IEC 61850電業自動化延伸領域之應用

一、前言

二、標準與延伸領域更新

三、規劃引進應用

四、未來與智慧電網之整合

五、結論

台電綜研所廖政立

於電腦公會 501 會議室

2017.10.19

引進IEC 61850標準

推廣擴散階段(2016~2020年)細部執行計畫
一、智慧發電與調度構面(4/9)

經濟部能源局 Bureau of Energy

具體做法		2017年執行成果(至8月底)	第二階段全程目標	第二階段分年目標規劃					負責單位
				2016	2017	2018	2019	2020	
A7	引進IEC61850標準通訊協定	已完成大潭電廠IEC 61850風機自動化系統建置，目前正在進行基於IEC 61850之太陽能電廠監控系統建置及IEC 61850與DNP3.0之間轉換研究。	2016預定完成現行數位電驛 IED與RTU校時系統與事故資料整合研究。2016~2020年 預定完成引進IEC 61850標準擴展部分(如part 80.xx, 90.xx相關標準)。	預定完成現行數位電驛 IED與RTU校時系統與事故資料整合研究。	引進IEC 61850標準擴展部分(如part 80.xx, 90.xx相關標準)-台電公司既有DNP3變電所與IEC 61850變電所過渡之調適 IEC 61850-80-2/ IEEE 1815.1。	引進IEC 61850標準擴展部分(如part 80.xx, 90.xx相關標準)- IEC 61850-90-3 (狀態監視)。參考已建置之IEC61850先導型變電所運轉情形，評估大量推廣之可行性。	引進IEC 61850標準擴展部分(如part 80.xx, 90.xx相關標準)-IEC 61850-90-6 DA(配電自動化)-配電SCADA/饋線故障位置檢出故障隔離與服務恢復/饋線電壓無效功率控制	引進IEC 61850標準擴展部分(如part 80.xx, 90.xx相關標準)-IEC 61850-90-8電動車充電系統模型。	台電綜研所

IEC 61850 與領域擴充文件

Communication Networks and Systems for Power Utility Automation

Part -80- 90-1

Part 1-10

IEC/TR 61850-1 ed2.0
IEC/TS 61850-2 ed1.0
IEC 61850-3 ed2.0
IEC 61850-4 ed2.0
IEC 61850-5 ed2.0
IEC 61850-6 ed2.0
IEC 61850-7-1 ed2.0
IEC 61850-7-2 ed2.0
IEC 61850-7-3 ed2.0
IEC 61850-7-4 ed2.0
IEC 61850-7-410 ed2.0
IEC 61850-7-420 ed1.0
IEC/TR 61850-7-510 ed1.0
IEC 61850-8-1 ed2.0
IEC 61850-9-2 ed2.0
IEC 61850-9-3 ed1.0
IEC 61850-10 ed2.0

Part	Title
IEC TS 61850-80-1:2008	Guideline to exchanging information from a CDC-based data model using IEC 60870-5-101 or IEC 60870-5-104
IEC 61850-80-2/IEEE1815.1	Exchanging Information between networks implementing IEC 61850 and IEEE 1815(DNP3)
IEC TR 61850-80-3:2015	Mapping to web protocols - Requirements and technical choices
IEC TS 61850-80-4:2016	Translation from the COSEM object model (IEC 62056) to the IEC 61850 data model
IEC/TS 61850-80-5	Guideline for mapping information between IEC 61850 and IEC 61158-6 (Modbus)
IEC 61850-90-1	Using IEC 61850 for communication between substations (published)
IEC 61850-90-2	Using IEC 61850 for communication between substations and control center
IEC 61850-90-3	Using IEC 61850 for condition monitoring
IEC 61850-90-4	Network engineering guidelines (LAN in substations)
IEC 61850-90-5	Using IEC 61850 to transmit synchrophasor information according to IEEE C37.118
IEC 61850-90-6	Using IEC 61850 for distribution automation
IEC 61850-90-7	IEC 61850 object models for photovoltaic, storage and other DER inverters
IEC 61850-90-8	IEC 61850 object models for electrical vehicles
IEC 61850-90-9	IEC 61850 object models for electrical energy storage systems
IEC 61850-90-10	Modeling of schedules in IEC 61850
IEC 61850-90-11	Methodologies for modeling of logics for IEC 61850 based applications
IEC 61850-90-12	Network engineering guidelines for WAN
IEC 61850-90-13	Extensions to include models for steam and gas turbines Interoperability test for hydro equipment based on IEC 61850
IEC 61850-90-14	Using IEC 61850 for FACTS data modeling
IEC 61850-90-15	Hierarchical DER system model
...	...

IEC 61850標準相關

已公布之IEC 61850其他相關IS/TR/PAS		
2012-03	-7-510	水電廠LNs功能建模之使用
2008-12	-80-1	CDC資料模型資訊交換使用IEC 60870-5-101,104指引
2015.11	-80-3	Web協定的映射-需求及技術選擇
2016.5	-9-3	IEC 61588 PTP profile
2010-03	-90-1	變電所之間通信
2016-02	-90-2	變電所與控制中心之間通信
2016-05	-90-3	設備狀態監測診斷與分析
2013-08	-90-4	變電所網路工程指南
2012-05	-90-5	依IEEE C37.118之IEC 61850同步相量資訊傳輸
2013-02	-90-7	PV、儲能和其他DER 電力轉換器的IEC 61850物件建模
2016-04	-90-8	電動汽車物件模型
2015-07	-90-12	廣域網路應用指南

IEC 61850標準相關

正在發展中之IEC 61850其他相關IS/TR/TS	
-7-5	IEC 61850建模概念
-7-500	變電所自動化系統LNs功能建模之使用
-7-520	DER LNs功能建模之使用
-8-2	SCSM mappings to XMPP
-80-2	IEC 61850與DNP3.0 Mapping
-80-4	轉換AMI COSEM(IEC 62056)
-80-5	Modbus與IEC 61850之間的資料轉化
-10-3	IEC 61850系統功能測試
-90-3	設備狀態監測診斷與分析

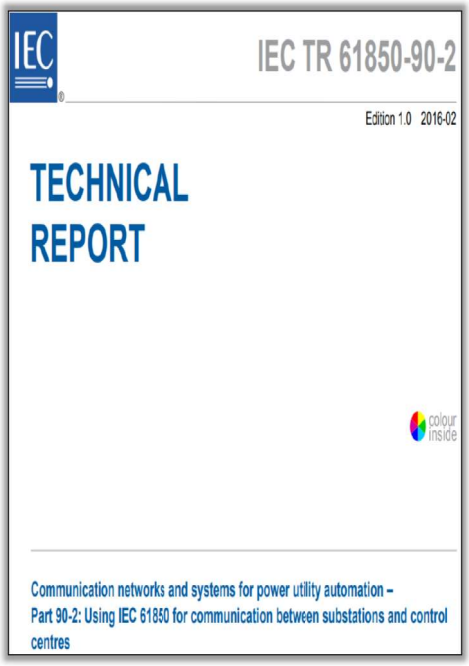
IEC 61850標準相關

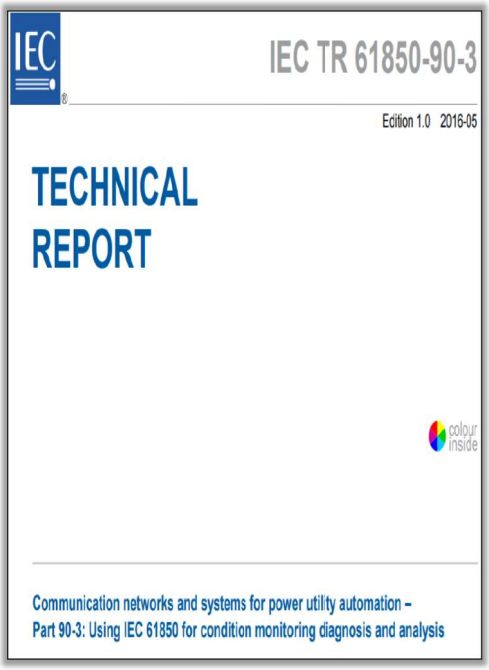
正在發展中之IEC 61850其他相關IS/TR/TS	
-90-6	配電自動化系統應用
-90-9	電力儲能物件模型
-90-10	調度物件模型
-90-11	IEC 61850應用的邏輯建模方法論
-90-13	Steam/Gas Turbines IEC 61850資訊模型及擴展
-90-14	FACTS物件模型
-90-15	DER系統整合
-90-16	系統管理
-90-17	電力品質
-90-...	

