

VIETNAM'S RENEWABLES REVOLUTION:

**Solutions with Satellite image,
Forecasting combination, and AGC**





BA HOAI NGUYEN

Deputy Manager of Renewable Energy Management Department

National Power System and Market Operator Company (NSMO)



(+84) 90 2277793



hoainb@nsmo.vn



Background

Mr. Nguyen Ba Hoai has been working for the National Power System and Market Operator (NSMO, formerly EVNNLDC) for more than 10 years. He is currently the Deputy Manager (in charge) of the Renewable Energy Management Department. He received both his Bachelor's and Master's degrees in Electrical Power System from Universiti Tenaga Nasional (UNITEN), Malaysia. His responsibilities include the application of science and technology in developing tools for renewable energy operations, such as monitoring, forecasting, and management renewable energy. He also serves as the key focal point for international cooperation with other system operators around the world. Prior to this role, he gained extensive experience in the field of SCADA/EMS, particularly with AGC and state estimation.



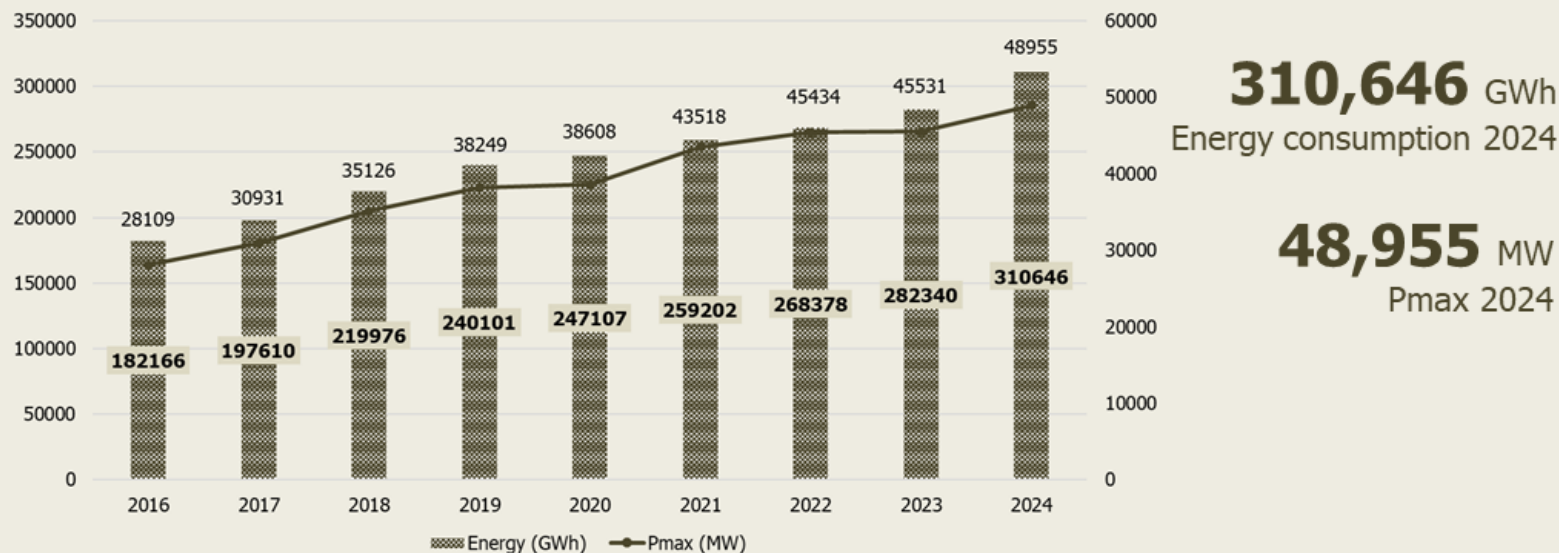
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Overview of Vietnamese Power System and Renewable Energy Development

Electricity Demand Development in Vietnam

ELECTRICITY DEMAND



AVERAGE GROWTH 2016-2024

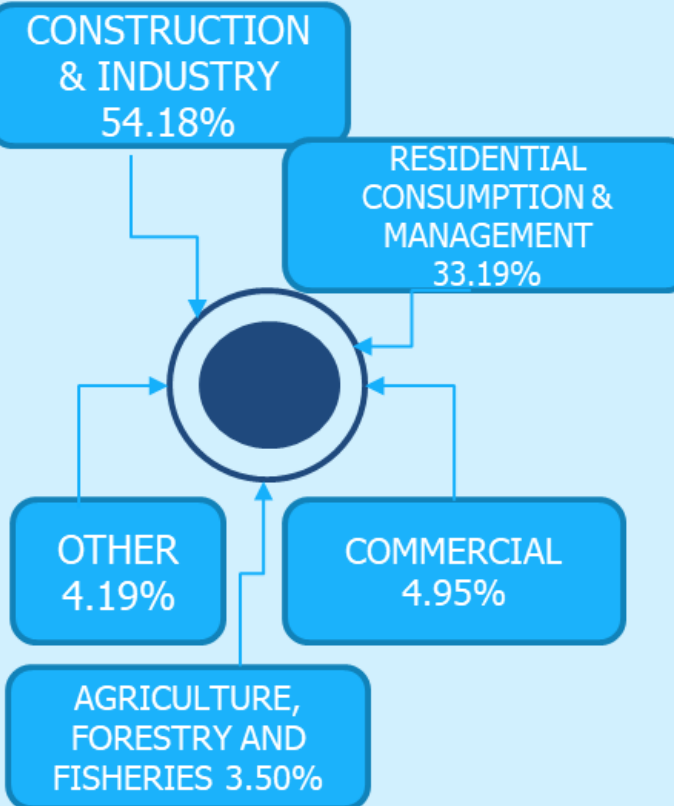


6.4%/year Energy growth



7.3%/year Pmax growth

BY CATEGORY



Renewable Energy in Vietnam



Wind Farm:

