NEDO-SGTECH Project

Survey research on the status and policy of smart grid related to the Virtual Power Plants (VPP) technology in Thailand

Tawat Suriwong

"Electricity Sector Transformation: Virtual Power Plants"
The Athenee Hotel Bangkok
Friday 19 March 2021

Contents

19 March 2021

THE RESEARCH PROBLEM AND ITS SIGNIFICANCE

Master Plan on Thailand's Smart Grid Development

2015 – 2036

Energy Policy and Planning Office

MINISTRY OF ENERGY

VISION

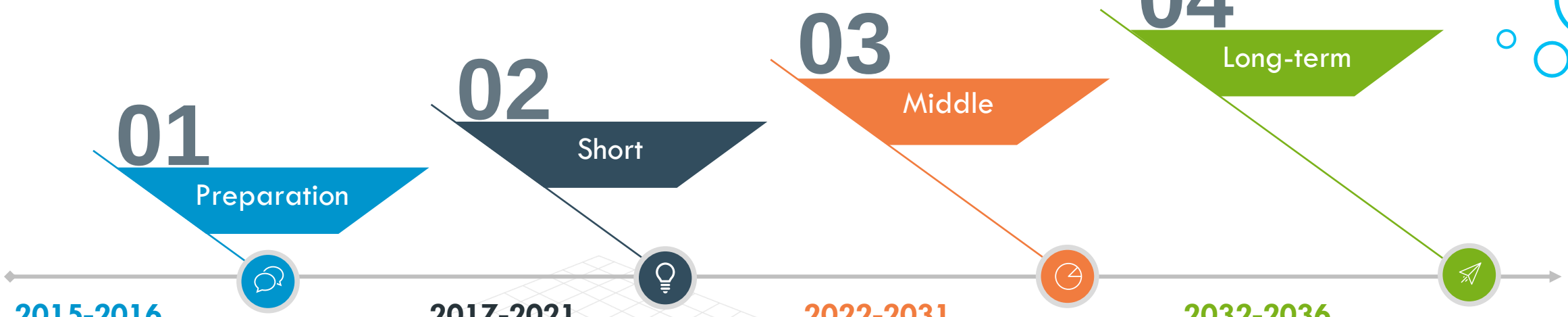
"Encouragement of sufficient electricity provision, efficiency, sustainable, excellent service quality and highest benefit to the country."

The development of the driving plan is covered :

- Energy management system (EMS),
- Pricing & incentive design & demand response,
- Microgrid,
- Energy storage system (ESS)
- Wind & Solar Power Forecast

Strategy for the development of smart grid network system

THE RESEARCH PROBLEM AND ITS SIGNIFICANCE



2015-2016

- Organize working group / Create action plan
- Organize propulsion department / set budget frame for yearly operation
- Organize working groups between 3 Electricity Authorities
  - Interoperability
  - Smart grid development system platform
- Organize working group for improving Grid Code supporting renewable energy
- Funding Educational institution to produce Smart Grid personnel
- Funding research in its initial phase
- Inform general public about Smart Grid system

2017-2021

- Funding research regarding pilot projects
  - HEMS/BEMS/FEMS pilot project
  - Load response pilot project
  - Microgrid system pilot project
  - Energy storage pilot project
- Study and review the results of pilot projects

Pilot projects

2022-2031

- Support Real Time Pricing (RTP)
- Establish Renewable Energy/Energy Storage system electricity production forecast data center
- Issue Local content proportion measure for government project
- Issue an encouragement measure for encourage private sector to be able to domestically develop software and hardware
- Issue tariff and financial support measure
- Support investment in developing infrastructure for Smart Grid technology in generate, import and trade system

Infrastructure development

2032-2036

- Electrical production and transmission system: issue a policy to have investment in the following technologies
  - Intelligent electric vehicle charging station / V2G
  - Renewable energy forecast
  - HVDC and electric power in transmission system control equipment (EHV/FACTS)
  - Demand Response Management System and Demand Side Management (DSM)
- Electrical trading system: issue a policy to have investment in the following technologies
  - Energy storage system in trade system
  - Intelligent electric vehicle charging station / V2G
  - Microgrid system
  - Demand Response Management System and Demand Side Management (DSM)
- Issue a policy encouraging installation of technology for full management of energy usage in every sector

Master Plan on Thailand's Smart Grid Development 2015 – 2036

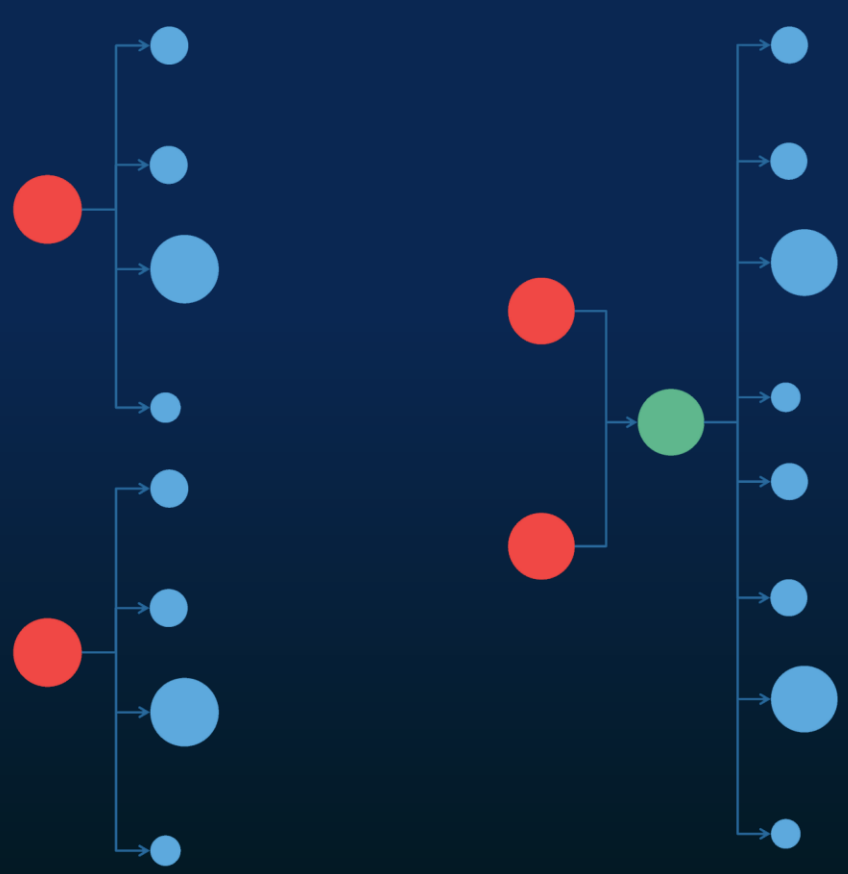
THE RESEARCH PROBLEM AND ITS SIGNIFICANCE

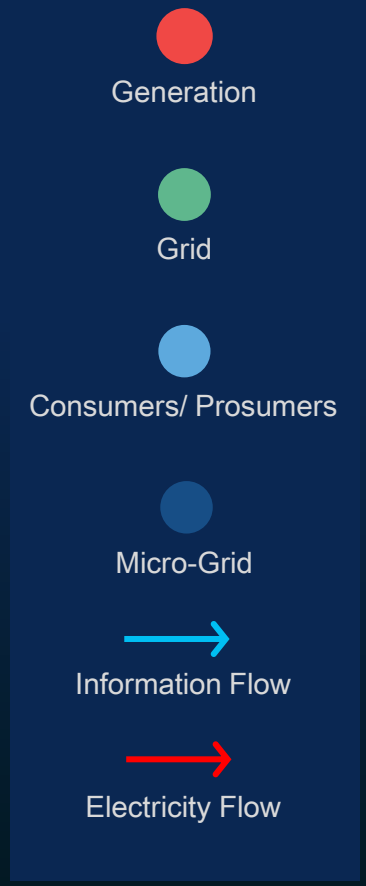
Ancient Past:
Disconnected
Energy Value Chain

