Thailand-EC Cooperation Facility
Enhancing Institutional Capacities for the Market Development of Decentralised Energy Systems in Thailand

Decentralised Energy
A Local Solution for Global Problems

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Enhancing Institutional Capacity for the Market Development of Decentralised Energy Systems in Thailand

Sridhar Samudrala
Director – ASIA
World Alliance for Decentralized Energy (WADE)

Stakeholders Consultation
2nd December 2009
Pullman Bangkok King Power, Room Epsilon
Decentralised Energy: DE Best Practice

- What is Decentralized Energy in this context
- Drivers
- Successful countries in the DE
- Cases
- WADE Model sample: Nigeria, China
What is Decentralized Energy?

Decentralized Energy is the high efficiency production of electricity (and heating/cooling where possible) near the point of use and energy source(s), irrespective of size or technology.

Fuels -- Gas, Wind, Solar, Biomass, Hydro and/or coal.
Key Drivers of DE -- World Population Growth and Energy Demand

Sources: U.S. Energy Information Administration (EIA)
DE as a Share of Total National Power Generation

World Average is 9% - Where is Thailand?

Drivers for DE Development

1. Plant Siting and Permitting
2. Policy needed
3. Interconnection – Standards from Utilities
4. Electric Rates – Feed in Tariffs
5. Utility Restructuring – Gen/Trans/Dist??
6. Market Design(s) – Allowed to sell at market price??
# Why Cogeneration/Trigeneration

<table>
<thead>
<tr>
<th>Energy Cost Savings</th>
<th>Energy costs can be a high proportion of the product cost in many industries. Cogeneration/trigeneration can reduce the energy costs by up to 40%.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Security of Supply</td>
<td>Cogeneration/trigeneration can increase the reliability of power supply. Production processes need to avoid unscheduled shutdown.</td>
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<tr>
<td>Environmental protection</td>
<td>The high overall thermal efficiency of cogeneration/trigeneration minimizes the production of carbon dioxide. Other exhaust emissions can be controlled by the use of low emission combustion technology.</td>
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<tr>
<td>Flexibility of operations</td>
<td>Optimize your operation, dependent on fuel and electricity prices, factory power and heat load.</td>
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Trigeneration System

Overall Plant Efficiency >80%

- Natural Gas
- Gas Turbine
- Heat Recovery Boiler
- Electricity for Captive use 3500 kW
- Absorption Chiller
- Steam 10 Tonnes/hr
- Heat Exchanger
- Chilled Water for Process (15 C)
- Hot water for Process

Funded by:
European Union
What is Possible for a Country

Centralized System of the mid 1980’s

More Decentralized System of Today

Small CHP
Large CHP
Wind

Source: Danish Energy Center
Denmark Policy

- PAST – No legislation for energy security environment (hit by first/second oil crises: in 1973, imported 88.7% of the Energy)
- PAST – 1976 – Plan to promote DH/CHP. Put into practice as of 1979
- PRESENT - DE/CHP and renewable energy to be given priority in dispatching
- PRESENT - 2000 Full liberalisation of the Danish power industry – Past -- customers of 10 GWh per year eligible to choose their electricity supplier in the free market. 2003, all consumers are eligible.
- PAST - All Utilities bundled -- PRESENT –(generation, transmission and distribution – unbundled)

RESULT of Policies
- DE operators, CHP plants benefitted -- customers had obligation to buy local energy. Sent right signals - Gave confidence -- ensured long-term revenues, encouraged investment, energy sold at market rates
- Biomass/biogas CHP plants (those originally mainly generating only electricity) receive a premium which is paid by all consumers.
- Increased DE use and local power production and utilization by over 60% - This meant more business to manufacturers, suppliers and service providers of DE equipment and the local players.
Germany CHP/DHC Scorecard – 4 Stars

Each country is given a scorecard rating as follows:

No material policy effort or intent to promote CHP/DHC. The market is not expected to grow for the foreseeable future. ★★★★★

Some minor recognition of the role of CHP/DHC, but policies are not fully effective or are otherwise insufficient to influence market development. ★★★★★