5,106 MW



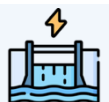
Solar Farm:

8,974 MW



Rooftop Solar:

7,660 MW



Small Hydro:

5,927 MW



Biomass:

439 MW

**Total Installed Capacity
(Renewable Energy)**

28,319 MW

(~34%)

Rapid capacity growth in a **short time (03 years: 2019-2021)**, **concentrated** in **specific regions**





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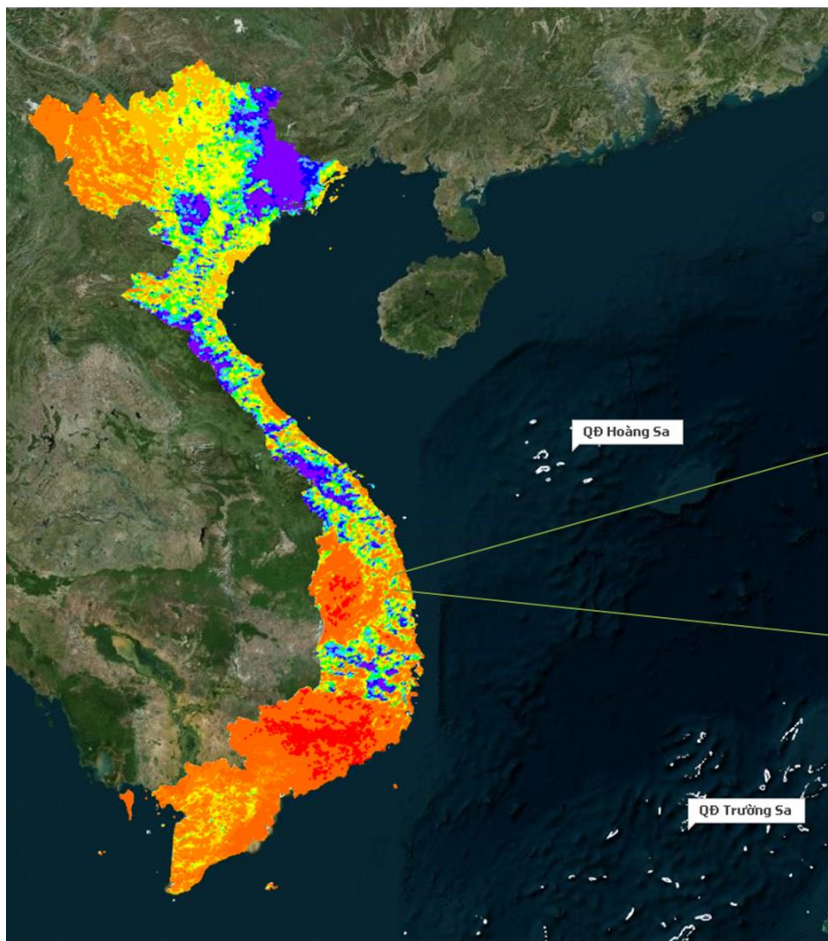
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NSMO's solutions in Renewables Operation

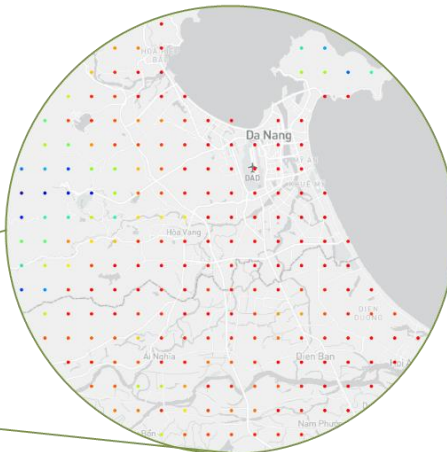
- **Satellite Image**
- **Forecasting Combination**
- **AGC**

Solar Rooftop - Satellite Image Data

Near-real-time Solar Irradiation Map



15-minute resolution
4 km² / Radiation
Measurement Point



SCALE

Estimation of Rooftop PV Generation for All
110kV Substation in Whole Country



INPUT DATA

Rooftop Solar Installed Capacity
Inverter Characteristics
Satellite Irradiation Data

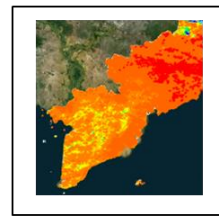


RESULTS

MW and Energy of Solar Rooftop in Vietnam

Solar Rooftop - Satellite Image Data

Estimation of Rooftop PV generation



Himawari-9 Satellite image

- Resolution of 10 minutes per image
- Spatial resolution of 2 - 5km
- 5 observation zones providing up to global coverage
- 16 image channels
- Real-time updates

