TNB Distribution Network's

A FLEXIBLE AND RELIABLE GRID ENABLED BY DIGITALISATION

Distribution Network (DN) the largest division of Tenaga Nasional Berhad serves complete capabilities in the ecosystem of electricity in Malaysia

GENERATION

As the key component of our electricity production comprising of thermal & hydro generation facilities in Peninsular Malaysia

GRID

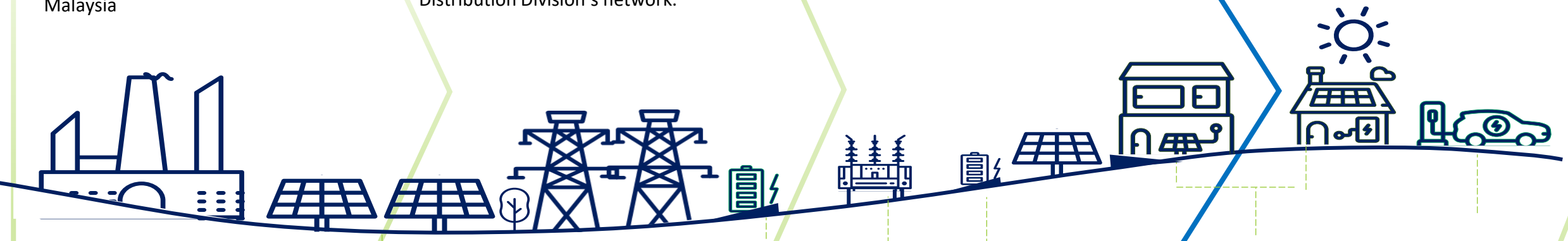
Links the power produced by our Company and IPPs throughout Peninsular Malaysia with the Distribution Division's network.

DISTRIBUTION NETWORK

Responsible for the asset lifecycle of the Nation's distribution electricity supply system to the end users.

RETAIL

Strive to win our customers by building long term & meaningful relationship through continuous ongoing customer centric approaches.



TNB Distribution Network (DN) transitioned over the years to support National Agenda & to achieve World Class User & Customer Experience.

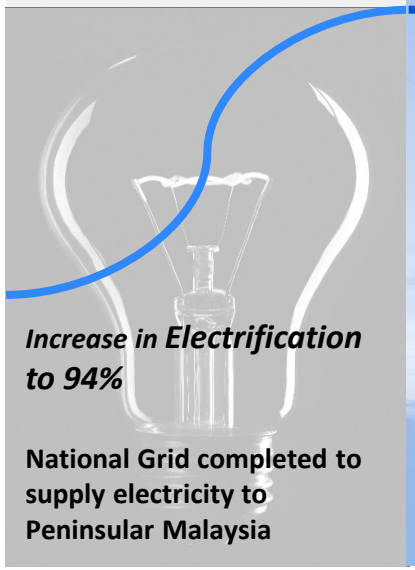
The journey together…

Kementerian Tenaga dan Sumber Asli

Suruhanjaya Tenaga Energy Commission

TENAGA NASIONAL

1 Electrifying the Nation 1990s



Increase in Electrification to 94%

National Grid completed to supply electricity to Peninsular Malaysia

2 Increasing Efficiency, Reliability & Service Delivery 1990s – 2019

One of the most reliable electricity system (SAIDI) in ASEAN countries

- 2002 : 150 mins
- 2017 : 50 mins
- 2019 : 48 mins
- 2020 : 44.95 mins
- **2021 : 45.25 mins**

World Bank 'Getting Electricity' Rank

- 2011 : 60th
- 2014 : 21st
- 2015 : 13th
- 2019 : 4th
- **2020 : 4th**

3 Focusing on enabling Green Energy, Digitalization and Network Sustainability

towards..

NET ZERO 2050

National Agenda

1. **Malaysia Renewable Energy Roadmap (MyRER)**
   - Green Energy penetration target of 31% by 2025 and 40% by 2035
2. **Malaysia's NDC 2030 (Paris Agreement)**
   - Reduce the GHG emissions intensity of its GDP by 45% by 2030
3. **Smart City Development via 12th Malaysia Plan**
   - Smart Meter
   - Smart S/Lighting
   - Energy Storage
   - EV Charging Stations
4. **Malaysia 1st Green Island Development** Collaboration with KETSA & ST

Industrial Transformation

5. **Industry Revolution 4.0** (IoT, Machine Learning, Automation)
6. **Smart Grid Demonstration** (Melaka by KPKT, ST-funded by United Nations Industrial Development Organisation, UNIDO)

- **TNB's Smart Grid Index (SGI) scoring**
  - 2018 : 50%
  - 2019 : 52%
  - 2020 : 62.5%
  - 2021 : 67.9 %
  - **2025 : 85% (Target)**

SGI is an international measures chart on Smart Grid Readiness.