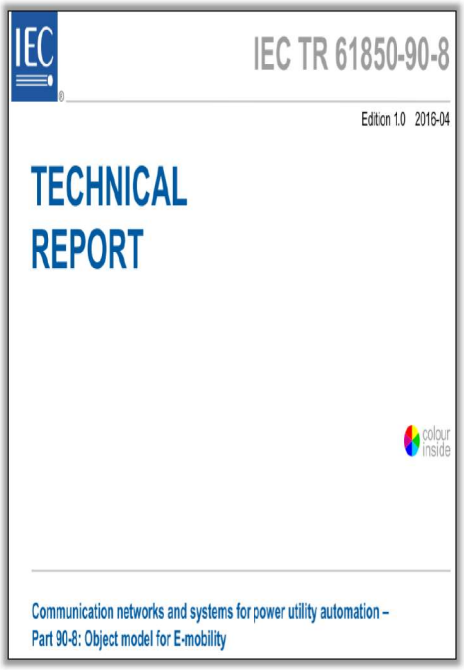
IEC 61850 DER相關標準

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 61850-8-2	SCSM mappings to XMPP

新出版之延伸領域TR例







相關延伸領域例亦即將出版

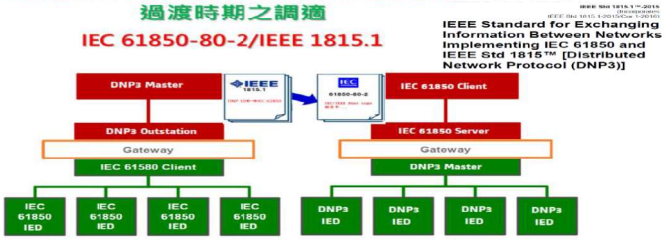
TC57 Work Programme generated on 2017-10-18				
Project Reference	**Title**	**Document Reference**	**Current Stage Date**	**Current Stage**
IEC 61850-7-420 ED2	Communication networks and systems for power utility automation - Part 7-420: Basic communication structure - Distributed energy resources logical nodes	57/1655/CD	2017-01	ACD
IEC 61850-8-2 ED1	Communication networks and systems for power utility automation - Part 8-2: Specific communication service mapping (SCSM) - Mapping to Extensible Messaging Presence Protocol (XMPP)	57/1833/CDV	2017-07	AFDIS
IEC TR 61850-90-6 ED1	Communication networks and systems for power utility automation - Part 90-6: Use of IEC 61850 for Distribution Automation Systems	57/1929/DTR	2017-10	CDTR
IEC TR 61850-90-10 ED1	Communication networks and systems for power utility automation - Part 90-10: Models for scheduling	57/1762/DTR	2017-09	BPUB
IEC TS 61850-90-16 ED1	Communication networks and systems for power utility automation - Part 90-16: System management for IEC 61850	57/1775/NP	2017-01	ACD

導入依國際標準之跨系統智慧電網先導系統之規劃

(以綜研所IEC 61850 Use Cases為例)

未來跨處所整體應用案例規劃

IEC 61850-80-2：
IEC 61850/DNP Gateway
既有DNP3變電所與IEC 61850變電所
過渡時期之調適
IEC 61850-80-2/IEEE 1815.1



電業自動化資通訊與委新標準發展

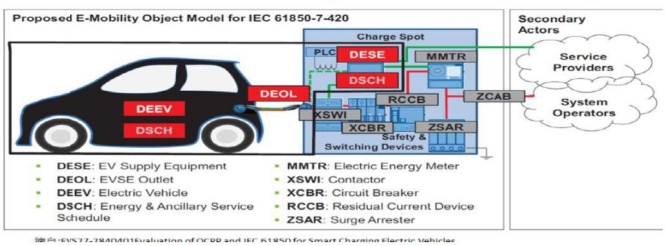
0602-太陽能電廠於未來智慧電網下之控制及運作模式之研究
IEC 61850/SG/IOT

未來跨處所整體應用案例規劃

0504 IEC 61850-90-3 CDM(狀態監視)

未來跨處所整體應用案例規劃

IEC 61850-90-8電動車充電系統模型
IEC/TR 61850-90-8 : Object model for E-mobility



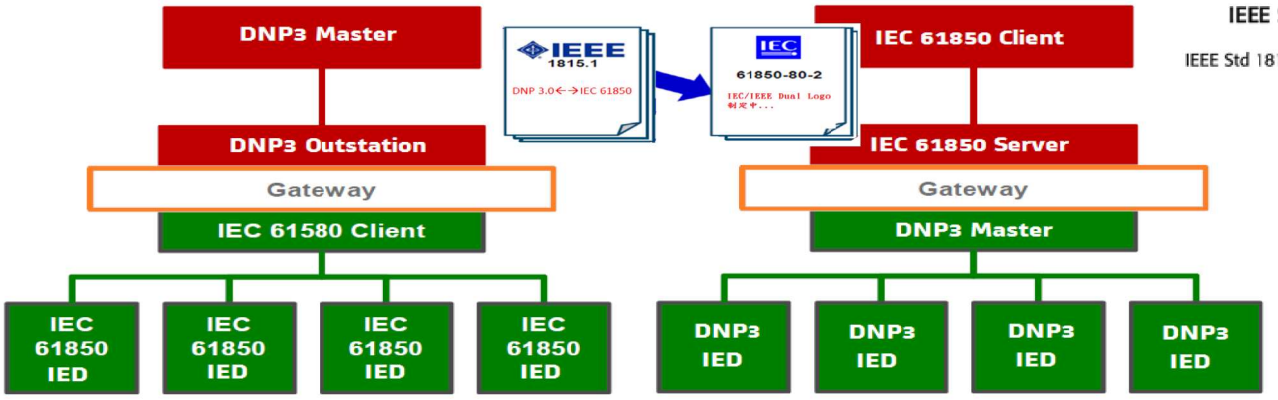
IEC 61850-80-2 :IEC 61850/DNP Gateway

既有DNP3變電所與IEC 61850變電所過渡時期之調適

IEC 61850-80-2/IEEE 1815.1

IEEE Standard for Exchanging Information Between Networks Implementing IEC 61850 and IEEE Std 1815™ [Distributed Network Protocol (DNP3)]

IEEE Std 1815.1™-2015
(Incorporates
IEEE Std 1815.1-2015/Cor 1-2016)



摘自: IEEE P1815.1/D4.00, June 2012

DNP3非SG核心標準

Background – IEEE 1815

- Distributed Network Protocol (DNP3)
- Originally developed by GE/Harris/Westronic
- Now controlled by DNP Users Group
- Designed for low bandwidth, low reliability links
- Combines best practices from hundreds of earlier protocols
- Most widely used utility protocol in North America (approx 75%)
- Flat, points-based data model
- DNP3-XML Device Profile Document provides configuration info
- Serial and IP profiles

dnp Distributed Network Protocol

IEEE

Flat, points-based data model

10

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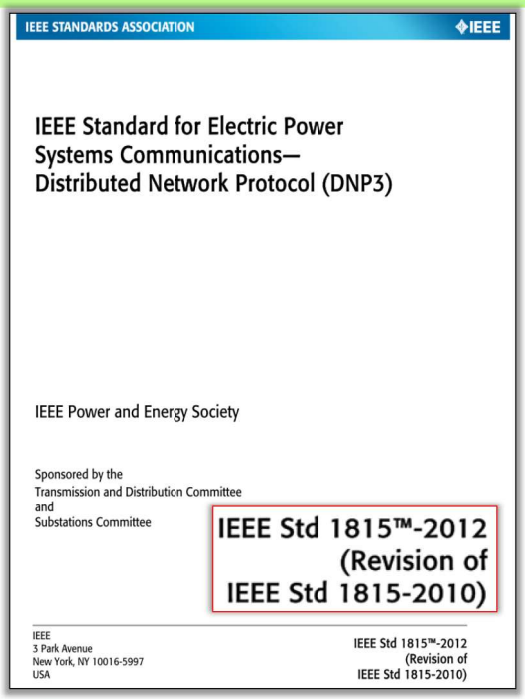
DNP 3 - IEEE 1815與IEEE 1815.1


IEEE STANDARDS ASSOCIATION IEEE

IEEE Standard for Electric Power Systems Communications—Distributed Network Protocol (DNP3)

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IEEE Std 1815™-2012 (Revision of IEEE Std 1815-2010)

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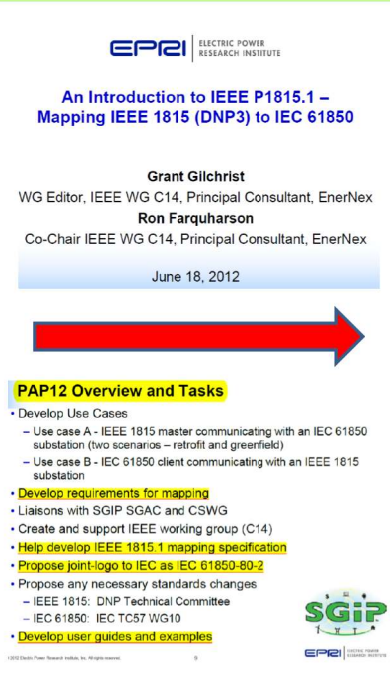
IEEE Std 1815™-2012
(Revision of
IEEE Std 1815-2010)


EPRI ELECTRIC POWER RESEARCH INSTITUTE

An Introduction to IEEE P1815.1 – Mapping IEEE 1815 (DNP3) to IEC 61850

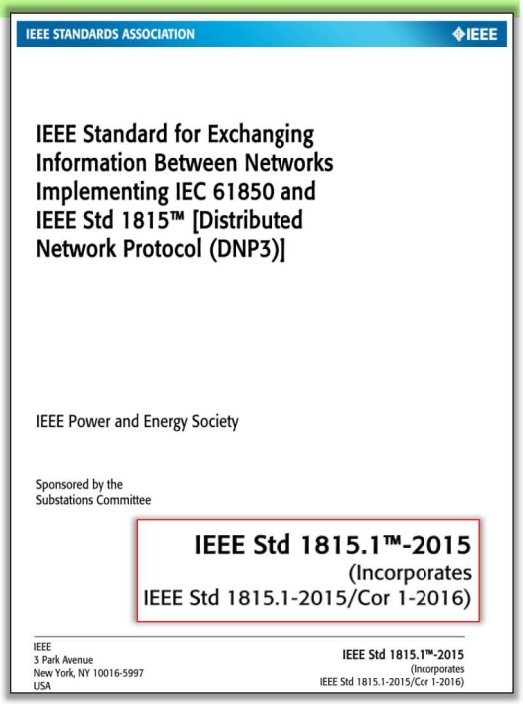
Grant Gilchrist
WG Editor, IEEE WG C14, Principal Consultant, EnerNex
Ron Farquharson
Co-Chair IEEE WG C14, Principal Consultant, EnerNex

