NEA SYMPOSIUM MARCH 8TH, 2018 IN LINO HALL TOKYO
STRATEGY FOR NORTHEAST ASIA POWER SYSTEM INTERCONNECTION
EDF TECHNICAL ASSISTANCE TO MONGOLIA
ADB PROJECT
MID-TERM INFORMATION ON THE PROJECT

PHILIPPE LIENHART EDF
EDF Group presentation with contributions and adaptations to EU PSI

Strategy for NAPSI / Technical Assistance for Mongolia: objectives and organization

Workshops and Steering Committees

Assumptions for the studies

Recommendations

Generation Studies

Market studies

Conclusion
EDF Group: a Responsible Industrial Firm with corporate social responsibility goals

1 Low carbon policy
Go beyond the requirements of the 2 °C trajectory set by COP21 by drastically reducing our CO₂ emissions.

2 Respect for people
Integrate best practice in the way we develop our people: health and safety, gender diversity and internal development.

3 Responsibility
Offer all vulnerable people information about and support with energy use and energy benefits.

4 Innovation
Innovate through digital energy efficiency solutions to enable all customers to use energy better.

5 Concertation
Systematically organise a process of transparent and open dialogue and consultation for every new project around the world.

6 Environment
Launch a positive approach to biodiversity, not limited to understanding and reducing the impacts of our activities in the long run but having a positive effect on biodiversity.

36.7 million customers worldwide
160 000 employees
€71 billion sales
584 TWh electricity generation

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160 000
€71 billion
584 TWh

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European Power System Interconnection
A long story of EDF contributions and adaptations

PHASE 1: 1956-2000 Common System Operation
Integration Goals:
• Exchanges of electricity
• Grid Safety improvement
• Cost Optimization

Harmonized Rules:
• UCTE
• NORDEL
• ETSOE

EDF adaptation
• Many Cross border OHL
• Submarine HVDC interco with UK: IFA

PHASE 2: Since 2000, EU Electricity Market
TPA introduced deep changes:
• Unbundling: 42 TSOs
• Private interconnections allowed
• Interconnections vs price zones

EU GRID CODES:
• ACER
• ENTSOE
• CORESO

EDF adaptation:
• Development of RES: EDF EN
• Reduction of coal-fired fleet
• Few new OCGTs & CCGTs

Phase 3: EU Energy Policy, 20% of RES in 2020
Interconnections are Key Assets
• Intermittency Management
• More Flexibility
• No RES Curtailment

EDF adaptation:
• Interconnections more difficult to built in OHL: underground HVDC interconnector with Spain INELFE

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ADB Contract TA-9001 MON:
Strategy for Northeast Asia Power System Interconnection

The contract consists of a support to Mongolia State (EA) for entering the NAPSI discussions with a consensual project based on the huge Renewable Energy Potential.

EDF’s recognized experience in Power System Integration in a region representing 25% of the world GDP

EDF with:
Nova Terra in Mongolia
China EPRI

3 MASTER PLANS over 20 years
- Renewable generation
- Market & Power Trade
- Interconnection Grid
WS1: Methodology and Work Organization

Module 1: Inception Mission
- Data collection & methodology

Module 2: Market & power trade assessment
- Demand scenarios
- Economic analysis

Module 3: Planning & evaluation criteria
- Development of technical, financial, political and environmental criteria

Module 4: Energy sector profile & projections
- Analysis of current sector and assessment of renewable potential
- Identification of suitable areas for solar and wind development

Module 5: Power system interconnection expansion plan
- Review of current planning and review of technologies for expansion plan
- Analysis of benefits of interconnection

Module 6: Power Trade and Regulation
- Create and enabling environment for power trade
- Promote coordinated regional planning and investment

EDF and Project Team added value
- Updating work with the latest data: a vision that integrates former studies
- Coherent vision of the five independent power systems
- Innovation with dedicated RE potential analysis tool
- Innovation with System models that integrate intermittency
- Innovation with experience EDF adaptation to the European free electrical market
- Demand and supply coherent scenarios suitable for the regional power systems
## Context

<table>
<thead>
<tr>
<th></th>
<th>GDP (in billion dollars)</th>
<th>Population (in million people)</th>
<th>Electricity generated (in TWh)</th>
<th>CO₂ emissions (in million tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>China</strong></td>
<td>8,909 (6.5)</td>
<td>1,376</td>
<td>5,811</td>
<td>9,154</td>
</tr>
<tr>
<td><strong>Japan</strong></td>
<td>5,986 (47.2)</td>
<td>127</td>
<td>1,036</td>
<td>1,208</td>
</tr>
<tr>
<td><strong>South Korea</strong></td>
<td>1,267 (25.0)</td>
<td>50</td>
<td>522</td>
<td>649</td>
</tr>
<tr>
<td><strong>Mongolia</strong></td>
<td>12 (3.9)</td>
<td>3</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td><strong>Russia</strong></td>
<td>1,616 (11.0)</td>
<td>143</td>
<td>1,063</td>
<td>1,483</td>
</tr>
<tr>
<td><strong>Northeast Asia</strong></td>
<td>17,790 (~10.5)</td>
<td>1,699</td>
<td>8,437</td>
<td>12,512</td>
</tr>
<tr>
<td><strong>World</strong></td>
<td>74,889 (10.2)</td>
<td>7,349</td>
<td>24,098</td>
<td>33,508</td>
</tr>
<tr>
<td><strong>Share of Northeast Asia</strong></td>
<td>20-25%</td>
<td>20-25%</td>
<td>30-35%</td>
<td>~37%</td>
</tr>
</tbody>
</table>

Source: Created by Renewable Energy Institute based on data released by national governments and international organizations.

