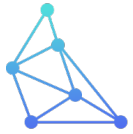
DER Communication and Data Management: From Interoperability to Impacts

ESIG Webinar. 28 November 2023



TELOS ENERGY

EnerNex

A CESI Company

Sean Morash
Sean.Morash@telos.energy

Aaron F. Snyder, Ph.D.
aaron@enernex.com

EnerNex

A CESI Company

Knoxville, TN
Headquarters

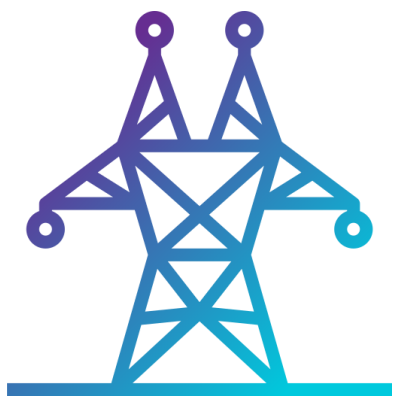
2003
Founded

- Go-to resource for understanding and solving an assortment of diverse, complex, and holistic energy challenges
- Capability to span energy topics from strategic guidance to detailed engineering analyses provides maximum flexibility and insight to our clients
- Joined the world-leading electric power testing, consulting and engineering company CESI in June 2018
- KEMA Labs is also part of CESI group, operating operating the largest independent high power and high voltage laboratories in US and Europe
- Our Mission: To advance a cleaner, smarter energy system of the future by combining our deep sector competence with innovative engineering and consulting in support of the electric power industry worldwide.

Photo Copyright © 2023 Aaron F. Snyder. All Rights Reserved. Used with permission.

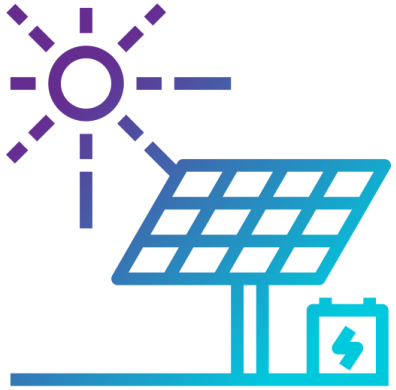
TELOS ENERGY

ANALYTICS & ENGINEERING FOR A CLEAN, RELIABLE, & EFFICIENT POWER GRID.



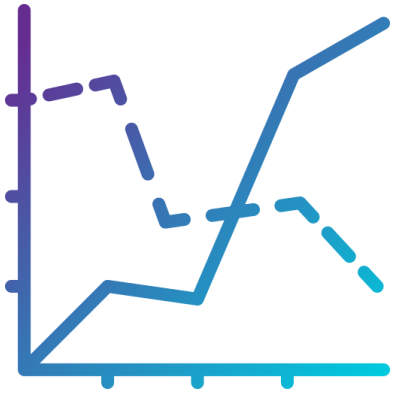
Transmission Planning

Wind and Solar Integration



Inverter Controls & Grid Monitoring

DER Planning and Storage Specification



Public Policy & Market Design

At Telos Energy, we're here to solve the industry's toughest challenges related to renewable integration.

Agenda

- Introduction - DER landscape
  - Adoption trends
  - FERC 2222
- Standards landscape
- DER Standards
  - Communication
  - Data and reporting standards from field deployed assets to utility back office
  - DERMS interoperability, data, standards, modeling, benefits
- Not just "DERMS”
  - DER in Planning
  - Planning on DER

Wunderkammer

(German, “wonder chamber”)

A room containing a private collection of rare natural history items such as corals, but above all curiosities such as mandrakes, misshapen antlers, and narwhal tusks

Predecessors of natural history museums

Adapted from oxfordreference.com
Image via ChatGPT

TELOS ENERGY

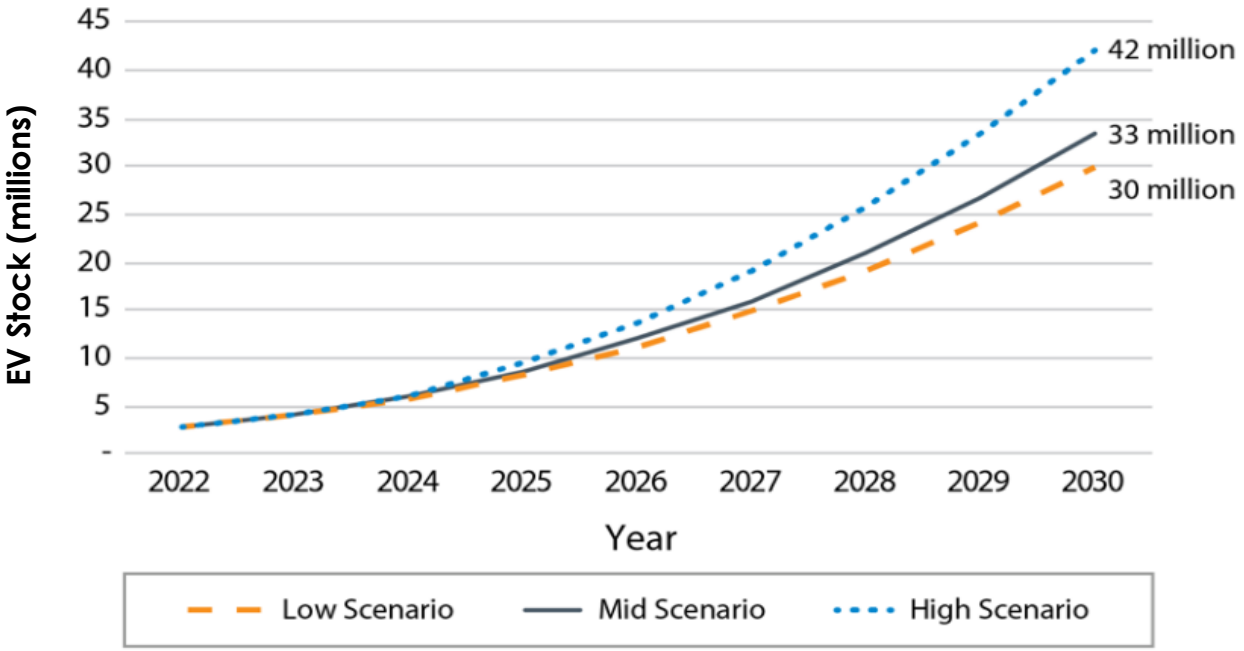
DER Adoption Trends: Vehicle Electrification

Vehicle electrification continues to accelerate

- Drivers: customer demand, commitments from vehicle manufacturers, public policy

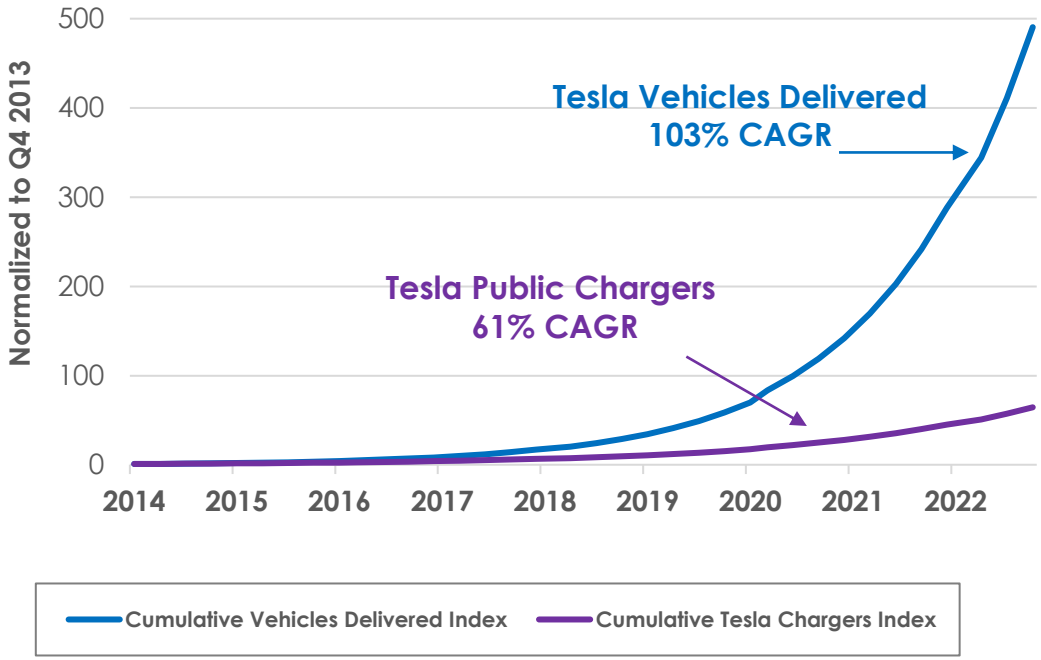
Dealing with large quantities now, growing larger

U.S: EV Adoption Scenarios (light-duty)[1]



Exponential Growth Recently

Tesla: vehicles delivered and public chargers[2]



[1]NREL. 2023. *The 2030 National Charging Network*
[2]Tesla

DER Adoption Trends: Building Electrification

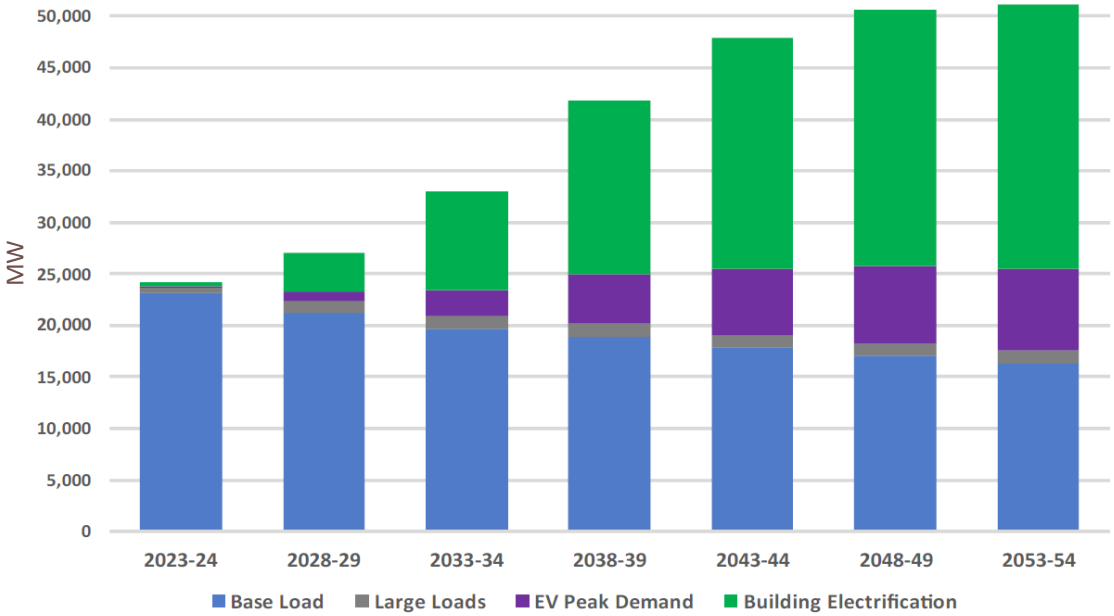
Building electrification shifting risk

- Drivers: public policy, weather events, customer preference

Changing Risk Profile with Winter Events

Winter peak events can last much longer than summer events. In 2019, the weighted average temperature across New York was less than 10°F for 36 consecutive hours.

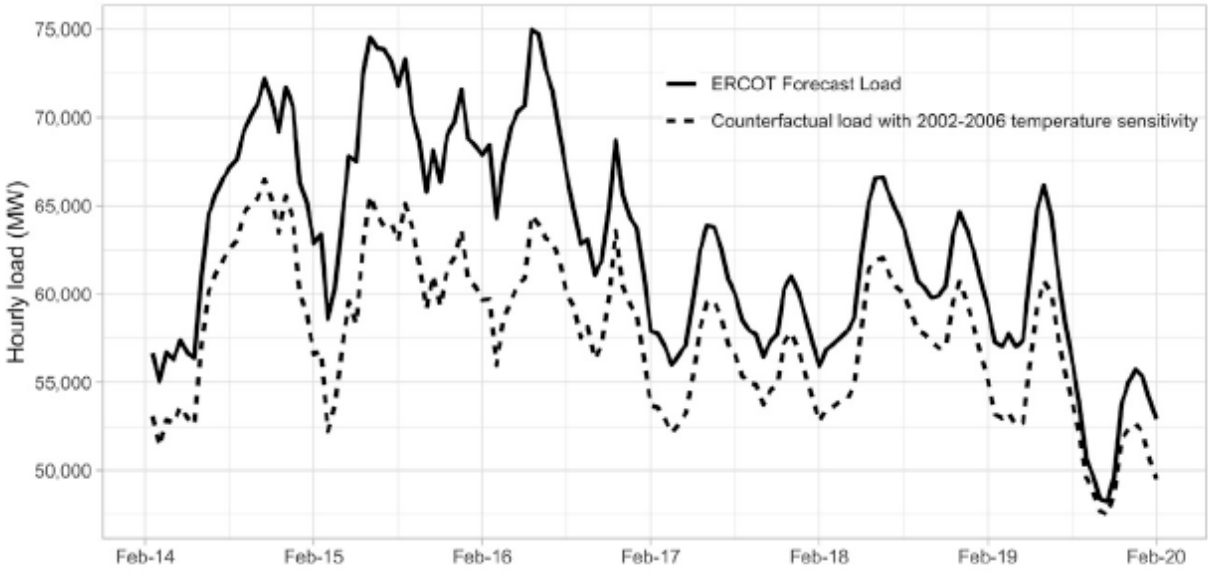
NYCA Winter Peak Demand Forecast Components



Increasing Electric Load Sensitivity to Weather

Before we get to a future with widespread heat pumps, buildings are already becoming more sensitive to temperature given technology adoption and aging building stock.