June 18, 2012

PAP12 Overview and Tasks

- Develop Use Cases
  - Use case A - IEEE 1815 master communicating with an IEC 61850 substation (two scenarios – retrofit and greenfield)
  - Use case B - IEC 61850 client communicating with an IEEE 1815 substation
- Develop requirements for mapping
- Liaisons with SGIP SGAC and CSWG
- Create and support IEEE working group (C14)
- Help develop IEEE 1815.1 mapping specification
- Propose joint-logo to IEC as IEC 61850-80-2
- Propose any necessary standards changes
  - IEEE 1815: DNP Technical Committee
  - IEC 61850: IEC TC57 WG10
- Develop user guides and examples

SGiP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DNP 3.0網路模型及Data Object

DNP Serial and LAN Network Models

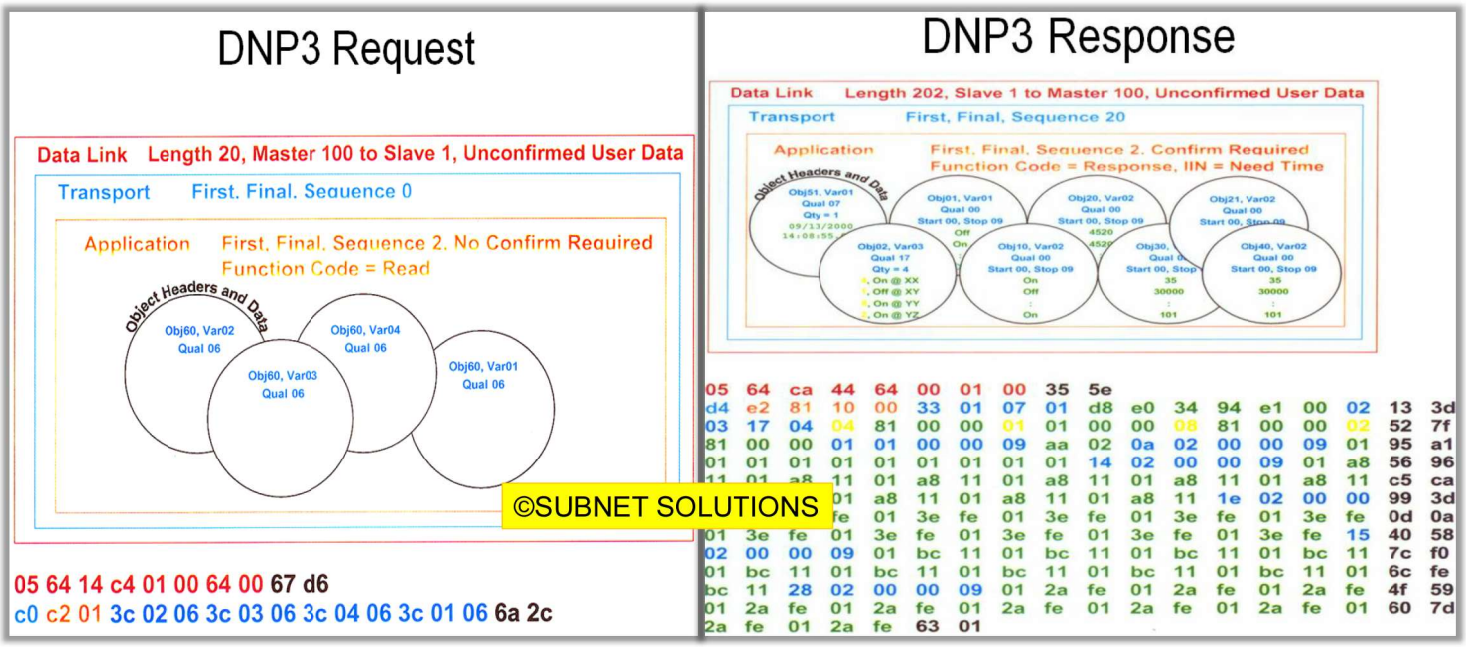
Object Model	DNP Data Object Library	
Application	DNP Application	
Presentation		
Session		
Transport	DNP Transport Function	DNP Transport Function DNP Data Link TCP or UDP
Network		Internet Protocol (IP)
Data Link	DNP Data Link	IEEE 802.2, 802.3
Physical	Serial	LAN

Supported Objects, Variations and Qualifiers

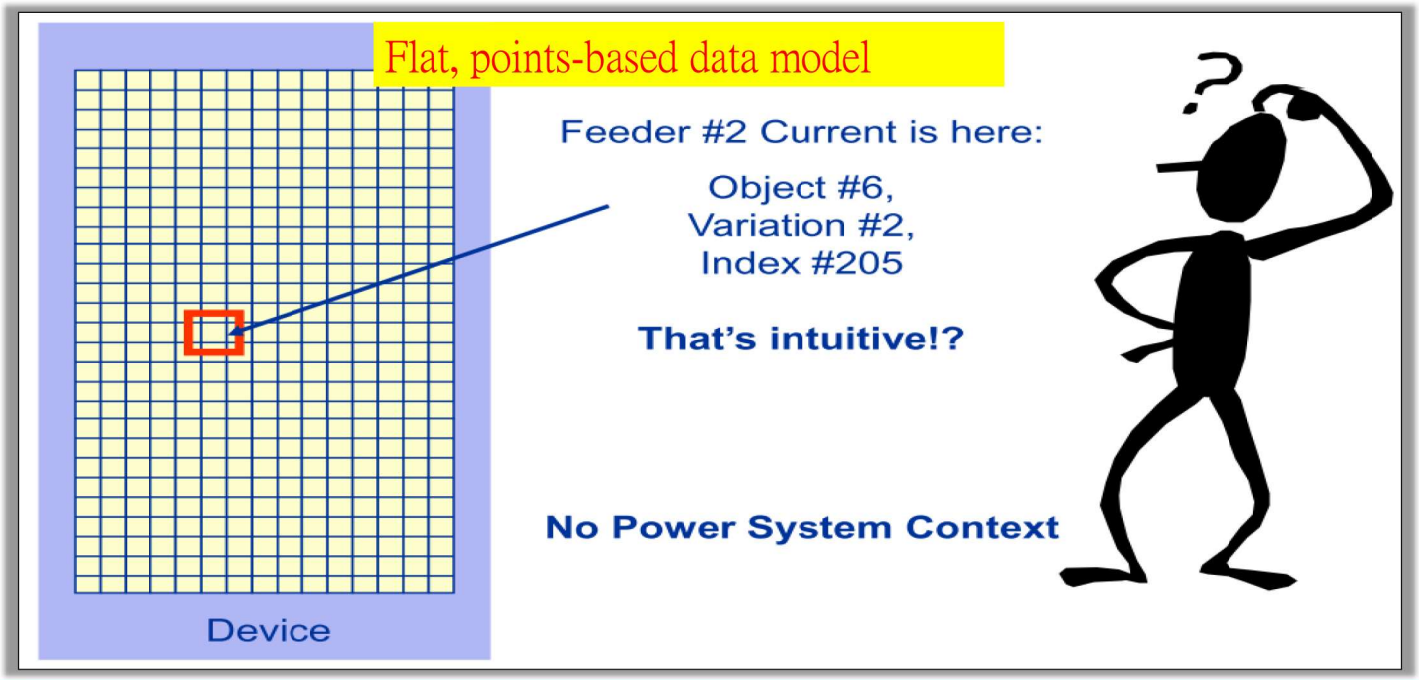
The following table lists all the objects, function codes and qualifiers supported by MOSCAD.