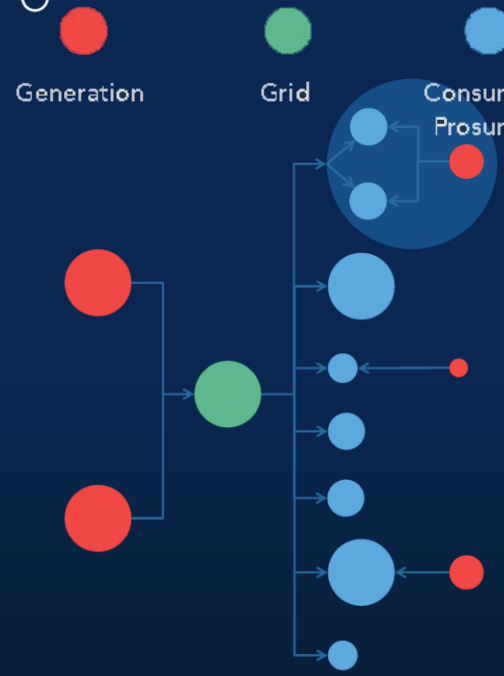
Recent Past:
Vertical Energy
Value Chain

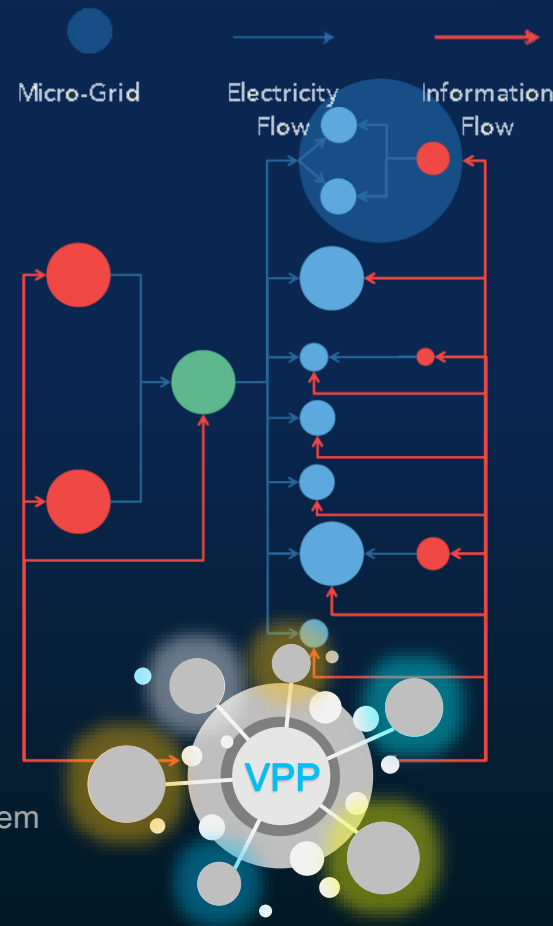
Now:
Bi-directional
Energy Value Chain

Touching Distance:
Interconnected
Energy Web









Trends in the direction of energy development :

- Power reliability and quality
- Distributed Generation, DG
- Backward power flow of RE in grid system
- Green society (RE shearing)
- Electric Vehicles, EVs

http://frost-apac.com/BDS/whitepaper/Bosch_WP.pdf, Virtual Power Plants (VPPs) for Smart Energy Frost & Sullivan

Energy Policy and Planning Office
MINISTRY OF ENERGY

Objectives

สมาร์ทกริด ไทยแลนด์

Renewable Energy

Smart Grid

VPP

1] To survey the status and policy of smart grid related to the VPP technology in Thailand and other countries

2] To analyze the different perspective on VPP from the Thai government, agencies and private companies in Thailand

3] To disseminate the results/recommendation gained from the study to the interested stakeholders

METHODOLOGY

Data analysis

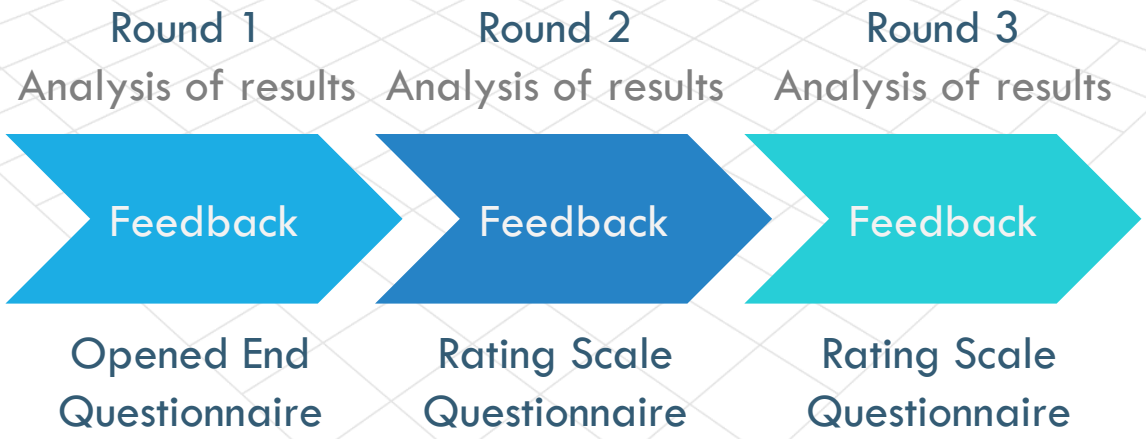
- Trends, directions, and policies supporting smart grid policy related to VPP technology

Delphi Technique

Step

1. Choose a Facilitator
2. Identify the Experts
3. Define the Problem
4. Round One Questions
5. Round Two Questions
6. Round Three Questions
7. Summary of data analysis

DELPHI FORECASTING METHOD



*Participate > 17 experts

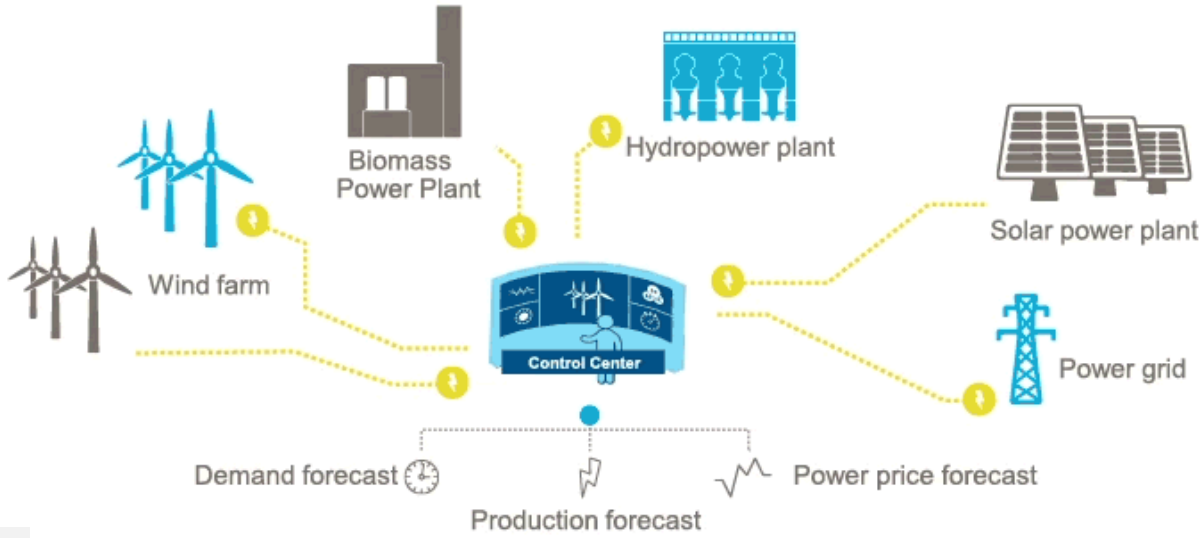
VPP DEFINITION/CONCEPTS

:: P. Asmus, *Electr. J.*, 23 (10), 2010 ::

> *"VPP rely upon software systems to remotely and automatically dispatch and optimize generation or demand side or storage resources in a single, secure web-connected system."*

:: G. Plancke and A. Delnooz ::

