



# CIP Energy Profiles

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**Technical Track**

**Introduction**

**Definition of Terms**

**CIP Energy Objects Review**

**Energy Profiles**

**CIP Energy Identification**

**Examples of Energy Capable Devices**

**Summary**

## Energy Profile concept presentation

- ▶ Variety of energy objects
- ▶ Required and optional attributes and services
- ▶ Possible difficulty for system developers and end users to select and deploy systems
- ▶ Energy Profile proposed
  - Define objects, attributes and services supported
  - Ease the effort to select and deploy systems

# Definition of Terms

- ▶ Device Profile – a specification of a device’s object model, configuration and behavior that promotes consistency and interoperability among devices of the same type
- ▶ Energy Profile – a specification that defines particular energy related objects, attributes, services and behaviors that are implemented in an energy-capable device
- ▶ Aggregation – the representation by an object of the totalized energy or power consumed or generated by a collection of devices
- ▶ Child – a member of a collection of devices being represented by an aggregation object

# CIP Energy Objects

## Optimization of Energy Usage (OEU™)

- ▶ Problem: Energy is indispensable but inefficient and costly to manage
- ▶ OEU three-phase approach
  - Awareness of energy usage
  - Consuming energy more efficiently
  - Procuring energy at the lowest cost
- ▶ A number of CIP objects support OEU

# Awareness of Energy Usage

## Three related objects

- ▶ Base Energy Object
  - Reports energy usage in kWh, easily converted to GJ
  - Attributes report accuracy, how data is produced
  - Can be a proxy for non-CIP Energy devices
  - Can aggregate a collection of devices
- ▶ Electrical Energy Object
  - Subordinate to Base Energy Object
  - Reports myriad electrical parameters
- ▶ Non-Electrical Energy Object
  - Reports usage in native units (e.g. natural gas in therms)

# Consuming Energy More Efficiently – Part A

## Power Management Object

- ▶ Objective: Reduce energy used during idle periods
- ▶ Client request device to pause for a time
- ▶ Instance transitions to a predefined pause mode
- ▶ Instance responds with the time needed to resume
- ▶ Some Ethernet devices can go to “sleep”
  - Wake-on-LAN message wakes device

# Consuming Energy More Efficiently – Part B

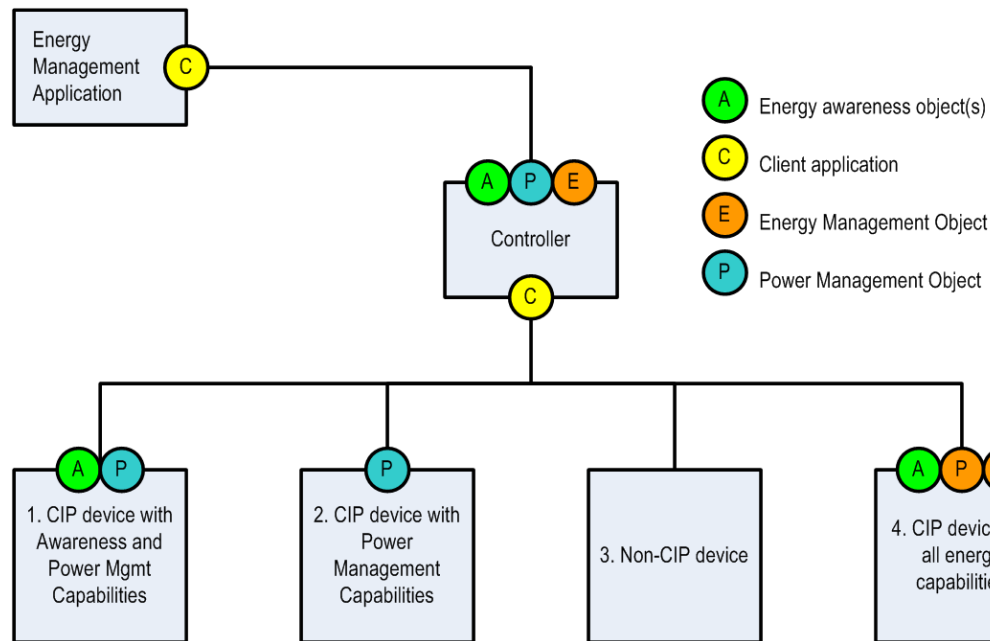
## Energy Management Object

- ▶ Goal: Increase energy efficiency and avoid demand peaks while production continues
  - Production continues, but at a reduced power level
- ▶ Client commands an instance to a predefined curtailment level