IBR RP1 → IBR RP2 → IBR RP3

HOW WE ENABLE ?

DN ROLES

Network Operator

- Efficient network management
- Strengthen network security
- Increase supply reliability

Energy Transition Facilitator

- Network readiness for RE & EV integration
- Decarbonize own operations
- Flexibility management

Customer Empowerment Enabler

- Self-managed energy consumption
- Option for Time of Use (ToU) tariff
- Better experience through digitalization

SMART UTILITY DOMAINS & TARGET STATE

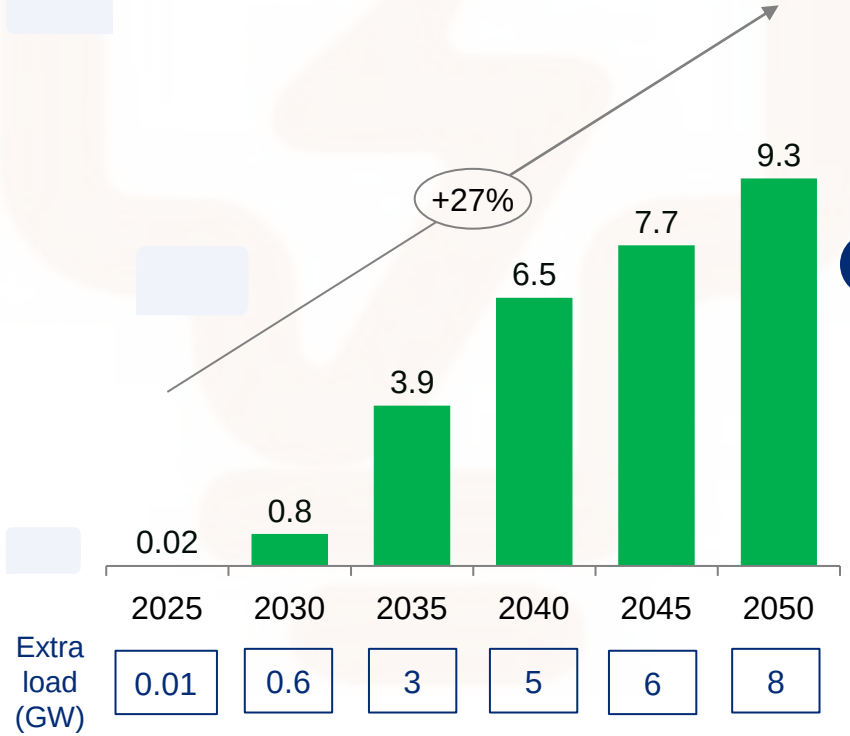
PROGRAM

SMARTUTILITY

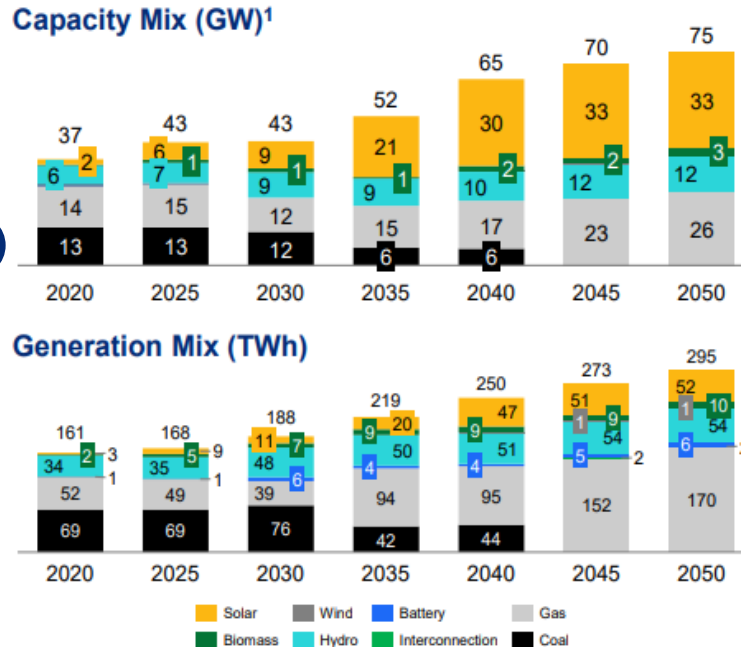
- **ASSET MANAGEMENT** — Resource Optimization
- **WORK MANAGEMENT** — Connected & Smart Workers
- **GRID OPERATIONS** — Self Healing Grid
- **ENERGY MANAGEMENT** — Energy Efficiency
- **CUSTOMER MANAGEMENT** — Customer Empowerment

With the anticipated significant increase of Electric Vehicle (EV) and Distributed Energy Resources (DER) penetration under net-zero forecast scenarios, TNB needs to be ready to address 3 key challenges.

