Sustainable Energy Development Authority Malaysia (SEDA Malaysia)
Workshop on Integration of Utility Scale Photovoltaic (PV) Plants
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Malaysian Grid Operation and Grid Code

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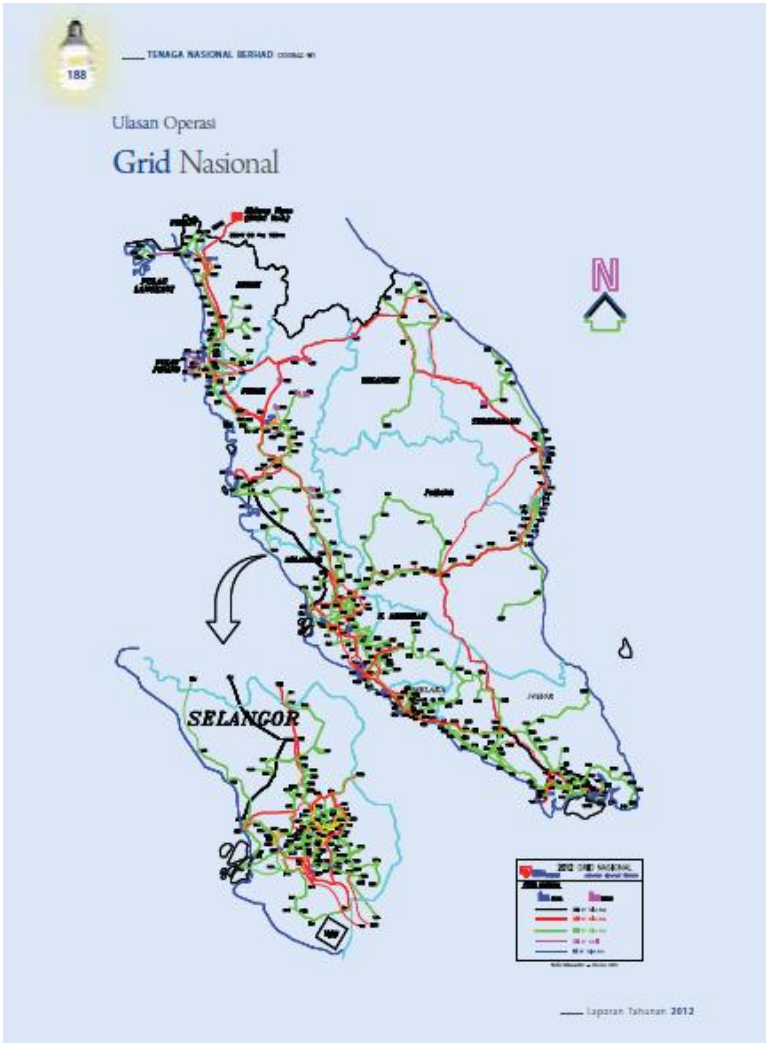
1. **Introduction**
2. Peninsular Malaysia power system
3. Definition and purpose of grid code
4. Definition of power system, transmission, users
5. How grid code works
6. Malaysian grid code (MGC) as it is today
7. List of MGC Requirements for grid connection
8. Connection process
9. Options for the way forward

Peninsular Malaysia power system

(as of 2012)	
Maximum demand	15,826 MW (June 2012)
Generation capacity	• TOTAL: 21,749MW • Thermal coal 7,170MW (33%) • Thermal gas 840MW • CCGT gas 9,373MW (58%) • OCGT gas 2,455MW • Hydro 1,910MW (9%)
Transmission	• 500kV, 275kV and 132kV
Inter-connection	• 275kV (450MW) with Singapore • 300kV HVDC (300MW) and 132kV AC with Thailand

ST Peninsular Malaysia Electricity Supply Industry Outlook 2013



(TNB Annual Report 2012)

Definition and purpose of Malaysian Grid Code (MGC)

About the MGC

MGC was established by ST in 2010 as a regulatory instrument to ensure the rules, guidelines and standards to be followed by various participants in the grid system.

Definition & purpose

A set of principles and procedures for day to day planning, design and operation governing relationship of Grid Owner, GSO and Users and responsibilities of all parties towards maintaining harmonious operation of the grid system under both normal and exceptional circumstances involving disturbances spanning from those initiated by climatic conditions to equipment failures and mal-operations.