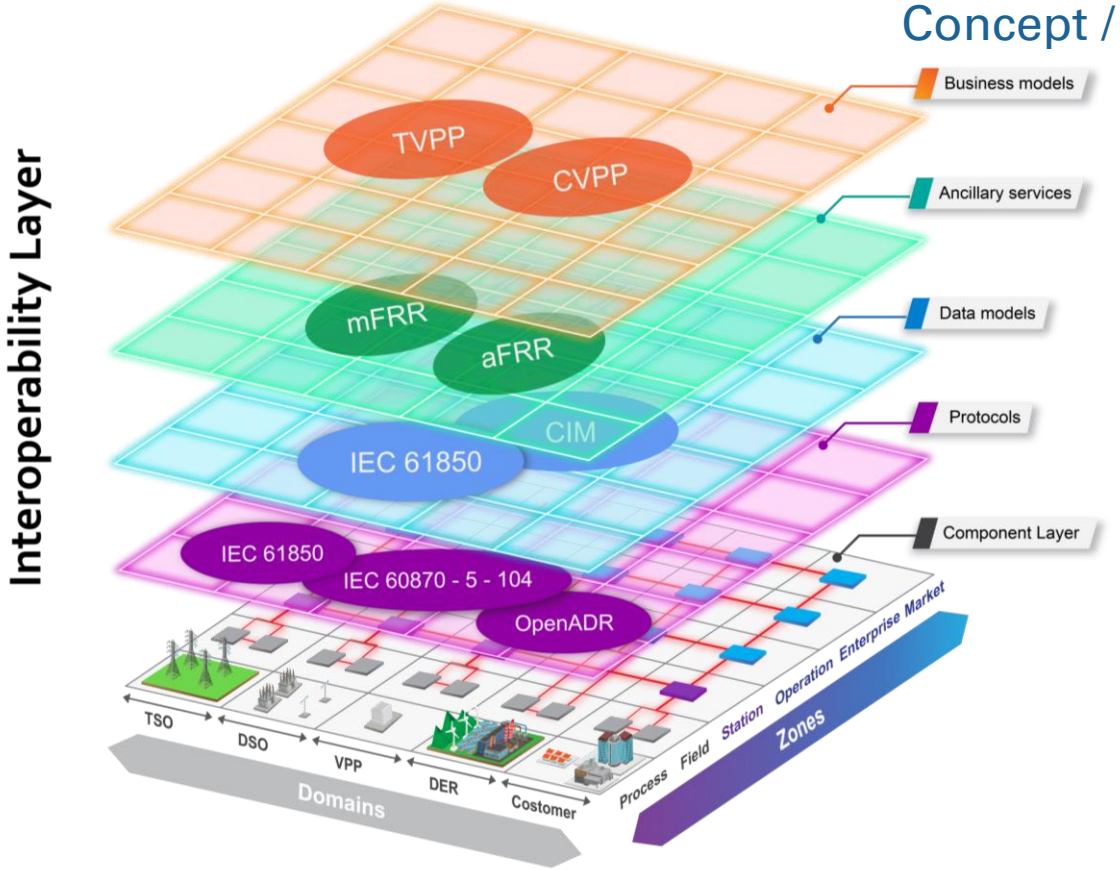
> *"A portfolio of DERs, which are connected by a control system based on information and communication technology (ICT). The VPP acts as a single visible entity in the power system, is always grid-tied and can be either static or dynamic."*

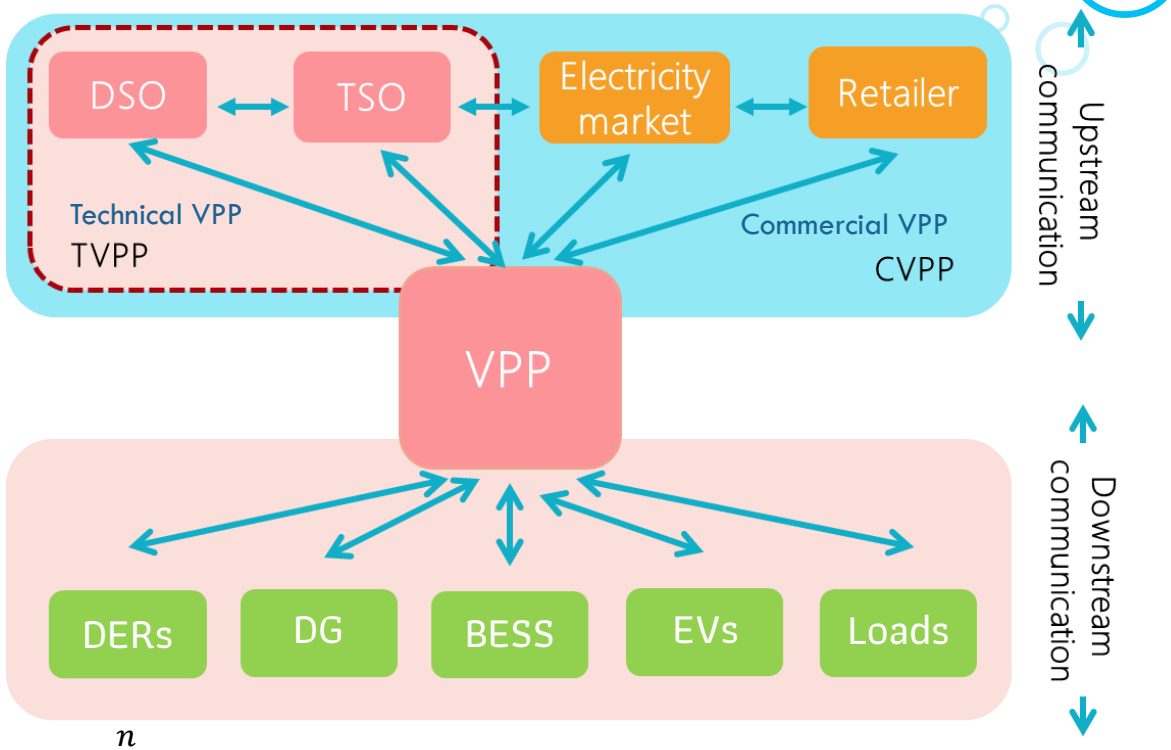


1) P. Asmus, *Electr. J.*, 23 (10), 2010 .
2) G. Plancke and A. Delnooz, Virtual power plants: Definition, applications and barriers to the implementation in the distribution system. 12th International Conference on the European Energy Market (EEM). 2015.

VPP DEFINITION/CONCEPTS

Concept / Architecture





$\sum_{i=1}^{n} P_{DER,i}(t)$: Aggregation of power on pool level for DERs

- New flexibility approaches based on DERs, ESS, and DR (negawatt) -> VPP
- To aggregate and control small-and medium scale DERs (hydro, wind, PV and other DG units: BESS, EV, etc.)
- To applies ICT, IoT and AI technologies
- To solve energy security problems in both the production, consumer and Prosumer.
- It controls them as one, like a single plant, a VPP via the same VPP Cloud Platform.

VPP is a new solution today,
-> essential <-
power infrastructure for tomorrow.

POLICY, MARKET, AND BUSINESS MODEL OF VPP

Business Model (BM) of VPP and trends

REASONS AND CONDITIONS OF VPP

Technical system:
- ICT
- SG
- SM
- RE Technologies
- Energy storage
- technologies of RE

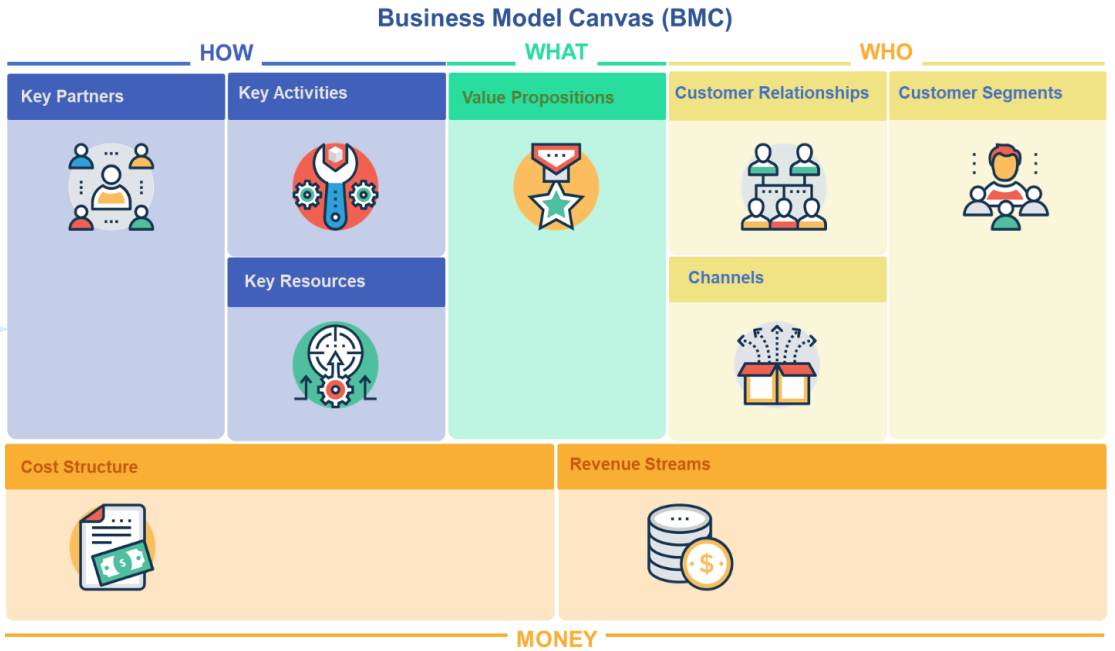
Economic System:
- Electricity market
- Local energy market
- DSM & DR
- Regionalization
- Economic cost

