Deploying a Smart Grid in Indonesia: Challenges and Opportunities

Japan RE Invest Indonesia 2022

16 June 2022

Mechanical Engineering: Graduate School of Engineering

Institute of Industrial Science, The University of Tokyo

epi.iis.u-tokyo.ac.jp

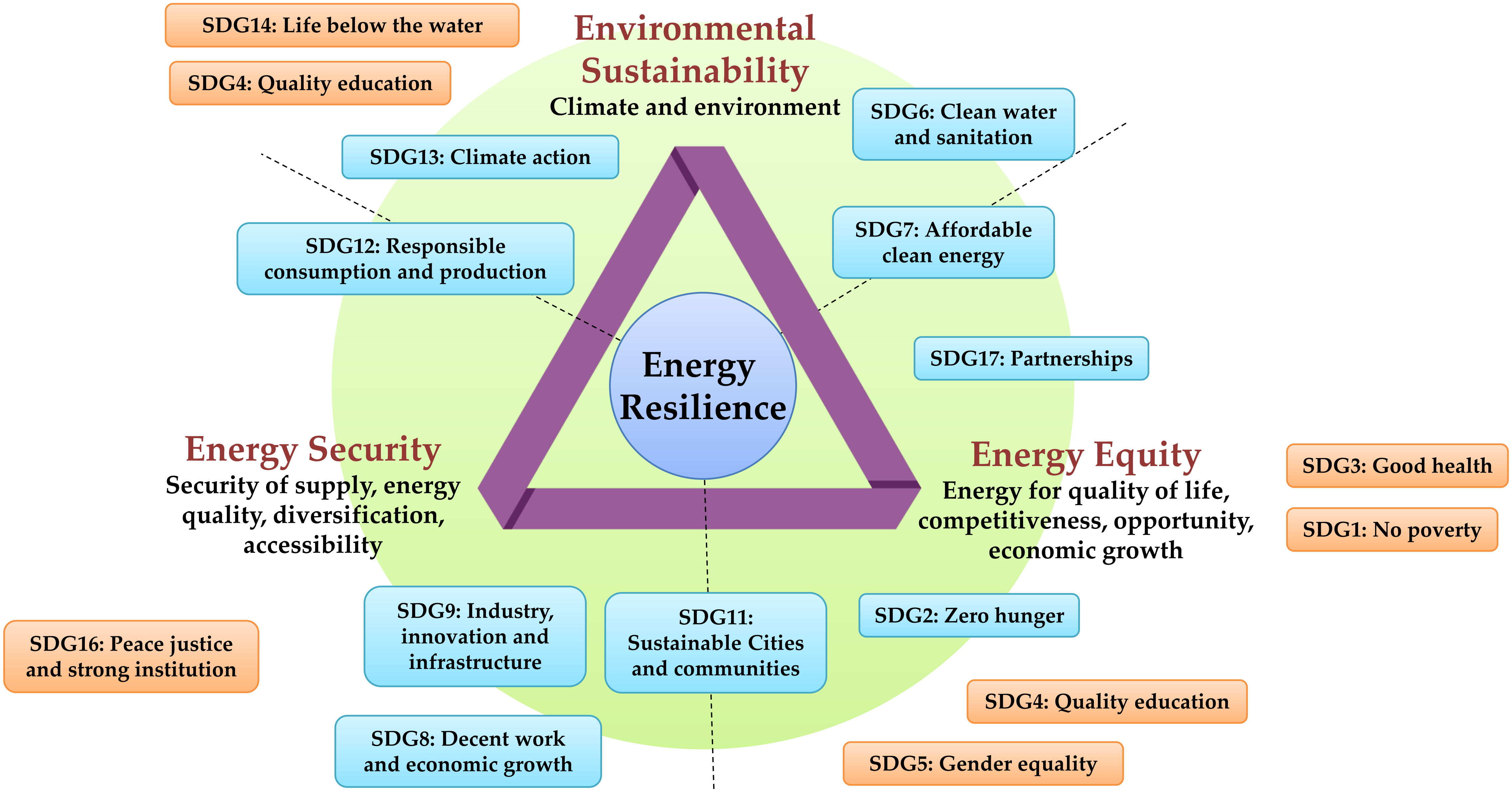
Muhammad Aziz

Assoc. Professor

東京大学 THE UNIVERSITY OF TOKYO

東京大学生産技術研究所 Institute of Industrial Science, The University of Tokyo

Energy Sustainability: Energy Triangle



Smart Energy Systems

東京大学 THE UNIVERSITY OF TOKYO

An approach in which **smart electricity, thermal and gas** grids are combined with **storage technologies** and coordinated to identify **synergies** between them in order to achieve an **optimal solution** for each individual sector as well as for the overall energy system

Smart electricity grids

Connects flexible electricity demands such as heat pumps and electric vehicles to the intermittent renewable resources such as wind and solar power

Smart thermal grids

connect the electricity and heating sectors. This enables the utilization of thermal storage for creating additional flexibility and the recycling of heat losses in the energy system

Smart gas grid

connect the electricity, heating, and transport sectors. This enables the utilization of gas storage for creating additional flexibility. If the gas is refined to a liquid fuel, then liquid fuel storages can also be utilized

Lund H, Ostergaard PA, Connolly D, Mathiesen BV. Smart energy and smart energy systems. Energy 137 (2017) 556-565

DX in Society 5 = Big Data + AI + 5G

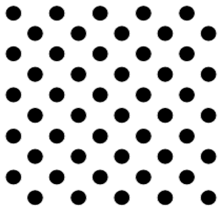
東京大学
THE UNIVERSITY OF TOKYO

Big Data is not 'just' data, there are a few new considerations

Big Data: Volume, Velocity, Variety, Veracity

Open Data: Visibility, Value

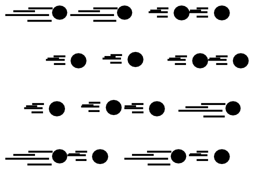
Volume



Data at Rest

Terabytes to exabytes of existing data to process

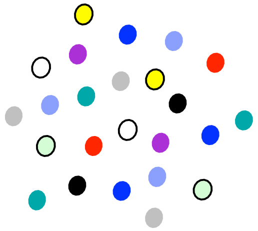
Velocity



Data in Motion

Streaming data, milliseconds to seconds to respond

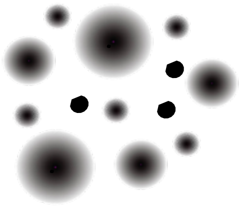
Variety



Data in Many Forms

Structured, unstructured, text, multimedia

Veracity



Data in Doubt

Uncertainty due to data inconsistency & incompleteness, ambiguities, latency, deception, model approximations

Visibility

Data in the Open

Open data is generally open to anyone. Which raises issues of privacy. Security and provenance

