**Draft IEC 62350**

# Final Draft International Standard (FDIS)

***For Internal WG17 Review Only***

August 31 2007

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# Communications Systems for Distributed Energy Resources (DER)

## IEC 61850 Part 7-420 DER Logical Nodes

Excerpt for information of the ongoing work to prepare the draft FDIS document for part 7-420.

The complete document will be discussed in Gatineau (Canada) from Oct 30 to Nov 02, 2007. After the meeting the FDIS will be finished and sent to IEC for FDIS publication.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**Distributed Energy Resources (DER) Logical Nodes –**

# FOREWORD

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This working draft of the International Standard IEC 61850 Part 7-xxx has been prepared by IEC technical committee 57: Working Group 17 on Distributed Energy Resources Object Modelling.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

# INTRODUCTION

## 1 Scope and object

### 1.1 Scope

This specification defines the IEC 61850 information models to be used in the exchange of information with distributed energy resources (DER), which comprise dispersed generation devices and dispersed storage devices, including reciprocating engines, fuel cells, microturbines, photovoltaic, combined heat and power, and energy storage.

The IEC 61850 DER information model standard utilizes existing IEC 61850-7-4 Logical Nodes where possible, but also defines DER-specific Logical Nodes where needed. The IEC 61850 DER Information model consists of the following parts:

- **Object models**, which are standardized names, formats, and meanings of data objects used for exchanging this data between different equipment and systems. These data objects are categorized by Logical Nodes that contain data object names, their Common Data Class (CDC) formats, the semantic meaning of the data objects, and whether they are mandatory or optional. These DER object models and additional DER CDCs are defined in clauses 5 – 8.
- **Service models**, which are methods and message formats for exchanging the data, such as transmitting selected groups of objects under different circumstances such as report-by-exception, periodically, upon request, or on issuing a control command. The service models are defined in clause 9.
- **Mappings to protocol profiles**, which translate the object models and service models into the protocols that actually send the bits and bytes over the communication channel. The mappings are defined in clause 10.

### 1.2 Objectives

There is a growing interest in implementing and interconnecting DER systems throughout the world. As the DER technology evolves and as the impact of dispersed generation on distribution power systems becomes an increasing challenge and opportunity, nations recognize the economic, social, and environmental benefits of integrating DER technology within their electric infrastructure.

The manufacturers of DER devices are facing the age-old issues of what communication standards and protocols to provide to their customers for monitoring and controlling DER devices, in particular when they are interconnected with the electric utility system. In the past, DER manufacturers developed their own proprietary communication technology. However, as utilities and other energy service providers start to manage DER devices which are interconnected with the utility power system, they are finding that coping with these different communication technologies present major technical difficulties, implementation costs, and maintenance costs. Therefore, utilities and DER manufacturers recognize the growing need to have one international standard that defines the communication and control interfaces for all DER devices. Such standards, along with associated guidelines and uniform procedures would simplify implementation, reduce installation costs, reduce maintenance costs, and improve reliability of power system operations.

Communications for DER plants involve not only local communications between DER units and the plant management system, but also between the DER plant and the operators or aggregators who manage the DER plant as a virtual source of energy and/or ancillary services. This is illustrated in Figure 1-1.

