智慧電網標準及應用研討會

TCA

10.16.19

IEC 61850 XMPP 於國外綠能之應用

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Elipse Software Taiwan

大綱

前言

認知落差與挑戰

能源行業應用標準

解決方案

國外案例介紹

未來擴充

前言

再生能源特性

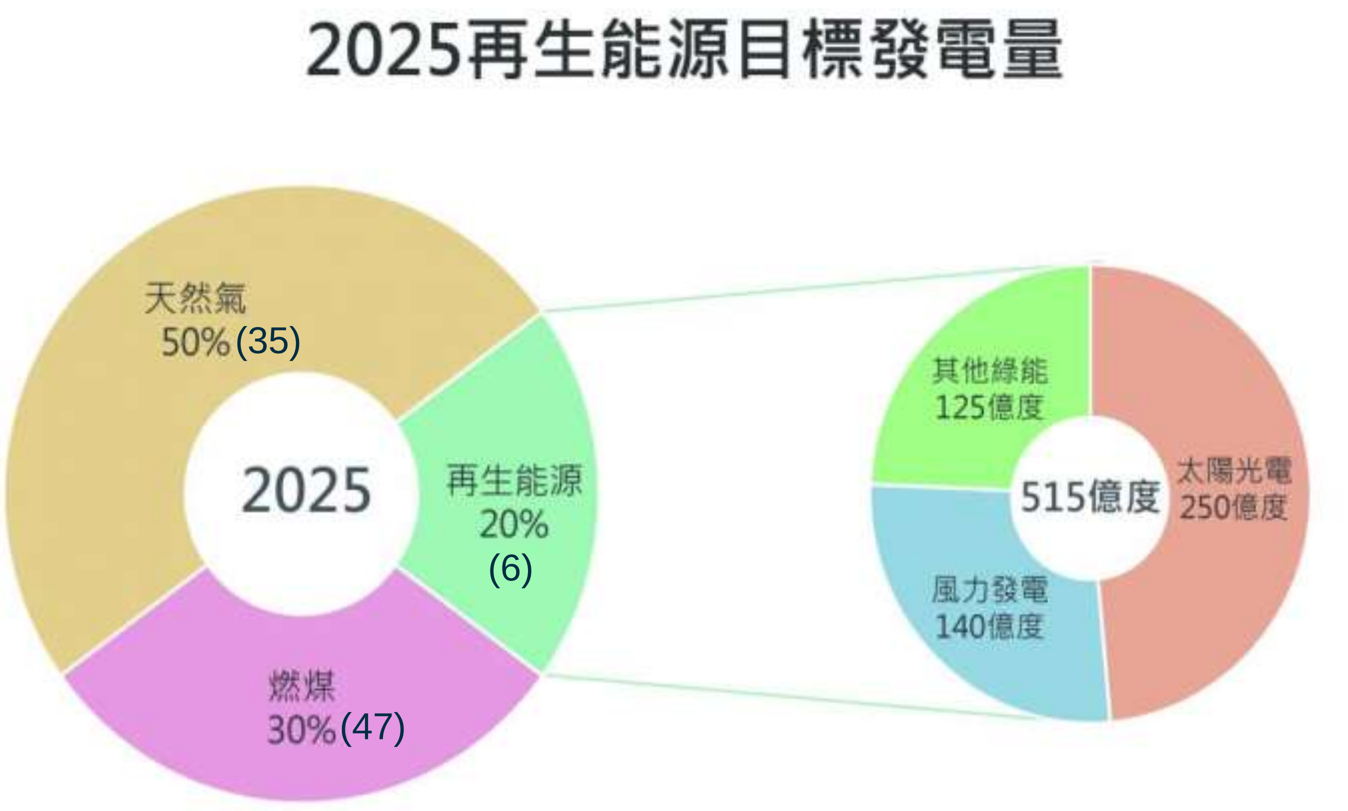
- 受天氣影響 – 間歇性
- 對電網穩定性產生衝擊
- 大潭電廠 815 大停電 (12%)

2025年再生能源占比目標20%

- PV 20GW
- 1.76萬座PV電站1.9GW (2018)
- 資訊傳回台電<100 PV電站(2018)
- 再生能源整合

能源物聯網

- 電力系統 + 工業務聯網



認知落差與挑戰

再生能源整合不只是資料收集

- IEC 62056 DLMS / COSEM / OpenADR / IEC 60870-5-104 / DNP 3.0
- IEC 61850-8-1 / IEC 61850-8-2 / GOOSE / IEC 61870 (CIM)

多樣性協議

- 通訊閘道器
- 資料模型

管理系統

- MDMS
- EMS
- DREAMS (DERMS)
- SCADA – CONTROL CENTER

分散式再生能源資訊整合面臨的挑戰

建置案場分散，佈建量大，系統管理困難

設備廠牌不一，供應商不一，建置方式沒有標準化

- 大多採用OPC / Modbus等非能源專用協議
  - Modbus 點表 – 非系統建模概念
  - DNP3 – IEC 61850–80-2 但還是基於MMS架構
- 建置廠商對電力通訊標準陌生
- 沒有依照標準建模方式，整合困難