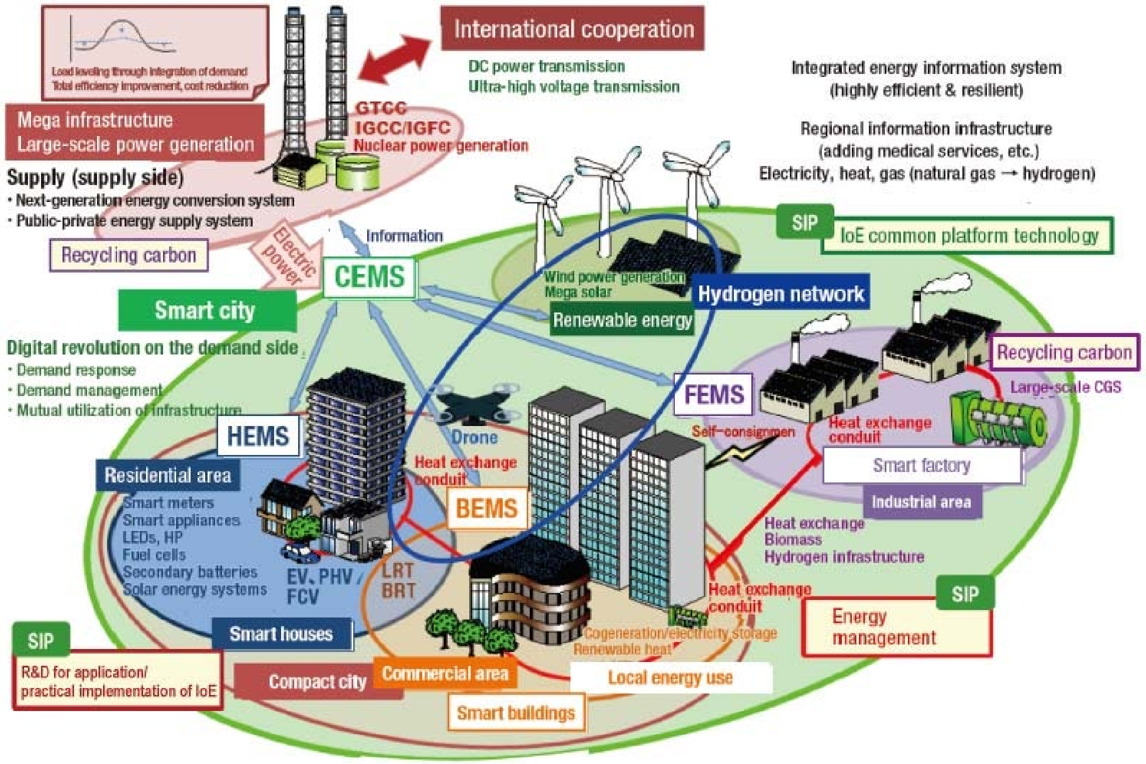
Value

Data of Many Values

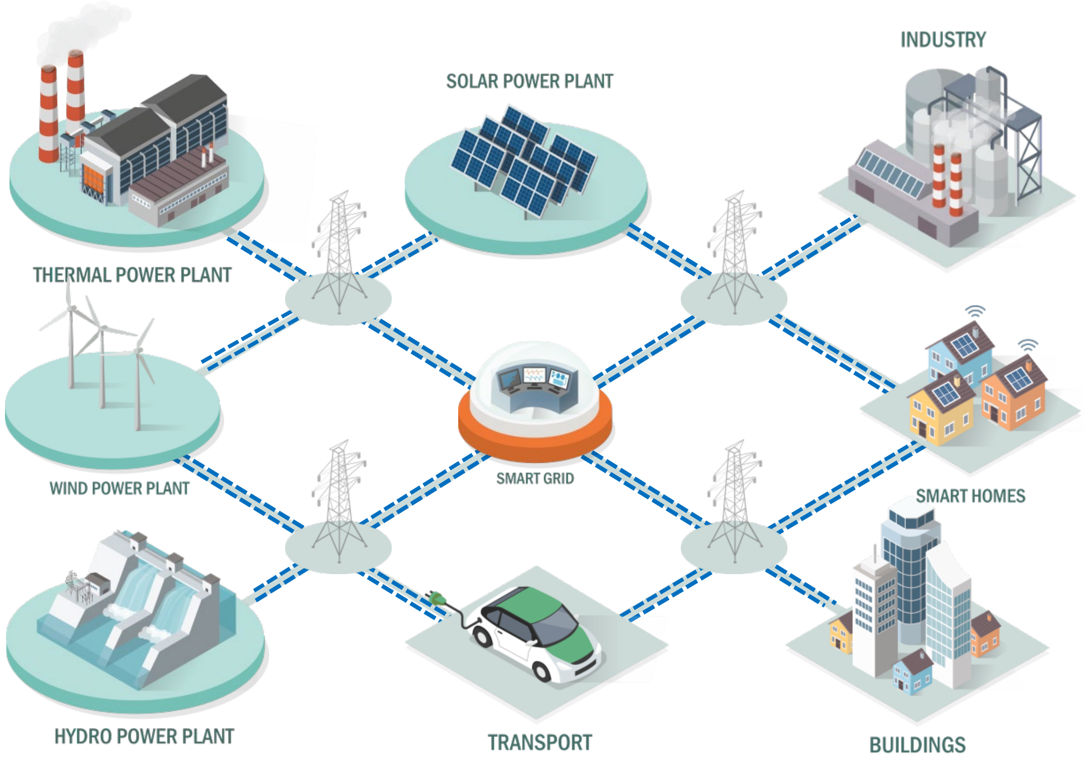
Large range of data values from free (data philanthropy to high value monetization)

Digital Transformation in Energy Sector

Digital technologies enable a multi-directional and highly integrated energy system placing cities in the forefront of decarbonising our societies as a whole