Definition of power system, transmission, users (under MGC)

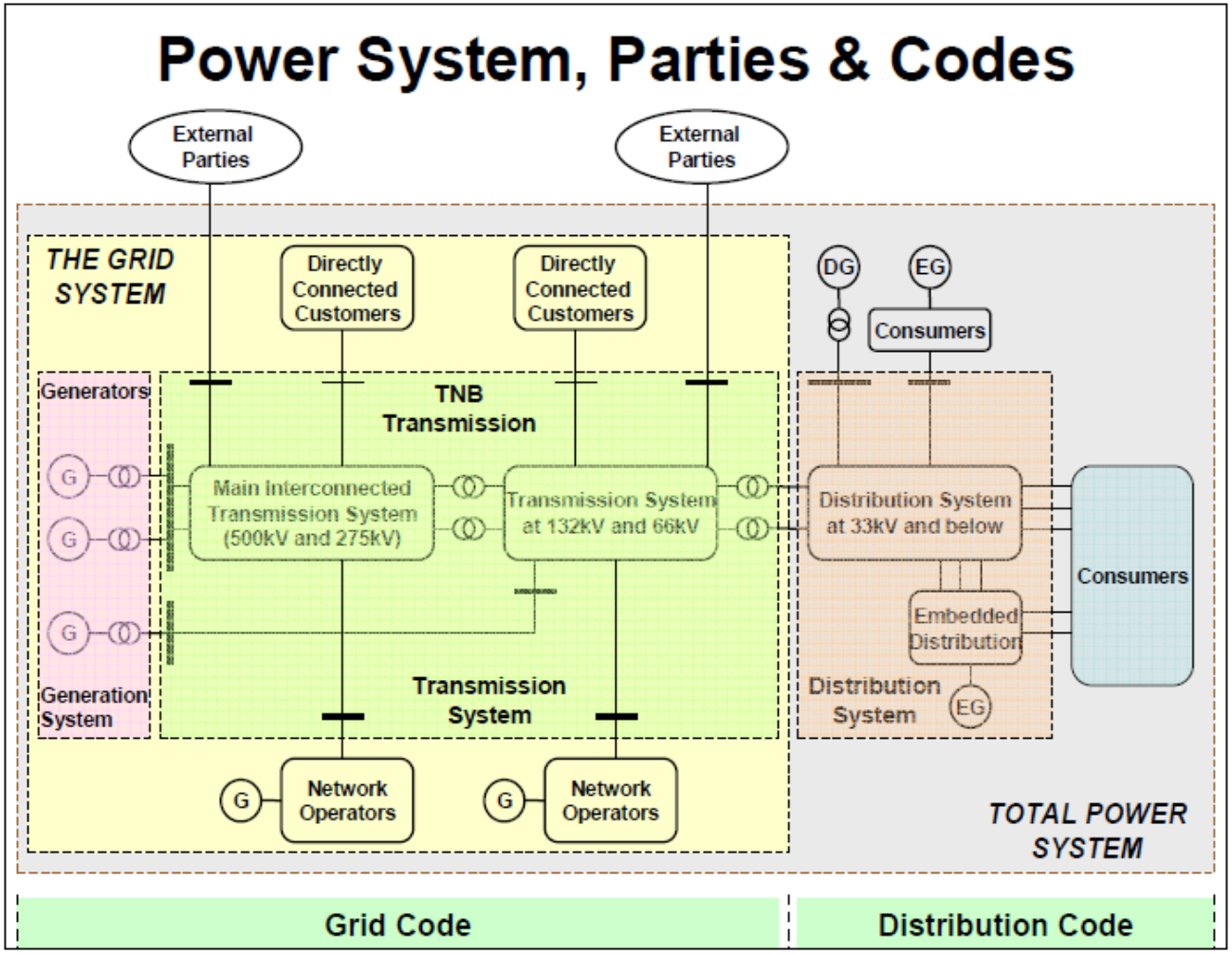
Power system

Grid system:

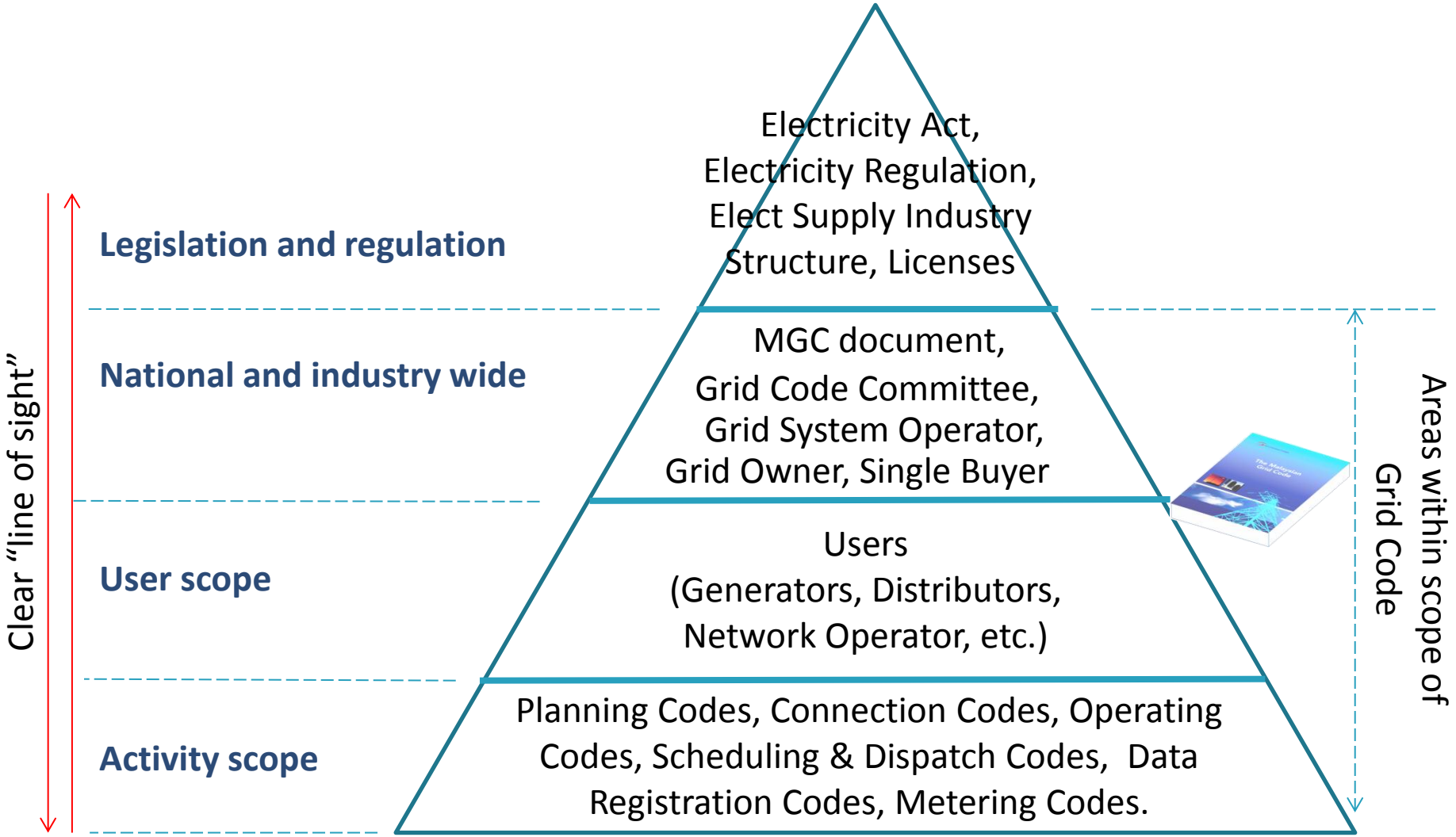
- Generation
- Transmission
- Distribution
- Grid connected customers
- Network operator system
- External systems

Users:

- Generators
- Transmission
- Network operators
- Directly connected customers
- External parties
- Any person who is seeking connection to the transmission system



How MGC works



MGC as it is today

MGC is enforced since its launching	MGC was launched at end of 2010
MGC is a living document	Mechanism for changes is provided (GC5.2)
It is based on past knowledge an experience	Changes and new requirements may be adopted by making changes to MGC
What technologies are inherent in MGC?	Conventional technologies of power generation (thermal, gas turbine, and hydro plants) and customer's network and loads.
Does MGC apply for RE such as utility scale solar?	No (i.e. not yet). Solar PV output variability and absence of frequency and voltage control in standard solar PV technology are some of the possible new challenges.

List of MGC Requirements for grid connection

Safety rules	• User shall comply safety rules
Range of limits of grid voltage, frequency, harmonics, phase unbalance, voltage fluctuation, basic impulse level, fault clearance, auto re-close switching, actions of special protection system and maximum short circuit level	• User shall design and enable operation of their system within the range stipulated in MGC • User's system shall not cause violation of limits
Design of interconnection facilities (including protective systems)and settings	• User shall comply standards and specifications