# Real-world Example

- ▶ A system can combine devices with different capabilities



- ▶ A clear method is needed to identify CIP energy capabilities

## Similar to Device Profiles...

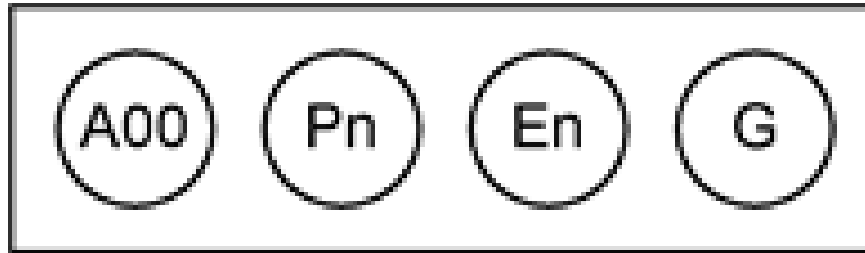
- ▶ Promotes interoperability and interchangeability
- ▶ Defines objects, behaviors, I/O data, configuration
- ▶ One-to-one association with a device type

## But different

- ▶ Can require implementation of optional attributes and services
- ▶ Can exist alongside **many** device types
- ▶ Can be added to Identity Object

# CIP Energy Identification

## Energy Identification Target



- ▶ A – Awareness
- ▶ P – Power Management
- ▶ E – Energy Management
- ▶ G – Smart Grid support (future)

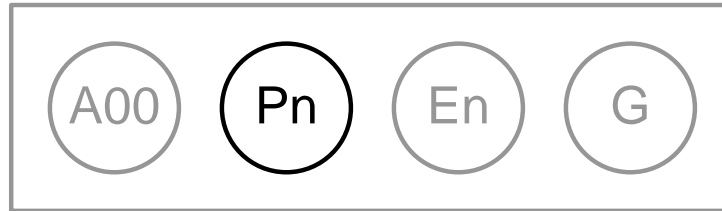
# CIP Energy Identification



## ► Awareness

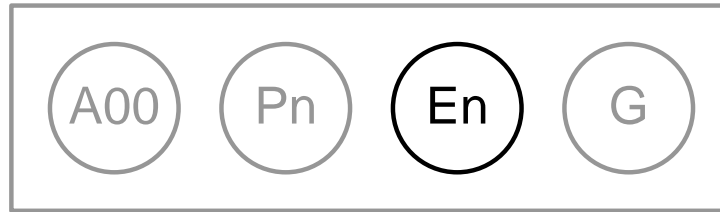
- 1<sup>st</sup> subscript
  - 0 = Generic
  - 1 = Electrical
  - 2 = Non-Electrical
- 2<sup>nd</sup> subscript
  - 0 = Energy Measured
  - 1 = Energy Derived
  - 2 = Energy Proxy
  - 3 = Energy Aggregated
  - 4 = Energy Rate Fixed
  - 5 = Non-Electrical Aggregated

# CIP Energy Identification



- ▶ Power Management
  - n = No Sleeping Mode support
  - s = Sleeping Mode Support

# CIP Energy Identification



- ▶ Energy Management
  - n = Curtailment Levels are modifiable
  - p = Curtailment Levels are protected from modification
  
- ▶ Benefits of CIP Energy Identification
  - Simplified, consolidated view of energy capabilities
    - Objects and capabilities implemented
    - Optional attributes and services implemented
  - A help in system development and device selection
  - Can be included in DoC