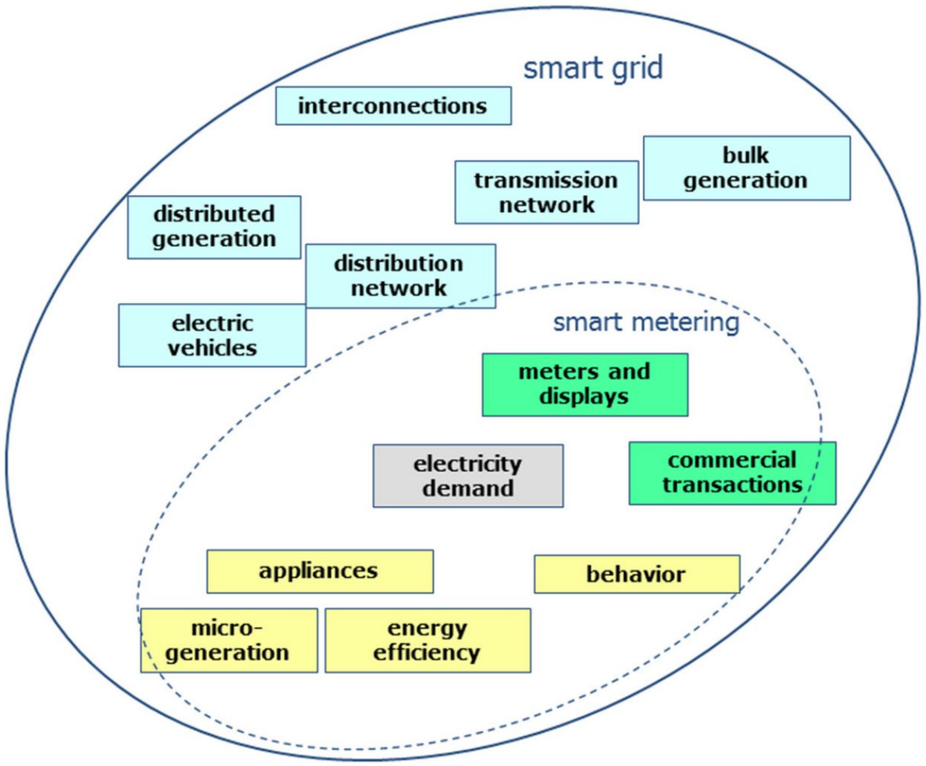
Shared information (big data) throughout the stakeholders



Example of integrated connection with smart grid system

Smart Grid Transition

- The need for gradual evolution of the distribution networks from a passive structure to an active one (bidirectional)
- Smartening the grid (software and hardware), smartening the generators (from *just being connected* to *integrated*), and smartening the load (awareness and active participation)



Elements in smart grid

Comparison between conventional and smart grid systems

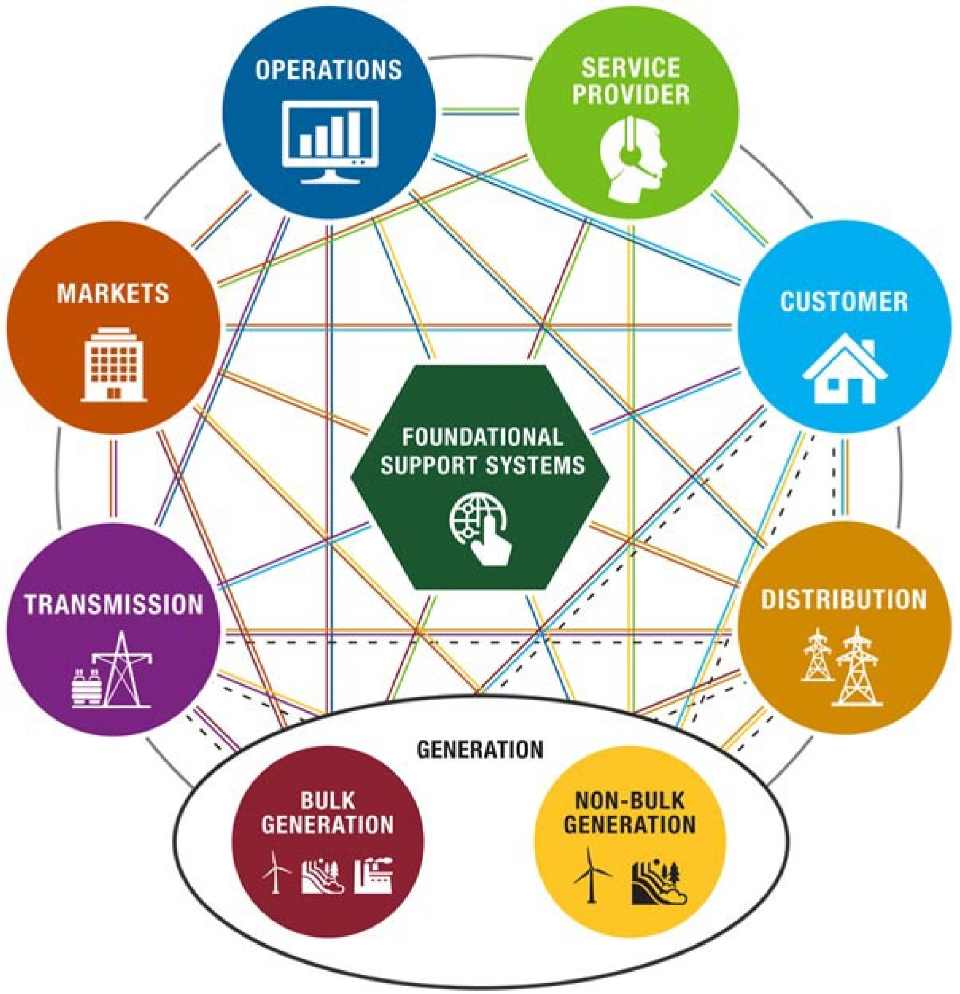
Technical Issue	BAU Distribution Network	Smart Grids (Active distribution networks)
Voltage rise/drop	• Limits/bands for demand and generation connection/operation • Generation tripping • Capacitor banks	• Coordinated volt-var control • Static var compensators • Coordinated dispatch of DER • On-line reconfiguration
Hosting Capacity	• Network reinforcement (e.g., lines/transformers)	• Coordinated dispatch of DER • On-line reconfiguration
Reactive Power Support	• Dependency on transmission network • Capacitor banks • Limits/bands for demand and generation connection/operation	• Coordinated volt-var control • Static var compensators • Coordinated reactive power dispatch of DER
Protection	• Adjustment of protection settings • New protection elements • Limits for generation connection • Fault ride through specifications for generation	• On-line reconfiguration • Dynamic protection settings
Ageing	• Strict network designs specifications based on technical and economic analyses	• Asset condition monitoring