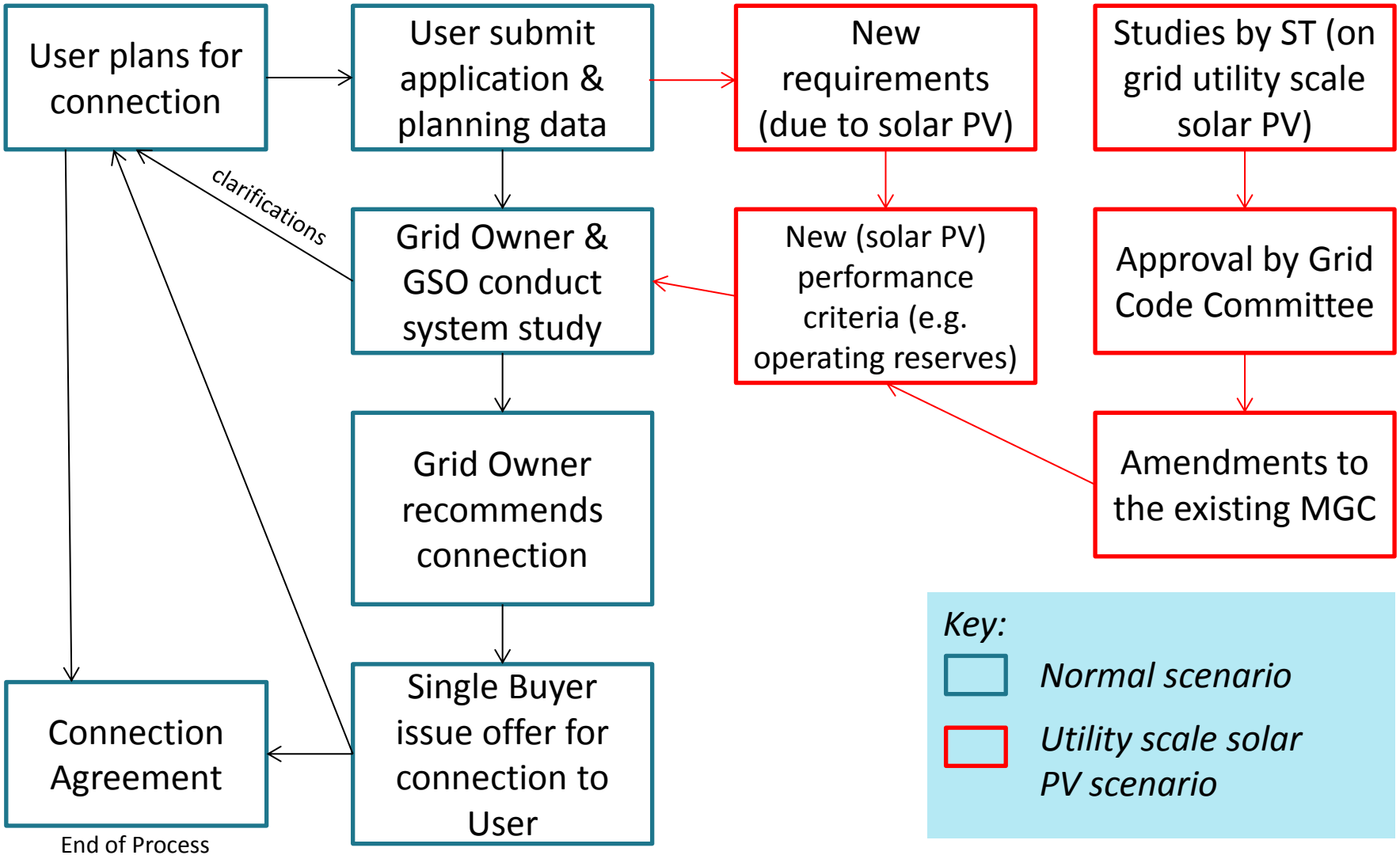
List of MGC Requirements for grid connection (continued)

Metering (power and energy)	• User shall comply
Limits on power factor	• User shall comply
Capability to execute dispatch instruction	• User (Generator) shall comply
Maintaining constant plant power and voltage output (or within agreed limits under exceptional circumstances)	• User (Generator) shall comply
Capability to perform frequency and voltage control (including power system stabilizer)	• User (Generator) shall comply

List of MGC Requirements for grid connection (continued)

Capability to perform load following and frequency correction	• User (Generator) shall comply
Capability to perform house load operation	• User (Generator) shall comply
Capability to black start	• User (Generator) shall comply (waiver may be given special circumstances)
Capable of voltage ride-through for up-to 600ms voltage loss	• User (Generator) shall comply
Equipped with disturbance recorders	• User (Generator) shall comply

Connection Process
(*with possibility under utility scale solar PV scenario)



Options for the way forward

1. User gather more detailed information and data on utility scale solar PV for power generation.
2. ST (engage experts to) conduct technical studies on connection of utility scale solar PV to the grid system (focusing on impact of solar PV on adequacy, stability, power quality and operation of the grid system as well as impacts to other users and recommend mitigation measures). ST forms a working group to assist the process.
3. ST Working Group draft and submit appropriate amendments to the MGC and obtain approval of Grid Code Committee.
4. Grid Owner/GSO conduct system study (of User application for utility scale solar PV connection) based on the new information & data.

Thank you

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