 69  Staff or support
           40 to 59  Public or guest
            1 to 39  Decorative or hospitality

           The value of eoImportance must remain constant at least
           from one re-initialization of the Energy Object local
           management system to the next re-initialization."
        DEFVAL          { 1 }
        ::= { eoEntry 11   }

    eoPowerCategory OBJECT-TYPE
        SYNTAX          INTEGER {
                            consumer(0),
                            producer(1),
                            meter(2),
                            distributor(3),
                            store(4)
                        }
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION
           "This object describes the Energy Object category, which
           indicates the expected behavior or physical property of
           the Energy Object, based on its design.  An Energy Object
           can be a consumer(0), producer(1), meter(2),
           distributor(3), or store(4).

           In some cases, a meter is required to measure the power
           consumption.  In such a case, this meter Energy Object
           category is meter(2).  If a device is distributing
```

```
           electric Energy, the category of the Energy Object is
           distributor (3).  If a device is storing electric Energy,
           the category of the device can be store (4)."
       ::= { eoEntry 12    }

   eoAlternateKey OBJECT-TYPE
       SYNTAX          SnmpAdminString
       MAX-ACCESS      read-write
       STATUS          current
       DESCRIPTION
          "The eoAlternateKey object specifies an alternate key
          string that can be used to identify the Energy Object.
          Since Energy Management Systems (EnMS) and Network
          Management Systems (NMSs) may need to correlate objects
          across management systems, this alternate key is provided
          to provide such a link.  This optional value is intended
          as a foreign key or alternate identifier for a
          manufacturer or EnMS/NMS to use to correlate the unique
          Energy Object Id in other systems or namespaces.  If an
          alternate key is not available or is not applicable, then
          the value is the zero-length string.
          The value of eoAlternateKey must remain constant at
          least from one re-initialization of the entity local
          management system to the next re-initialization."
       ::= { eoEntry 13 }

   eoPowerInterfaceType            OBJECT-TYPE
       SYNTAX          INTEGER {
                           inlet(0),
                           outlet(1),
                           both(2)
                       }
       MAX-ACCESS      read-only
       STATUS          current
       DESCRIPTION
          "This object describes the Power Interface for an Energy
          Object.  A Power Interface is an interface at which an
          Energy Object is connected to a power transmission
          medium, at which it can in turn receive power, provide
          power, or both.  A Power Interface type can be an inlet(0),
          an outlet(1), or both(2), respectively."
       ::= { eoEntry 14 }

   eoRelationTable OBJECT-TYPE
       SYNTAX          SEQUENCE OF EoRelationEntry
       MAX-ACCESS      not-accessible
       STATUS          current
       DESCRIPTION
```

```
            "This table describes the relationships between Energy
            Objects."
        ::= { energyObjectContextMIBObjects 2 }

    eoRelationEntry OBJECT-TYPE
        SYNTAX          EoRelationEntry
        MAX-ACCESS      not-accessible
        STATUS          current
        DESCRIPTION
            "An entry in this table specifies the Energy relationship
            between Energy objects.  Energy relations between two
            Energy objects are defined in RFC 7326."
        REFERENCE
            " RFC 7326: Energy Management Framework"
        INDEX        { entPhysicalIndex, eoRelationIndex }
        ::= { eoRelationTable 1 }

    EoRelationEntry ::= SEQUENCE {
                   eoRelationIndex        Integer32,
                   eoRelationID           UUIDorZero,
                   eoRelationship         IANAEnergyRelationship,
                   eoRelationStatus       RowStatus,
                   eoRelationStorageType  StorageType
                  }

    eoRelationIndex     OBJECT-TYPE
        SYNTAX          Integer32 (0..2147483647)
        MAX-ACCESS      not-accessible
        STATUS          current
        DESCRIPTION
            "This object is an arbitrary index to identify the Energy
            Object related to another Energy Object."
        ::= { eoRelationEntry 1 }

    eoRelationID        OBJECT-TYPE
        SYNTAX          UUIDorZero
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION
            "This object specifies the Universally Unique Identifier
            (UUID) of the peer (other) Energy Object.  The UUID must
            comply with the specifications of UUID in UUID-TC-MIB.