OBJECT			REQUEST (Master->Slave)		RESPONSE (Slave->Master)	
Obj	Var	Description	Func Code (dec)	Qual Code (hex)	Func Code (dec)	Qual Code (hex)
1	0	Binary Input - All Variations	1	00,01, 06		
1	1	Binary Input	1	00,01, 06	129, 130	00,01
1	2	Binary Input with Status	1	00,01, 06	129, 130	00,01
2	0	Binary Input Change - All Variations	1	06,07, 08		
2	1	Binary Input Change without Time	1	06,07, 08	129, 130	17,28
2	2	Binary Input Change with Time	1	06,07, 08	129, 130	17,28
2	3	Binary Input Change with Relative Time	1	06,07, 08	129, 130	17,28
10	0	Binary Output - All Variations	1	00,01, 06		
10	2	Binary Output Status	1	00,01, 06	129, 130	00,01
12	0	Control Block - All Variations				
12	1	Control Relay Output Block	3,4,5,6	17,28	129	echo of req
20	0	Binary Counter - All Variations	1,7,8,9, 10	00,01, 06		
20	1*	32-Bit Binary Counter	1	00,01, 06	129, 130	00,01
20	2	16-Bit Binary Counter with Flag	1	00,01, 06	129, 130	00,01
20	3*	32-Bit Delta Counter	1	00,01, 06	129, 130	00,01
20	4*	16-Bit Delta Counter with Flag	1	00,01, 06	129, 130	00,01
20	5*	32-Bit Binary Counter without Flag	1	00,01, 06	129, 130	00,01
20	6	16-Bit Binary Counter without Flag	1	00,01, 06	129, 130	00,01

DNP3 訊息解析



DNP3資訊

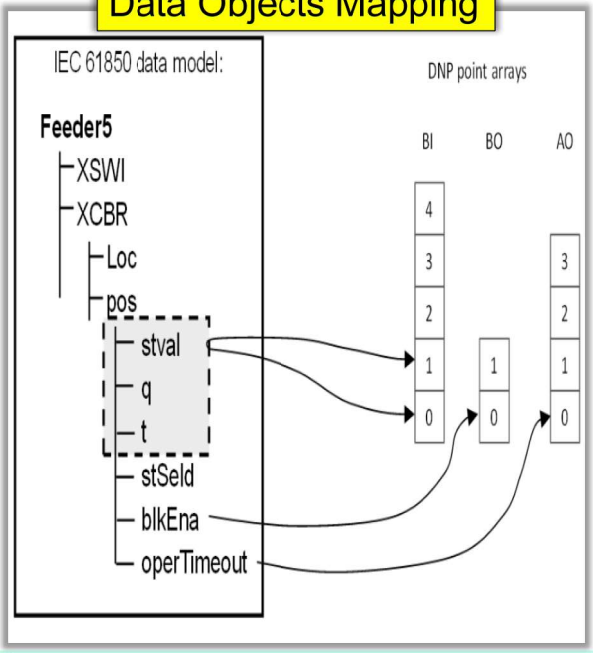


IEEE P1815.1 (Mapping IEEE 1815 (DNP3) to IEC 61850) - Overview

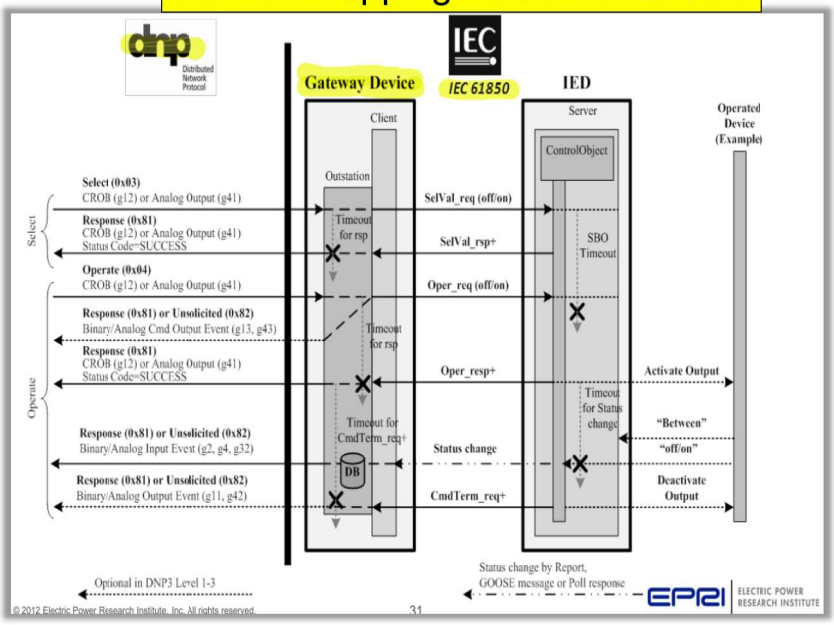
- Key aspects:
  - Conceptual architectures
  - How to map data
  - How to map services
  - Use case descriptions
  - Security considerations
  - Leaf level mapping rules
  - Configuration file formats

IEC 61850/DNP3 Mapping

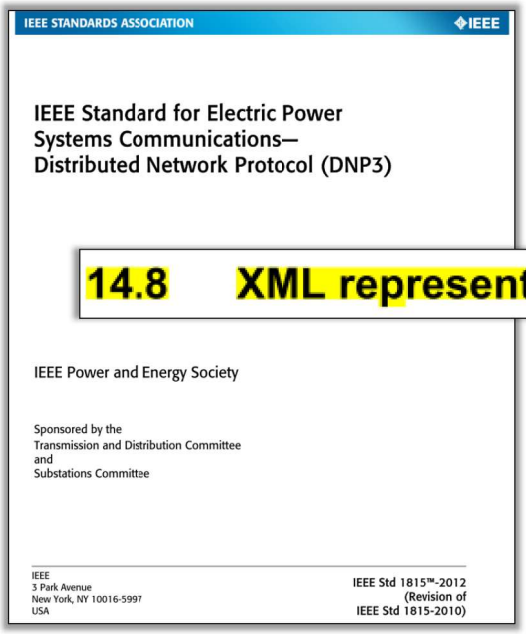
Data Objects Mapping



Service Mapping - SBO Enhanced



XML Mapping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IEEE Standard for Electric Power Systems Communications—Distributed Network Protocol (DNP3)

14.8 XML representation

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(Revision of
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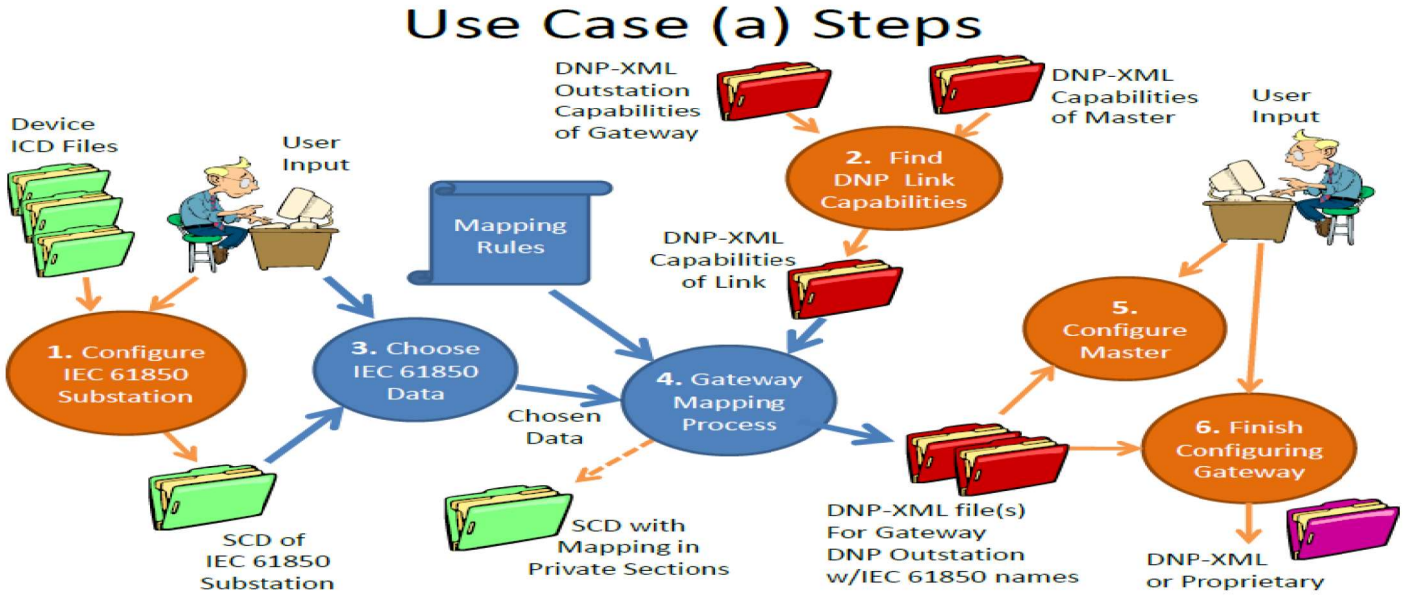
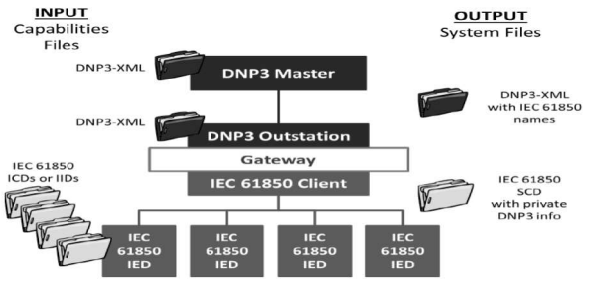
- Captured in DNP3-XML Device Profile Document
- Profile definition already lists all the DNP3 points in a device
- IEEE 1815.1 specifies additional elements for mapping
- Each mapping contains
  - Path within the Profile to one or more DNP3 points
  - Fully qualified name of corresponding IEC 61850 object(s)
  - Leaf-level mapping rule to apply OR an equation to apply
- The entire profile can be embedded in an SCL file
- IEEE 1815.1 specifies where it is embedded