Server Provider (Domestic)

- Receiving satellite image with ~30min delay
- Calculation of solar irradiance parameters from satellite image, applying specialized models and modules
- Assessment of atmospheric reflectivity and cloud index available

Solar irradiance data for the whole territory of Vietnam

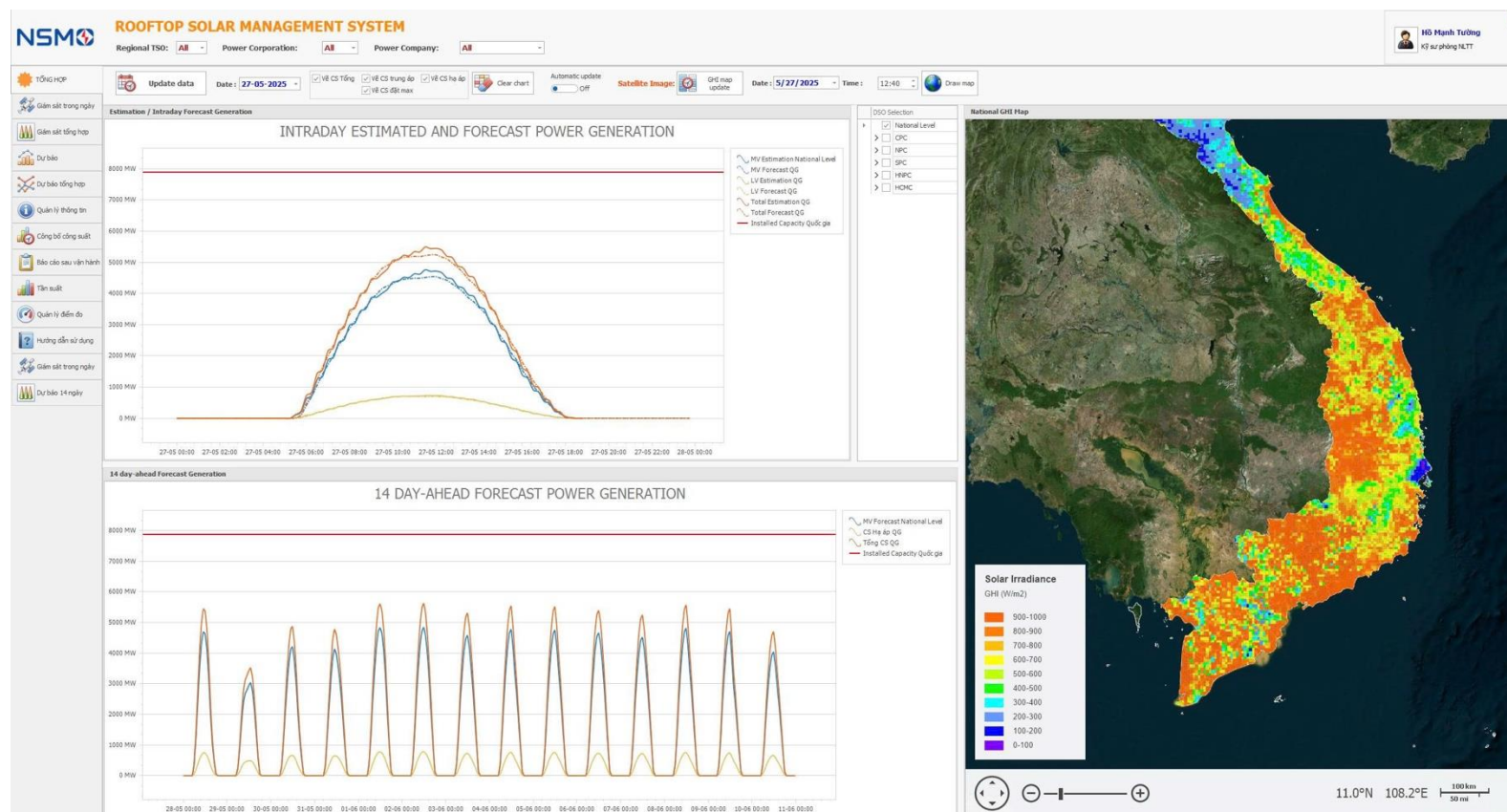
- Stored on FTP server
- Each point simulates an area of 4km²
- Standardized irradiance for each district, ward
- Delay compared to real-time: 40 - 60min

Solar Rooftop monitoring capacity

- Details to each and every 110kV substation of provincial Power Companies, for 2 levels of Medium and Low Voltage connection
- Resolution 15 minutes
- Minimum update frequency: 5 minutes

