TCA智慧電網核心標準應用研討會

IEC 61850標準與新示範應用案例簡介

(智慧電網IEC 61850新標準應用)

[Part Ⅰ]

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October 24, 2018

報告內容

一.IEC 61850標準發展現況

二.DER標準推廣相關議題

三.XMPP先導應用案例

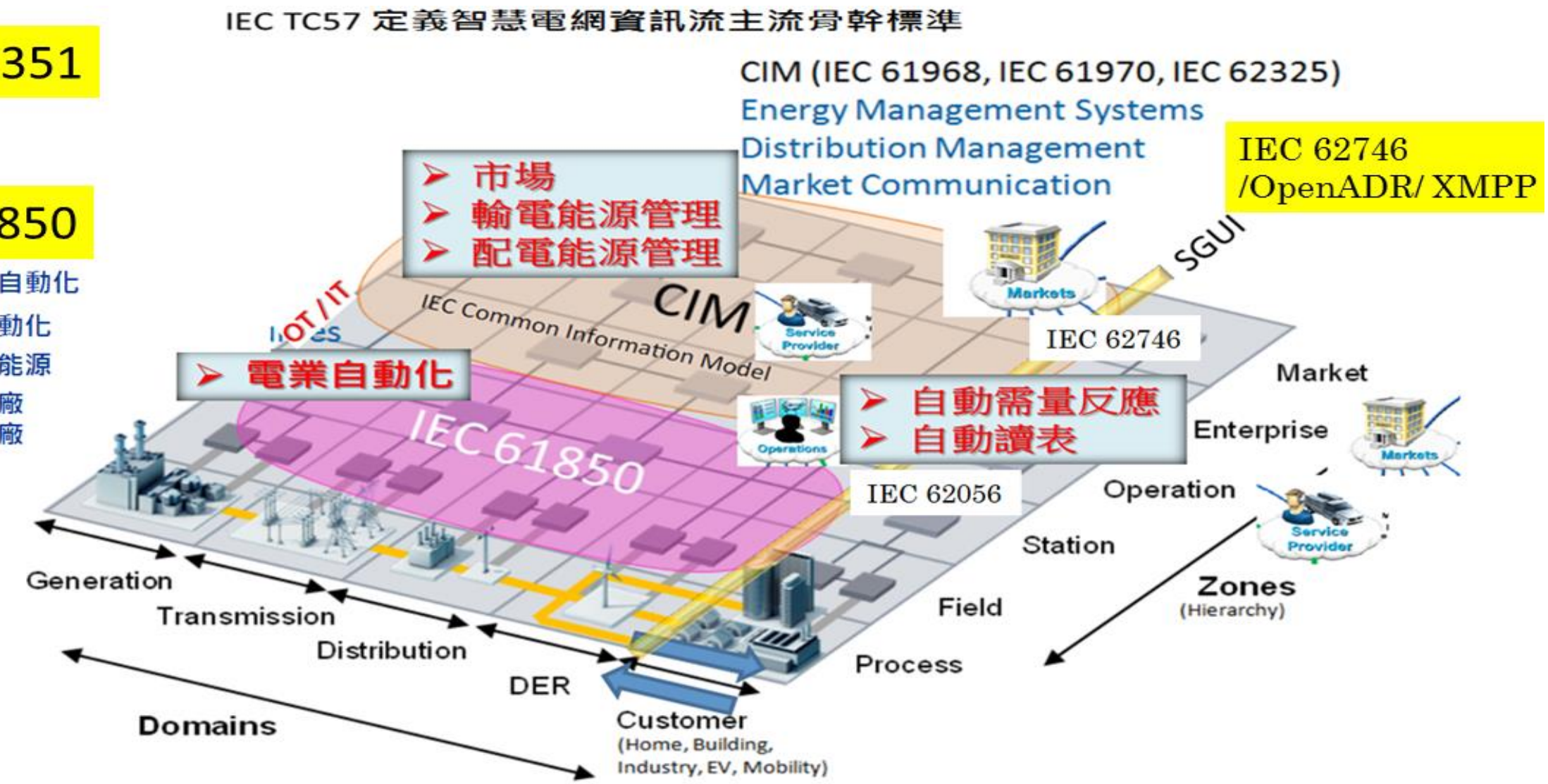
四.結論與討論

IEC 61850是智慧電網重要核心標準之一

IEC 62351

IEC 61850

變電所自動化
配電自動化
分散式能源
水力電廠
風力電廠
...



已公布之IEC 61850 (1/2)

標準及出版年份	標題
IEC TR 61850-1:2013	Introduction and overview
IEC TS 61850-2:2003	Communication networks and systems in substations - Part 2: Glossary
IEC 61850-3:2013	General requirements
IEC 61850-4:2011	System and project management
IEC 61850-5:2013	Communication requirements for functions and device models
IEC 61850-6:2009/AMD1:2018 Amendment 1	Configuration description language for communication in power utility automation systems related to IEDs
IEC 61850-8-1:2011	Specific communication service mapping (SCSM) - Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3
IEC 61850-9-2:2011	Specific communication service mapping (SCSM) - Sampled values over ISO/IEC8802-3
IEC/IEEE 61850-9-3:2016	Precision time protocol profile for power utility automation
IEC 61850-10:2012	Conformance testing

已公布之IEC 61850 (2/2)

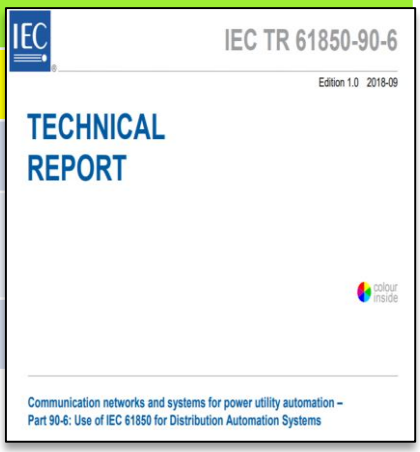
標準及出版年份	標題
IEC 61850-7-1:2011	Basic communication structure - Principles and models
IEC 61850-7-2:2010	Basic information and communication structure - Abstract communication service interface (ACSI)
IEC 61850-7-3:2010	Basic communication structure - Common data classes
IEC 61850-7-4:2010	Basic communication structure - Compatible logical node classes and data object classes
IEC TS 61850-7-7:2018	Machine-processable format of IEC 61850-related data models for tools
IEC 61850-7-420:2009	Basic communication structure - Distributed energy resources logical nodes
IEC TR 61850-7-500:2017	Basic information and communication structure - Use of logical nodes for modeling application functions and related concepts and guidelines for substations
IEC TR 61850-7-510:2012	Basic communication structure - Hydroelectric power plants - Modelling concepts and guidelines
IEC 61850-7-410:2012/AMD1:2015	Basic communication structure - Hydroelectric power plants - Communication for monitoring and control

已公布之IEC 61850相關TS/TR (1/2)

90-xxr及出版年份	標題
IEC TS 61850-80-1:2016	Guideline to exchanging information from a CDC-based data model using IEC60870-5-101 or IEC 60870-5-104使用IEC60870-5-101或IEC 60870-5-104從基於CDC的數據模型交換信息的指南
IEC TR 61850-80-3:2015	Mapping to web protocols - Requirements and technical choices映射到Web協定 - 要求和技術選擇
IEC TS 61850-80-4:2016	Translation from the COSEM object model (IEC 62056) to the IEC 61850 data model從COSEM對像模型（IEC 62056）到IEC 61850數據模型的轉換

已公布之IEC 61850相關TS/TR (2/2)

90-xxr及出版年份	標題
IEC TR 61850-90-1:2010	Use of IEC 61850 for the communication between substations變電所間的通信
IEC TR 61850-90-2:2016	Using IEC 61850 for communication between substations and control centers變電所和控制中心之間的通信
IEC TR 61850-90-3:2016	Using IEC 61850 for condition monitoring diagnosis and analysis狀態監測診斷和分析
IEC TR 61850-90-4:2013	Network engineering guidelines區域網路工程指南
IEC TR 61850-90-5:2012	Use of IEC 61850 to transmit synchro-phasor information according to IEEE C37.118根據IEEE C37.118傳輸同步相量資訊
IEC TR 61850-90-6:2018	Use of IEC 61850 for Distribution Automation Systems配電自動化系統的應用
IEC TR 61850-90-7:2013	Object models for power converters in distributed energy resources (DER) systems分散式能源（DER）系統電力轉換器物件模型
IEC TR 61850-90-8:2016	Object model for E-mobility電動車物件模型
IEC TR 61850-90-10:2017	Models for scheduling排程模型
IEC TR 61850-90-12:2015	Wide area network engineering guidelines廣域網工程指南
IEC TR 61850-90-17:2017	Using IEC 61850 to transmit power quality data傳輸電力品質資訊



發展中之IEC 61850相關IS/TS/TR

IEC 61850-7-7: Specification of schema for namespace definition files
IEC 61850-90-11: Methodologies for modeling of logics for IEC 61850 based applications
IEC 61850-90-14: Using IEC 61850 for FACTS data modeling
IEC 61850-90-16: System Management
IEC 61850-90-18: Alarm handling
IEC 61850-90-19: Implementation of role based access
IEC 61850-90-20: Guideline for redundant IEDs with IEC 61850
IEC 61850-90-21: Using IEC 61850 for traveling wave fault location systems
IEC 61850-1-2: Guideline for Technical Committees and Working Groups on extending IEC 61850
IEC 61850-7-5: Use of logical nodes to model applications – generic principles
IEC 61850-80-5: Data Conversion between Modbus and IEC 61850
IEC 61850-10-3: Methodologies for testing of functions in IEC 61850 based systems
IEC 61850-7-6: Guideline how to create Basic Application Profiles
IEC 61850-6-100: Guideline for function modeling in SCL for substation automation
– May include as well standardizing Function / Subfunctions names for SCL
– Similar parts required for other domains
IEC 61850-6-2: Configuration description language extension for HMIs

WG10 Ongoing work related to IEC 61850

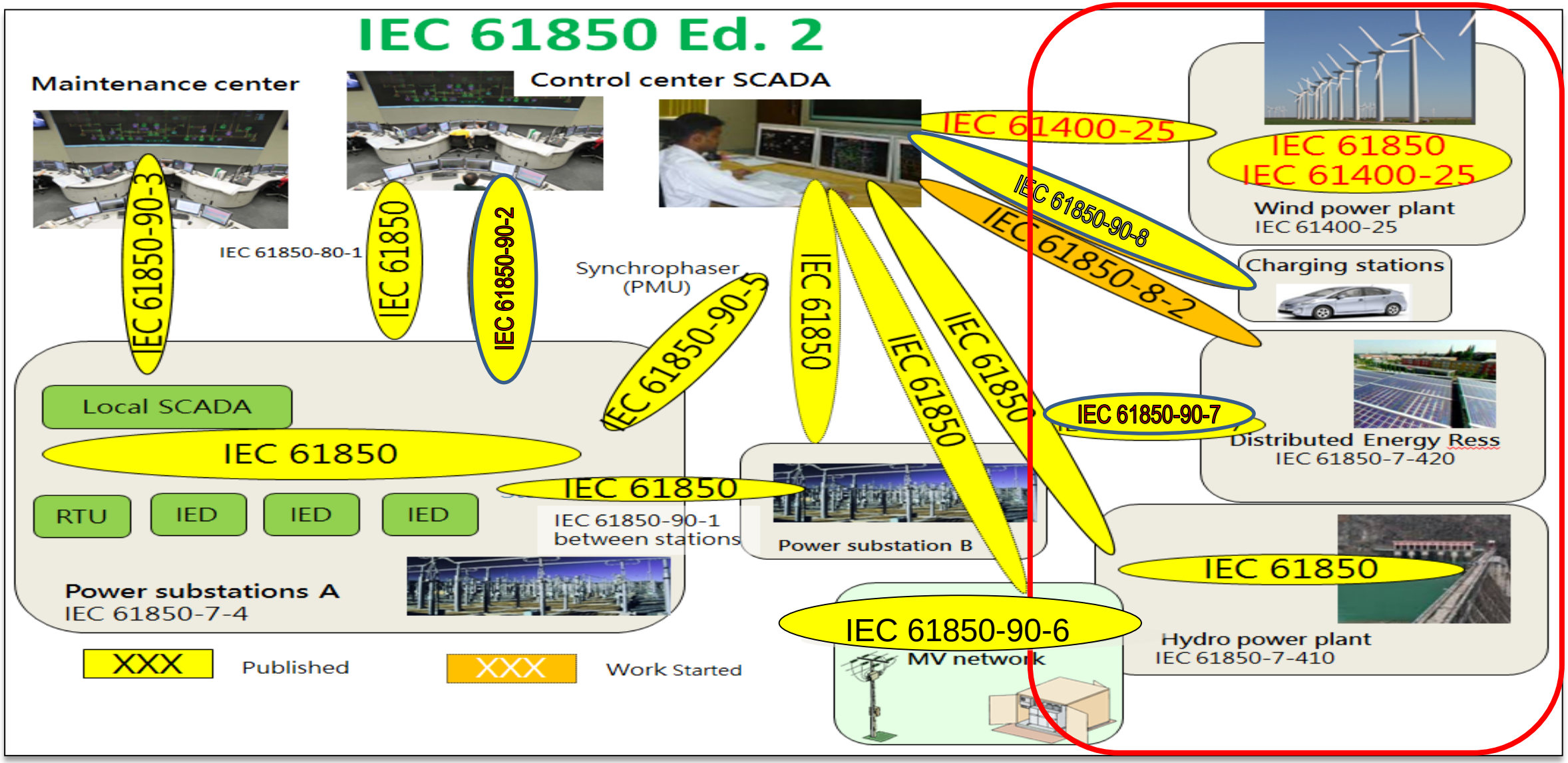
IEC 61850-90-9: IEC 61850 object models for electrical energy storage systems
IEC 61850-90-15: IEC 61850 based DER Grid Integration
IEC 61850-8-2: Mapping on Web Services XMPP
IEC 61850-7-420: Preparation of Ed 2 – Add modeling of Grid codes

WG17 Ongoing work related to IEC 61850

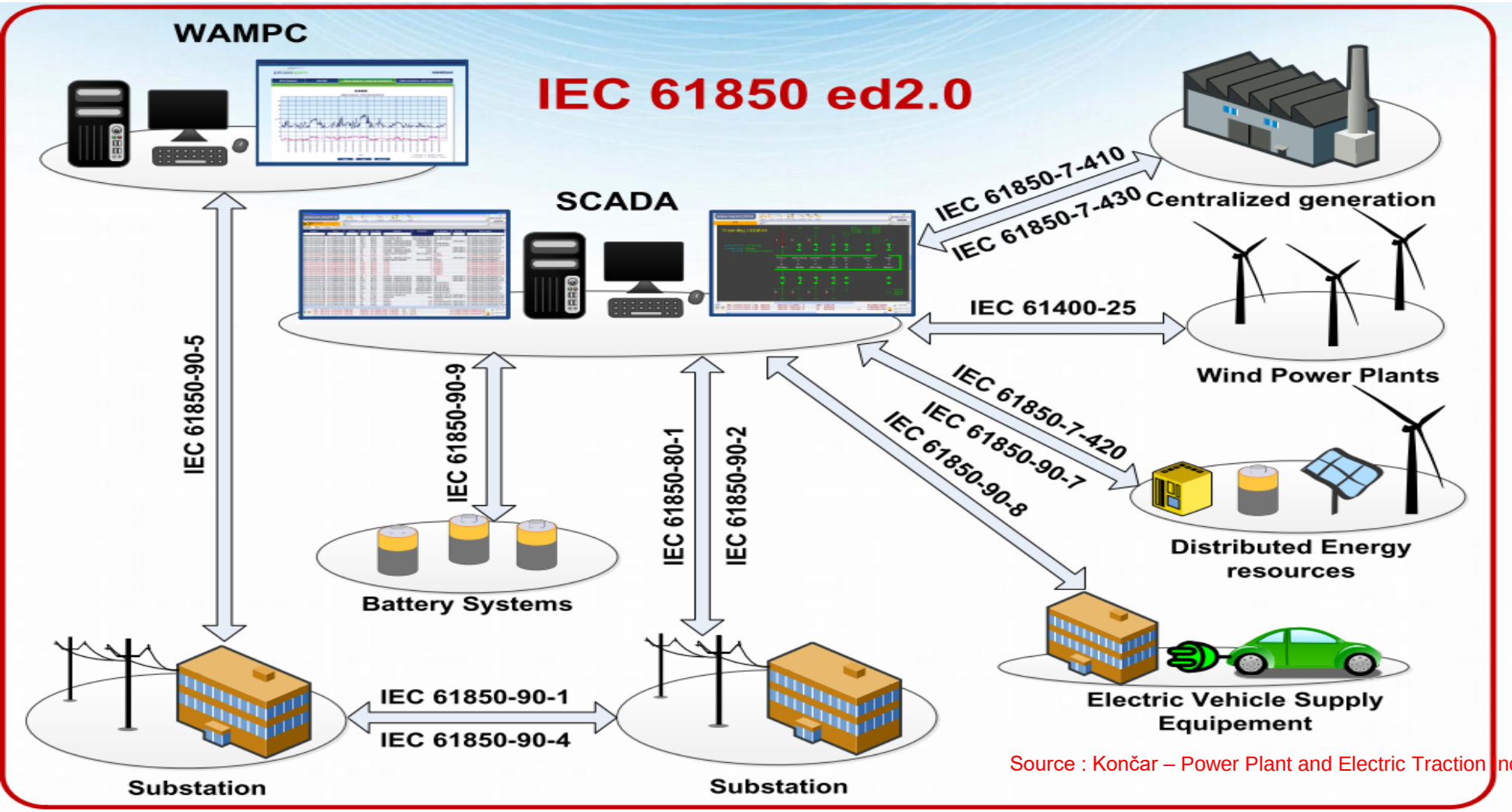
Communication network structure in hydro power plantsIEC 61850-7-410, Amd: Extensions to include models for steam and gas turbines

WG18 Ongoing work related to IEC 61850

IEC 61850 Ed.2標準之應用範圍與內容



新版IEC 61850應用於智慧電網不同領域



Source : Končar – Power Plant and Electric Traction Inc.