ERCOT Temperature Sensitivity Increasing



Left: NYISO / Maniaci 2023. Right: Shaffer, Quintero, Rhodes. Changing Sensitivity to cold weather in Texas power demand.

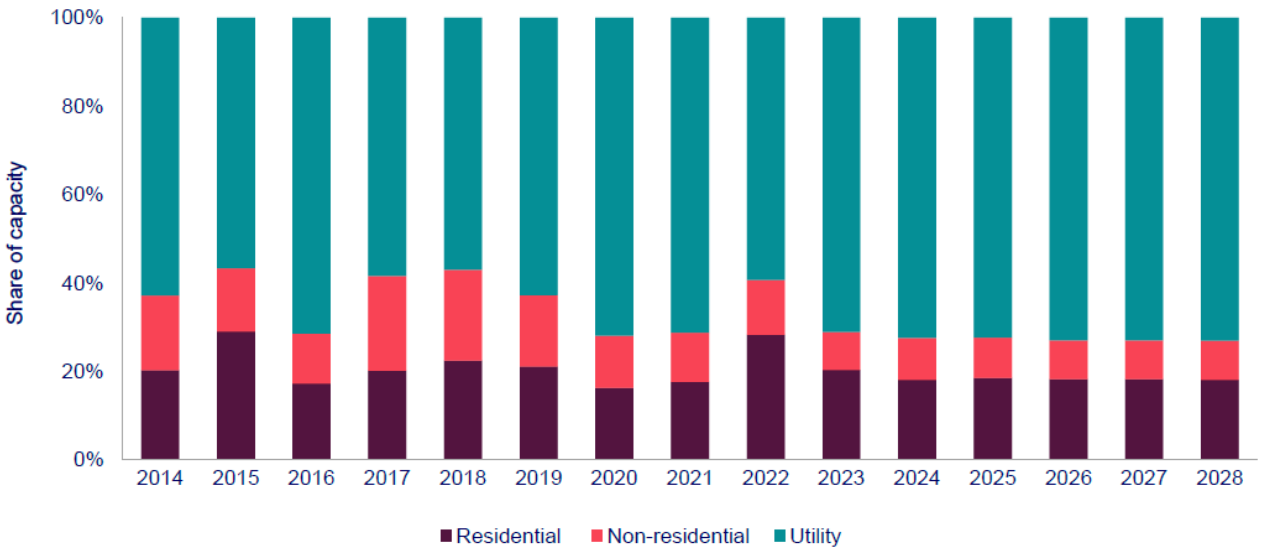
DER Adoption Trends: Solar and Storage

Distributed Solar and Storage aren't going away

- Drivers: public policy, costs, customer preference

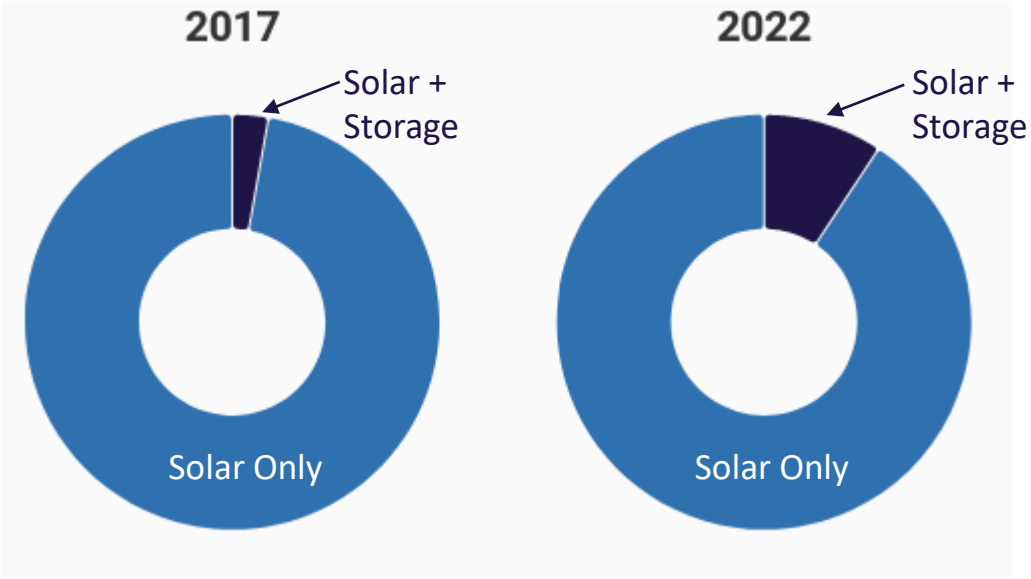
Distributed solar has been a large part of the pie

US PV Share of Capacity (historical and forecast)



Distributed Solar+Storage Market Growing

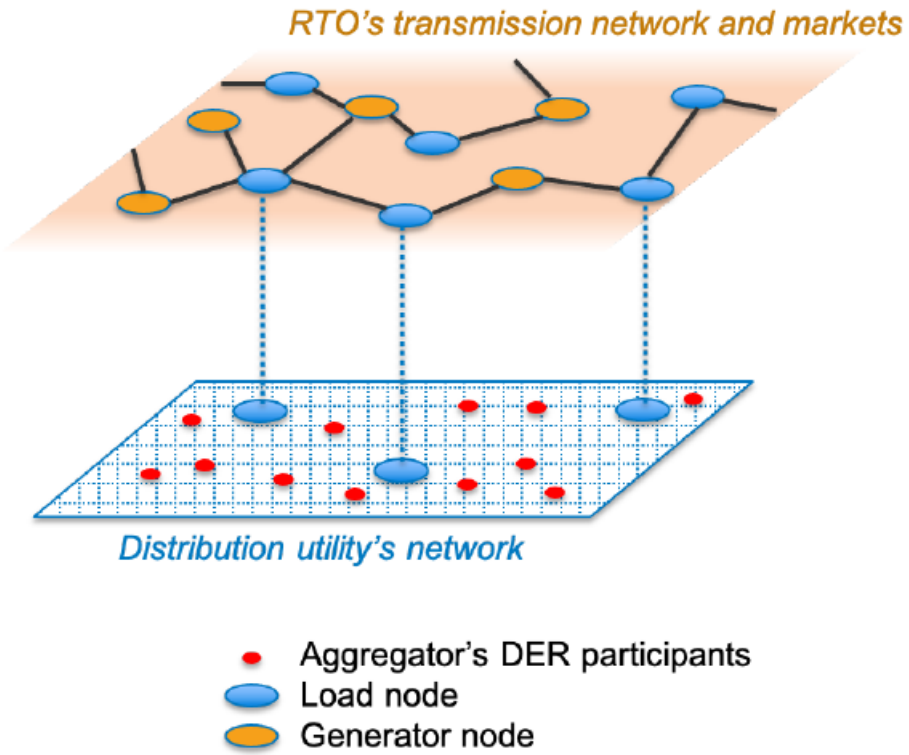
Distributed Solar Systems Paired with Energy Storage



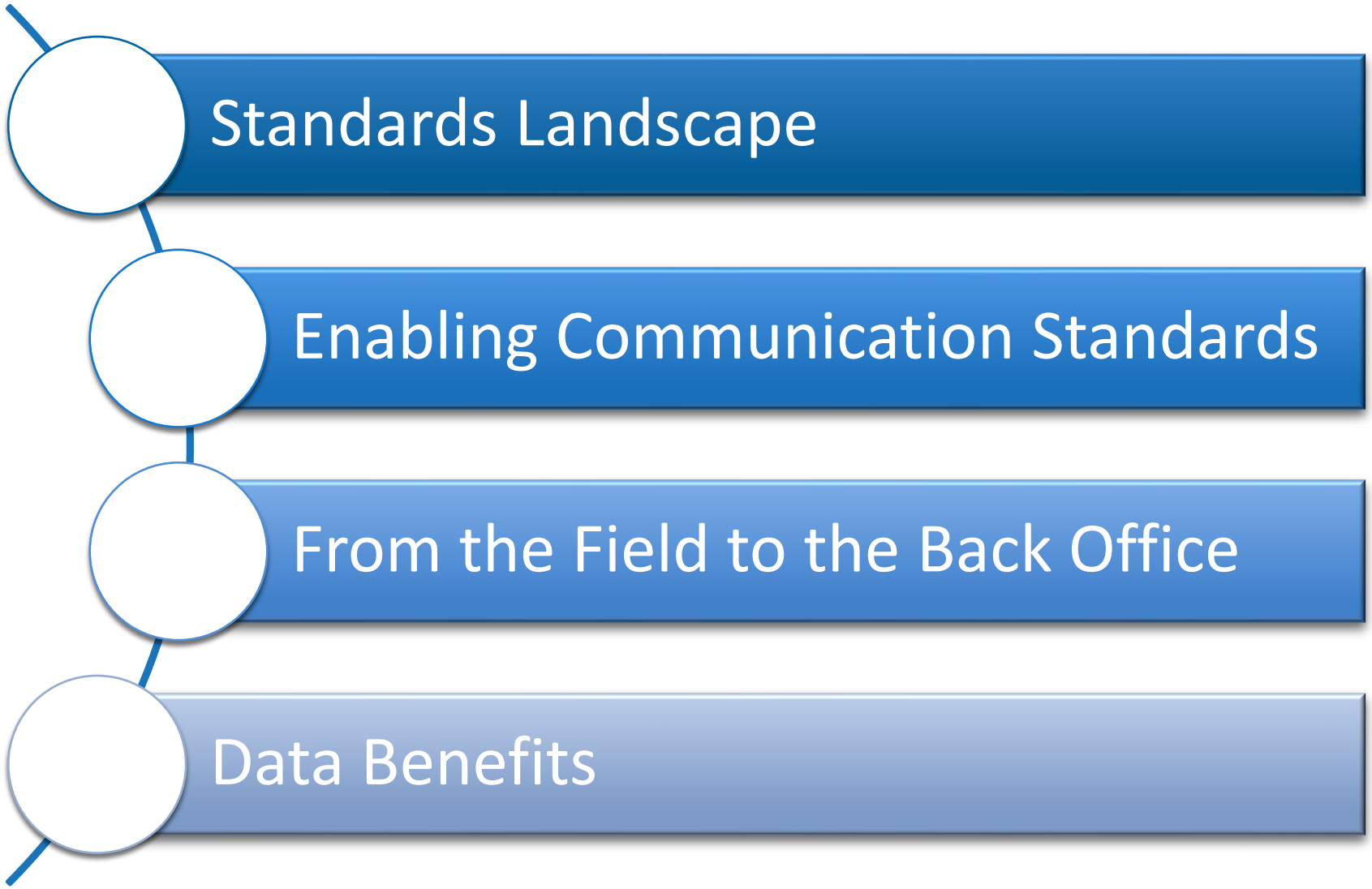
Source: SEIA / Wood Mackenzie Power & Renewables Solar Market Insight 2022 Year in Review

FERC Order No. 2222 – issued in Sept. 2020

- The main goal is to better enable DERs to participate in the electricity markets run by regional grid operators.
- **Includes a minimum size requirement no larger than 100 kW (0.1 MW).**
- The RTO/ISOs **must incorporate a process to allow the distribution utility's review** of the individual DER to determine:
  - If DER can physically participate in an aggregation
  - If DER will create a distribution network reliability or safety issue.
- The RTO/ISO must have **operational coordination with distribution utilities**; addressing data flows and communication between the RTO/ISO, DER provider, and the distribution utility; and establishes protocols and processes that **allow distribution utilities to override the RTO/ISO dispatch of a DER aggregation on the operating day.**



Source: NREL Primer on FERC Order No. 2222.

