The Challenges and Impacts of Digital Technology in Power System and VRE Integration

The 74th Indonesia National Electricity Day

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PJCI

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PLN’s Challenge ahead

- Influx of Intermittent Renewables.
- Grid is not flexible enough to cater VRE penetration.
- Deployment of battery storage system is slow, capacity will not be sufficient.
- PLN will be in the “defensive“ mode.
- Promise of Law 16/2016 and 23% RE penetration by 2025 is hard to be achieved.
- Who will be blamed if 23% @ 2025 is not achieved ?

Preparing for the challenge

- PLN will need to reposition itself to support Govt. RE commitment
- Need support from Energy NGOs
- PJCI can help mobilize the support
- PJCI can spread the understanding of what it needs to make a grid “flexible”
- Hence PJCI can be the outer defence and buffer to biz-environment dynamics

What is PJCI Identity ?

- System Operation – SCADA, AGC, EMS
- Computer based to AI based
- Support to RE, Stochastic approach to VRE
- Support to Industry 4.0, Mobility & Storage
- Promote Data-Base Analytics
- Support Demand Response

Paralel Path Between Industry 4.0 and Smart Grid

5D

DECENTRALIZATION

- Industry 4.0 is said to be a fundamental shift from 'centralised' to 'decentralised' manufacturing, focussing on highly specialised-and at times, 'on-demand' customisation-and low-volume production involving rapid prototyping.
- With the increasing penetration of Distributed Energy Generation, the existing power grid will have to adapt and transform into decentralised grid consist of many on-grid Microgrids

DIGITALIZATION

- Renewed emphasis on moving towards higher levels of energy efficiency in industrial processes as well. This, and far greater reliance on digitalisation, is likely to have bearing on long-term energy demand projections that presently do consider higher efficiency levels

DECARBONIZATION

- Smaller, decentralised manufacturing facilities-as opposed to the present-day necessity of having large and centralised ones to achieve economies of scale-will have implications on the quanta of energy consumed as also on the way it is consumed. And this is where the distributed and decentralised characteristics of renewable energy could be utilised most optimally.
- Electricity industry is currently facing transformation from fossil-based energy toward renewable energy. As intermittency is a major challenge to the grid, grid has to be redesign to allow a prompt response while maintaining an optimum cost.

DEMAND RESPONSE.

- Industry 4.0 requires the ability not only to obtain operational data, but also to develop necessary information and knowledge to predict and forecast the operation. Thus vast networks of IoT sensors are implemented for data gathering, while more compute and compact capability of data processing in low power modules are essential to CPS capability.
- Smart Grid requires Wide area monitoring systems, consist of arrays of PMU, smart meters network as well as vast IoT sensors to maintain power quality

DISRUPTIVE

- The building blocks of both, Industry 4.0 and energy transition, are mutually complementary. Both rely on innovative technological choices, decentralised approach, as well as disruptive business models.
- To really draw full benefits from such developments, it is imperative to create a nurturing environment that provides freedom to experiment, to innovate technologically and commercially. Regulatory oversight in such a scenario needs to be more of a guiding framework balancing out different interests. A holistic and advance strategic planning would be the key impetus for both, Industry 4.0 and energy transition.