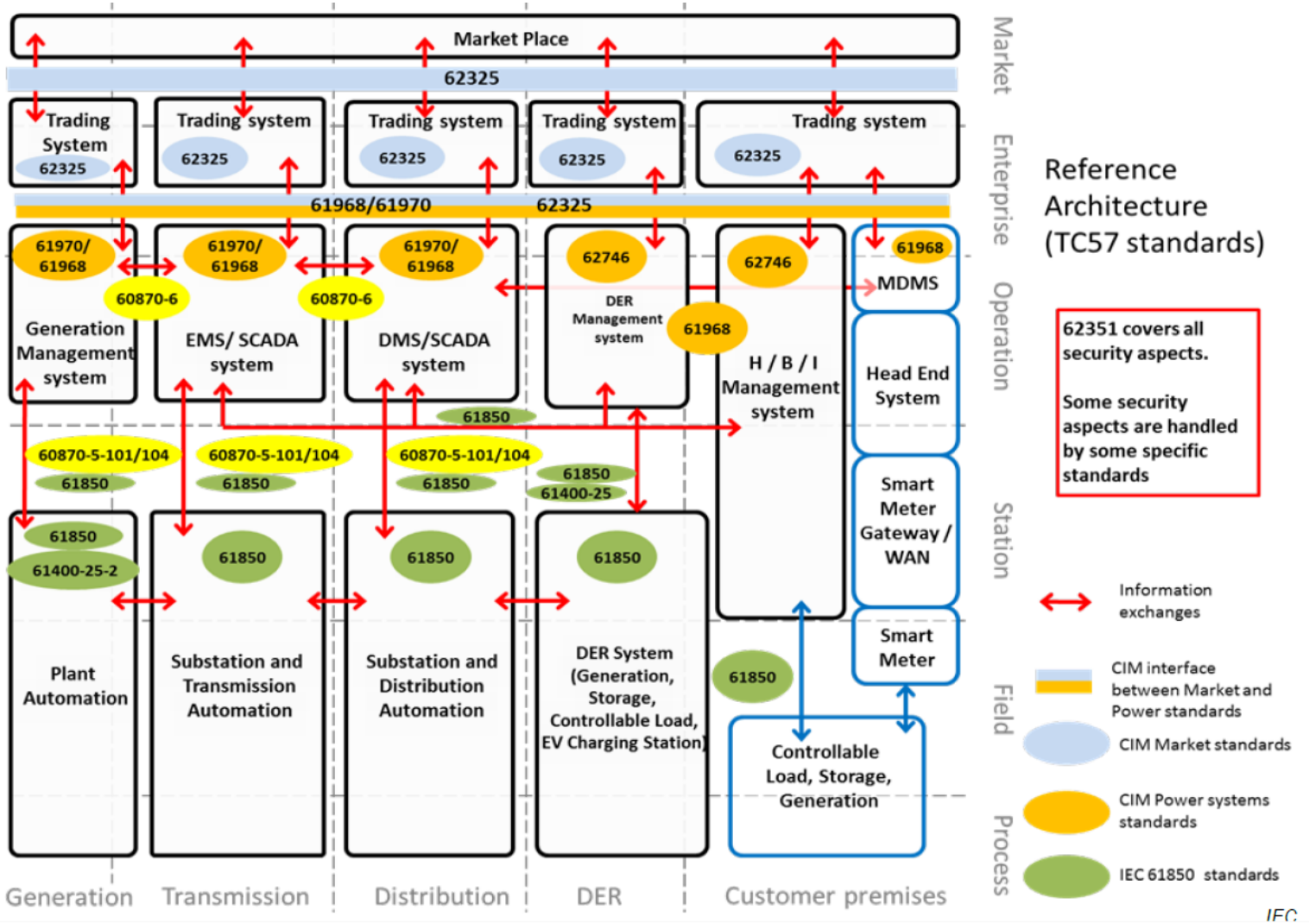
IEC 61850 ed2.0

- 2005-???
- 5 working groups
- 30 + documents
- 2500 + pages

IEC 61850 Ed.2 : Communication networks and systems for power utility automation

台電將IEC 核心標準納入智慧電網基礎建設關鍵策略

IEC/TR 62357、61970 、61968 、 62325、61850 、62351 、62056、62746 、...



台灣電力股份有限公司智慧電網設備採購資通訊標準要點

中華民國 101 年 4 月 20 日發布(綜研所主辦)
中華民國 107 年 9 月 13 日修正(綜研所主辦)

一、本公司為配合政府順利推動智慧電網政策，確保電業智慧電網應用系統資通訊之互通性，降低智慧電網整合應用之投資成本，促進國內智慧電網產業之升級，接軌國際智慧電網之技術、標準與應用，特訂定本要點。

二、本公司智慧電網設備及系統採購之資通訊標準適用

三、採購時資通訊標準應遵循之原則

(一)未有國家標準 (IEC)、國際標準化組織(ISO)及國際電信聯盟(I 信力，較能保證設備與系統之資訊應用互通性之國際標準， 次考量。

(二)各單位採購各類型智慧電網設備時，其資通訊應分階段朝 IEC 國際標準(為世界各電業共同認定之主流標準)方向調適，但對新發布之 IEC 標準，各單位得考量設備與技術之穩定度及普及度，自行決定採用 IEC、電子電機工程師學會(IEEE)或本公司慣用之標準設備。

(三)IEC 智慧電網核心標準及高度相關標準包含：IEC 62357、IEC 61850、IEC 61970、IEC 61968、IEC 62325、IEC 62351、IEC 62443、IEC 62056、IEC 61400-25、IEC 60870、IEC 62746 等，具基礎建設及整合關鍵指標，應根據實際需求，納入採購規格，並採用最新修訂版本。

(四)採購規格得包含資訊模型、資訊交換服務(方法)、通訊協定、規劃設定工具、應用系統介面、資安機制等項目之標準；其內容得委託綜合研究所或其他相關研究機構協助各單位訂定。

(五)採購規範之訂定以各單位專業領域分工導向為原則。各單位得依本身實際業務領域及在智慧電網之分工角色，深入研究了解各項 IEC 標準文件之相關內容，以及其他國家將 IEC 標準納入採購規範之實際案例，再依各重要標準分階段納入採購規範。

(六)各單位新設置或改建之變電所均需納入 IEC 國際標準相關規範，為考量一致性，由供電處作最後規範審核。

(七)綜合研究所依實際需求，不定期舉辦智慧電網資通訊設備採購技術研商會議及邀請外界專業機構研討技術標準，以提供本公司各單位訂定智慧電網資通訊設備採購之參考。

四、本要點未盡事宜，悉依相關法規及本公司其他有關規定辦理。

五、本要點自發布日施行。

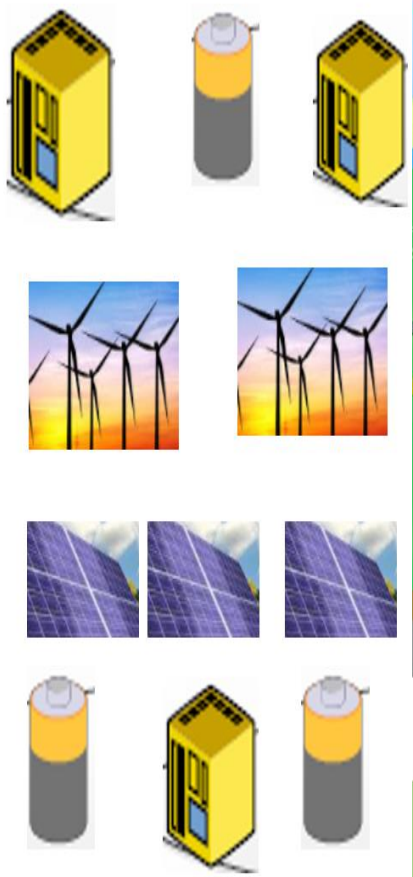
修訂並導入新國際標準

二、DER標準推廣相關議題

美國DER標準相關報告

發展DER/RE是台灣重要能源政策

Replace Nuclear Power with DER /RE

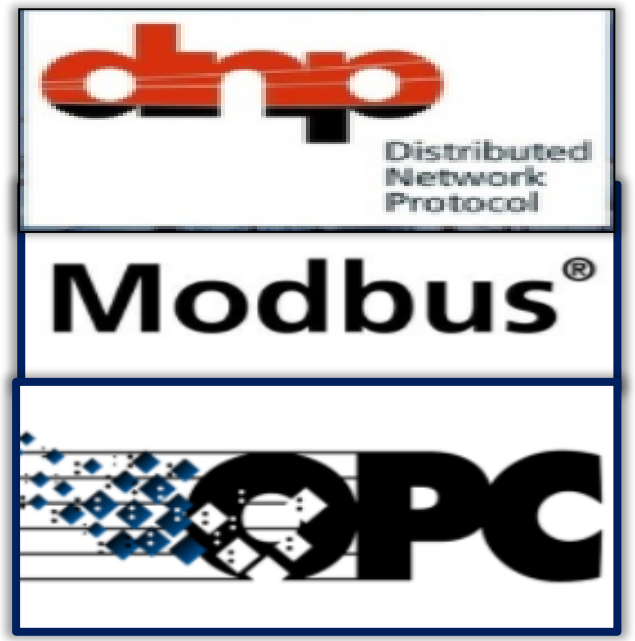


Source：Europe Smart Grids Technology Platform, EUROPEAN COMMISSION, 摘自NEP2綠能科技產業推動中心

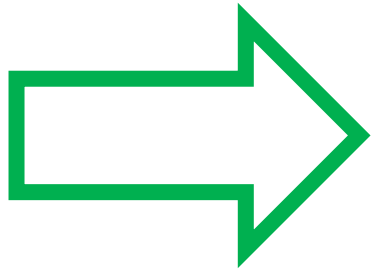
2025年台灣太陽光電與離岸風力電廠之裝置容量預計分別達到20GW與3GW

希望引進符合智慧電網國際標準之IOT技術

IEC 61850-8-2(XMPP) standard for DER are expected



From DNP / Modbus to XMPP



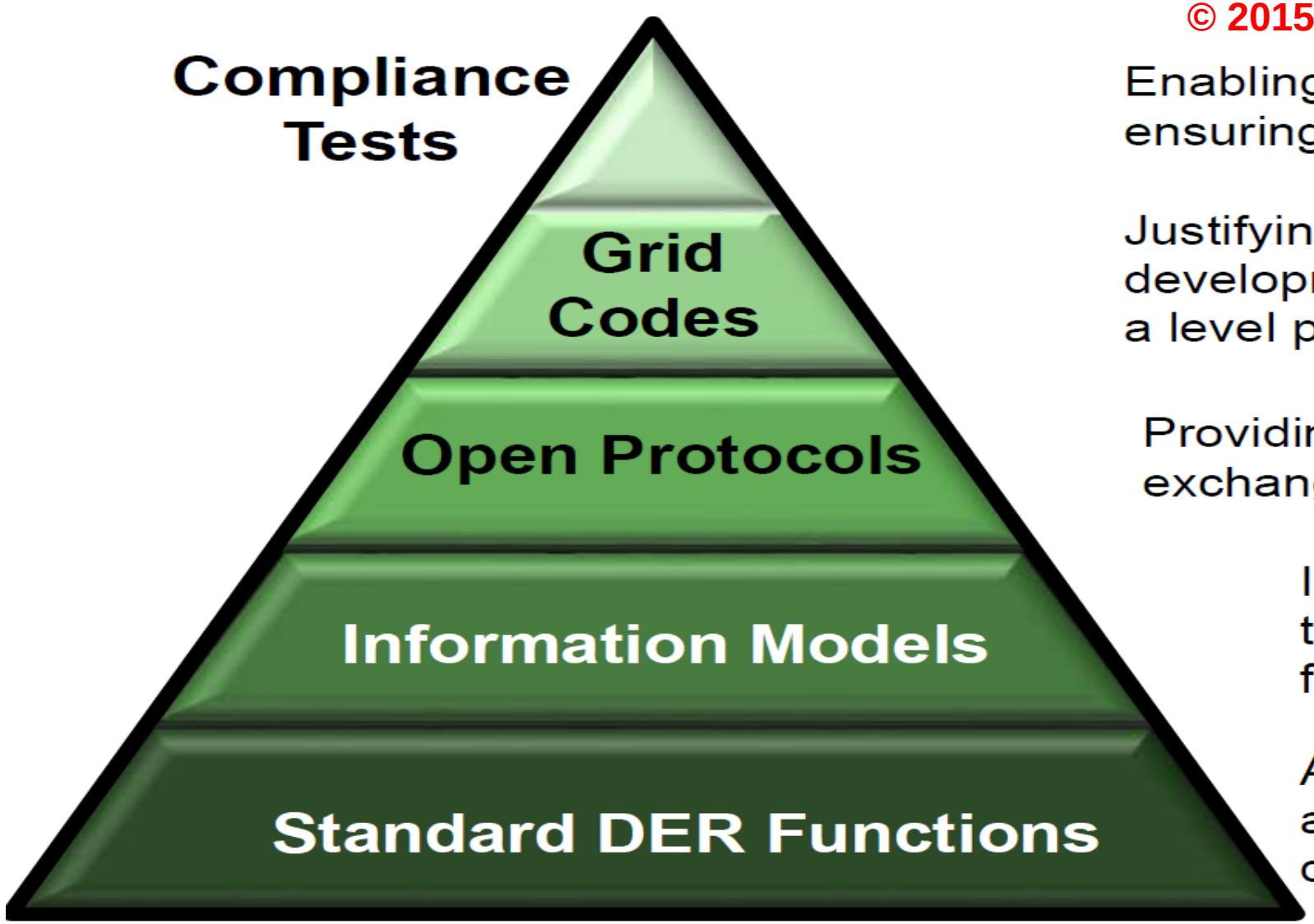
IEC 61850-8-2有助於分散式能源資訊廣泛應用在電力管理及需量反映上。此部分(Part)標準誕生後，將加速再生能源資通訊在多領域複雜的智慧電網系統上應用之實現。

DNP / Modbus /OPC are the main Protocols used in Taipower now.

We are considering replaced these legacy ones by XMPP due to the Scalability , Security, Compatibility, etc. problems

We would like to use IEC 61850 - 8 - 2(XMPP) as the future standard communication protocol for distributed energy resources.

美國整合DER的各類型“標準”考量方向



Enabling ready products and ensuring performance

Justifying manufacturer's development efforts, maintaining a level playing field

Providing, interoperable ways to exchange data

Identifying data elements that need to be exchanged for each function

Achieving understanding among stakeholders, documenting what is needed

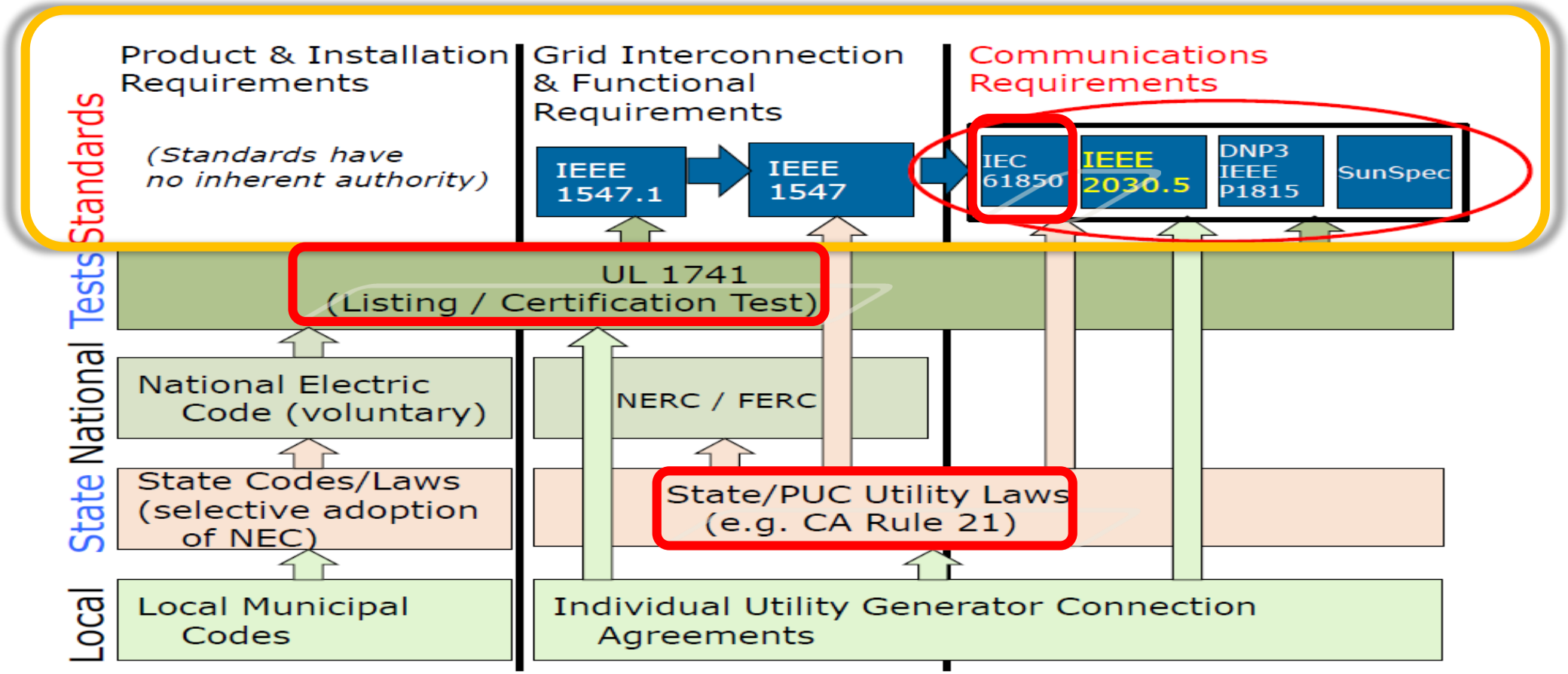
DER互通之各種不同標準及法規

IEEE 2030 (Interoperability)
IEEE 1547 (Interconnection)