Projected # of EVs (Million)



Projected capacity for TNB (GW)



Source: TNB internal analysis

Key challenges

Plan for sufficient infrastructure to **integrate high EV penetration in network**

Build a resilient and flexible network to manage **intermittency of high** penetration of **solar**

Meet **evolving customer engagement** with network operators in a new energy landscape

In line with National Agenda in preparing our Infrastructure Readiness, DN has a key role to play in delivering Net Zero aspirations as well to serve World Class User & Customer Experiences.

SUSTAINABILITY PATHWAY *towards* NET ZERO 2050

1 MAKING THE CORE SUSTAINABLE

a. Generation decarbonization
b. Retail decarbonization
c. Grid Readiness
e. Operational Efficiencies (DN addition)
f. DN Decarbonization

Direct contribution from DN

+

2 BUILD NEW SUSTAINABLE BUSINESSES

a. Large scale renewables
b. Carbon capture, utilization & storage
c. Low-carbon hydrogen
d. Commercial carbon management
e. Low carbon services & adjacencies

MAKING THE CORE SUSTAINABLE FOR DN..

Grid Readiness

- Enhance network for intermittent **Variable Renewable Energy (VRE)**
- Integrate high penetration of **Electric Vehicle (EV)** and **Distributed Energy Resources (DER)**

☑ Operator of Network ☑ Facilitator of Energy Transition

Operational Efficiencies

- **Analytics, automation and digitalization** to deliver operational efficiencies