Smart Electricity Grid

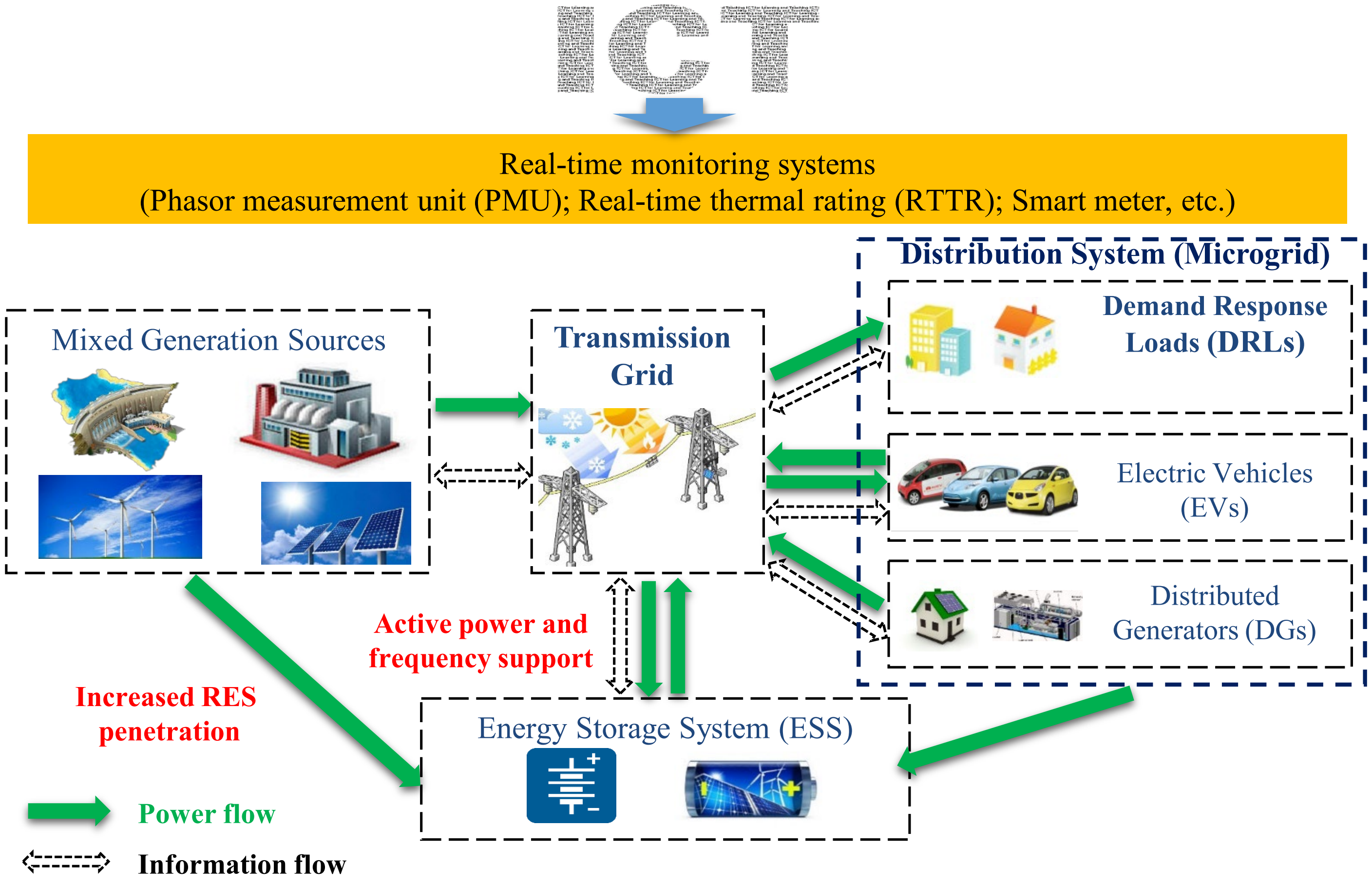
Electricity network using **digital** and other **advanced technologies** to monitor and **manage the transport of electricity** from all generation sources.

Key Characteristics

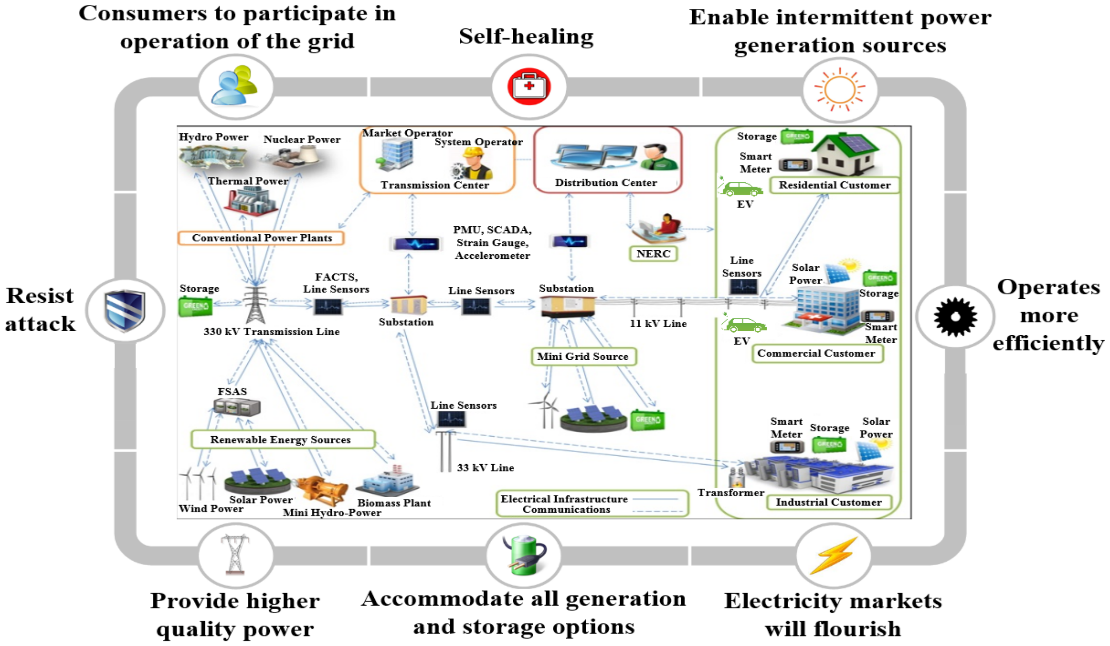
- Uses information technologies to improve how electricity travels from power plants to consumers
- Allows consumers to interact with the grid
- Integrates new and improved technologies into the operation of the grid
- Self healing: grid detects, analyzes, responds,…
- Provides power quality to consumer and industry
- Accommodates demand responds, combined heat and power, wind, PV, and end-use efficiency
- Transform the power sector into a secure, adaptive, sustainable and digitally



Smart Grid



Coverage of smart grid

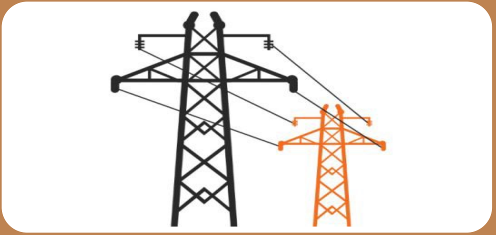


Concept of smart electricity
Source: Velankani Communications

Indonesian Grid Problems

Generation

- High dependencies on fossil fuels, low total efficiency, high CO2 emission (0.8 t-CO2/MWh)
- Demand-driven,
- Quantity oriented and minimum attention on quality services, limited balancing resources/capacities
- Low predictability (both generation and demand)

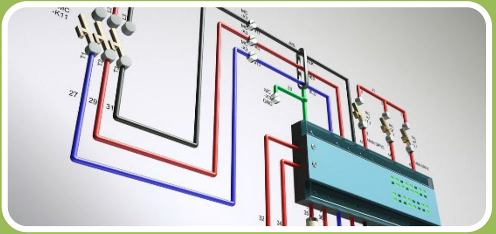


Transmission/Distribution

- No/minimum energy storage
- Separated generation and consumption
- No national (and international) integrated grid
- Congested electrical grid