There is a clear recognition of the role of CHP/DHC, accompanied by the introduction of some measures to accelerate the market, but CHP/DHC are not high priorities compared to other energy solutions. In addition, the country lacks an integrated CHP/DHC strategy. As a result, market growth is likely to be modest. ★★★★★★

CHP/DHC is at or close to the top of the list of energy policy priorities and a series of effective policies are being implemented as part of a coherent strategy. Important growth is expected in CHP/DHC markets. ★★★★★★☆

A world leader in promoting CHP/DHC, with a clear and proven strategy for bringing about significant market development and the implementation of at least one global best-practice policy measure. ★★★★★★☆

Energy Overview

Germany has the largest energy market in Europe and is the backbone of the continent’s electricity and gas networks. Electricity generation is largely based on nuclear and coal power plants, although this is changing. The use of renewable energy in the country is expanding significantly. Germany has set ambitious targets to increase the share of renewable electricity and heat from 10% in 2000 to 55% by 2030. By 2020, 75% of the country’s electricity generation is expected to come from renewable sources.

The electricity grid is one of the most advanced in Europe, with a high degree of integration and interconnection. Germany has made significant investments in transmission and distribution infrastructure, allowing for the efficient transport of electricity across the country.

Despite the high share of renewable energy, the country remains heavily dependent on coal and natural gas for its electricity generation. This has led to concerns about energy security and environmental impacts.

To address these challenges, Germany has implemented a series of policies aimed at promoting the use of renewable energy sources. These policies include feed-in tariffs, renewable energy certificates, and a carbon price. The government has also encouraged the development of large-scale renewable energy projects, such as wind farms and solar parks.

The success of these policies has been significant, with the share of renewable energy in electricity generation increasing steadily over the past decade. However, despite these efforts, the country still relies on fossil fuels for a significant portion of its energy needs.

In recent years, Germany has also been exploring new technologies, such as hydrogen, to diversify its energy mix. The government has set ambitious targets for hydrogen production and use, with the goal of creating a hydrogen economy by 2050.

Overall, Germany’s approach to energy policy is focused on promoting the transition to a low-carbon, sustainable future. The country has made significant progress in this regard, but there is still room for improvement, particularly in terms of reducing greenhouse gas emissions and increasing the share of renewable energy in its energy mix.
German Policy

Key Drivers

• Existing non-operational cogeneration plants can be brought back into use
• Funding for bio-fuels – National policy introduced
• Incentives for municipal cogeneration and sub 2 MWe cogeneration – Tax holidays and financial incentives for sale of power
• Guarantees minimum prices for feeding renewable energy into the grid over a 20-year period
• building code targets reduction of primary energy use
• Attractive feed in Tariff, particularly for biogas CHP, modernization of existing plants
• Exemption from Ecotax for NG and heating oil used for DE/CHP
• CHP/DHC is recognised in Renewable Heat Law

Key Barriers

• The major generating companies have been consolidated and continue to hold considerable power, discouraging growth in cogeneration and DE – Vertically integrated companies
• Low wholesale electricity prices over the last few years
• Perceived grid stabilization issues due to increasing DE grid-connection – no standards and control mechanisms
WADE model

**INPUT OUTPUT MODEL**

**INPUT:**
- Capacity & Generation
  - Existing capacity & generation
  - Load factor
- Pollution level
  - Pollution level (NOx, SOx, PM10, CO2)
  - Heat rate
- Cost
  - Investment cost
  - O&M cost
  - Fuel cost
- Growth Properties
  - System growth properties
  - Capacity

**OUTPUT:**
- Total capital cost
- Retail cost
- Fuel used
- Emission level

**METHODOLOGY USED**

- Data collection
- Data input into WADE’s economic model
- Scenario development
- Sensitivity analysis
- Model run
- Comparison & analysis
- Recommendations
ALTERNATIVE ENERGY SCENARIOS

