



# Benefits of Interoperability Using IEC Standards for DER Management

Frances Cleveland

*Xanthus Consulting International*

# Topics

- Benefits of DER to stakeholders
- Benefits of Standardization
- IEC Communication Standards: IEC 61850 and IEC 61870 (CIM) for DER
- Next Steps



## Benefits of DER to Utility Operations, Customers, and Society

Market opportunities, improved energy  
reliability, reduced environmental  
impacts, cost savings

# DER Stakeholders



# Benefits of DER to Utility Operations #1

- **Increase generation capacity / decrease load:**
  - Provide energy to offset load within a customer site
  - Provide energy with net metering and feed-in tariffs
  - Provide energy within a substation for local generation
- **Improve energy efficiency:**
  - Provide energy close to loads, thus minimizing losses
  - Provide voltage support along feeders in place of voltage regulators, so that voltage levels from the feeder substation could be lowered, while still remaining within the nominal limits
  - Provide VAr support to improve power efficiency
  - Support load-following of local loads to improve power efficiency
  - Counteract any large non-conforming loads of the DER owner, thus providing a more stable load profile to utilities

# Benefits of DER to Utility Operations #2

- **Increase reliability**
  - Provide spinning or operational reserve for local areas
  - Support intentional islanding for campuses, housing developments, and industrial/commercial areas if normal energy supply is not available
- **Decrease costs**
  - Defer construction of distribution facilities through DER generation, which acts as negative load, provides peak shaving, and supports voltage and VARs on the feeder
  - Directly control DER generation to provide peak shaving to minimize start-up of costly peaker generation
  - Use Demand Response or market incentives to increase DER generation during peak times
- **Improve power quality**
  - Provide smooth transitional VAR support in place of switched capacitor banks to minimize harmonics

# Benefits of DER to Customers #1

- **Provide shared cost-savings for utilities and customers:**
  - Through net metering, to reduce overall electricity usage and costs
  - Through different types of tariffs such as Demand Response
  - Directly through direct market participation and/or dynamic pricing tariffs
  - Indirectly through overall lower electricity costs due to utility gains in efficiency
- **Provide emergency backup generation**
  - Customers can install DER for emergency power to their critical loads
  - Customers can sell emergency power into a microgrid island which was formed due to a loss of utility power

# Benefits of DER to Customers #2

- **Use by-products from customer industrial processes to generate and sell electricity:**
  - Use heat to generate electricity through Combined Heating and Power (CHP) systems, thus off-setting some of the customer's costs.
  - Provide biomass as source of gas, production of hydrogen as transportable energy.
- **Participate in carbon trading:**
  - If and when carbon trading becomes a reality, customers can “trade” their low-carbon DER generation

# Benefits of DER for Society

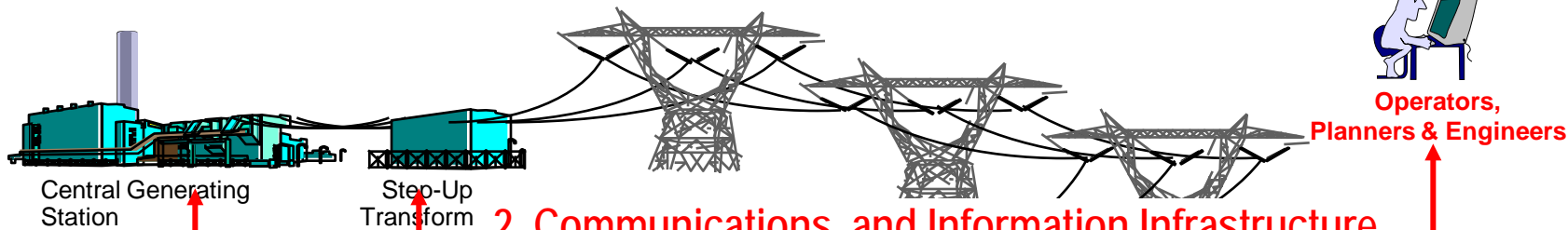
- **Minimize carbon and pollution production:**
  - Renewable DER units produce less carbon dioxide, thus helping in the battle against global climate change
  - Efficient re-use of “waste heat” or other by-products of industry improve the overall efficiency of energy usage
  - Many DER units, including burning biomass and CHP, can also minimize non-carbon pollutants
- **Meet mandated renewable portfolios:**
  - Many states have legislated renewable portfolios that mandate increasing use of renewable sources of energy. Most renewables to-date are small generators
- **Provide “green power” for socially conscious people**
  - Many people are willing to pay extra for power or to off-set their carbon “footprint”