Consumption

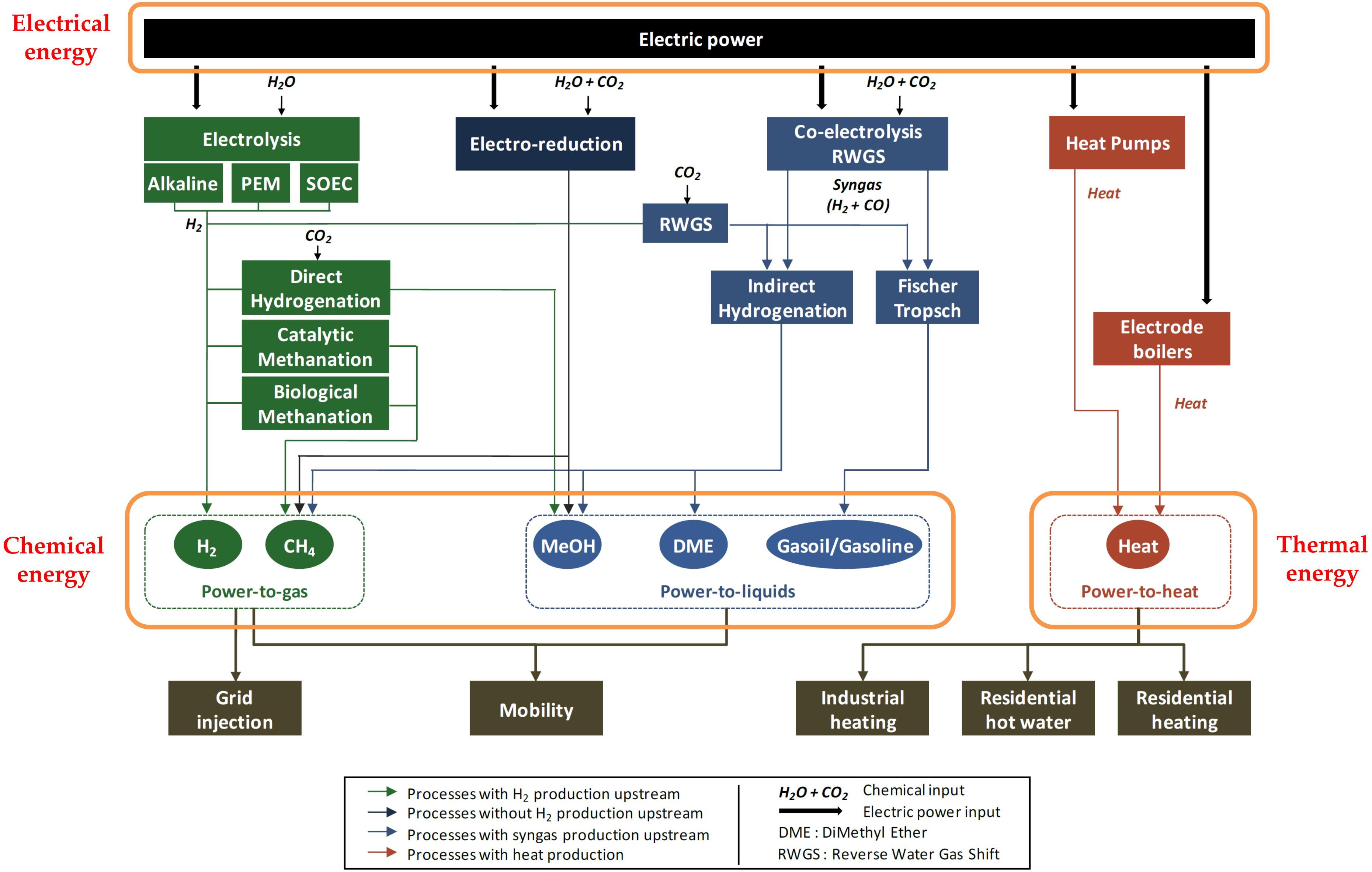
- Low awareness, responsibility, and ownership
- Uni-directional (no active participation)
- Large consumption gap and lifestyle
- No smart metering system (low capabilities on monitoring, visualization, data collection, and prediction)



Systems

- Closed market, no profit distribution, unclear mechanism and regulation
- Unclear grand scenario for future
- Minimum transparency, difficult to access contract, regulation, guarantee, and assistance
- Low self healing capability, prone to disaster,

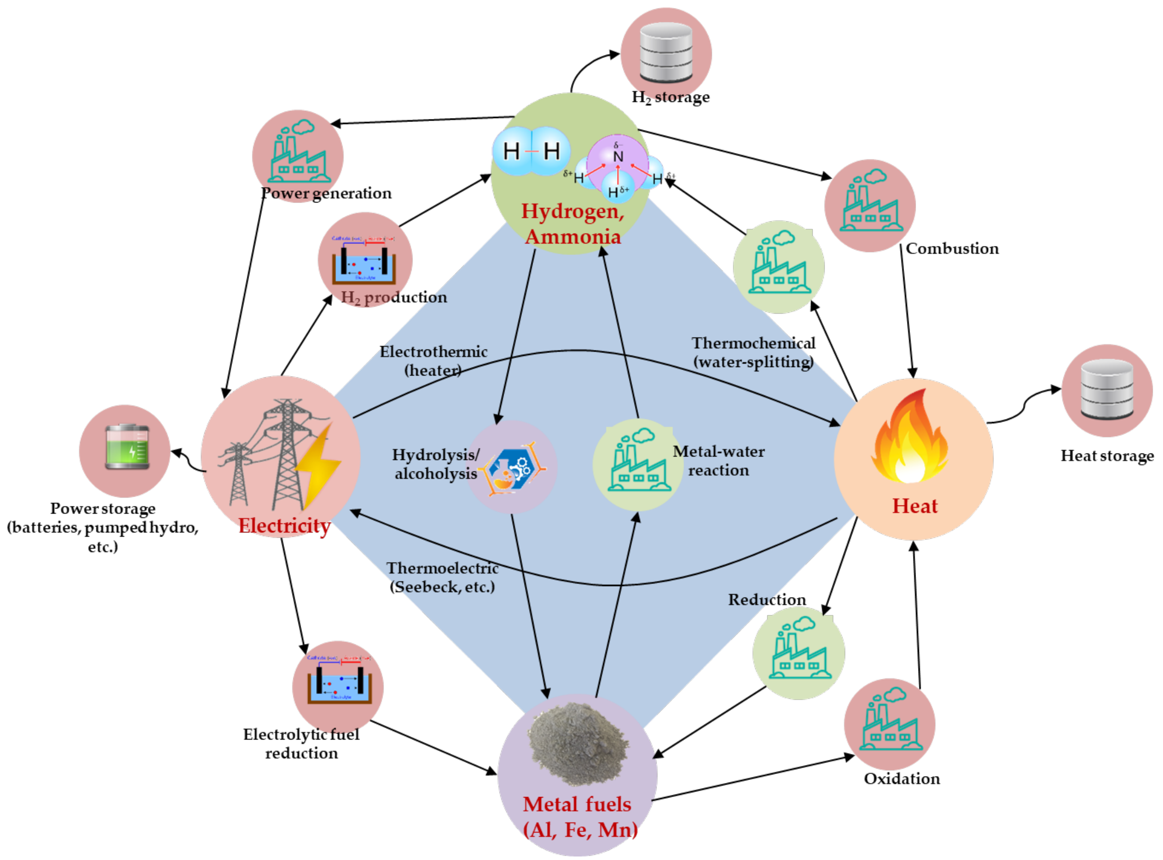
Mutual Conversion of Secondary Energy Sources