Legal System:
- Supporting RE
- Becoming prosumers
- Limiting GHGs emission

Social System:
- Changing behaviors of energy end-users
- Higher ecological awareness network cooperation
- Energy security need

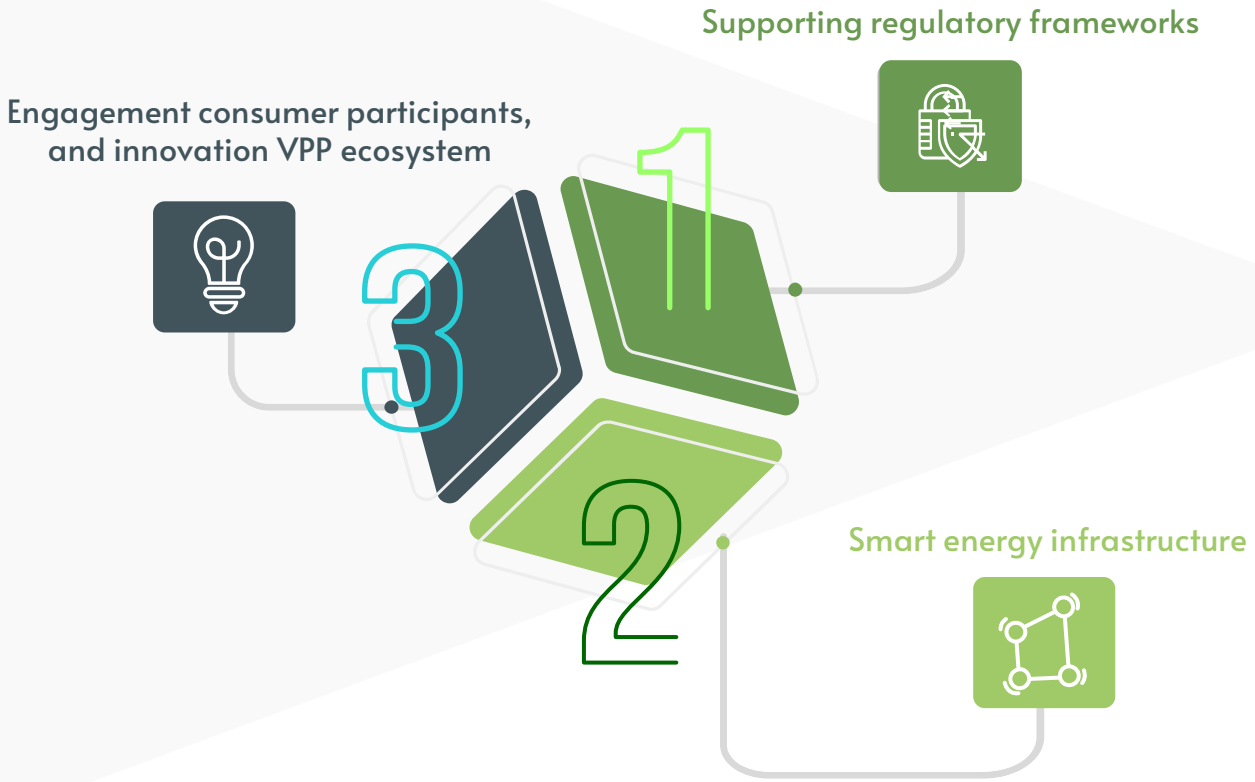
VPP

How to make money with VPP ?



POLICY, MARKET, AND BUSINESS MODEL OF VPP

The key enable for VPPs implementation into electricity markets



A guideline for achievement of VPP projects

01 Business Objectives

02 Prototype

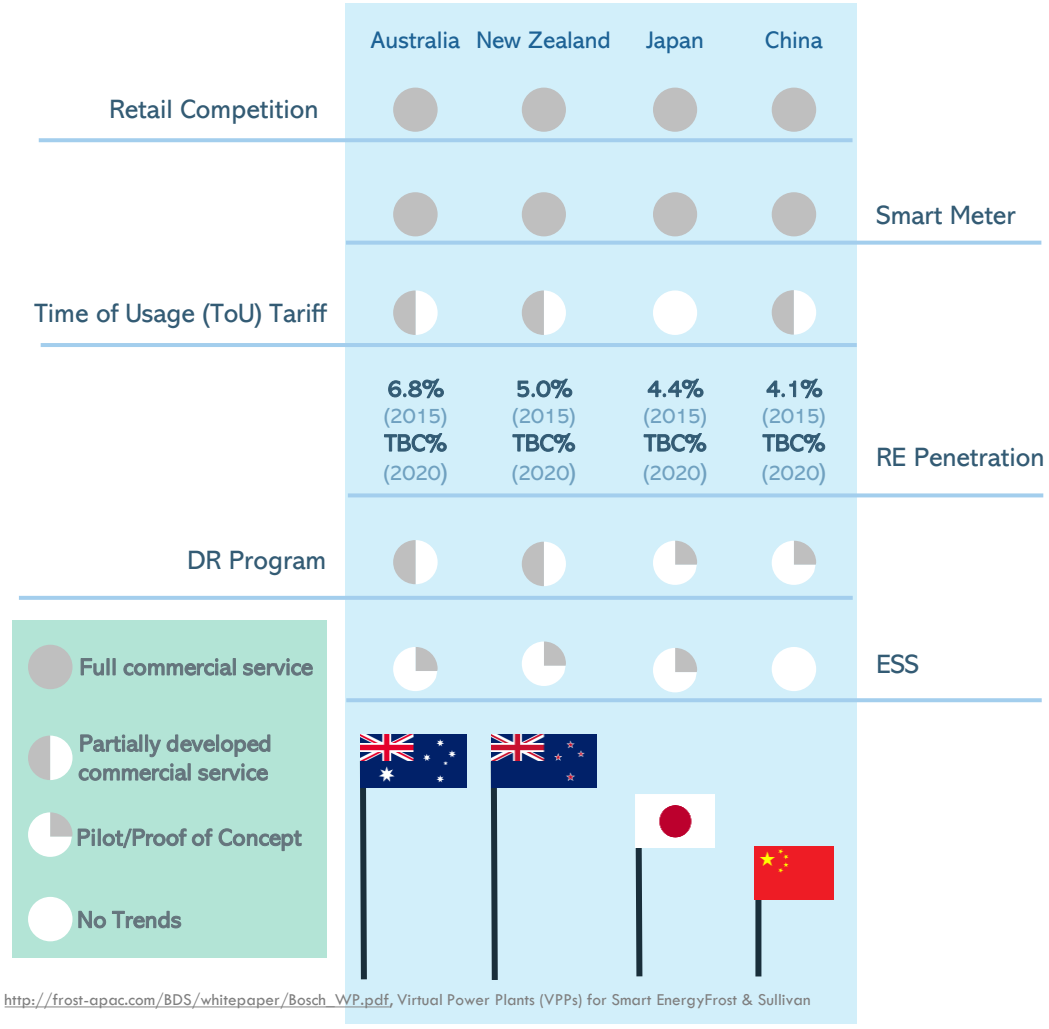
03 Validation

04 Scaling up

http://frost-apac.com/BDS/whitepaper/Bosch_WP.pdf, Virtual Power Plants (VPPs) for Smart Energy, Frost & Sullivan

POLICY, MARKET, AND BUSINESS MODEL OF VPP

Real cases and demonstration Projects of VPP



http://frost-apac.com/BDS/whitepaper/Bosch_WP.pdf, Virtual Power Plants (VPPs) for Smart EnergyFrost & Sullivan