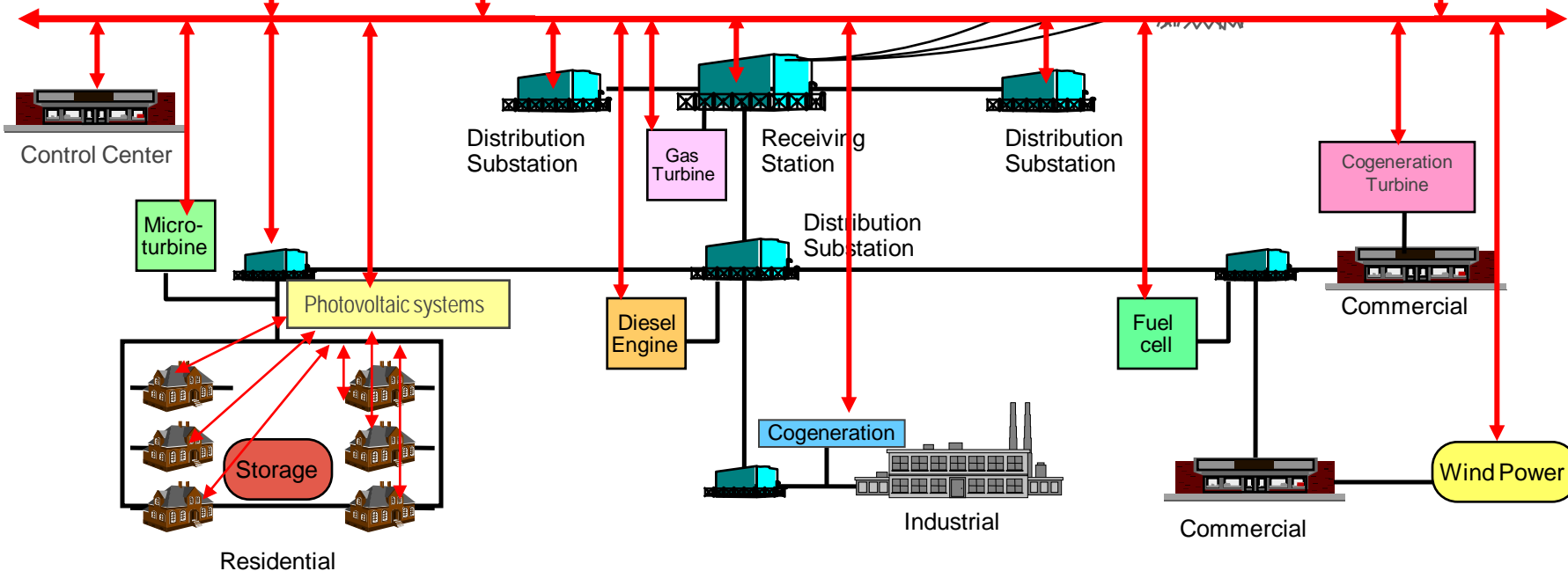
# Benefits of Standardization for Information Exchanges

# Need to manage both the power system infrastructure and the information infrastructure

## 1. Power System Infrastructure



## 2. Communications and Information Infrastructure



# Why Are Communication Standards Important?

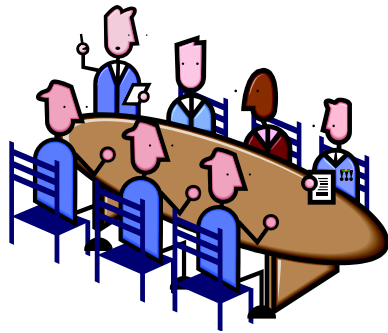
How do disparate human groups communicate with each other?