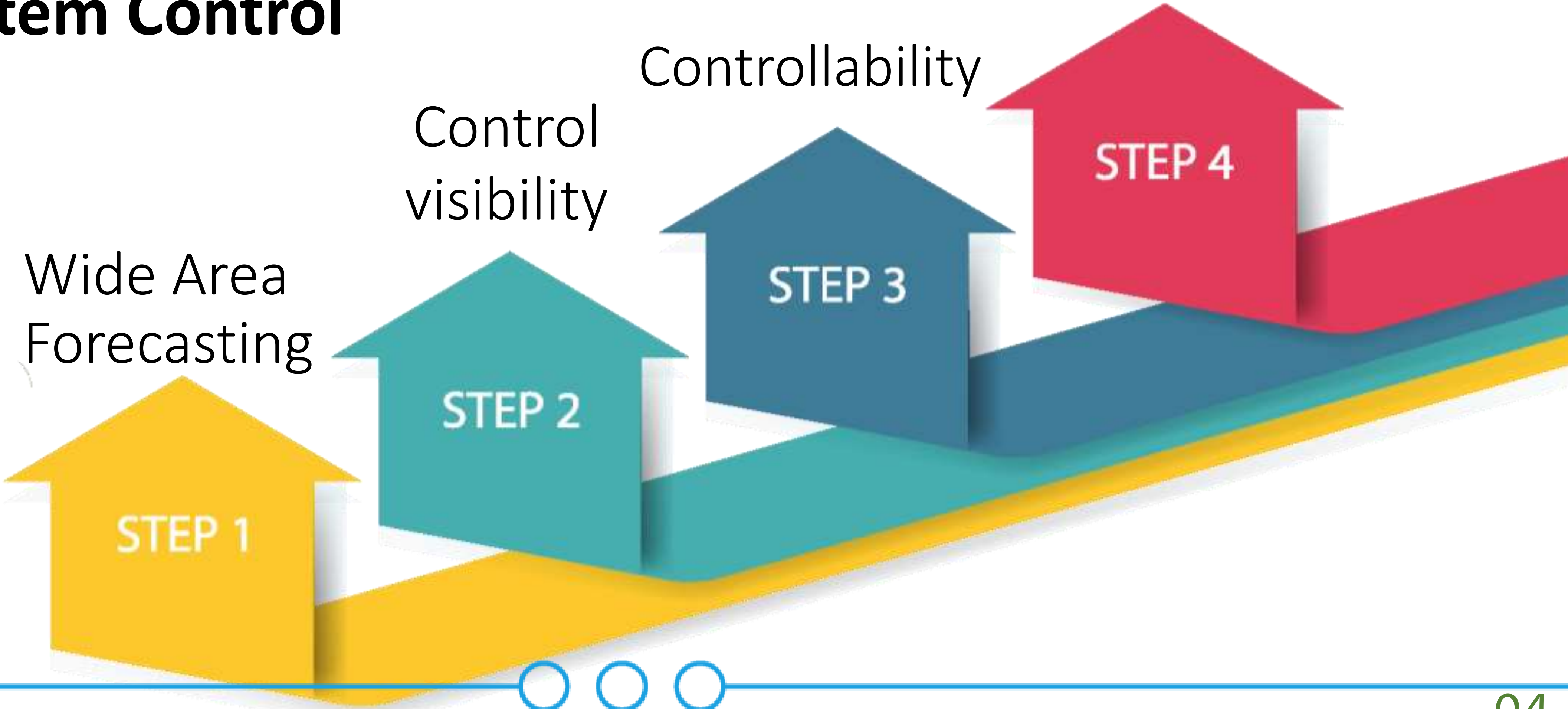
4 Stages of Smart System Control

Data Driven Analytics

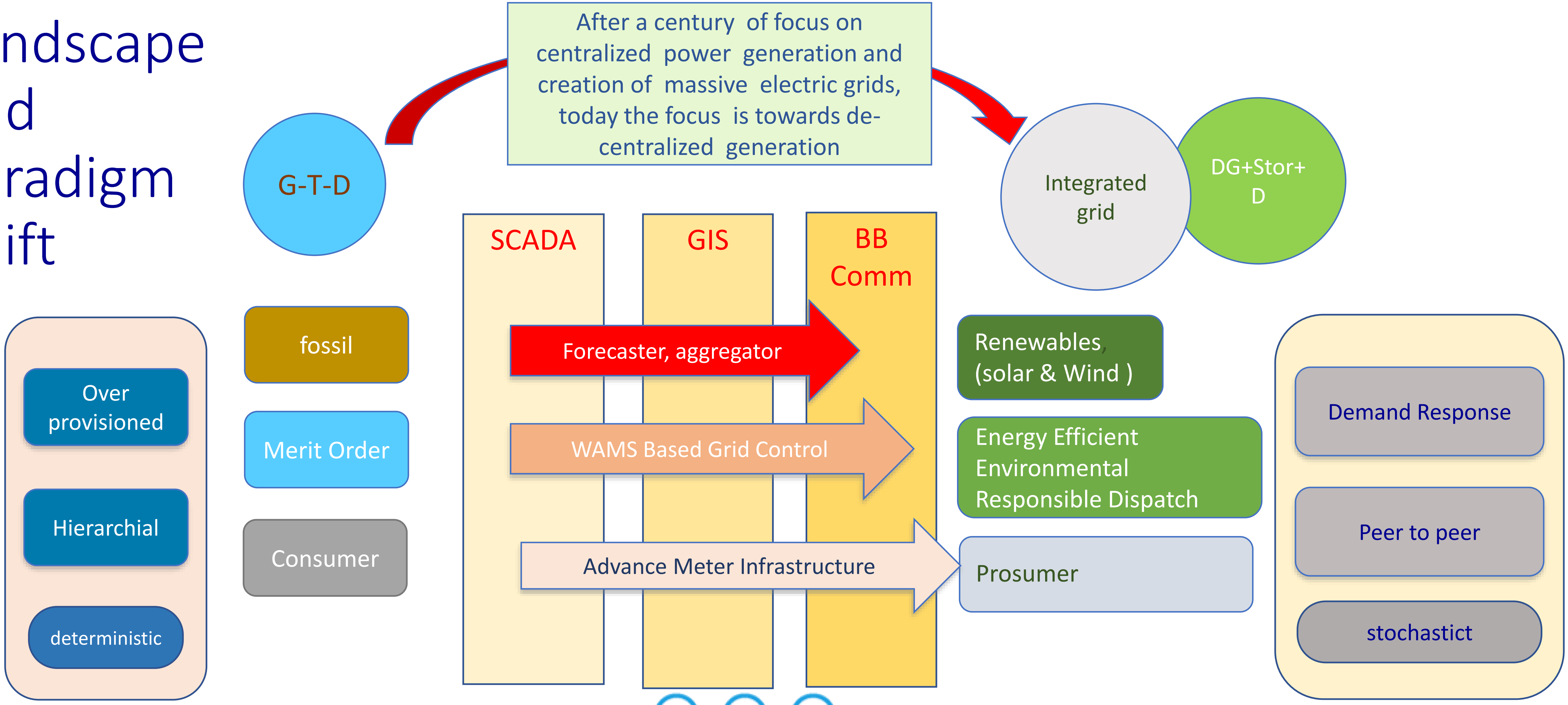
Controllability

Control visibility

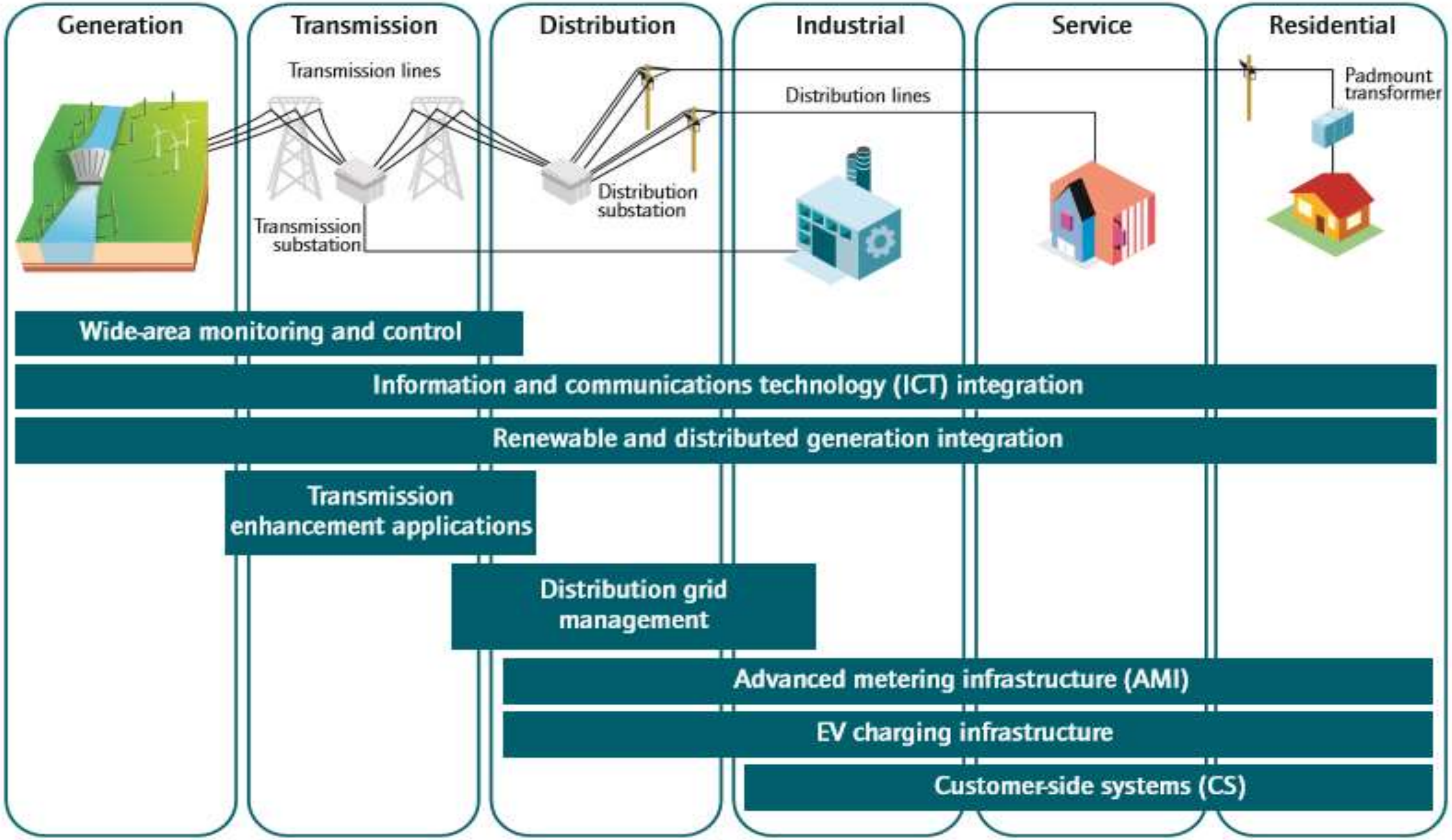
Wide Area Forecasting



Landscape and Paradigm Shift



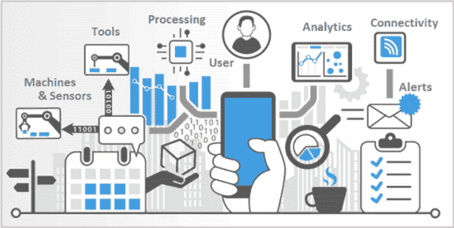
Global Technology Development



Industry 4.0 Digital Transformation





9 Technology Driver

1. Cybersecurity
2. Augmented Reality
3. Big Data & Analytic
4. Advanced Robotics
5. Additive Manufacturing
6. Industrial Internet
7. Cloud Computing
8. Horizontal & Vertical Integration
9. Simulation

