Feasibility Study

Project Number: 42039-034
November 2011

Multitranche Financing Facility
Socialist Republic of Viet Nam: Power Transmission Investment Program

Summary Report
500/220 kV Bac Ninh 2– Pho Noi Transmission Lines
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Chapter 1:

NECESSITY AND OBJECTIVES OF THE PROJECT

1.1 Necessity of the project

Bac Ninh province is located in key economic areas - growth triangle: Ha Noi - HaiPhong - Bac Ninh 2; near the area, the region's major industrial center in the North.

Because of such importance, provincial leaders and EVN (Electricity of VietNam) have attended to the construction of infrastructure, especially electricity.

According to the result of balanced power of Bac Ninh province, to meet the load demand in 2015, need to build 220kV Bac Ninh 2 substation with a capacity of 3x250MVA and 220kV Bac Ninh 3 substation with a capacity of 3x250MVA.

Therefore, the construction of transmission line 500/220kV Bac Ninh 2 – Pho Noi to power 220kV Bac Ninh 2 substation and associated 500kV grid northern region is needed.

1.2 Objective of the project

- Receiving power from 500/220kV Pho Noi substation and supplies power with 220kV Bac Ninh 2 substation to provide electricity for the Western – Southern region of Bac Ninh province, and partial support for Bac Ninh city.

- Overload protection for 220kV & 110kV grids.

- Linking 500kV-220kV power grid in Northern region and ensuring national energy security.

- Saving land in Bac Ninh province.
Chapter 2:

PRESENT STATUS OF NORTH VIET NAM

2.1 Natural features and administration of the project area

Bac Ninh is a province in the northern delta region, fits in the Red River Delta, adjacent to Hanoi.

- In the North : borders on Bac Giang province
- In the South : borders on Hung Yen province and a part of Hanoi
- In the East : borders on Hai Duong
- In the West : borders on Hanoi

Bac Ninh province has eight district-level administrative units, including Bac Ninh city and seven districts of Bac Ninh is: Yen Phong, Que Vo, Tien Du, Tu Son, Thuan Thanh, Gia Binh Luong Tai.

In recent years economic and social of Bac Ninh has made development, gross domestic product GDP average growth of 12.9%. Structural economic shifts towards industrialization.

2.2 Status of power system of the project area

Bac Ninh province is now mainly supply from national grid by regional transmission grids and power stations as:

- Bac Ninh 220kV station is receiving power from Pha Lai Thermal Power Plant by 220kV Pha Lai – Bac Ninh transmission line and from 220kV Soc Son substation by 220kV Soc Son – Bac Ninh transmission line; and supplies for 110kV substation as: Que Vo, Kinh Noi, Khac Niem, Tien Son, Gia Luong, Binh Dinh, Vo Cuong and Dap Cau Glass.

- 110kV grid region is supported from sources surrounding the following:
  - From Pha Lai Thermal Power Plant by double circuit 110kV Pha Lai - Bac Ninh transmission line, wire AC-150, 21.8 km.
  - From 220/110kV Dong Anh substation by double circuit 110kV Dong Anh – Bac Ninh transmission line, wire AC-150, 35.8km.
  - From 220/110kV Dong Anh substation by single circuit 110kV Dong Anh - Dinh Tram transmission line, wire AC-185, 36.8km.
Table 2-1: List of existing 220kV, 110kV transmission lines of the Bac Ninh area

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of transmission line</th>
<th>Conductor</th>
<th>Length (km)</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>220kV T/L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Pha Lai – Bac Ninh</td>
<td>ACSR-520</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Soc Son – Bac Ninh</td>
<td>ACSR-520</td>
<td>46,1</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>110kV T/L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Bcc Ninh - Pha Lai</td>
<td>ACSR-150</td>
<td>2x21,8</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Gia Luong branch turn</td>
<td>ACSR-185</td>
<td>1x8,0</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Binh Dinh branch turn</td>
<td>ACSR-185</td>
<td>1x9,2</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Bac Ninh - Kinh Noi</td>
<td>ACSR-150</td>
<td>2x9</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Kinh Noi - Tien Son</td>
<td>ACSR-150</td>
<td>2x6,5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Tien Son - Chau Khe</td>
<td>ACSR-150</td>
<td>2x11,25</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Chau Khe - Dong Anh</td>
<td>ACSR-150</td>
<td>2x9</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Dong Anh - Vo Cuong</td>
<td>ACSR-185</td>
<td>1x22,5</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Vo Cuong branch turn</td>
<td>ACSR-185</td>
<td>1x3</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Vo Cuong - Dap Cau</td>
<td>ACSR-185</td>
<td>1x6,9</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Dap Cau - Dinh Tram</td>
<td>ACSR-185</td>
<td>1x8,2</td>
<td></td>
</tr>
</tbody>
</table>

Table 2-2: List of existing 220kV, 110kV substations of the Bac Ninh area

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of substation</th>
<th>Capacity (MVA)</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>220kV Bac Ninh</td>
<td>125+250</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>110kV Gia Luong</td>
<td>1x25</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>110kV Binh Dinh</td>
<td>1x63</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>110kV Kinh Noi</td>
<td>1x10</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>110kV Tien Son</td>
<td>40+63</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>110kV Que Vo</td>
<td>1x40</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>110kV Khac Niem</td>
<td>1x20</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>110kV Chau Khe</td>
<td>40+63</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>110kV Kinh Noi</td>
<td>1x10</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>110kV Vo Cuong</td>
<td>3x25</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>110kV Dap Cau</td>
<td>1x6,3</td>
<td></td>
</tr>
</tbody>
</table>

2.3 Developing orientation of power sources and network

Based on "Plan for National Electricity Development for 2006-2015, with perspective to 2025 (overall scheme VI)" was approved by the Prime Minister and "Planning the
improvement and development of grid Bac Ninh power 2008-2010 period, considering that by 2015” was approved by the Ministry of Industry and Trade, plans to develop regional power grid and Bac Ninh in the period 2008-2010 and in 2011-2015 as follows:

Table 2-3: Developing orientation for 220kV, 110kV T/L of Bac Ninh (2015)

<table>
<thead>
<tr>
<th>No.</th>
<th>Project</th>
<th>Conductor</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>2008-2010</td>
</tr>
<tr>
<td>I</td>
<td>220kV T/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bac Ninh 3 branch turn</td>
<td>AC-2x330</td>
<td>2 x 7km</td>
</tr>
<tr>
<td></td>
<td>Long Bien - Bac Ninh 2</td>
<td>AC-500</td>
<td>2x28.5km</td>
</tr>
<tr>
<td>II</td>
<td>110kV T/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Bac Ninh - Tien Son</td>
<td>AC-240</td>
<td>2x27km</td>
</tr>
<tr>
<td>2</td>
<td>Bac Ninh - Dai Kim - Bac Giang</td>
<td>AC-300</td>
<td>2x20km</td>
</tr>
<tr>
<td>3</td>
<td>Yën Phong branch turn</td>
<td>AC-300</td>
<td>2x8km</td>
</tr>
<tr>
<td>4</td>
<td>Yen Phong - Yen Phong 2</td>
<td>AC-300</td>
<td>2x7km</td>
</tr>
<tr>
<td>5</td>
<td>Thuan Thanh 2 branch turn</td>
<td>AC-240</td>
<td>2x4.5km</td>
</tr>
<tr>
<td>6</td>
<td>VSIP branch turn</td>
<td>AC-240</td>
<td>2x3km</td>
</tr>
<tr>
<td>7</td>
<td>Que Vo 2 branch turn</td>
<td>AC-185</td>
<td>2x1km</td>
</tr>
<tr>
<td>8</td>
<td>Khac Niem branch turn</td>
<td>AC-185</td>
<td>2x0.5km</td>
</tr>
<tr>
<td>9</td>
<td>Thuan Thanh 2 - Thuan Thanh 3</td>
<td>AC-240</td>
<td>2x7km</td>
</tr>
<tr>
<td>10</td>
<td>Hanaka branch turn</td>
<td>AC-300</td>
<td>2x5km</td>
</tr>
<tr>
<td>11</td>
<td>Binh Dinh - Hung Yen</td>
<td>AC-240</td>
<td>2x12km</td>
</tr>
<tr>
<td>12</td>
<td>220kV Bac Ninh 2 substation feeder</td>
<td>AC-240</td>
<td>6x0.2km</td>
</tr>
<tr>
<td>13</td>
<td>220kV Bac Ninh 3 substation feeder</td>
<td>AC-300</td>
<td>4x0.5km</td>
</tr>
<tr>
<td>14</td>
<td>Bac Ninh 3 - Yen Phong</td>
<td>AC-300</td>
<td>2x7km</td>
</tr>
</tbody>
</table>
Table 2-4: Developing orientation for 220kV, 110kV substation of Bac Ninh (2015)

<table>
<thead>
<tr>
<th>No.</th>
<th>Project</th>
<th>Scale (MVA)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2008-2010</td>
</tr>
<tr>
<td>I</td>
<td>220kV substation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>New construction</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>220kV Bac Ninh 2</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>220kV Bac Ninh 3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improved capacity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>220kV Bac Ninh</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>110kV substation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>New construction</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>110kV Yen Phong</td>
<td>1x63</td>
</tr>
<tr>
<td>2</td>
<td>110kV Yen Phong 2</td>
<td>1x63</td>
</tr>
<tr>
<td>3</td>
<td>110kV Dai Kim</td>
<td>1x63</td>
</tr>
<tr>
<td>4</td>
<td>110kV VSLP</td>
<td>1x63</td>
</tr>
<tr>
<td>5</td>
<td>110kV Thuan Thanh 2</td>
<td>1x40</td>
</tr>
<tr>
<td>6</td>
<td>110kV Que Vo 2</td>
<td>1x40</td>
</tr>
<tr>
<td>7</td>
<td>110kV Khac Niem</td>
<td>1x63</td>
</tr>
<tr>
<td>8</td>
<td>110kV Thuan Thanh 3</td>
<td>1x63</td>
</tr>
<tr>
<td>9</td>
<td>110kV Bac Ninh 2</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>110kV Hanaka</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improved capacity</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>110kV Chau Khe</td>
<td>1x63</td>
</tr>
<tr>
<td>2</td>
<td>110kV Vo Cuong</td>
<td>2x80</td>
</tr>
</tbody>
</table>
### Feasibility Study Summary Report

<table>
<thead>
<tr>
<th></th>
<th>110kV Gia Luong</th>
<th>1x25</th>
<th>1x40</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>110kV Binh Đinh</td>
<td>1x63</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>110kV Que Vo</td>
<td>1x40</td>
<td>1x63</td>
</tr>
<tr>
<td>6</td>
<td>110kV Tien Son</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.1 Load forecast

Based on topography, existing economic partitions and economic development plans of the Bac Ninh province, there are 2 load zone as follows:

Zone 1: comprises Bac Ninh city, Yen Phong district, Tu Son district, Tien Du district and Que Vo district.

Zone 2: comprises Thuan Thanh district, Luong Tai district and Gia Binh district.

Zone 1 is now supplied power from 110kV Vo Cuong substation and 110kV Dap Cau substation. Zone 2 is now supplied from 110kV Gia Luong substation and 110kV Binh Dinh substation.