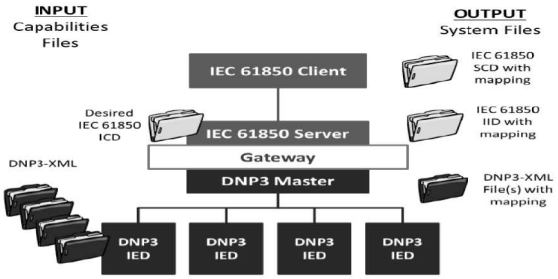
IEC 61850-80-2 : IEC 61850/DNP Gateway



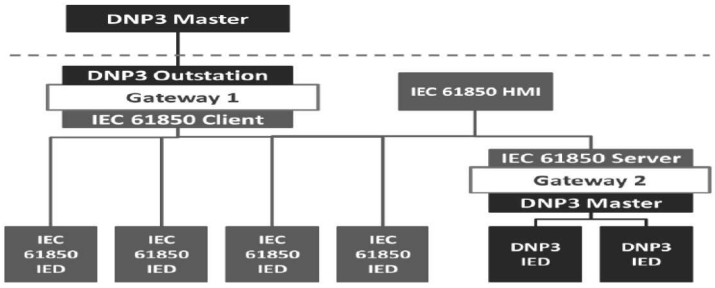
IEC 61850/DP3轉換型態



IEC 61850轉為DNP3

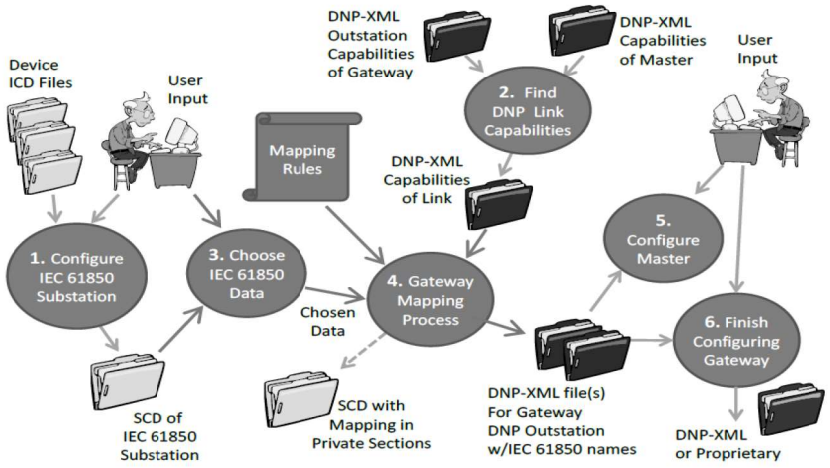


DNP3轉為IEC 61850



混合式IEC 61850/DNP3合併為DNP3

IEC 61850/DNP3 Gateway規劃流程



IEC 61850/DNP3 Gateway規劃流程

1. 使用系統規劃工具將所有IED的ICD檔規劃為整個變電所的SCD檔
2. 找尋Gateway所有支援的DNP能力(DNP並無支援所有IEC 61850的物件)
3. 選擇IEC 61850中需要轉換為DNP3的物件
4. Gateway自動映射連結
5. 使用者規劃並審視轉換後的參數
6. 完成配置並輸出DNP-XML檔

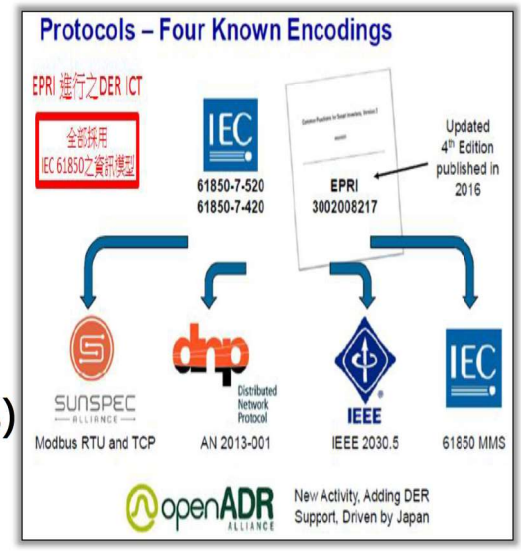
RE(含DER/PV)大規模運用議題

- 分散式能源(DER)分布廣泛具跨Internet特性
- 須考量大量佈建(Plug-Play)及資安問題
- 既有封閉網路所用協定或標準無法直接用於未來發展
- 需要運用雲端技術
- IOT技術目前被IEC 61850/62746標準納入的須重視
- IEC 61850-8-2/IEC 61850-80-3 XMPP通訊協定DER應用是個好選項之一
- XMPP - eXtensible Messaging and Presence Protocol - An IOT open standard for instant messaging

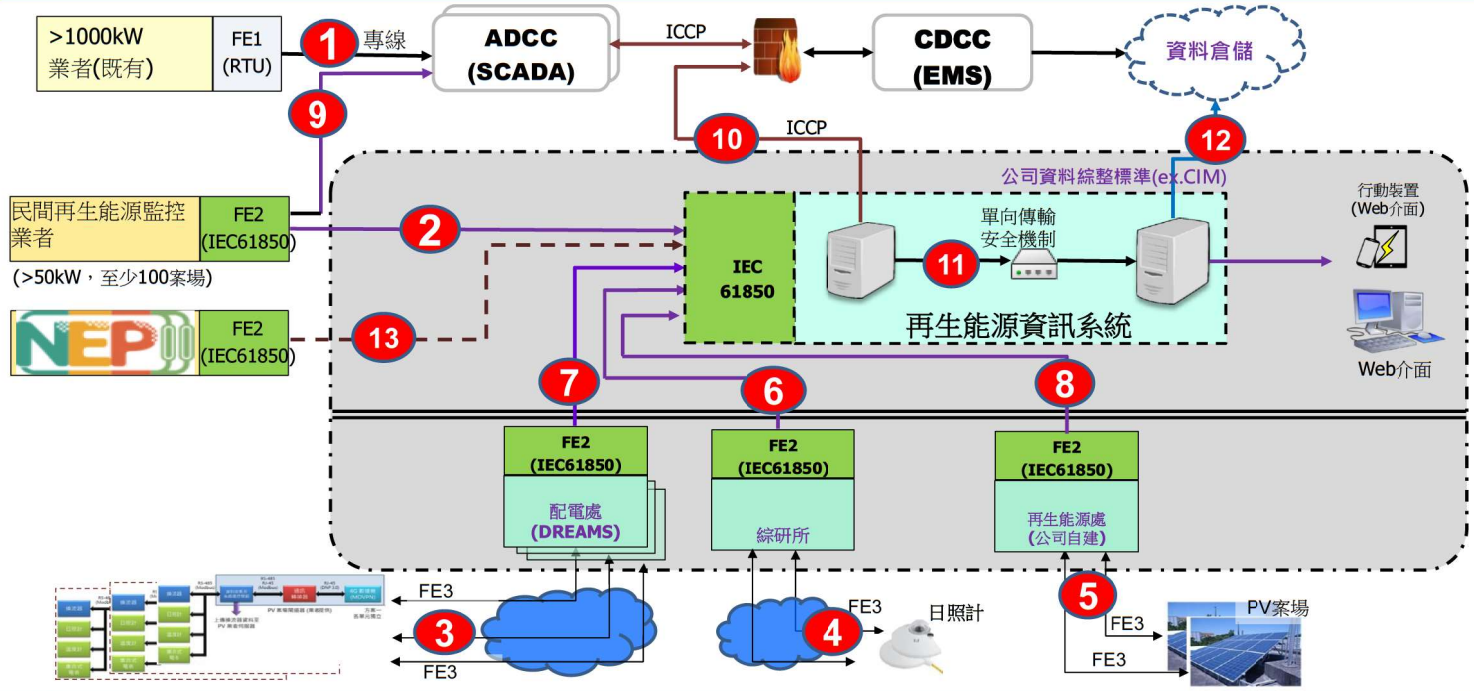
IEC 61850 Gateway議題闡釋

SG ICT 國際標準化...

- 資料封裝格式問題(Information Models)
- 資料叫用問題(information Services)
- 資訊傳輸問題(Communication Protocols)