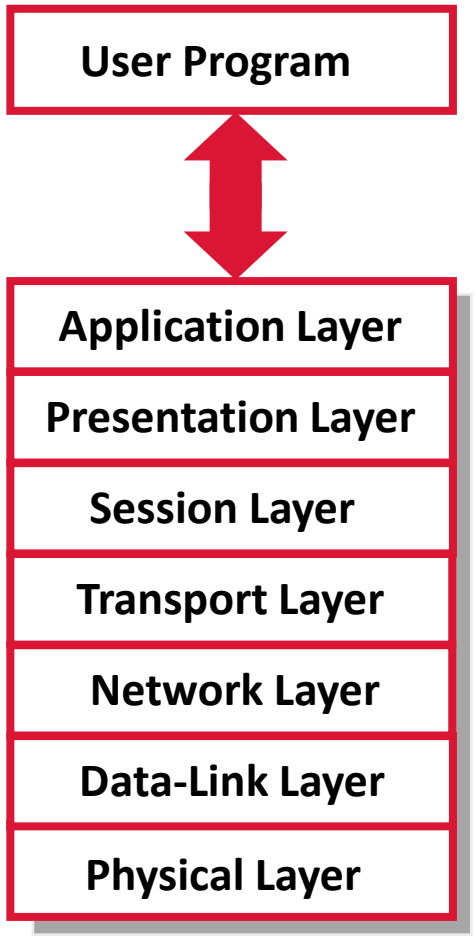

Standards Landscape
Enabling Communication Standards
From the Field to the Back Office
Data Benefits

Standards Landscape

- The “layers” concept is often used in communications and our industry to create well-defined points of integration and interoperability

- A way to organize the tasks that make up a protocol’s job
- The accepted international standard for evaluating and comparing different networking solutions
- Seven layers, each with a specific function
- A user program accesses communications through the application layer
- OSI stands for “Open Systems Interconnect”

The OSI Reference Model



What is the job the protocol needs to do?

How is the data encoded?

How can several conversations take place?

How to recover from link errors & failures?

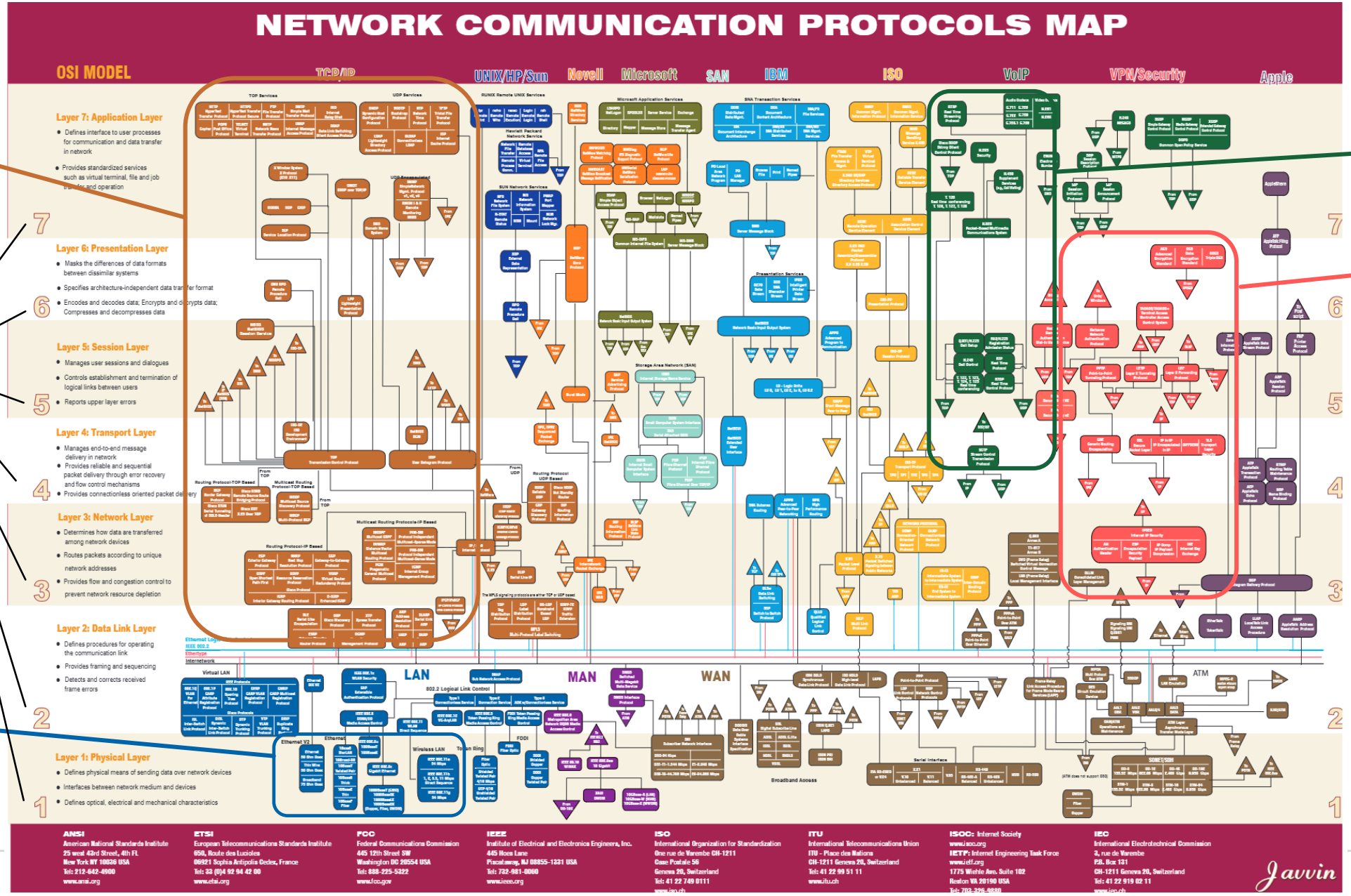
What route should the messages take?

Who gets to talk on the link when?

What are the physical signals and wires?

Standards Landscape

Famous poster (no longer available)



TCP/IP

Protocols & Standards

Ethernet & WiFi

VoIP

VPN

Competing & Complementary

Standards Landscape - Application Layer Protocols

All support TCP/IP

- For Distribution Automation
  - IEEE 1815/DNP3
  - Modbus
  - IEC 61850
  - IEC 60870-5

All support TCP/IP

- DER/DR
  - IEEE 2030.5
  - IEEE 1815/DNP3
  - IEC 61850-7-420
  - SunSpec Modbus
  - OpenADR

Supports TCP/IP

- Meter Reading
  - ANSI C12.19/C12.22

All support TCP/IP

- Information Exchange
  - IEC 61968 CIM
  - Multispeak

- Field Device Coordination
  - OpenFMB

Purpose is to coordinate devices across protocols

Standards Landscape - IEEE 1547 & DER

- IEEE 1547 is a standard which defines features / functionality for smart inverters
  - Not a Field Area Network standard, but it does specify that DER shall support a communication protocol (application layer) from a list of eligible protocols and selected by the utility.

IEEE 1547-2018 excerpt

The DER shall support at least one of the protocols specified in Table 41. The protocol to be utilized may be specified by the Area EPS operator. Additional protocols, including proprietary protocols, may be allowed under mutual agreement between Area EPS operator and DER operator. Additional physical layers may be supported along with those specified in the table.

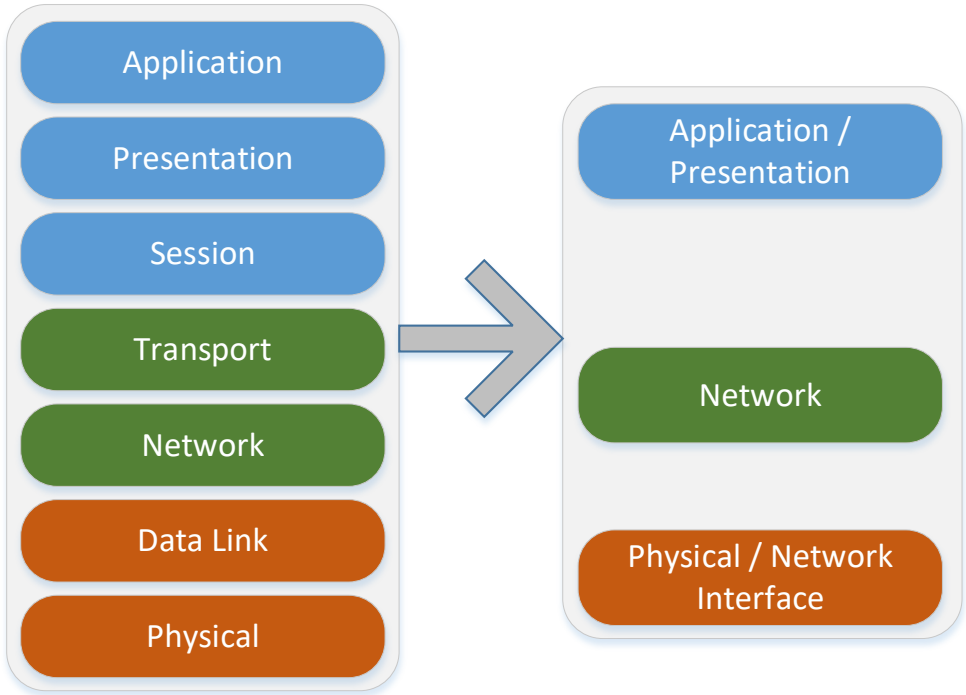
Table 41—List of eligible protocols

Protocol	Transport	Physical layer
IEEE Std 2030.5 (SEP2)	TCP/IP	Ethernet
IEEE Std 1815 (DNP3)	TCP/IP	Ethernet
SunSpec Modbus	TCP/IP	Ethernet
	N/A	RS-485

The three columns correspond to the simplified three-layer model.

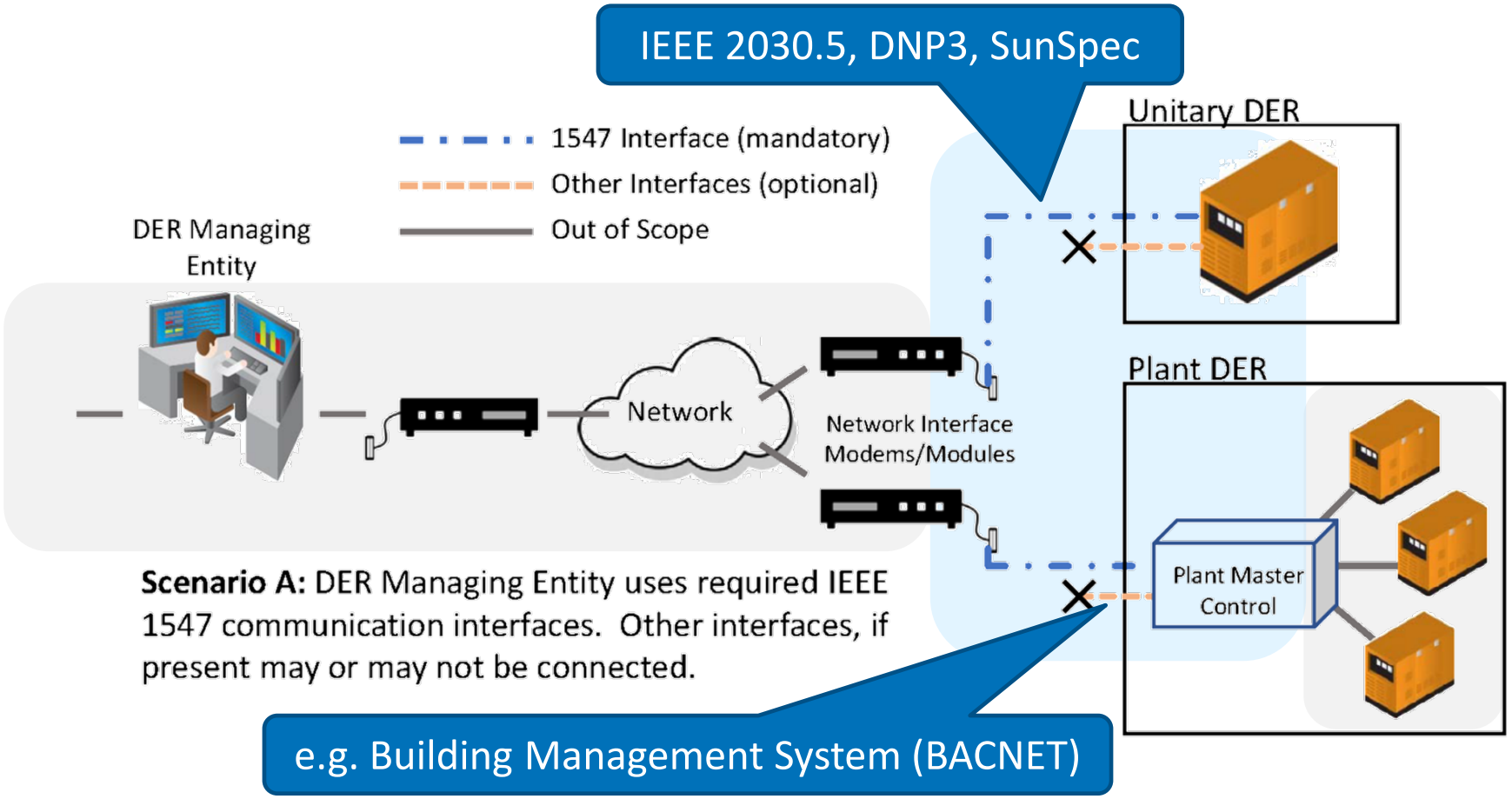
https://standards.ieee.org/standard/1547-2018.html