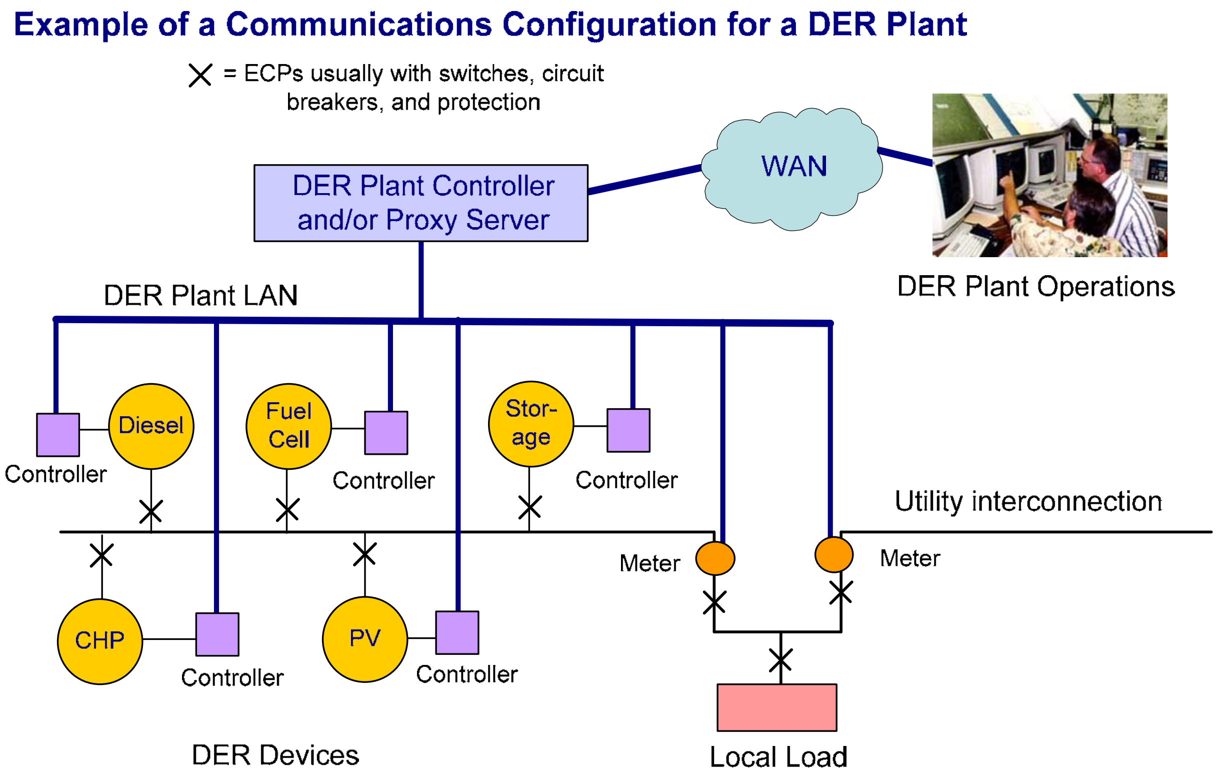


Figure 1-1: Example of a Communications Configuration for a DER Plant

At the same time that DER technologies have started to mature, the technology for information modelling has developed to become well-established as the most effective method for managing information exchanges. In particular, the IEC 61850 object models for the exchange of information within substations have become International Standard. Many of the components of this standard can be reused for object models of other types of devices.

In addition to the IEC 61850 standards, IEC TC57 has developed the Common Information Model (CIM) that models the relationships among power system elements and other information elements so that these relationships can be communicated across systems. Although this standard does not address these CIM relationships for DER, it is fully compatible with the CIM concepts.

The interrelationship between IEC TC57 modelling standards is illustrated in Figure 1-2.This illustration shows as horizontal layers the three components to an information exchange model for retrieving data from the field, namely, the communication protocol profiles, the service models, and the object models. Above these layers is the information model of utility-specific data, termed the Common Information Model (CIM), as well as all the applications and databases needed in utility operations. Vertically, different object models are shown:

- Substation automation (IEC 61850-7-4)
- Large hydro plants (IEC 61850-7-410)
- DER (IEC 61850-7-420)
- Distribution automation (under development)

- Advanced metering infrastructure (as pertinent to utility operations) (pending)