# Energy Profile Examples

## What does “Energy Capable” really mean?

- ▶ “Energy Capable” is a broad term
- ▶ Many varied details
  - What objects are supported?
  - What attributes are supported?
  - What capabilities are supported?
  - What behavior is supported?
- ▶ Examples that follow
  - Not a comprehensive list
  - Intended to provoke thought and discussion
  - More are described in the paper

# Simple Energy Aware Device

- ▶ Example: power supply with communications
- ▶ Reports fixed power when “on”
- ▶ Base Energy Object implemented in communications firmware



Object / Capability	Supported?	Comments
Base Energy Object	Yes	
Capabilities – Energy Fixed	Yes	
Energy Odometers	No	Reports only a nominal power value in kW
Energy Transfer Rate	Yes	Required since odometer is not implemented.
Energy Accuracy = undefined	Yes	Power value is estimated, not measured.



# Measurement Devices

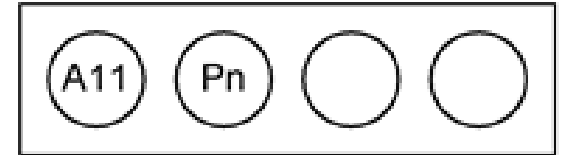
- ▶ Examples: Power Monitor, AC Drive, Soft Start
- ▶ Measures voltage and current
- ▶ Calculates power, integrates into energy



Object / Capability	Supported?	Comments
Base Energy Object	Yes	
Capabilities – Energy Measured	Yes	
Energy Odometers	Yes	
Energy Transfer Rate	Optional	Power in kW
Accuracy	Yes	May be very accurate, even revenue grade (power monitor). AC drives and similar devices may be less accurate.
Electrical Energy Object	Optional	Provides electrical values in addition to power and energy, e.g. volts, amps, frequency, etc. Desirable in any device that supports the Energy Measured capability.

# Energy-aware Power Manageable Devices

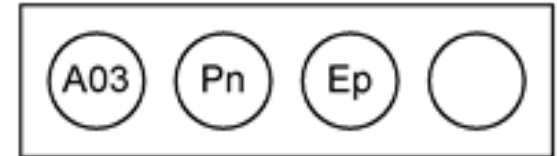
- ▶ Example: AC Drive with the Power Management Object



Object / Capability	Supported?	Comments
Base Energy Object	Yes	
Capabilities – Energy Measured	Yes	
Energy Odometers	Yes	Required
Energy Transfer Rate Accuracy - nominal	Optional Yes	Power in kW Calculated; may be in the range of 5 to 15%
Electrical Energy Object	Optional	Implemented in this example
Power Management Object	Yes	
Pause Modes	Yes	2 modes likely: Not Paused and Paused
Sleeping State	Optional	Additional hardware needed; Pn changes to Ps

# Energy Manageable Machine Controller

- ▶ Controller reports energy used in the machine
- ▶ OEM defines protected curtailment levels



Object / Capability	Supported?	Comments
Base Energy Object	Yes	
Capabilities – Energy Aggregated	Yes	
Energy Odometers	Yes	Required
Energy Transfer Rate	Optional	Power in kW
Accuracy - nominal	Yes	Calculated; based on accuracy and contribution of child devices
Energy Management Object	Yes	
Capabilities = Protected	Yes	Protected from modification
Curtailment Levels	Yes	As defined by the machine builder
Power Up Curtailment Level	Optional	Uncurtailed or Last Level as defined by the machine builder
Power Management Object	Optional	As defined by the machine builder

- ▶ Energy Profiles can help in many ways
  - Information for vendors, OEMS, users and others on energy capabilities of devices
  - Coordinate applications of energy related CIP objects
  - Facilitates productive device selection and application
- ▶ Can be included in DoC
- ▶ Can be included in augmented Identity Object
- ▶ Promote interoperability
- ▶ Profiles make it easier to get results consistent across vendors
  - Energy on the BOM
  - Energy / cost per widget