OSI 7 Layer Network Model and the 4 Layer TCP/IP Network Model can be abstracted into 3 Layers



Standards Landscape - IEEE 1547 Scope of Communications Interface

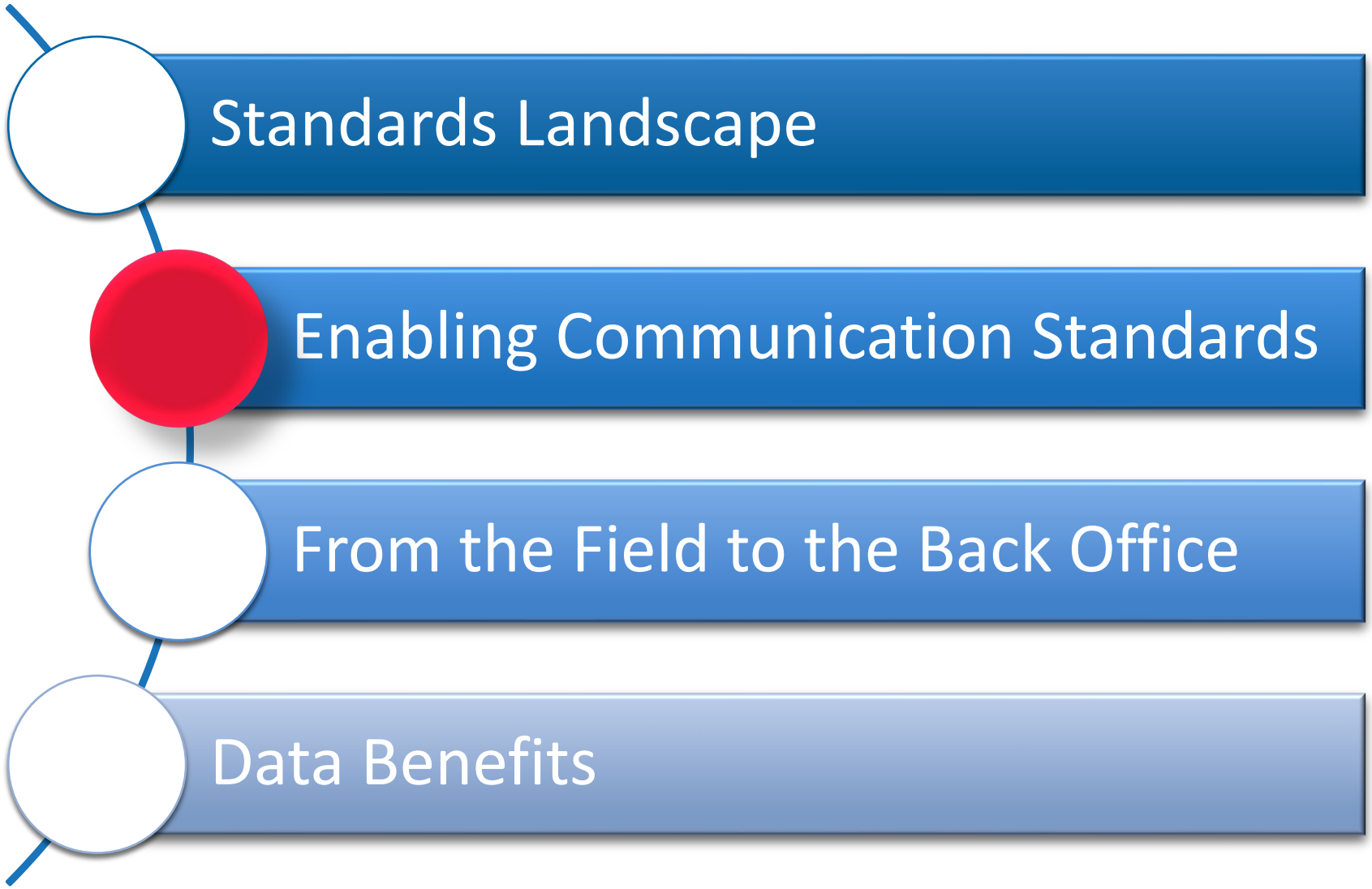
- Scope of 1547 is limited to the communications interface between the DER system and the network interface used to communicate with the DER system.



Scenario A: DER Managing Entity uses required IEEE 1547 communication interfaces. Other interfaces, if present may or may not be connected.

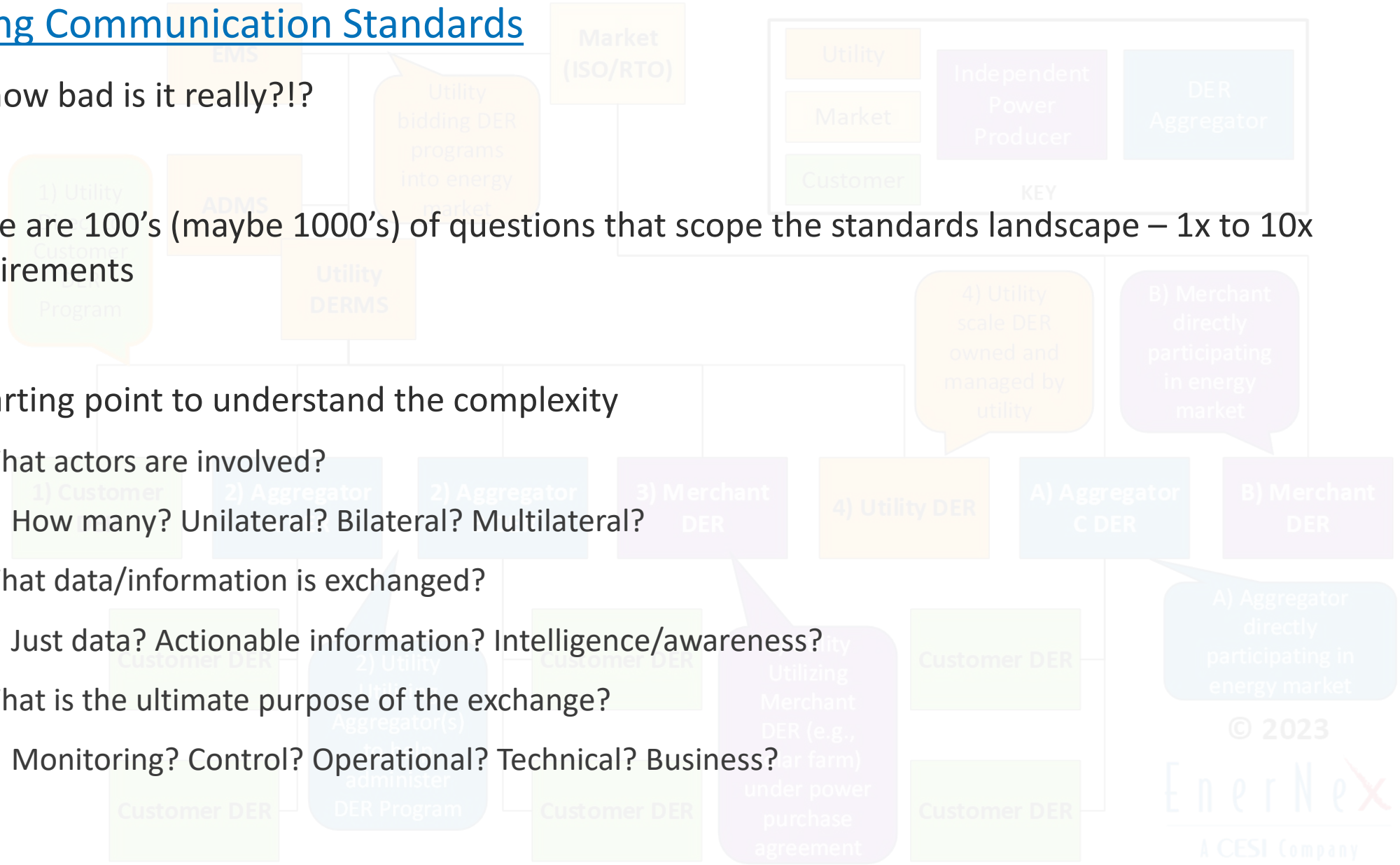
Figure D.1—DER using standardized local DER communication interface

https://standards.ieee.org/standard/1547-2018.html


Standards Landscape
Enabling Communication Standards
From the Field to the Back Office
Data Benefits

Enabling Communication Standards

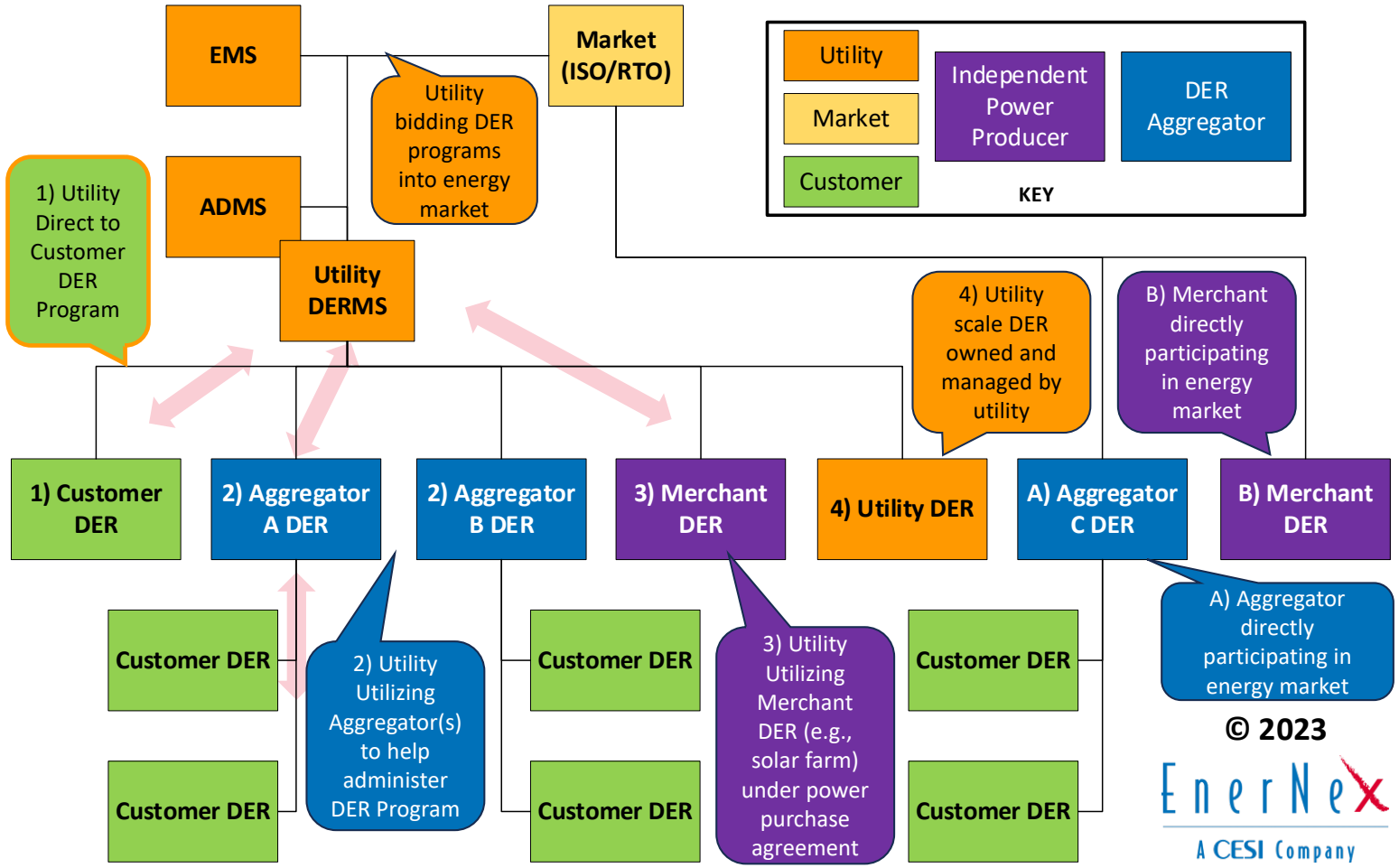
- So, how bad is it really?!?
- There are 100's (maybe 1000's) of questions that scope the standards landscape – 1x to 10x requirements
- A starting point to understand the complexity
  - What actors are involved?
    - How many? Unilateral? Bilateral? Multilateral?
  - What data/information is exchanged?
    - Just data? Actionable information? Intelligence/awareness?
  - What is the ultimate purpose of the exchange?
    - Monitoring? Control? Operational? Technical? Business?



Enabling Communication Standards – Business View

What actors are involved?
- How many?
- Unilateral?
- Bilateral?
- Multilateral?