Solar Rooftop - Satellite Image Data

Rooftop solar management tool



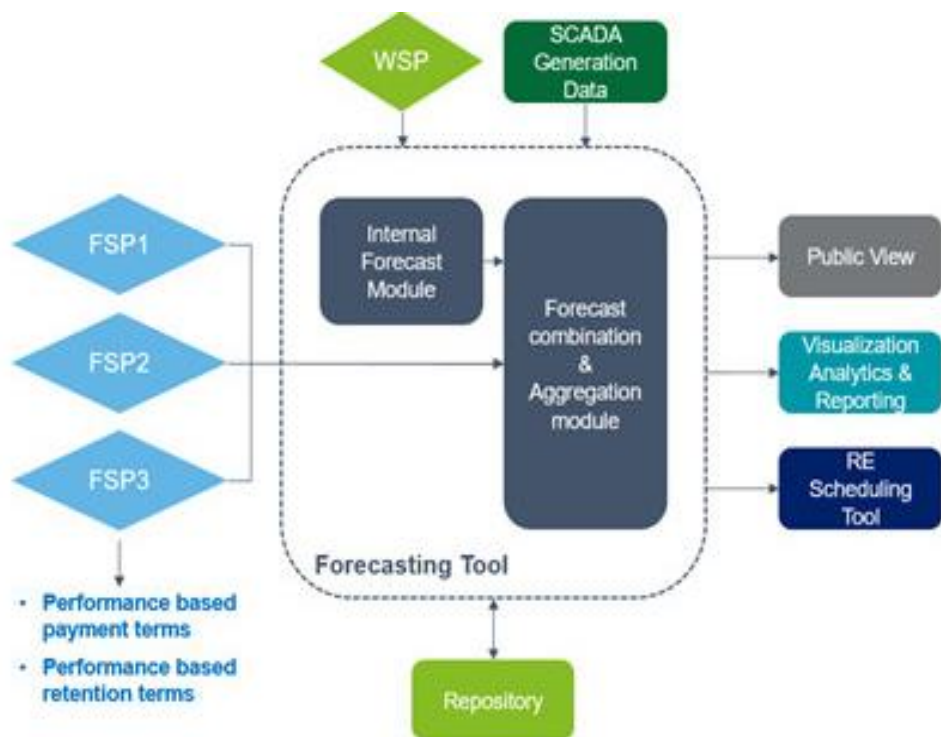
2x2km resolution irradiance

> 800 110kV Substations (for Whole Country)