Germans sprechen Deutsch zusammen



Argentinesans hablan español juntos



French people parlent le français entre eux



Martians speak گن♣♠???

*English has been accepted as the common business language*

*Similarly, System Integration establishes common “data” languages for “interoperating” among computer systems*

# U.S. Senator Maria Cantwell:

## *“Reducing Demand through Electricity Grid Intelligence” Proposed Act\**

- **This Act**, released April 25, 2007:
  - *“proposes a broad and flexible definition of smart grid technology, which includes*
    - *smart metering systems,*
    - *demand response systems,*
    - *distributed generation management systems,*
    - *electrical storage management systems,*
    - *distribution automation systems, ...”*
- **Standards (Section of Senator Cantwell’s Act)**
  - *“Standard-setting provisions are considered to be vital to ensure interoperability and allow for smart appliances and equipment. ...*
  - *This section insures that smart grid systems and components by different manufacturers will in fact someday be able to constitute an “electranet” (Al Gore’s term) - a “community” of intelligent devices on the grid.”*

# So, What's Holding Up the Standards Process?

- Separate industries:
  - Utilities, DER vendors. and Customers with DER
- DER units are relatively new forms of electric energy
  - Separate industries: DER units are typically owned by customers, not by utilities
  - No long standing history of exchanging information
  - No de facto communication protocols or generally accepted data exchanges
- Some differences of opinion between DER vendors and utilities
  - For DER vendors, utilities are viewed as delaying DER interconnections to the distribution system
  - For utilities, DER vendors are making demands on power system operations that the distribution system was not designed for
- Therefore to bridge the different industries and help establish common ground:

***Internationally accepted standards  
are even more critical to success!!***

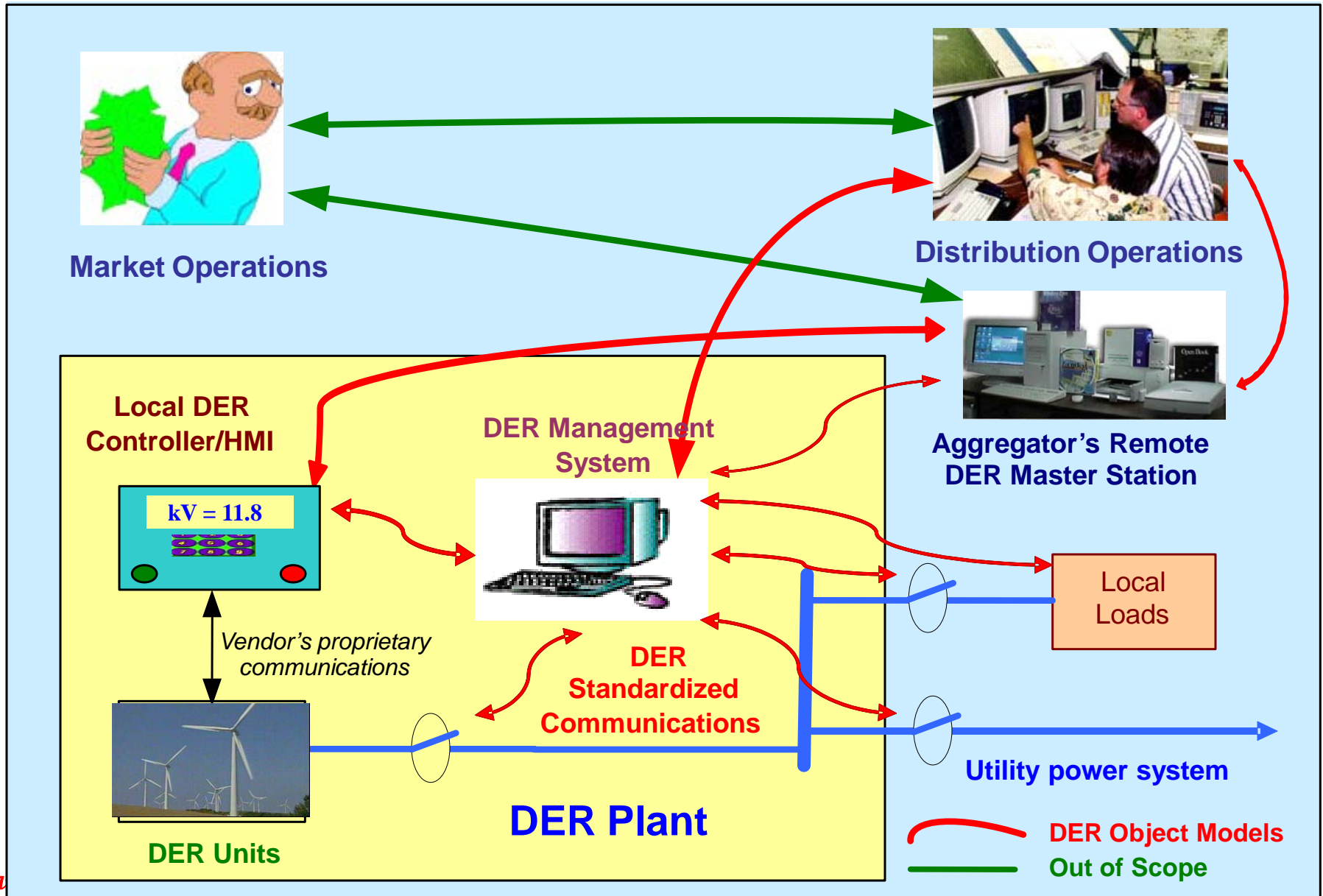
# Win-Win Situation?

- Integration of DER into power systems can be a win-win situation, if ...
  - Utilities, Customers, and DER vendors understand both the **benefits** and the **challenges**
  - Electric interconnection standards are adhered to, specifically the **IEEE P1547** series of standards
  - **Computer applications** are developed to assist utilities, customers, and vendors to achieve the promised benefits
- Communication information standards are developed
  - Not only to (passively) monitor the DER units
  - But also to **manage the power system with widespread DER**