Country	Company	Business outline	Feature
Germany	Next Kraftwerke	○ Aggregate DERs of biomass, CHP, DR, PV, wind, etc. to provide reserve capacity for balancing market and sell it on the spot market.	✓ Total number of generators: 3,820 ✓ VPP capacity: 2,452MW
Germany	Energy2Market	○ Aggregate generation by PV, wind, biomass, hydro etc. to sell the power on the spot electricity market and participate in the reserve market.	✓ Total number of generators: More than 3,000MW
UK	Statkraft energy & meteo	○ Fully commercial energy market VPP ○ Aggregate DR and emergency generators at customer's premise and participate in FCR, STOR :Short Term Operating Reserve, etc.	✓ 1 GW DERs ✓ Real time and trade power on the who lesale market
US	Edison, SunPower and Sunverge	○ Utility owner ship ○ Ancillary services, DR program ○ Capacity markets and wholesale markets.	✓ Approx. 300 homes ✓ 7-9 kW PV rooftop + 6/19.4 kWh Lion ✓ Targets: 1.8 MW, 4 MWh
US Vermont	GMP Tesla	○ Backup power ○ Peak leveling ○ Retailer electricity market	✓ ~ 2,000 households : PV+BESS ✓ 13 MW capacity of BESS ✓ Remote control ✓ Improving reliability for the customer
Australia	Tesla	○ Behind-the-meter (BTM) market ○ Responding to energy shortfalls ○ Frequency control ancillary services (FCAS) markets ○ Network support.	✓ ~ 3000 systems : PV+BESS ✓ To install 5 kW of PV and a 13.5 kWh BESS ✓ A significant opportunity of EV -> V2G (40 kWh)
Japan	Tohoku EPCO Next Kraftwerke	○ Energy market (ancillary, balancing, capacity, etc. ○ VPP demonstration project	Aggregation: ✓ Large scale DERs ✓ Demand site units ✓ Home resources (PV, heat pump, air conditioner, batteries etc.)
China	Jibei Electric Power ABB	○ VPP demonstration project: DR program in commercial district ○ To stabilize the VRE supply and load balance	✓ IOTIPS ✓ #1 = 26.5 MW and #2) 226 MW ✓ 12.4 million people Zhangjiakou, Qinh uangdao and Langfang

POLICY, MARKET, AND BUSINESS MODEL OF VPP

VPP MAKERS/PIONEERS

SMART GRID IN THAILAND

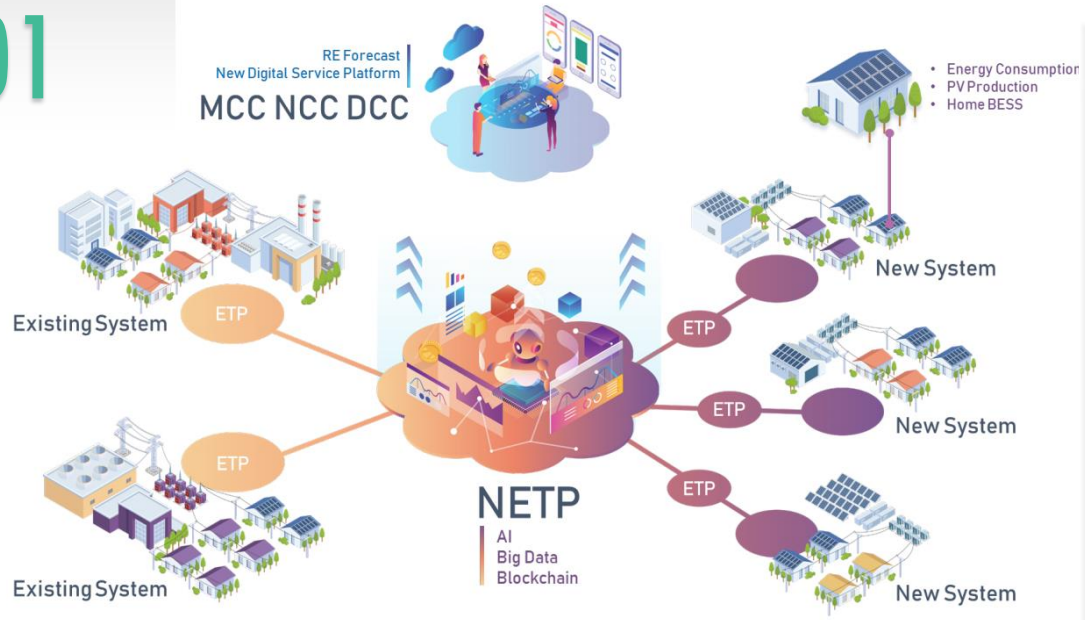
VPP in Thailand: P2P Pilot project

Thailand in need of “Energy 4.0”

NETP

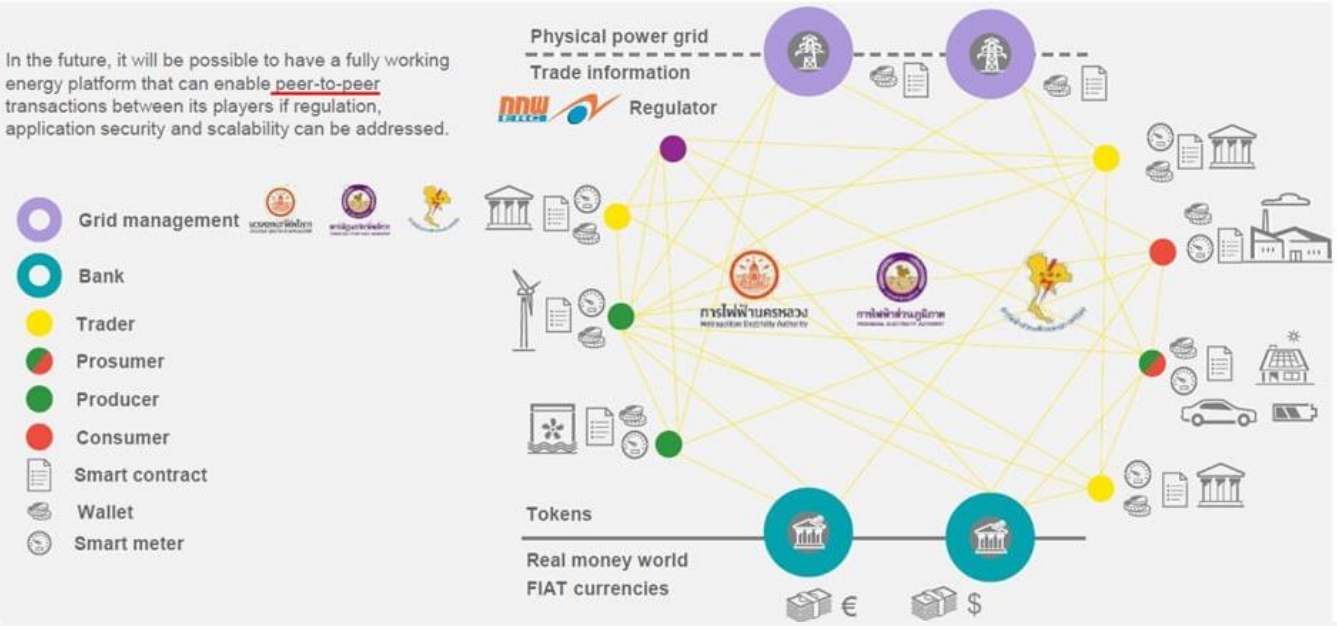
01

Collaboration of MEA PEA and EGAT



National Energy Trading Platform

In the future, it will be possible to have a fully working energy platform that can enable peer-to-peer transactions between its players if regulation, application security and scalability can be addressed.



02

Automated DR

VPP technology

สมาร์ทกริด ไทยแลนด์

Master Plan on Thailand’s Smart Grid Development 2015 – 2036

Middle Phase 2022-2031

VPP Pilot Project

Pillar	1	Demand Respond (DR)
Pillar	2	RE Forecast
Pillar	3	Micro grid–Prosumer/VPP (MG-VPP)
Pillar	4	Energy Storage System (ESS)
Pillar	5	Electric Vehicle (EV)

Data analysis : Delphi Technique

Summary : The questionnaires

Anonymity of Delphi participants:

"allows the participants to freely express their opinions without undue social pressures to conform from others in the group"

n = 22

Response (n) of the questionnaire

Data analysis : Delphi Technique

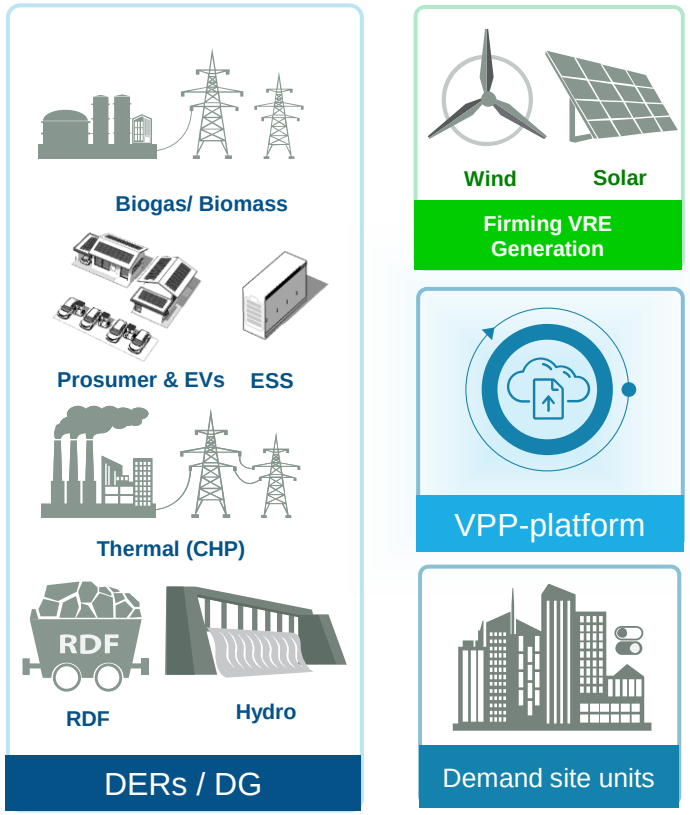
- Surveying status and direction of VPP policies in Thailand and foreign countries

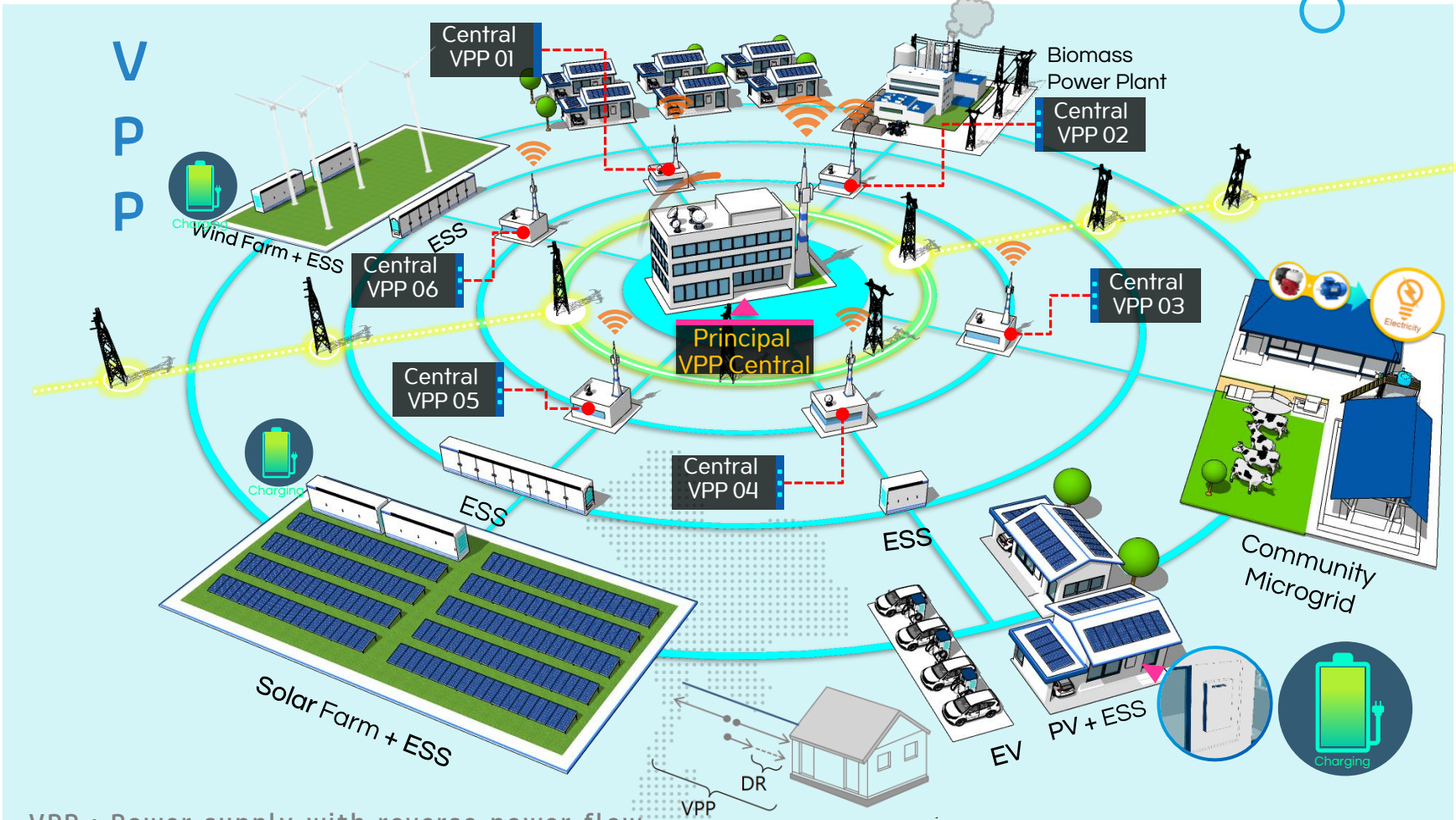
SURVEY FROM THE EXPERTS

- Government sector
- Utility sector
- International academic sector
- Private sector

WHAT IS AN APPROPRIATE VIRTUAL POWER PLANT IN THAILAND?

VPP technology





VPP : Power supply with reverse power flow

DR: Demand adjustment without reverse power flow

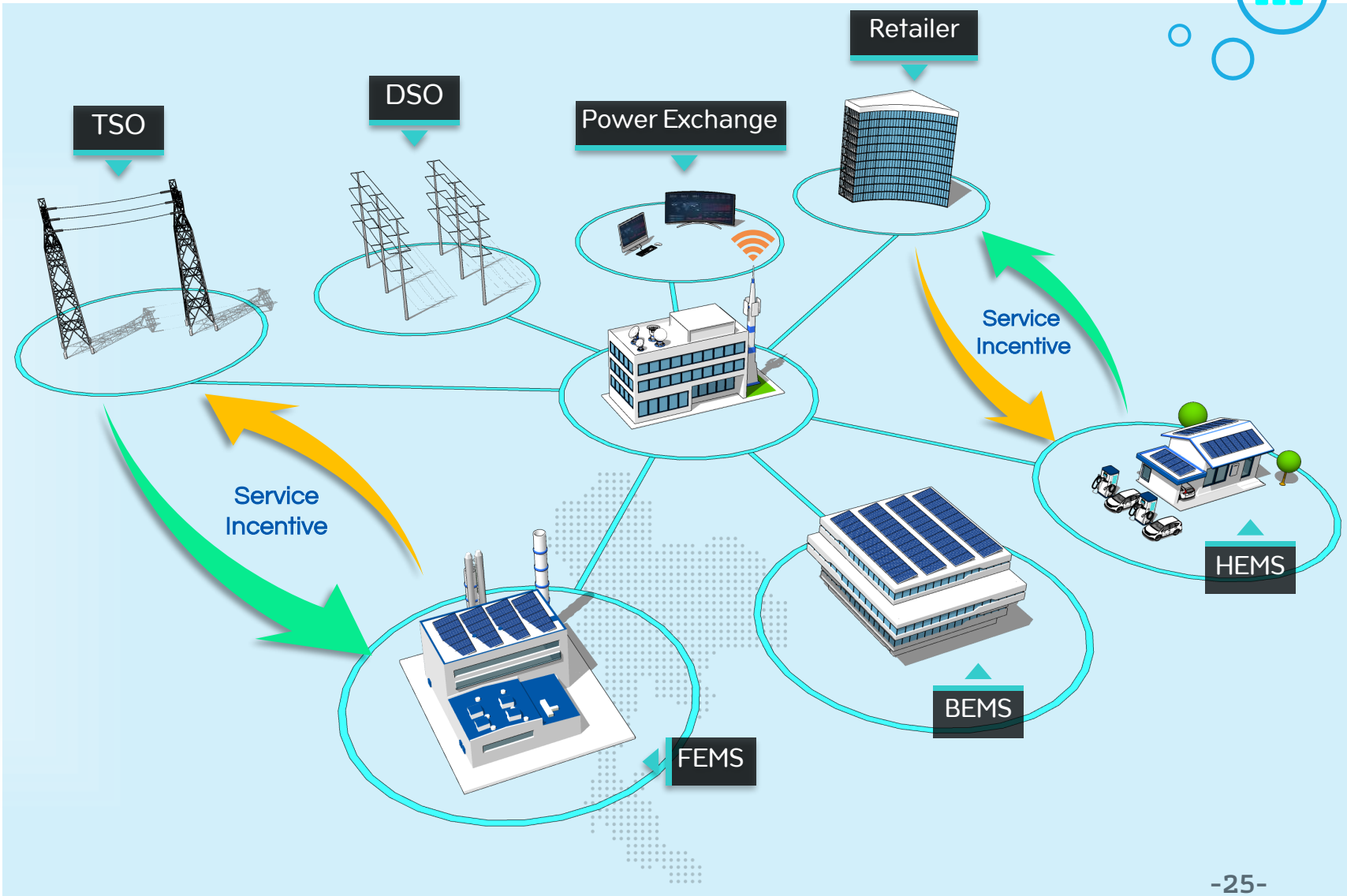
Part I

WHAT IS AN APPROPRIATE VIRTUAL POWER PLANT IN THAILAND?