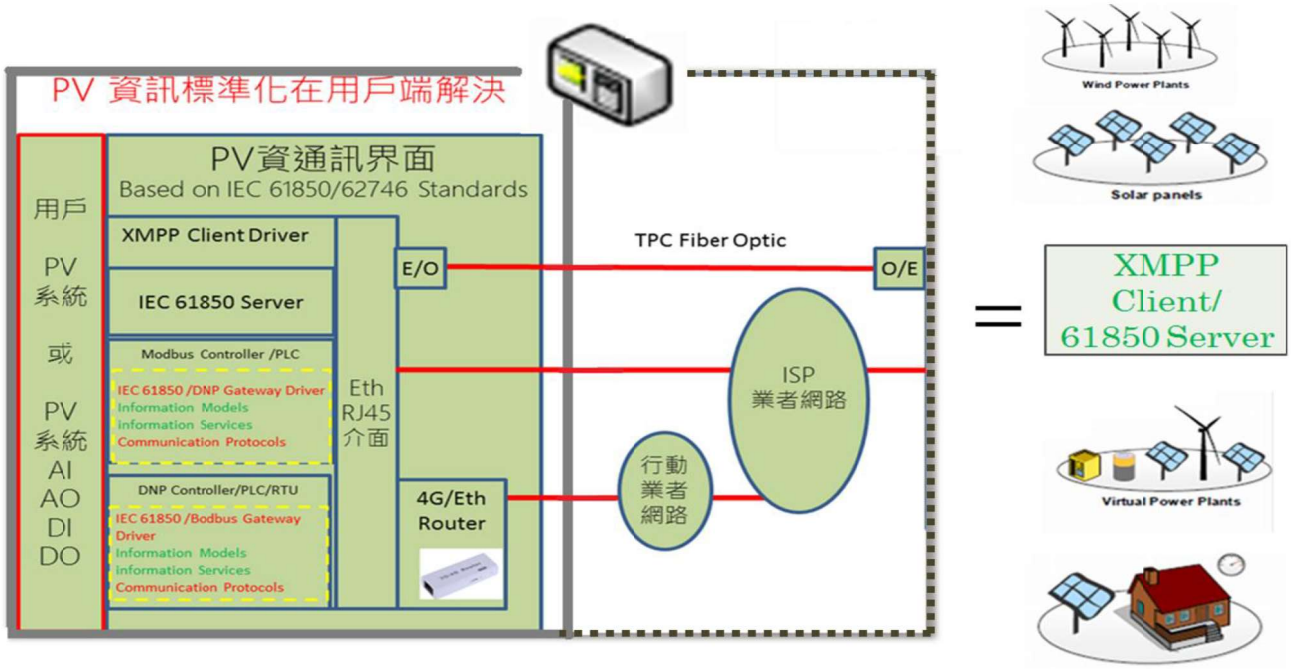


IEC 61850 Gateway在再生能源資訊中心端

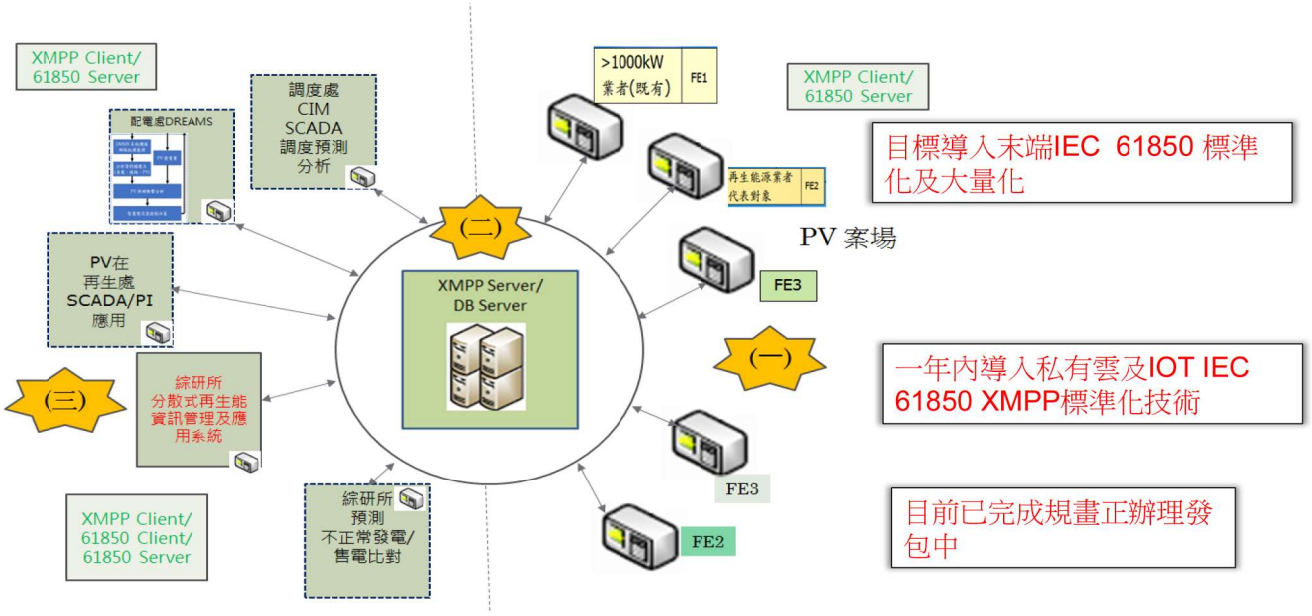


IEC 61850-8-2 Gateway在案場端

綜研所

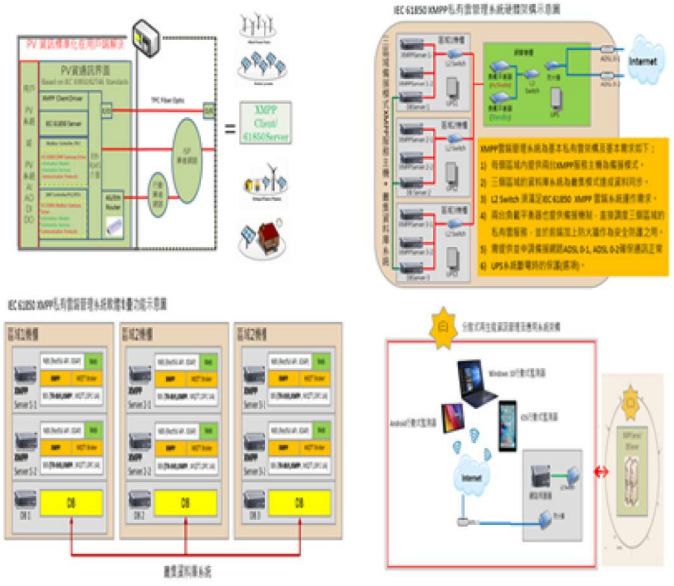


再生能源資訊管理平台導入IEC 61850協定轉換器、物聯網及雲端平台技術

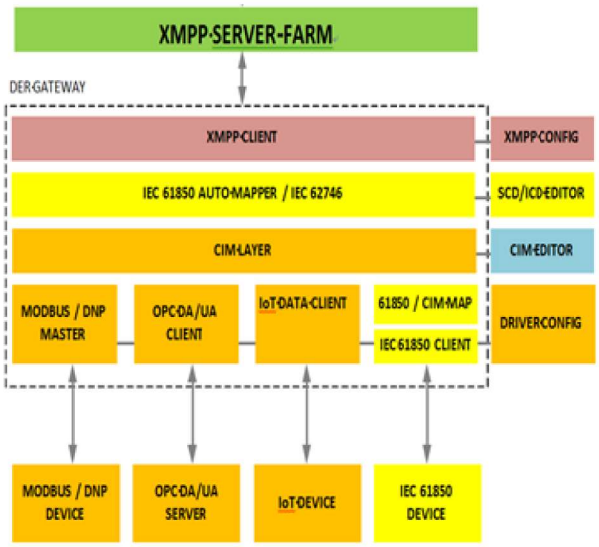


再生能源資訊管理平台導入IEC 61850協定轉換器、物聯網及雲端平台技術

IEC 61850 再生能源資訊管理平台之組成

