APEC Workshop on Small Hydro and Renewable Grid Integration, Ha Noi, Vietnam

Issues on grid integration of small scale RE electricity
APEC Economies—Electric Utilities Perspective

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- References
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INTRODUCTION
INTRODUCTION

- **Small Renewable Energy scenario in TNB**

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<th>Types</th>
<th>TNB</th>
<th>RE developer</th>
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</thead>
<tbody>
<tr>
<td>Mini hydro</td>
<td>20 sites</td>
<td>4 sites (29.2MW)</td>
</tr>
<tr>
<td></td>
<td>(97MW)</td>
<td></td>
</tr>
<tr>
<td>Solar PV</td>
<td>-</td>
<td>20 sites (25.5MW)</td>
</tr>
<tr>
<td>Biomass</td>
<td>-</td>
<td>3 sites (20MW)</td>
</tr>
<tr>
<td>Biogas</td>
<td>-</td>
<td>6 sites (7MW)</td>
</tr>
</tbody>
</table>

- **Feed-in Tariff in 2011 (up to 30MW)**
  - **Regulators** : Electricity Commission Malaysia
  - : SEDA Malaysia
Connection point is based on RE output capacity
REFERENCES
REFERENCES

Renewable Energy Act, 2011
(SEDA Malaysia)

Distribution Code
(Energy Commission Malaysia)

Connection of PV Generation
(TNB)

DG Generation Guidebook
(TNB)
“TNB is committed to support the national green agenda and minimise the environmental impact of our business by applying sustainable, efficient operations and delivering green energy through the application of appropriate technologies and investments”.

TNB GREEN ENERGY POLICY
ISSUES
ISSUES

a) Voltage regulation
   i- MV
      ▪ Proposed RE sites are away from load centre: low load, smaller cables
      ▪ High generation results in out-of-range voltage (±5%)
        ▪ Reduce generator pf
        ▪ Install reactor
        ▪ Install larger cable
        ▪ Reduce capacity
        ▪ Connect to higher voltage
        ▪ Upgrade utility cable/line

   ii- LV
      ▪ Voltage increase during low load causing inverter to trip
b) Nearest connection point is a “weak” system

- Low load
- Small cable, bottleneck
- Long interconnection cable/line required to connect to suitable substation

>>> Reduced generation capacity
ISSUES

c) Network losses due to reversed power flow & supply of Var
   - Higher current flow results in higher losses
ISSUES

d) High system fault level

- Addition of RE generators exacerbate
  - 33kV 25kA
  - 11kV 20kA, 25kA

>>> Unparallel transformers
Reduce fault contribution from RE
e) Penetration limit
- Based on capacity
- Based on existing trough load
- Based on expected voltage rise

>>> Prevailing limit is 85% of trough load, TNB is currently reviewing the limit
f) Favourite sites

- Some sites are favoured by RE developers resulting in high number of proposals due to:
  - Cluster of potential rivers
  - State government support
  - “Cheaper” land
    - Penetration limit
    - Insufficient space for additional switchgears at Main Intake Substation
g) Upgrading at existing substation/feeder
   - Existing small substation
   - Connection from multiple developers
   - No nearby existing substation
   - RE site nearest to worst performing feeder
ISSUES

h) Numerous connection schemes
   - Multiple feed causing difficulty to isolate fault during operation
   - Standardised for FiT connections
     - Single connection point
     - Standardised connection point based on connected capacity
ISSUES

Standardised interconnection feeder
  - Interlocking scheme to ensure TNB equipments not used to sync
  - Interfacing with TNB
    - Cable – Unit Protection and OCEF
  - Interlocking facilities
    - A trip – B to trip
    - B close position – A cannot close
    - A open position – B cannot close
    - Earth switch B ON – A cannot close
ISSUES

i) Boundary of ownership/operation

- Energy meter installed at connection point ie TNB substation.
- Energy meter reading by Remote Metering
- Ownership of RE developer until connection point
- Interconnection Operation Manual (IOM) for every site
j) Inconsistent energy output (steady state)

- **Solar**: due to varying solar irradiance
- **Biomass**: due to unavailability of biomass, fuel
- **Biogas**: due to inconsistency of gas – sanitary landfill, anaerobic digester
- **Hydro**: due to reduced workflow
k) Reduced Main Intake Substation capacity utilisation

PMU Pajam transformer load profile: Pre & post PV connection [MW, MVA, MVar]

<table>
<thead>
<tr>
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<th>Without RE</th>
<th>With RE</th>
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<tbody>
<tr>
<td>PMU</td>
<td>11.5</td>
<td>5.5</td>
</tr>
<tr>
<td>RE</td>
<td>0</td>
<td>6.0</td>
</tr>
</tbody>
</table>
ISSUES

I) Change in Main Intake Substation power factor

- Reduced substation power factor due to reduced P, increased Q
m) Exact machine data not available during power system study
   ▪ Use of typical parameters
n) Increase maintenance of substation equipment
   - Use of VCB switchgears at connection points
CONCERNS

i) Safety of workmen during operation

ii) Harmonic contribution to distribution network

iii) Yo-yo like energy output complicates load forecast, capacity planning

iv) Local industry technical support - skilled
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