控制中心資通架構以傳統方式建構

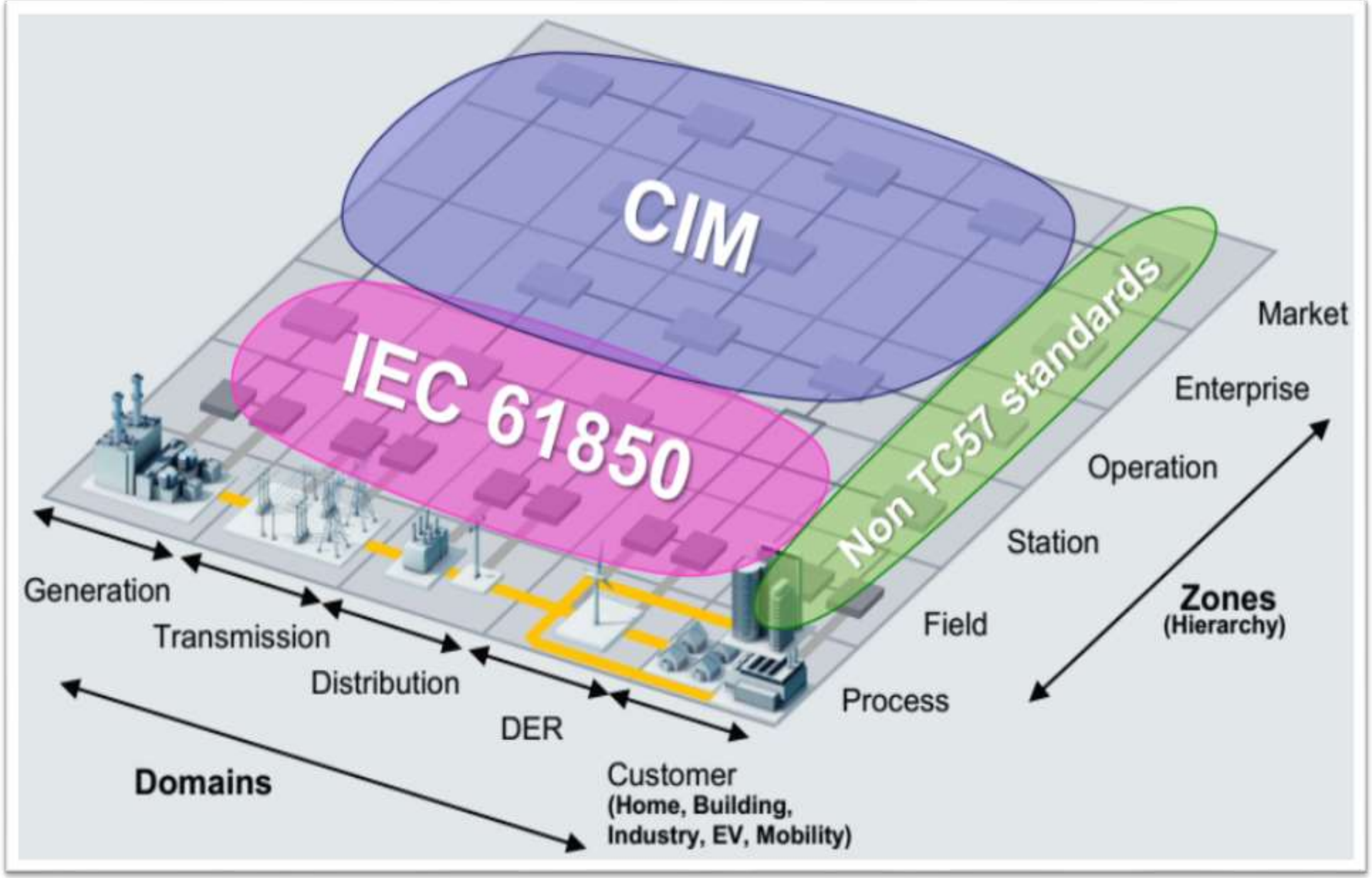
資料互通性不足，導致整合困難

跨網域，跨網路整合，資料安全性考量及認證困難

能源行業應用標準

IEC 62357

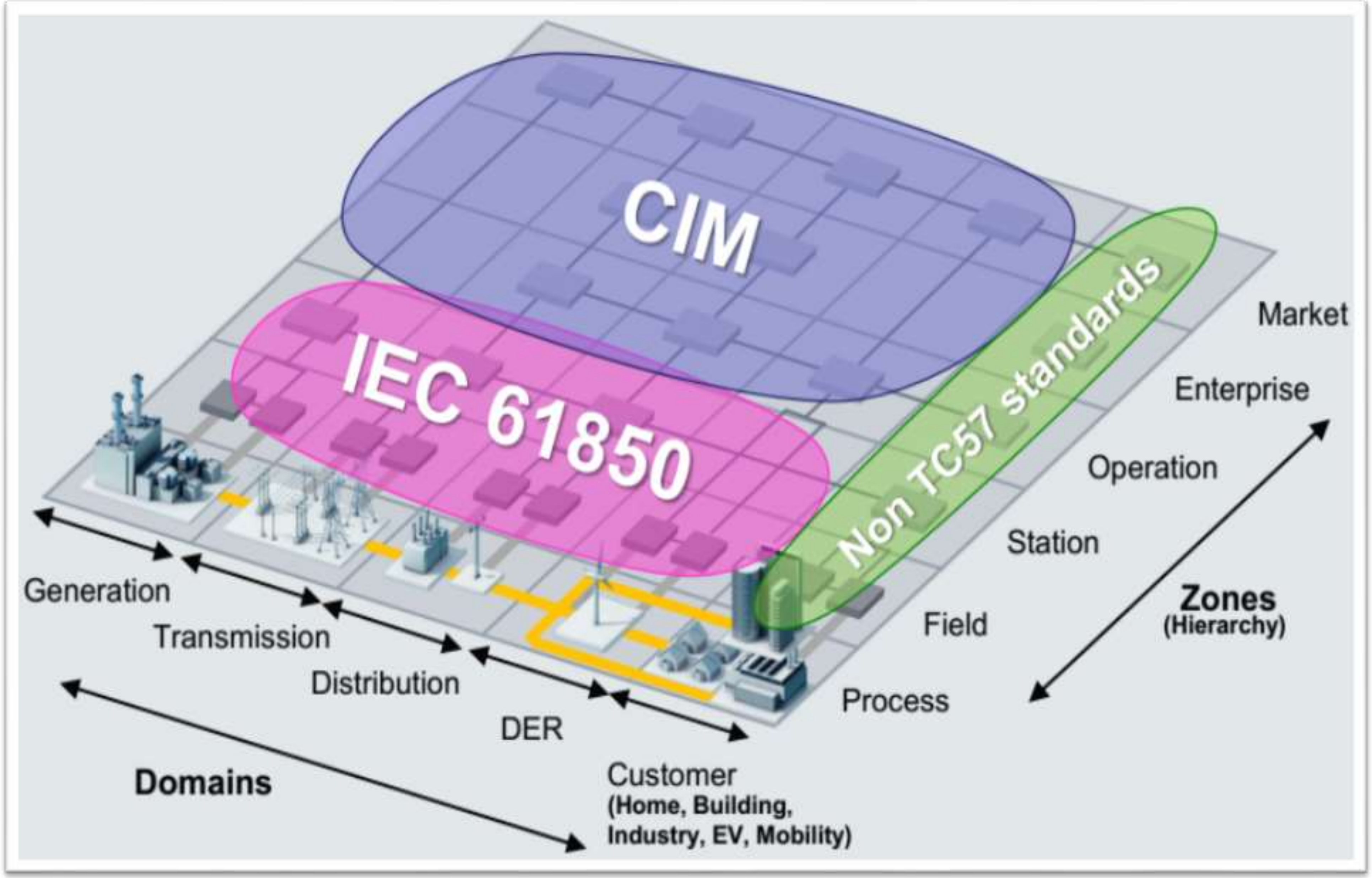
- 智慧電網互通性架構



能源行業應用標準

IEC 62357

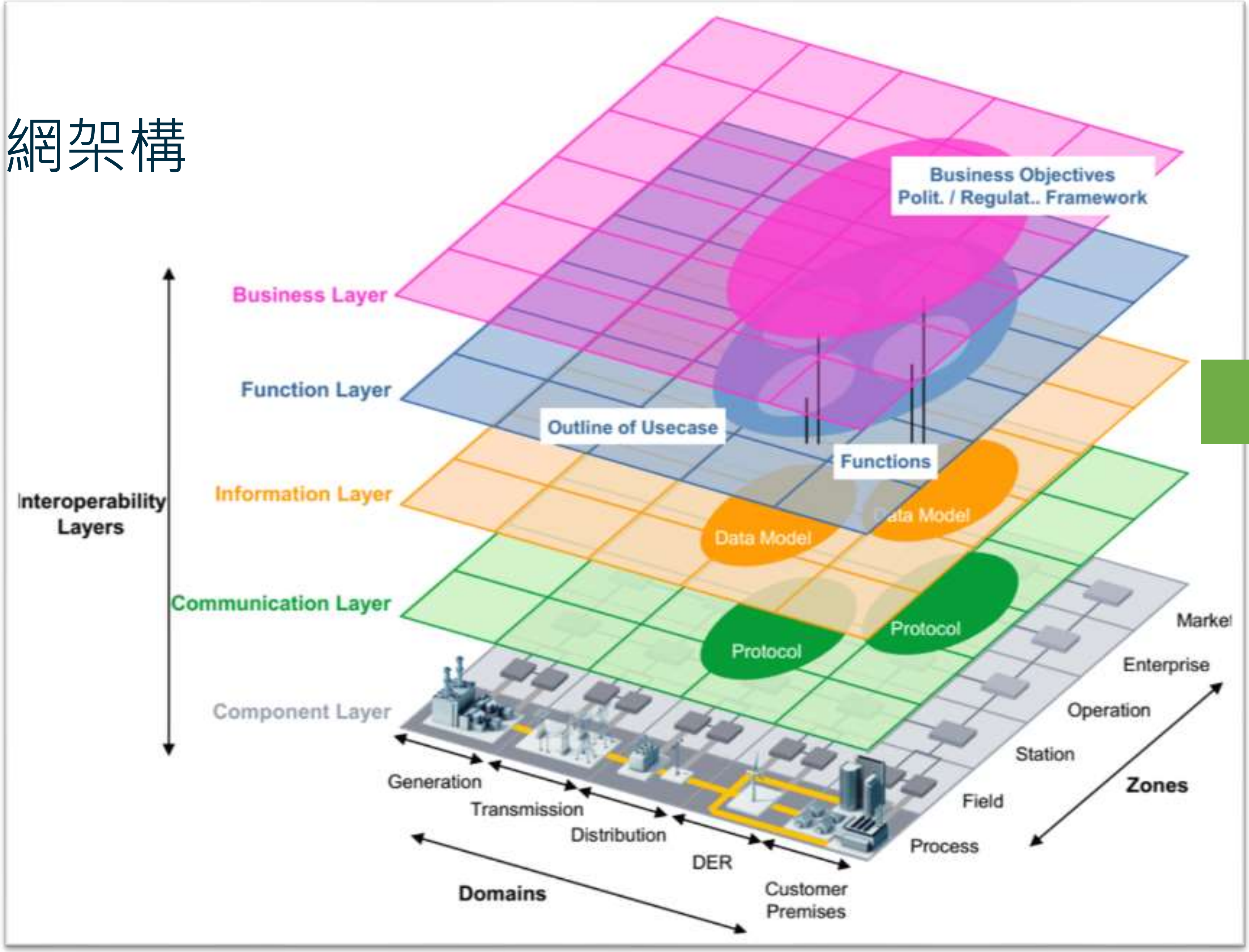
- 智慧電網互通性架構



能源行業應用標準

IEC 62357

- 對應到物聯網架構



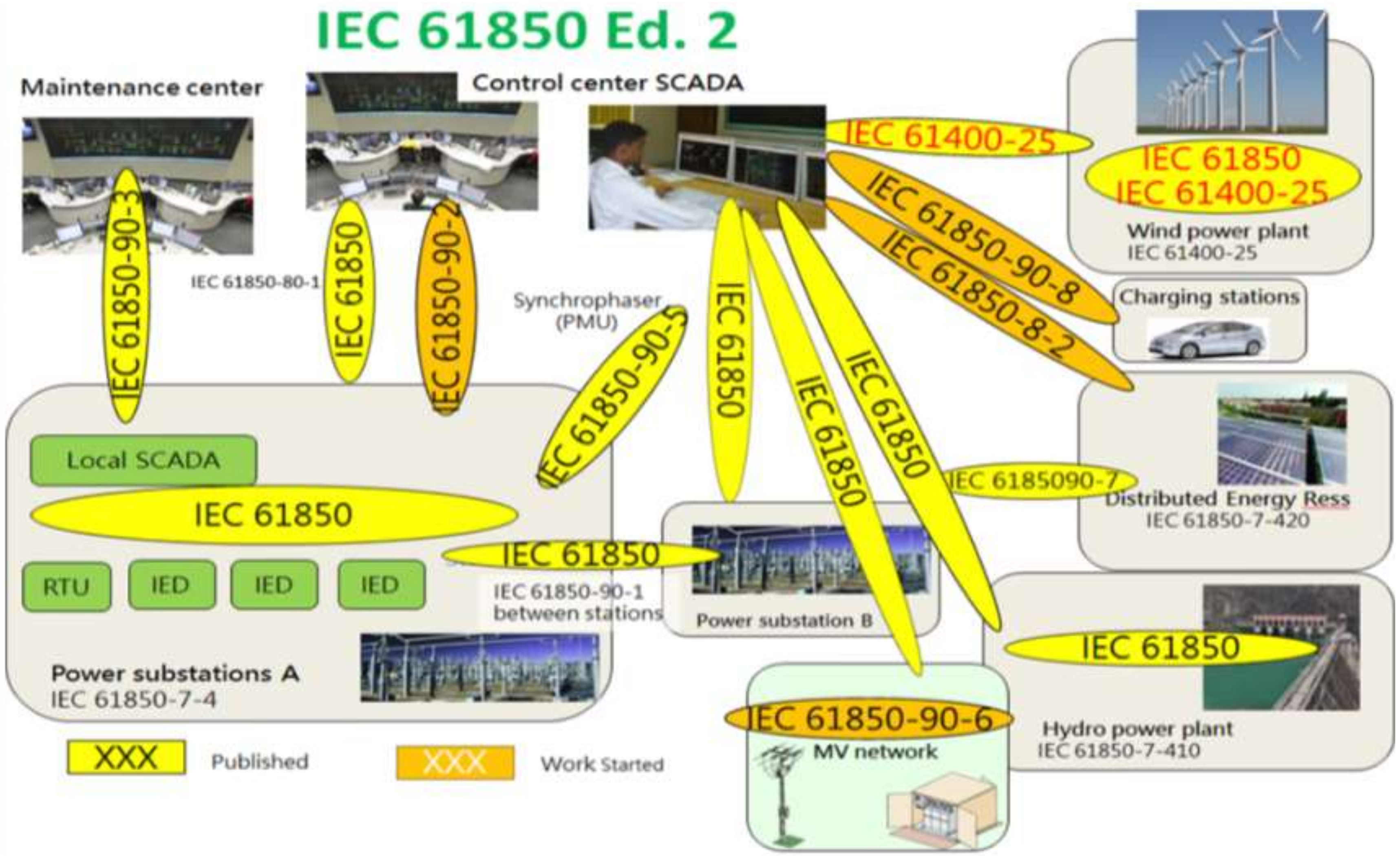
Industry 4.0

- Operation
- SaaS
- PaaS
- IaaS
- Comm. Layer
- Edge Layer
- Device Layer

能源行業應用標準

IEC 61850

- 智慧電網(能源)標準



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本研究案建置解決方案(初期導入階段)

依IEC 62357 智慧電網通訊標準架構(Smart Grid Architecture Model)

依照IEC 61850-7-420 建立標準再生能源模型 – 標準化

參考IEC 61850-80-2 (IEC 61850 – DNP3 映射規則)建構通訊轉換

參考IEC 61970-301 CIM 建立PV 站模型 – 標準化

開發IEC 61850-8-2 XMPP 通訊協議建構於雲端平台

- 用戶授權認證管理 (SASL)
- 資料加密(TSL)

採用工業物聯網參考架構(IIRA)，導入雲端管理平台: DM / DA

嵌入TR-069電信標準架構，達到遠短設備維護管理功能

提供PV站之通訊協定轉換器: 標準化，建模與隨插即用功能

提供標準RESTFul API供提他服務存取CIM 模型資訊

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期刊論文


IEEE Access
XMPP-based Network Man
for agile IoT applicati
IEC 61850 and
Energy Manage
Considering Ele
Design and Impleme
Resources Infor
XMPP-base
architecture
A Lightweig
for Resour
energies
Article
Modeling and Integrating PV Stations into IEC 61850
XMPP Intelligent Edge Computing Gateway
Chun-Hung Liu and Jyh-Cheng Gu
1. Introduction
Keywords: DER; IEC 61850; XMPP; edge computing gateway; smart grid