Background and Context

Role of IEEE Standards 2030.5, 1547, 1815, IEC 61850 and SunSpec

Source : Distributed Energy Resources (DER) Management with IEEE 2030.5™ Symposium, 1 November 2016



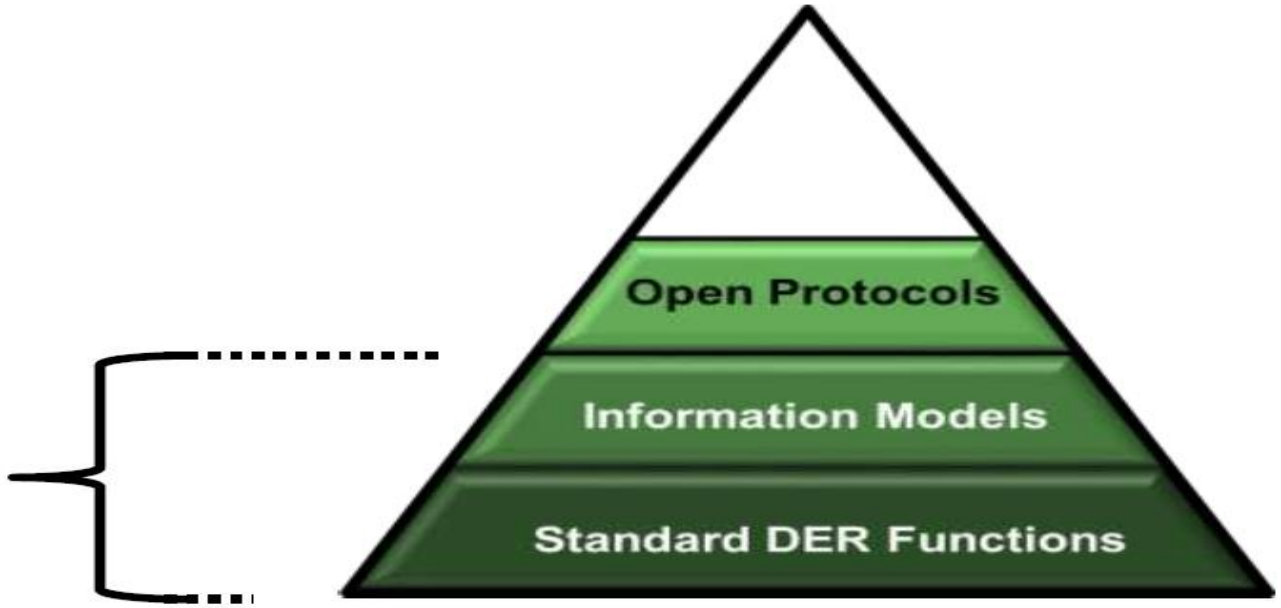
IEC 61850 – Functions and Information Model

Broad International Alignment

IEC

IEC 61850-90-7 and 61850-7-420

IEC 61850 Object Models for Photovoltaic, Storage, and Other DER inverters



- International Standard, a dejure ISO
- Originated and driven by a mixed stakeholder group – utilities and manufacturers
- Participation is open, Specifications are expensive
- Includes function descriptions, an information model
- Other parts of 61850 also provide protocol mappings (EdF has decided to use these protocols)

DER智慧變流器功能分類

Monitoring and Scheduling	Frequency Support	Real Power Support	Power Factor Support	Voltage Support
Basic Device Settings And Limits	Frequency-watt Function	Limit DER Power Output Function	Fixed Power Factor Function	Dynamic Volt-watt Function
Connect/Disconnect Function	Low/High Frequency Ride-Through Requirements	Dynamic Real-Power Support	Volt-Var Function	Dynamic Reactive Current Support Function
Der Settings To Manage Multiple Grid Configurations (Including Islanding)		Peak Power Limiting Function	Watt-Power Factor Function	Volt-watt Function
Status Monitoring Points		Load And Generation Following Function		Low/High Voltage Ride-Through Requirements
Event Logging And Reporting		Watt-Var Function		
Time Adjustment Function		Battery Storage: Price-based Charge/ Discharge Function		
		Battery Storage: Direct Charge/Discharge Management Function		
		Battery Storage: Coordinated Charge/ Discharge Management Function		

The function called "Price Or Temperature Driven Functions" is not specific to any of the fields above.

Source : Common Functions for Smart Inverters 4th Edition December 2016 - EPRI

DER案場 IEC 61850資訊標準與協定

Field Communication for DER

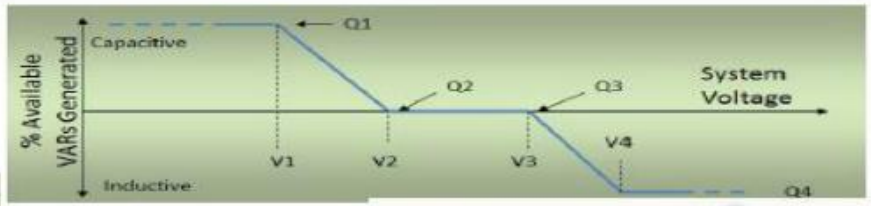
IEC 61850-90-7 → IEC 61850-7-420

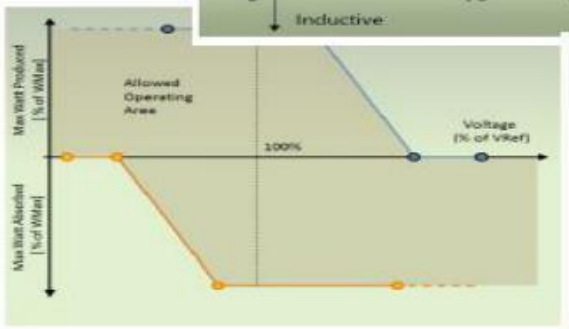
Standard Function Descriptions

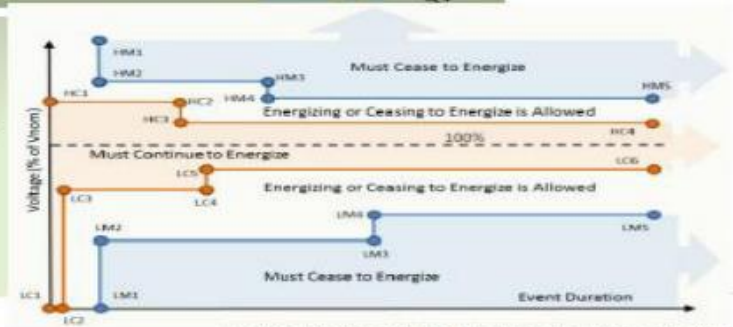
Standard Information Model (IEC 61850)

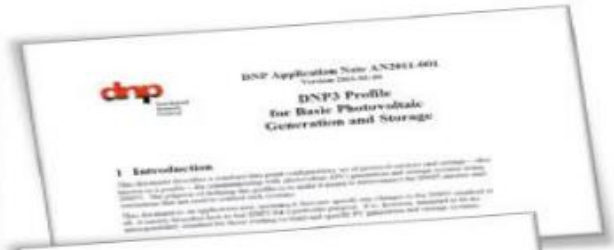
Mapped to Protocols

- DNP3
- SunSpec Modbus
- SEP2.0
- 61850 MMS









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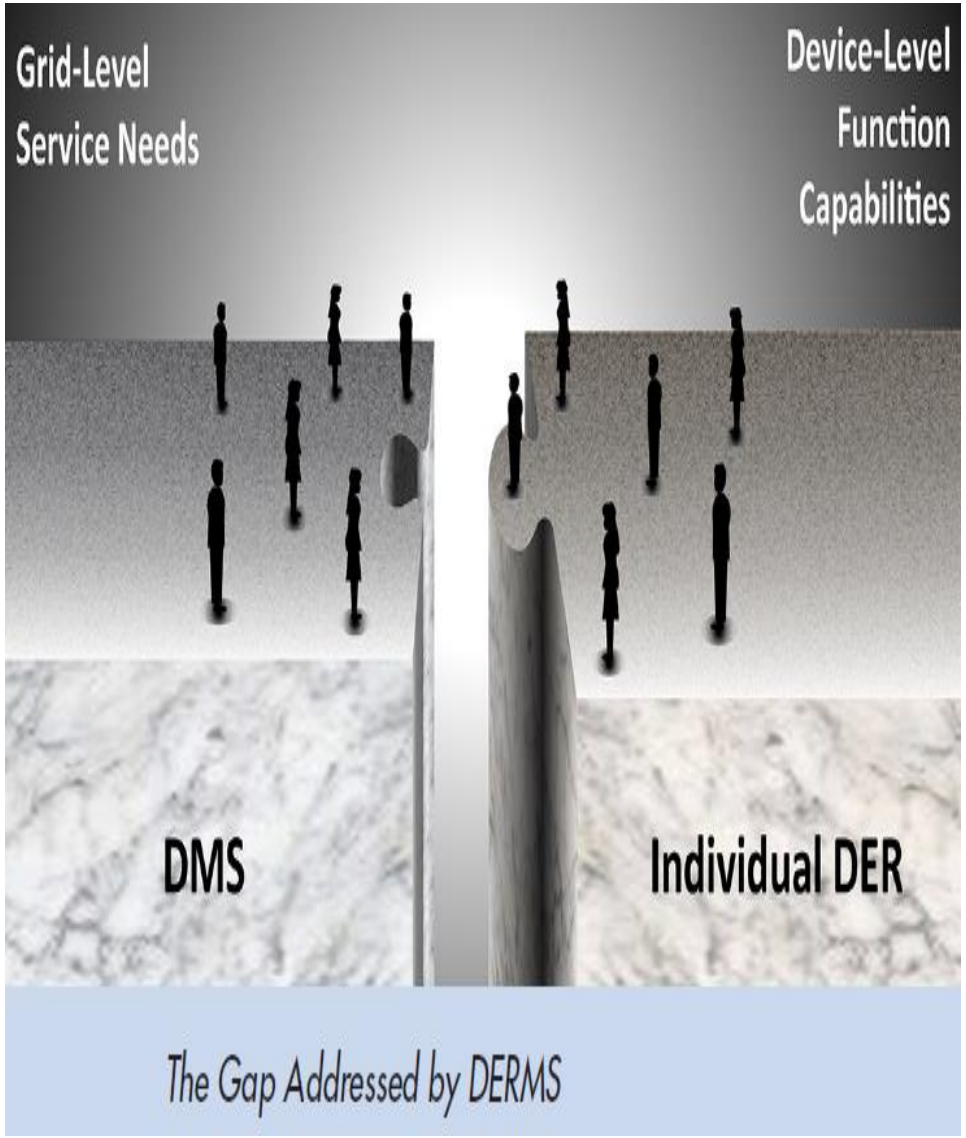
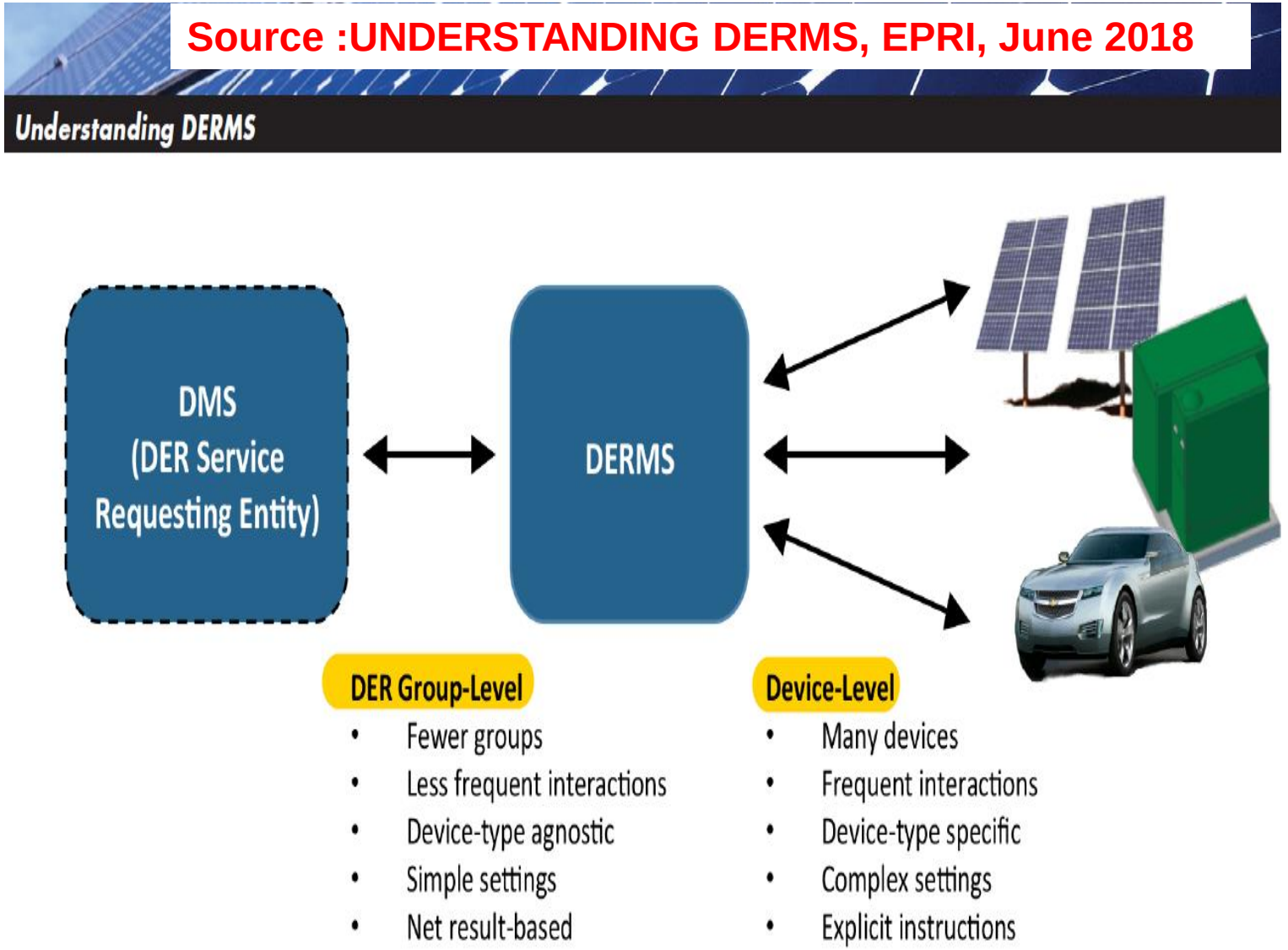
EPRI ELECTRIC POWER RESEARCH INSTITUTE

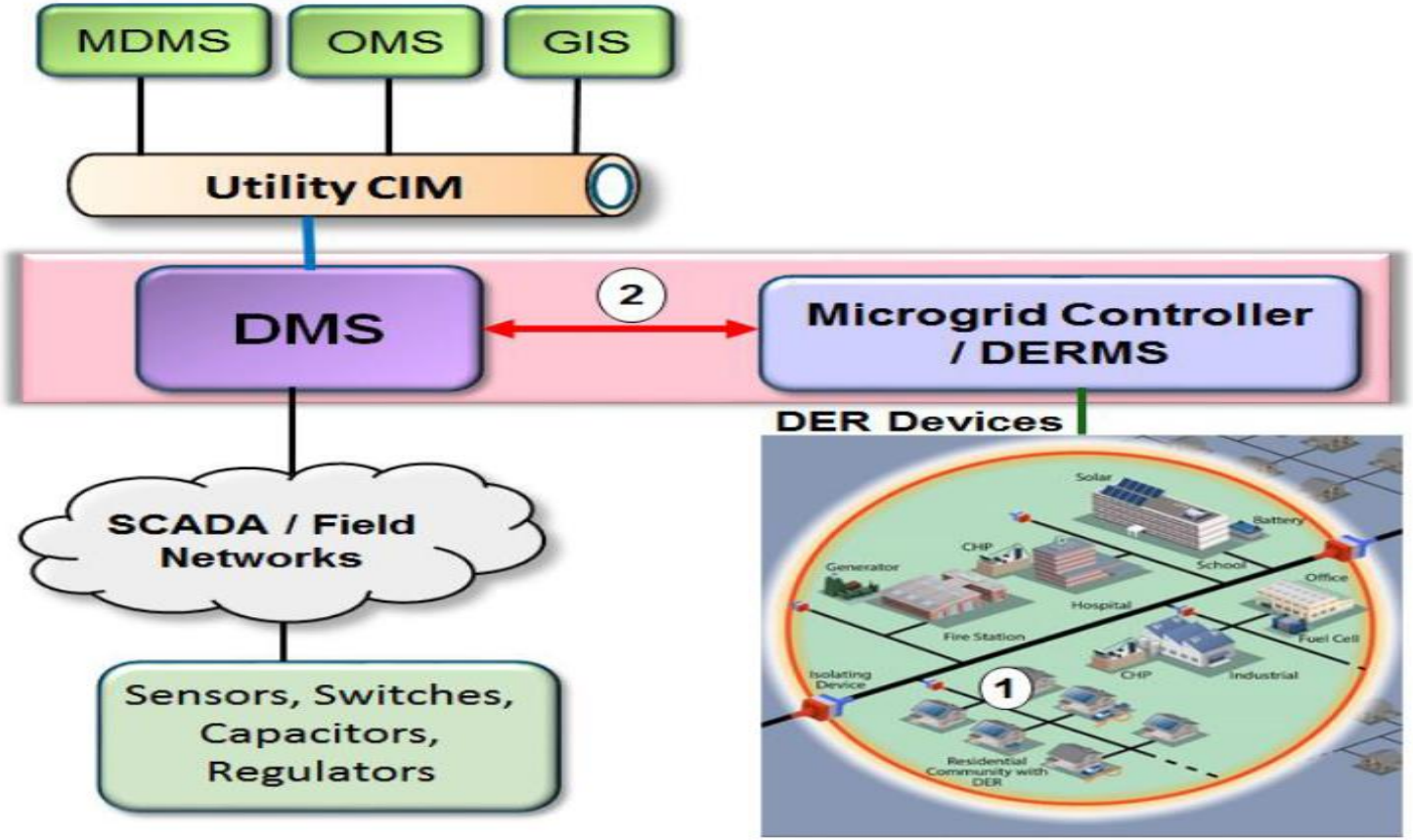
EPRI, June 2018



Source :UNDERSTANDING DERMS, EPRI, June 2018



Relationship Between Microgrid Controller and DER Management System (DERMS)



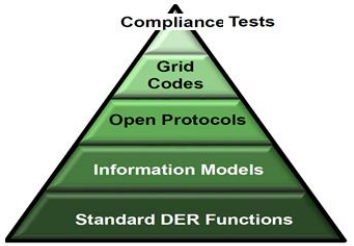
courtesy: EPRI

There is a need to develop standardized functions for the microgrid controller and establish the relationshi with the utility DMS system at the DSO level leading to technical and business processes that are both effective and replicable in many jurisdictions with increasing adoption of microgrids and DER.