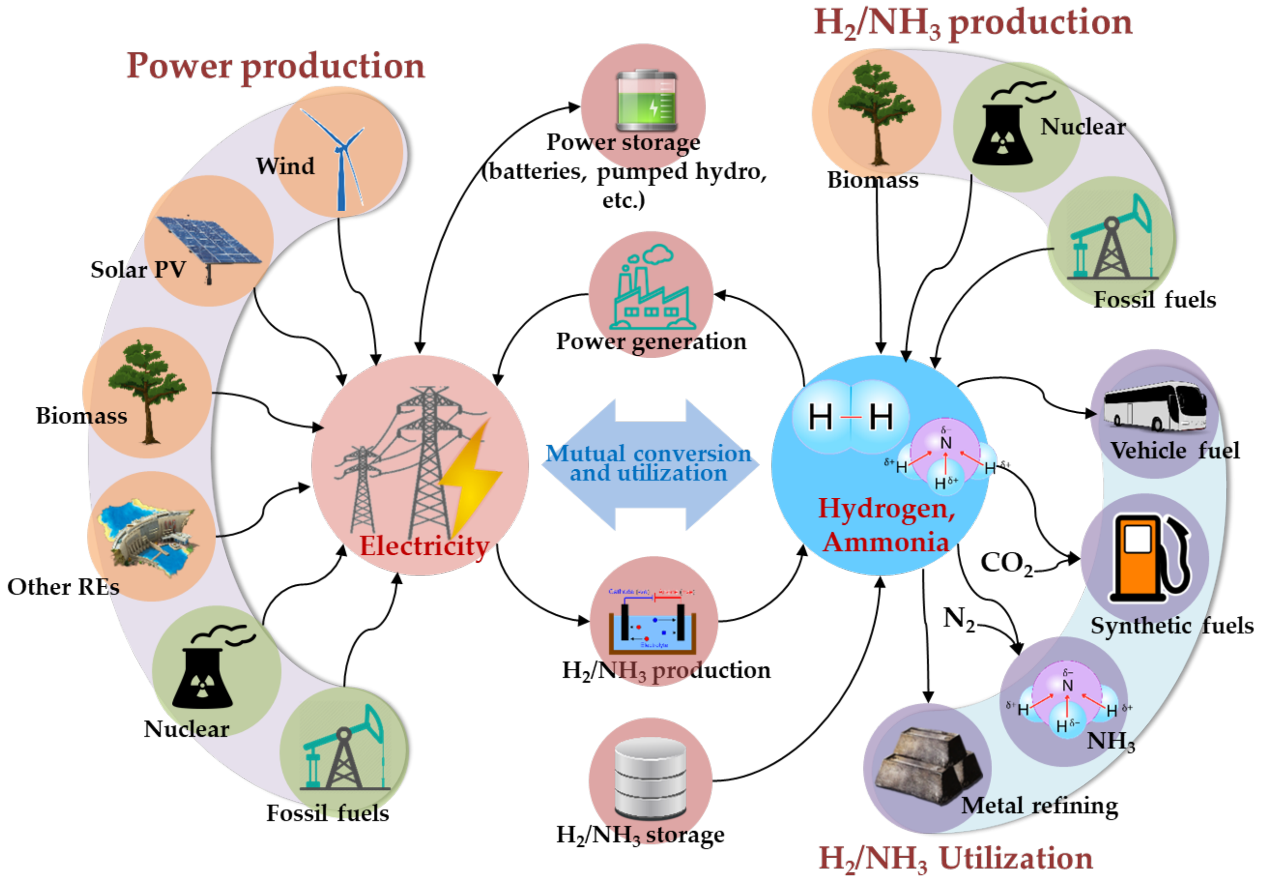
Carbon-free secondary resources

東京大学 THE UNIVERSITY OF TOKYO

Mutual conversion and utilization

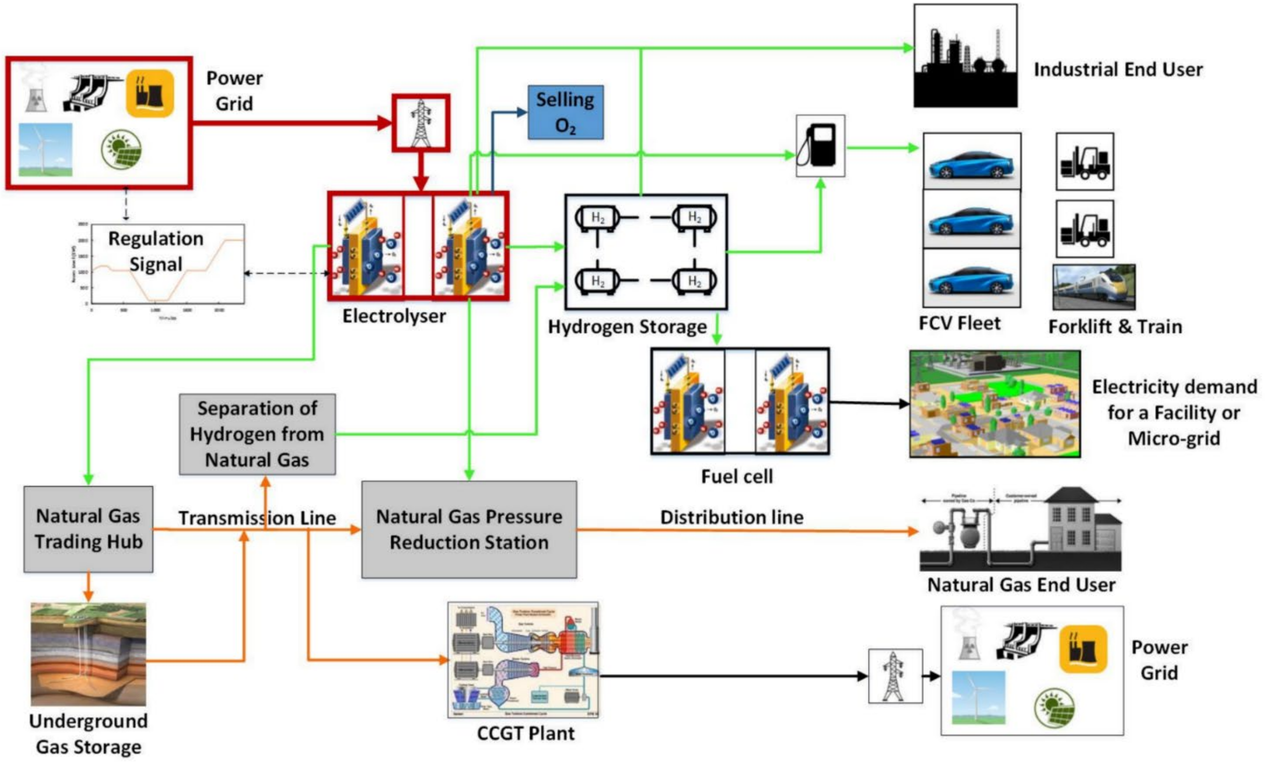


Possible adopted carbon-free secondary energy resources and their mutual conversion