解決方案

導入智慧電網標準應用架構

- CEN-CENELEC-ETSI智能電網協調小組(SG-CG)
- IEC 62357 NIST智慧電網互操作性標準
- 智慧電網架構模型(SGAM)

工業物聯網平台 (AWS Cloud)

- 設備管理、可視化
- Middleware
- 資料處理、儲存、分析、演算模型

邊緣計算閘道器

- Multi-protocol (Legacy): 450+ protocols / Agent (TR-069)
- Intelligent Edge Analytic and storage

案例介紹

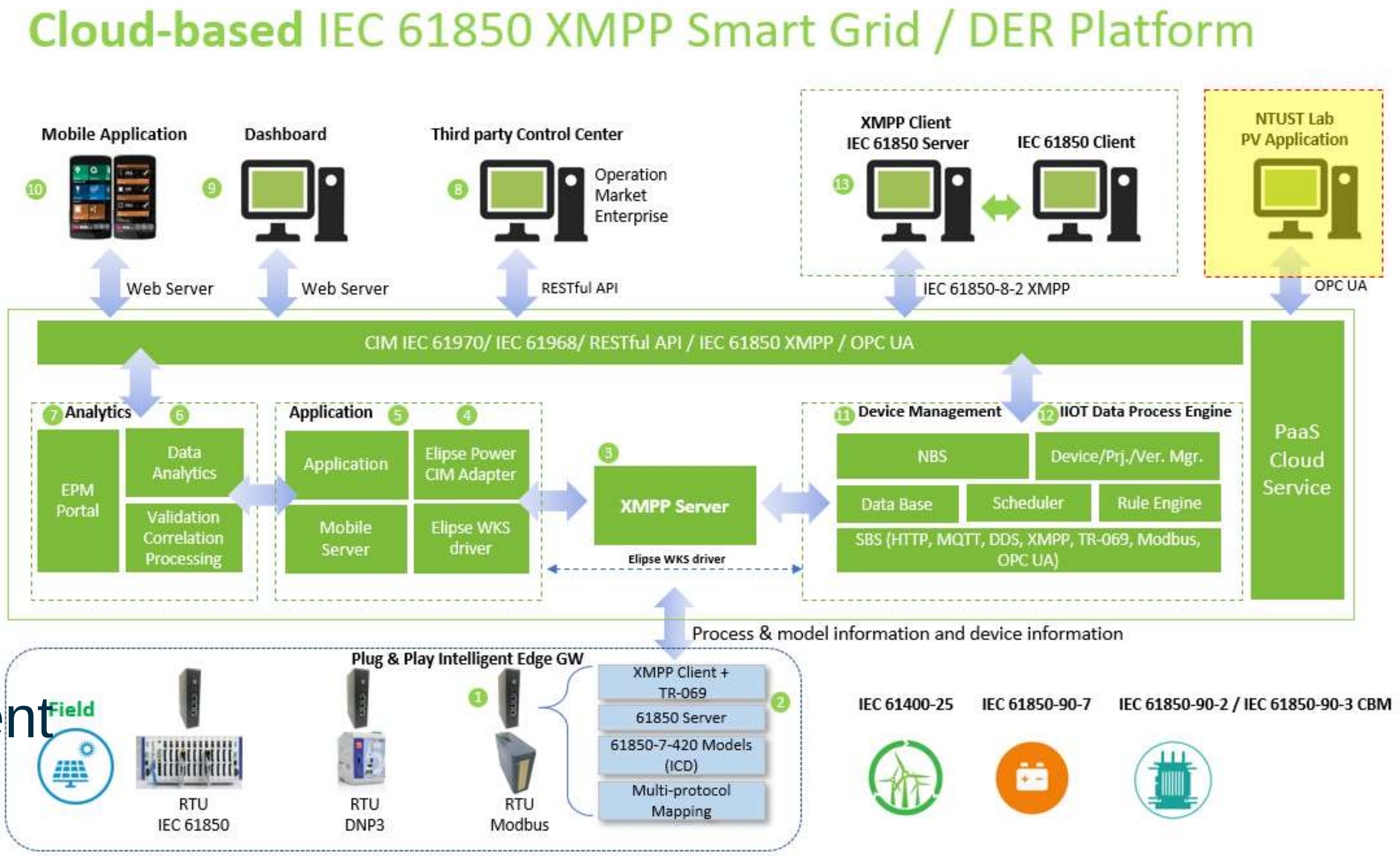
Cloud-based IEC 61850 XMPP Smart Grid / DER Platform

Deployed in Taiwan (Private cloud) and Thailand (AWS Cloud)

能源行業應用標準

特色

- 智慧電網標準架構
- IEC 61850 XMPP
- DMS
- IEC 61970 CIM
- Data Analytics
- 邊緣計算閘道器
  - DER Data modeling
  - IEC 61850 XMPP Client
  - TR-069 Agent
  - Solar power forecasting
  - AWS Greengrass



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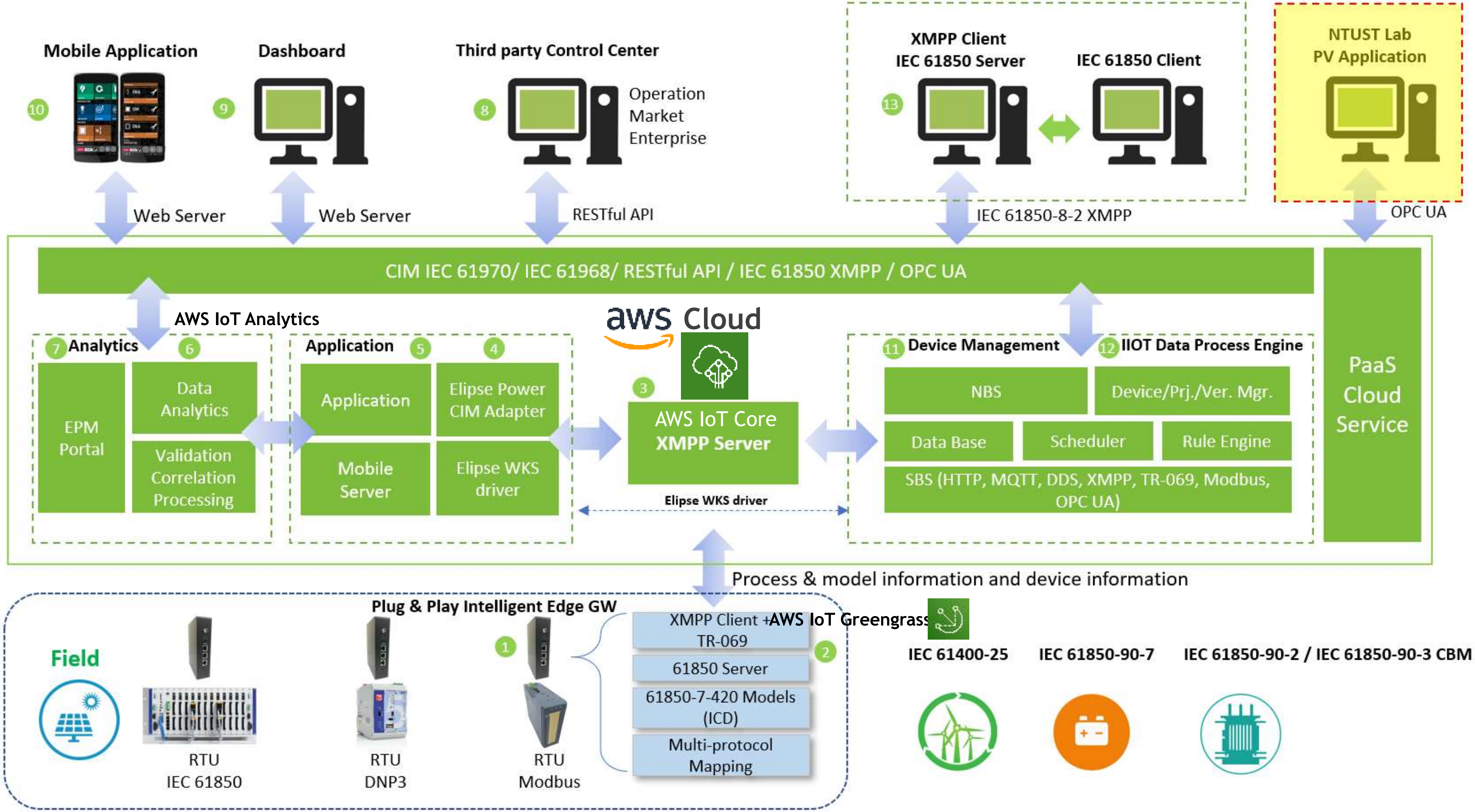
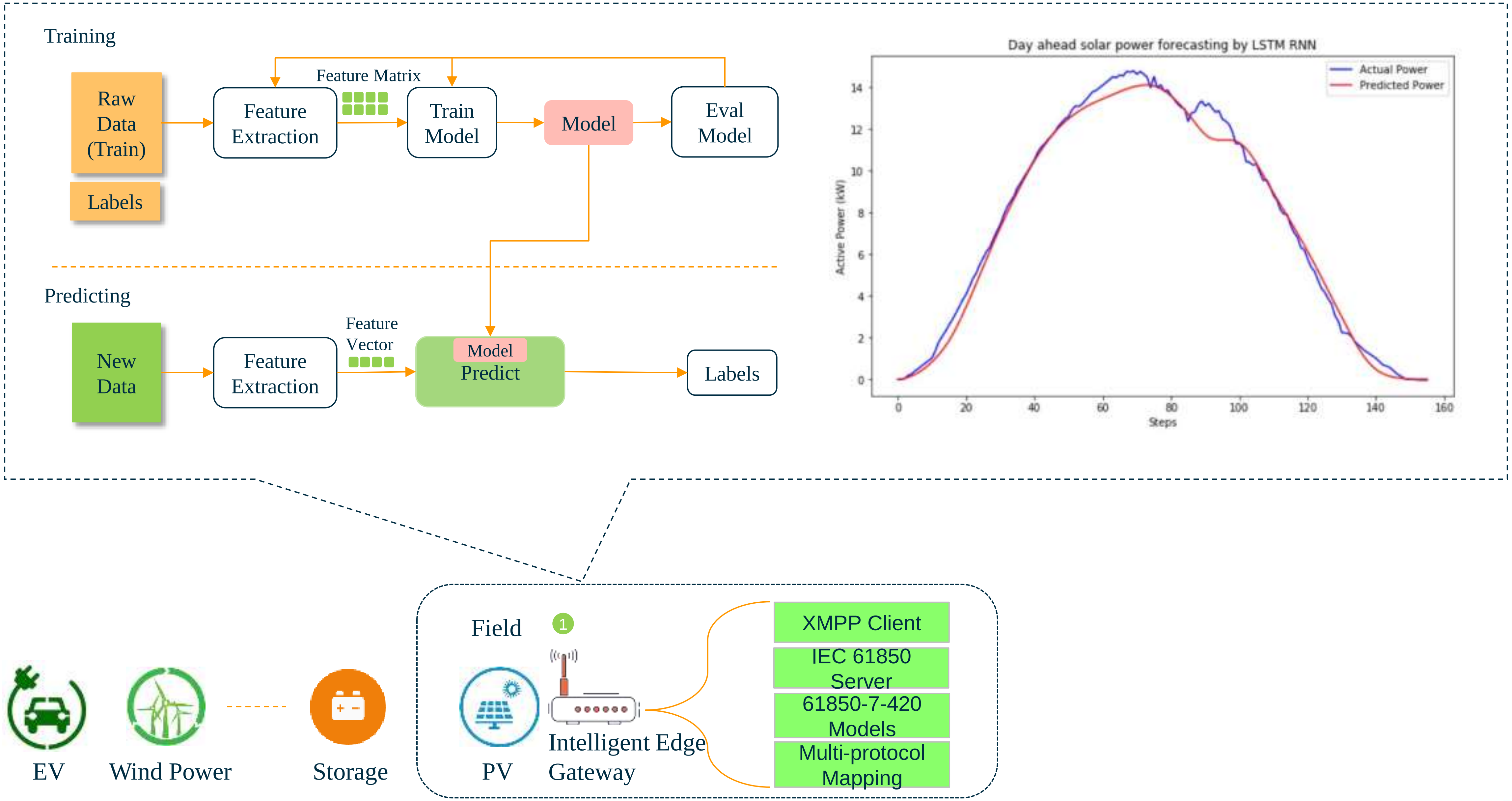
Cloud-based IEC 61850 XMPP Smart Grid / DER Platform