Standard Function / Protocol Capability at DERMS Interfaces , EPRI, June 2018

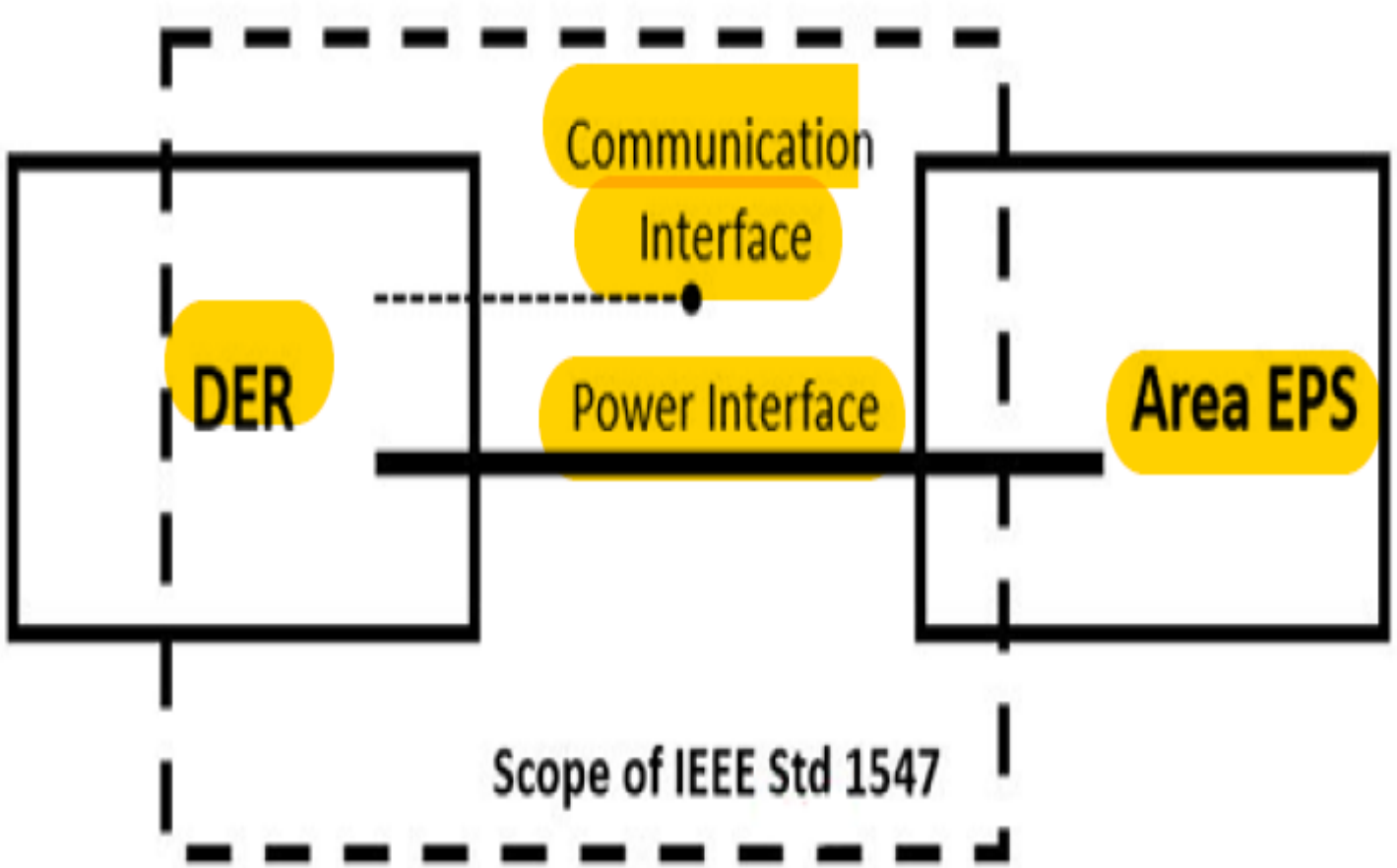
Table 2 – Standards for Communication Protocols at DERMS Interfaces

DER-Group Level (DMS-to-DERMS) Interfaces	Device Level (DERMS-to-DER) Interfaces
Standard information Model: IEC 61968-5 (Common Information Model for DER)	**Standard information Model:** IEC 61850-7-420
Protocol Encodings for DER Groups: • IEC 61968-100:2013 "Application Integration for 61968 Profiles" • MultiSpeak 5.0 • OpenFMB (alignment/ mapping in process) • OpenADR 2.0 (mapping being considered)	**Defined DER Device-Level Functions:** • SunSpec Modbus • DNP3 AN2013-001, AN2018-001 • IEEE 2030.5 • IEC 61850-8-2 XMPP
DER Grid Codes with Protocol Requirements: Not Applicable at the Group Level	**DER Grid Codes with Protocol Requirements:** • Multiple worldwide, unique by region • IEEE 1547-2018 (specific set of device-level functions required, three protocol options) • CA Rule 21
Protocol Testing: UCAI Users Group, CIM for DER compliance testing.	**Protocol Testing:** • IEEE 1547.1 – test specification for IEEE 1547, expected Q1 2019, mandates that DER support at least one of three standard protocols (DNP3, SunSpec Modbus, 2030.5) includes communication/ interoperability test requirements. • UL1741SA - Supports Rule 21, to be updated to support 1547.1 • SunSpec Alliance – defines test requirements for the three 1547-specified protocols.
Protocol Certification/Listing: UCAI Users Group, CIM for DER certification and listing.	**Protocol Certification/Listing:** SunSpec Alliance provides certification listing for the three 1547-specified protocols.



Source :UNDERSTANDING DERMS, EPRI, June 2018

IEEE Std 1547™-2018範圍



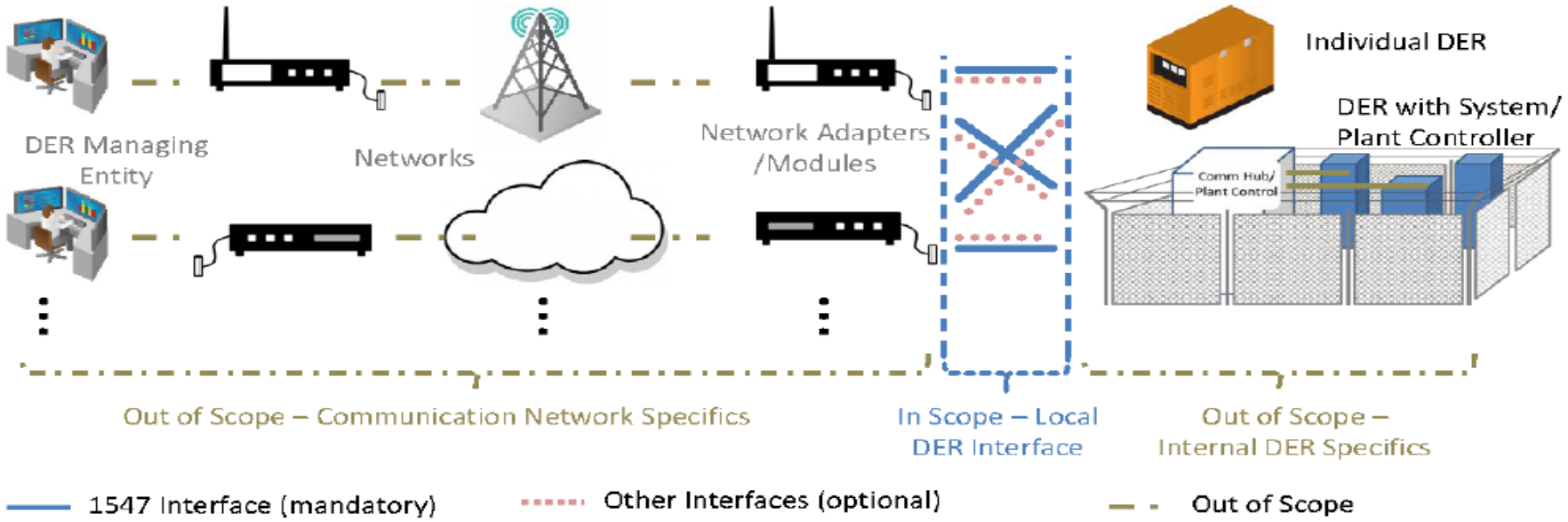
Electric Power Systems (EPSs)

IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces

IEEE Std 1547 was the first of a series of standards developed by Standards Coordinating Committee 21 on Fuel Cells, Photovoltaics, Dispersed Generation, and Energy Storage (SCC21) concerning distributed resources interconnection. IEEE Std 1547 was amended in 2014 (IEEE Std 1547a™-2014) in response to a widely expressed need to make changes to subclauses related to voltage regulation, voltage response to Area EPS abnormal conditions, and frequency response to Area EPS abnormal conditions in IEEE Std 1547-2003. The additional documents in that series are as follows:

1. IEEE Std 1547.1™ [B17] provides conformance test procedures for equipment interconnecting distributed energy resources (DER) with electric power systems (EPS).1
2. IEEE Std 1547.2™ [B18] is an application guide for IEEE Std 1547.
3. IEEE Std 1547.3™ [B19] provides guidance for monitoring, information exchange, and control of DER interconnected with EPS.
4. IEEE Std 1547.4™ [B20] provides guidance for design, operation, and integration of distributed resource island systems with EPS.
5. IEEE Std 1547.6™ [B21] is a recommended practice for interconnecting DER with electric distribution secondary networks.
6. IEEE Std 1547.7™ [B22] provides guidance for conducting distribution impact studies for DER interconnection.

美國2018 IEEE 1547 - DER IEC 61850 MMS及XMPP也是選項之一



Protocol	Transport	Physical layer
IEEE Std 2030.5 (SEP2)	TCP/IP	Ethernet
IEEE Std 1815 (DNP3)	TCP/IP	Ethernet
SunSpec Modbus	TCP/IP	Ethernet

IEEE Std 1547™-2018 Control protocol in/out of scope mapping and List of eligible protocols

The protocol requirements set forth in this subclause apply at the *local DER communication interface*. As illustrated in Figure 4, the protocols and physical layers utilized within communication networks and within the DER may differ according to the network architecture and technology, and are out of scope of this standard.118

[118] For example, the Area EPS operator may deploy networks that utilize the IEEE 2030.5 protocol even if it is not the native protocol supported at the *local DER communication interface*. The standard protocol support requirement does not preclude the use of additional protocols such as the information model defined by IEC 61850-7-420 [B8] exchanged using IEC 61850-8-1 [B9] or IEC 61850-8-2 [B10], or profiles of the IEC 61850-7-420 information model mapped to IEEE Std 1815 (DNP3) or to SunSpec Modbus.

DER/PV IEC 61850-90-7功能協定測試認證

Certification Protocols for Advanced Inverter Functions

Jay Johnson
Sandia National Laboratories, Albuquerque, NM, USA

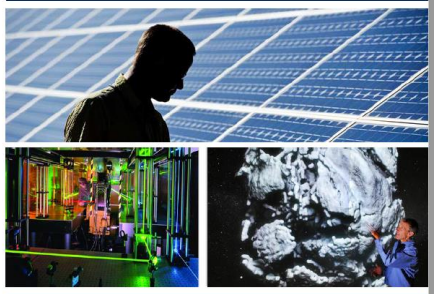
Smart Grid International Research Facility Network (SIRFN) Meeting
17 November, 2014

International Conference on Integration of Renewable and Distributed Energy Resources (IRED)

Kyoto, Japan

Exceptional service in the national interest

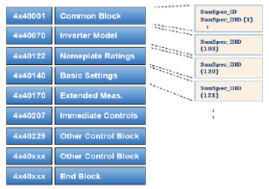
Sandia National Laboratories



SunSpec-Sandia Collaboration

Sandia National Laboratories

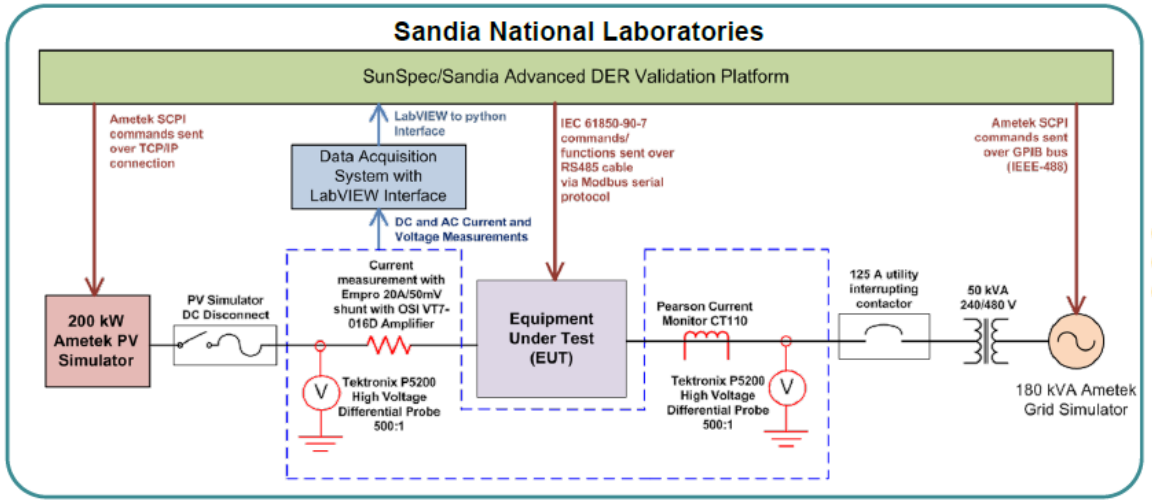
- SunSpec has defined Modbus map specifications for DER devices so 3rd parties can adjust functions/settings.
- Sandia and the SunSpec Alliance are collaborating to establish tools for verifying IEC 61850-90-7 functions:
  - Works for all SunSpec-compliant PV Inverters (and other devices)
  - Modes of operation: direct manipulation of Modbus registers, python scripting, and interaction via a graphical user interface.