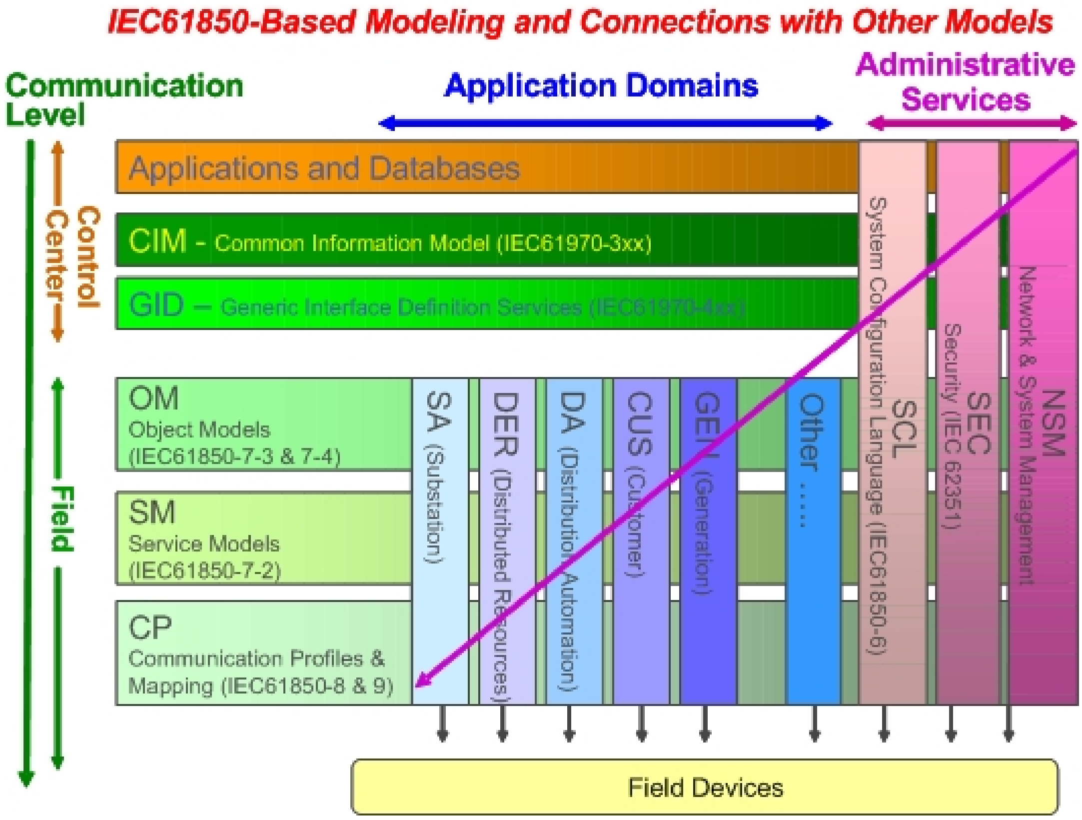


Figure 1-2: IEC 61850 Modelling and Connections with Other IEC TC57 Models

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

### 2.1 Specific normative references for IEC 61850 object modelling

- IEC 61850-7-3, Communication networks and systems in substations – Part 7-3: Basic communication structure for substations and feeder equipment – Common data classes
- IEC 61850-7-4, Communication networks and systems in substations – Part 7-4: Basic communication structure for substations and feeder equipment – Compatible logical node classes and data classes

### 2.2 Specific normative references for IEC 61850 service models

- IEC 61850-7-2, Communication networks and systems in substations – Part 7-2: Basic communication structure for substations and feeder equipment – Abstract communication service interface (ACSI)

### 2.3 Specific normative references for IEC 61850 protocol mapping

- IEC 61850-8-1, Communication networks and systems in substations – Part 8-1: Specific Communication Service Mapping (SCSM) – Mapping to MMS (ISO/IEC 9506 Part 1 and Part 2) and to ISO 8802-3
- IEC 61400-25-4, Communications for monitoring and control of wind power plants – Mapping to XML based communication profile