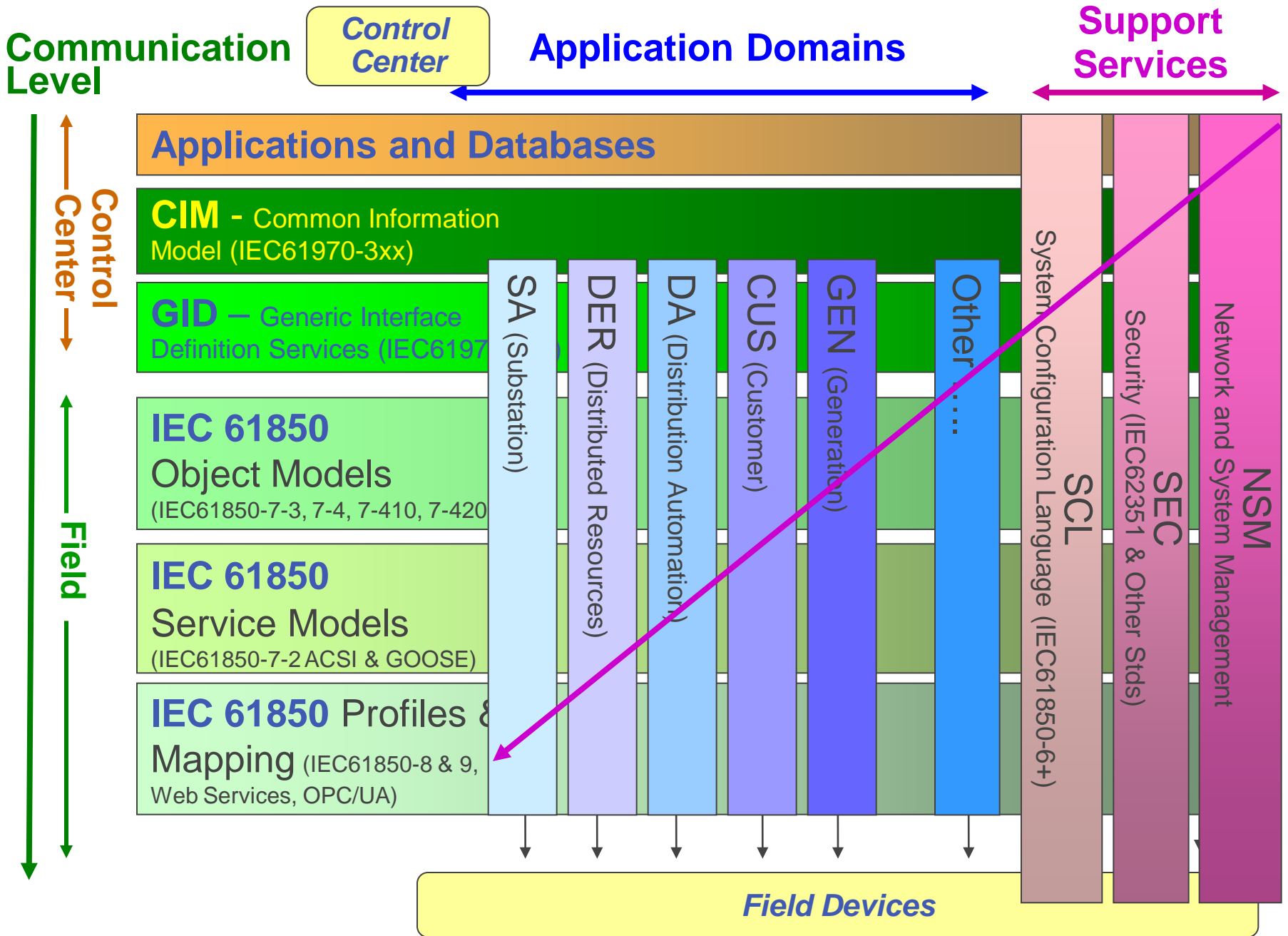


## IEC Communication Standards: IEC 61850 and IEC 61970 (CIM)

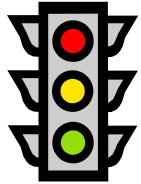
# Scope of DER Information Exchanges



# IEC 61850 Models and the Common Information (CIM) Model



# What Components are Involved in Interoperability? Similar to Any Language ...