Based on "Planning the improvement and development of grid Bac Ninh power 2008-2010 period, considering that by 2015" was approved by the Ministry of Industry and Trade, power demand of each area as follows in table 3-1:
Table 3-1: Load data of each area

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of area</th>
<th>Industrial &amp; Construction</th>
<th>Agriculture, Forestry &amp; Fisheries</th>
<th>Trade &amp; Service</th>
<th>Sector management</th>
<th>Others</th>
<th>Pmax (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BacNinh city</td>
<td>16 400</td>
<td>27 630</td>
<td>1 110</td>
<td>1 280</td>
<td>2 620</td>
<td>4 930</td>
</tr>
<tr>
<td>2</td>
<td>Yen Phong district</td>
<td>84 880</td>
<td>191 59</td>
<td>2 110</td>
<td>2 540</td>
<td>2 540</td>
<td>1 200</td>
</tr>
<tr>
<td>3</td>
<td>Tu Son district</td>
<td>95 350</td>
<td>187 450</td>
<td>3 170</td>
<td>3 580</td>
<td>3 10</td>
<td>4 480</td>
</tr>
<tr>
<td>4</td>
<td>Tien Du district</td>
<td>81 480</td>
<td>188 150</td>
<td>1 370</td>
<td>1 690</td>
<td>870</td>
<td>1 330</td>
</tr>
<tr>
<td>5</td>
<td>Que Vo district</td>
<td>98 180</td>
<td>206 820</td>
<td>2 030</td>
<td>2 350</td>
<td>3 20</td>
<td>1 950</td>
</tr>
<tr>
<td>6</td>
<td>Thuan Thanh district</td>
<td>33 170</td>
<td>111 940</td>
<td>660</td>
<td>890</td>
<td>3 20</td>
<td>960</td>
</tr>
<tr>
<td>7</td>
<td>Gia Binh district</td>
<td>2 170</td>
<td>22 715</td>
<td>1 360</td>
<td>1 690</td>
<td>150</td>
<td>500</td>
</tr>
<tr>
<td>8</td>
<td>Luong Tai district</td>
<td>50 660</td>
<td>94 520</td>
<td>1 810</td>
<td>2 230</td>
<td>310</td>
<td>920</td>
</tr>
<tr>
<td>Pmax(kW)</td>
<td></td>
<td>392 000</td>
<td>930 000</td>
<td>13 000</td>
<td>15 000</td>
<td>5 000</td>
<td>15 500</td>
</tr>
</tbody>
</table>
3.2 Power flow calculation

According to the load flow calculation in 2025, the transmitted power through 500/220kV Bac Ninh 2 - Pho Noi TL such as:

- **220kV voltage**: \( S_{\text{max}} = 765.4 + j415.8 \) (MVA)
- **500kV voltage**: \( S_{\text{max}} = 990.9 + j198.7 \) (MVA)
Chapter 4:

CONSTRUCTING SITE AND SCOPE OF THE PROJECT

4.1 Constructing site and the line route

The 500/220kV Bac Ninh 2 – Pho Noi transmission line has total length about 30.5km. The start point is at the 500/220kV Pho Noi substation and end point is at the 220/110kV Bac Ninh 2 substation.

This transmission line passes through 2 provinces: Bac Ninh and Hung Yen.

In Bac Ninh province, length of line route is about 29.3km, and passes through 4 district: Thuan Thanh, Gia Binh, Que Vo, Tien Du.

In Hung Yen province, length of line route is about 1.2km, and passes through Van Lam district.

Generally full of 500/220kV Bac Ninh 2 – Pho Noi transmission line passes through flat country terrain which is planting rice and farm produce of Bac Ninh and Hung Yen province.

This transmission line has 1 crossing wide, Duong river.

The line route is described in table 4-1 as following:

Table 4-1: The number of basic data of 500/220kV Bac Ninh 2 – Pho Noi transmission line.

<table>
<thead>
<tr>
<th>No.</th>
<th>ITEMS</th>
<th>UNIT</th>
<th>NUMBERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The length of line</td>
<td>km</td>
<td>30.5</td>
</tr>
<tr>
<td>2</td>
<td>Total steering angle</td>
<td>angle</td>
<td>26</td>
</tr>
<tr>
<td>3</td>
<td>Number of crossing with Highway No.38</td>
<td>times</td>
<td>02</td>
</tr>
<tr>
<td>4</td>
<td>Number of crossing with provincial road 282</td>
<td>times</td>
<td>01</td>
</tr>
<tr>
<td>5</td>
<td>Number of crossing with provincial road 284</td>
<td>times</td>
<td>01</td>
</tr>
<tr>
<td>6</td>
<td>Number of crossing with communal road</td>
<td>times</td>
<td>77</td>
</tr>
<tr>
<td>7</td>
<td>Number of crossing with Duong river dike</td>
<td>times</td>
<td>01</td>
</tr>
<tr>
<td>8</td>
<td>Number of crossing with Duong river</td>
<td>times</td>
<td>01</td>
</tr>
<tr>
<td>9</td>
<td>Number of crossing with canal, width &lt;10m</td>
<td>times</td>
<td>63</td>
</tr>
<tr>
<td>10</td>
<td>Number of crossing with canal, width &gt;10m</td>
<td>times</td>
<td>14</td>
</tr>
<tr>
<td>11</td>
<td>Number of crossing with pond, width &lt;100m</td>
<td>times</td>
<td>04</td>
</tr>
<tr>
<td>12</td>
<td>Number of crossing with pond, width &gt;100m</td>
<td>times</td>
<td>05</td>
</tr>
<tr>
<td>13</td>
<td>Number of crossing 500kV TL</td>
<td>times</td>
<td>01</td>
</tr>
</tbody>
</table>
4.2 Scope of Project

The scope of the project is includes building the 500kV single circuit and 220kV double circuit transmission line on the same pole.

- Voltage: 500kV & 220kV
- Number of Circuits: 01 (500kV) & 02 (220kV)
- Start point: 500kV Pho Noi substation.
- End point: 220kV Bac Ninh 2 substation.
- Total length: 30.5 km.
- Conductor: 4×ACSR330/42 (500kV) & 3×ACSR400/51 (220kV); at the crossing Duong river, using: 4×ASTER-366 & 3×AAAC-400
- Overhead Ground Wires: PHLOX-147 & OPGW-120
- Insulator: U70B, U120B, U160BS, U300B suspension and tension insulator sets.
- Tower: galvanized steel tower.
- Foundation: Raft foundation made from steel concrete in - situ cast.
- Grounding: directly by 12mm dia galvanized round iron bar combined with galvanized earth-electrode.
Chapter 5:

TECHNICAL SOLUTIONS

5.1 Electrical solutions

5.1.1 Selection of Voltage level

The voltage level has to be selected based on the duty of the line within the network and network planning. Selected voltage levels are based on Vietnamese standard voltage levels:

- Super high voltage level: 500kV.
- High voltage levels: 220kV, 110kV.
- Medium voltage level: 22kV.

According to the power distribution calculation and transmission distance, voltage level is selected 500kV & 220kV.

5.1.2 Selection of Conductor

Conductor are selected according to electrical, thermal, mechanical and economic aspected.

In accordance with the result of calculation power flow, the cross-section of conductor used for 500/220kV Bac Ninh 2 – Pho Noi transmission line is $4 \times$ ACSR 330/42 (550kV) and $3 \times$ ACSR 400/51 (220kV).

5.1.3 Selection of Overhead Ground Wires

To satisfy requerements of lightning protection of 500/220kV Bac Ninh 2 – Pho Noi transmission line and link optical communication, used two ground wires above the power lines: PHLOX and OPGW (Composite Fiber Optic Overhead Ground Wire).

Calcualted cross-section [mm$^2$] of Overhead Ground Wires be selected by taking the limits of temprature rise caused by short-circuited transmission lines.

In accordance with the result of calculation one phase fault, the kinds of Overhead Ground Wires are selected are PHLOX-147 and OPGW120/24 SM-fibres.

5.1.4 Selection of Insulators and Accessories

Insulators

To satisfy mechanical failing load, insulators of transmission line be used types below: U70BL, U120B, U160BS, and U300B
Glass or porcelain insulator is used for insulator string type. As countermeasure against corrosion of the pin, each insulator shall be armored with a zinc sleeve around the pin shank.

Insulators and fittings must be manufactured in accordance with international standard IEC-305.

Number of insulators per string is calculated in accordance with nominal creepage distance.

Calculation results

- **Voltage of 220kV**

<table>
<thead>
<tr>
<th>No.</th>
<th>Insulator</th>
<th>Sign</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Single suspension insulator string</td>
<td>CD 12-1-17</td>
<td>1x17</td>
</tr>
<tr>
<td>2</td>
<td>Single suspension insulator string</td>
<td>CD 16-1-16</td>
<td>1x16</td>
</tr>
<tr>
<td>3</td>
<td>Double suspension insulator string</td>
<td>CDVD 12-2-18</td>
<td>2x18</td>
</tr>
<tr>
<td>4</td>
<td>Double suspension insulator string</td>
<td>CDVD 16-2-17</td>
<td>2x17</td>
</tr>
<tr>
<td>5</td>
<td>Double suspension insulator string</td>
<td>CDVVS 30-2-17</td>
<td>2x17</td>
</tr>
<tr>
<td>6</td>
<td>Double tension insulator string</td>
<td>CN 12-2-18</td>
<td>2x18</td>
</tr>
<tr>
<td>7</td>
<td>Double tension insulator string</td>
<td>CN 30-2-14</td>
<td>2x14</td>
</tr>
<tr>
<td>8</td>
<td>Single jumper suspension insulator string</td>
<td>CDL 7-1-17</td>
<td>1x17</td>
</tr>
</tbody>
</table>

- **Voltage of 500kV**

<table>
<thead>
<tr>
<th>No.</th>
<th>Insulator</th>
<th>Sign</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Single suspension insulator string</td>
<td>CD 12-1-37</td>
<td>1x37</td>
</tr>
<tr>
<td>2</td>
<td>Double suspension insulator string</td>
<td>CDV 12-2-38</td>
<td>2x38</td>
</tr>
<tr>
<td>3</td>
<td>Double suspension insulator string</td>
<td>CDV 16-2-36</td>
<td>2x36</td>
</tr>
<tr>
<td>4</td>
<td>Double suspension insulator string</td>
<td>CDVVBD 16-2-36</td>
<td>2x36</td>
</tr>
<tr>
<td>5</td>
<td>Double suspension insulator string</td>
<td>CDVVBD 30-2-29</td>
<td>2x29</td>
</tr>
<tr>
<td>6</td>
<td>Double suspension insulator string</td>
<td>CDVVS 30-2-34</td>
<td>2x34</td>
</tr>
<tr>
<td>7</td>
<td>Double tension insulator string</td>
<td>CN 16-2-35</td>
<td>2x35</td>
</tr>
<tr>
<td>8</td>
<td>Double tension insulator string</td>
<td>CN 30-2-29</td>
<td>2x29</td>
</tr>
<tr>
<td>9</td>
<td>Double tension insulator string</td>
<td>CN 30-2-31</td>
<td>2x31</td>
</tr>
<tr>
<td>10</td>
<td>Single jumper suspension insulator string</td>
<td>CDL 7-1-37</td>
<td>1x37</td>
</tr>
</tbody>
</table>

**NOTE:** Contamination level is 2.0cm/kV

5.1.5 Protection solutions

**Lightning protection:** To reduce of lightning directly striking overhead transmission lines, used two ground wires above the power lines with protect angles ≤ 20.
**Earthing:** Directly grounded GSW conductor at all tower, gantry and tower themselves.

**Damper:**

Stockbridge vibration dampers are used on ground wires.

5.2 Main construction solutions

5.2.1 *Design of the Towers*

All towers of 500/220kV Bac Ninh 2 – Pho Noi transmission line are designed as self-supporting structure, steel latticed towers type.

Types of basic tower is used for this project are suspension and tension towers.

- The height of suspension towers: 41.5m; 67m, 71m, 77m; 34m, 38m; 57.5m, 61.5m, 69.5m, 73.5m; 102m.

- The height of tension towers: 23.5m, 30m, 40m, 56m; 62m; 34m; 47m, 59m, 64m; 47m, 59m.

5.2.2 *Design of the foundation*

**Foundation solutions**

Engineering-geology, relief, hydrology along line route is the same kind of relative identical land, so choosing pad-and-chimney foundations are logical and economical.