40-60 minutes
Near-real-time

Forecasting Combination for Utility-scale RE Power Plants

Vietnam Forecasting Model



Forecasting Sources

Third party supplier 1

Third party supplier 2

Power plants forecast

In-house forecasting



Forecast resolution: **30** min → **15** min

Forecasting Combination for Utility-scale RE Power Plants

Forecasting combination algorithm



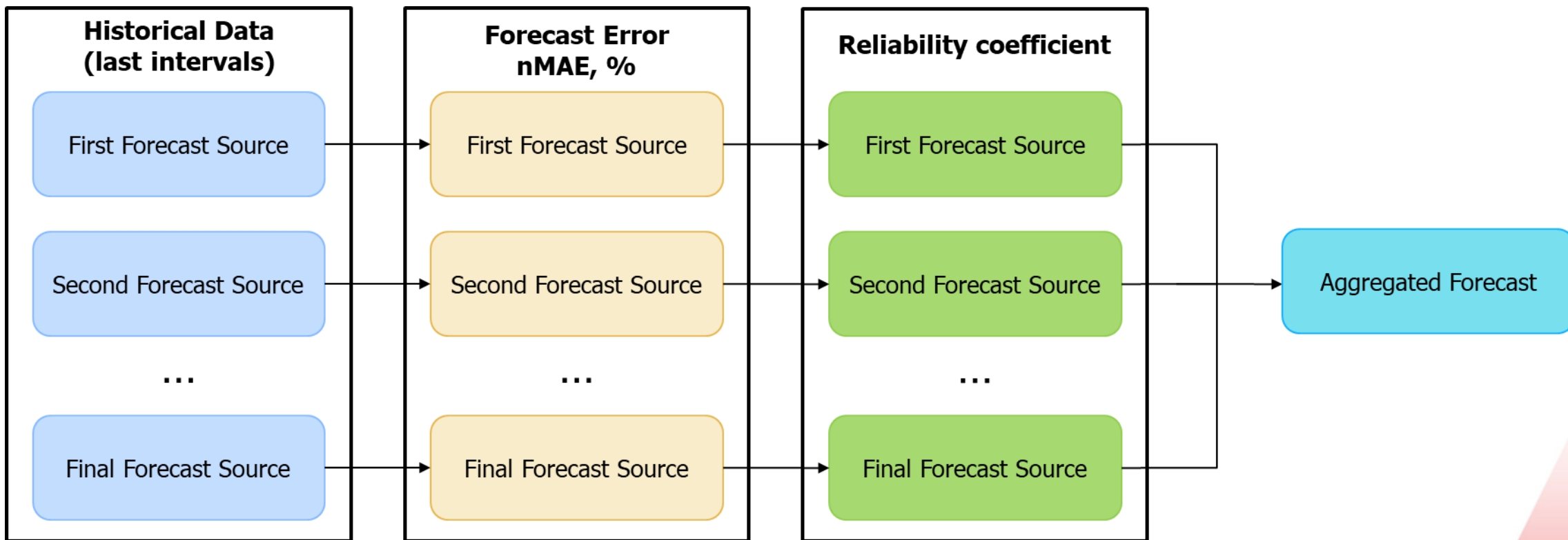
Real-time running



Tool for RE Operator



Accuracy Improvement

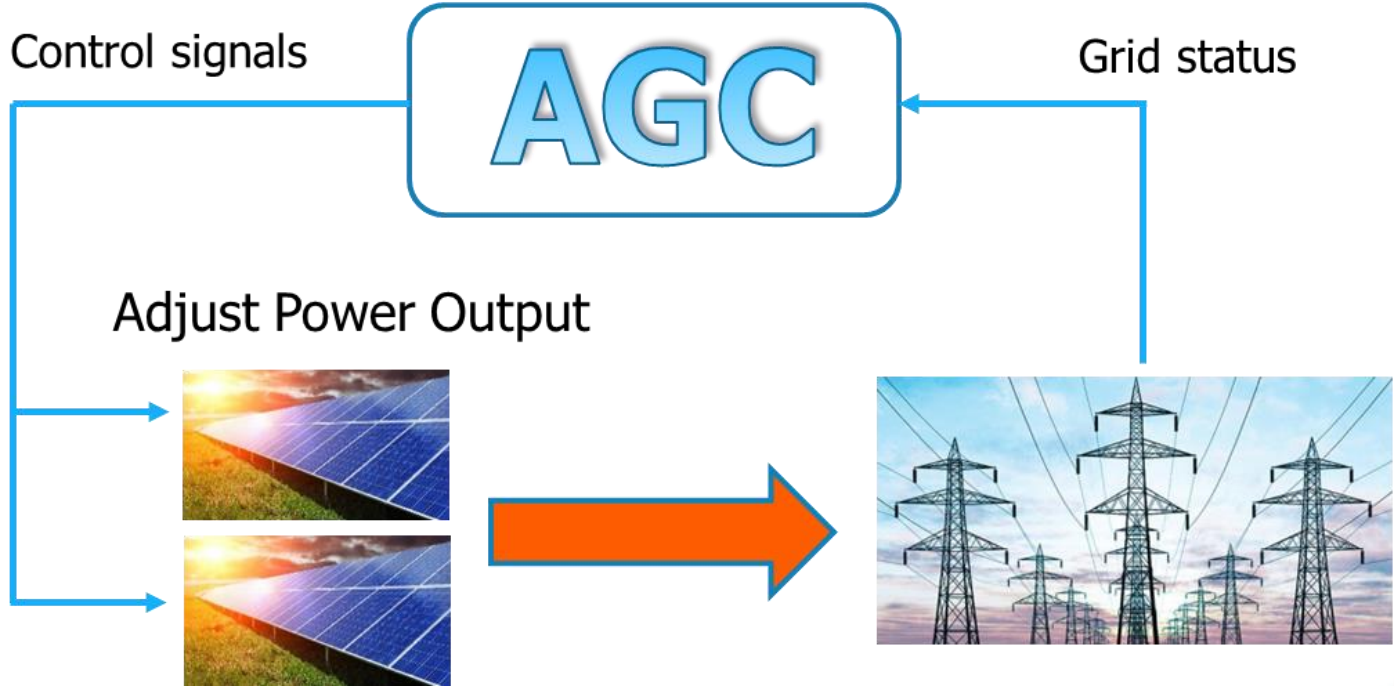
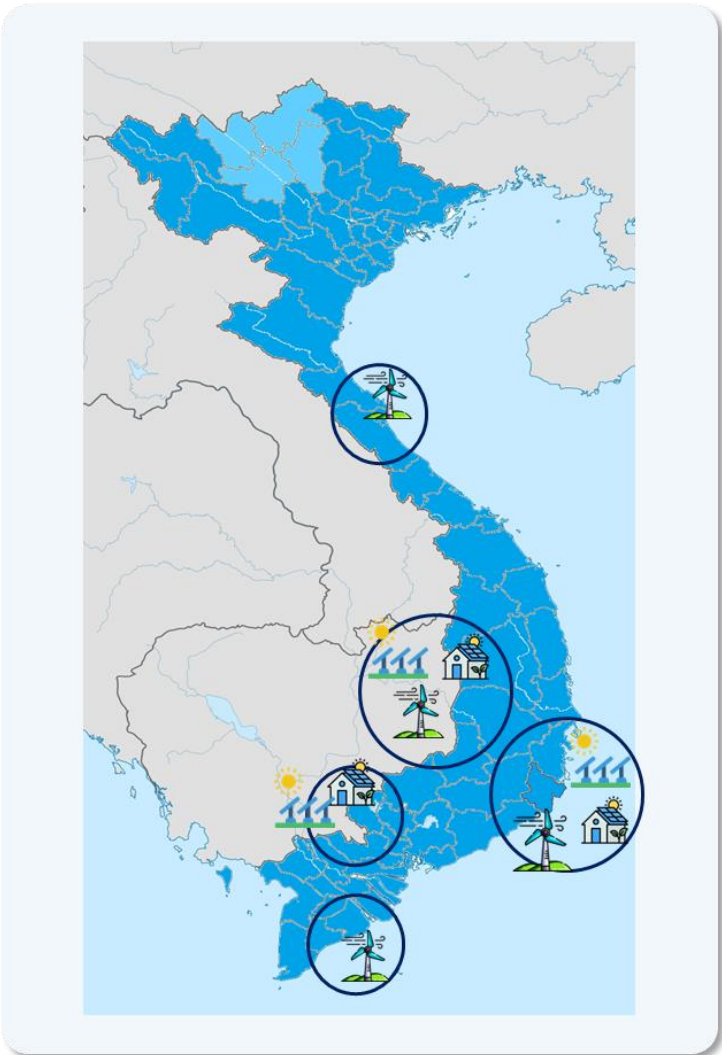