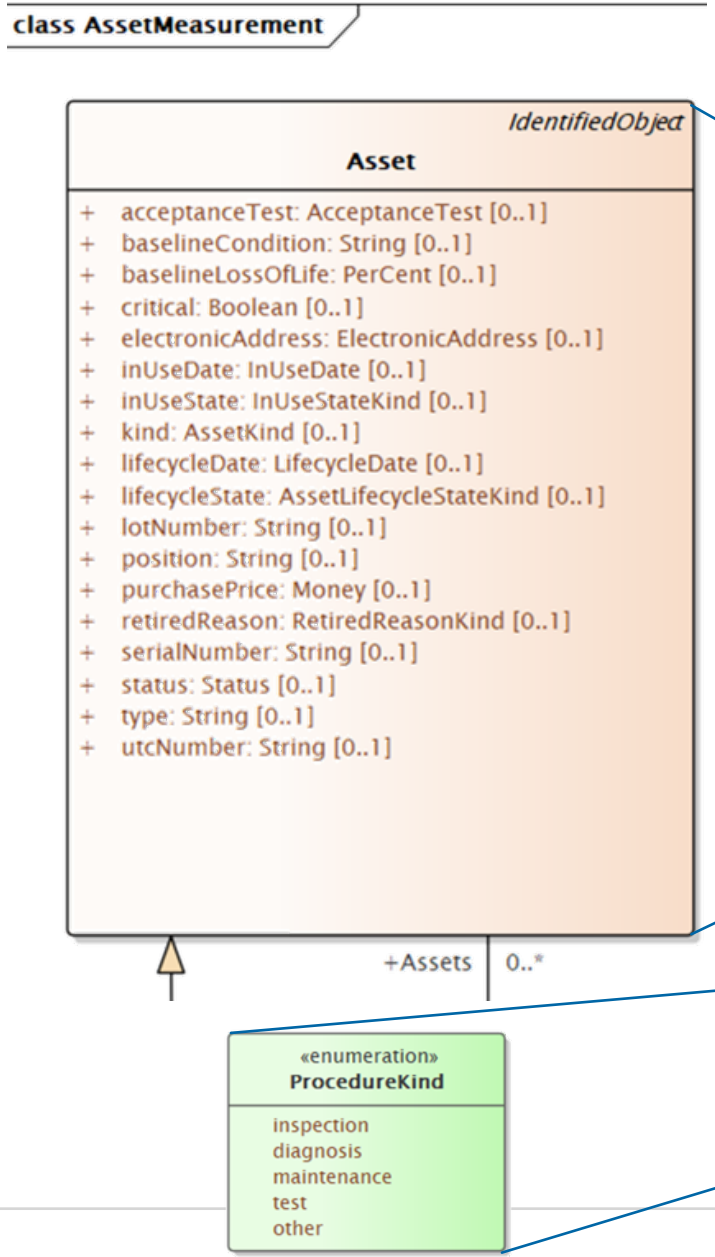
What data/information is exchanged?
- Just data?
- Actionable information?
- Intelligence/awareness?

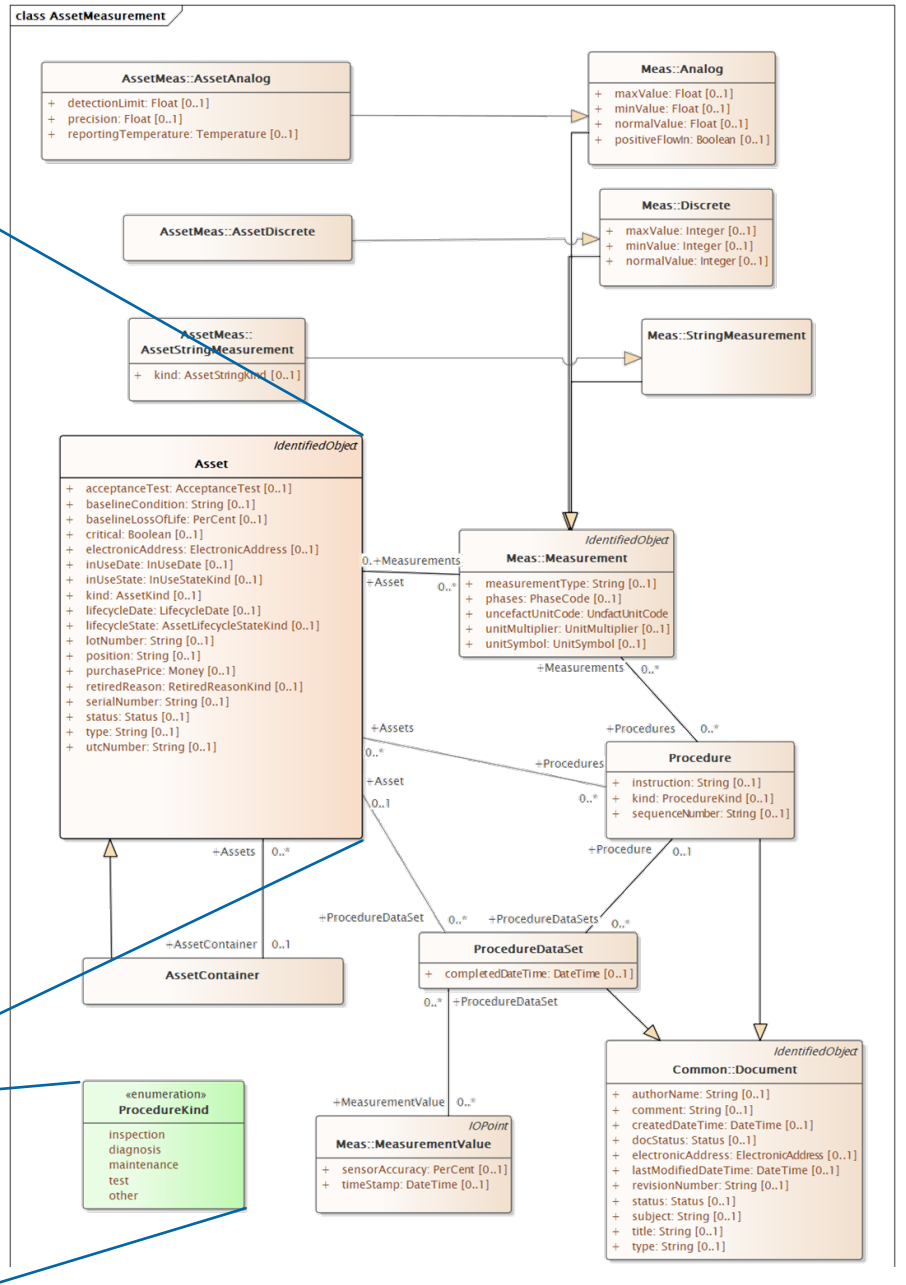


Enabling Communication Standards – Technical View

What actors are involved?
- How many?
- Unilateral?
- Bilateral?
- Multilateral?

What data/information is exchanged?
- Just data?
- Actionable information?
- Intelligence/awareness?

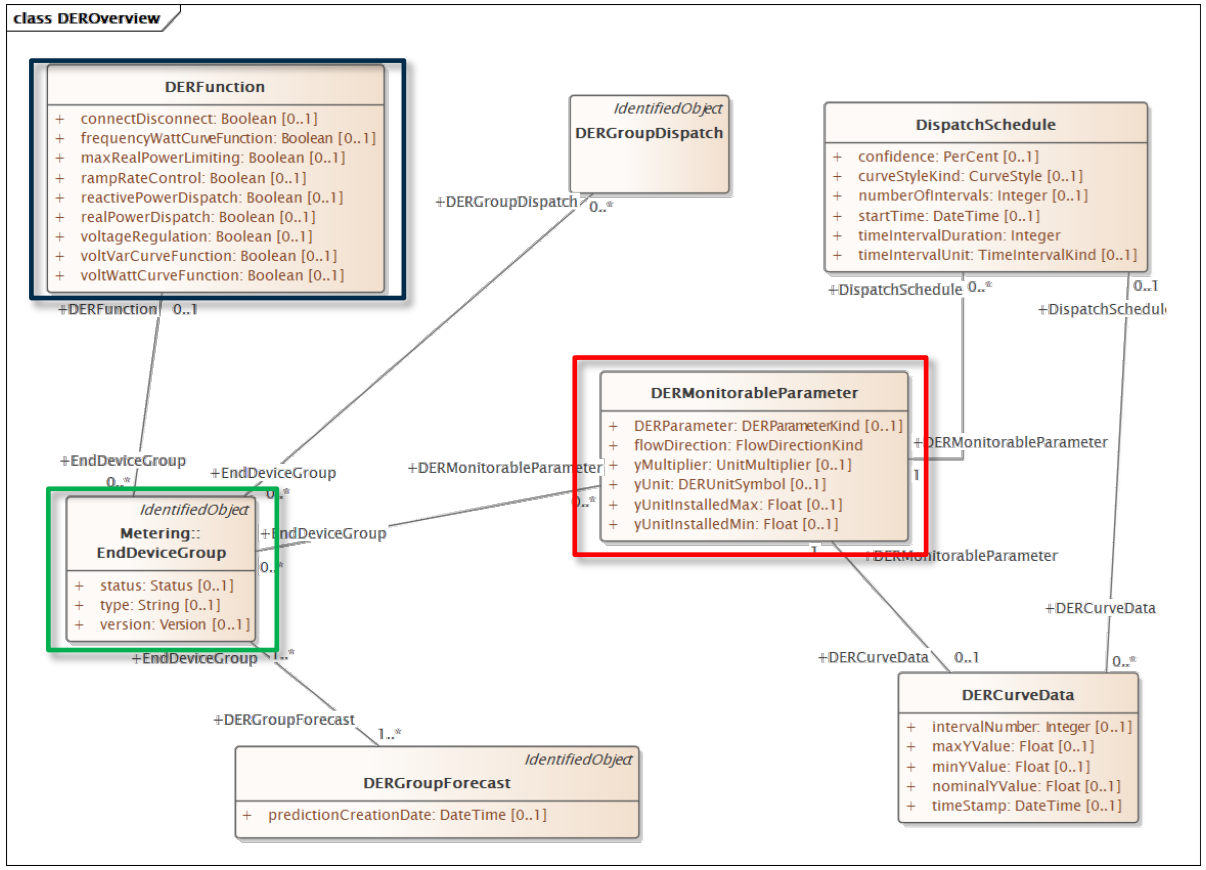




Viewpoint Example
IEC 61968 “Application integration at electric utilities - System interfaces for distribution management”

iec61970cim17v16_iec61968cim13v11_iec62325cim03v14

Enabling Communication Standards – Operational View

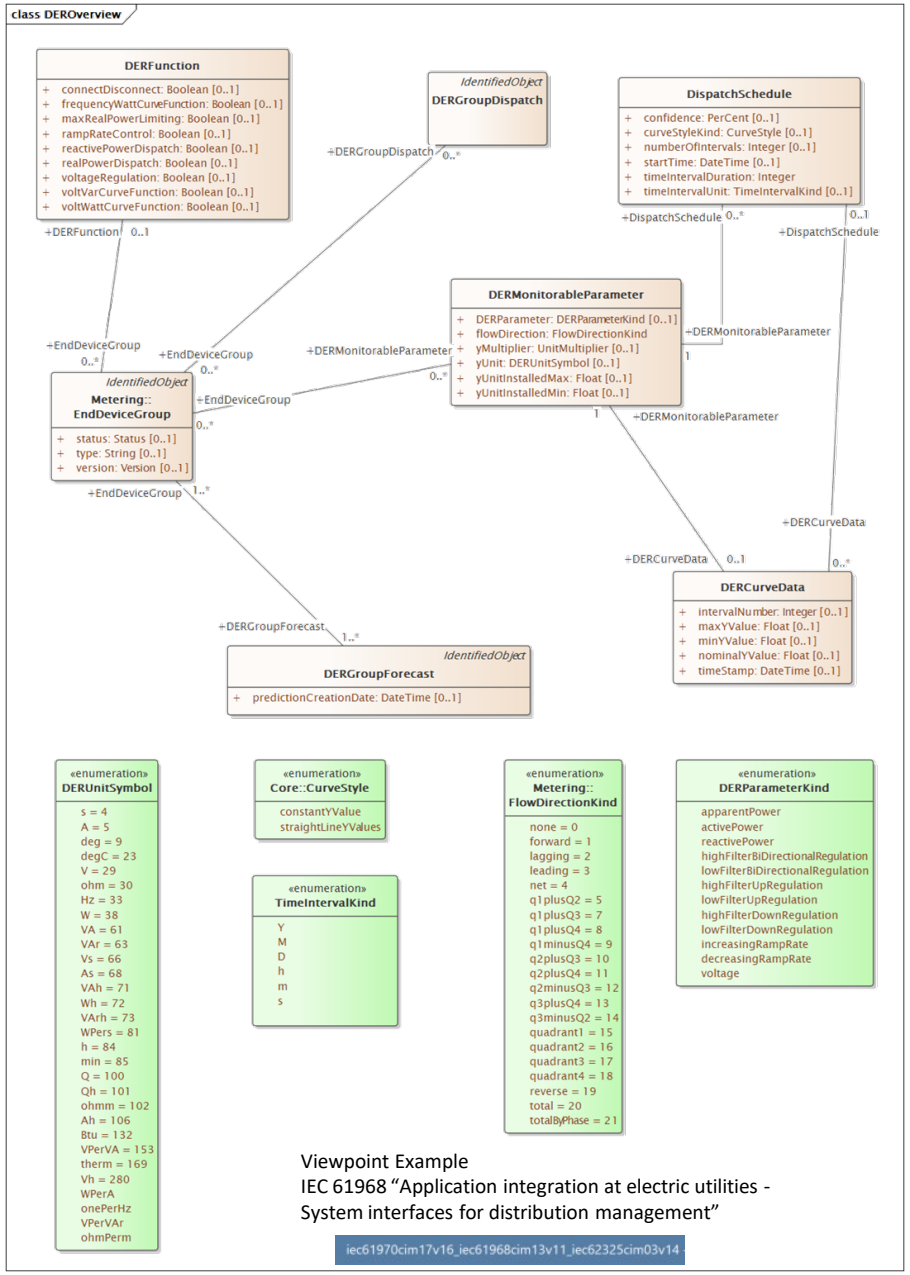


What data/information is exchanged?