GUI Version of the SunSpec Test Tool

SNL, AIT, and TECNALIA Test-Bed Designs

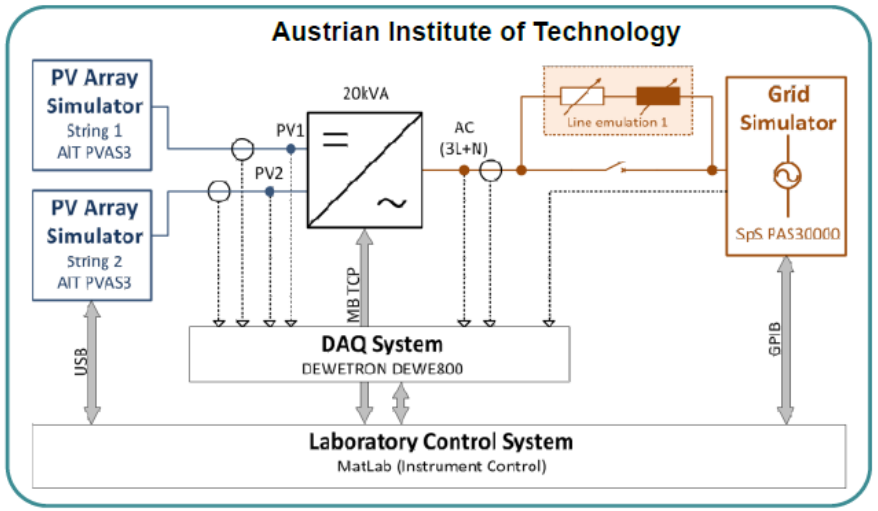
Sandia National Laboratories

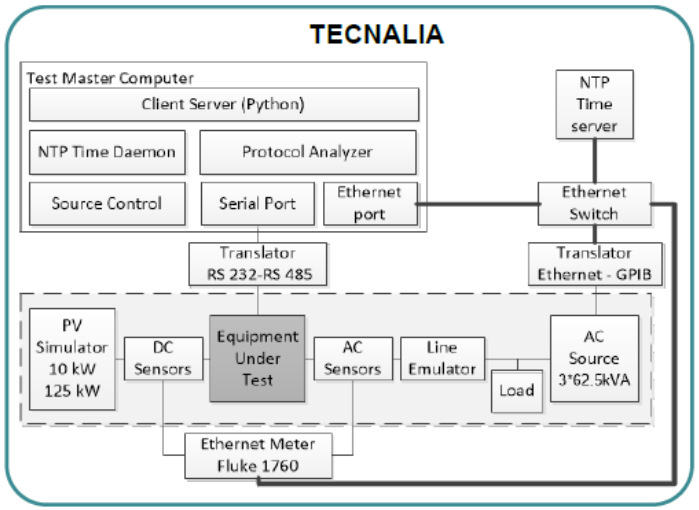


EUTs:
- SNL: 3 kW single-phase inverter
- AIT: 20 kW three-phase inverter
- Tecnalia: 5 kW single-phase inverter

EUT Communications
- SNL: 61850-90-7 over serial
- AIT: 61850-90-7 over TCP
- Tecnalia: 61850-90-7 over serial

Control system
- SNL: SunSpec Test Tool (Python)
- AIT: Lab Control System (Matlab)
- Tecnalia: Master Computer (Python)





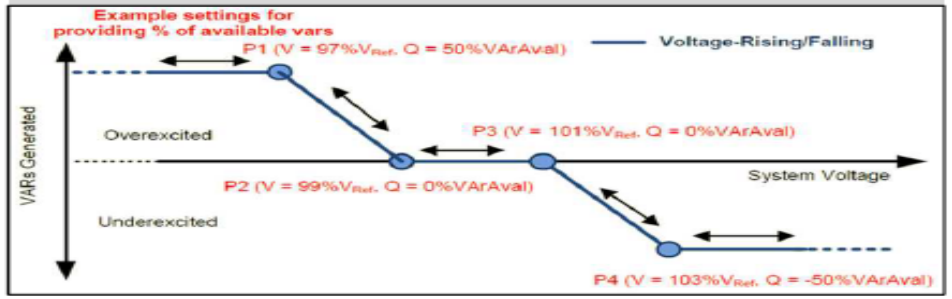
J. Johnson, R. Bründlinger, C. Urrego, R. Alonso, "Collaborative Development Of Automated Advanced Interoperability Certification Test Protocols For PV Smart Grid Integration," EU PVSEC, Amsterdam, Netherlands, 22-26 Sept, 2014.

PV Function Test Example by SNL

Example Function: Volt/Var (VV11)

Sandia National Laboratories

Volt/Var Curve



Test Parameters

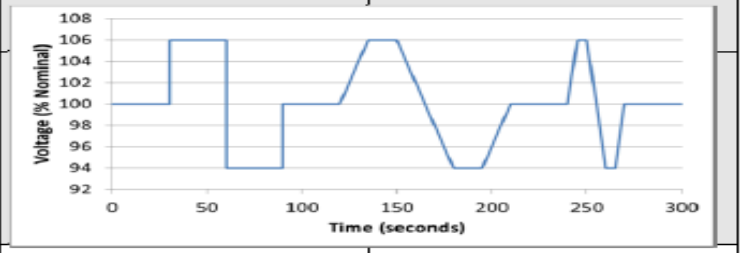
Volt/Var Initiation	Volt/Var [V,Q] Array				Requested Ramp Time (% VArAval/s)	Time Window for Randomization (seconds)	Timeout Period to Reach 95% of Target (seconds)
Binary, 1	V1	97	Q1	50	-	-	-
	V2	99	Q2	0			
	V3	101	Q3	0			
	V4	103	Q4	-50			
Binary, 1	V1	97	Q1	50	25	-	-
	V2	99	Q2	0			
	V3	101	Q3	0			
	V4	103	Q4	-50			
Binary, 1	V1	97	Q1	50	50	-	-
	V2	99	Q2	0			
	V3	101	Q3	0			
	V4	103	Q4	-50			
Binary, 1	V1	97	Q1	50	-	60	-
	V2	99	Q2	0			
	V3	101	Q3	0			
	V4	103	Q4	-50			

Data Collection

Command/Action	Command Send Time (seconds)	EUT Response (seconds)	Time Stamped Data from Volt/Var Test Profile and EUT Response
DS93 Request			
VV11 Parameter Set 1			
DS93 Request			
VV11 Parameter Set 2			
DS93 Request			
VV11 Parameter Set 3			
DS93 Request			
VV11 Parameter Set 4			
.			
.			
.			

Test Procedure

	Step	Task	Function	Notes
Communication	1	Utility requests status from EUT.	DS93 – Status Reporting	Log time sent.
	2	Utility receives response to the command.		Log time received.
	3	Utility issues a Volt/Var VV11 Command to EUT.	VV11 – Volt/Var	Log time sent. Command may include the following parameters: • Requested ramp rate (optional) • time window (optional) • timeout period (optional)
	4	Utility receives response to the command.	–	Expected response message: • Successful • Rejected (includes reason)
Electrical Behavior	5	If Success response received, verify command was successfully executed by varying the voltage profile according to Table A6-3 and Figure A6-2, using the grid simulator.		Monitor and record electrical output of EUT. • Voltage • Active power • Reactive power
	6	Repeat test with varying parameters as described in Table A6-2. Each test should be repeated until behavior of the EUT is reasonably understood. Test the time out period by rerunning the test profile in Figure A6-2.		
Analysis	7	Characterize EUT's response.		Determine if command was executed correctly.



10

二、DER標準推廣相關議題

我國DER標準可參考國際作法相關報告

我國DER/RE併網標準(法規)...

台灣電力股份有限公司再生能源發電系統併聯技術要點(草案)

中華民國 98 年 12 月 31 日
發布(業務處主辦)

中華民國 106 年 03 月 XX 日修
正(配電處主辦)

一、依據：
本要點依再生能源發展條例第八條第四項規定訂定之。

二、本要點用詞，定義如下：
(一) 低壓系統：電壓等級 600 伏特以下之配電系統。
(二) 高壓系統：電壓等級超過 600 伏特至 25,000 伏特以下之配電系統。
(三) 特高壓系統：電壓等級超過 25,000 伏特之輸電系統。
(四) 責任分界點：再生能源發電系統與台灣電力股份有限公司(以下簡稱

責任分界點之
。
合下列適用規

線 110 伏特
380 伏特之低

接於三相四線
0 瓩以上未滿
電設備總容量
在 100 瓩以上未滿 20,000 瓩者，得併接於 22,800 伏特之高壓系

再生能源發電業申請直供審查規則
再生能源憑證機制
綠能科技產業創新方案
前瞻基礎建設計畫
再生能源發展條例
…
…

台電所有相關平行條例涉及調度、輸電、配電、及用戶端的相關臺電規範

再生能源電能收購作業要點
電業供電線路裝置規則
屋內線路裝置規則
電壓閃爍管制要點
電力系統諧波管制暫行標準
再生能源發電系統調度操作準則
再生能源發電系統即時運轉資料提供及傳送方式原則
再生能源發電設備設置者與電業爭議調解辦法
…
…

七(八)1. '再生能源發電系統調度操作準則'
七(八)3. '再生能源發電系統即時運轉資料提供及傳送方式原則'
八 '再生能源發電設備設置者與電業爭議調解辦法'

Source: 因應再生能源大量推廣之併聯規劃技術與運轉安全等議題研究 *nexant.com*

我國DER/RE併網標準(法規)...

有關綠電轉直供最新法規, 申請程序, 費用組成
台電系規處解答:本公司已公布在如下網站
http://powerwheeling.taipower.com.tw/powerwheeling/

台灣電力股份有限公司再生能源發電系統併聯技術要點

中華民國98年12月31日發布(業務處主辦)
中華民國105年2月5日修正(配電處主辦)
中華民國105年10月6日修正(配電處主辦)

一、依據：
本要點依再生能源發展條例第八條第四項規定訂定之。
二、本要點用詞，定義如下：
(一)低壓系統：電壓等級600伏特以下之配電系統。
(二)高壓系統：電壓等級超過600伏特至25,000伏特以下之配電系統。
(三)特高壓系統：電壓等級超過25,000伏特之輸電系統。
(四)責任分界點：再生能源發電系統與台灣電力股份有限公司（以下簡稱台電公司）系統之產權分界點。
(五)發電設備總容量：同一發電計畫或同一籌設許可

台灣電力股份有限公司再生能源電能收購作業要點

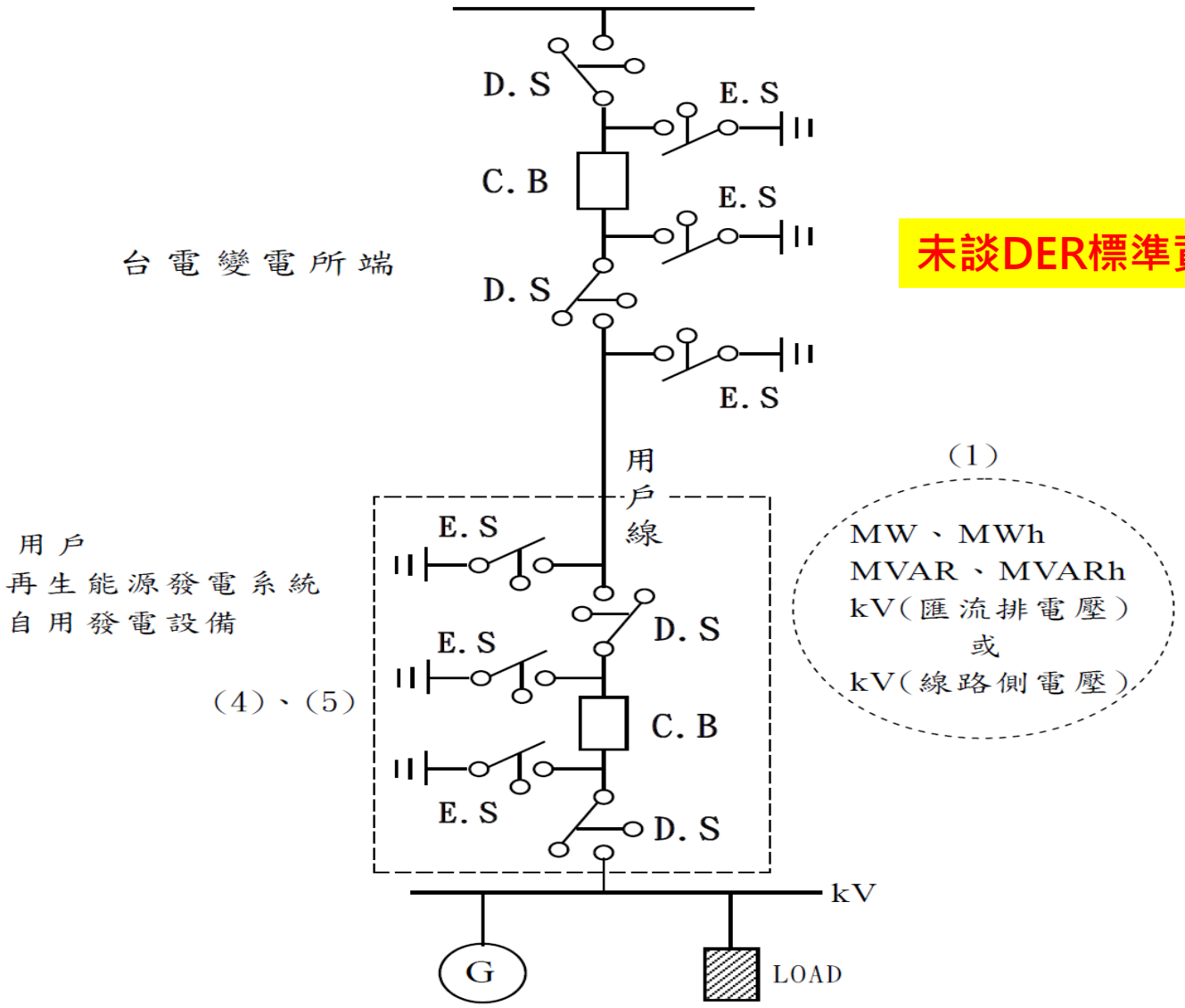
中華民國92年11月11日發布
中華民國93年6月25日修正
中華民國94年12月29日修正
中華民國99年8月16日修正
中華民國100年7月5日修正

一、本公司為配合政府推動再生能源政策及鼓勵國內再生能源發電應用發展，特依再生能源發展條例及電業法相關規定訂定本要點。

二、再生能源發電設備設置者(以下簡稱設置者)設置經中央主管機關(經濟部)依再生能源發展條例相關規定認定之第一型、第二型、第三型再生能源發電設備（以下簡稱發電設備），悉依本要點向本公司辦理購售電相關事宜。

未談DER資通訊法規議題

用戶再生能源發電系統自用發電設備：11kV以上且躉售電力時



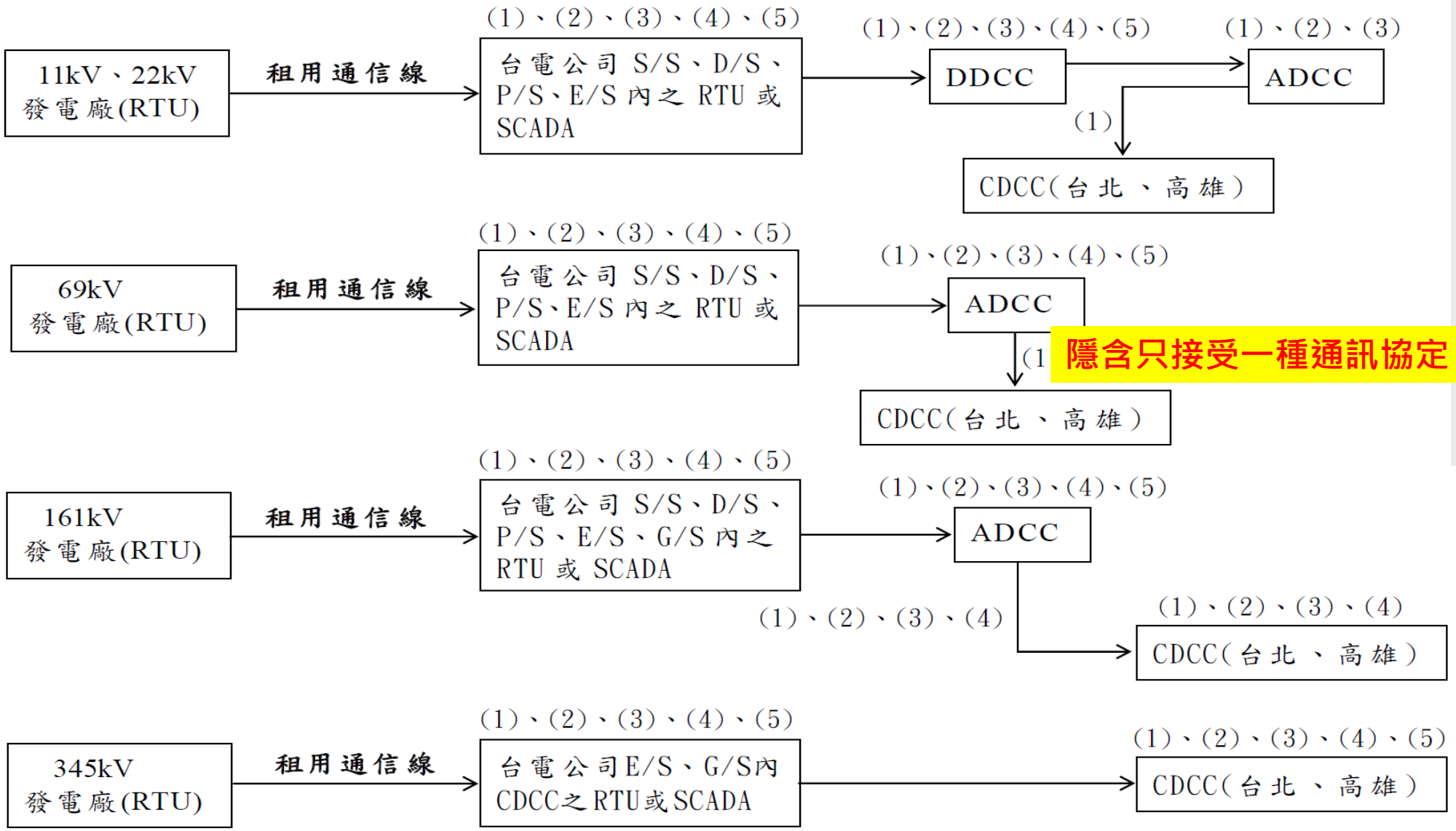
未談DER標準資訊模型

1) 發電廠端整廠總量之有效電力瞬間值(MW) 與每小時有效電力值(MWh)、無效電力瞬間值(MVAR)與每小時無效電力值(MVARh)、線路側電壓或匯流排電壓(kV)。(註2.)
2) 電源線台電變電所端責任分界點之AI點，如： 有效電力瞬間值(MW)、無效電力瞬間值(MVAR)、電流瞬間值(A)。
3) (電源線台電變電所端責任分界點之DI點，如：斷路器(C.B)、隔離開關(D.S)、接地開關(E.S)之CLOSE/OPEN狀態。
4) 發電廠端責任分界點之DI點，如：斷路器(C.B)、隔離開關(D.S)、接地開關(E.S)之CLOSE/OPEN狀態。
5) 『再生能源發電系統併聯技術要點』內規範之責任分界點保護電驛狀態。

- 註1.： 11kV以上用戶設置再生能源發電系統自用發電設備且躉售電力時， 僅提供資料(1)、(4)、(5)，如附圖二。
- 註2.：若變電所內RTU無法配合MWh、MVARh取樣，則暫由調度中心監控系統以軟體累計方式提供MWh、MVARh；將來俟變電所內RTU更換後再配合MWh、MVARh取樣。
- 註3.：上列資料均依台電自動化取樣標準取樣。