$$nMAE = \sum_{i=1}^n \frac{|F_i - A_i|}{P_{installed_capacity}}$$

F_i : Forecast values
 A_i : Actual values

Grid Overload – Automatic Generation Control

Online control RE plant



Grid Overload – Automatic Generation Control

Online control RE plant

L10	276NP2-276TNam	To Bus	232.2	59.9	19.2	163.3	153.1	944.1	ON
			230.6	-59.4	-22.2	153.1			
L11	172PNinh-178HSA	From...	114.7	3.9	4.9	33.0	33.0	666.3	ON
			114.3	-3.6	-4.4	26.0			
L12	172CLam-172BDC	To Bus	113.1	-1.5	1.8	0.0	15.2	494.7	ON
			112.7	1.3	-2.8	16.6			
L13	272DTrong-276DL	From...	231.5	127.4	-11.8	314.6	314.6	489.9	OFF
			0.0	0.0	0.0	0.0			
L14	172DNai-175TC2	From...	114.7	-32.8	-3.6	168.2	168.2	445.0	OFF
			116.1	33.1	0.4	168.0			
L15	171TC1-174TC220	From...	116.7	-23.1	5.0	114.3	114.3	536.4	ON
			115.3	22.9	-4.3	119.0			
L16	171HBRE-171DHon	From...	117.8	12.3	0.0	60.0	60.0	494.7	ON
			117.2	-12.3	-0.9	66.4			
L17	172TNguy-175Krb	From...	116.2	15.6	-3.4	80.8	80.8	460.4	ON
			116.0	-15.6	2.3	80.9			

Unit	No.	Alarm	TYPE	Area	Name	Group	CE
	75		TD_0_xa	NamMT	CH1-SONGHINH_H2	0	
	29		DMTroi	NamMT	CP1-AMIKHANHH...	L06	
	82		DMTroi	NamMT	CP1-BINHNGUYEN	L07	
	116		DMTroi	NamMT	CP1-BMT (A3)	L08	
	31		DMTroi	NamMT	CP1-CAMLAMVN	L09	
	83		DMTroi	NamMT	CP1-CATHIEP	L10	
	84		DMTroi	NamMT	CP1-CUJUT	L11	
	160		DMTroi	NamMT	CP1-DAMTRAO	L12	
	6		DMTroi	NamMT	CP1-DLMIENTRUNG	L13	
	148		DMTroi	BacMT	CP1-DOHWALETH...	L21	
	57		DMTroi	NamMT	CP1-EUROPLAST...	L19	
	85		DMTroi	NamMT	CP1-FUJIWARA	L03	



Online control

Calculate every 4s, send control signal every 8s



Overload areas

Covers 220/110kV network & inter-area 500kV AC lines



NSMO Innovation

NSMO inhouse algorithms: the power ceiling and sequential line



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Operational challenges and solutions under study

Distributed Energy Resource Management System (DERMS)