- Just data?
- Actionable information?
- Intelligence/awareness?

What actors are involved?

- How many?
- Unilateral?
- Bilateral?
- Multilateral?



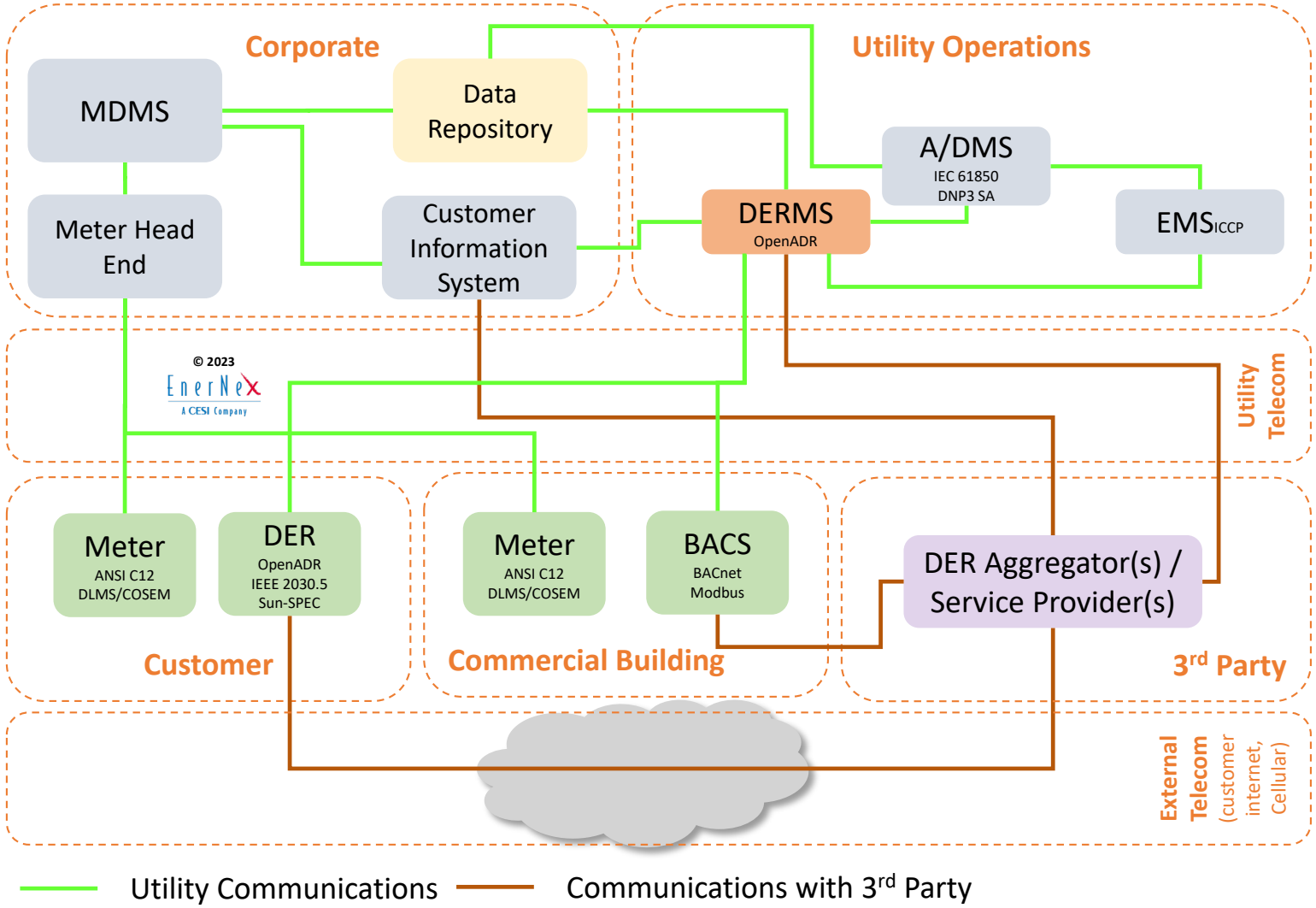
Viewpoint Example
IEC 61968 "Application integration at electric utilities - System interfaces for distribution management"

iec61970cim17v16_iec61968cim13v11_iec62325cim03v14

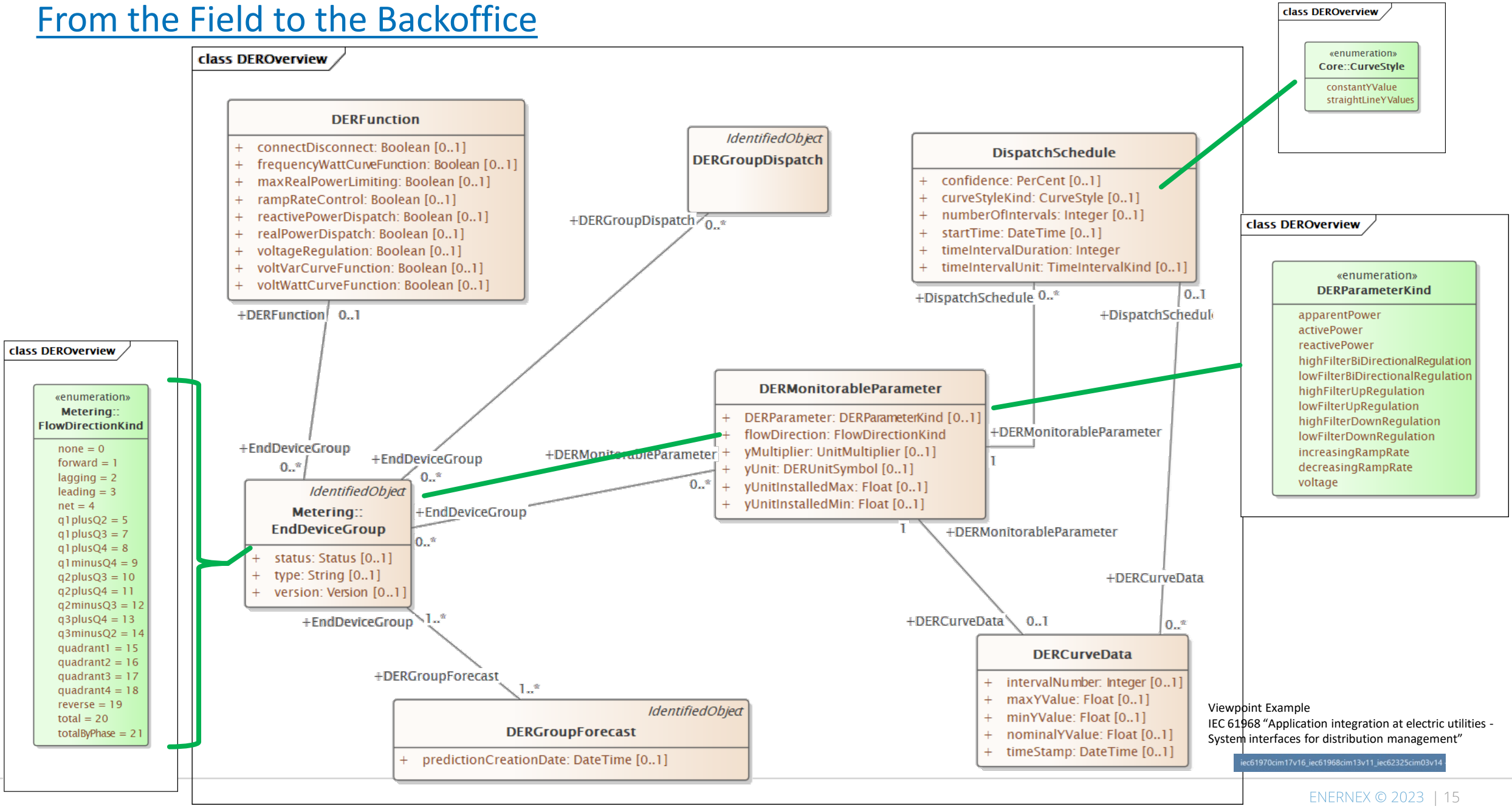
Enabling Communications Standards

- Communications Standards needed to enable various types of DER monitoring & control

- Field
  - IEEE 2030.5
  - SunSPEC MODBUS
  - IEC 61850
- Field to Enterprise
  - OpenADR
  - DNP3.0 SA
  - IEC 61850
- Enterprise to Enterprise
  - IEC CIM
- External
  - Proprietary