發電預測模型

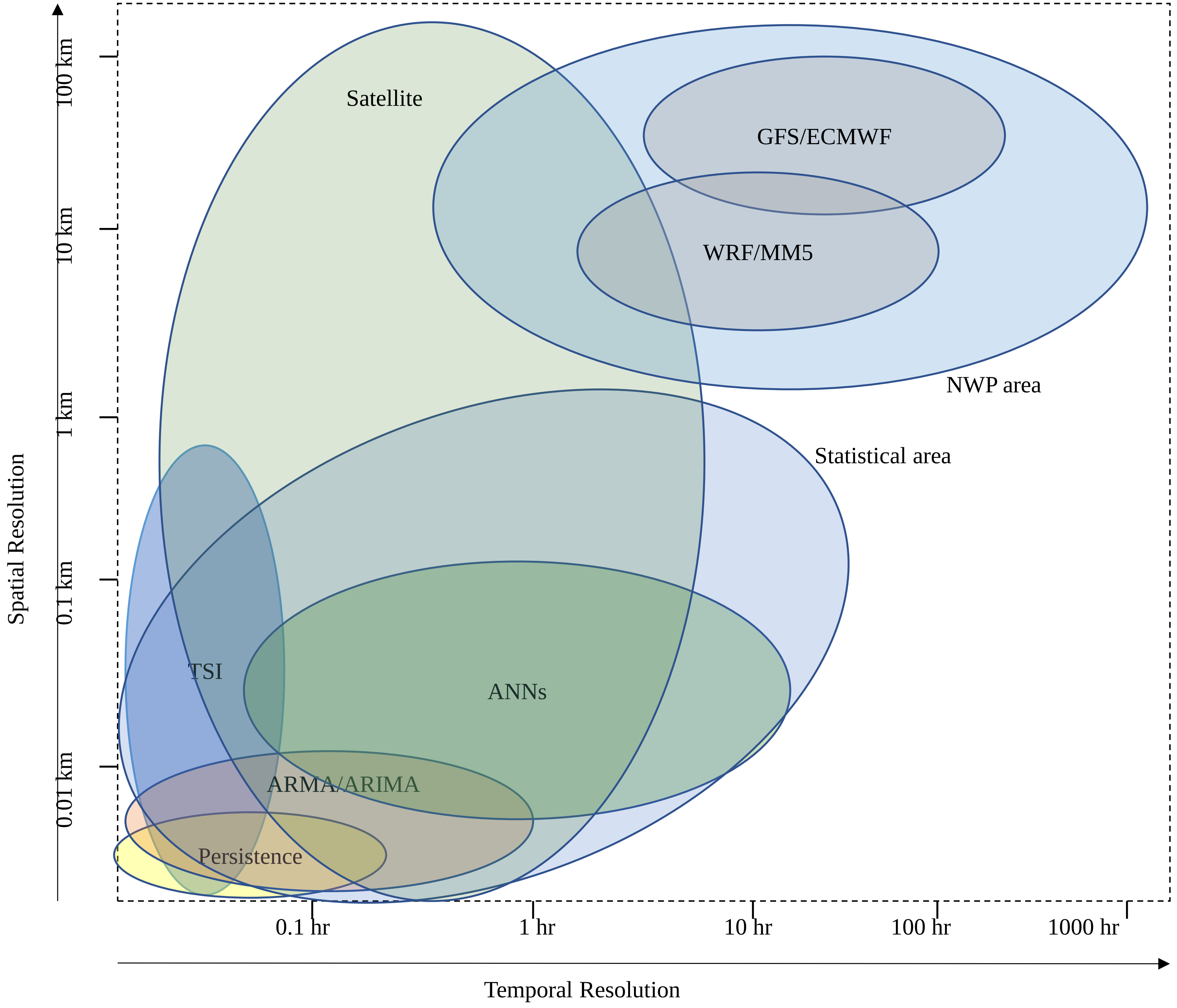


Training
Raw Data (Train)
Labels
Feature Extraction
Feature Matrix
Train Model
Model
Eval Model
Predicting
New Data
Feature Extraction
Feature Vector
Model
Predict
Labels
Day ahead solar power forecasting by LSTM RNN
Actual Power
Predicted Power
Active Power (kW)
Steps
EV
Wind Power
Storage
Field
1
PV
Intelligent Edge Gateway
XMPP Client
IEC 61850 Server
61850-7-420 Models
Multi-protocol Mapping