            If the UUID of the Energy Object is unknown or nonexistent,
            the eoRelationID will be set to a zero-length string
            instead.  It is preferable that the value of
            entPhysicalUUID from ENTITY-MIB is used for values for
            this object."
```

```
     REFERENCE
           "RFC 6933: Entity MIB (Version 4)"
        ::= { eoRelationEntry 2 }

    eoRelationship      OBJECT-TYPE
        SYNTAX          IANAEnergyRelationship
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION
           "This object describes the relations between Energy
           Objects.  For each Energy Object, the relations between
           the other Energy Objects are specified using the bitmap."
        ::= { eoRelationEntry 3 }

    eoRelationStatus OBJECT-TYPE
        SYNTAX          RowStatus
        MAX-ACCESS      read-create
        STATUS          current
        DESCRIPTION
         "The status controls and reflects the creation and
          activation status of a row in this table to specify energy
          relationship between Energy Objects.

         An entry status may not be active(1) unless all objects in
         the entry have the appropriate values.

         No attempt to modify a row columnar object instance value
         in the eoRelationTable should be issued while the value of
         eoRelationStatus is active(1).  The data can be destroyed by
         setting up the eoRelationStatus to destroy(2)."

    ::= { eoRelationEntry 4 }

     eoRelationStorageType OBJECT-TYPE
       SYNTAX          StorageType
       MAX-ACCESS      read-create
       STATUS          current
       DESCRIPTION
        "This variable indicates the storage type for this row."
           DEFVAL { nonVolatile }
     ::= {eoRelationEntry 5 }

    -- Conformance

    energyObjectContextMIBCompliances  OBJECT IDENTIFIER
        ::= { energyObjectContextMIBConform 1   }

    energyObjectContextMIBGroups  OBJECT IDENTIFIER
```

```
        ::= { energyObjectContextMIBConform 2   }

    energyObjectContextMIBFullCompliance MODULE-COMPLIANCE
        STATUS          current
        DESCRIPTION
            "When this MIB is implemented with support for
            read-write, then such an implementation can
            claim full compliance.  Such devices can then
            be both monitored and configured with this MIB.
            Module Compliance of ENTITY-MIB with respect to
            entity4CRCompliance MUST be supported."

        MODULE          -- this module
        MANDATORY-GROUPS {
                    energyObjectContextMIBTableGroup,
                    energyObjectRelationTableGroup
                         }

        GROUP     energyObjectOptionalMIBTableGroup
                  DESCRIPTION
                  "A compliant implementation does not have to
                  implement."
        ::= { energyObjectContextMIBCompliances 1 }

    energyObjectContextMIBReadOnlyCompliance MODULE-COMPLIANCE
        STATUS          current
        DESCRIPTION
            "When this MIB is implemented without support for
            read-write (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 ENTITY-MIB with respect to
            entity4CRCompliance MUST be supported."
        MODULE          -- this module

        MANDATORY-GROUPS {
                     energyObjectContextMIBTableGroup,
                     energyObjectRelationTableGroup
                         }

       GROUP energyObjectOptionalMIBTableGroup
          DESCRIPTION
          "A compliant implementation does not have to implement
           the managed objects in this GROUP."

       ::= { energyObjectContextMIBCompliances 2 }
```

```
    -- Units of Conformance
    energyObjectContextMIBTableGroup OBJECT-GROUP
        OBJECTS         {
                            eoDomainName,
                            eoRoleDescription,
                            eoAlternateKey,
                            eoKeywords,
                            eoImportance,
                            eoPowerCategory,
                            eoPowerInterfaceType
                        }
        STATUS          current
        DESCRIPTION
            "This group contains the collection of all the objects
            related to the EnergyObject."

        ::= { energyObjectContextMIBGroups 1 }

    energyObjectOptionalMIBTableGroup OBJECT-GROUP
           OBJECTS         {
                            eoEthPortIndex,
                            eoEthPortGrpIndex,
                            eoLldpPortNumber,
                            eoMgmtMacAddress,
                            eoMgmtAddressType,
                            eoMgmtAddress,
                            eoMgmtDNSName
                           }
        STATUS          current
        DESCRIPTION
            "This group contains the collection of all the objects
            related to the Energy Object."
        ::= { energyObjectContextMIBGroups 2 }