## 3 Terms and definitions

### 3.1 New terms

The following are new terms defined in this document. Additional terms used in this document but defined in other documents are found in clause 11.2.

| Term | Definition |
|---|---|
| **3.1.1 Electrical Connection Point (ECP)** | The point of electrical connection between the DER source of energy (generation or storage) and **any** electric power system (EPS).<br>Each DER (generation or storage) unit has an ECP connecting it to its local power system; groups of DER units have an ECP where they interconnect to the power system at a specific site or plant; a group of DER units plus local loads have an ECP where they are interconnected to the utility power system.<br>NOTE – For those ECPs between a utility EPS and a plant or site EPS, this point is identical to the Point of Common Coupling (PCC) in the IEEE 1547 "*Standard for Interconnecting Distributed Resources with Electric Power Systems*". |

### 3.2 New abbreviated terms

IEC 61850-7-4, Clause 4, defines Abbreviated Terms for building concatenated Data Names. The following new abbreviated terms are proposed as additional terms for building concatenated Data Names.

| Term | Description |
|---|---|
| Abs | Absorbing |
| Acc | Accumulated |
| Act | Active, Activated |
| Alt | Altitude |
| Amb | Ambient |
| Arr | Array |
| Avail | Available |
| Azi | Azimuth |
| Bas | Base |
| Bckup | Backup |
| Cal | Calorie, Caloric |
| Circ | Circuit |
| Cmut | Commute, Commutator |
| Cntct | Contractual |
| Con | Constant |
| Conn | Connected, connections |
| Conv | Conversion, converted |
| Cool | Coolant |

| Term | Description |
|---|---|
| Cost | Cost |
| Csump | Consumption, consumed |
| DCV | DC voltage |
| Deg | Degrees |
| Dep | Dependent |
| DER | Distributed Energy Resource |
| ECP | Electrical Connection Point |
| Efc | Efficiency |
| El | Elevation |
| Em | Emission |
| Emrg | Emergency |
| Encl | Enclosure |
| Eng | Engine |
| ExIm | Export/Import |
| Exp | Export |
| Forc | Forced |
| Fuel | Fuel |
| Fx | Fixed |
| Gov | Governor |
| Heat | Heat |
| Hor | Horizontal |
| Hr | Hour |
| Hyd | Hydrogen (suggested in addition to $H_2$) |
| Id | Identity |
| Imp | Import |
| Ind | Independent |
| Iso | Isolation |
| Isld | Islanded |
| Maint | Maintenance |
| Man | Manual |
| Mat | Material |
| Mdul | Module |
| Mgt | Management |
| Mrk | Market |
| Obl | Obligation |
| Off | Off |
| On | On |
| Ox | Oxidant, oxygen |
| Pan | Panel |
| PCC | Point of Common Coupling |
| Perm | Permission |
| Pk | Peak |
| Plnt | Plant, Facility |
| Pv | Photovoltaics |
| Proc | Process |
| Qud | Quad |
| Ramp | Ramp |
| Rng | Range |
| Sched | Schedule |
| Self | Self |
| Ser | Series, Serial |
| Srt | Short |
| Stab | Stabilizer |
| Stp | Step |
| Tilt | Tilt |
| Tim | Timing |
| Trk | Track |
| Tur | Turbine |
| Util | Utility |
| Ver | Vertical |
| Volm | Volume |
| Wtr | Water (suggested in addition to $H_2O$) |
| Xsec | Cross-section |

## 4 Conformance

Claiming conformance to this specification shall require the provision of a PICS document identifying all requirements from this document that are being conformed to.