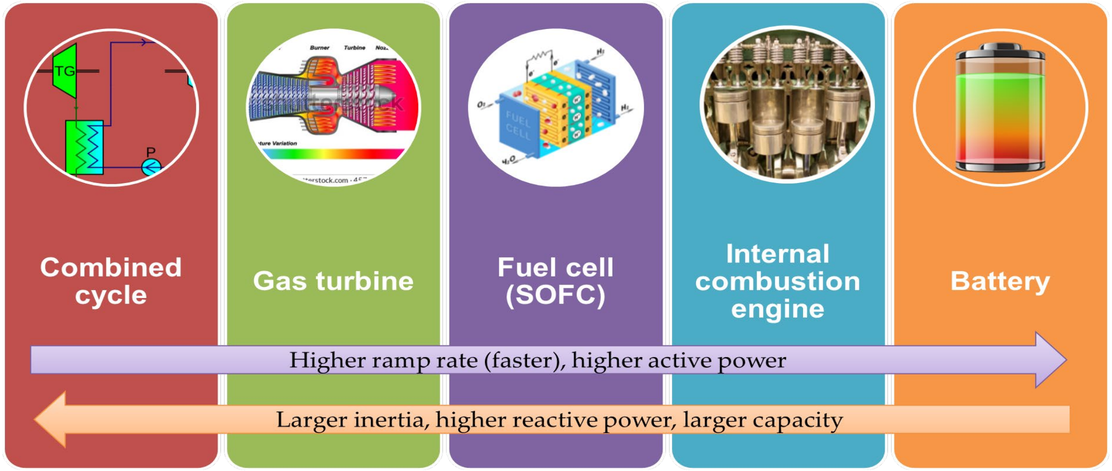


Possible mutual conversion between electricity and hydrogen

Integration of H2/NH3 to Electrical Grid

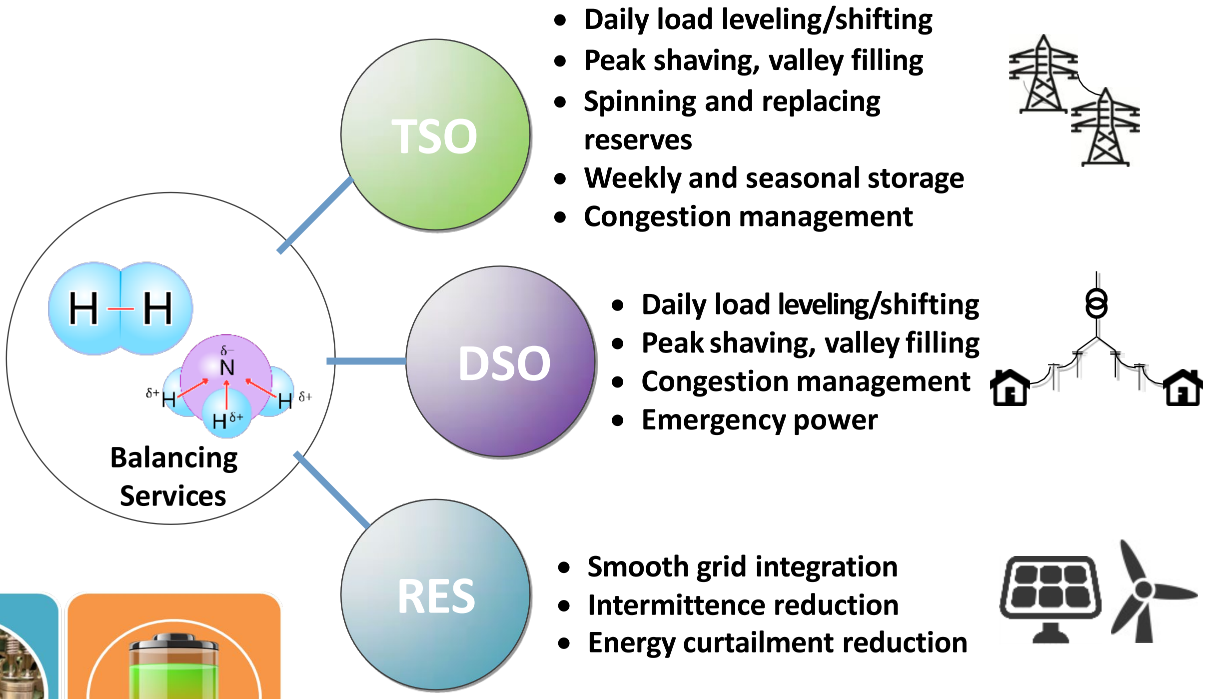


Big picture of hydrogen integration in region's electricity

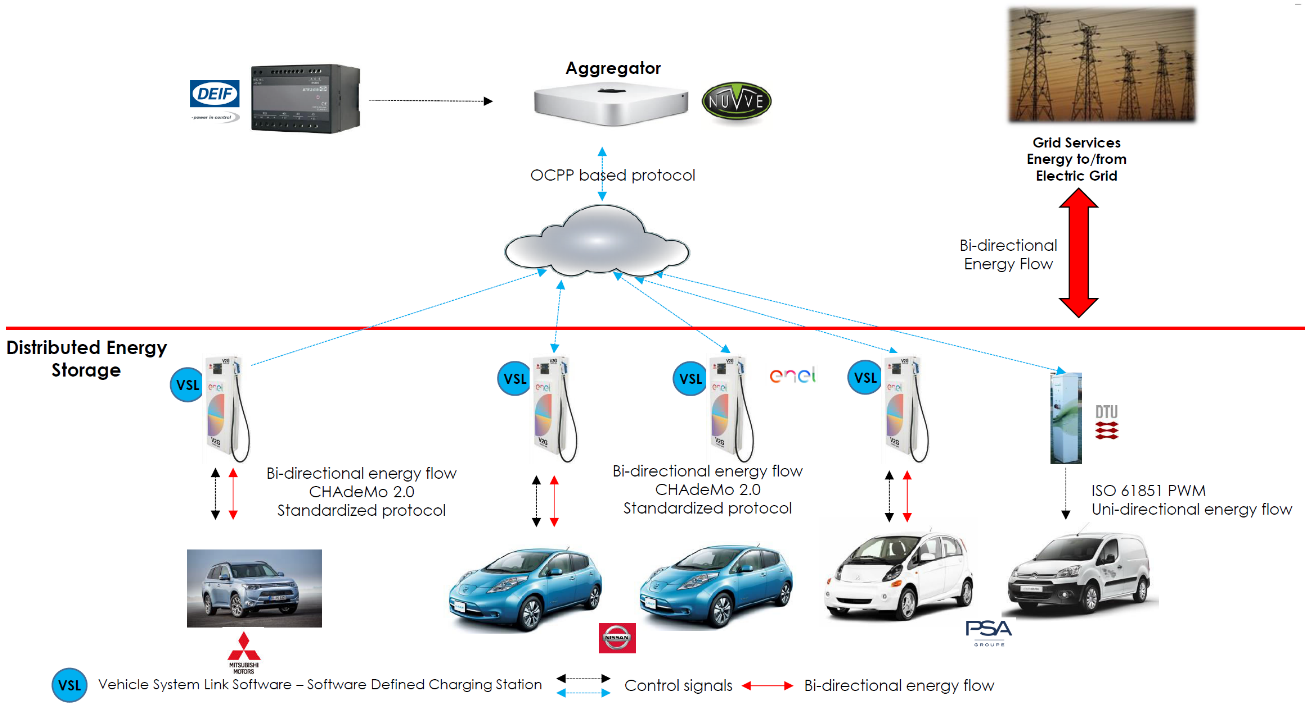


Priority of integration, based on responsiveness for possible quality service

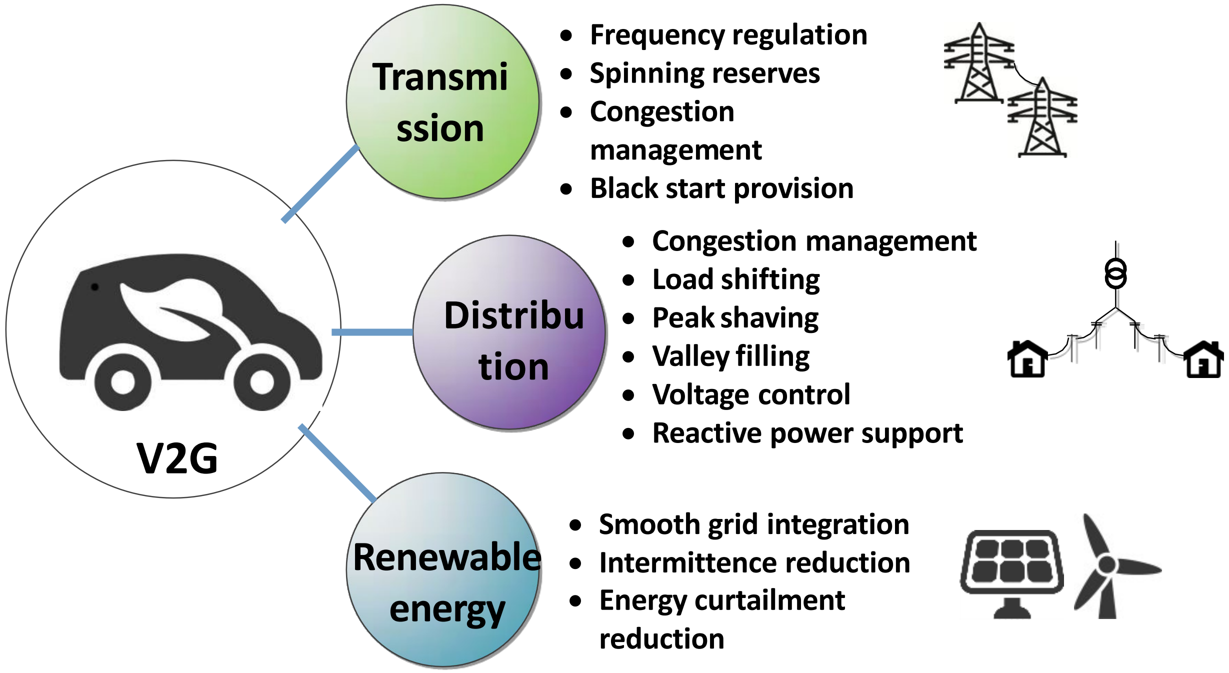
Possible Balancing and Ancillary Services



Integration of Electric Vehicles (Vehicle-to-Grid, V2G)



Conceptual architecture of V2G technology
(Source: Parker project final report)



Various ancillary services which can be provided through V2G

- Integration of transportation and energy sectors
- V2G facilitates new economic and social opportunities to the owners/drivers, not only as transportation, but also energy services
- Increasing the total energy efficiency and reducing CO_2 emission

Conclusions: What Indonesia needs?

- Decarbonization
  - Clean conversion technology
  - Fuel carbon reduction, intermediate conversion
- Energy efficiency
  - Awareness on the "consumed energy amount", impact to economy and environment
  - Incentives on introduction of energy-efficient technology/devices
- Renewable energy
  - Optimum adoption of RE (geothermal, biomass, PV, wind, etc.)
  - Accurate forecast technology
  - Domestic components manufacturing