**Choosing materials**

The foundations steel uses for group A. The steel A1 is $R_s=2250\text{kg/cm}^2$, the steel A2 is $R_s=2800\text{kg/cm}^2$ and the steel A3 is $R_s=3650\text{kg/cm}^2$. Foundations will be reinforced concrete, in situ cast with 2x4 stones, concrete grade M200. The pave under foundations, in situ cast with 4x6 stones, concrete grade M50.
Feasibility Study

Project Number: 42039-034
November 2011

Multitranche Financing Facility
Socialist Republic of Viet Nam: Power Transmission Investment Program

Summary Report
Pho Noi 500 kV Substation and Connecting Lines
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CHAPTER 1: GENERAL INTRODUCTION

1.1. BASIS OF ESTABLISHED FEASIBILITY STUDY

Feasibility Study (FS) for 500kV Pho Noi substation and connecting branches project is established based on the following basis:

- Master Plan of Power Sector Development of Vietnam No. VI.
- Plan of power network improvement and development of Hung Yen province, period of 2006-2010 perspective to 2015.
- Correspondence to No. 6195/CV-EVN-KH dated 21/11/2007 of Viet Nam Electricity about “Assigning establish feasibility study for 500kV Pho Noi substation and connecting branches project”.
- Correspondence to No. 653/UBND-KTTH dated 29/04/2008 of Hung Yen province people’s committee about “Agree local construction for 500kV Pho Noi substation and connecting branches project”.

1.2. OBJECTIVES OF PROJECT

Investment of 500kV Pho Noi substation and connecting branches project aims to:

- Connecting and transmitting power capacity from Hai Phong 3 Thermal Power Complex aim to load demand of Northern region in general and national.
- Create a ring circuit connection of 500kV Pho Noi – Dong Anh – Hiep Hoa, aim to load demand of Ha Noi center.
- Increase reliability and safety of power supply and power quality to power grid of Northern region in general and national.
CHAPTER 2: NECESSITY OF PROJECT INVESTMENT

To explain the necessity and the construction time of 500kV Pho Noi substation, the project shall be analysed by focusing on 2 factors:

- The facilitation for the connection and power transmission between Hai Phong 3 Thermal Power Complex and The National Power System.
- The guarantee of continuous power supply and safe operation in all cases of the system for the load demand of Hung Yen province and neighboring provinces.

To find the most reasonable way of connecting Hai Phong 3 Thermal Power Complex into the National Power System, this project shall focus on:

- Power balance, load balance in Ha Noi and neighboring provinces including Ha Tay, Ha Nam, Hung Yen, Hai Duong, Bac Ninh, Vinh Phuc and Phu Tho.
- The study of current status and expected development of electricity transmission grid in the project area to propose the connection plan.

2.1. POWER BALANCE AND LOAD BALANCE IN THE AREA

Table 2.1: Power balance, load balance in Ha Noi and neighboring provinces

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Year 2010</th>
<th>Year 2015</th>
<th>Year 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Total power in the area (MW)</td>
<td>3.220</td>
<td>3.220</td>
<td>4.420</td>
</tr>
<tr>
<td>2</td>
<td>Total power load (MW)</td>
<td>3.937</td>
<td>7.809</td>
<td>12.749</td>
</tr>
<tr>
<td>3</td>
<td>Balance, residual (+), insufficient (-)</td>
<td>-717</td>
<td>-4.589</td>
<td>-8.392</td>
</tr>
</tbody>
</table>

Source: Plan for connecting all thermoelectric plants in the whole country to the National Power System.
Figure 2.1: Power and load balancing in the North area in 2015

Figure 2.2: Power and load balancing in the North area in 2020
2.2. ALTERNATIVES FOR CONNECTING HAI PHONG 3 THERMAL POWER COMPLEX TO THE NATIONAL POWER SYSTEM

2.2.1 Connection Alternatives:

Hai Phong 3 Thermal power complex is proposed to be put in operation in stage 2014 - 2015 with the following power capacity and operating schedule:

Table 2.2: Operating schedule of Hai Phong 3 Thermal power complex

<table>
<thead>
<tr>
<th>No.</th>
<th>Generator</th>
<th>Power Capacity (MW)</th>
<th>Operating year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Generator 1 and 2</td>
<td>1200</td>
<td>2014</td>
</tr>
<tr>
<td>2</td>
<td>Generator 3 and 4</td>
<td>1200</td>
<td>2015</td>
</tr>
</tbody>
</table>

With the main purpose of Hai Phong 3 Thermal Power Complex power transmission which supplies the load demand in Ha Noi and neighboring provinces, this project shall consider 2 connection alternatives as below:

Alternative 1: Build Pho Noi 500kV substation at Van Lam district, Hung Yen province and the substation shall be connected to the existing Quang Ninh – Thuong Tin 500kV transmission line.

Figure 2.3: 500kV power network in the North area until 2020 - Alternative 1

To execute plan 1, it is necessary to completely build 500kV power network until 2020 as below:

- Build Pho Noi 500kV substation: 2x600MVA.
- Build 500kV transmission line, double circuits, approximate 1.34km in
length which shall connect Pho Noi 500kV substation to Quang Ninh – Thuong Tin 500kV transmission line by conductor 4xACSR330.

- Build 500kV transmission line, approximate 58km in length which shall connect Hai Phong 3 Thermal power complex to Pho Noi 500kV substation.
- Build 500kV transmission line, approximate 60km in length which shall connect Thai Binh 500kV substation to Pho Noi 500kV substation.
- Build 500kV transmission line, approximate 35km in length which shall connect Dong Anh 500kV substation to Pho Noi 500kV substation.

**Alternative 2:** Hai Phong 3 Thermal power complex shall be connected to Thuong Tin 500kV substation.

![Diagram](image-url)

**Figure 2.4:** 500kV power network in the North area until 2020 - Alternative 2

To execute alternative 2, it is necessary to completely build 500kV power network until 2020 as below:

- Install 900MVA transformer at 500kV Thuong Tin substation.
- Build 500kV transmission line, approximate 80km in length which shall connect Hai Phong 3 Thermal power complex to Thuong Tin 500kV substation.
- Build 500kV transmission line, approximate 72km in length which shall connect Thai Binh 500kV substation to Thuong Tin 500kV substation.
- Build 500kV transmission line, approximate 45km in length which shall connect Dong Anh 500kV substation to Thuong Tin 500kV substation.
2.2.2 Calculate power distribution and define power loss of electricity grid

Table 2.3: Power loss of entire system of alternatives

<table>
<thead>
<tr>
<th>No.</th>
<th>Alternative</th>
<th>Power Loss (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Year 2015</td>
</tr>
<tr>
<td>1</td>
<td>Alternative 1 (PA₁)</td>
<td>837</td>
</tr>
<tr>
<td>2</td>
<td>Alternative 2 (PA₂)</td>
<td>852</td>
</tr>
</tbody>
</table>

Δ(PA₂ - PA₁) 15 45

Figure 2.5: Load flow of 500kV power network in the North area in 2015 - Alternative 1
Figure 2.6: Load flow of 500kV power network in the North area in 2015 – Alternative 2

Figure 2.7: Load flow of 500kV power network in the North area in 2020 – Alternative 1
Figure 2.8: Load flow of 500kV power network in the North area in 2020 – Alternative 2

Table 2.4: Cases of calculation at maximum load in 2015

<table>
<thead>
<tr>
<th>No</th>
<th>Case</th>
<th>220kV Transmission Line or 500kV Substation</th>
<th>Power load in line or transformer</th>
<th>Load percentage</th>
<th>Power loss of VN power system</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Alternative 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>In normal case</td>
<td>Thuong Tin - Mai Dong (1 circuit)</td>
<td>249+j76.5</td>
<td>72%</td>
<td>837 MW</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mai Dong - An Duong (1 circuit)</td>
<td>91.5+j6.7</td>
<td>25%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thuong Tin - Van Dien (1 circuit)</td>
<td>119+j87</td>
<td>41%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thuong Tin - Pho Noi</td>
<td>12-j11.1</td>
<td>6%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pho Noi 500kV substation</td>
<td>768+j128</td>
<td>65%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thuong Tin 500kV substation</td>
<td>1,161+j517</td>
<td>94%</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Alternative 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>In normal case</td>
<td>Thuong Tin - Mai Dong (1 circuit)</td>
<td>297+j104.5</td>
<td>87%</td>
<td>852.3MW</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mai Dong - An Duong (1 circuit)</td>
<td>139.5+j70.3</td>
<td>43%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thuong Tin – Van Dien (1 circuit)</td>
<td>172+j107.9</td>
<td>69%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thuong Tin - Pho Noi</td>
<td>193-j5.3</td>
<td>65%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thuong Tin 500kV substation</td>
<td>1,707+j683</td>
<td>136%</td>
<td></td>
</tr>
</tbody>
</table>

(*) : Thuong Tin 500kV substation with power at (450+900)MVA (as Master Plan VI)
**Table 2.5: Cases of calculation at maximum load in 2020**

<table>
<thead>
<tr>
<th>No</th>
<th>Case</th>
<th>220kV Transmission Line or 500kV Substation</th>
<th>Power load in line or transformer</th>
<th>Load percentage</th>
<th>Power loss of VN power system.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong> Alternative 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>In normal case</td>
<td>Thuong Tin – Mai Dong (1 circuit)</td>
<td>329+j75.5</td>
<td>88%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mai Dong - An Duong (1 circuit)</td>
<td>148+j16.7</td>
<td>41%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thuong Tin - Van Dien (1 circuit)</td>
<td>119+j87</td>
<td>41%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thuong Tin – Pho Noi</td>
<td>250+j121</td>
<td>91%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pho Noi 500kV substation (1 transformer)</td>
<td>702+j225</td>
<td>82%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thuong Tin 500kV substation (1 transformer)*</td>
<td>839+j163</td>
<td>95%</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B</strong> Alternative 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>In normal case</td>
<td>Thuong Tin - Mai Dong (1 circuit)</td>
<td>335+j78</td>
<td>95%</td>
<td>1,741MW</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mai Dong - An Duong (1 circuit)</td>
<td>173+j17.6</td>
<td>48%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thuong Tin - Van Dien (1 circuit)</td>
<td>281+j117</td>
<td>84%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thuong Tin - Pho Noi</td>
<td>270+j17.7</td>
<td>92%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thuong Tin 500kV substation (1 transformer)*</td>
<td>871+j221</td>
<td>99%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(*) : Thuong Tin 500kV substation with capacity in: Alternative 1 - 2x900MVA, Alternative 2 - 3x900MVA

The result of table 2.4 shows that it is necessary to replace two 450MVA transformers with two new 900MVA transformer if without building Pho Noi 500kV substation until 2015 (only replace 1 transformer in master plan VI).

### 2.2.3 Economical analysis for each alternative:

#### Table 2.6: Volume and investment cost in alternative 1

<table>
<thead>
<tr>
<th>No</th>
<th>Item</th>
<th>Unit</th>
<th>Cross section, capacity</th>
<th>Volume</th>
<th>Unit Price ($10^9$ VND)</th>
<th>Amount ($10^9$ VND)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong> Transmission Line</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>500kV connecting branch, double circuit put into Thang Long Thermal power complex – Thuong Tin 500kV transmission line</td>
<td>km</td>
<td>4xAC330</td>
<td>1.34</td>
<td>12.69</td>
<td>17.01</td>
</tr>
<tr>
<td>2</td>
<td>Hai Phong 3 Thermal power complex - Pho Noi 500kV transmission line, double circuit.</td>
<td>km</td>
<td>4xAC330</td>
<td>58</td>
<td>12.69</td>
<td>736.02</td>
</tr>
<tr>
<td>3</td>
<td>Thai Binh - Pho Noi 500kV transmission line, double circuit.</td>
<td>km</td>
<td>4xAC330</td>
<td>60</td>
<td>12.69</td>
<td>761.4</td>
</tr>
</tbody>
</table>
Pho Noi 500kV Substation & Connecting Branches Feasibility Study Summary Report

Table 2.7: Volume and investment cost in alternative 2

<table>
<thead>
<tr>
<th>No</th>
<th>Item</th>
<th>Unit</th>
<th>Cross section, Capacity</th>
<th>Volume</th>
<th>Unit Price</th>
<th>Amount (10^9 VND)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>Transmission Line</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Hai Phong 3 Thermal power complex - Thuong Tin 500kV transmission line, double circuit.</td>
<td>km</td>
<td>4xAC330</td>
<td>80</td>
<td>12.69</td>
<td>1,015.2</td>
</tr>
<tr>
<td>2</td>
<td>Thai Binh - Thuong Tin 500kV transmission line, double circuit.</td>
<td>km</td>
<td>4xAC330</td>
<td>72</td>
<td>12.69</td>
<td>913.68</td>
</tr>
<tr>
<td>3</td>
<td>Dong Anh - Thuong Tin 500kV transmission line, double circuit.</td>
<td>km</td>
<td>4xAC330</td>
<td>45</td>
<td>12.69</td>
<td>571.05</td>
</tr>
<tr>
<td>4</td>
<td>Pho Noi - Gia Loc 220kV transmission line, double circuit.</td>
<td>km</td>
<td>AC500</td>
<td>22</td>
<td>6.5</td>
<td>143</td>
</tr>
<tr>
<td>5</td>
<td>Pho Noi - Yen My 220kV transmission line, double circuit.</td>
<td>km</td>
<td>AC500</td>
<td>12</td>
<td>6.5</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>Substation and feeder</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Enhance power capacity of 500kV Thuong Tin substation</td>
<td>s/s</td>
<td>2x900MVA*</td>
<td>1</td>
<td></td>
<td>282</td>
</tr>
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<td>feeder</td>
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<td></td>
<td></td>
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</tbody>
</table>

(*) : Replace two 450 MVA transformers with two new 900MVA transformers at Thuong Tin 500kV substation in 2015.