- 資料傳送之通訊協定及資料型式：應配合台電公司端之設備介面方式。
- 量測用PT、CT 之準確度：採用0.3級。

民營再生能源發電系統即時運轉資料傳送方式示意圖

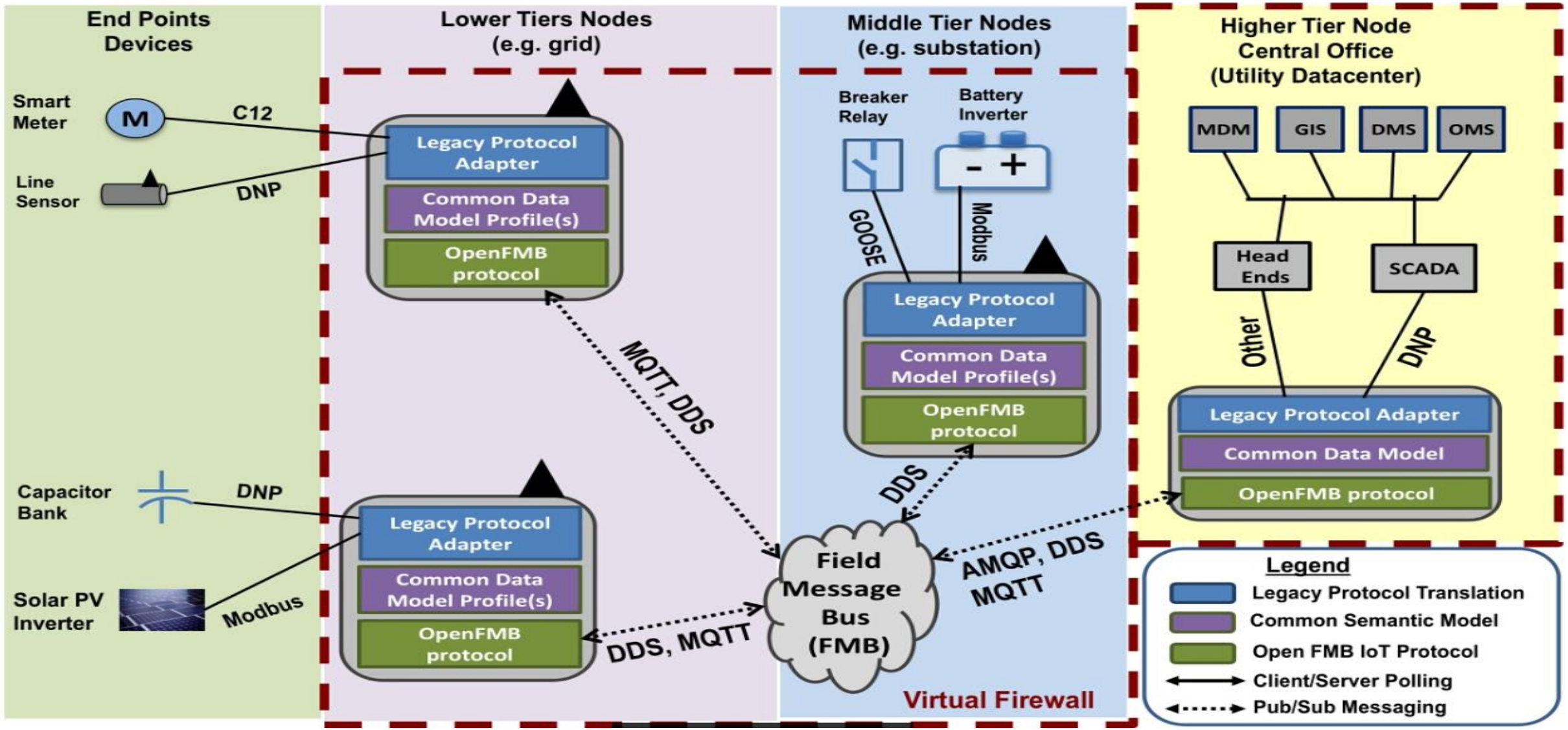


隱含只接受一種通訊協定

民營再生能源發電廠，原則上應將各項所需運轉資料傳送至所屬具RTU或Local SCADA系統之台電變電所或發電廠後再傳送至相關調度中心，其所增設之各項資訊設備由民營電廠提供及維護，由台電變電所內既設RTU或Local SCADA系統提供運轉資訊之接收介面。

11kV以上用戶設置再生能源發電系統自用發電設備且躉售電力時，應比照民營再生能源發電廠將即時運轉資料傳送至本公司。

OpenFMB Framework



OpenFMB與IEC 61850?

What is OpenFMB?

HITACHI
Inspire the Next

What it is:

- A framework
  - Business Case / Use Case(s) / Modeling / Implementation
  - Distributed intelligent nodes interacting with one another
- A North American Energy Standards Board (NAESB) standard (RMQ 26)
  - Specification
  - Reference architecture
- Uses IoT standard communications protocols
  - Publish/Subscribe (Pub/Sub)
- Use-case and data-driven
- Secure

What it isn't:

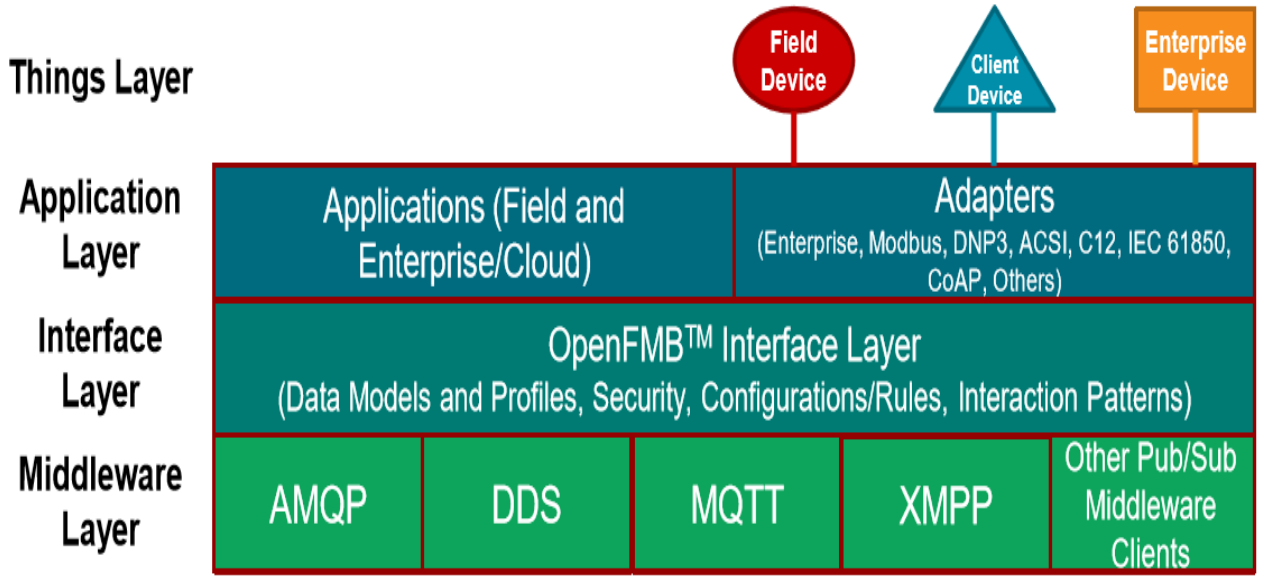
- A technology
- A semantic model standard
- A protocol standard
- A competitive standard to IEC 61850, 61968/70, MultiSpeak®
- Client/Server
- Device-driven

OpenFMB = Distributed Intelligence

 3

What does the OpenFMB™ architecture look like?

HITACHI
Inspire the Next



Source : Open Field Message Bus (OpenFMBTM) Overview, Stuart McCafferty VP, EnergyIoT Hitachi Americas, Ltd. Co-Chair, SGIP OpenFMB Priority Action Plan

 4

三、XMPP先導應用案例

SA與DER在SG應用上比較

Requirements	Station Automation	Smart Grid / Market Use Cases
Number of devices	Up to 100 devices per substation	1.000 – 10.000.000 devices in systems
Number of data points	> 1000 DP per device	Ca. 10-100 DP per device
Engineering	Static, seldom changes	Dynamic system management
Real time Performance	In miliseconds	In seconds / minutes
Communication Structures	Local, homogeneous (LAN, Ethernet)	Heterogeneous (FAN, NAN, WAN)
Networks	Private communication networks	Private and public communication networks
Security	Role based access control (RBAC)	End-to-End Authentication and Confidentiality, RBAC, no open interface ports at device

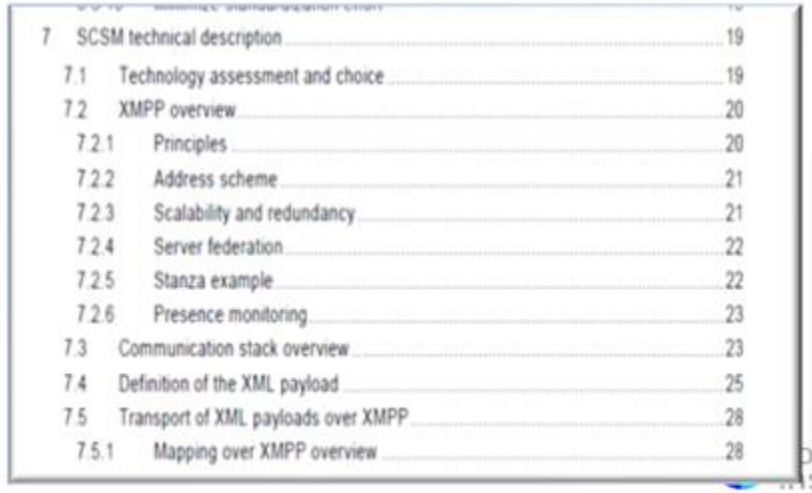
目前IEC 61850-80-3 (TR)已公布

已公布

IEC TR 61850-80-3

Edition 1.0 2015-11

TECHNICAL REPORT



IEC/TR 61850-80-3與將公布的IEC 61850-8-2新通訊協定息息相關

Communication networks and systems for power utility automation – Part 80-3: Mapping to web protocols – Requirements and technical choices

IEC 61850-80-3候選技術

- XMPP
- IEC 62541 (OPC UA)
- IEC 61400-25-4 Annex A
- XML over WebSocket
- DPWS
- REST
- ACSI XML

XMPP 是目前唯一已被納入IEC 61850/62746/62351標準之IOT

IOT Protocol Overview

- MQTT: a protocol for collecting device data and communicating it to servers (D2S)
- XMPP: a protocol best for connecting devices to people, a special case of the D2S pattern, since people are connected to the servers
- DDS: a fast bus for integrating intelligent machines (D2D)
- AMQP: a queuing system designed to connect servers to each other (S2S)
- ....

IEC 61850-8-2 (IS)將公布

XMPP 是目前唯一已被納入IEC 61850/62746/62351標準之IOT

TC 57	WG 17	B. Bony	BPUB	2018-10	2020

History

Stage	Document	Downloads	Decision Date	Target Date
PNW	57/1181/NP	434 kB	2011-10-07	
ANW	57/1221/RVN	234 kB	2012-03-09	2012-02
1CD	57/1583/CD	5019 kB	2015-06-05	2015-02
ACDV	57/1642/CC	319 kB	2015-11-06	2015-10
TCDV			2017-01-13	2016-11
CCDV	57/1833/CDV	4080 kB	2017-03-03	2017-03
PRVC			2017-05-26	2017-05
AFDIS	57/1903/RVC	507 kB 64 kB	2017-07-21	2017-09
TFDIS			2018-04-12	2017-12
DECFDIS			2018-05-24	2018-05
RFDIS			2018-06-04	2018-06
CFDIS	57/2020/FDIS		2018-07-13	2018-08
PRVD			2018-08-24	2018-08
APUB	57/2039/RVD	276 kB	2018-08-31	2018-09
BPUB			2018-08-31	2018-09
PPUB				2018-10

IEC 61850-8-2 ED1

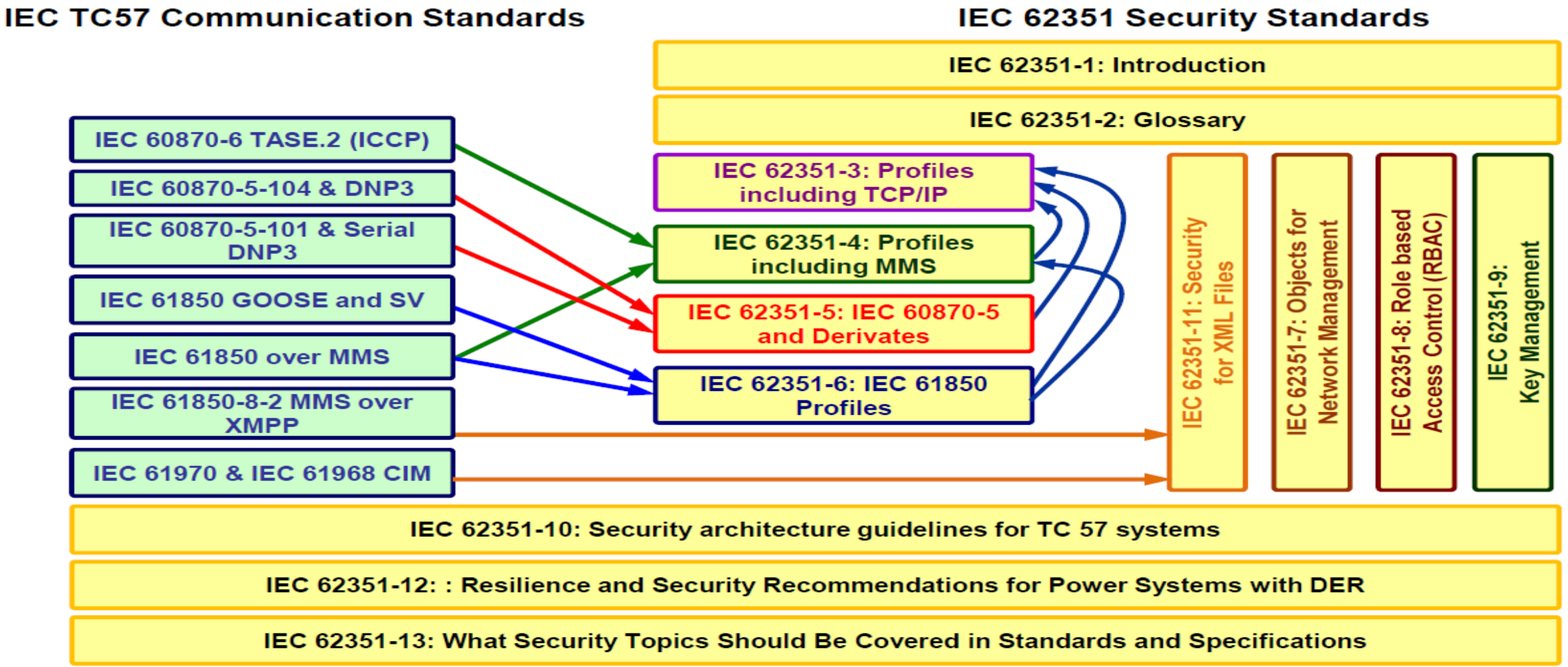
Communication networks and systems for powe utility automation - Part 8-2: Specific communication service mapping (SCSM) - Mapping to Extensible Messaging Presence Protocol (XMPP)

Associated Documents:

57/1585/INF
1561 kB
57/1584/DTR
2952 kB
SMB/5970/DL
471 kB
SMB/5347/DL
221 kB
SMB/5256/DL
186 kB
SMB/4881/DL
348 kB

IEC 61850-8-2有助於分散式能源資訊廣泛應用在電力管理及需量反映上。此部分(Part)標準誕生後，將加速再生能源資通訊在多領域複雜的智慧電網系統上應用之實現。

IOT技術目前已被IEC 61850/62746/62351標準納入



IOT技術目前已被IEC 61850/62746/62351標準納入

- **62746 Ed.1: Systems Interface between Customer Energy Management System and the Power Management System**
  - 62746-1 Overview (include Glossary)
  - TR 62746-2 Use Cases and Requirements
  - TS 62746-3 Architecture
  - 62746-4 Data Model
  - 62746-5 Service interface to customer system
  - 62746-10 Mapping
  - **62746-10-1 PAS OpenADR 2.0b**
  - **62746-10-2 CIM compliant Mapping to XMPP**
    - Message content and exchange patterns
    - Message transport and services
    - Security
    - Availability, redundancy
    - Profiles, Interoperability
    - …

IEC 61850 DER相關標準

IEC 61850 標準	DER相關
IEC 61850-7-420	**Basic communication structure – DER logical Nodes**
IEC 61850-90-6	Using IEC 61850 for DAS
IEC 61850-90-7	Object models for inverter based applications
IEC 61850-90-8	Object model for electric mobility
IEC 61850-90-9	Object models for electrical energy storage systems
IEC 61850-90-10	Modeling of schedules in IEC 61850
IEC 61850-90-15	DER Grid Integration using IEC 61850
IEC 61850-80-3	Requirement analysis for mapping to Web Protocols
IEC 61850-80-4	COSEM object model (IEC 62056) to the IEC 61850 data model
IEC 61850-80-5	Mapping information IEC 61850 and IEC 61158-6 (Modbus)
IEC 61850-8-2	SCSM mappings to XMPP

*** DNP Application Note AN2013-001 : DNP3 Profile for Advanced Photovoltaic Generation and Storage**

Functions are Mapped into Open Protocols

IEC

IEC 61850 MMS and Web Services XMPP

SUNSPEC ALLIANCE

Modbus

SunSpec Alliance Interoperability Specification

Common Elements

SunSpec Alliance Common Elements Workgroup

John Blair, John Nunneley, Karl Lambert, Pat Adamosky, Ronnie Petterson

Version 1.0

IEEE

ZigBee Alliance

IEEE P2030.5

Smart Energy Profile

SEP 2

dnp Distributed Network Protocol

DNP Application Note AN2013-001

DNP3 Profile for Advanced Photovoltaic Generation and Storage

1 Introduction

This document describes a standard data point configuration, set of protocol services and settings – also known as a *profile* – for communicating with photovoltaic (PV) generation and storage systems using DNP3. The purpose of defining this profile is to make it easier to interconnect the DNP3 masters and outstations that are used to control such systems.