發電預測模型

Spatial resolution

Temporal resolution

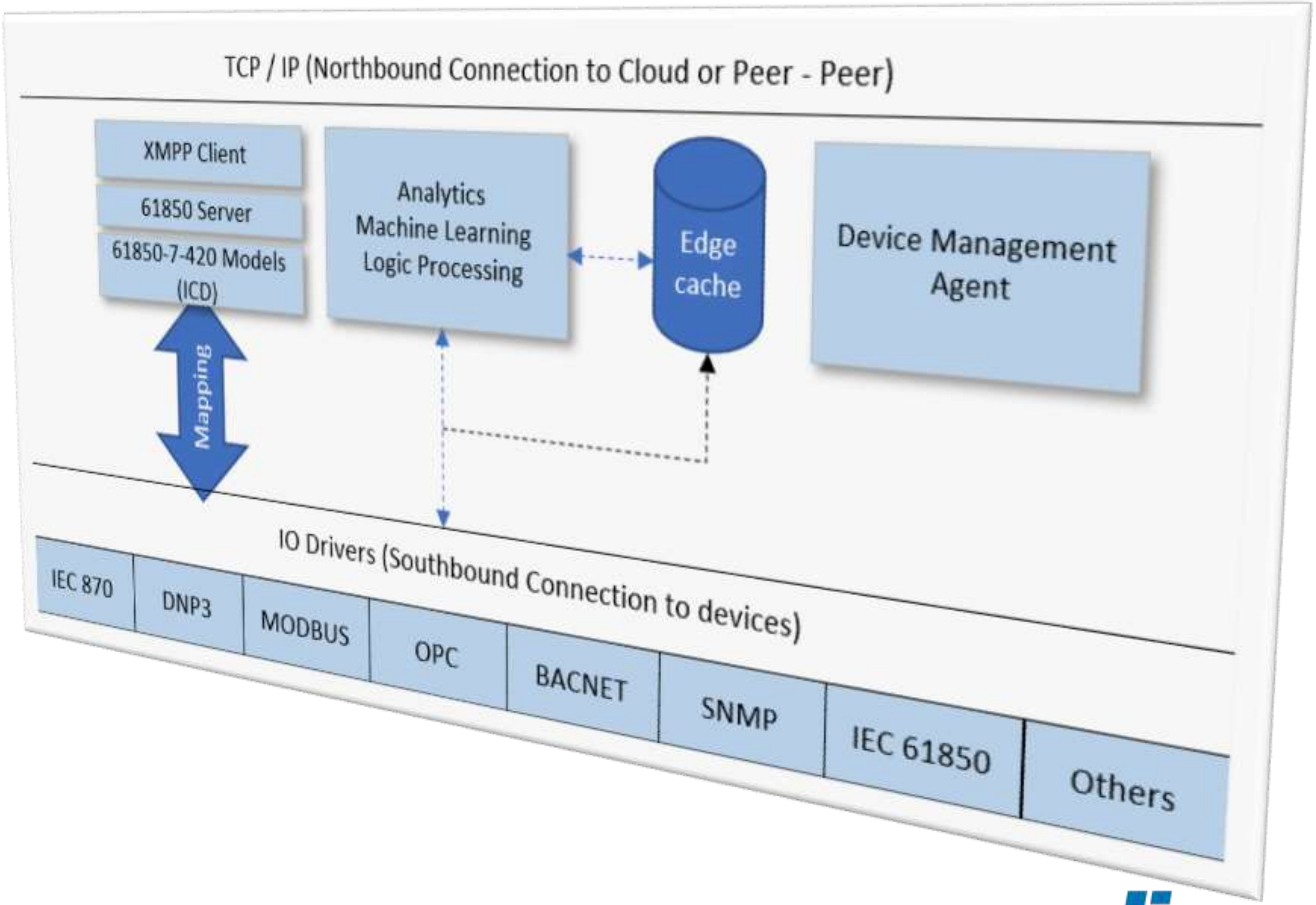


發電預測模型

建置邊緣計算閘道器

Machine Learning

LSTM Multi-step Time series



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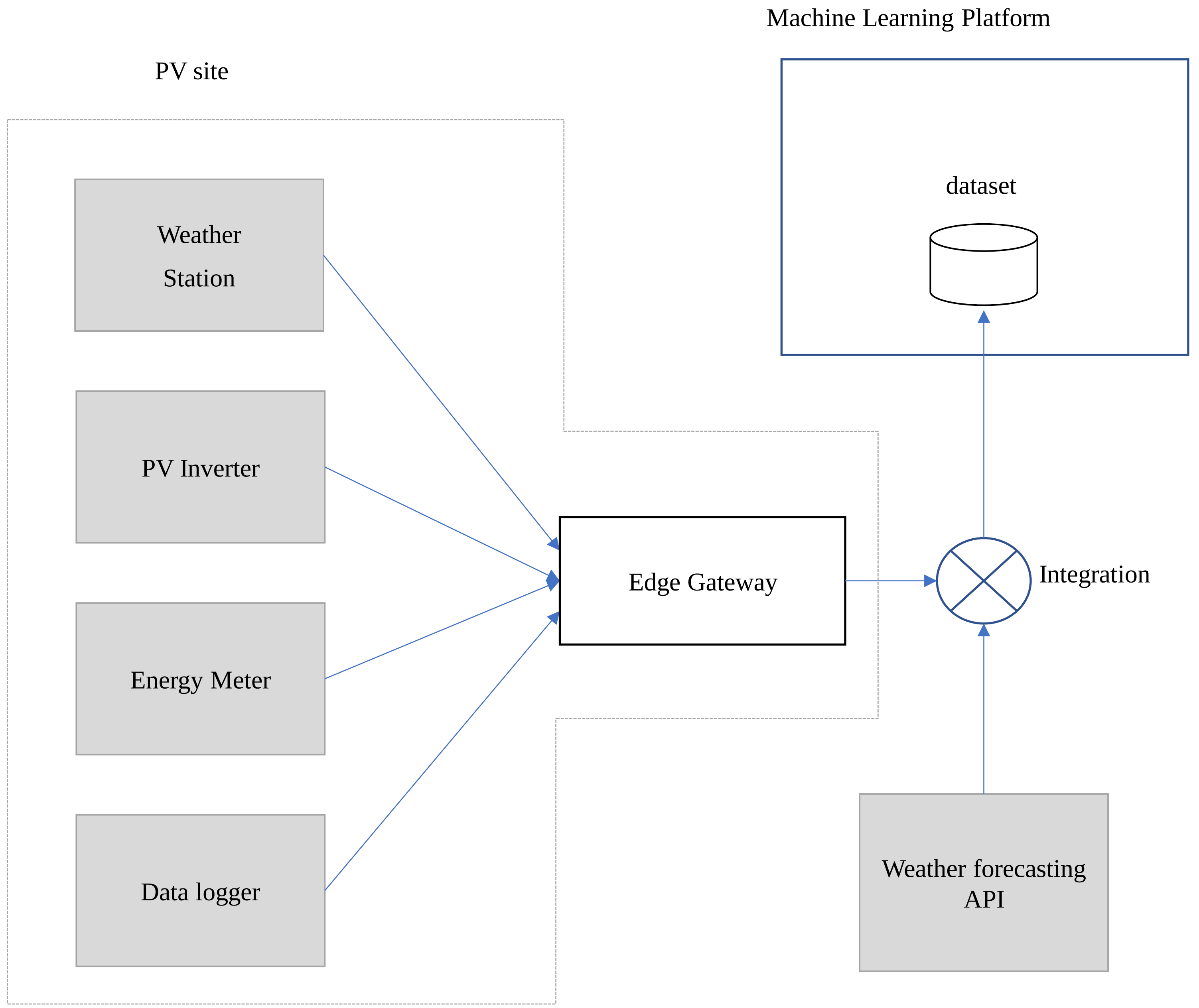
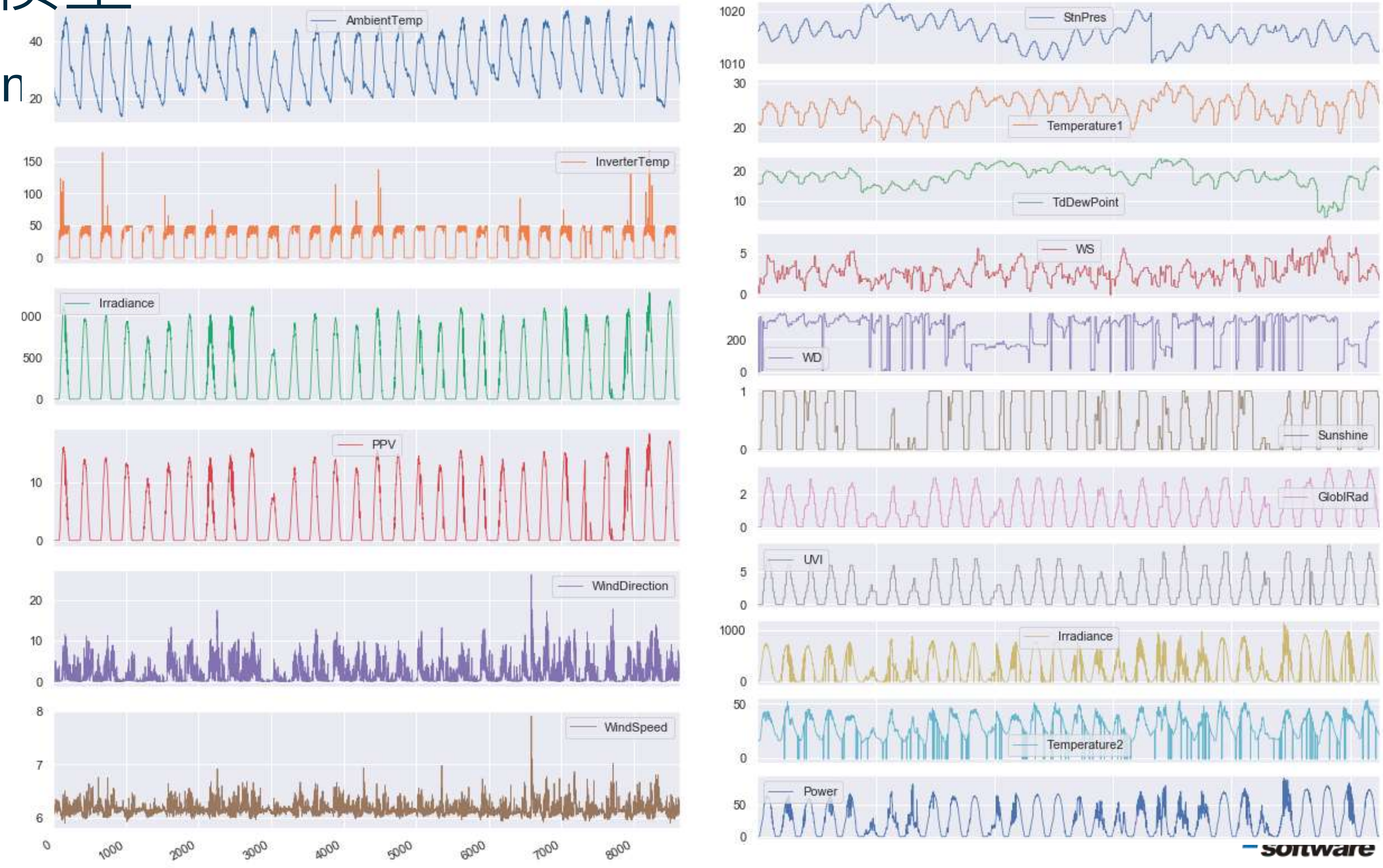
發電預測模型