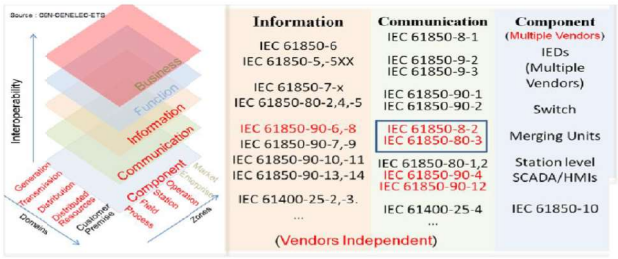


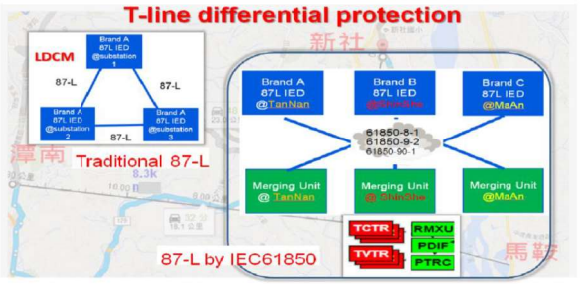
IEC 61850 XMPP IOT Gateway



IEC 61850應用導入具互通性之智慧電網架構模型概念

- SGAM 應用在新社先導型IEC 61850智慧變電所ICT之標準例



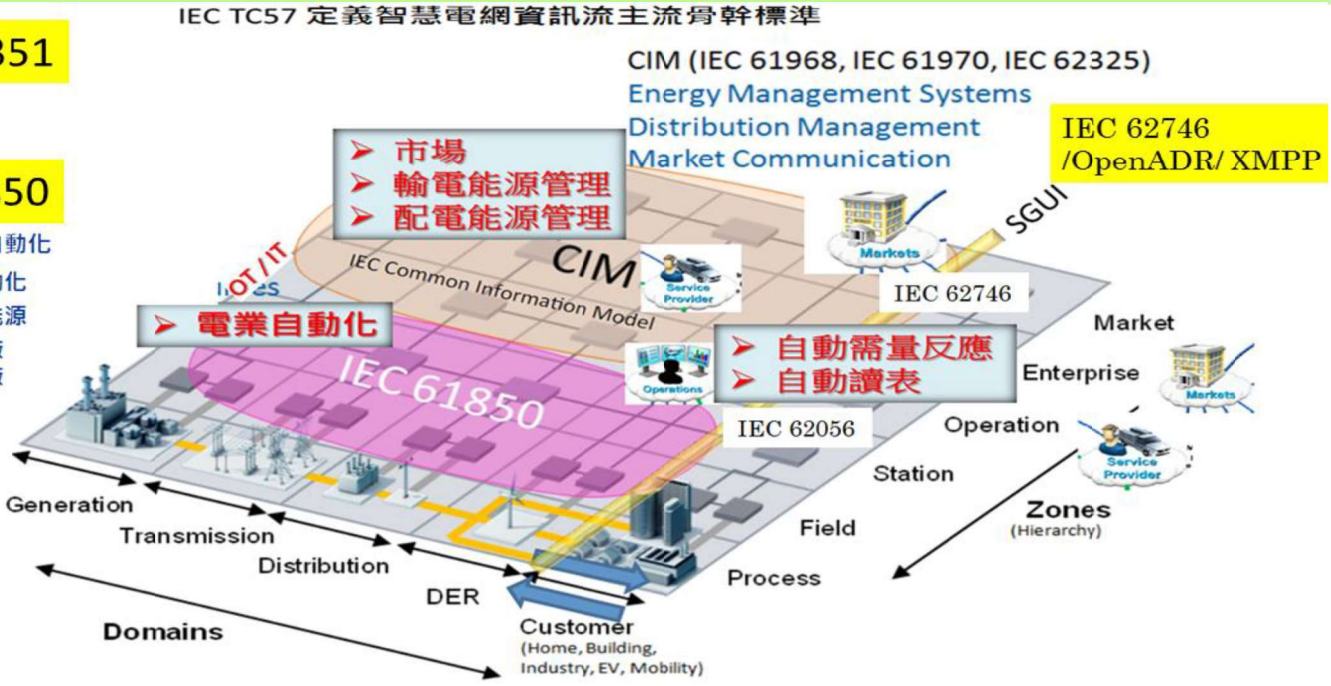


智慧電網資通訊核心標準

IEC 62351

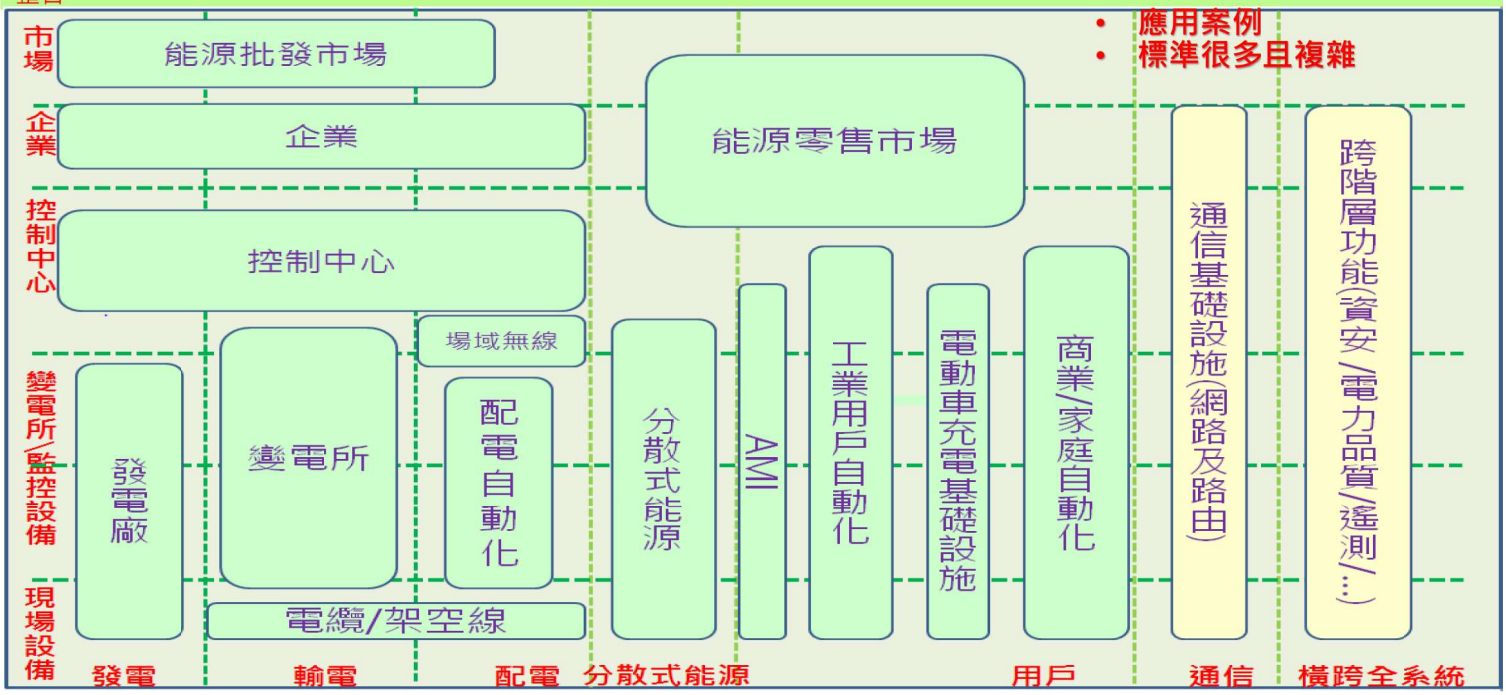
IEC 61850

變電所自動化
配電自動化
分散式能源
水力電廠
風力電廠
...