☑ Operator of Network

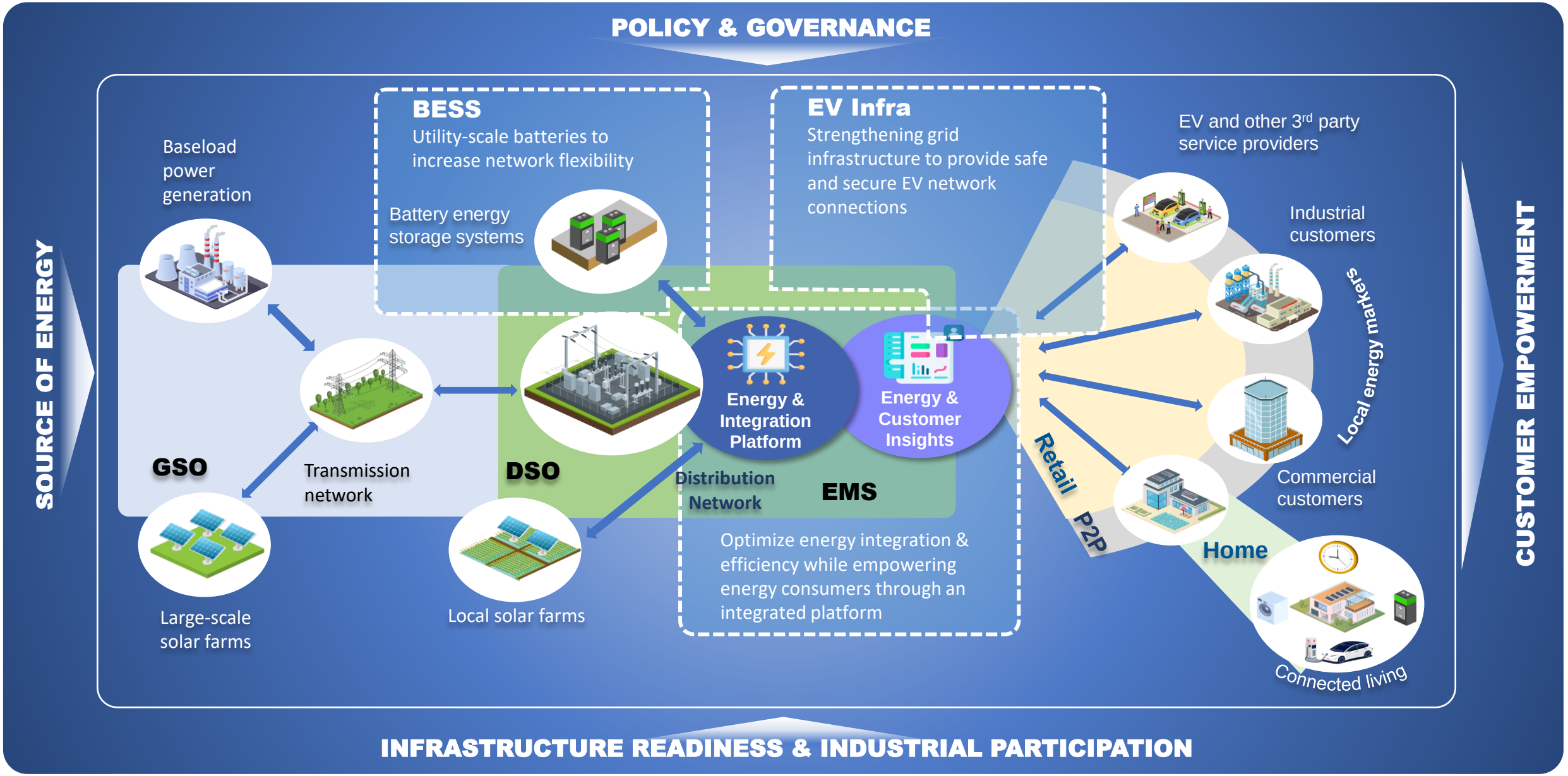
DN Decarbonization

- Reduce **direct (eg: distribution[1] losses[1] , mobile combustion)** and **indirect emissions (eg: fleet travel reduction, waste reduction)** from DN

☑ Facilitator of Energy Transition ☑ Enabler of Customer Empowerment

1. Technical and non-technical losses for vertically integrated utility is considered under Scope 1 as per GHG protocol

TNB Distribution Network plays important roles towards enabling Low Carbon Transition; in term of setting up infrastructure readiness ultimately empower our customers.



Our Smart Utility Program which comprises of 12 Projects set the foundational capabilities; with End-to-End Grid Readiness

2021 -2030
3.6 GW rooftop solar
0.4GW EV load (0.5M EV)
10% increase in demand (+13 TWh)

2031 -2040
7.0 GW rooftop solar
5GW EV load (6.5M EV)
56% increase in demand (+70 TWh)

2041 -2050
12.4 GW rooftop solar
8GW EV load (9.3M EV)
83% increase in demand (+104 TWh)

Market Maturity / DER Penetration

SMART UTILITY

Foundational Capabilities | **Extend & Expand** | **Optimization**

NETWORK OPERATOR

ASSET MANAGEMENT

WORK MANAGEMENT

GRID OPERATIONS

Digital Enterprise Asset Management System
AAA GIS SWATS

Smart Grid Asset Management
- Digital Twins
- Dynamic & Real Time Asset Management
- Advanced Analytics with AI Support
- Wide Area Telecommunication & Network Coverage

Cognitive Asset Modelling
- Integrated DER & Network Capacity management
- Private wireless/LTE

Bionics Workforce
Robotics assisted work management system

Self Directed Work Team
- Artificial Intelligence assisted diagnostics
- Augmented & Virtual Reality

Smart & Connected Worker
SWATS

Super Grid
'Multi-agent distributed control system
DSO,TSO & GSO collaboration

DER Despatching & Market Management
- Distribution Market Facilitation

Market Facilitator
- Market Hub Operation & Participation

Active Network Management
- Integrated DER interconnection & control
- Microgrid Management

Flexibility Capacity Management
- 3rd Party DER Aggregation
- Local Congestion & Flexibility Management

Value Chain Service Facilitator
- Auto & seamless DN Driven Contracting
- Energy Trading Services
- EV Facility Management (Planning & Consultation)

Self Healing Grid
DA ADMS VVO

Integrated Energy Management Monitoring
SEMI MH AMI

Energy & Customer Insights Foundation
SEMI AMI LED

CYBERSECURITY MANAGEMENT & DEFENCE

DATA DRIVEN DN

ENERGY MANAGEMENT | CUSTOMER MANAGEMENT

FACILITATOR OF ENERGY TRANSITION — CUSTOMER EMPOWERMENT

DN has taken proactive measures in modernizing the network through our Smart Utility Masterplan 2025 (SU 2025) which consists of 5 domains.