Grid Smartening (1) Adding Advance Meter

Always Online

- Real time Monitoring & Control
  - Network Parameters
  - Customer Consumption

Remote Connect & Disconnect

- Early Realization of Dues
- Recovery Cost Saving

Cry Out Alarms

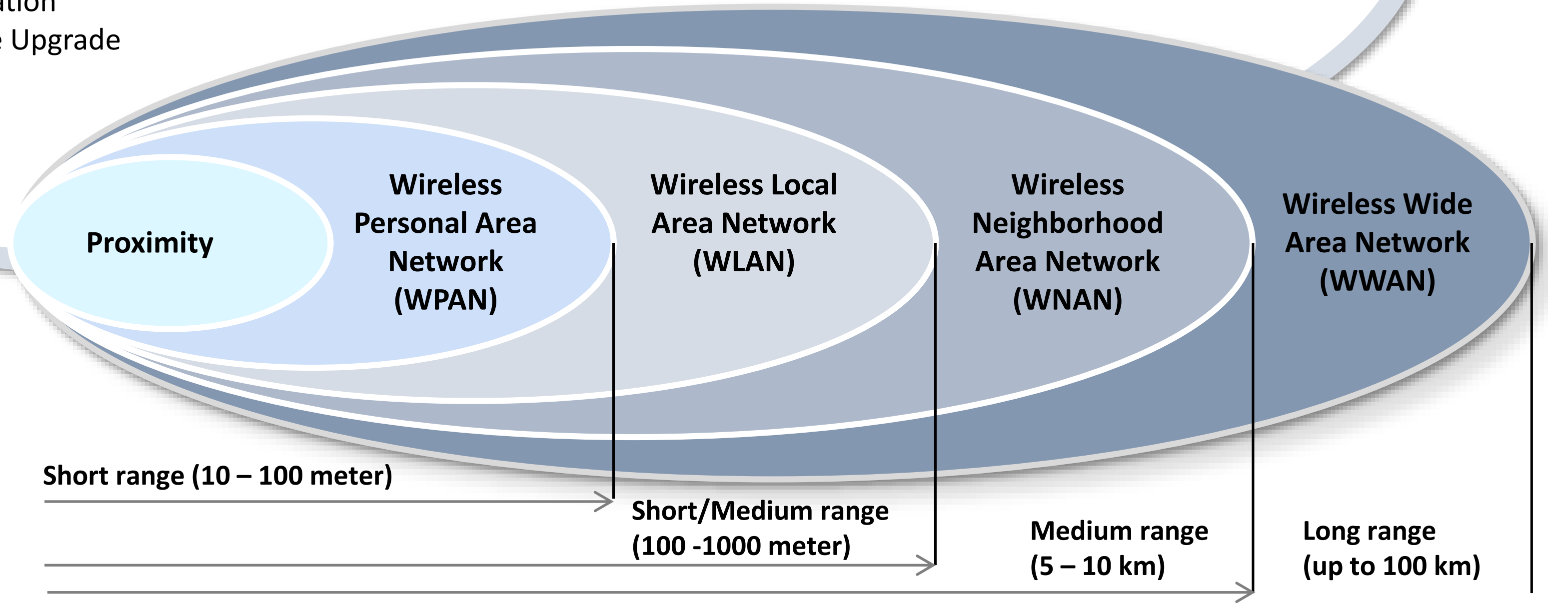
- Theft Prevention
- Loss Reduction

Remote Management

- Remote Configuration
- Remote Firmware Upgrade

- Standard Based
- Wi-Sun Alliance
- ZigBee Alliance
- LoRa Alliance
- IPSO (Internet Protocol for Smart Objects) Alliance
- Proprietary