    energyObjectRelationTableGroup OBJECT-GROUP
         OBJECTS         {

                        eoRelationID,
                        eoRelationship,
                        eoRelationStatus,
                        eoRelationStorageType
                         }
         STATUS          current
         DESCRIPTION
            "This group contains the collection of all objects
            specifying the relationship between Energy Objects."
        ::= { energyObjectContextMIBGroups 3 }
    END
```

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

         ianaEnergyRelationMIB MODULE-IDENTITY
           LAST-UPDATED "201502090000Z"  -- February 9, 2015
           ORGANIZATION "IANA"
           CONTACT-INFO "
                         Internet Assigned Numbers Authority
                         Postal: ICANN
                         12025 Waterfront Dr., Suite 300
                         Los Angeles, CA 90094
                         United States
                         Tel: +1-310-301-5800
                         EMail: iana@iana.org"

           DESCRIPTION
            "Copyright (c) 2015 IETF Trust and the persons identified as
             authors of the code.  All rights reserved.

             Redistribution and use in source and binary forms, with or
             without modification, is permitted pursuant to, and subject
             to the license terms contained in, the Simplified BSD
             License set forth in Section 4.c of the IETF Trust's Legal
             Provisions Relating to IETF Documents
             (http://trustee.ietf.org/license-info).

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

             The initial version of this MIB module was published in
             RFC 7461; for full legal notices see the RFC itself."

           REVISION     "201502090000Z"  -- February 9, 2015
           DESCRIPTION  "Initial version of this MIB as published in
                         RFC 7461."
           ::= { mib-2 232 }

         -- Textual Conventions

      IANAEnergyRelationship ::= TEXTUAL-CONVENTION
          STATUS            current
          DESCRIPTION
                "An enumerated value specifying the type of
                 relationship between an Energy Object A, on
```

```
                which the relationship is specified, with the
                Energy Object B, identified by the UUID.

                The enumeration 'poweredBy' is applicable if
                Energy Object A is poweredBy Energy Object B.

                The enumeration 'powering' is applicable if
                Energy Object A is powering Energy Object B.

                The enumeration 'meteredBy' is applicable if
                Energy Object A is meteredBy Energy Object B.

                The enumeration 'metering' is applicable if
                Energy Object A is metering Energy Object B.

                The enumeration 'aggregatedBy' is applicable if
                Energy Object A is aggregatedBy Energy Object B.

                The enumeration 'aggregating' is applicable if
                Energy Object A is aggregating Energy Object B."

        SYNTAX      INTEGER  {
                     poweredBy(1),    --  power relationship
                     powering(2),
                     meteredBy(3),    --  meter relationship
                     metering(4),
                     aggregatedBy(5), -- aggregation relationship
                     aggregating(6)
                     }

    END
```

6. Security Considerations

There are a number of management objects defined in this MIB module 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 opens devices to attack. These are the tables and objects and their sensitivity/vulnerability:

Unauthorized changes to the eoDomainName, entPhysicalName, eoRoleDescription, eoKeywords, eoImportance, eoAlternateKey, eoRelationID, eoRelationship, eoRelationStatus, and/or eoRelationStorageType MAY disrupt power and energy collection, and therefore any predefined policies defined in the network.

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

Implementations SHOULD provide the security features described by the SNMPv3 framework (see [RFC3410]), and implementations claiming compliance to the SNMPv3 standard MUST include full support for authentication and privacy via the User-based Security Model (USM) [RFC3414] with the AES cipher algorithm [RFC3826]. Implementations MAY also provide support for the Transport Security Model (TSM) [RFC5591] in combination with a secure transport such as SSH [RFC5592] or TLS/DTLS [RFC6353].

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 this MIB module is properly configured to give access to the objects only to those principals (users) that have legitimate rights to indeed GET or SET (change/create/delete) them.

In certain situations, energy and power monitoring can reveal sensitive information about individuals' activities and habits. Implementors of this specification should use appropriate privacy protections as discussed in Section 9 of RFC 6988 and monitoring of individuals and homes should only occur with proper authorization.

7. IANA Considerations

The MIB modules in this document use the following IANA-assigned OBJECT IDENTIFIER values recorded in the SMI Numbers registry:

Descriptor	OBJECT IDENTIFIER Value
energyObjectContextMIB	{ mib-2 231 }

This document defines the first version of the IANA-maintained IANA-ENERGY-RELATION-MIB module, which allows new definitions of relationships between Energy Objects.

A Specification Required as defined in [RFC5226] is REQUIRED for each modification of the energy relationships.

The MIB module in this document uses the following IANA-assigned OBJECT IDENTIFIER values recorded in the SMI Numbers registry.

Descriptor	OBJECT IDENTIFIER Value
ianaEnergyRelationMIB	{ mib-2 232 }

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