**VERBS & GRAMMAR**  
**Messaging & Security**  
Monitoring, Control,  
Protocols, Networking



## **MEDIA**

**Communications Media**  
Fiber optics, Wireless, BPL,  
Cellphone, Internet, LANs



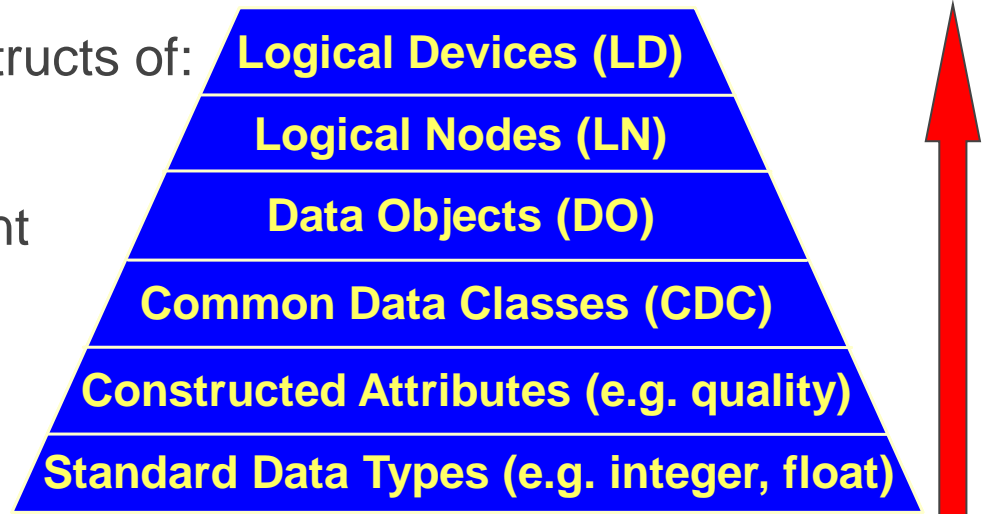
**NOUNS**  
**Data Management**  
Measurements, Data,  
Calculations, Files, Databases