Data collection



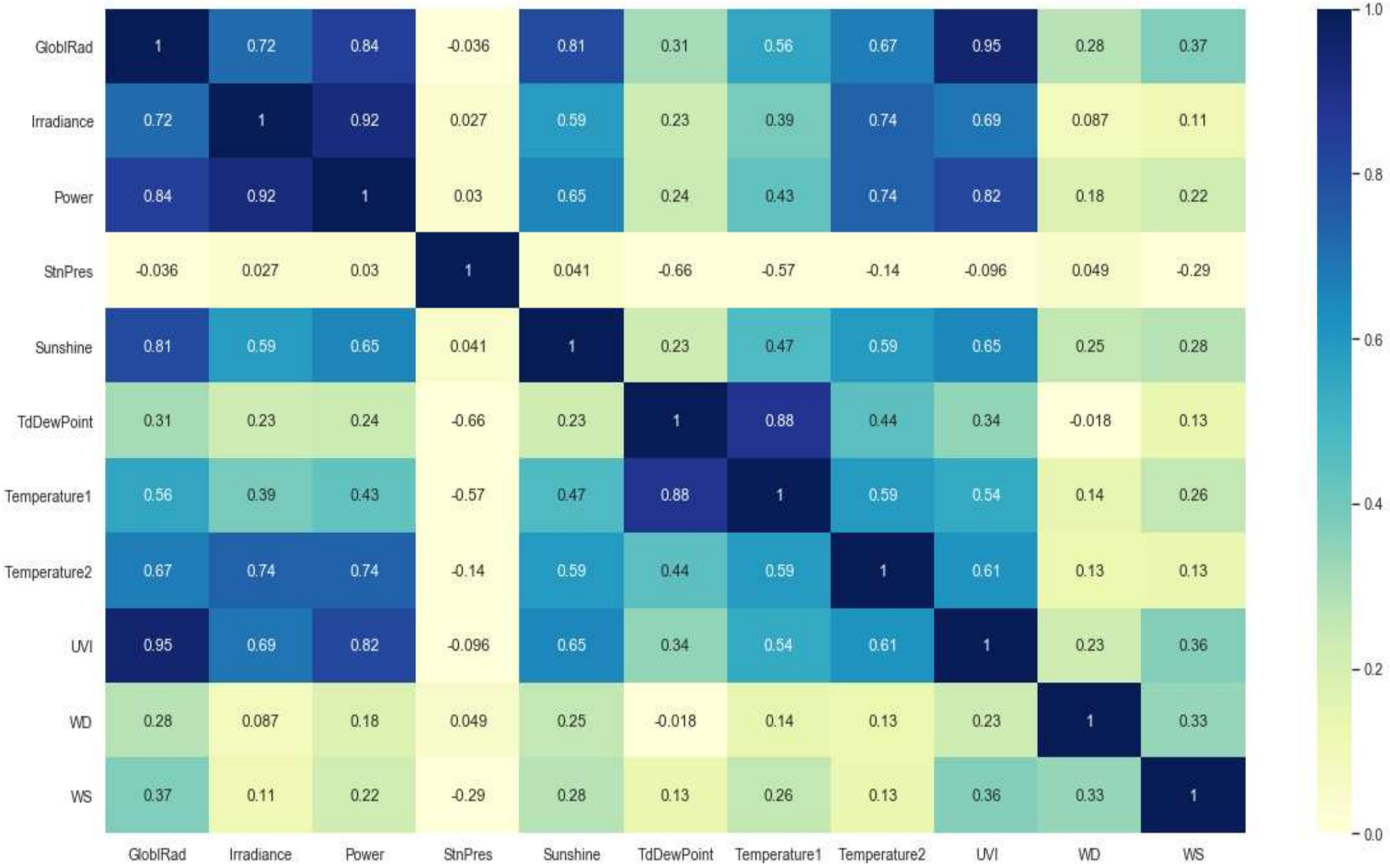
發電預測模型

Data inspection



發電預測模型

Signal correlations



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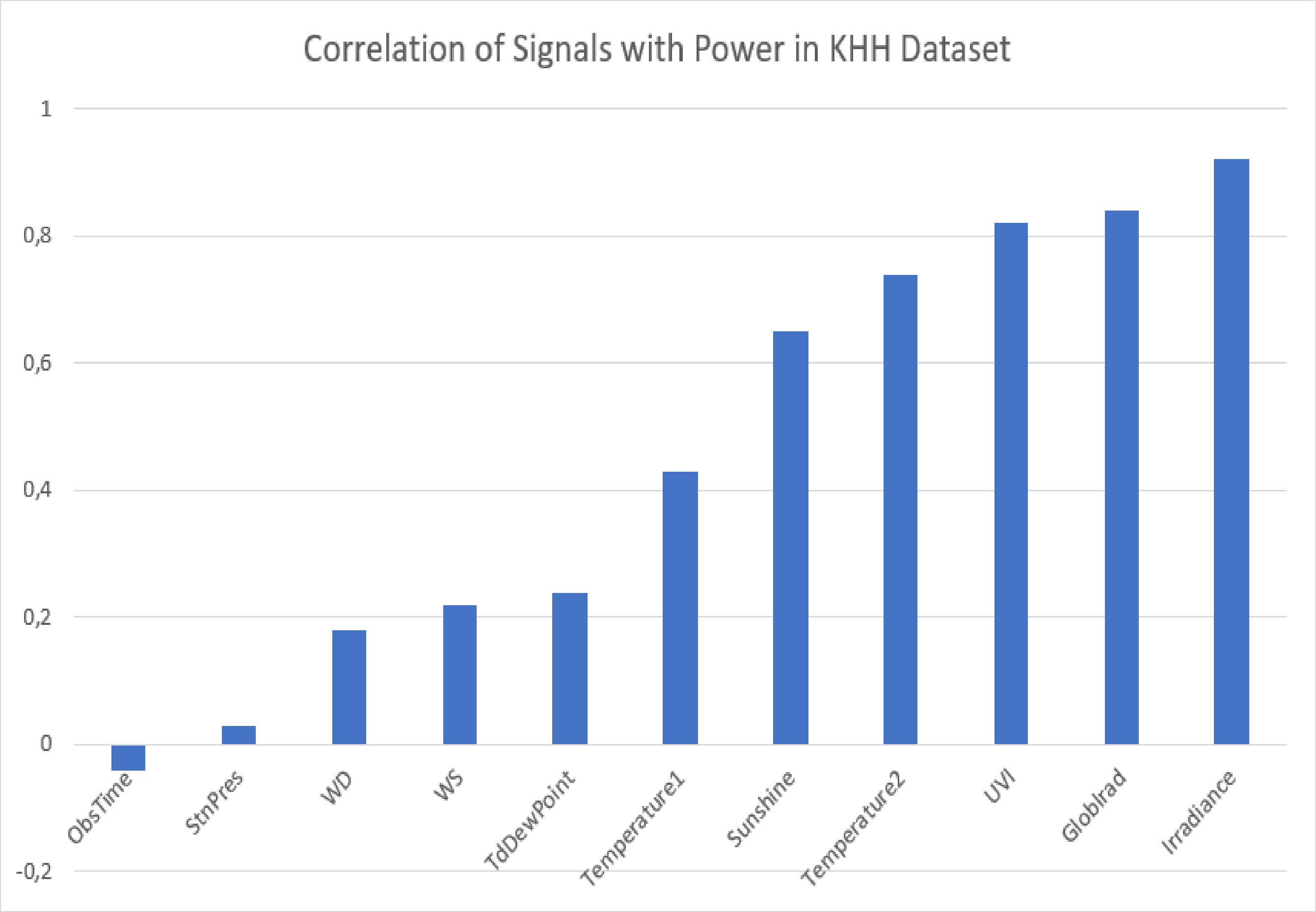
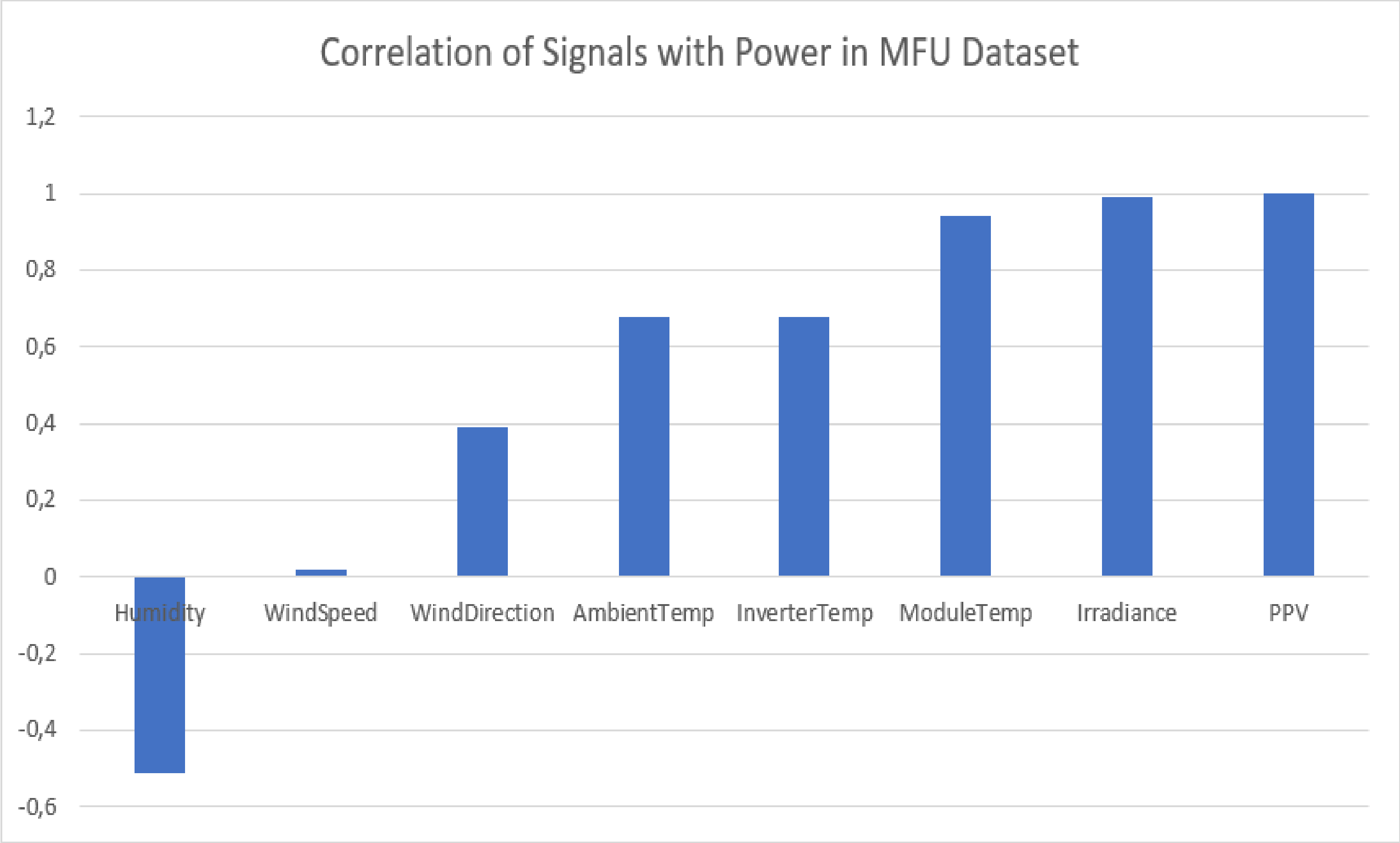
發電預測模型