  - Appropriate incentives planning (fiscal, licensing, FIT, etc.)
  - Larger RE adoption is not always greener: balancing and mapping
- Security
  - Strong focus on security must be balanced with other pillars
  - Security on energy storage to balance the supply and demand
  - Accurate potential calculation on domestic energy resources
  - Optimum spatial mapping in accordance with the resources

Conclusions: What Indonesia needs?

- Smart system
  - Smart and automated system, but flexible and facilitative
  - Capability for big data processing, good data accessability
- Open market and participation opportunity
  - Clear regulation and mechanism
  - Participation encouragement from private and residential sectors
  - Overall monitoring
  - Profit distribution
- Resiliency
  - Strong against the disaster
  - Self healing capability
- Social
  - Employment
  - Energy-saving awareness
- General policies
  - Clear and accurate grand scenario on energy sector
  - Prioritization on domestic human resource
  - Establishment of environmental conservations obligations
  - Ease of contract, transparency, guarantee, and assistance in fiscal risks

感謝！

Thank you.

Muhammad Aziz, Dr. Eng.
Assoc. Professor
Institute of Industrial Science,
The University of Tokyo
E-mail : maziz@iis.u-tokyo.ac.jp
Tel : +81-3-5452-6196
http://epi.iis.u-tokyo.ac.jp