By comparing the volume and investment cost of alternative 1 with that of alternative 2, the total investment cost of alternative 1 is 76.91 billion VND lower.

2.2.4 Select reasonable alternative:

Through above calculation, the technical specification of alternative 1 is better and the total investment cost is lower than that of alternative 2. Alternative 1 takes advantages of the implementation of connecting 500kV transmission lines to big Thermal power complexes, of extensible ability for simple substation, of safe operation and long time planning until 2020.
With above analysis, plan 1 should be recommended for connecting Hai Phong 3 Thermal power complex to the National Power system and it is necessary to build Pho Noi 500kV substation in this alternative. Besides the convenient connection, the other missions of Pho Noi 500kV substation is to distribute power and supply power for load demand in the area.

Pho Noi 500kV substation can be completely built before Hai Phong 3 Thermal power complex shall be put into operation. To select the suitable time of building Pho Noi 500kV substation, it is necessary to analyse, calculate load flow in 2012 and 2013.

- In 2012: Without Pho Noi 500kV substation, the voltage quality at 220kV busbar of substation in the North area shall be in range \( \pm 5\%U_{\text{rated}} \) and the lowest one is of An Duong 220kV substation (216.9kV), Bac Ninh 2 (217.9kV); the total power loss of North power system is 126MW (500kV and 220kV power network).

- In 2013: Without Pho Noi 500kV substation, the voltage quality at 220kV busbar of the substations connected after 500kV Thuong Tin such as Pho Noi (205.8kV), Hai Duong (205.1kV), Bac Ninh 2 (205kV) will exceed \(-5\%U_{\text{rated}}\), the total power loss of the North electricity system is 256MW (500kV and 220kV power network). If install two 600MVA transformers at Pho Noi 500kV substation, the voltage quality becomes better (219.4kV, the lowest voltage is of 220kV bus bar at Hai Duong 220kV substation) and the total power loss of the North power system is 233MW (23MW lower).

- With above mentioned analysis, Pho Noi 500kV substation should be equipped with two new 600MVA transformers and be put into operation in 2013. As above mentioned selection, the project shall be considered connecting Pho Noi 500kV substation to the National Power System in 2 following cases.

- **Case 1**: Pho Noi 500kV substation shall be connected to one existing circuit of Quang Ninh – Thuong Tin 500kV transmission line (or Thang Long Thermal Power Complex – Thuong Tin 500kV transmission line).
Figure 2.9: Load flow of 500kV power network in the North area in 2015 - Case 1

Figure 2.10: Load flow of 500kV power network in the North area in 2020 – Case 1
- **Case 2:** Pho Noi 500kV substation shall be connected to 2 existing circuits of Quang Ninh – Thuong Tin 500kV transmission line (the result of calculation is shown in figure 2.5 and 2.7)

In case 1, because Pho Noi 500kV substation was directly powered by Hai Phong 3 and Thang Long Thermal Power Complex, voltage quality and operation are ensured in case of normal operation as well as fault. Otherwise, because Pho Noi 500kV substation shall be equipped with two 600MVA transformers, the majority of power thermal power complexes shall be transmitted to transformers and reduce power transmission capacity on Pho Noi - Thuong Tin 500kV transmission line as well as Quang Ninh –Thuong Tin 500kV transmission line. Therefore, if one of the transmission lines may disconnect with Pho Noi 500kV substation, the rest transmission lines can ensure power transmission in limit. Power loss of entire system in case 1 is more than of in case 2 but this amount is small (0.5MW in 2015 and 1MW in 2020).

In terms of economic, total investment cost in building substation in case 1 is smaller than in case 2. Therefore, the quantity of 500kV transmission lines connected to Pho Noi 500KV substation as well as compensating equipments in case 1 is less than in case 2.

Based on technical specification and economic factor, alternative 1 should be deleted and case 1 is recommended for plan connecting 500KV Pho Noi substation to the system. This alternative shall be:

- Invest in building Pho Noi 500kV substation, install two 600MVA transformers and put into operation in 2013.
- Connect Pho Noi 500kV substation to one existing circuit of Thang Long- Thuong Tin 500kV transmission line.
- To facilitate for connecting Bac Ninh 2 220kV substation into the system (in 2012), the 220kV distribution system of 500kV Pho Noi substation should be constructed in advance.
CHAPTER 3 : SELECTING SUBSTATION CONSTRUCTION LOCATION

3.1. LOCATION ALTERNATIVES

Alternative 1: 500/220kV Pho Noi substation is located on the paddy field area belonging to Dong Chung and Sam Khuc Hamlet, Viet Hung Commune, Van Lam District, Hung Yen Province.

Alternative 2: 500/220kV Pho Noi substation is located on the paddy field area belonging to Nhuan Trach Hamlet, Duong Quang Commune, My Hao District, Hung Yen Province.

Via analysis on technical and economic indicators of two alternatives, the alternative 1 is proposed to be selected for construction of 500/220kV Pho Noi substation. The alternative 1 is agreed by Hung Yen Provincial People’s Committee.

3.2. DESCRIPTION ON PROJECT CONSTRUCTION SITE

3.2.1. Geographical location

The 500/220kV Pho Noi substation is located on the paddy field area belonging to Dong Chung and Sam Khuc Hamlet, Viet Hung Commune, Van Lam District, Hung Yen Province, with geographical location as follows:

- North : boundary with the paddy field belongs to Sam Khuc Hamlet.
- South : boundary with the paddy field belongs to Dong Chung Hamlet.
- East : boundary with Bac Ninh Province.
- West : boundary with the paddy field belongs to Dong Chung Hamlet.

3.2.2. Topography

The topography in the location of substation construction is even.
CHAPTER 4: MAIN TECHNOLOGICAL SOLUTIONS

4.1. VOLTAGE LEVEL
Voltage level: 500kV, 220kV, 110kV and 35kV.

4.2. SUBSTATION CAPACITY
Capacity: install 02 transformers 500/220/35kV - 600MVA and 01 transformer 220/110/22kV – 125MVA.

4.3. SINGLE LINE CONNECTION DIAGRAM
- At 500kV side: using the single line connection diagram “3/2”, including: 02 transformer bays, 3 transmission lines bays and 7 spare bays.
- At 220kV side: using the single line connection diagram “Two busbar systems with coupling breaker”, including: 03 transformer bays, 01 coupling breaker bay, 6 transmission lines bays and 7 spare bays.
- At 110kV side: using the connection diagram “Two busbar systems with coupling breaker”, including 01 transformer bay and 10 spare bays.
- At 35&22kV side: Design in accordance with transformer block diagram

4.4. SOLUTIONS APPLIED FOR CONTROL, PROTECTION SYSTEM

4.4.1. Control system
Using computerized control system for the substation.
The computerized control mode shall have structure of 4 levels:
- Level 1: Controlling and monitoring from load dispatch center.
- Level 2: Controlling from control room of substation.
- Level 3: Controlling from control-protection cubicles of incoming bays.
- Level 4: Controlling at equipment.

4.4.2. Protection system
The protection system for controlling elements inside substation shall be complied with regulation specified by Vietnam Electricity. The main relays of protection system shall be of digital relays with micro processors have interface with computerized control system and SCADA system.

4.5. AUXILIARY POWER SUPPLY

4.5.1. AC auxiliary power
AC auxiliary power shall be supplied from 02 auxiliary transformers 35/0.4kV – 560kVA, receive power from equipotential winding of 02 transformers 500/220/35kV.

4.5.2. DC auxiliary power
DC auxiliary power shall be supplied from 02 Nikel-Cadimi (NiCd) battery system with capacity of 300Ah, voltage level 220VDC. The battery system shall operate under regime of
regular recharge and surcharge via 02 rectifiers with input voltage of 380VAC, output voltage of 220VDC.

4.6. EARTHING, GROUNDING SYSTEMS
- The rod-wire combination earthing system is used within substation range. Using galvanized steel earthing rod with diameter Φ22, 5m length. The main earthing wire and radial earthing wires shall be of galvanized steel wires with diameter Φ14, electric welding shall be applied for connection between earthing rods and bars, earthing bars and bars. The resistivity value of earthing system shall be in accordance with current prevailed norms.
- Earthing for equipment, equipment supports shall be of M120 copper wires, earthing wires and earthing grid shall be connected by cad-welding.
- The substation is protected from direct lightning striking by lightning rods installed on independent lighting poles-earthing, wires shall be installed on gantry towers of 500kV, 220kV, 110kV switchgear.
- Protection of over atmospheric voltage transmitted from the transmission lines to substation and local over voltage by surge arresters.

4.7. LIGHTING SYSTEM
- The neon lamps 40W shall be used for control house lighting, incandescent lamps 75W shall be used for emergency lighting.
- The 400W beacon lights installed on lighting poles – independent lightning protection poles shall be used for outdoor lighting.
- The 70W bulb lamps installed on 3.4m height poles shall be used for lighting substation surrounding area.

4.8. COMPENSATING SOLUTION
At 500kV Pho Noi substation: install 02 shunt reactors 500kV - 65MVAr (shall be moved from 500kV Thuong Tin and Quang Ninh substation).

4.9. SELECTING OF MAIN ELECTRICAL EQUIPMENT
The main electrical equipment shall be selected with basic technical parameters as follows:

1/ Electrical equipment 500kV, outdoor installation:
   - Rated voltage : 550kV
   - Rated current : 2000A
   - Rated short circuit current withstands : 50kA/3sec
   - Testing voltage at power frequency 50Hz, 1min : 680kV
   - Impulse withstand testing voltage 1.2/50μs : 1550kV
   - Creepage distance : 25mm/kV
   - Auxiliary power : 380/220VAC, 220VDC

2/ Electrical equipment 220kV, outdoor installation:
Pho Noi 500kV Substation & Connecting Branches

<table>
<thead>
<tr>
<th></th>
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<td>- Auxiliary power</td>
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</tbody>
</table>
CHAPTER 5: MAIN SOLUTIONS APPLIED FOR CIVIL CONSTRUCTION PART

5.1. GENERAL PLAN LAYOUT AND FOUNDATION GRADING

5.1.1. General plan layout

Land acquisition area for structures within substation general plan layout:

- Acquisition land area for substation (1): 124,730 m²
- Acquisition land area for access road to substation (2): 55,030 m²
- Acquisition land area for operation shifting house (3): 2,350 m²
- Total acquisition land area for substation [(1)+(2)+(3)]: 182,110 m²

5.1.2. Foundation grading

Foundation grading: The substation construction location is located on the paddy field and crops planting areas, with inundation in flood and rainy season in accordance with flood level +3.35 m (with frequency 2%). So, the substation foundation grading shall be done based on filling soil.

  + Total overburden removal quantity with 0.15m thickness: 26,595 m³
  + Total soils excavation quantity: 13,254 m³
  + Total soils embankment quantity: 288,206 m³
  + Boulder stones masonry quantity: 9,643 m³

5.1.3. Road system

The roads inside substation shall have structure of asphaltic concrete in 4m and 6m width.