This document is an application note, meaning it does not specify any changes to the DNP3 standard at all; it merely describes how to use DNP3 for a particular purpose. It is, however, intended to be an interoperability standard for those wishing to build and specify PV generation and storage systems.

Although this document describes a DNP3 profile, it is designed based on the structured data models of

DNP3 Photovoltaic Profile

DNP3 Photovoltaic Profile

- Official DNP3 Application Note
- Published on DNP Users Group web site
- Specifies required protocol Options
- Mapping to the DER smart inverter functions
- Mapping to IEC 61850-90-7 Object Model
- Minimum points list
- Std. data formats

Distributed Network Protocol

2.2.3 **Binary Inputs**

Table 4 lists the binary input points to be used in the DNP3 Profile for Photovoltaic Generation and Storage Systems. Table 5 specifies the options to be used by outstations in reporting these points

Table 4 – Binary Input Points List

Point Index	Name / Description	Default Event Class	Name for State when value is 0	Name for State when value is 1	IEC 61850			
					LN Class	LN Inst	Data Object	CDC
0	Mode of operation – limited Watts	2	Disabled	Enabled	DOPM	2	OpModWLim	SPC
1	Mode of operation – fixed power factor	2	Disabled	Enabled	DOPM	3	OpModPFAng	SPC
2	Mode of operation – charge/discharge rate	2	Disabled	Enabled	DOPM	4a	OpModWRte	SPC
3	Start PV generation	2	Null	Started	DRCC	1	DERStr	SPC
4	Stop PV generation	2	Null	Stopped	DRCC	1	DERStop	SPC
5	Set automatic mode	2	Not Auto	Auto	DRCC	1	AutoManCtl	SPC
6	Set local/remote control mode	2	Remote	Local	DRCC	1	LocRemCtl	SPC
7	PV system is in automatic mode	3	Not-Auto	Auto	DRCS	1	AutoMan	SPS
8	PV is generating and connected	3	Null	On-Connected	DRCS	1	ModOnConn	SPS
9	PV is generating and available for connection	3	Null	On-Not-Connected	DRCS	1	ModOnAval	SPS
10	PV is off but available to start generating	3	Null	Off-Available	DRCS	1	ModOffAval	SPS
11	PV is off and not available to start generating	3	Null	Off-Not-Available	DRCS	1	ModOffUnav	SPS
12	VAR management capability	3	No VAR Mgmt	VAR Mgmt Available	DRCS	1	ModVAr	SPS
13	Inverter active power output too high	1	Normal	Alarm	MMXU	1	TotW.range	MV
14	Inverter active power output too low	1	Normal	Alarm	MMXU	1	TotW.range	MV
15	Inverter reactive output too high	1	Normal	Alarm	MMXU	1	TotVAr.range	MV
16	Inverter reactive output too low	1	Normal	Alarm	MMXU	1	TotVAr.range	MV
17	Current output frequency	1	Normal	Alarm	MMXU	1	Hz.range	MV

EPRI Smart Distribution and Power Quality 2013 Conference and Exhibitic

An Exelon Company

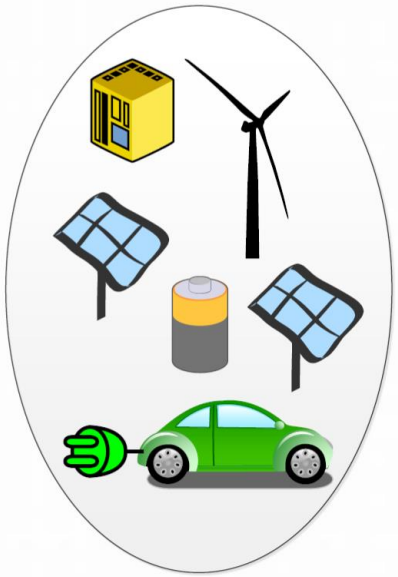
AN2013-001 DNP3 profile 包含

- 假設的PV系統結構和IEC 61850-7-420數據模型
- DNP3數據點列表和與每個點對應的IEC 61850名稱
- DNP3服務列表（即功能代碼，物件和點索引），用於實作IEC TR 61850-90-7和EPRI Common Functions for Smart Inverters文件規定的每項功能
- 協定實作符合性聲明（PICS）表單

模型化重要觀念

- 將電力自動化不同領域下任何不同廠牌之實體設備或系統或功能用統一標準化的邏輯節點(LN-DO-Attribute)來表示其資訊。

- 不同領域涵蓋發輸配及分散式能源等



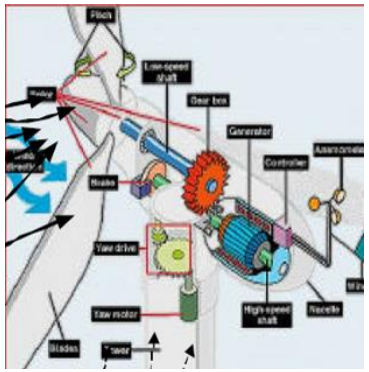
DER

current measurement transformers

circuit breaker (can break short-circuit current)

disconnector (can't be switched under load)

IED – Line Dist. Protection

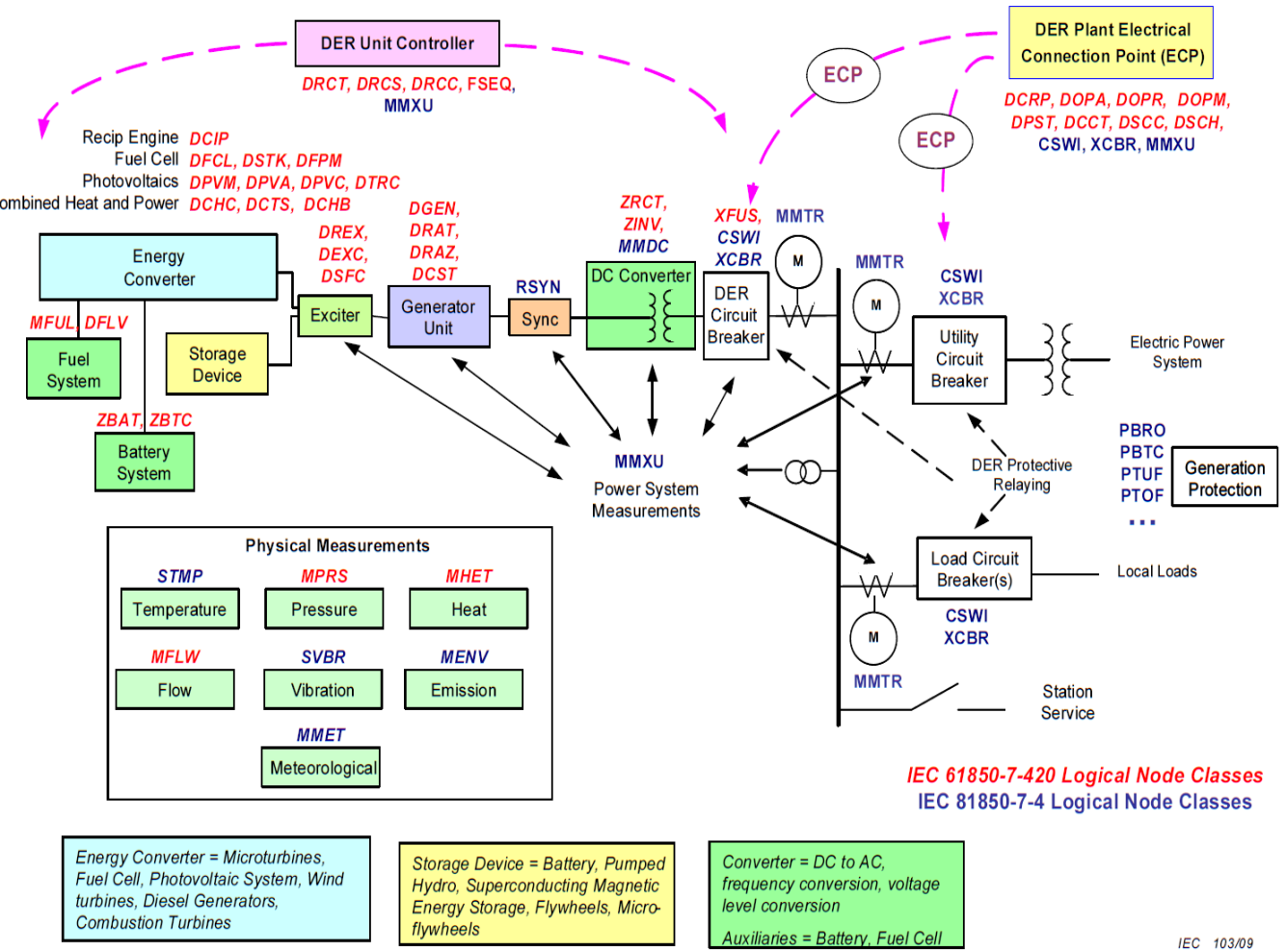


WTGS

. . .

分散式能源設備相關功能LN

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



MMET class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Measured and metered values				
EnvTmp	MV	Ambient temperature		O
WetBlbTmp	MV	Wet bulb temperature		O
CloudCvr	MV	Cloud cover level		O
EnvHum	MV	Humidity		O
DewPt	MV	Dew point		O
DffInsol	MV	Diffuse insolation		O
DctInsol	MV	Direct normal insolation		O
DlDur	MV	Daylight duration (time elapsed between sunrise and sunset)		O
HorInsol	MV	Total horizontal insolation		O
HorWdDir	MV	Horizontal wind direction		O
HorWdSpd	MV	Horizontal wind speed		O
VerWdDir	MV	Vertical wind direction		O
VerWdSpd	MV	Vertical wind speed		O
WdGustSpd	MV	Wind gust speed		O
EnvPres	MV	Barometric pressure		O
RnFll	MV	Rainfall		O
SnwDen	MV	Density of snowfall		O
SnwTmp	MV	Temperature of snowfall		O
SnwCvr	MV	Snow cover		O
SnwFll	MV	Snowfall		O
SnwEq	MV	Water equivalent of snowfall		O

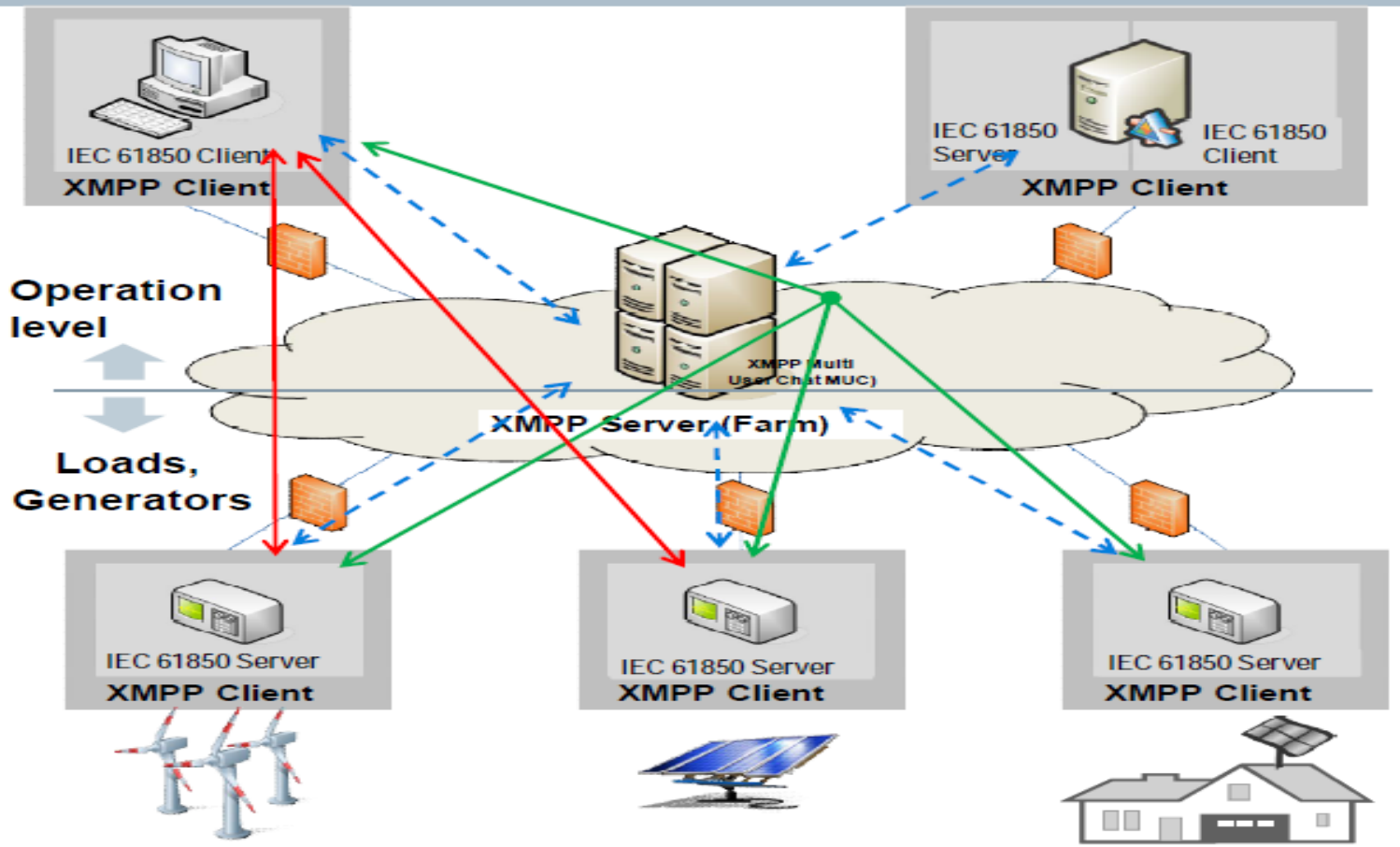
Relation between IEC 61850-5 and IEC 61850-7-4 for metering and measurement LNs

Functionality	Defined in IEC 61850-5 by LN	Modelled in IEC 61850-7-4 by LN	Comments
Measurement	MMXU	MMXU	Three-phase version
		MMXN	Non-phase-related version (single phase)
		MMDC	DC-related version
Metering (three-phase)	MMTR	MMTR	Metering (three-phase values)
		MMTN	Metering (single-phase values)
		MSTA	Metering (statistics) – obsolete, moved to annex
Harmonics and interharmonics	MHAI	MHAI	Three-phase version
		MHAN	Non-phase-related version (single phase)
Environmental measurement	MENV	MENV	Environmental data objects
		MMET	Meteorological data objects

新作法DER應用XMPP 案例

SIEMENS

Security Relations of DER Integration



Trust relations

- DER resource (XMPP client on IEC61850 server) belongs to DER owner
- DER control (XMPP client on IEC 61850 client/server) incl. control center belongs to DNO
- XMPP server may belong to DNO or 3rd party service provider

Resulting requirements

- **Authentication**
  - End-to-middle between XMPP client and server or between XMPP servers
  - End-to-end authentication between IEC 61850 client and server instances
- **Integrity** protection between all instances
- **Confidentiality** protection between IEC 61850 client and server instances

↔ **Hop-to-Hop**

↔ **End-to-End unicast**

↔ **End-to-End multicast**

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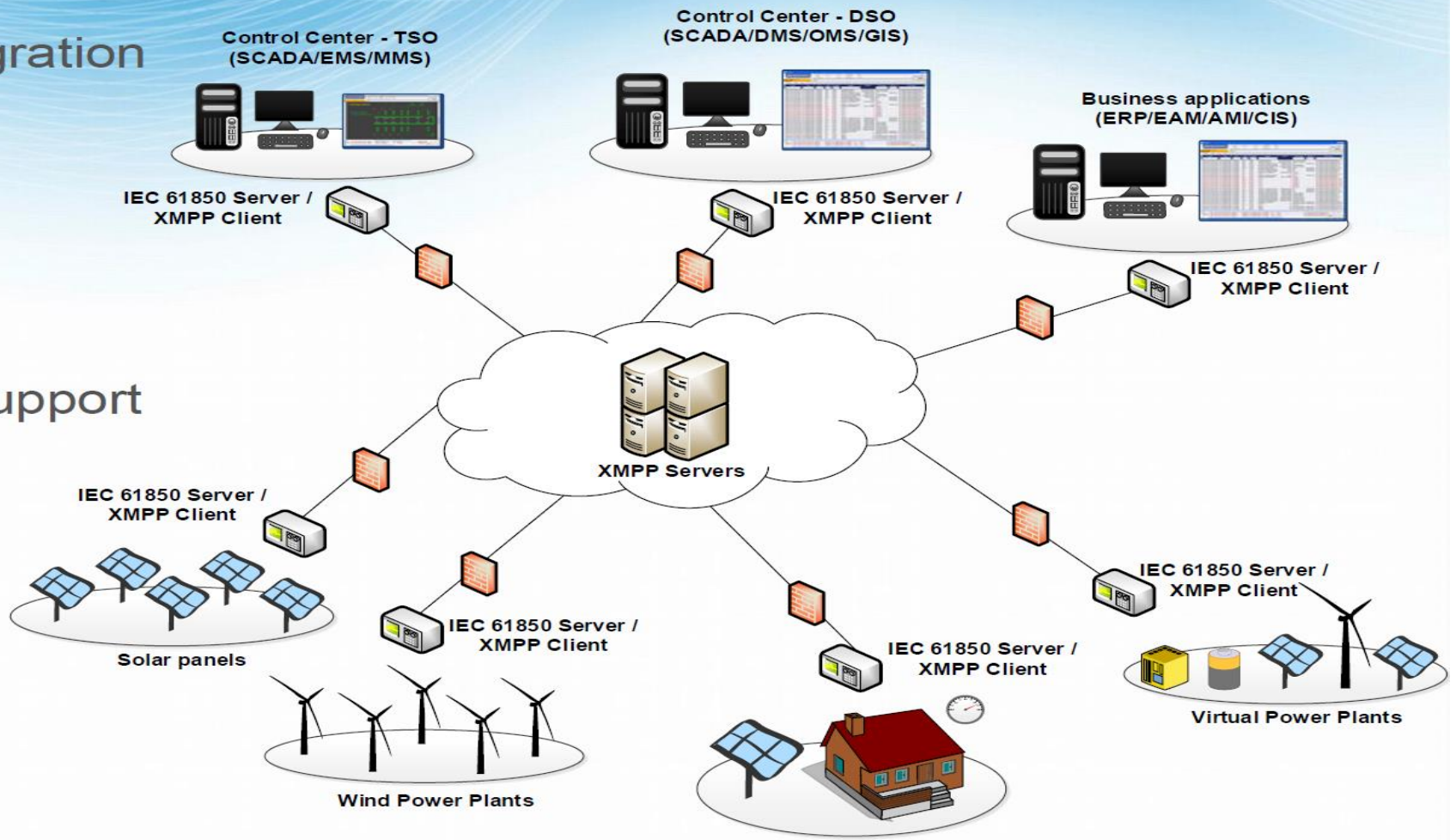
DER應用XMPP 案例-KONČAR