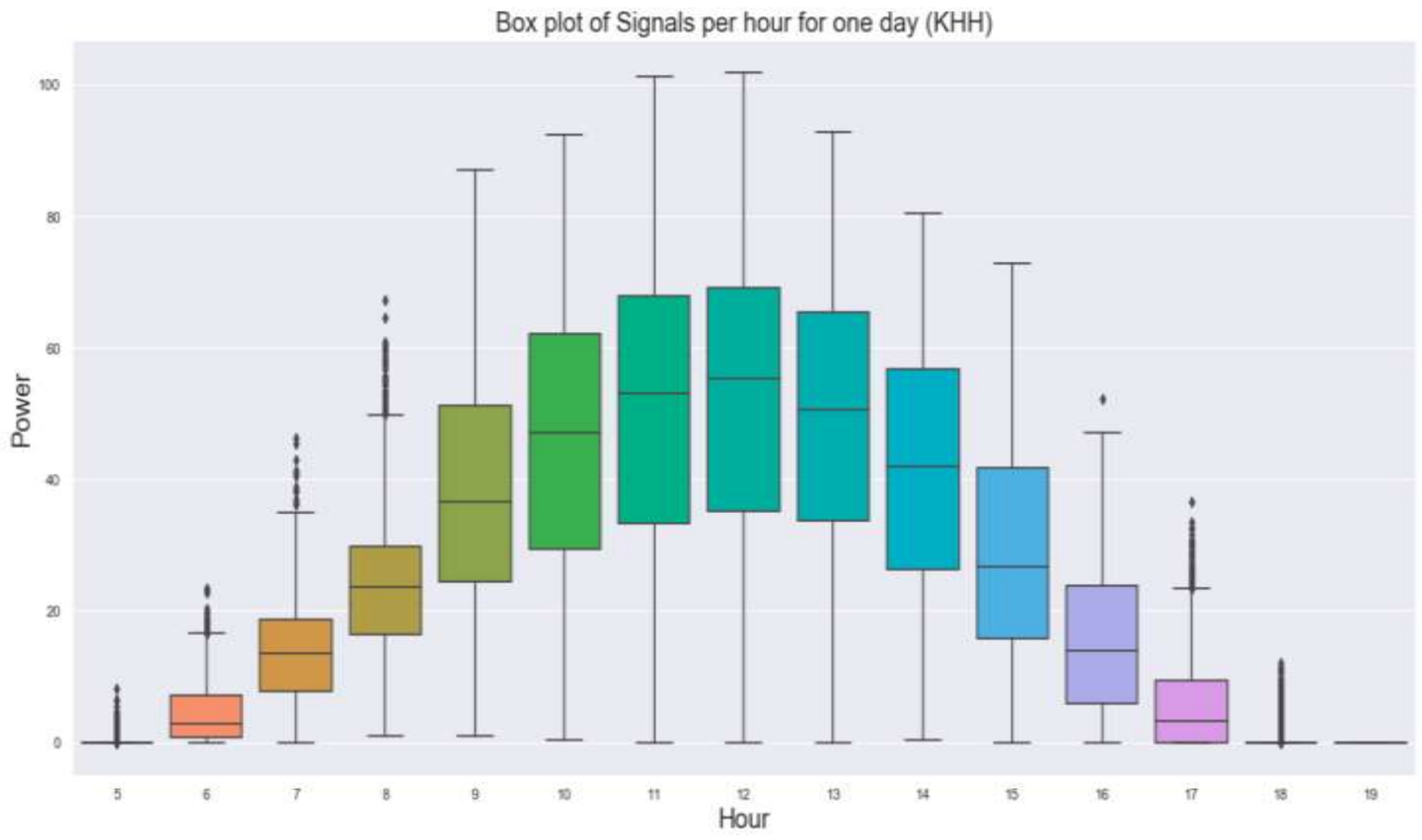
Signal correlations

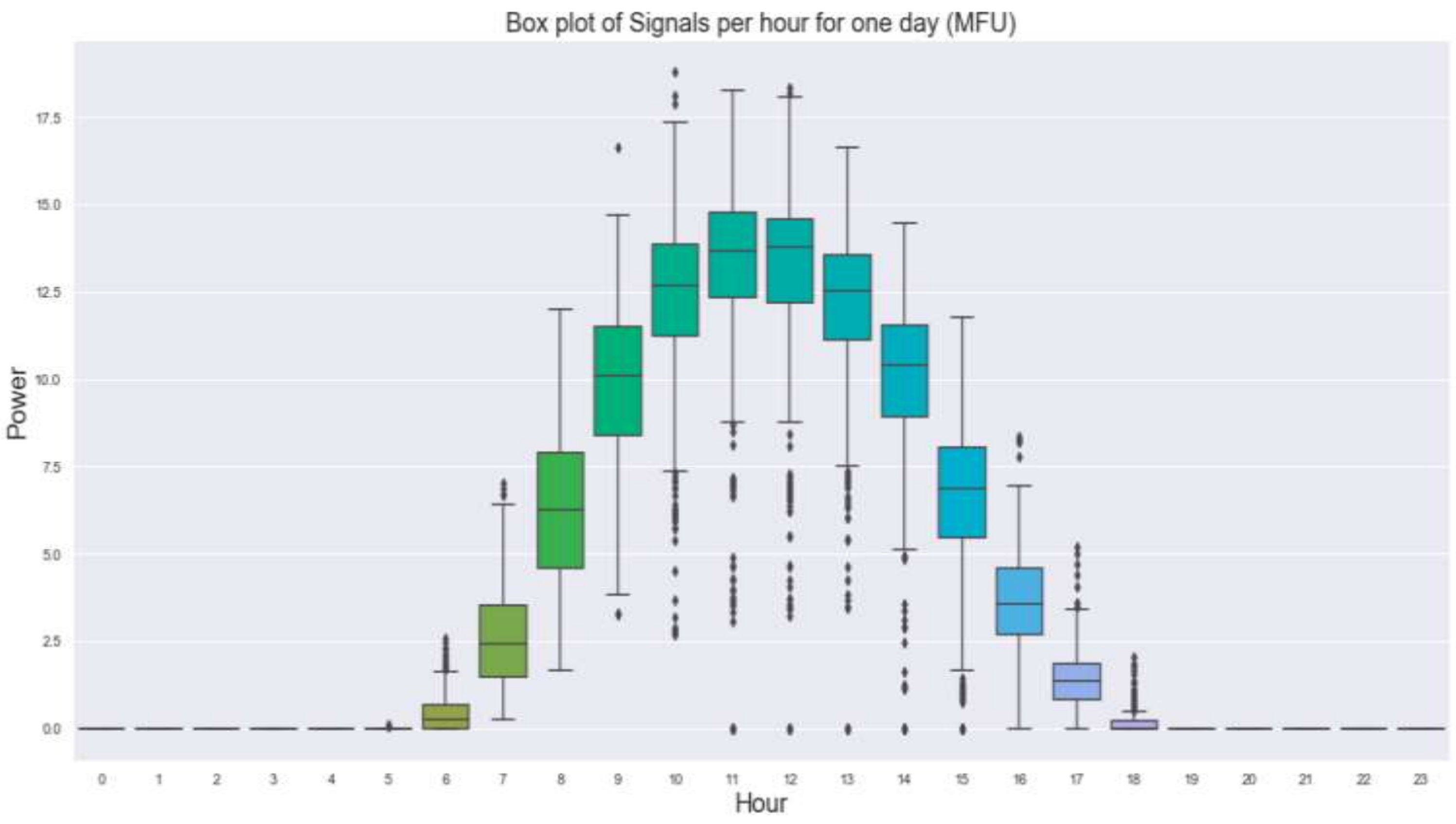




發電預測模型

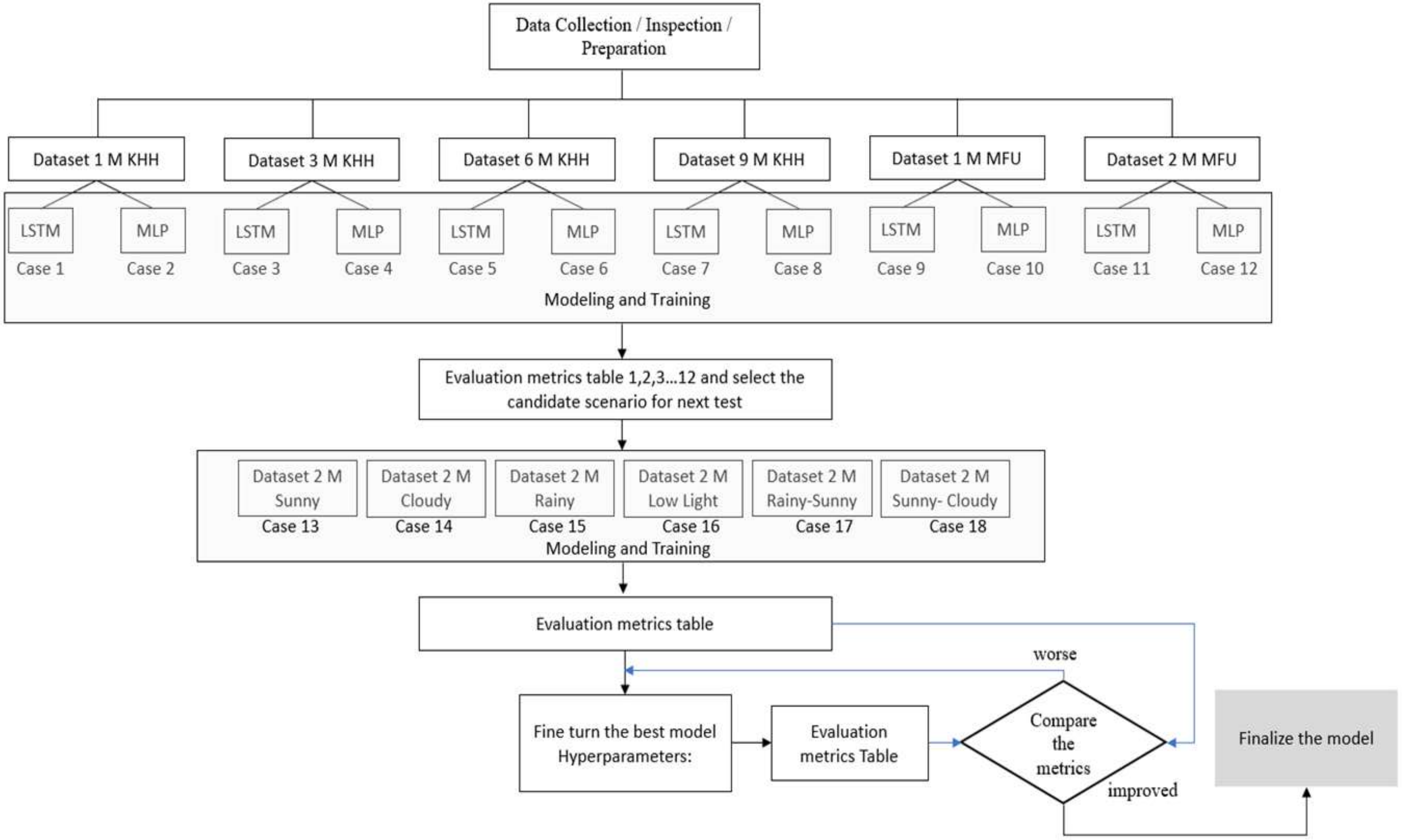
Box plot of power per hour for one day





Box plot of Power signal per Hour for one Day

發電預測模型



Data Collection / Inspection / Preparation
Dataset 1 M KHH
Dataset 3 M KHH
Dataset 6 M KHH
Dataset 9 M KHH
Dataset 1 M MFU
Dataset 2 M MFU
LSTM
Case 1
MLP
Case 2
LSTM
Case 3
MLP
Case 4
LSTM
Case 5
MLP
Case 6
LSTM
Case 7
MLP
Case 8
LSTM
Case 9
MLP
Case 10
LSTM
Case 11
MLP
Case 12
Modeling and Training
Evaluation metrics table 1,2,3...12 and select the candidate scenario for next test
Dataset 2 M Sunny
Case 13
Dataset 2 M Cloudy
Case 14
Dataset 2 M Rainy
Case 15
Dataset 2 M Low Light
Case 16
Dataset 2 M Rainy-Sunny
Case 17
Dataset 2 M Sunny- Cloudy
Case 18
Modeling and Training
Evaluation metrics table
worse
Fine turn the best model Hyperparameters:
Evaluation metrics Table
Compare the metrics
improved
Finalize the model

發電預測模型

LSTM Model training

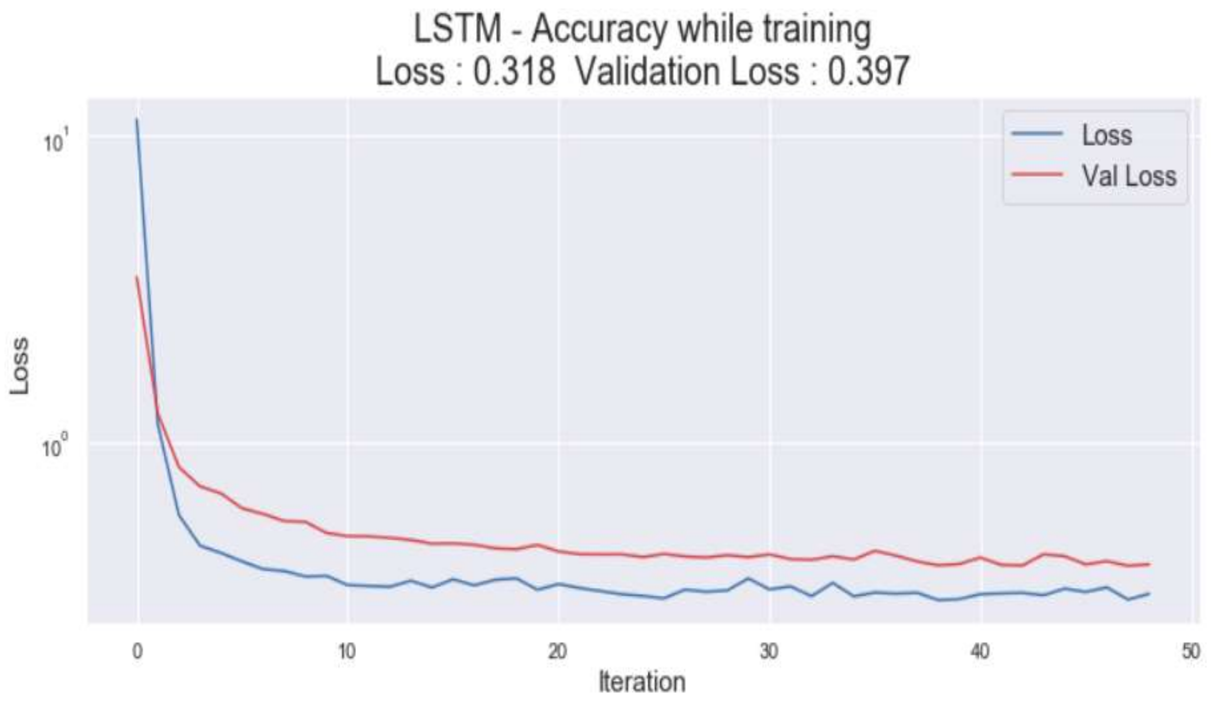


Figure 1-21 : Loss and Validation Loss for the trained model with 30 days

Table 1-13: Metrics Table for Relu Activation Function

Activation Function : Relu				
Test Case	#23	#24	#25	#26
Metric	**50 nodes**	**100 nodes**	**150 nodes**	**200 nodes**
Loss	0.533	0.358	0.337	0.341
Validation Loss	0.374	0.358	0.396	0.395
Validation RMSE	0.408	0.407	0.465	0.455