The roads outside substation shall have structure of asphaltic concrete in 7.5m width.

5.2. SOLUTIONS APPLIED FOR OUTDOOR STRUCTURES

5.2.1. Towers, steel arms and equipment supports:
- All of towers, steel arms shall be manufactured with figural galvanized steel linked by bolts, hollow pyramid structure.
- The equipment supports shall be manufactured with galvanized I shape steel, fabricated and manufactured at the factory.

5.2.2. Solutions applied for tower foundation, equipment support foundation, transformers foundation:
- The foundation of gantry towers, busbar towers shall be of reinforced concrete, cast in-place reinforced concrete single footing structure.
- The equipment support foundation shall be of reinforced concrete, cast in-place independent reinforced concrete single footing structure.
- The power transformer foundation shall be of cast in-place reinforced concrete, raft foundation, upper part having points for jacking and positioning transformers.

5.2.3. Solutions applied for cable trenches
- The cable trenches shall be of cast in-place reinforced concrete, underground
structure, with bottom slope to drain water to water drainage pipes, galvanized steel
cable hanging frames shall be arranged inside cable trenches.

- The cable trenches cover slabs shall be of pre-cast reinforced concrete.

5.3. SOLUTIONS APPLIED FOR STRUCTURE OF CONTROL HOUSE, OPERATION
SHIFT WORKING HOUSE

5.3.1. Solutions applied for control house
- Two storeys house, plan area (18x27)m, height to ceiling 4.55m.
- Principle force bearing structure shall be of reinforced concrete frame cast in one
block, brick masonry walls, reinforced concrete tower foundation, masonry walls
hewn stone foundation.
- The reinforced concrete roof with slope to drain water to both sides, heat proof and
anti-leakage corrugated steel sheets shall be covered on top.

5.3.2. Solutions applied for operation shift working house
- Two houses of one storey, plan area (9.5 x 18)m², including 05 rooms.
- Force bearing structure shall be of reinforced concrete frame, masonry walls hewn
stone foundation, masonry walls, ceramic bricks floor, heat proof and anti-leakage
color steel sheets shall be covered on top.

5.4. SOLUTIONS APPLIED FOR WATER SUPPLY AND DRAINAGE, FIRE AND
EXPLOSION PREVENTION AND FIGHTING

5.4.1. Water supply and drainage system
- The water source for daily life activities shall be supplied from 02 bored wells 70m
depth.
- The water source for fire fighting shall be supplied from 02 bored wells 70m depth.
- The rain water shall be drained following to the slope direction of substation base,
partial rain water shall be drained directly through the water drainage pipes at bottom
of substation surrounding walls, remaining part of rain water shall be drained following
to the slope of road pavement inside the substation to the catch pits arranged at
edges of road pavement.
- The water in cable trenches shall be drained along the cable trenches to the water
collecting pipes, then drained to the nearest catch pits.

5.4.2. Fire and explosion prevention and fighting system
- Fire fighting with water using solution: Two water tanks shall be arranged inside the
substation for supplying water for fire fighting system, with capacity of each water tank
of 130m³. The water tank structure shall be of reinforced concrete M200, self-
overflowed surface structure.
- Fire fighting with sand using solution: The sand containers shall be of reinforced
concrete with diameter 1m.
– Bored well: The bored wells shall have 70m depth, arranged inside substation. The regular water exploiting discharge shall be 1.875 liters/s, with sufficient volume for supplying water for daily life activities and fire fighting.

– Fire and explosion prevention and fighting system: The automatic fire fighting system shall be equipped. In addition, the fire fighting inside substation shall also be equipped with the fire fighting drums such as foam, CO₂ and other manual tools including ladders, buckets, shovels...
CHAPTER 6 : SOLUTIONS APPLIED FOR CONNECTING BRANCHES

6.1. CONNECTING BRANCHES 500kV

The 500kV connecting branches connected to Pho Noi 500kV substation shall cross through territory of Van Lam district, Hung Yen Province.

- Voltage level: 500kV.
- Number of circuits: 2
- Starting point: shall be connected to the tower span 273 - 274 of existing Quang Ninh – Thuong Tin 500kV transmission lines.
- Ending point: At gantry tower 500kV of Pho Noi 500kV substation.
- Length: 1,230 m
- Conductors: 4xACSR-330/42.
- Grounding wires: Suspension of 01 optical composite grounding wire OPGW-80 and 01 grounding wire PHLOX-116.
- Insulators: glass or ceramic insulator or equivalent technical characteristics insulators in accordance with IEC standards.
- Tower: Using free standing figural galvainzed steel, linked by bolts.
- Earthing: Using radial type earthing system. The resistivity value of earthing system shall be in accordance with current prevailed norms.
- Vibration damper: The vibration dampers shall be used for conductor, grounding wires and optical cables.

6.2. CONNECTING BRANCHES 220kV

6.2.1 Connecting branches No.1:

The 220kV connecting branches connected to Pho Noi 500kV substation shall cross through territory of Van Lam district, Hung Yen Province; Thuan Thanh district, Bac Ninh Province; Cam Giang district, Hai Duong Province;

- Voltage level: 220kV.
- Number of circuits: 4 (install 02 circuits in this stage)
- Starting point: shall be connected to the tower span 68 - 69 of existing Pha Lai – Pho Noi – Thuong Tin 220kV transmission lines.
- Ending point: At gantry tower 220kV of Pho Noi 500kV substation.
- Length: 5,107 m
- Conductors: ACSR-400/51.
- Grounding wires: Suspension of 01 optical composite grounding wire OPGW-70 and 02 grounding wire GSW-70.
- Insulators: glass or ceramic insulator or equivalent technical characteristics insulators in accordance with IEC standards.
- Tower: Using free standing figural galvainzed steel, linked by bolts.
- Earthing: Using radial type earthing system. The resistivity value of earthing system shall be in accordance with current prevailed norms.
- Vibration damper: The vibration dampers shall be used for conductor, grounding wires and optical cables.

**6.2.2 Connecting branches No.2:**

The 220kV connecting branches connected to Pho Noi 500kV substation shall cross through territory of Ngoc Lien Commune, Cam Giang District, Hai Duong Province; Luong Tai and Viet Hung Commune, Van Lam District, Hung Yen Province.

- Voltage level: 220kV.
- Number of circuits: 4 (install 02 circuits in this stage)
- Starting point: shall be connected to the tower span 73 - 74 of existing Pha Lai – Pho Noi – Thuong Tin 220kV transmission lines.
- Ending point: At gantry tower 220kV of Pho Noi 500kV substation.
- Length: 4,578 m
- Conductors: ACSR-400/51.
- Grounding wires: Suspension of 01 optical composite grounding wire OPGW-70 and 02 grounding wire GSW-70.
- Insulators: glass or ceramic insulator or equivalent technical characteristics insulators in accordance with IEC standards.
- Tower: Using free standing figural galvainzed steel, linked by bolts.
- Earthing: Using radial type earthing system. The resistivity value of earthing system shall be in accordance with current prevailed norms.
- Vibration damper: The vibration dampers shall be used for conductor, grounding wires and optical cables.
CHAPTER 7 : SOLUTIONS APPLIED FOR SUBSTATION SERVICE POWER SUPPLY TRANSMISSION LINE

- Voltage level: 22kV
- Number of circuits: 1
- Starting point: Tower No. 136 of the 22kV transmission line supplying power for Nhan Vinh 22kV substation.
- Ending point: Substation service power supply 22 (35)/0.4kV-560kVA substation.
- Construction local: Dai Dong and Viet Hung Commune, Van Lam District, Hung Yen Province.
- Length: 2,423m.
- Conductor: ACSR-70/11.
- Insulators: glass or ceramic insulator or equivalent technical characteristics insulators in accordance with IEC standards.
- Tower: Centrifugal spun reinforced concrete column, 10.5m height.
- Tower foundation: Cast in-place reinforced concrete mass foundation.
- Arms, fastening belts: using figural hot dip galvanized steel.
- Other technical solutions: Earthing, prohibition boards, signboards on the transmission lines shall be arranged according to Electrical equipment Code No. 11 Branch Standard TCN 19-2006.
CHAPTER 8 : SOLUTIONS APPLIED FOR TELECOMMUNICATION

8.1. SOLUTION APPLIED FOR PLC TELECOMMUNICATION

8.1.1 At 500kV side:

Currently, phase-phase (A-B) Power Line Carrier telecommunication system is operating on Quang Ninh – Thuong Tin 500kV transmission line. When Pho Noi 500kV substation shall be put into operation, it shall be connected to 500kV Quang Ninh – Thuong Tin transmission line.

This project shall consider transferring PLC equipments (line trap, power line carrier, device coupling, teleprotection…) from Thuong Tin to Pho Noi in order to re-establish PLC telecommunication system on Quang Ninh – Pho Noi 500kV transmission line and to equip new PLC equipments which shall be synchronous with equipments of Thuong Tin – Pho Noi for establishing PLC telecommunication system on Thuong Tin – Pho Noi 220kV transmission line (protecting for Thuong Tin – Pho Noi 500kV transmission line).

8.1.2 At 220kV side:

Currently, phase-ground (phase B) PLC telecommunication system is operating on Pha Lai Thermal power complex – Thuong Tin 220kV transmission line. The PLC telecommunication system of Pha Lai Thermal power complex – Pho Noi has been taken back for other projects.

The electricity solution of project: connecting to Pha Lai Thermal power complex – Thuong Tin and Pha Lai Thermal power complex – Pho Noi 220kV transmission line.

This project shall consider transferring PLC equipments (line trap, device coupling, power line carrier …) from Thuong Tin 500kV substation to Pho Noi 500kV substation in order to re-establish PLC telecommunication system on Pha Lai Thermal power complex – Pho Noi 220kV transmission line (1 circuit). The PLC telecommunication system on 220kV transmission line connecting Pho Noi 220kV substation to Pho Noi 500kV substation shall be formed (and equipped with new ground wire) for optical transmission application.

Invest new PLC telecommunication system on Thuong Tin - Pho Noi 220KV transmission line (or consider transferring equipments of internal NPT) to supply intertripping telecommunication channel for back-up protection of Thuong Tin – Pho Noi 500kV transmission line (2 circuits)

At that time, intertripping transmission for protection of Thuong Tin – Pho Noi 220kV transmission line shall use digital channel of optical telecommunication line on 500kV transmission line, intertripping transmission for protection of 220kV transmission line connecting Pho Noi 220kV substation to 500kV Pho Noi substation shall use digital channel of optical communication line on 220kV transmission line.

Intertripping transmission for protection of Pha Lai – Pho Noi 220kV transmission line (2 circuits) shall use its circuit 1 for PLC telecommunication transmission.

8.2. SOLUTION APPLIED FOR OPTICAL TELECOMMUNICATION

The OPGW-24SM optical telecommunication system is operating with the transmission speed of 2,5Gbit/s on Quang Ninh – Thuong Tin 500kV transmission line. This project will invest 1 equipment package including STM16, PCM-30, PABX for Pho Noi 500kV substation to
It is expected that when Pho Noi 500kV substation shall be put into operation, it shall be connected to one 500kV feeder of Hiep Hoa 500kV substation and two 220kV feeders of Bac Ninh 2 220kV substation. Therefore, STM-16 equipment shall be equipped with spare interface transmission cards to transmit telecommunication signal to Hiep Hoa 500kV substation and Bac Ninh 2 220kV substation.

Establish ring telecommunication system: << Thuong Tin – Pho Noi – Quang Ninh – Thuong Tin >>. When Hiep Hoa 500kV substation and Bac Ninh 2 220kV substation shall be connected to Pho Noi 500kV substation, this will form a ring << Pho Noi – Hiep Hoa – Bac Ninh 2 - Pho Noi >>.

For 220kV transmission line connecting Pho Noi 220kV substation to Pho Noi 500kV substation: invest optical cable (and equip with new ground wire) and equip it with terminal equipment at Pho Noi 220kV substation which shall be synchronous with that of Pho Noi 500kV substation to establish telecommunication channels for application (intertripping, transferring equipments from PLC channels to optical telecommunication channels for SCADA and hot-line…)

The exchange capacity at Pho Noi 500kV substation shall have more than 32 telecommunication channels which are served for telecommunication demand and electricity system balance of substation. It shall be connected 2MBps trunk to Flexicom-6000 exchange at VT1 (18 Tran Nguyen Han) and shall be prepared with spare trunks for connecting to exchanges at Hiep Hoa 500kV substation and Bac Ninh 2 220kV substation.