**USERS**  
**Computer Applications**  
Alarms, Analyzes ,  
Displays, Stores data

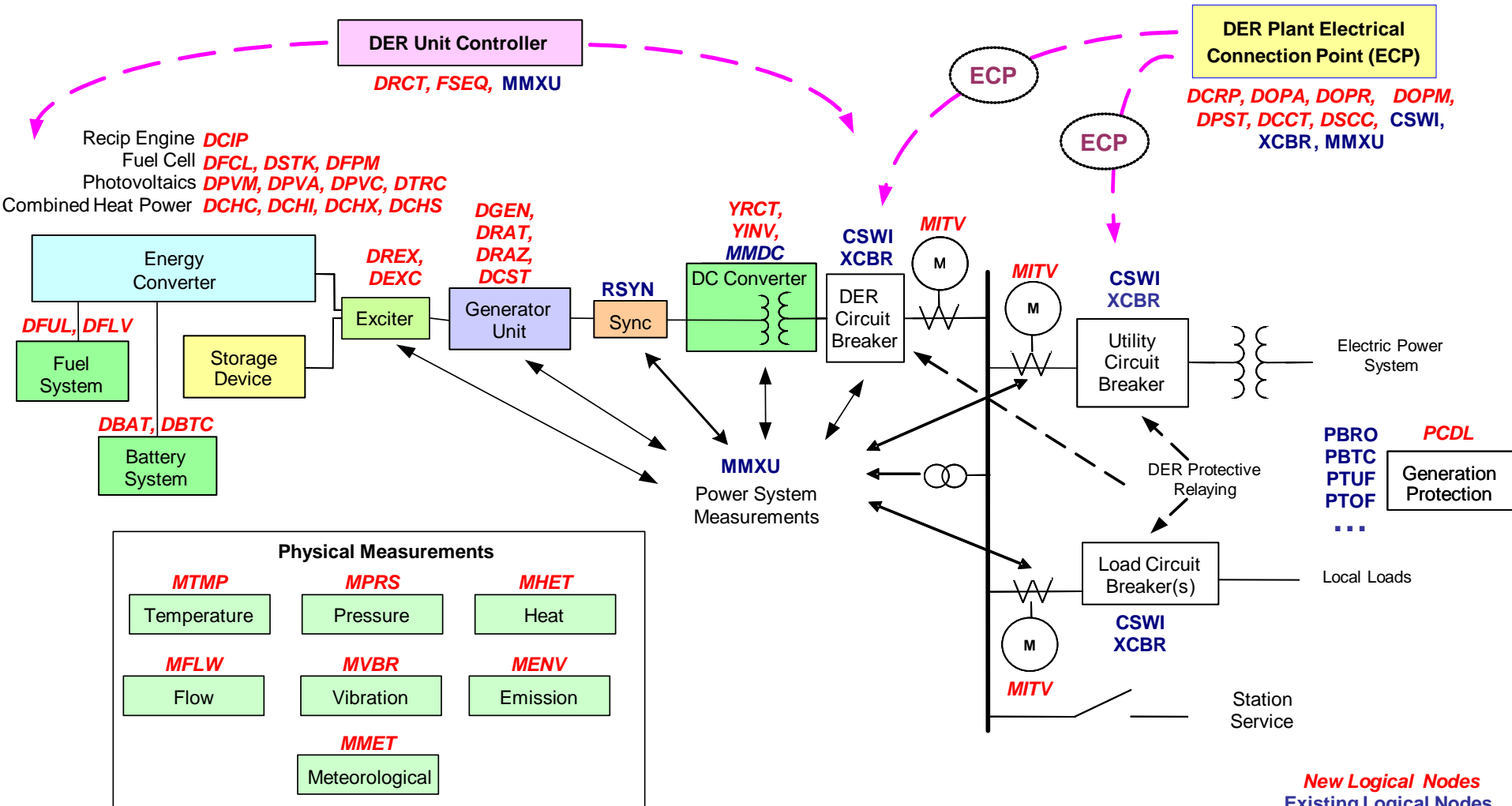


# IEC 61850-7-420 for DER Models

- IEC 61850-7-420 for DER
  - Addresses only abstract “Nouns”
  - Uses the IEC 61850 constructs of:
- Covers:
  - General DER management
  - Photovoltaic systems
  - Fuel cells
  - Diesel generation
  - Combined heat and power
  - Wind power is handled separately (IEC 61400-25)
- IEC 61850-7-2, plus mappings, cover the “verbs”
  - Services define when and how to exchange messages
  - Mappings convert abstract standards to “bits and bytes”



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



Energy Converter = Microturbines, Fuel Cell, Photovoltaic System, Wind turbines, Diesel Generators, Combustion Turbines

Storage Device = Battery, Pumped Hydro, Superconducting Magnetic Energy Storage, Flywheels, Micro-flywheels

Converter = DC to AC, frequency conversion, voltage level conversion  
Auxiliaries = Battery, Fuel Cell