# 5 Logical Nodes for DER management systems

## 5.1 Overview of object modelling (informative)

### 5.1.1 Data object modeling constructs

Data object models provide standardized names and structures to the data that is exchanged among different devices and systems. Figure 5-1 illustrates the object hierarchy used for developing UCA-SA object models. The process from the bottom up is described below:

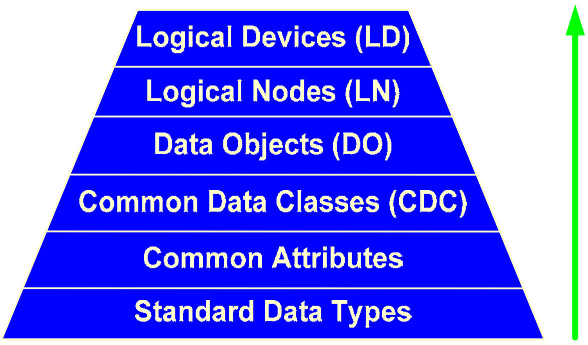


Figure 5-1: Object Model Hierarchy

1. **Standard Data Types**: common digital formats such as Boolean, integer, and floating point
2. **Common Attributes**: predefined common attributes that can be reused by many different objects, such as the Quality attribute. These common attributes are defined in IEC61850-7-3 clause 6.
3. **Common Data Classes (CDCs)**: predefined groupings building on the standard data types and predefined common attributes, such as the Single Point Status (SPS), the Measured Value (MV), and the Controllable Double Point (DPC). In essence, these CDCs are used to define the type or format of Data Objects. These CDCs are defined in IEC61850-7-3 clause 7.
4. **Data Objects (DO)**: predefined names of objects associated with one or more Logical Nodes. Their type or format is defined by one of the CDCs. They are listed only within the Logical Nodes. An example of a DO is “Auto” defined as CDC type SPS. It can be found in a number of Logical Nodes. Another example of a DO is “RHz” defined as a SPC (controllable single point), which is found only in the RSYN Logical Node.
5. **Logical Nodes (LN)**: predefined groupings of Data Objects that serve specific functions and can be used as “bricks” to build the complete device. Examples of LNs include MMXU which provides all electrical measurements in 3-phase systems (voltage, current, watts, vars, power factor, etc.); PTUV for the model of the voltage portion of under voltage protection; and XCBR for the short circuit breaking capability of a circuit breaker. These LNs are described in IEC61850-7-4 clause 5.
6. **Logical Devices (LD)**: the device model composed of the relevant Logical Nodes for providing the information needed for a particular device. For instance, a circuit breaker could be composed of the Logical Nodes: XCBR, XSWI, CPOW, CSWI, and SMIG. Logical Devices are not directly defined in any of the documents, since different products and different implementations can use different combinations of Logical Nodes for the same Logical Device.

### 5.1.2 Logical devices concepts

Controllers or servers contain the IEC61850 Logical Device models needed for managing the associated device. These Logical Device models consist of one or more Physical Device models as well as all of the Logical Nodes needed for the device.

Therefore a Logical Device Server can be diagrammed as shown in Figure 5-2.