ASSET MANAGEMENT

Asset Performance Management System for 33kV Tx & S/Gear Assets Across Klang Valley

100% MV asset location and topology digitalized nationwide to provide assets' visibility

Automated, online planning tool with actual renewable energy impact

WORK MANAGEMENT

Automation of 30 Modules Business Process Towards Smart & Connected DN Talents

Real time information update (~2 mins) on work management

~ 97% average compliance to GSL & MSL Service delivery improvement

GRID OPERATIONS

83,147 SCADA-DA installed with **24.7%** Penetration

Faster restoration, with **5 mins for 1st Restoration**

Initiation Digital Substation with IoT features for Switchgear, Transformer & Feeder Pillars

ENERGY MANAGEMENT

Instant Information of **Potential RE Points** with Hosting Capacity Platform

Provide supply connection point to various locations in Peninsular for EV fast charging hub

Total of **1,338 MW Renewables Energy** Capacity with 7.01% Penetration at Distribution Network.

CUSTOMER MANAGEMENT

Installed > 2.8 Mil. Environmentally Friendly Smart Meters

97% Customers are able to view their bill and load profile via portal and mytnb apps.

Reduction from 15% to **2% Street Light failure rate.** Increase public safety and customer

ADVANCED ASSET ANALYTICS

Optimize asset lifecycle

GEOGRAPHICAL INFORMATION SYSTEM

Geographical network visualization

SMART WORK & TOTAL SOLUTIONS

Improve fieldworkers productivity

ENVIRONMENT FRIENDLY ASSET MANAGEMENT

- **SF6 Load Break Switch**
- **Synthetic Ester Biodegradable Transformer Oil**

ADVANCED DISTRIBUTION MANAGEMENT SYSTEM

To enable automated network control

DISTRIBUTION AUTOMATION (DA)

Enhance fast supply restoration

Volt-VAR Optimisation (VVO)

Improve stability of voltage level

MINI HYDRO REFURBISHMENT (MH)

Provide more efficient green sources

SMART ENERGY MANAGEMENT INFRASTRUCTURE (SEMI)

Enabling a flexible grid

ADVANCED METERING INFRASTRUCTURE (AMI)

Facilitate energy efficiencies and reduce distribution losses

LED Relamping (LED)

Energy Efficient Street Lights

SMART GREEN ISLAND

Sandboxing (control environment) of Smart Grid

ELECTRIC VEHICLE (EV) INFRA

Facilitate EV industry growth

BATTERY ENERGY STORAGE SYSTEM (BESS)

Enabler of RE penetration

In order to develop end to end Smart Utility Capabilities, three vital layers needed to be built accordingly

TENAGA NASIONAL

SUSTAINABILITY PATHWAY *towards* NET ZERO 2050

MAKING THE CORE SUSTAINABLE FOR DN..

- Grid Readiness
- Operational Efficiencies
- DN Decarbonization

SMART UTILITY DOMAINS & TARGET STATE

SMART UTILITY 2030

ASSET MANAGEMENT
Predictive Asset Management

WORK MANAGEMENT
Smart & Connected DN talents

GRID OPERATIONS
Self Healing Grid

ENERGY MANAGEMENT
Integrated Energy Management

CUSTOMER MANAGEMENT
Energy & Customer Insights

Three layers of building holistic Smart Utility Capabilities

3

CUSTOMER EMPOWERMENT SOLUTION

Enable customer empowerment via digital system

SEMI

2

SMART GRID SOLUTION

Smarter solution to complement Grid Intelligence

AAA GIS SWATS ADMS AMI SEMI

1

GRID HARDENING

Improve network resilient from DG impact & Climate Change

DA VVO MH

Key Take Aways

THE IMPORTANCE OF DIGITALIZATION IN BUILDING A FLEXIBLE AND RELIABLE ENERGY GRID

Digitalization is a critical component of building a flexible and reliable energy grid. By incorporating advanced technology such as sensors and data analytics, utilities can monitor the health of the grid in real-time and take proactive steps to avoid outages and other disruptions.

MANAGING THE VARIABILITY OF RENEWABLE ENERGY THROUGH SMART TECHNOLOGIES

A flexible and reliable grid is essential for meeting the growing demand for renewable energy sources. By integrating digital systems and smart technologies, utilities can better manage the variability of these energy sources and ensure that they are integrated into the grid in a reliable and efficient manner.

EMPOWERING CUSTOMERS TO BUILD A SUSTAINABLE ENERGY FUTURE WITH DIGITAL TOOLS

Customers play a key role in building a flexible and reliable energy grid. Through digital tools such as energy insight systems and billing tariffs, customers can become more informed and engaged in their energy usage, helping to balance the supply and demand of electricity and contribute to a more sustainable energy future.

Thank You !

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