New Logical Nodes  
Existing Logical Nodes

Logical Device

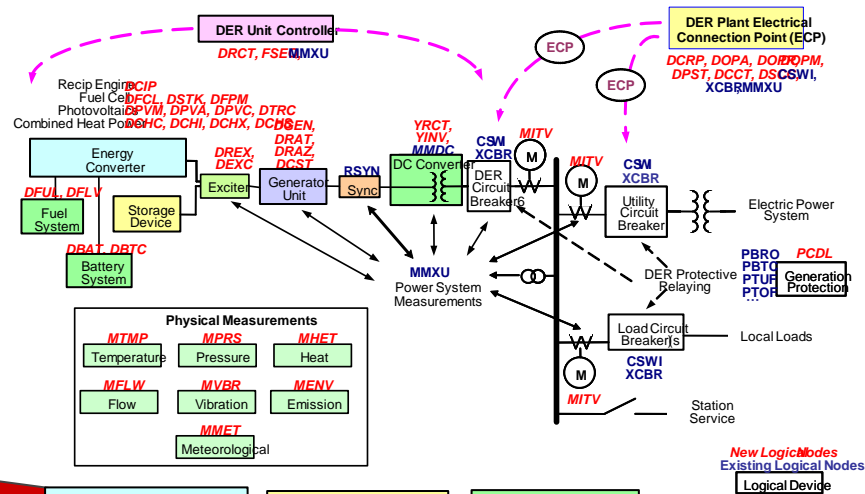
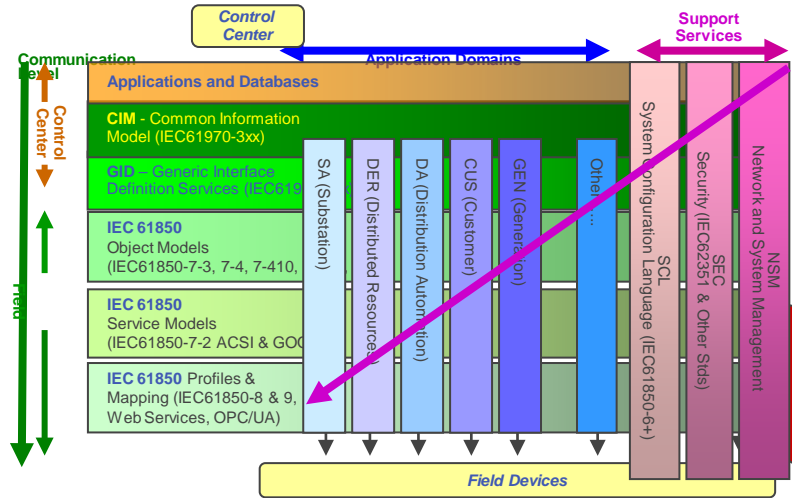
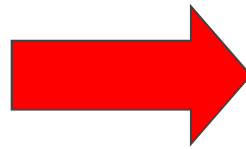
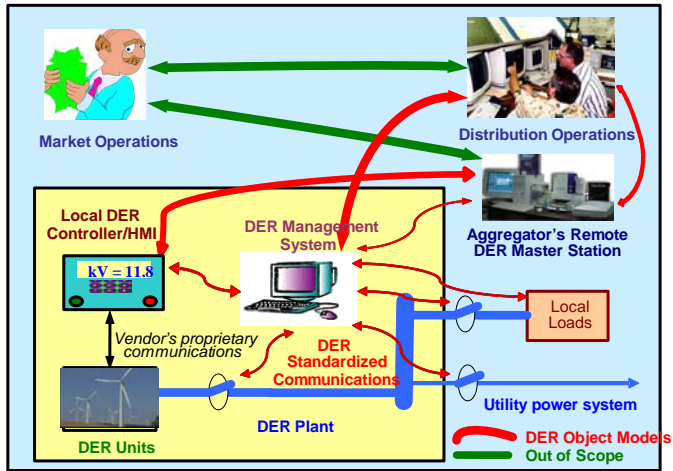
## Example of (part of) DGEN Logical Node

<i>Status information</i>																				
GnOpSt	INS	Generation operational state: <table border="1"> <thead> <tr> <th>Value</th> <th>Explanation</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Not operating</td> </tr> <tr> <td>1</td> <td>Operating</td> </tr> <tr> <td>2</td> <td>Starting up</td> </tr> <tr> <td>3</td> <td>Shutting down</td> </tr> <tr> <td>4</td> <td>At disconnect level</td> </tr> <tr> <td>5</td> <td>kW ramping</td> </tr> <tr> <td>6</td> <td>kVar ramping</td> </tr> </tbody> </table>	Value	Explanation	0	Not operating	1	Operating	2	Starting up	3	Shutting down	4	At disconnect level	5	kW ramping	6	kVar ramping		M
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GnSync	INS	Generator is synchronized to EPS, or not		O																
ParlSt	SPS	Paralleling status: <table border="1"> <thead> <tr> <th>Value</th> <th>Explanation</th> </tr> </thead> <tbody> <tr> <td>True</td> <td>Paralleling</td> </tr> <tr> <td>False</td> <td>Standby</td> </tr> </tbody> </table>	Value	Explanation	True	Paralleling	False	Standby		O										
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## Next Steps

- Finalize IEC 61850-7-420 by mid-2008
- Address the “verbs” issues:
  - MMS-based?
  - Web services based?
  - Both, depending upon requirements?
- Conformance testing requirements
  - Pilot implementations
  - Interoperability testing
- Determine what DER aspects should be modeled in CIM
  - Distribution power system configurations with DER
  - Distribution Management Systems
- Undertake models of additional DER types
  - Energy storage?
  - Plug-in electric vehicles?
  - Biomass?

# Questions?



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