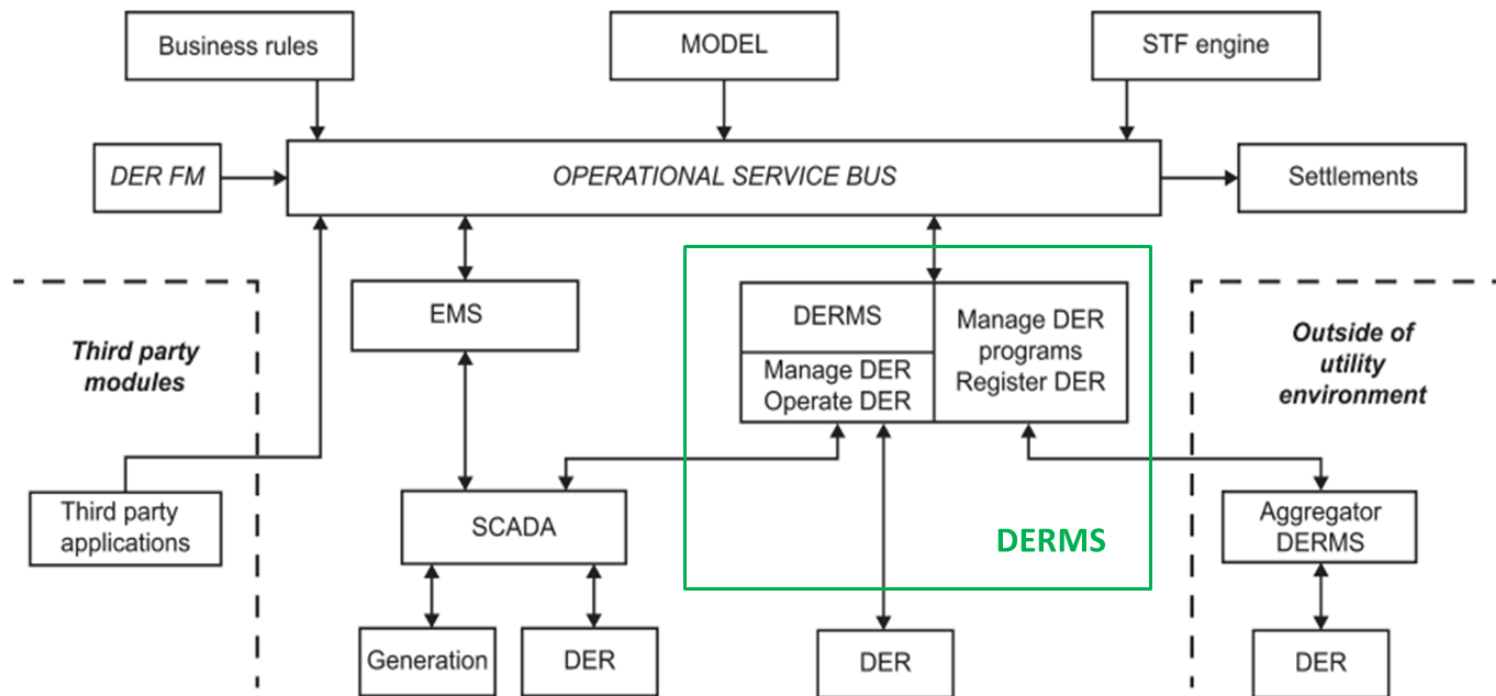
OBJECTIVES

DERs include

- Rooftop
- Small Hydro
- BESS
- EV

FUNCTIONS

- Data collection: telemeter, data logger, SCADA/EMS
- Utilizing existing data to produce reliable data
- Monitoring and forecasting power generation
- Automatic connect to TSO/DSO



Source: IEEE Guide for Distributed Energy Resources Management Systems (DERMS) Functional Specification, " 2021.

Upcoming Event: G-PST Workshop on DERMS & AI Applications



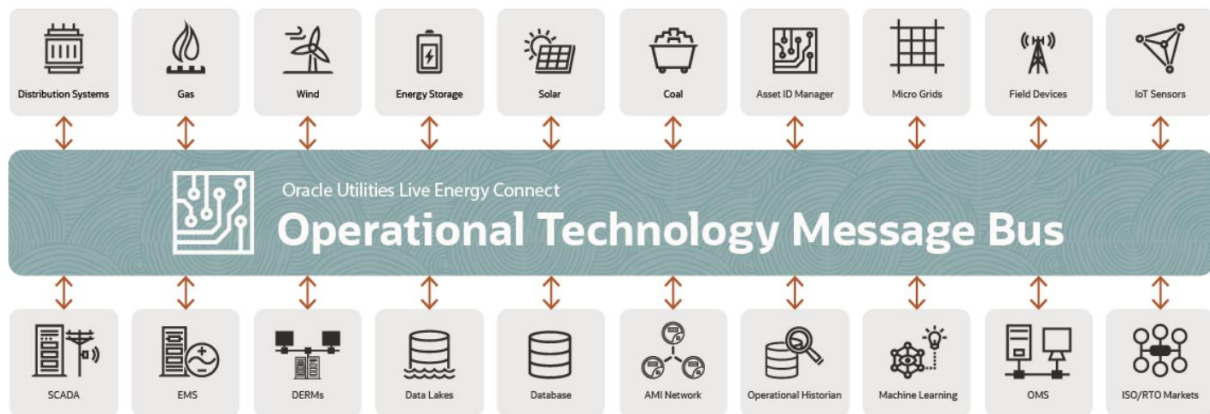
October, 2025



Hanoi, Vietnam

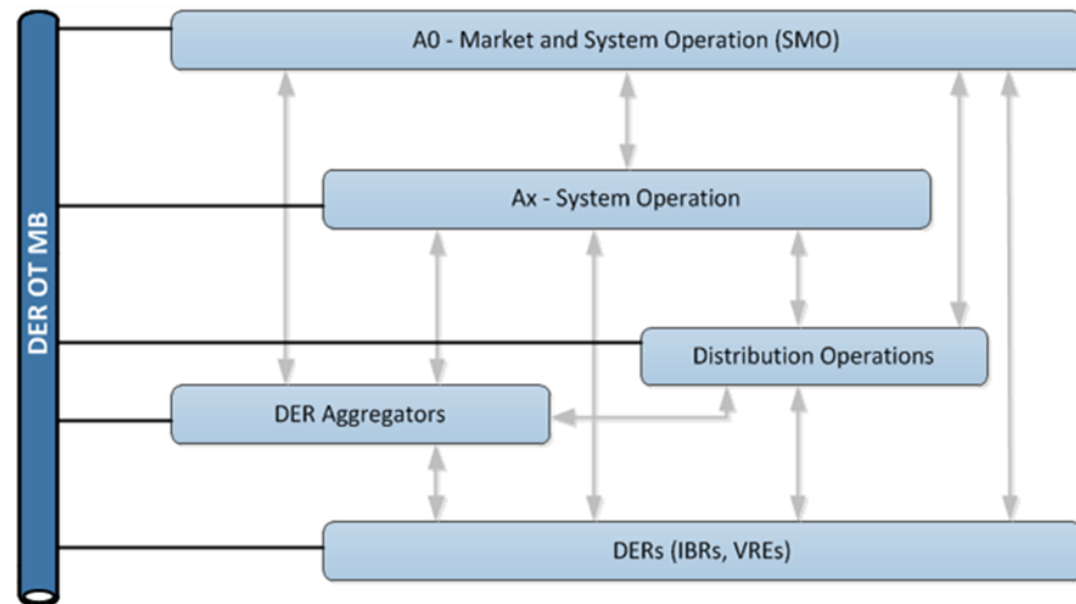
Enterprise Service Bus (ESB) – Message Bus