Establish voice channel and data channel to transmit SCADA signal and hot-line to A1 and A0.

This project has been a change of PLC transmission to optical telecommunication transmission at Pho Noi 220kV substation. Therefore, it is necessary to modify its connection for re-establishing the current PLC channel to optical telecommunication channel in this investment.
Feasibility Study

Project Number: 42039-034
November 2011

Multitranche Financing Facility
Socialist Republic of Viet Nam: Power Transmission Investment Program

Summary Report
200 kV Phu My 2 Industrial Zone Substation
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1. Necessity

1.1 Project necessity

According to “Power grid scheme development and improvement in 2006-2010 stage, regarding to 2015 of Tan Thanh district, Ba Ria-Vung Tau province”, load forecasting of zones of Tan Thanh district was listed as follows:

**Table A: 110 kV substations on period before 2010**

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<th>Substation</th>
<th>Year of Operation</th>
<th>Power Installation (MVA)</th>
<th>Load (%)</th>
<th>Power load (MVA)</th>
<th>Total (MVA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phu My steel</td>
<td>Existing</td>
<td>100</td>
<td>75</td>
<td>75</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td></td>
<td>60</td>
<td>75</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Phu My</td>
<td>Existing</td>
<td>63</td>
<td>75</td>
<td>47.25</td>
<td>94.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>63</td>
<td>75</td>
<td>47.25</td>
<td></td>
</tr>
<tr>
<td>Phu My 1</td>
<td>Existing</td>
<td>30</td>
<td>75</td>
<td>22.5</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30</td>
<td>75</td>
<td>22.5</td>
<td></td>
</tr>
<tr>
<td>Thep Viet</td>
<td>Existing</td>
<td>45</td>
<td>75</td>
<td>33.75</td>
<td>67.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>45</td>
<td>75</td>
<td>33.75</td>
<td></td>
</tr>
<tr>
<td>Posco</td>
<td>2008</td>
<td>150</td>
<td>74</td>
<td>111</td>
<td>111</td>
</tr>
<tr>
<td>Thi Vai</td>
<td>2008</td>
<td>63</td>
<td>50</td>
<td>31.5</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td></td>
<td>63</td>
<td>50</td>
<td>31.5</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>501</strong></td>
</tr>
</tbody>
</table>

On this condition, two transformers T5 and T6 (2x250MVA) of Phu My 1 thermal plant can be suitable.

**Table B: Load forecast 110 kV substations on period after 2010**

<table>
<thead>
<tr>
<th>Substation</th>
<th>Year of operation</th>
<th>Power installation (MVA)</th>
<th>Load factor (%)</th>
<th>Consumed power (MVA)</th>
<th>Total (MVA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phu My steel</td>
<td>Existing</td>
<td>100</td>
<td>80</td>
<td>80.0</td>
<td>128.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>60</td>
<td>80</td>
<td>48.0</td>
<td></td>
</tr>
<tr>
<td>Phu My</td>
<td>Existing</td>
<td>63</td>
<td>80</td>
<td>50.4</td>
<td>100.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>63</td>
<td>80</td>
<td>50.4</td>
<td></td>
</tr>
<tr>
<td>Phu My 1</td>
<td>Existing</td>
<td>30</td>
<td>80</td>
<td>24.0</td>
<td>48.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30</td>
<td>80</td>
<td>24.0</td>
<td></td>
</tr>
</tbody>
</table>
The solution of power supplying for this region as follows:

(i) Period 2005–2010: this region will be supplied by 220 kV- 2x250 MVA Phu My 1 substations.

(ii) Period 2010–2015: it’s expected to be also supplied by the 220 kV- 3x250 MVA Phu My 2 industrial zone substations, which will be operated in 2010 in order to support to load demand of this region in this period.

1.2 Project objectives

220 kV Phu My 2 substations will respond to load growth of zone 2 of Ba Ria-Vung Tau province with total load demand about 186 MW in 2007 and 501 MW in 2010.

Ensure the supply reliability.

Enhance the electrical quality and power supply ability

Expected energy sold and losses rating of the system with the project:

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2010</th>
<th>2015</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (GWh)</td>
<td>788</td>
<td>2989</td>
<td>5855</td>
<td>9281</td>
</tr>
<tr>
<td>Losses (%)</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>

1.3 Geographical features

Tan Thanh district of Ba Ria-Vung Tau province locates in the East area of South Viet Nam, belong the main sector of economy of the South.
Being contiguous to Dong Nai province in the North, to Chau Duc district in the East, to Can Gio district (Ho Chi Minh City) in the West and Ba Ria town in the South. It’s about 65km far from Ho Chi Minh City.

Natural area: 34,152 ha.
The district has 1 township and 8 communes: Phu My Township, My Xuan, Phuoc Ha, Hoi Bai, Chau Pha, Hac Dich, Toc Tien and Song Xoai commune.

1.4 Economy, society of project situation

Economic structure had rather grown quick, by 78% industry and 16% living activities agriculture in the last two year.

Industry: Industrial production has averaged value out at 38% a year.


Agricultural: Cultivated area: 53,841 ha, decrease 1.8% in the same time of the last year.

Import-export: Import-export turn-over has averaged value out at 28.9% a year.

In period of 2010 (2020), Tan Thanh district has planned to develop 07 industrial zones with total area 5,233ha such as : Phu My II; Cai Mep, Phu My II extension, Phu My III, Cai Mep Ha, Long Huong and Long Son.

1.5 Existing and future electrical source layout

In present, Ba Ria-Vung Tau power grid is mainly supplied by the 500 kV- 450 MVA Phu My substation and two 500 kV Phu My-Nha Be and Phu My- Phu Lam transmission lines and the 220 kV Phu My-Ba Ria, Phu My-Long Thanh, Phu My-Nha Be, Phu My-Cat Lai transmission lines across this province.

There are substations in this area as follows:

500 kV Phu My substation:
- Situated in Tan Thanh district, Ba Ria-Vung Tau province
- Rated voltage: 500/220 kV-450 MVA, 220/110 kV-2x250 MVA
- Supplied by the transmission lines 500 kV Phu My-Nha Be and Phu My-Phu Lam.
- Supply mainly to 110 kV Phu My, Thep Viet, Phu My steel plant and Posco substations.

220kV Phu My substation:
- Situated in Tan Thanh district, Ba Ria-Vung Tau province.
- Rated voltage: 220/110kV
- Capacity: 2x250MVA
- Supplied by the 500/220kV Phu My substation.
- Supply mainly to 110kV Phu My, Thep Viet, Phu My steel plant and Posco substations.

110 kV Phu My steel plant substation:
- Situated in Tan Thanh district, Ba Ria-Vung Tau province.
- Rated voltage: 110/22 kV
- Capacity: 1x100 MVA + 1x60 MVA
- Supplied by the 220/110 kV Phu My substation.

110 kV Phu My substation:
- Situated in Tan Thanh district, Ba Ria-Vung Tau province.
- Rated voltage: 110/22 kV
- Capacity: 2x63 MVA
- Supplied by the 220/110 kV Phu My substation.

110 kV Thep Viet substation:
- Situated in Tan Thanh district, Ba Ria-Vung Tau province.
- Rate voltage: 110/33 kV and 110/22 kV
- Capacity: 2x45 MVA
- Supplied by the 220/110 kV Phu My substation.
2. Location and Project size

2.1 Geography

The 220 kV Phu My 2 industrial zone substation will be constructed in Ong Trinh ward, Tan Phuoc commune, Tan Thanh district, Ba Ria-Vung Tau province.

2.2 Scope of Project

Substation

Two power auto-transformers: 225±8x1.25%/115/23 kV– 250 MVA.

220 kV side: double busbar diagram with bus-tie.

220kV bays: two transformer bays, four O/H line outgoing bays (Phu My 1, Phu My 2 and Ba Ria 1, Ba Ria 2), one bus coupling bay.

110 kV side: double busbar diagram with bus-tie.

110 kV bays: two 250 MVA transformer bay, one bus coupling bay, eight O/H line outgoing bays (Posco 1, Posco 2, Thi Vai 1, Thi Vai 2, Phu My 1, Phu My 2, Southern Steel 1, and Southern Steel 2).

22 kV side diagram: single busbar (only supply power for 02 auxiliary transformers)

Control and protection equipment: using computerized control and modern protection systems. The control, protection cubicles are placed indoor, and communicate with computerized control system by fiber optic cables. Measuring and protection is equipped in accordance with EVN Standard and Regulations.

Communication and SCADA system

One optical communication route is established between 220kV Phu My 2 industrial zone substation and 220 kV Phu My thermal plant substation.

One public telephone subscribe of Ba Ria-Vung Tau province.

Send/Receive SCADA/EMS signals between Southern Load Dispatching Center and 220 kV Industrial zone Phu My 2 substation via the computerized system gateway connected to optical communication system of 220 kV Industrial area Phu My 2 substation and existing optical communication system.

Transmission line connection

220 kV side

The substation is connected to the 220 kV Phu My thermal plant – Ba Ria thermal plant double circuit transmission lines.

110 kV side:

220/110 kV Phu My 2 industrial zone substation has 8 outgoing feeders, including 2 feeders supply power to the existing 110 kV Southern Steel substation, 2 feeder supply to the existing Phu My substation, 2 feeder supply to Posco substation and 2 feeder supply to Thi Vai substation.
3. Load forecast

3.1 Local load situation

Industry and agriculture

Agriculture:
- The cultivated area is decrease because the new areas for industrial zone increase very fast in recent years.

Industry:
- Due to geography, it can attract investment’s capital for industry such as: steel, mechanism, textile and others. There are some industrial zones which are planed by the local governor such as Phu My I, II; My Xuan A1, My Xuan A2, My Xuan B1, Cai Mep, Long Son and Phu My III and so on.
- Industrial economic sector plays important roles and bases for improving other economic sectors.

Infrastructure

Traffic:
- The local governor is constructing and upgrading traffic routes of the district very fast.

Import-export:
- Import-export turn-over has averaged value out at 29% a year.

Investment attraction project

Domestic investment: In present, Tan Thanh district has 157 private, limited, joint-stock companies … with total charter capital is about 5.89 billion USD and total business capital has increased about 3–5 times.

Foreign investment: In present, Tan Thanh district has 75 foreign-invested projects with total invested capital more than 4.43 billion USD.

Load and generation needs

In future, Tan Thanh district will be one of the best industrial and economic centers in the East South of Viet Nam. Power demand increases continuously. Responding to this demand is an urgent task of the EVN, so constructing transmission substations and lines for this area is urgent necessity.

a. Electrical using structure: see Table 1.