四、未來與智慧電網之整合

IEC 智慧電網關聯類別



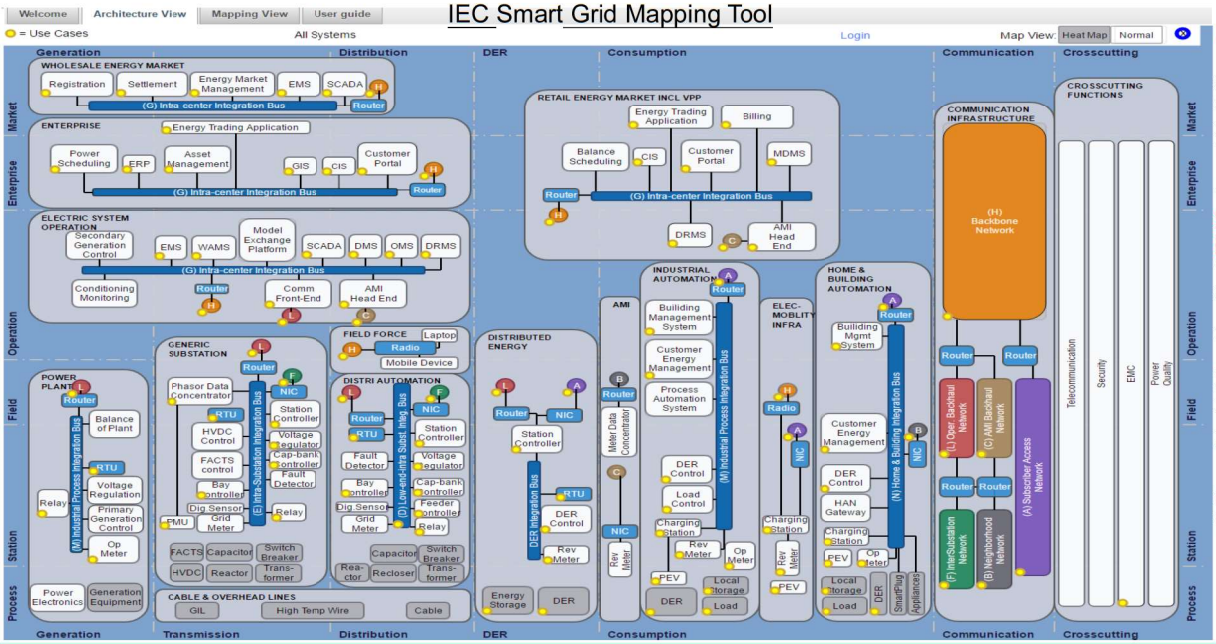
- 應用案例
- 標準很多且複雜

四、未來與智慧電網之整合

IEC 智慧電網關聯類別

http://smartgridstandardsmap.com

- 智慧電網應用案例及潛力標準很多且複雜



6項關聯類別

批發能源市場 H
零售能源市場 H C
企業 H
電力系統操作 H L C

電廠 L
變電所 L F
配電自動化 L F
電纜架空線
場域強化 H

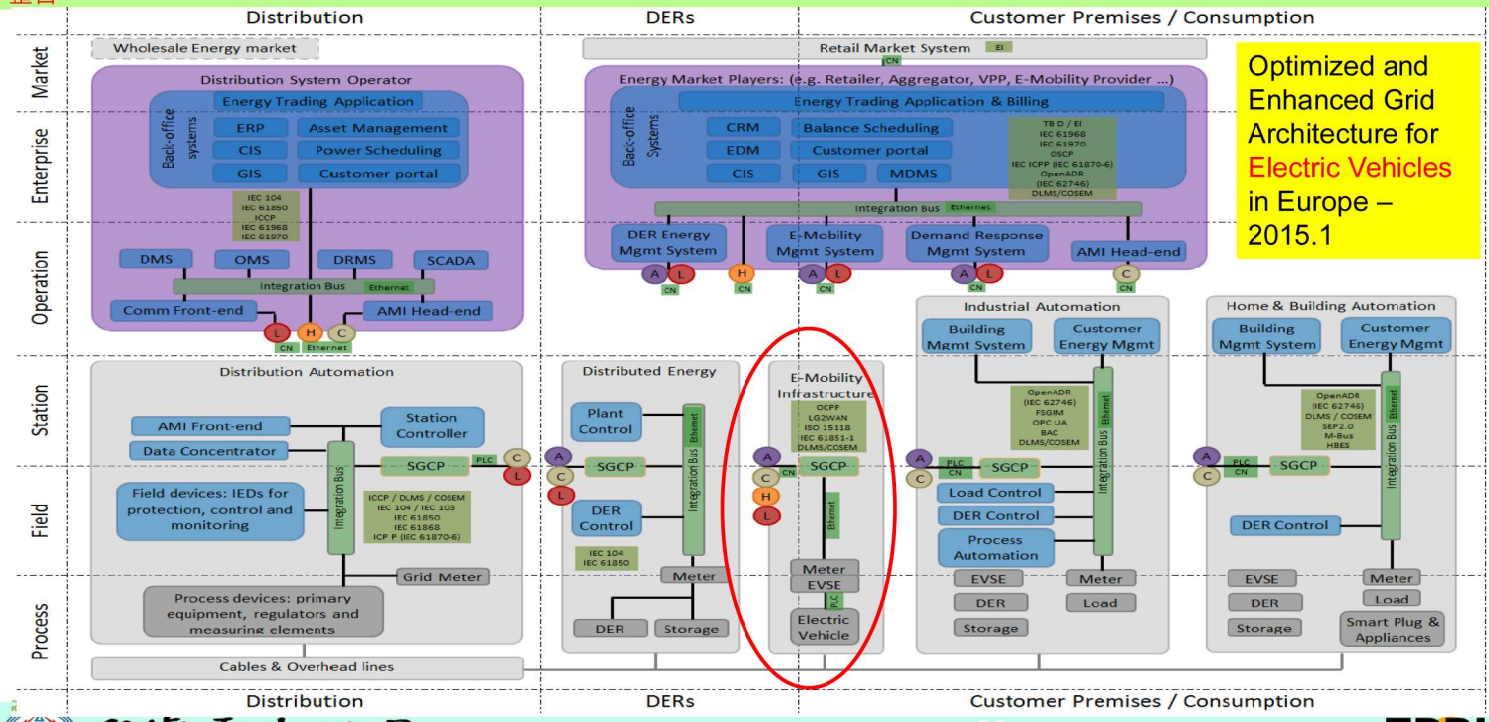
分散式能源 A L

AMI B C
商業家庭自動化 A B
電動車充電基礎設施 A H
工業自動化 A

通信基礎設施
橫跨全系統功能

台灣電力公司 TPRI

不同關聯類別研究計畫整合應用(以EV為例)



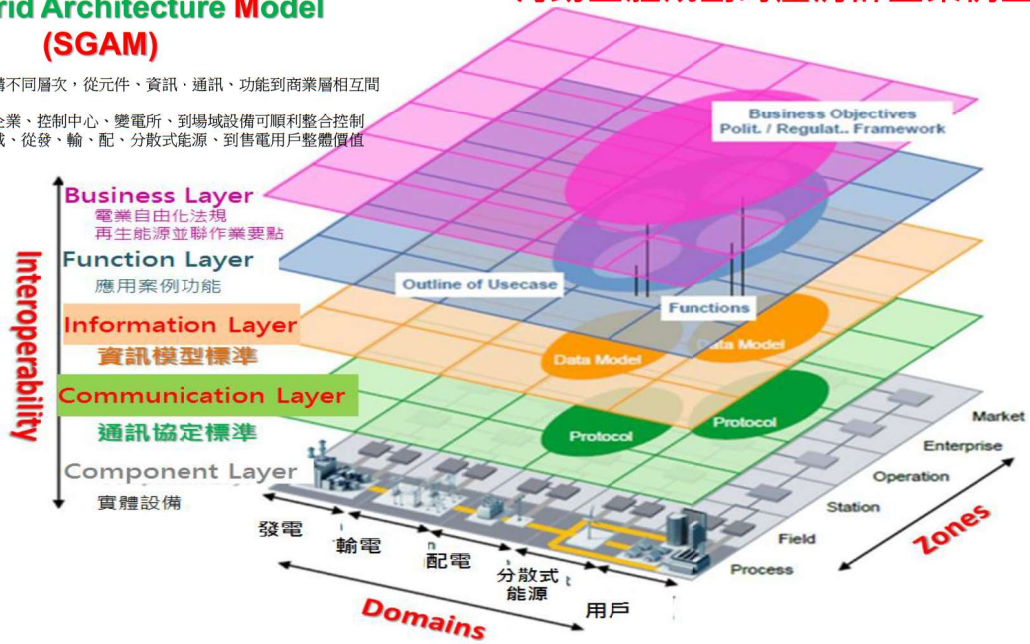
Optimized and Enhanced Grid Architecture for Electric Vehicles in Europe – 2015.1

導入具互通性之智慧電網架構模型概念

Smart Grid Architecture Model (SGAM)

1.經由國際標準建構不同層次，從元件、資訊、通訊、功能到商業層相互間協調搭配之互通性
2.進而使從市場、企業、控制中心、變電所、到場域設備可順利整合控制
3.從而創造不同領域、從發、輸、配、分散式能源、到售電用戶整體價值

有助整體規劃時釐清計畫案例互通階層與權責



3D SG架構模型

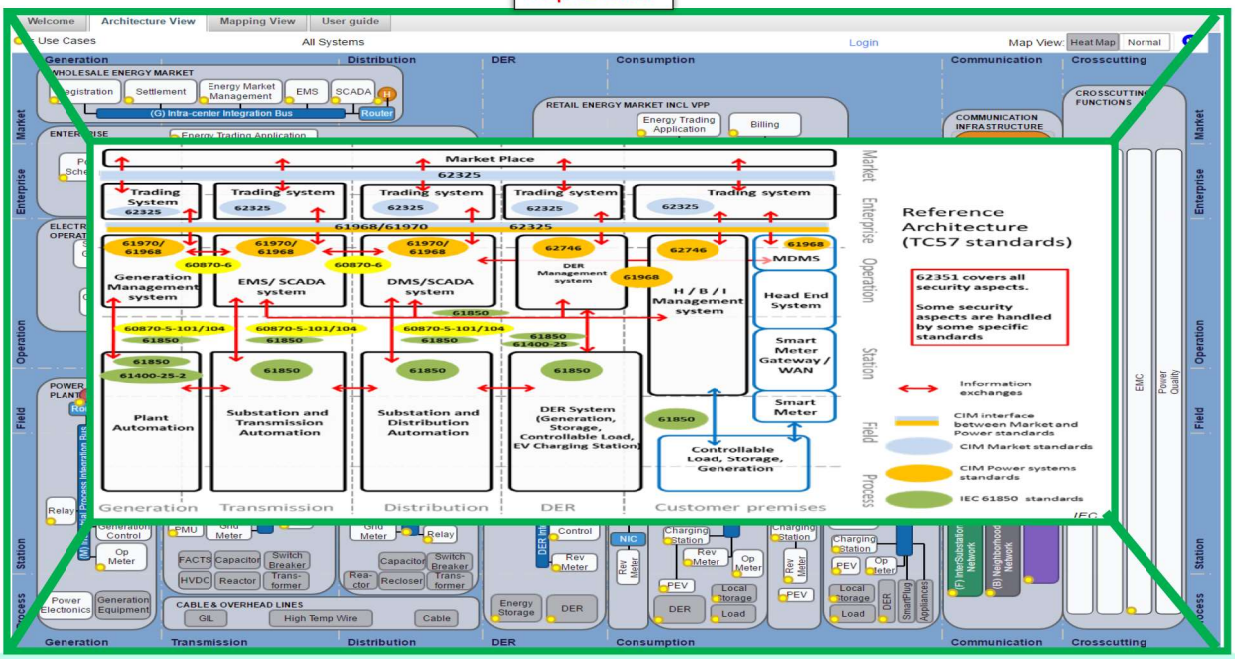
Domains
(能源供應鏈)
發、輸、配、分散式能源、用戶

Zones
(能源階層控制)
市場、企業、控制中心、變電所、監控設備、現場設備

Interoperability
(互通)
商業層、功能層、**資訊層、通訊層**、設備層

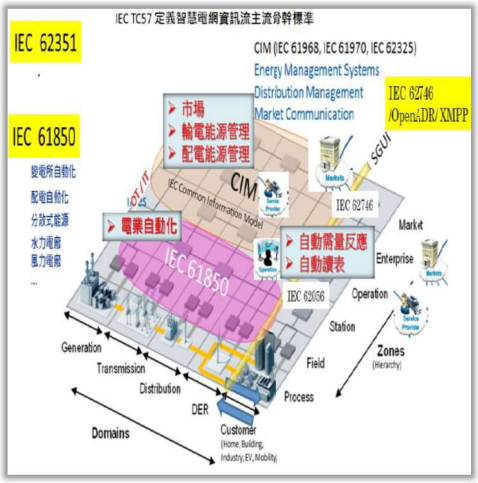
將主流ICT IEC標準導入智慧電網計畫

Top-Down



六、結論

1. Gateway將資訊標準化成IEC 61850方便應用於智慧電網。
2. 本議題實作IEC 61850-80-2標準及IEC 61850-8-2標準資通訊。
3. IEC 61850電業自動化延伸領域之應用，早點採用SG核心標準設備或系統，能加速實現SG之建置。



報告完畢

謝謝聆聽 敬請 指正