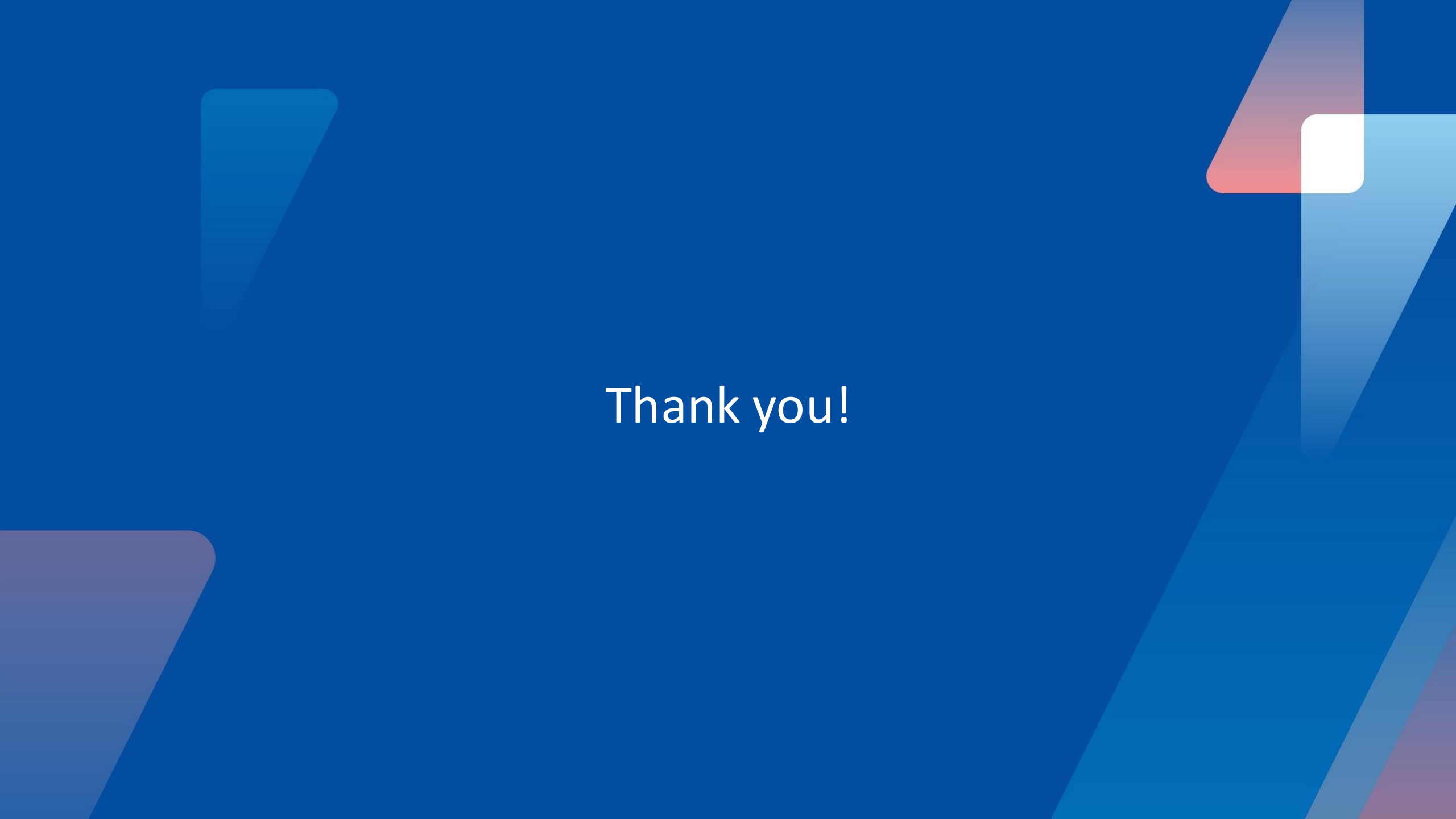
OTMB/ESB Architecture from Oracle



Source: <https://www.oracle.com/ie/a/ocom/docs/industries/utilities/utilities-integrate-operational-tech.pdf>

Proposed model for Vietnamese TSO- DSO Coordination





Thank you!