According to statistical and forecasted values in 2005, 2010 and 2015 periods, electricity supplying for living activities was over 16.8%, this rate reduced to 15.7% in 2015. The rate of electricity for industry came the first, after living activities, always over 74% each year and has increased gradually in recent years.

b. The average rate of electricity demand growing per year:

(i) 2006–2010 periods: 25%
(ii) 2015 periods: 36%
**Load forecast after 2010**

The 220 kV Phu My 2 industrial zone substation is expected to supply power for 110 kV substations after 2010, as following:

<table>
<thead>
<tr>
<th>Substation</th>
<th>Year of operation</th>
<th>Power installation (MVA)</th>
<th>Load (%)</th>
<th>Power load (MVA)</th>
<th>Total (MVA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phu My steel</td>
<td>Existing</td>
<td>100</td>
<td>80</td>
<td>80.0</td>
<td>128.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>60</td>
<td>80</td>
<td>48.0</td>
<td></td>
</tr>
<tr>
<td>Phu My</td>
<td>Existing</td>
<td>63</td>
<td>80</td>
<td>50.4</td>
<td>100.8</td>
</tr>
<tr>
<td>Phu My 1</td>
<td>Existing</td>
<td>30</td>
<td>80</td>
<td>24.0</td>
<td>48.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30</td>
<td>80</td>
<td>24.0</td>
<td></td>
</tr>
<tr>
<td>Thep Viet</td>
<td>Existing</td>
<td>45</td>
<td>80</td>
<td>36.0</td>
<td>72.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>45</td>
<td>80</td>
<td>36.0</td>
<td></td>
</tr>
<tr>
<td>Posco</td>
<td>2008</td>
<td>150</td>
<td>80</td>
<td>120.0</td>
<td>120.0</td>
</tr>
<tr>
<td>Thi Vai</td>
<td>2008</td>
<td>63</td>
<td>80</td>
<td>50.40</td>
<td>100.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>63</td>
<td>80</td>
<td>50.40</td>
<td></td>
</tr>
<tr>
<td>Hoa Sen steel</td>
<td>After 2010</td>
<td>40</td>
<td>50</td>
<td>20.0</td>
<td>20.0</td>
</tr>
<tr>
<td>Essar steel</td>
<td>After 2010</td>
<td>40</td>
<td>50</td>
<td>20.0</td>
<td>40.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40</td>
<td>50</td>
<td>20.0</td>
<td></td>
</tr>
<tr>
<td>Phu My 3 IZ</td>
<td>After 2010</td>
<td>63</td>
<td>50</td>
<td>31.50</td>
<td>63.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>63</td>
<td>50</td>
<td>31.50</td>
<td></td>
</tr>
<tr>
<td>Cai Mep Ha IZ</td>
<td>After 2010</td>
<td>63</td>
<td>50</td>
<td>31.50</td>
<td>31.5</td>
</tr>
<tr>
<td>Phu My 2 extension</td>
<td>After 2010</td>
<td>63</td>
<td>50</td>
<td>31.50</td>
<td>31.5</td>
</tr>
<tr>
<td>Trung Tuong steel</td>
<td>After 2010</td>
<td>63</td>
<td>50</td>
<td>31.50</td>
<td>31.5</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>787.1</td>
</tr>
</tbody>
</table>
4. Technical solutions

Choosing voltage level

Selected voltage levels are:
- High voltage levels: 220 kV, 110 kV
- Medium voltage level: 22 kV

Choosing substation capacity, quantity of power transformer

In accordance with the result of power flow, expectation of substation’s capacity is 3x250 MVA for 220/110 kV substation. In this stage will be installed the two transformers 250 MVA. In the future stage will be installed the third transformer 250 MVA.

Choosing quantity of outgoing feeders at voltage levels

According to “The master plan of electrical developing of Tan Thanh district” and local power grid, expectative outgoing feeders are listed below:

220 kV side:
- In this stage will be installed 04 outgoing feeders as follows: Phu My 1, Phu My 2 and Ba Ria 1, Ba Ria 1.
- The spare space will be planed for 02 outgoing feeders as follows: Son My 1, Son My 2 and two spare feeders.

110 kV side:
- In this stage will be installed 08 outgoing feeders as follows: Posco 1, Posco 2, Thi Vai 1, Thi Vai 2, Phu My 1, Phu My 2, and Southern steel 1, Southern steel 2.
- The spare space will be planed for 08 future outgoing feeders as follows: 02 bays for Cai Mep industrial zone, 02 bays for Phu My 3 industrial zone, 02 bays for Phu My 2 industrial zone extension, and two spare feeders for capacitors.

22 kV side:
- Only supply for auxiliary transformer.

Choosing main connection diagram

The basic requirements of electrical connection diagram are security, confidence, simple structure, flexible operation, economy and human safety.

220 kV side
- Use double busbar scheme. In this stage, it is installed with following bays:
- Two bays for O/H line feeder to Phu My substation.
- Two bays for O/H line feeder to Ba Ria substation.
- Two bays for 1T and 2T transformers (250MVA)
- One bay for bus coupler

In future, the following bays will be installed:
- One bay for the transformer 3T.
- Two bays for O/H line feeder to Son My thermal plant.
- Two bays for spare
- The 220 kV busbar: aluminium Ø160/148mm.

110 kV side
Use double busbar scheme. In this stage, it is installed with following bays:
- Two bays for 1T and 2T transformers (250 MVA)
- One bay for bus coupler
- Two bays for O/H line feeder to 110 kV Posco substation.
- Two bays for O/H line feeder to 110 kV Thi Vai substation.
- Two bays for O/H line feeder to 110 kV Southern Steel substation.
- Two bays for O/H line feeder to 110 kV Phu My 1 substation.

In future, the following bays will be installed:
- One bay for 3T transformer (250 MVA).
- Two bays for O/H line feeder to 110 kV Cai Mep industrial zone substation.
- Two bays for O/H line feeder to 110 kV Phu My 3 industrial zone substation.
- Two bays for O/H line feeder to 110 kV Phu My 2 industrial zone extension substation.
- Two spare bays for 110 kV capacitor banks.
- The 110 kV busbar: aluminium Ø160/148mm.

22 kV side
Use single busbar scheme, outdoor equipment. Only supply for auxiliary transformer with following bays:
- Two set of 22 kV incoming circuit breakers
- Six set of 22 kV voltage transformers
- Six set of 22 kV current transformers
- Two set of three phases disconnectors
- Six set of 22kV lightning arresters

Electrical layout regarding to future upgrading

220 kV Phu My 2 industrial zone substation’s layout is designed for installation for 3 auto-power transformers 250 MVA.
Choosing technical solution for measuring, control and protection system.

**Control system**

Control system for 220 kV, 110 kV, 22 kV feeders will be equipped with several levels as follows:

- **Bay levels**: at equipment for maintenance only and “Bay controller” placed at control and protection cubicles, for emergency control.
- **Substation level**: by computerized control system in the control room.
- **System level**: from SLDC by SCADA system.

Computer control system must use the open system, using LAN net, Ethernet with the new communication standard: IEC 61850.

**Measuring system**

System state parameter will be accessed by bay’s measuring system, computer system and SCADA.

220 kV side of main transformer: equip one multi-functional meter for A, V, W, VAr, CosØ, Wh, VArh, and communication port for central control system and SCADA/EMS system.

110 kV side of main transformer: equip one multi-meter system for A, V, W, VAr, CosØ, Wh, VArh, and communication port for center control system and SCADA/EMS system.

110 kV feeders: equip multi-functional meter for A, V, W, VAr, CosØ, WH, VArh, and communication port for central control system and SCADA/EMS system.

22 kV incoming: equip one multi-functional meter for A, V, W, VAr, CosØ, Wh, VArh, and communication port for central control system and SCADA/EMS system.

Auxiliary supply: measuring for voltage, DC current, AC current, Wh.

**Protection and automation system**

All main protection relays are digital or numerical type, with communication ports to communicate with central control system, SCADA/EMS.

**220 kV feeders**

Main protection:

- Line differential protection (87L)
- Distance protection (21)
- Autoreclosing (79) with synch-check function (25)
- Directional spare overcurrent grounded protection (67N)
- Spare overcurrent protection (51) for losing voltage
- Communication (85)

Back-up protection:

- Distance protection (21)
- Directional phase overcurrent and ground overcurrent (67/67N)
- Breaker failure (50BF)
Trip circuit supervision (74)

110 kV feeders
Main protection:
- Distance protection (21)
- Autoreclosing (79) with synch-check function (25)
- Directional overcurrent grounded protection (67N)
- Spare overcurrent protection (51) for losing voltage
- Communication (85)
Backup protection:
- Directional phase overcurrent and ground overcurrent (67/67N)
- Breaker failure (50BF)
- Trip circuit supervision (74)

220 kV busbar protection
Low impedance differential protection for double busbar having bus coupler

110 kV busbar protection
Low impedance differential protection for double busbar having bus coupler
Load shedding.

Main transformer protection
First main protection:
- 3 phase transformer differential protection using transformer feeder’s CT
Second main protection:
- 3 phase transformer differential protection transformer’s bushing CT
Backup protection:
- Overload protection (49)
- Restricted earth fault (REF) protection.
- Neutral overcurrent grounding at 220kV side of main transformer (51N).
- Directional phase and grounding overcurrent at 110kV side (67/67N).
- Directional phase and grounding overcurrent at 220kV side (67/67N)
- Breaker failure protection (50BF)
- Transformer internal relays such as bucholz relay (96-1, 96-2), OLTC bucholz relay, double temperature relay (26-1, 26-2), rapid pressure relay, oil low (33) ...

22 kV Incoming feeder
- Phase overcurrent protection (50/51)
- Breaker failure protection (50BF)
- Trip circuit supervision (74)

Auxiliary transformer
Medium voltage side: using fuse combines with load break switch, placed in metal-clad cubicle for main auxiliary transformer and outdoor fuse-cut-out (FCO) for the reserve auxiliary transformer.

Low voltage side: using miniature circuit breaker.

Overvoltage, undervoltage alarms

**Auxiliary supply**

**380/220 V AC system**

In first stage, there are two auxiliary transformers connecting to different sources:

- One 3-phases main auxiliary transformer 22+2x2.5%/0.4kV – 250 kVA is connected to 22 kV side of 1T power autotransformer.

- One 3-phases spare auxiliary transformer 22+2x2.5%/0.4 kV – 250 kVA is connected to 22 kV side of 2T power autotransformer.

**DC distribution system**

In this stage, 220 V DC auxiliary source will be installed. This system consists of two battery chargers, two 220 V DC – 300 Ah nickel-cadmium battery and DC distribution system. This system include two inverters UPS 2500 VA to supply 220 V AC for computer system. This 220 V AC system supplies for computers, servers, printers.

48 V DC system: feed the communication system and SCADA. This system includes one charger cubicle, 48 VDC 200 Ah nickel-cadmium battery and DC distribution system.

**Lightning protection, earthing and illuminating system:**

**Lightning protection system**

The substation will be installed lightning rod and GSW conductor for protection against direct lightning stroke. Surge arresters will be installed in front of and in the rear of the power transformers.

**Earthing system**

Earthing system are designed based on thermal-mechanical reliability, touch and step-voltages according to IEEE 80-1986 and according to Vietnamese regulations.

**Illuminating and security systems**

Illuminating system consists of two main parts: outdoor and indoor lightings.

Outdoor lighting system lights the substation switchyard, the substation’s fence and the entrance road. Outdoor lighting use mercury high-pressured lamps, placed on 220 kV, 110 kV gantries and lightning towers. The requesting luminosity is >20lux.

Indoor lighting system equipped for control room, medium switchgear house, guarding house, water pump house etc., using mainly fluorescent lamps. Unexplosive lamp will be used for battery room.

Working lighting system: using 2x40 W, 1x40 W fluorescent lamps. The requesting luminosity is >300 lux.

Emergency lighting system: using 75 W, 220 V DC incandescent lamps and supplying power by the substation’s batteries.
Beside, for the security supervision, a monitoring camera system with 05 cameras will be installed around substation and at the main entrance gate.

**Main construction solutions**

**Main characteristics**
The 220 kV Phu My 2 industrial zone substation will be constructed in Ong Trinh ward, Tan Phuoc commune, Tan Thanh district, Ba Ria-Vung Tau province.

**General layout**
The general layout is designed based on the arrangement of 22 kV, 110 kV and 220 kV equipment, power transformers, auxiliary transformers in outdoors. The computer system, servicing panels are located indoor.

The total area counted by the substation fences: 29,735m² and a dormitory house 18.5x45.0m.

The total area entrance road: 6,259m², connecting with the existing 965 province road.

**Level the layout**
Natural high level is from 0.9m to 1.1m, higher than 2% frequency flood level (+1.52m). Complete high level after leveling is: +2.70m.

After constructing all foundations, cable trances, all area extension will be laid by a 100 mm deep 1x2 grade macadam to finish.

**Outdoor construction solutions**

**Supporting structures**
Supporting structures of 110 kV, 220 kV circuit breakers and disconnecting switches will be supplied complete with equipment.

110 kV, 220 kV gantries, CT-CVT-PI-SA supporting structures will be locally made of galvanized shape steel.