VPP technology

INFRASTRUCTURE

- Resilience Electricity Infrastructure
- DERs
- ESS
- EV
- AMI / Smart Meter
- Information and Communication Technology (ICT)



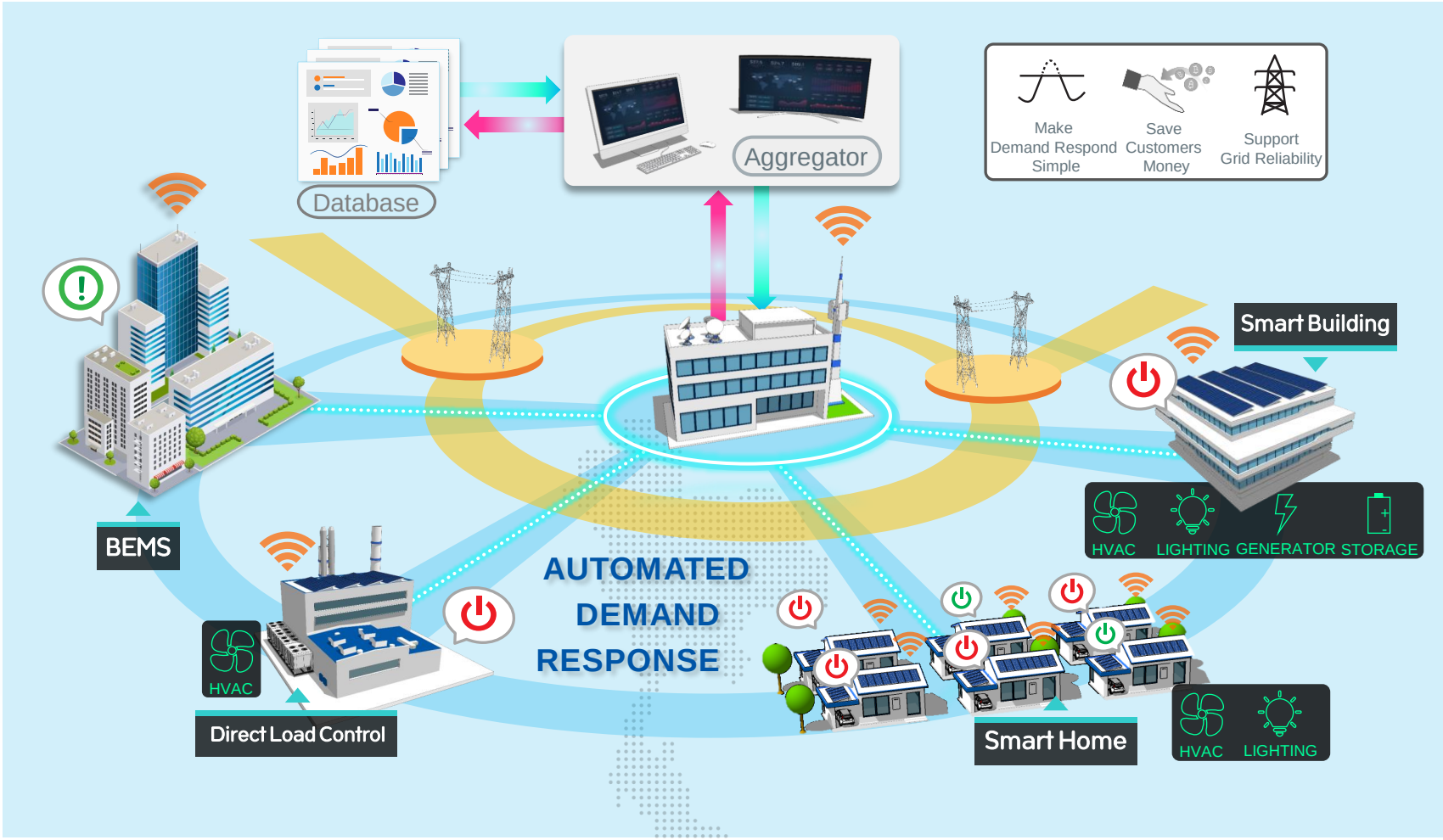
Part I

WHAT IS AN APPROPRIATE VIRTUAL POWER PLANT IN THAILAND?

VPP technology

DR Program

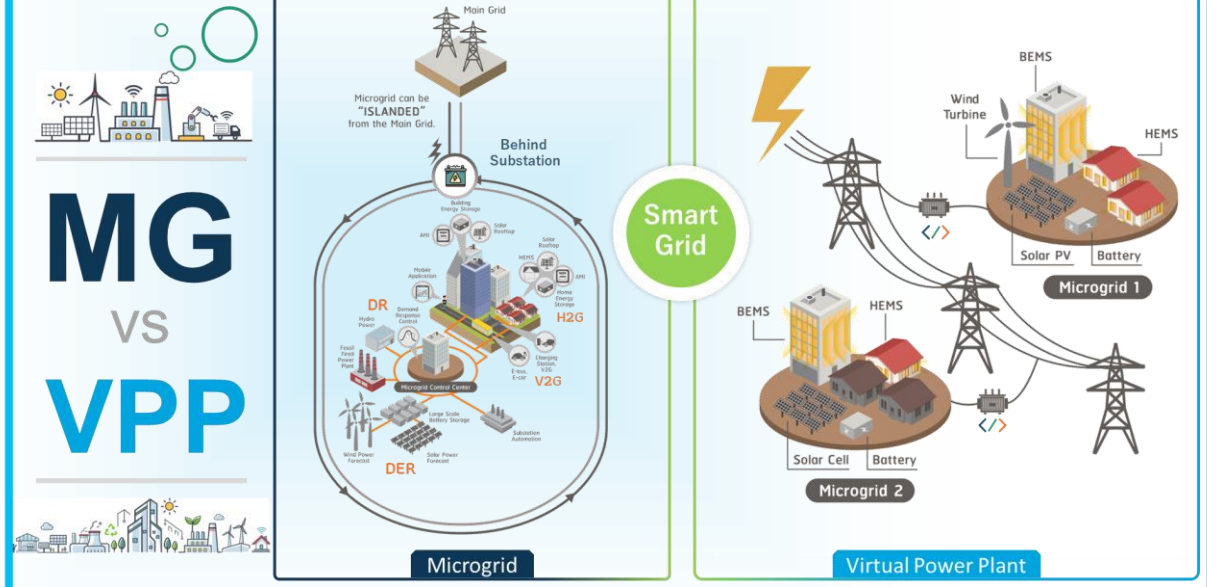
- reduce electricity consumption
- a negative electrical load or "negawatt" power
- The negawatt can be exchanged or traded within the VPP platform.
- VPP also delays construction of new power plant to support the peak. (peak plants)



Part I

WHAT IS AN APPROPRIATE VIRTUAL POWER PLANT IN THAILAND?

VPP technology



Part I

A. Microgrids and VPPs share some essential features like the ability to integrate demand response (DR), generation from distributed energy systems, and battery storage at the distribution level.

B. Micro-grids can be both grid-connected or off-grid systems, VPP's are always grid connect systems.

C. Microgrids usually require some levels of storage; however, the presence or absence of storage in VPPs is possible.

D. Microgrids are typically traded only in the form of retail distribution, while the VPPs can build a bridge to the wholesale market.

E. The VPP should minimize the obstacles to make electricity generation from microgrid systems connected to the grid and sell electricity to the power market.

WHAT INFRASTRUCTURE POLICIES ARE NEEDED?