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### NAPSI
- 25% of Global GDP
- 22% of Global population
- 40% of Global CO₂ Emission

### Mongolia
- Central Key Position
- Huge Potential in Wind and Solar RES
- Main Stake: Private investor attractivity
Assumptions for the Studies

Review of 4 key drivers for Mongolia, Russia, Japan, ROK and PRC

Technical analysis
• Generation
Cost of technologies
Criteria for Generation planning,
• Transmission,
Comparison HVAC vs HVDC
Cost of Transmission Technologies
Safety Systems Rules
Overview of the organizational needs
The NAPSI Authority
Overview of the HVDC Grid Code Needs
Transmission: Existing and Expansion Plan

Economic and Financial analysis
• Economies of Different Markets
• Electricity Consumptions

Political and Regulatory analysis
• Demographics
• Geopolitical environment
• Foreign investment
• Regulation of Power Sector

Socio-Environmental analysis
• CO2 emissions
• Energy Mix
• Focus on Coal
• Export Driven RES capacity
• Interviews of 7 Mongolian Representatives
Recommendation: NAPSI Grid code for rules harmonization

Principles:

- Different synchronous electricity systems in the Northeast Asian region have different characteristics, which need to be taken into account when setting the requirements for HVDC systems.

- System security depends partly on the technical capabilities of HVDC systems

Harmonized rules for grid connection for HVDC systems should be set out:

- To provide a clear legal framework for grid connections, facilitating Northeast Asian Region wide trade in electricity,

- To ensure system security,

- To facilitate the integration of renewable electricity sources,

- To develop competition, and

- To allow more efficient use of the network and resources, for the benefit of consumers.
Co-operation between Countries, Mutual assistance between Authorities, and Fair competition between Players

Main Functions:

- To enable NAPSI implementation including financing the interconnection assets through capital injection from the relevant Authorities/Entities;
- To manage the NAPSI-Supervision Center including supervision of real-time power transfers, performing adequate technical studies and coordinating bilateral energy transactions;
- To provide a transparent and efficient decision process;
- To be the owner of the NAPSI assets;
- To organize the operation and maintenance of the equipment;
- To ensure fair transaction between players scattered all over the five interconnected Northeast Asian Countries.

Recommendation: NAPSI Grid Authority
A specific Regulation framework will be necessary to favour private RES Investments

• Stable Revenues
• Priority dispatch / curtailment
• Legal maturity
• Financing facilities
• Visibility on the renewable targets
• Pre-permitted sites,
• Grid connection
Confirmation of Mongolian Wind and Solar potential

Specific GIS model with last updated data and most recent technologies
Including grid and ranking methodology

Best common wind & solar areas
Wind & Solar Potential for exportation

Best score areas are close to exportation representing 200 GW Wind – 1200GW Solar PV
In the short term (2020), limited to grid capacity around 350MW-550MW

Wind areas > 10 km\(^2\) (i.e. capacity > 50 MW). Wind speed > 8 m/s (Score 4)

Solar PV areas > 0.25 km\(^2\) (i.e. capacity > 10 MW). GHI > 1700 kWh/m\(^2\) (Score 4)

A new strong national and exportation grid will be necessary
Market Assessment: Scenarios

- 2020: 0.3GW
- 2026: 5GW
- 2036: 10GW
- 2036: 100GW

Renewable capacity Y connected at the GOBI node in the year XXXX
Transmission capacity Z (in GW) between countries/areas A and B

- Mongolia-Ulaanbaatar
- Mongolia-GOBI
- China-West
- China-East
- Russia-FarEast
- Russia-Siberia
- Republic of Korea
- Japan

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Results on profitability

- **Gross gain**: collective benefits, including the savings in terms of investment expenses and operation expenses, but excluding the investments linked to interconnection infrastructures and renewables in Mongolia.
- **Net gain**: final collective profits including all expenses and revenues.
- Consideration of a **range** around net gain to take into account uncertainties (particularly on interconnection infrastructure costs).
Impact of interconnection and RES in Mongolia on the CO2 emissions within the NAPSI region in the 2036 scenarios

Combined effect of interconnection and RES in Mongolia: significant CO2 emissions savings thanks to the substitution of coal and gas by renewables
Conclusions

Generation in Mongolia

- Mongolia Wind and Solar Potential is confirmed:
  - Short term limited by 2020 grid to 350 - 550MW
  - Provided a new strong national and exportation grid, 5GW in 2026, 10 GW in 2036 and even 100GW are feasible

NAPSI Market

- Interconnection is beneficial for exchange of electricity
- Wind and Solar RES Development in Mongolia is the most competitive
- NAPSI will reduce CO2 emissions

Recommendations

- Mongolia: a specific Regulation framework will be necessary to favour private RES Investments
- NAPSI Grid code for rules harmonization
- NAPSI Authority for supervision, feedback analysis and decision making