<table>
<thead>
<tr>
<th>Reference scenario</th>
<th>Env concern scenario</th>
<th>Security of Supply scenario</th>
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<tbody>
<tr>
<td>The future technology distribution is based on Nigerian power development plan 2009-2020</td>
<td>Increase share of RE (small hydro, biomass, PV) and clean coal technology enter the framework</td>
<td>Ensure security of supply. Increase coal share and commissioning of nuclear power plant</td>
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The variation mix of 90% CG/10% DE “CG Case”, and 60% CG/40% DE “DE case” was applied in all the different scenarios.
Sensitivity Analysis Scenario

The following scenarios were compared to reference scenario

• **Case A: Low electricity demand growth scenario**
  Concerning a great need of a national program on Demand Side Management (DSM). lower demand growth of 2.5% was applied in Case A while 3.1% in reference scenario

• **Case B: High natural gas price scenario**
  Examines the sensitivity involved if the natural gas price in Nigeria is to be equal to the international gas price which is 4 US$/mscf. Substantial subsidy reduction from the government

• **Case C: Low heat rate of fossil fuel-fired DE**
  This scenario examines the heat rate of fossil fuel-fired DE applications and evaluates the impact on the output by assuming that a DE-fired plant could achieve high overall efficiency, translating to a heat rate of 6,000 kJ/KWh
Electricity Supply in Nigeria by scenario 2020-2028

Total power generation
- CG case: 82,436 GWh
- DE case: 64,023 GWh

The DE case reduced total capacity of 3% by 2020 and increased to 5%.

The reduction in principal comes from high energy utilization through DE for example through the reduction of network losses.
Model Output (cont’d)

Fuel used 2028

Emission level 2028

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Reference</th>
<th>Environment</th>
<th>SoS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂ EMISSIONS (Mt)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CG-DE DIFFERENCE</td>
<td>-15%</td>
<td>-9%</td>
<td>-9%</td>
</tr>
<tr>
<td>NOₓ EMISSIONS (kt)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CG-DE DIFFERENCE</td>
<td>-13%</td>
<td>-9%</td>
<td>-6%</td>
</tr>
<tr>
<td>SO₂ EMISSIONS (kt)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>CG-DE DIFFERENCE</td>
<td>-30%</td>
<td>-29%</td>
<td>-29%</td>
</tr>
<tr>
<td>PM₁₀ EMISSIONS (kt)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CG-DE DIFFERENCE</td>
<td>-18%</td>
<td>-13%</td>
<td>-11%</td>
</tr>
</tbody>
</table>
Summary of Main Findings

• Decentralized energy will deliver significant benefits to Nigeria’s economic and environmental sectors.

• saving above US$2.7 billion, or a 19-20% reduction in capital costs by 2028, compared to CG. Result from reduced investment in transmission lines. Nevertheless, approximately US$1.43 billion must be invested in each DE case.

• Among the three scenarios, the Reference scenario -- lowest capital costs
• Security of Supply scenario -- highest capital costs as a result of commissioning a nuclear plant
• DE -- lower retail cost compared to the CG case (17-18% reduction) -- Environmental Concern scenario - lowest retail cost - reduced fuel costs due to a high renewable energy share.
Example: Capital Costs in China

The diagram illustrates the capital costs in China for different percentages of decentralized energy (% DE) of total generation. The costs are represented in billions of US dollars for new capacity.

- **100% Central / 0% DE**: The highest costs, with a significant portion allocated to new generation (red) and the rest to decentralized energy (blue).
- **75% / 25% DE of Total Generation**: Costs are reduced compared to the centralized option, with a notable decrease in new generation investment.
- **50% / 50% DE**: Costs further decrease, with equal investments in centralized and decentralized energy.
- **25% / 75% DE**: Costs continue to decrease, with a larger investment in decentralized energy.
- **0% Central / 100% DE**: The lowest costs, with all investment in decentralized energy.

The legend indicates the different types of investments:
- **Inv. In New Cent. Gen.** (red)
- **Inv. in new DE** (blue)
- **Inv. In T&D** (yellow)
Example – Sensitivity Analysis for China Model Run

[Bar chart showing different scenarios and their investment costs in billions of US$ for new capacity in 2021, with categories like Reference case, 3% (low) demand growth, high coal capacity, high gas capacity, T&D cost + 1/3, High nuclear and renewables capacity, 8% (high) demand growth.]
THANK YOU

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