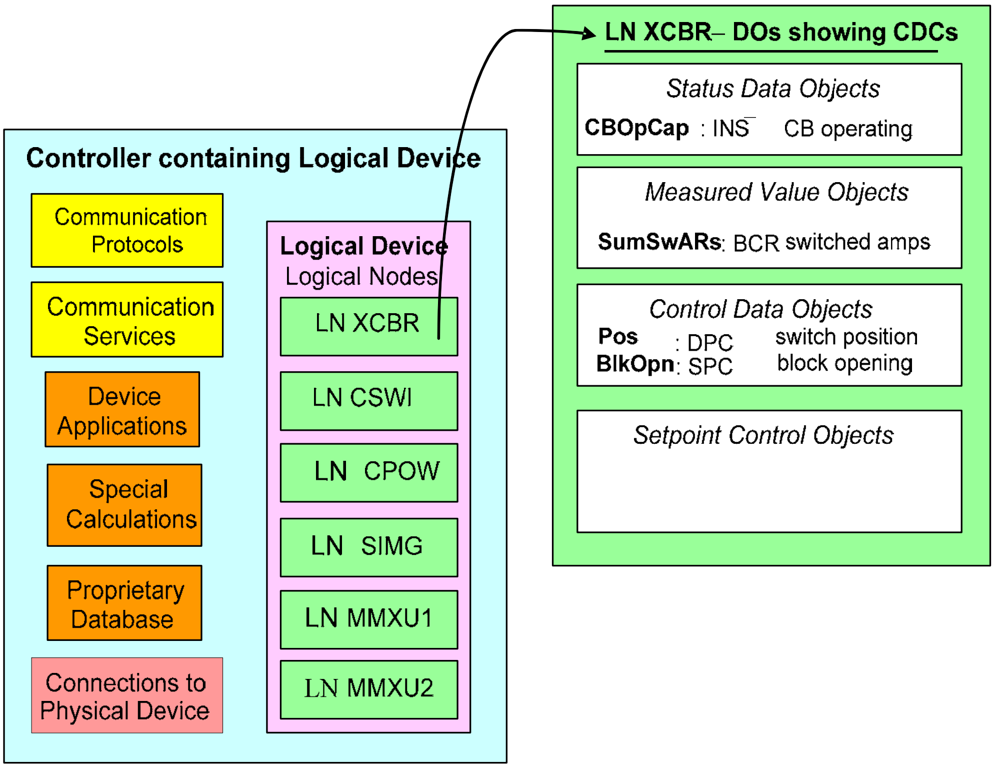


Figure 5-2: Example of Relationship of Logical Device, Logical Nodes, Data Objects, and Common Data Classes

### 5.1.3 Logical Nodes structure

In the following tables, the Logical Nodes (LNs) for DER devices are defined. For each LN implemented, all Mandatory items shall be included (those indicated as an M in the M/O column). For clarity, these LNs are organized by typical Logical Devices that they may be a part of, but they may be used or not used as needed. The organization of IEC 61850 DER object models is illustrated in Figure 5-4. This illustration does not include all LNs that might be implemented, nor all possible configurations, but exemplifies the approach taken to create object models.

Each subclause contains an initial informative clause, followed by normative clauses. Specifically, any clause identified as informative, is informative; any clause with no identification is considered normative.

Each LN table contains the following:

- **Attribute name**: Formal data object name that shall be used in referencing the data.
- **Attribute type:** The name of the Common Data Classes (CDC) that defines the structure of the data, and which is defined in IEC 61850-7-3 or clause 8 of this document.

- **Explanation:** Short explanation of the data and how it is used.
- **T:** Transient data – the status of the data with this designation is momentary and must be logged or reported to provide evidence of its momentary state.
- **M/O:** Mandatory or Optional – the data object either shall be included if the LN is instantiated, or the data object may but does not need to be included in the LN.

### 5.1.4 Naming structure

The naming conventions and format shall be as specified in IEC 61850-7-2, Clause 19. For convenience, this information is replicated here, but if any deviations are found, IEC 61850-7-2 has precedence.

The allowed format is as shown in Figure 5-3.

| LD Name | LN Name | | | Data Name | Data Attribute Name |
|---|---|---|---|---|---|
| | LN Prefix | LN Class | LN Instance # | | |

Figure 5-3: Data object naming structure

The lengths of each field in the naming format are:

- The Logical Device name (**LDName**) may consist of up to 32 alphanumeric characters.
- The Logical Node name (**LNName**) may consist of up to 11 alphanumeric characters, arranged as follows:
  - Logical Node prefix: m characters
  - Logical Node Class name: 4 characters (e.g. as specified in IEC 61850-7-4)
  - Logical Node instance number: n numeric characters, where m + n may be up to 7 characters