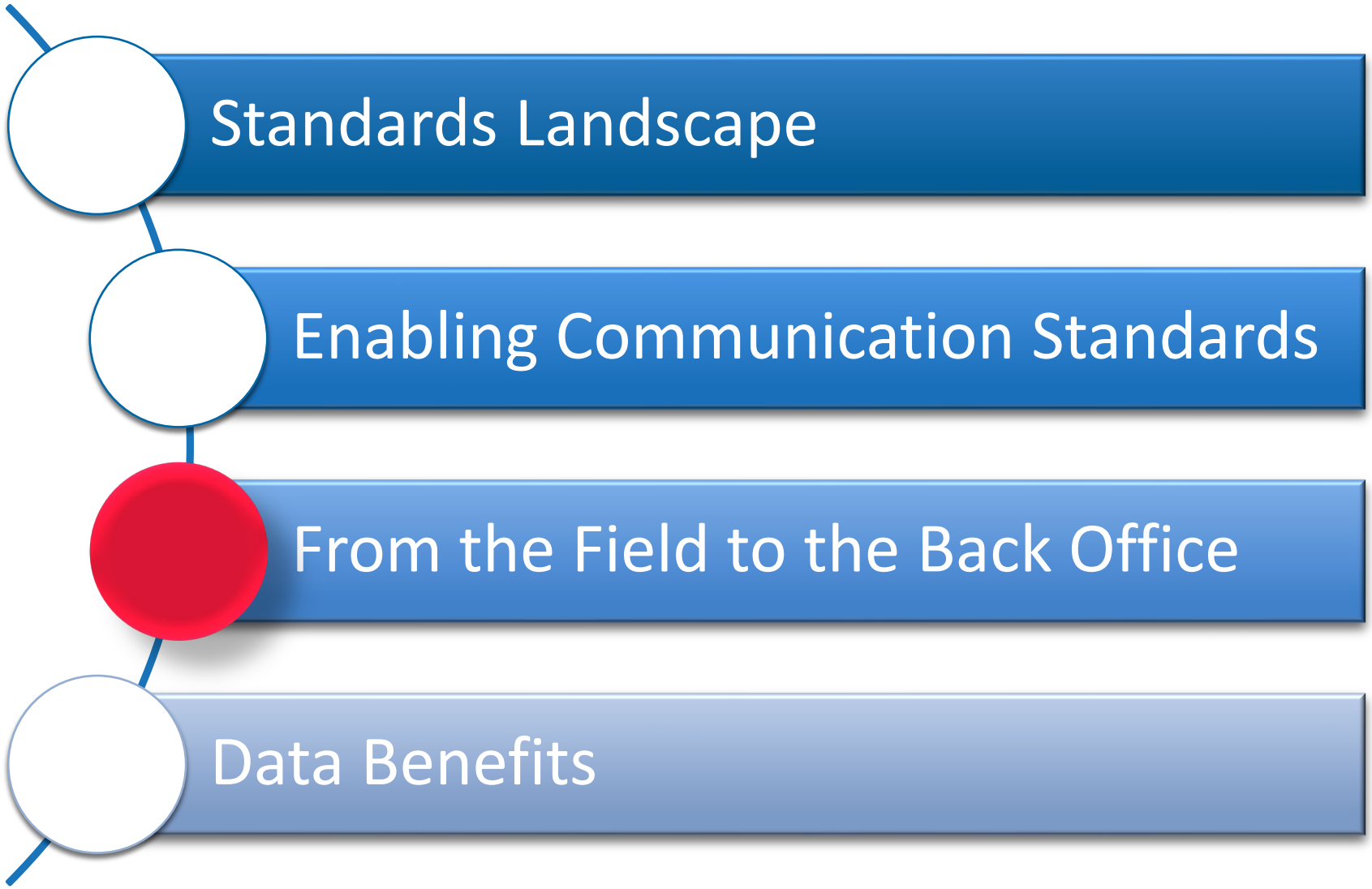


From the Field to the Backoffice



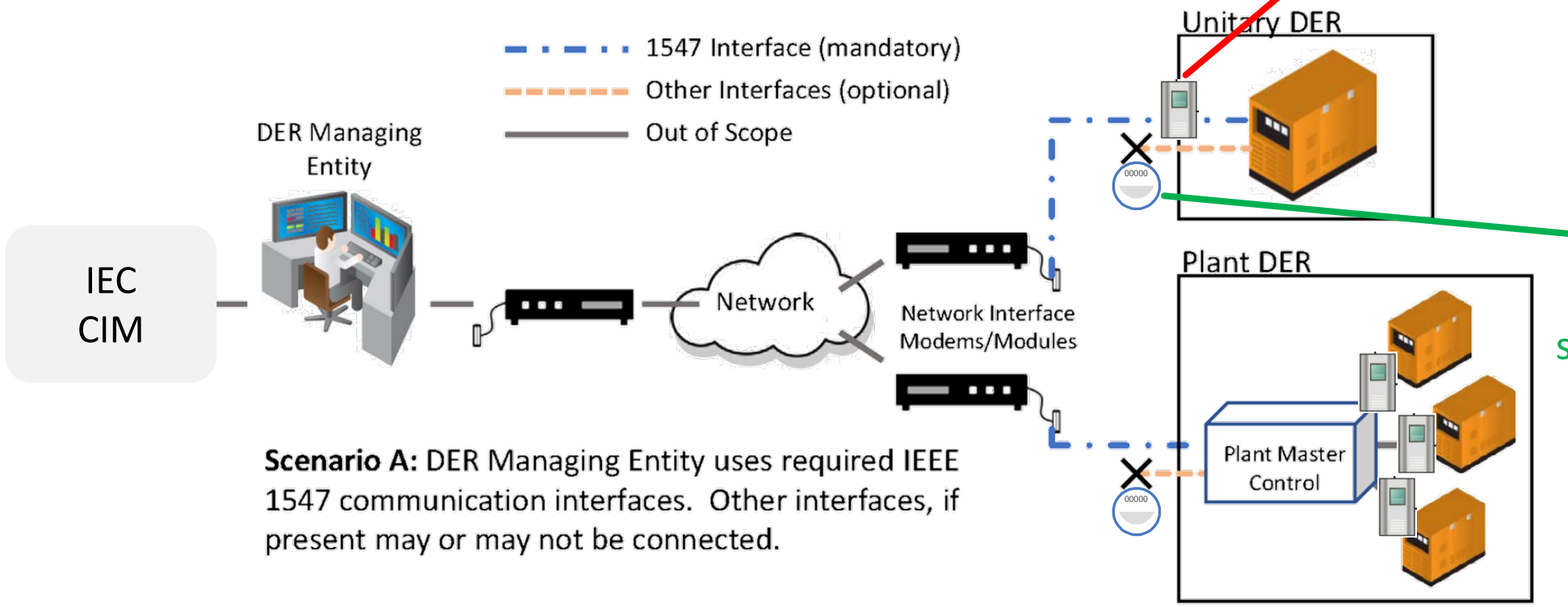
Viewpoint Example
IEC 61968 “Application integration at electric utilities - System interfaces for distribution management”

iec61970cim17v16_iec61968cim13v11_iec62325cim03v14


Standards Landscape
Enabling Communication Standards
From the Field to the Back Office
Data Benefits

From the Field to the Backoffice

What does/could the inverter provide and by what standard(s) and protocol(s)



What does the meter provide and by what standard(s) and protocol(s)

Scenario A: DER Managing Entity uses required IEEE 1547 communication interfaces. Other interfaces, if present may or may not be connected.

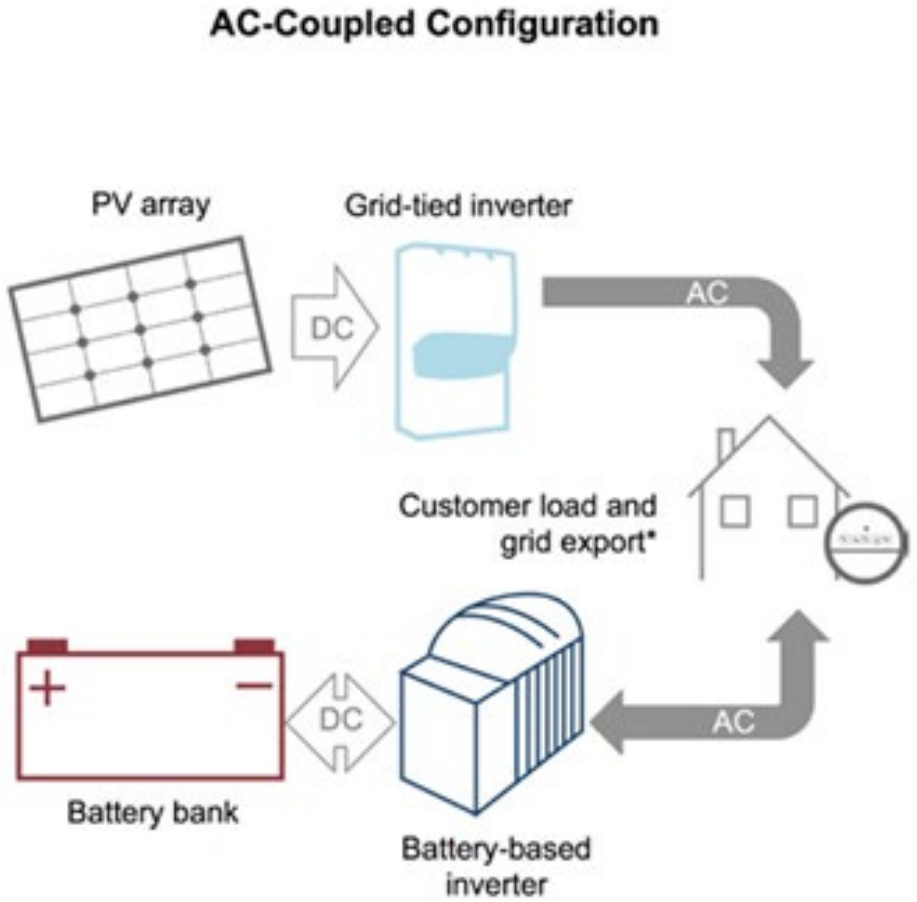
Figure D.1—DER using standardized local DER communication interface

From the Field to the Back Office

Data and Communications
Perspective – Context – Point of View

Modeling
Simulation and Performance
- Nameplate?
- Real output?
- Ramp rates?
- V/I/P/Q
- Charging /Output curves…
- …

Health
Monitoring and Service
- Charge Cycles?
- % life vs. nameplate?
- Operating voltage?
- Internal/External Temperature?
- Component Status?
- …

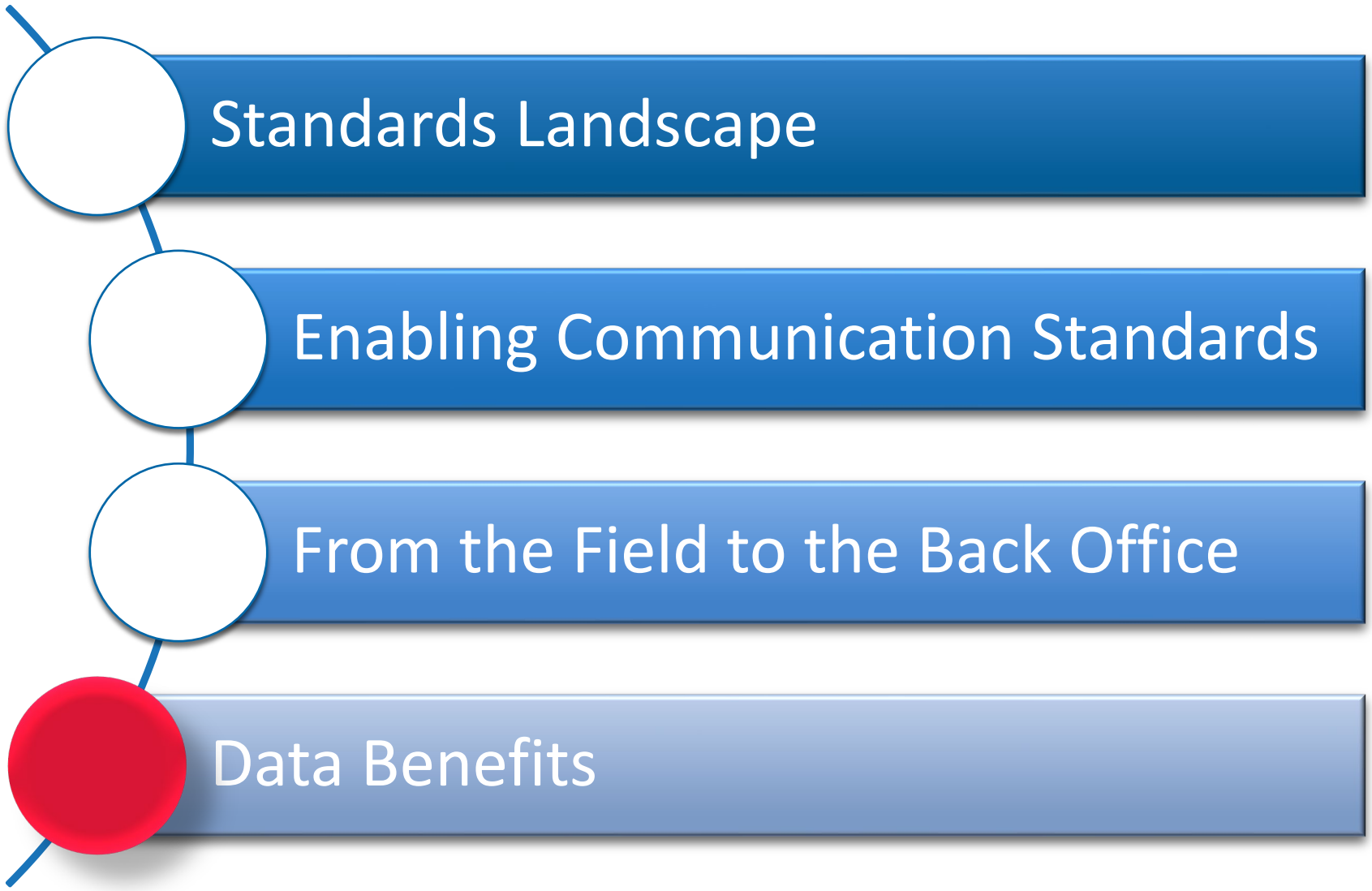


Operations
Monitoring and Control
- Behind the Meter?
- Grid Asset?
- Behind an Aggregator?
- Net Metered?
- Dispatchable kX/kXh?
- Ancillary Services?
- …

Geospatial
Modeling and Dispatching
- X/Y/Z?
- Phasing?
- Connectivity / Conductors?
- 3D image?
- Thermal image?
- …

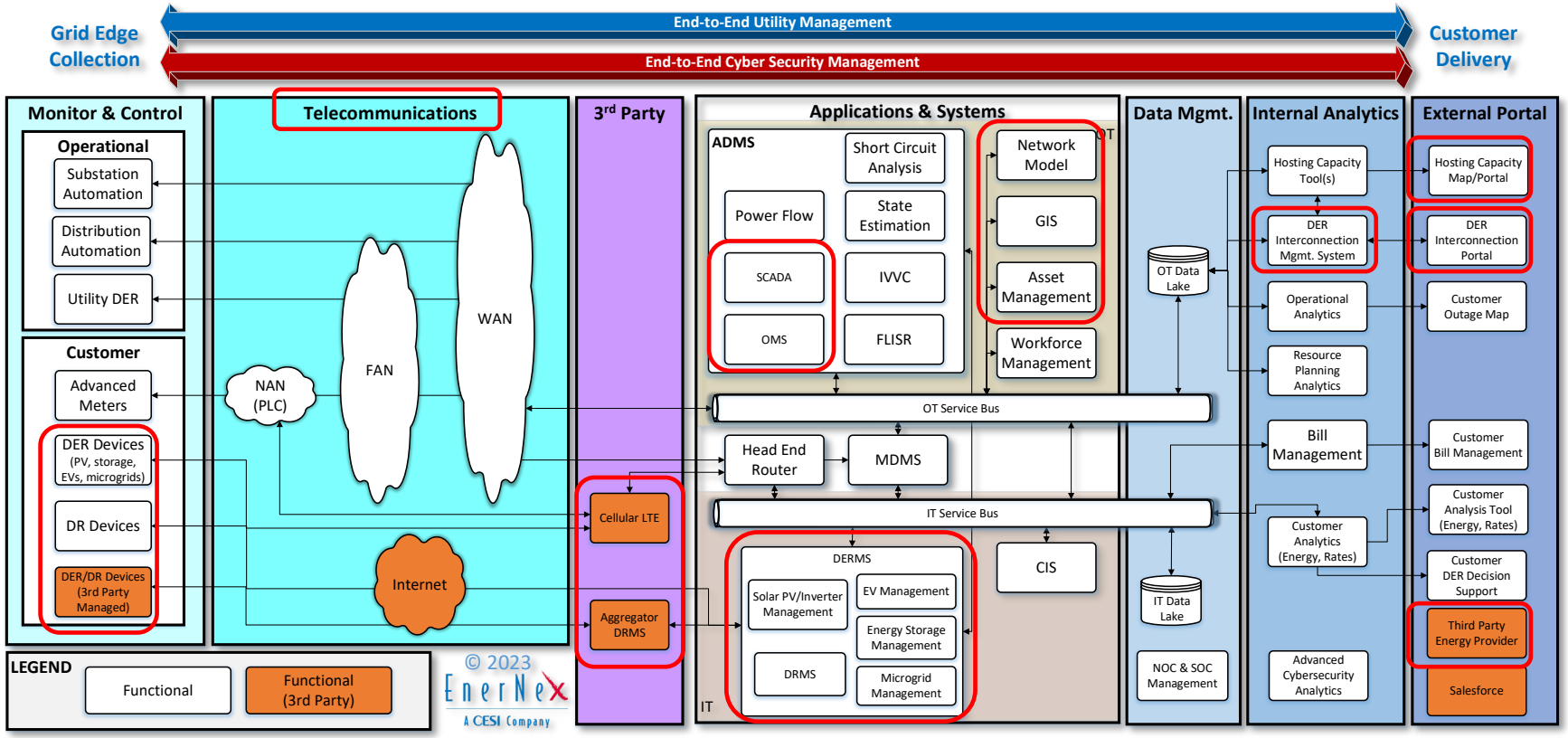
Granularity – Periodicity – Volume - Dynamism