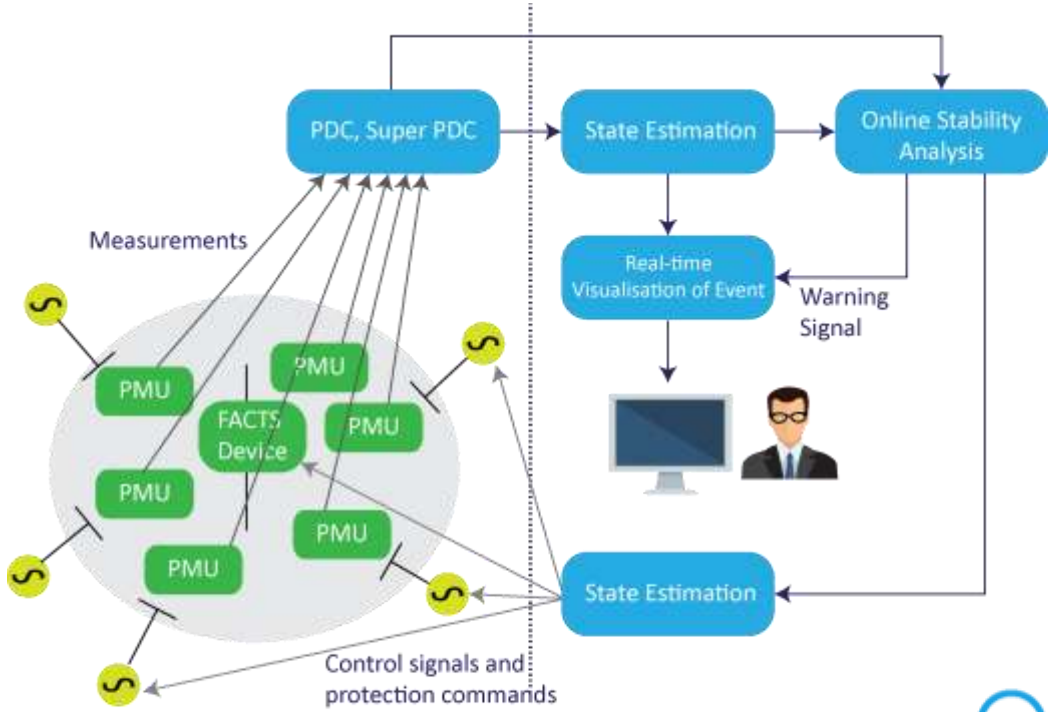
AMI AND COMMUNICATION



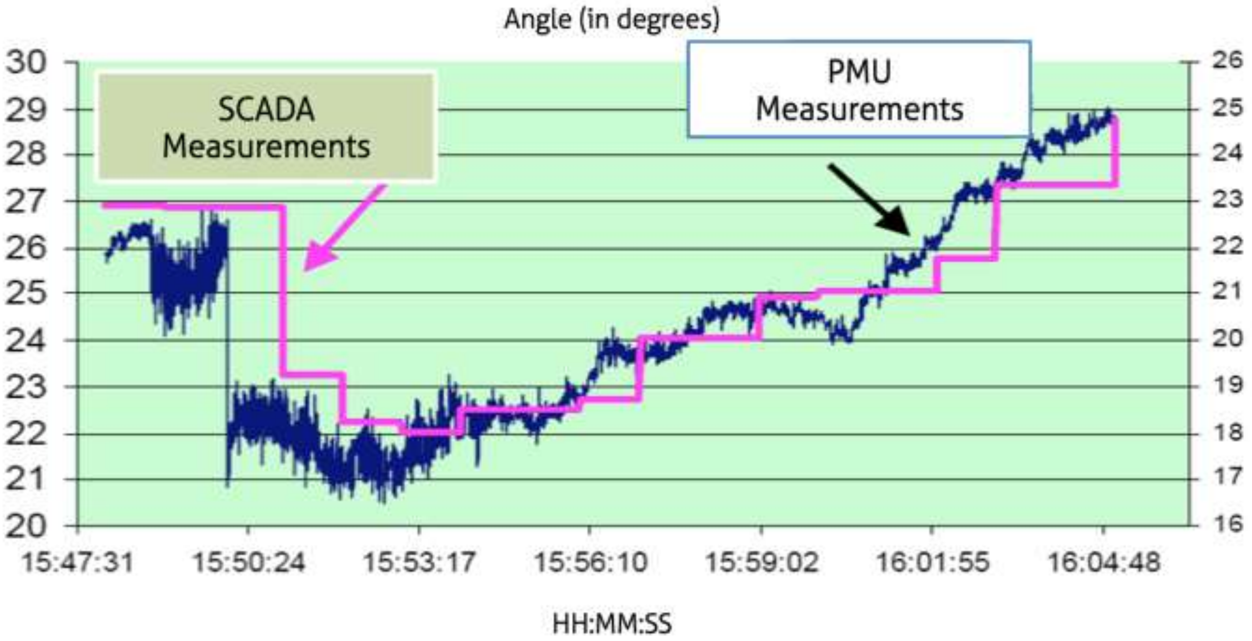
Grid Smartening (2)
WAMPACS – Wide area Monitoring and Control System

PMU resolution is much higher than SCADA

SIMPLIFIED REPRESENTATION OF WAMPAC



Higher Resolution (typically 25 samples/second compared to 4 to 10 seconds/sample of SCADA)



Effects from August 4, 2019 Blackout

- Direct and indirect damage or loss for PT PLN and customer. All together is a national economic loss and could lead to social or politic damage
- Telecommunication, transportation and financial service is interrupted as well as food storage and clean water
- (intangible damage = decreased in sense of security and credibility towards the government from public need to be addressed

Four Stages of Electricity Reliabilty

- Phase I : Electricity availability --- Indicated by Electrification Ratio
- Phase II : Reliability --- Indicated by SAIDI & SAIFI (System Average Interruption Duration Index & System Average Frequency Index)
- Phase III : Service Quality --- Indicated by Service Level Agreement involving tolerance band of frequency, voltage deviation/flicker and Allowable total harmocic distortion
- Phase IV : Resiliency

4 Pillars of Efforts to Achieve Resilient Electrical Systems

- **Grid Hardening**; (Development of new network, Re-conductoring, Improvement of Substation capacity and transformer
- **Grid Smartening**; Effort to improve electricity network intelligence through the addition of sensors, short data collection interval and data latency of data delivery, improvement of system operator visibility and controllability)