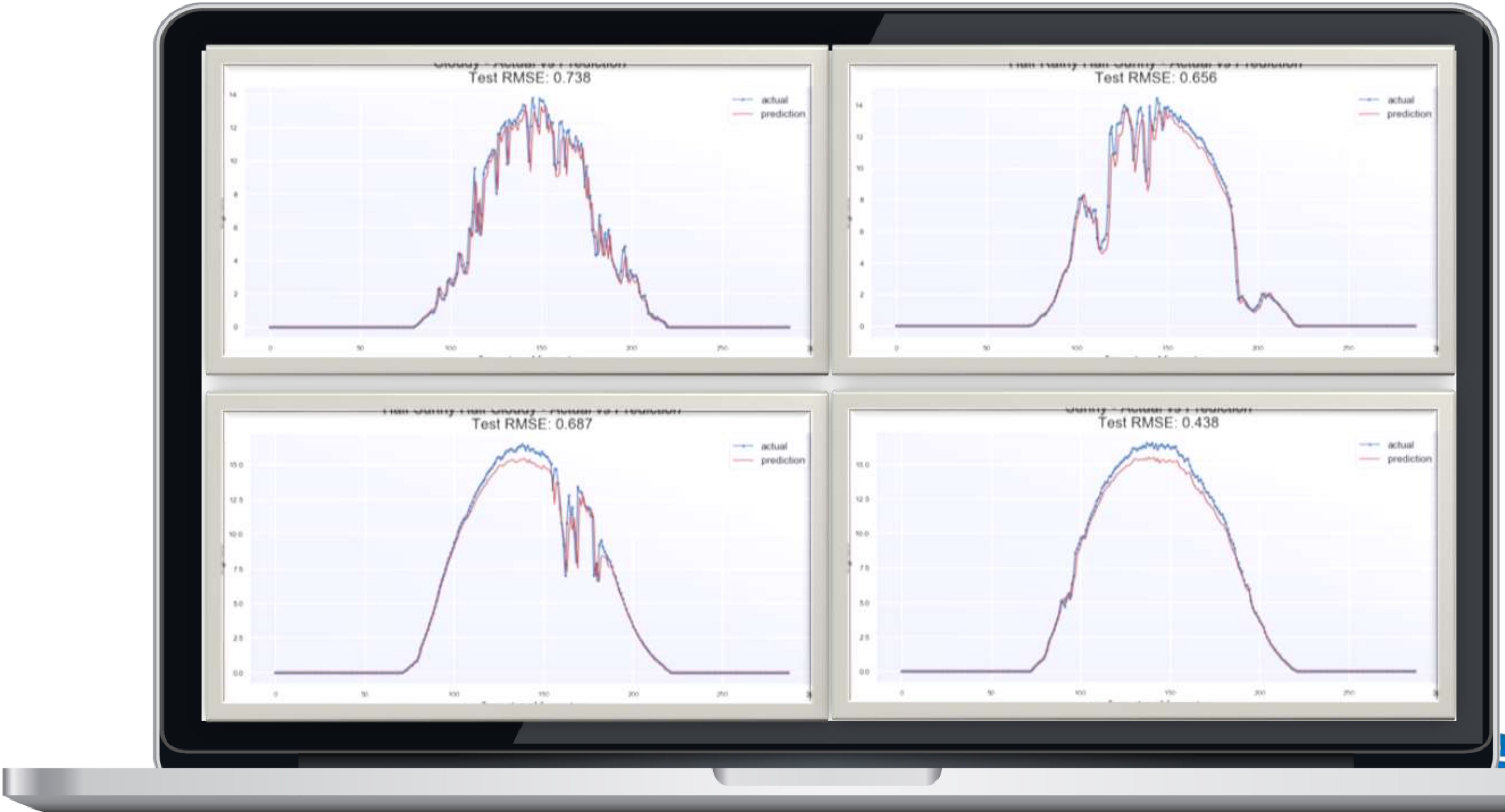
Weather Scenario	**Test RMSE**	**Test RMSE**	**Test RMSE**	**Test RMSE**
Sunny	0.377	0.295	0.270	0.261
Cloudy	0.723	0.718	0.755	0.745
Rainy	0.604	0.625	0.638	0.659
Low Light	0.136	0.145	0.164	0.156
Half Rainy, Half Sunny	0.603	0.599	0.635	0.644
Half Sunny, Half Cloudy	0.688	0.638	0.669	0.664
Average	0.522	0.503	0.522	0.522

Table 1-14: Metrics Table for TanH Activation Function

Activation Function : Tanh				
Test Case	#27	#28	#29	#30
Metric	**50 nodes**	**100 nodes**	**150 nodes**	**200 nodes**
Loss	0.415	0.318	0.289	0.287
Validation Loss	0.407	0.400	0.404	0.473
Validation RMSE	0.418	0.450	0.449	0.530

Weather Scenario	**Test RMSE**	**Test RMSE**	**Test RMSE**	**Test RMSE**
Sunny	0.395	0.267	0.269	0.321
Cloudy	0.719	0.739	0.739	0.775
Rainy	0.645	0.621	0.640	0.674
Low Light	0.143	0.161	0.159	0.249
Half Rainy, Half Sunny	0.605	0.615	0.617	0.684
Half Sunny, Half Cloudy	0.703	0.654	0.669	0.684
Average	0.535	0.509	0.516	0.565

發電預測結果 (不同天氣類型)



可視化界面

SCADA

Web Server

Modulization

Machine Object Lib

Play back

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診斷分析

Historical Trending

Professional Analytics

Predictions

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效益

PV 站監控設備資訊模型化 (IED 61850-7-420 Data Model)

- 隨插即用及遠端設備管理(TR-069)
- 縮短系統建置時間
- 系統擴充容易

邊緣計算閘道器

- 支援多通訊協議整合 (450+)
- 導入機器學習功能: 發電預測、狀態維護模型 (CMB)

DER 雲平台系統 (AWS Cloud)

- 互通性標準
- AI 計算能力
- 圖形介面

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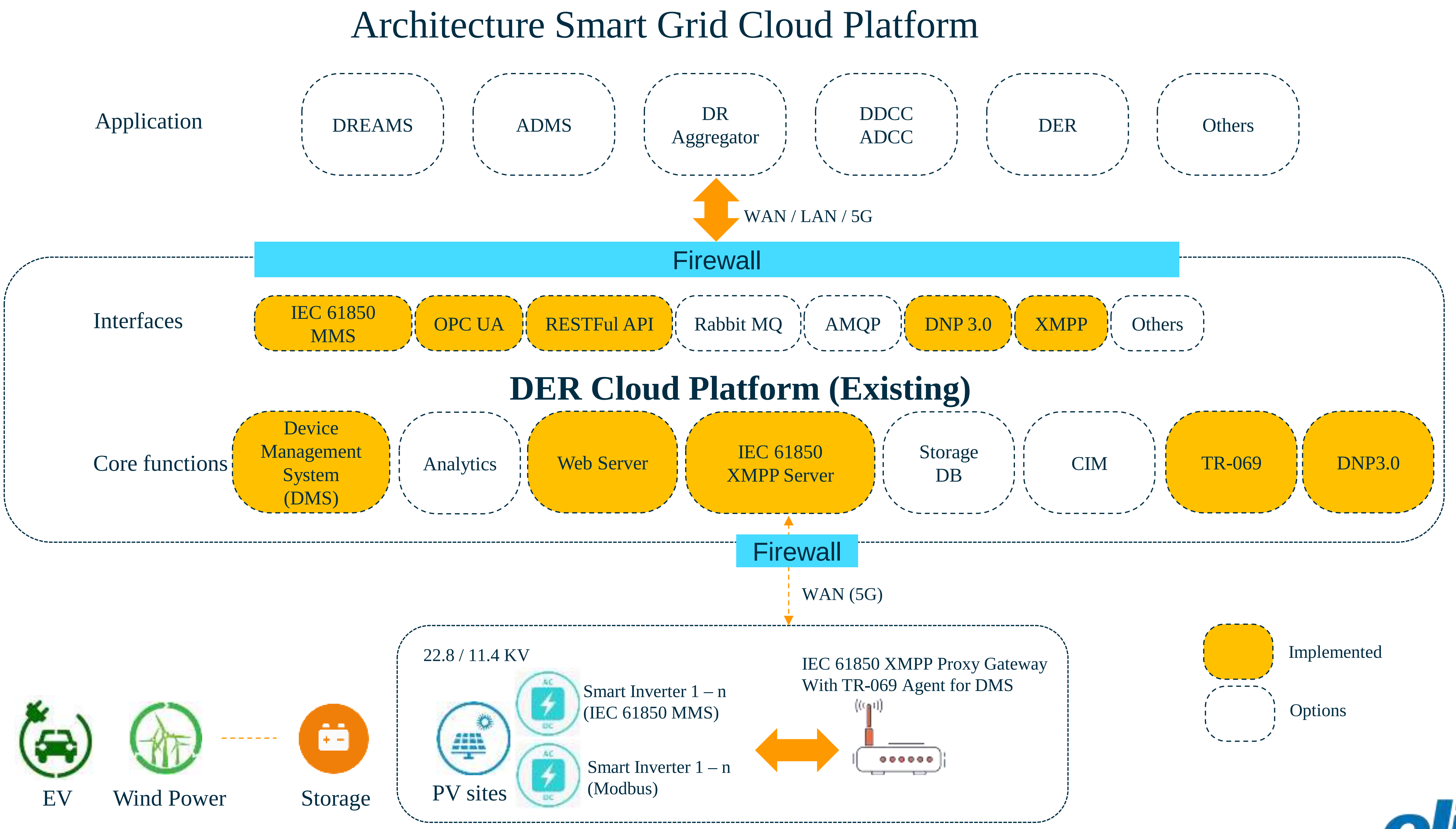
未來擴充



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Thank you!

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Special thanks to partners:

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