Government sector

- promote resiliency in the existing electricity infrastructure
- promote DERs such as; Combined heat technology, Biomass energy, Biogas, Wind energy, Solar energy (using both PV and thermal systems), Small hydropower, Gas turbine power plants and Diesel power plants

Relevant authorities

- promote DERs
- promote and develop ESS technology
- promote the production and use of EV
- explore the electricity needs of consumers in order to define the VPP infrastructure
- promote the widespread use of AMI and Smart Meters

Relevant agencies

- promote a cybersecurity system.
- promote the efficiency of ICT infrastructure and networks (e.g., 5G technology).

Part II

HOW WILL THE ELECTRICITY MARKET BE DEVELOPED?

VPP Market

Relevant agencies roles

Interconnection

- ICT/Energy security system
- SG
- SM
- RET
- ESS

Grid code

- between the three power utilities
- efficient interconnection

VPP license

- to act as a producer
- the management of the public electric power

Liberalization

- power trading market/platform
- the rules
- safety standards of communication technology.

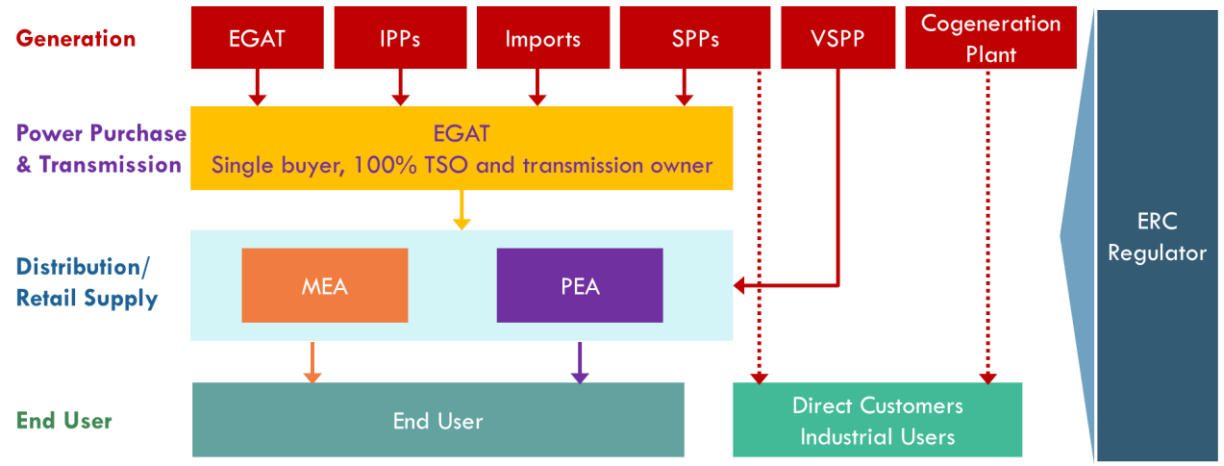
VPP project

- formulation and implementation of VPP
- Incentive to investor

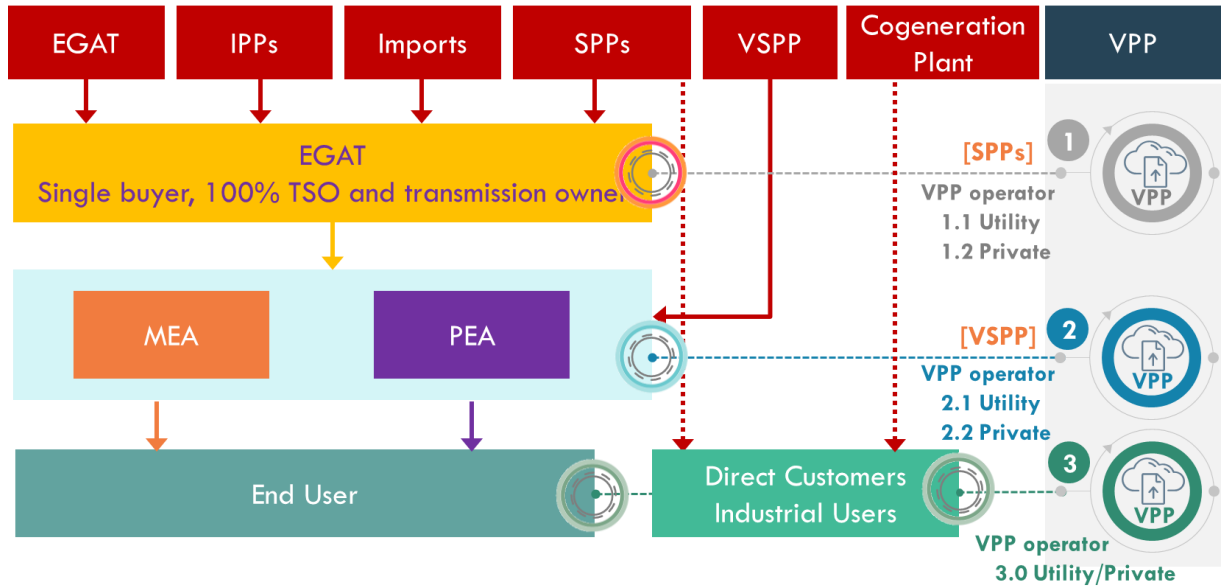
Part III

TENTATIVE VPP'S BUSINESS MODELS IN THAILAND

Power Industry Structure in Thailand "Enhanced Single Buyer (ESB) model"



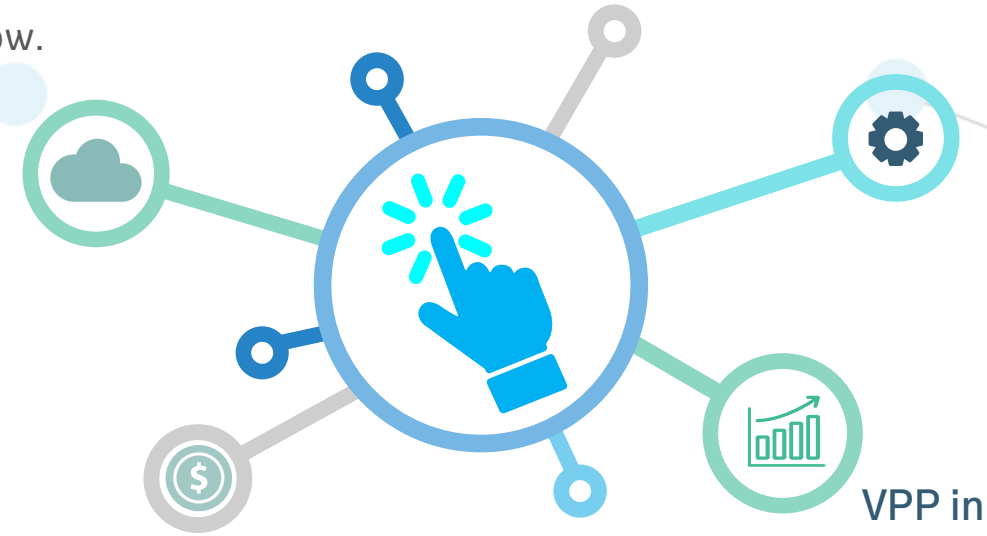
Thailand Tentative VPP's BM



4 CONCLUSION AND OPPORTUNITIES

1 VPP technology

VPP is a new solution today, essential power infrastructure for tomorrow.



2 Policy/Market trends

Electricity market structure is an insignificant influence on VPP implementation

3 VPP <–> Smart Grid

VPP cloud be implemented by integral all pillars in Master Plan on Thailand's Smart Grid Development 2015 – 2036.

4 VPP in Thailand

- TVPP could be considered.
- TSO/DSO can operate the VPP by himself to harvest the flexibility from DERs assets.
- Pilot project -> Trial/POC

4. CONCLUSION AND OPPORTUNITIES

What is an appropriate Virtual Power Plant in Thailand?

- Definition of VPP for Thailand
- DERs, DG, ESS, EV, EMS, ICT, Main Grid
- DR

What Infrastructure Policies are Needed?

- The efficiency of ICT
- A cybersecurity system.
- DERs, ESS, EV, AMI

How Will the Electricity Market be Developed?

- Interconnection of ICT, SG, SM, RET and EST and Energy security system
- Grid code
- licensing of VPP
- Incentive to investor
- A fair power exchange market

VPP Technology

Policy

Market

THANK YOU FOR YOUR ATTENTIONS

School of Renewable Energy and Smart Grid Technology
Naresuan university