## Overview: Logical Devices and Logical Nodes for Distributed Energy Resource (DER) Systems

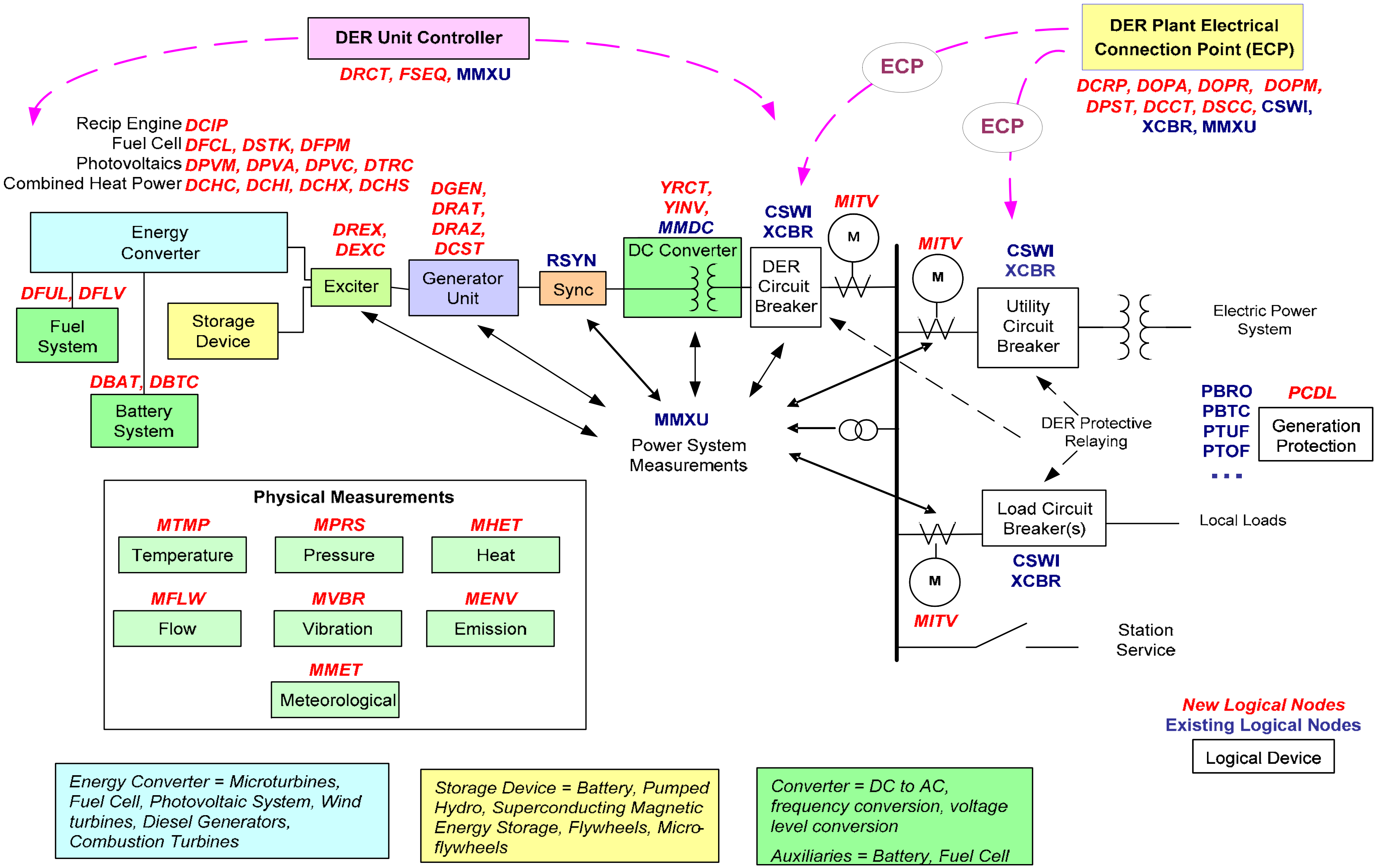


Figure 5-4: Overview: Conceptual Organization of DER Logical Devices and Logical Nodes