Image source NREL: https://doi.org/10.2172/1829460


Standards Landscape
Enabling Communication Standards
From the Field to the Back Office
Data Benefits

Data Benefits

- Interoperability
  - Make connectivity “consumer” and “user” friendly – Ethernet, WiFi, cellular
  - Make data “consumer” and “user” friendly for device, communications, and application needs



- Standards
  - Data model / application layer – have to understand device, communications, and application needs
  - Network communications layers – have to understand data volume and velocity, periodicity and frequency

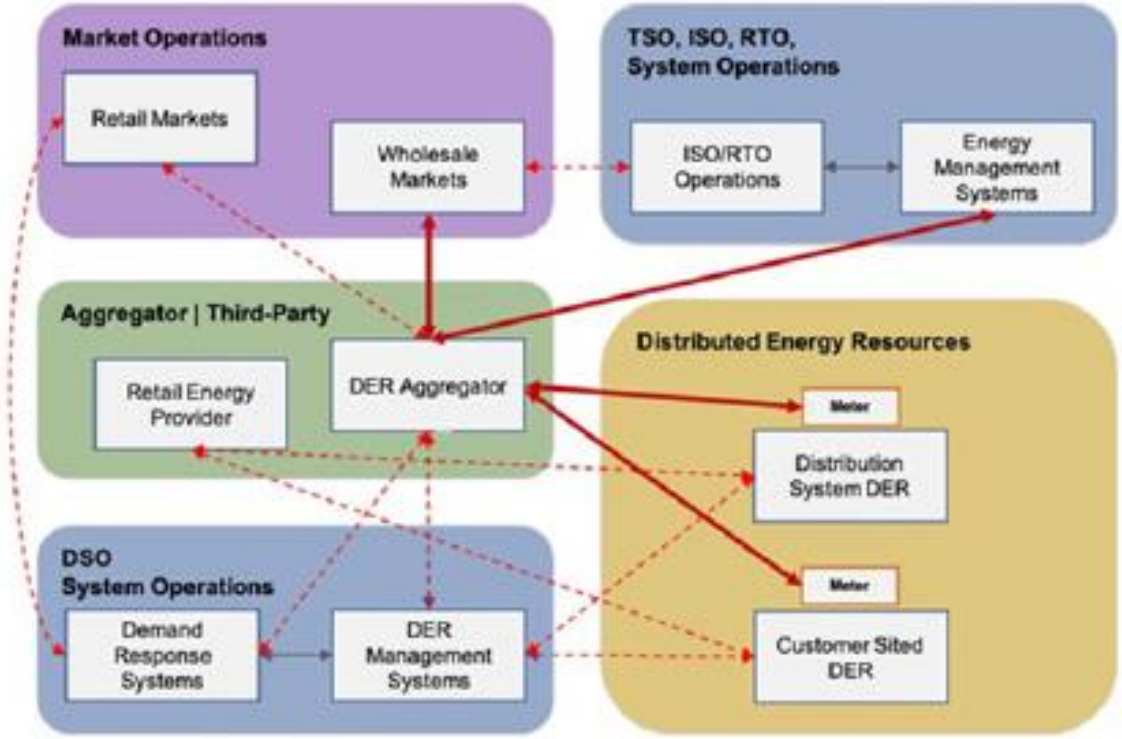
- Modeling
  - Device data model – remember the device has to capture/record the necessary data and best if it is all standardized
  - Communications data model – unlikely to need a “new” one, work within existing standards where possible
  - Enterprise application data model – ease the data exchange between applications and across domains

Not Just “DERMS”

Using DER Data in Planning

Not just “DERMS” – Use Data Across Utility

“Simple” DERMS Architecture

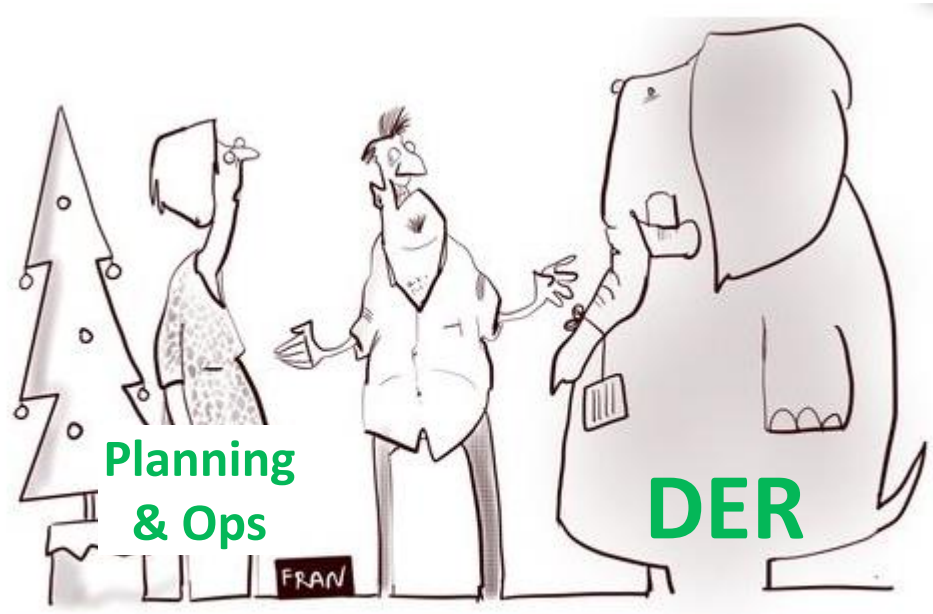


Operations and Markets are just one part of the equation

- Value of DER data in planning
  - Asset management
  - Interconnection evaluation
  - Capacity expansion
  - Resilience planning
  - **Resource adequacy**
  - **Distribution planning**
- Customer Services, Metering, and Billing

Source: EPRI DER Aggregation Participation in Electricity Markets

Variables in DER and DR in Bulk Planning (and Ops)



When I said I wanted something exotic for Christmas I meant PERFUME.

Economic vs. reliability tradeoff. If you only get X events, how does one decide when to use them?

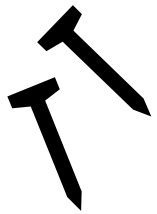
Uncertainty in resource availability. Sometimes a DER doesn't show up in the quantity that is called upon.

Energy losses and snapback effects. Care should be taken for resource behavior around DER events.

Timing of events. Many customer-side programs include rules on event timing, regardless of grid needs.

Snapback (rebound) effects are discussed at length here

Examples of DER and DR in RA Analysis



Fixed

Run an initial model to determine when DER would be dispatched and use that as an input into later optimizations

Performance Factor

Discount the DER rating (MW) based on how the resources performed during mandatory events in the past

Bid History

Restrict the DER to its maximum hourly bids over a certain timeframe

Unrestricted

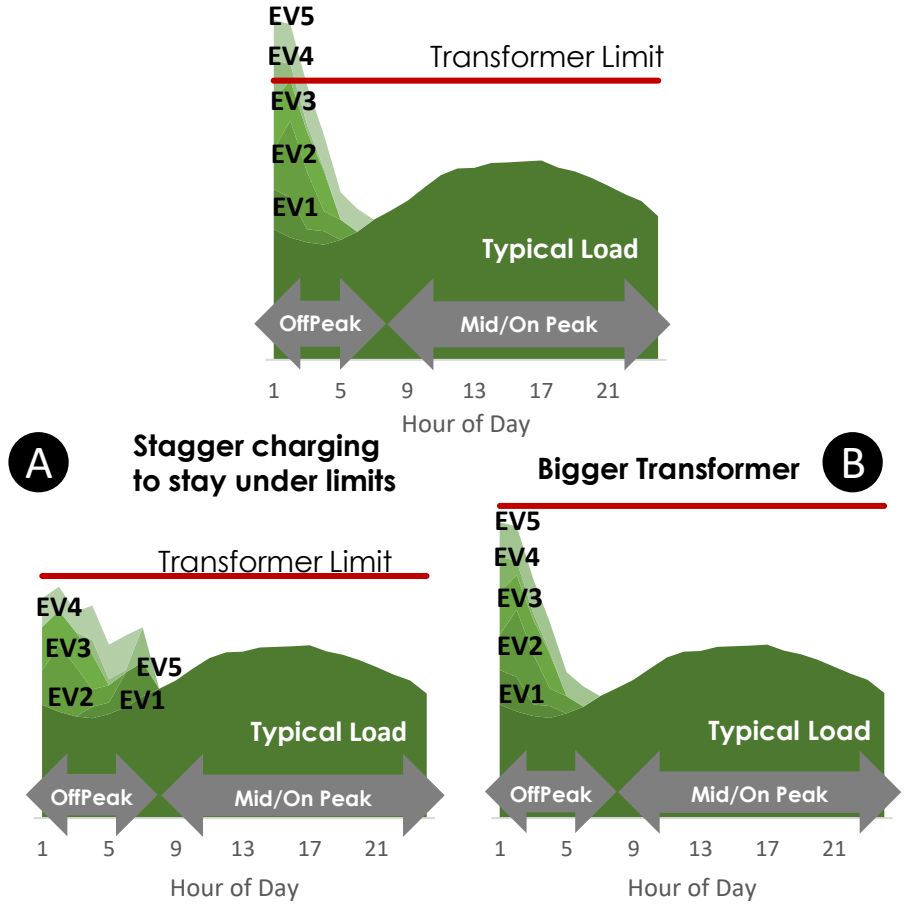
Allow optimization of DER at full nameplate, but with certain energy limits as appropriate.

DER and DR in Distribution Planning

Non-Wires Alternatives (NWA) are in a tough spot in the hype cycle: the trough of disillusionment

Driver: Siting Challenges	Geotargeting DR, in combination with other DERs, may be a faster and less costly solution than traditional upgrades.
Driver: Cost-effectiveness	Most states consider NWA as third party-owned DERs. But utility-owned and managed NWA are important to evaluate.
Status: Pilots	Most distribution system pricing pilots are technology tests sending prices to devices already in place.
Needs: Tools and Data	Insufficient planning tools and poor data constrain NWA consideration and implementation

EV charging may change the urgency



TELOS ENERGY

Sources: LBNL/Carvallo, Schwartz. The use of price-based demand response as a resource in electricity system planning
ESIG Grid Planning for Vehicle Electrification (forthcoming)

DER in Wholesale Markets

Start with planning to overcome hurdles[1]:

- Backoffice technological and institutional
  - ISO #1 proposed a plan to permit VPPs to begin participation in 2030
    - Reason: A prerequisite, multi-year update to legacy software systems
  - ISO #2 proposes a minimum capacity of 10kW for each DER in any aggregation
    - Reason: lack of personnel capacity to manage enrollment and auditing of a high volume of DER.
- Legal agreements and procedure language
- Real-time situational awareness
- Technologies to orchestrate DER *reliably*

Source: 1. DOE VPP Liftoff

DER Wunderkammer

(German, “wonder chamber”)

A room containing a private collection of rare DER such as distributed PV, but above all curiosities such as… EVs, water heaters, thermostats

Predecessors of coordinated distributed grid architectures

Adapted from oxfordreference.com
Image via ChatGPT

TELOS ENERGY

Let’s chat

TELOS ENERGY

Sean Morash
Sean.Morash@telos.energy

EnerNex
A CESI Company

Aaron F. Snyder, Ph.D.
aaron@enernex.com