- **Distributing Generator** ; In accordance with the characteristic of renewable energy. Generally in small or medium capacity and distributed at the required locations.
- **Responsive Demand** ; In line with Indonesia’s Law of Energy, Development of clusters that capable to meet its own power requirement particularly during emergency condition should be implemented in bottom – up scheme to ensure efficient and massive development)

CAUTIONS! GRID SMARTENING INCREASE ATTACK VECTORS

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Approach for the Development of Electricity Infrastructure in Rural and Remote Areas

APPROACH METHOD

Government Model

- APBN utilization (including DAK and Village funds.
- Construction of off-grid facilities (free or paid).
- Top down approach.

- Shot term perspective.
- Inability to reinvest.
- Vulnerable to infiltration.

TNPK Model

- Encourage CSR raising.
- Construction of off-grid (solar panel).
- Top down approach.

- Inability to reinvest.
- More towards the utilization of other funding resources.

IBK Model

- Government and non-government financing (5-p / pro poor PPP).
- Off & on-grid facility development (paid) – RE
- Encourages community participation.

- Relatively sustainable than others.
- Lack of compliance with rules
- Vulnerable to infiltration.

"Program Indonesia Terang" Model Plan

- APBN utilization.
- Construction of off-grid facilities (paid) – RE
- Top down approach.

- Not implemented yet.

Source: BAPENAS

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