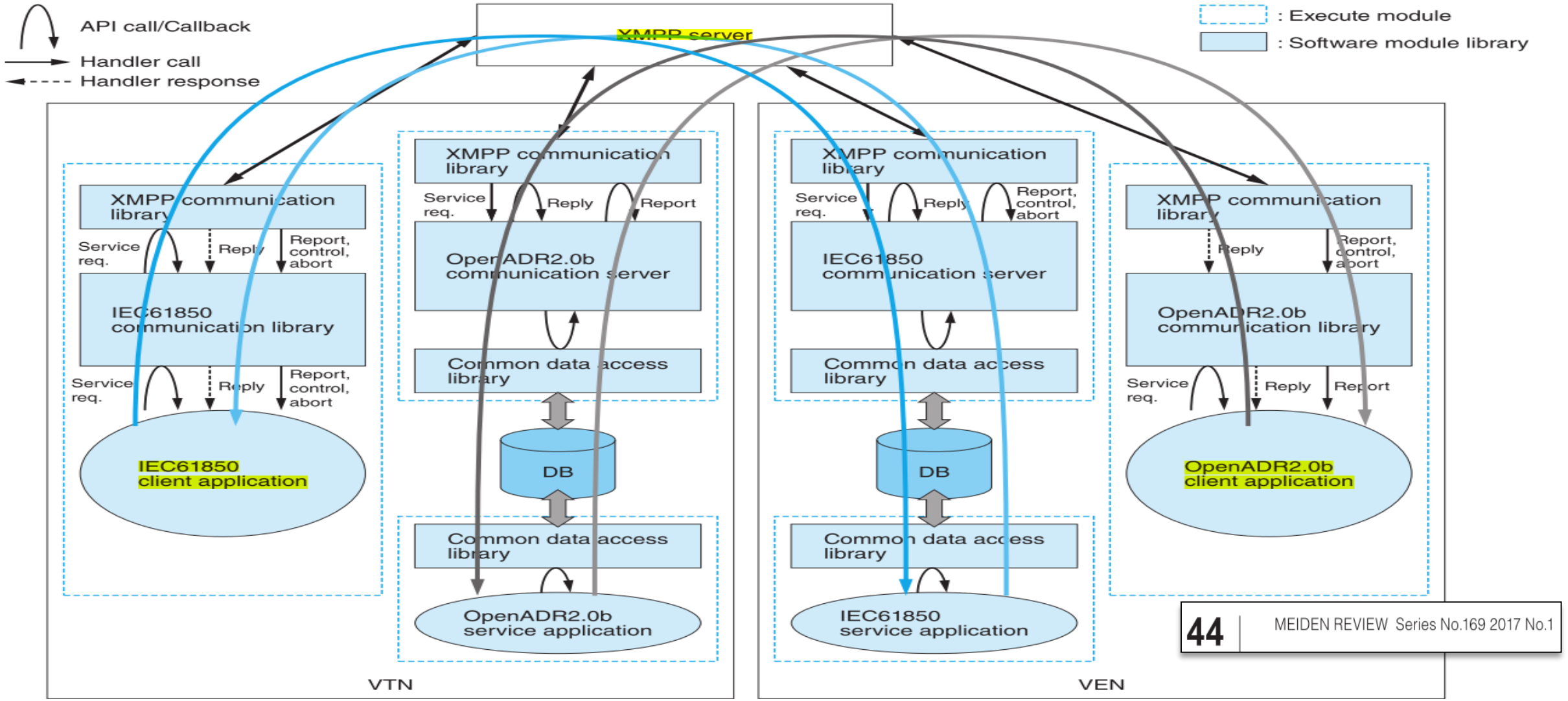
IEC 61850-8-2- SCSM mappings to XMPP

- Secure DER integration
- Authentication
- Integrity
- Confidentiality
- Mandatory TLS support
- IEC 62351 ed.2



日本智慧社區聯盟在未來能源系統應用IEC 61850 XMPP

For the OpenADR2.0b and IEC61850, the position of the client and server to the upper and lower layers is reversed and installation into the same device is very difficult. We analyzed the behavior of the applications installed separately and rearranged the common factors



Development of Communication Platform for Next Generation Distribution and Demand-Side Systems

The 18th IERE General Meeting and Japan Forum
May 21-24, 2018, Kyoto, Japan

Development of Communication Platform for Next Generation Distribution and Demand-Side Systems

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Keywords: *International standard, XMPP, Distribution automation, Demand response, Advanced metering infrastructure*

Abstract

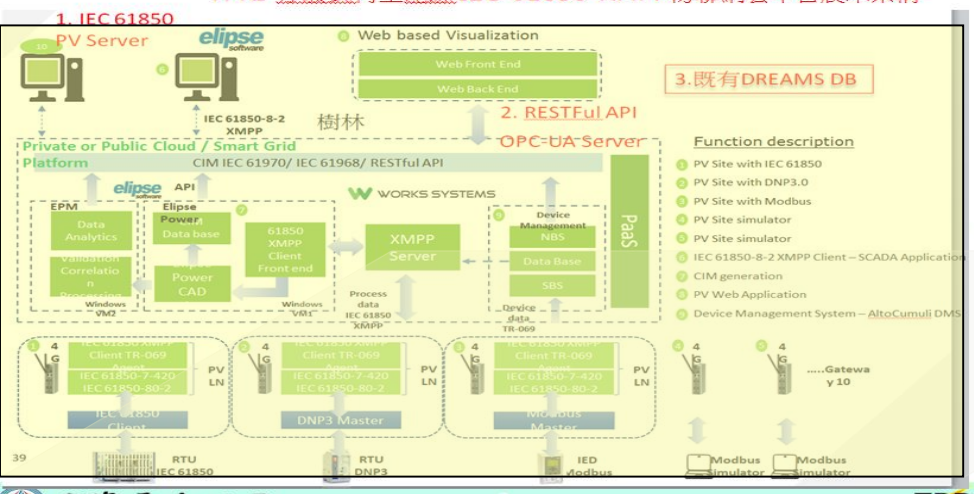
It is expected that interactions among electric power utilities and their customers will progress according to increase of renewable energy resources such as photovoltaic generation systems connected to distribution systems and expansion of introduction of demand-side systems for advanced metering infrastructure and demand response. The progress will accelerate digitalization of the utilities. ICT for the exchange of various information among the utilities and their customers will play an important role for creation of added value by the digitalization. So it is important to facilitate information exchange among systems. On the other hand, IEC 61850, IEC 62056 and OpenADR are indispensable standards for each communication in the systems. To realize the interaction among these systems, it is necessary to apply and integrate these standards properly. As Extensible Message and Presence Protocol (XMPP) has a possibility to be applied to and integrate these communications, we proposed a communication platform based on XMPP as the data transmission protocol. The platform involves common application programming interface (API) for XMPP messages. Each data of application protocols is assembled to XMPP message so the platform can handle every communication protocols defined in the standards without concerning the difference of the protocols.

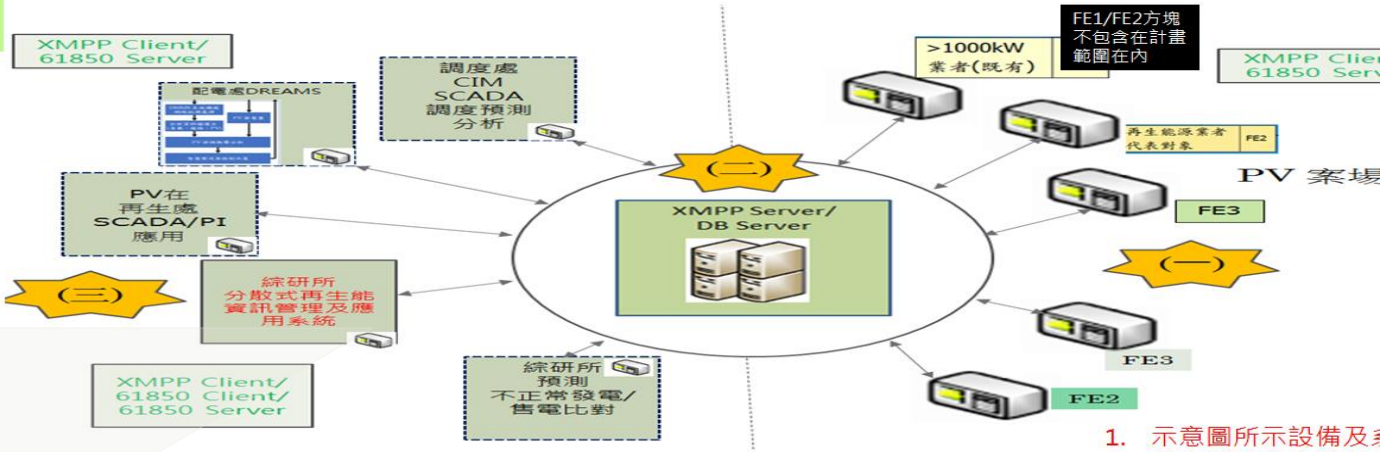
We developed an experimental system incorporating the common API and application programs which include programs for the communication in IEC 61850 protocol between master and field controller of distribution automation application. The results of the experiment shows that the function of the platform worked properly. We also measured communication performance with generic computer equipment and communication line then confirmed the applicability of the platform for the distribution automation application.

TPC/TPRI新應用-DER導入先導型IEC 61850 XMPP 雲端系統

TPC/TPRI - IEC 61850 XMPP物聯網雲平台對外介面

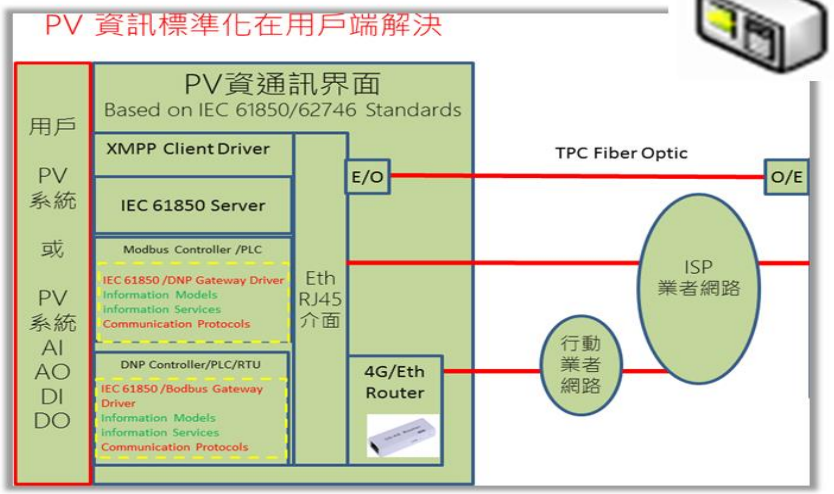
TPRI 分散式再生能源IEC 61850 XMPP物聯網雲平台展示架構





1. 示意圖所示設備及系
月內於實驗室內完成
2. 導入IEC 61850協定
網及雲端平台技術及
案場連線測試預計-

台灣電力公司



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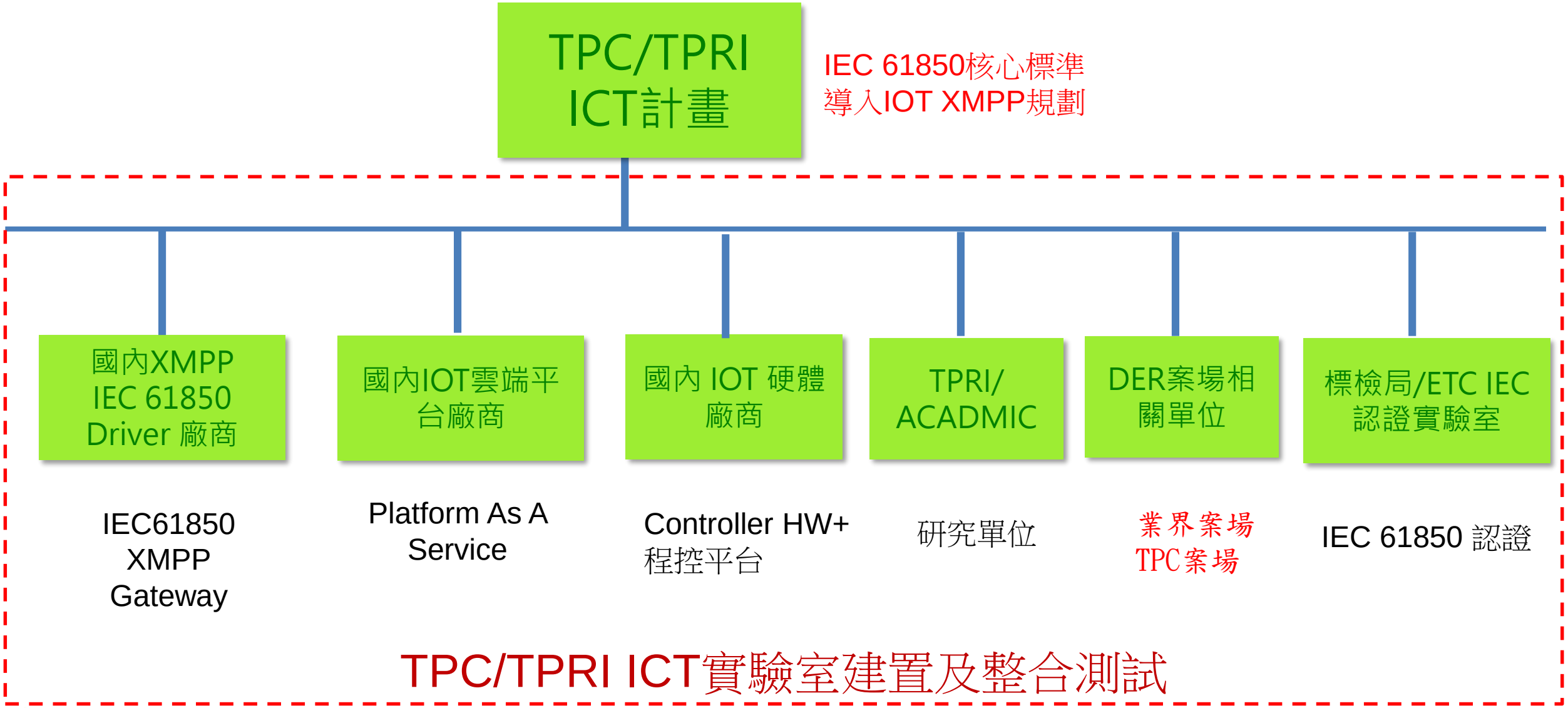
新IEC 61850標準應用大量DER佈建並升級國內產業

智慧電網分散式能源導入IEC 61850核心標準IOT技術規劃



DER/RE運用採用IEC國際標準將單純化系統運用

- 綠能運用涵蓋:水、風、分散式能源(PV 、EV、Storage)等，其資訊之監視、分析、預測之最終目的是整體調度或控制，以達到系統穩定兼顧提高綠能占比之目的。
- 綠能資通訊標準內涵含資訊模型(資訊之封裝或格式)、資訊交換服務(存取方法)、以及其透過網路傳輸之協定通訊，建議採用國際標準較能有未來性及一致性。
- 綠能資通訊建議可考慮採用最新國際標準通訊協定XMPP(已被列入IEC 61850-8-2 、IEC 62746 、IEC 62351標準中) 。
- 採用XMPP通訊協定滿足INTERNET、大量佈建或移除、PLUG –PLAY及資安等特性。
- 綠能運用來源端就採用國際標準將單純化系統運用。
- 採用國際標準省時省力又省錢。

結論

- DER資通訊導入國際標準有利智慧電網整合運用
- DER分散式能源資通訊標準須由法規面著手
- 依國際標準制定相關法規較能達到政府、電業(含台電)及業者(廠商)有三贏共識。
- XMPP雲端管理平台適合廣域網路分散式能源大量布建
- DER導入國際新標準可促進產業升級及競爭力

報告完畢

謝謝聆聽 敬請 指正