**Foundations**
Main transformer’s foundation (designed for 250 MVA transformer) will be reinforced concrete, in situ cast with 2x4 stones, concrete grade M200. The structure of foundation will satisfy requisition of fire protection – having a void volume that can contain all transformer oil in case of fire or explosion.

Foundation of supporting structures ... will be also reinforced concrete and in situ cast with concrete grade M200, 2x4 stones. They will be connected to steel structures by anchor bolts.

**Cable trenches**
Outdoor cable trenches have inside dimensions b = 200mm and b=1000mm. The base and walls will be reinforced concrete, in situ cast with concrete grade M200, 1x2 stone. All the cover plates will be recast. The bottom of trenches bottom will be slopped for draining purpose.

Crossing road trenches will be reinforced strong enough to bear vehicle load of transformer conveying (H30).

Trenches in control room and 22 kV switchgear room have inside width b = 600mm, 1000mm and 2000m, made of in situ cast reinforced concrete having concrete grade
M200. The cover plates will be checkered leaves of 5/7 galvanized steel sheets and the bottom will be sloped for drainage.

All the supports will be galvanized shape steel and connected to the walls of cable trench by anchor bolts

**Gates and fences**

Main gate will be sliding frame made of shape steel and have an inside width of 6000mm.

Man gate will be 2 leaves opening outside and have an inside width of 3000mm.

Fences will be brick wall.

Steel structures of gates and fences will be covered by rust – proof coat and colored coat.

Gate posts, fence posts and their base will be in situ cast with reinforced concrete having concrete grade M200. The posts will be bound each other by reinforced concrete beams. These link beams will be made of 1x2 stones concrete grade M200.

**Interior road and access road**

Interior roads width is varying 4.0 to 6.0m. The structure includes following layers:

- Macadam layer with the depth of 300mm, density K = 0.95
- Oil-paper layer with the depth of 2mm
- Concrete grade M300 layer with the depth of 200-250mm
- There are expansive joints each 4m along the road.

**Oil sump tank**

Oil sump tank will have capacity of 70m$^3$. Its base and walls will be in situ cast reinforced concrete with concrete grade M200.

**Structural and architectural solutions for control building and other auxiliary houses**

**Structural solution**

Plan size of the control building will be 12m x 28m.

Plan size of the dormitory house will be 9.6m x 25.2m.

Plan size of the control-protection cubicle houses will be 10.8m x 3.6m.

All these will be one-story houses and their main bearing structures will be reinforced concrete frame and continuous foundation. The reinforced concrete roofs will be covered by thermal insulating layer and water-proof layer.

**Architectural solution**

Walls will be made of hollow and solid brick, 200mm thick for exterior walls and 100mm thick for interior walls. They will be all painted.

The floor will be covered by ceramic tile.

Doors and windows will be all grass with aluminum frame.

The control building has following rooms and compartments:
- Control room.
Substation manager’s room.
- Telecommunication room.
- General room.
- Battery room
- Hall and corridor.
- Storage.
- WC.

The total area of control building will be 336.0m² (by axes of lateral column)

**Technical solutions for water supply, drainage and fire fighting systems**

**Water supply system**

Water will be pumped from well to 5m³ tank placed on 15m high shape steel tower and it supplies sanitary wares then.

**Drainage system**

Drainage system includes drainage of the area and drainage of the cable trenches.

Cable trenches' bottom will be slopped in order to drain off the water to the deepest place and then water will be discharged to terminal manholes.

The substation’s yard will have a slope 0.2% and the cross section of interior roads will have a slope 1%. Rainwater will be collected to manholes arranged both side of roads and discharge to terminal manholes by sewers.

From terminal manholes, water will be discharged into existing sewers outside the substation.

**Fire fighting system**

**Fire pump house**

Total plan area: 24.0m²

Painted brick wall

Cement floor

Scrolling door, ventilated by louvers

Steel cladding roof, steel rafter

There are two electric pumps, with Q=70m³/h - H= 70m each, one jockey pump 5.4m³/h - H=80m, and other devices.

**Outdoor fire fighting system**

Cylinders

Steel pipes ø100-150mm and fitting devices.

In situ cast reinforced concrete bases having concrete grade M200

Shape steel supports for pipes. These supports will be connected to bases by anchor bolts.

Cylinders and pipes will be arranged along the roads.

**Other devices**
Sand stands  
Fire-extinguishers  
Ladders, shovels  
These tools will be placed at easily access positions.

**Fire fighting tank**

In substation’s yard, a fire-fighting tank will be constructed. The tank will be reinforced concrete, has a volume of 150m³ for ensure fire-extinguished capacity.

**Ventilation of control building**

Control room and workrooms will be equipped with air-conditioners and ventilators.  
Chambers will have ceiling fans  
Battery room will have ventilators

**Network connection solutions**

**Substation transmission line connections**

**220 kV side:**

220 kV Phu My thermal plant – Phu My 2 substation transmission line (two circuits): from 220 kV entrance gantry of 220 kV Phu My thermal plant substation to 220kV entrance gantry of 220 kV Phu My 2 substation.

220 kV Ba Ria thermal plant – Phu My 2 substation transmission line (two circuits): from 220 kV entrance gantry of 220 kV Ba Ria thermal plant substation to 220kV entrance gantry of 220 kV Phu My 2 substation.

The connection line (four circuits) is 1,707m length with ACSR/MZ500/64 conductor (two conductors/phase).

**110 kV side:**

In this stage, 110 kV side of 220/110 kV Phu My 2 substation has 8 outgoing feeders including : Posco 1, Posco 2, Thi Vai 1, Thi Vai 2, Phu My 1, Phu My 2, and Southern steel 1, Southern steel 2.

110 kV transmission line with two OH lines (four circuits) from 110 kV entrance gantry of 220 kV Phu My 2 substation to 110 kV Posco-Thi Vai existing gantry.

The first connection line (four circuits) is 831m length with ACSR/MZ400/51 conductor.  
The second connection line (four circuits) is 913m length with ACSR/MZ400/51 conductor.

**Communication**

For control, management and SCADA link to Southern Load Dispatching Center (A2). This system installed completely in this stage.

**Data transmission technology solution**

The substation uses the computerized control system to gather DATA and transmits to A2 by the optical communication.
Feasibility Study

Project Number: 42039-034
November 2011

Multitranche Financing Facility
Socialist Republic of Viet Nam: Power Transmission Investment Program

Summary Report
220 kV Song May–Uyen Hung Transmission Line
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Annexes
ABBREVIATION

EMP : Environmental Management Plan
EVN : Viet Nam Electricity
NPT : National Power Transmission Corporation
DSM : Detail measurement survey
PAH : Project affected household
PAP : Project affected person
PC : People’s Committee
PPC : Provincial People’s Committee
PECC3 : Power Engineering & Consulting Joint Stock Company No.3
PTC4 : Power Transmission Company No.4
RCC : Resettlement & Compensation Committee
ROW : Right of way
RP : Resettlement Plan
SPPMB : Southern Power Project Management Board
VND : Vietnam Dong
CHAPTER 1
NECESSITY OF PROJECT

1.1. Project’s legal backgrounds

FEASIBILITY STUDY (FS) on 220kV Song May - Uyen Hung transmission line are prepared based on the following backgrounds:

- Vietnam’s Power Network Master Plan in phase-six approved by Prime Minister as the decision 110/2007-QD-TTg, signed on on 18th of July, 2007.
- The route of line is approved by People’s Committee of Dong Nai Province by letter No. 752/UBND-CNN dated on 24 January, 2008.
- The route of line is approved by People’s Committee of Binh Duong Province by letter No. 404/UBND-SX dated on 20 February, 2008.
- Feasibility study report on 220kV Song May - Uyen Hung transmission line approved by NPT as the decision 688/QĐ-NPT, signed on 17th April, 2009.
- Revised Feasibility study report on 220kV Song May - Uyen Hung transmission line approved by NPT as the decision 711/QĐ-NPT, signed on 23th August, 2010.

1.2. The necessary of investment project

220kV Song May - Uyen Hung transmission line is built with main reasons as follows:

- Based on the electricity demand of Binh Duong in 2005-2015 and Binh Duong’s power network development plan.
- Supply electricity for Tan Uyen district, Binh Duong province through 220kV Uyen Hung substation.

1.3. Objective of project.

- The lines are built to supply electricity for Tan Uyen district, Binh Duong province.
- The lines and 220kV Uyen Hung substation are able to meet the demand forecast and improve the quality of electrical supply for Tan Uyen district, Binh Duong province and neighboring areas.
- Reduction of network losses and reduction of outages time due to faults.
CHAPTER 2
EXISTING AREA NETWORK

2.1. Existing power sources and electrical network

2.1.1. Existing Dong Nai province’s power sources and electrical network

Presently, Dong Nai province’s existing electrical networks are supplied from power sources such as:

- Tri An hydropower plant (4x100MW).
- Formosa power plant (150MW).
- Ham Thuan hydro power plant (2x150MW), Da Mi (2x87MW).
- Phu My1 power plant (360MW) and Phu My2 power plant (1015MW).
- Ve Dan power plant (68MW).
- AMATA power plant (2x6.4MW).
- Hoa An diesel power plant (13MW).

The existing transmission lines at Dong Nai province are as follows:

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of transmission line</th>
<th>Conductor</th>
<th>Length</th>
<th>Load current (Imax)</th>
<th>% load</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>220kV Double circuit Formosa -</td>
<td>AC-400</td>
<td>1km</td>
<td>168A</td>
<td>22%</td>
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<tr>
<td></td>
<td>Long Thanh T/L</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>220kV double circuit Long Thanh -</td>
<td>ACSR -795</td>
<td>25km</td>
<td>500A/598A</td>
<td>67%/80%</td>
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<td></td>
<td>Long Binh T/L</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>220kV Phu My - Long Thanh T/L</td>
<td>ACSR -795</td>
<td>25.4km</td>
<td>523A</td>
<td>70%</td>
</tr>
<tr>
<td>4</td>
<td>220kV Da Mi - Long Thanh T/L</td>
<td>AC-400</td>
<td>124km</td>
<td>515A</td>
<td>69%</td>
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<td>Project Description</td>
<td>Type</td>
<td>Length</td>
<td>Current</td>
<td>Load Factor</td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------------------</td>
<td>-------</td>
<td>--------</td>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>5</td>
<td>220kV Ham Thuan - Long Thanh T/L</td>
<td>AC-400</td>
<td>140km</td>
<td>620A</td>
<td>83%</td>
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<tr>
<td>6</td>
<td>220kV Tri An - Long Binh T/L</td>
<td>AC-300</td>
<td>29km</td>
<td>689A</td>
<td>111%</td>
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<tr>
<td>7</td>
<td>220kV Bao Loc - Long Binh T/L</td>
<td>ACSR-795</td>
<td>130km</td>
<td>448A</td>
<td>60%</td>
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<tr>
<td>8</td>
<td>220kV double circuit Long Binh - Thu Duc T/L</td>
<td>2xACSR-795</td>
<td>18km</td>
<td>776A</td>
<td>52%</td>
</tr>
<tr>
<td>9</td>
<td>220kV Tri An - Hoc Mon T/L</td>
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<td>17km</td>
<td>545A</td>
<td>73%</td>
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<td>10</td>
<td>220kV Tri An - Binh Hoa T/L</td>
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<td>575A</td>
<td>77%</td>
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<td>12</td>
<td>110kV Long Thanh - Tuy Ha T/L</td>
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<td>168A</td>
<td>30%</td>
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<td>110kV double circuit Long Thanh - Long Binh T/L</td>
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<td>25.6km</td>
<td>480A/413A</td>
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<td>441A/408A</td>
<td>80%/74%</td>
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<td>11km</td>
<td>391A</td>
<td>71%</td>
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<td>16</td>
<td>110kV Long Binh - Thu Duc Bac T/L</td>
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<td>0.5km</td>
<td>525A</td>
<td>70%</td>
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<td>110kV Long Binh - Bien Hoa 1 T/L</td>
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<td>110kV Long Binh - Bien Hoa 2 T/L</td>
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<td>110kV Long Binh - An Binh T/L</td>
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<td>0.5km</td>
<td>335km</td>
<td>45%</td>
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</tbody>
</table>
2.1.2. Existing Binh Duong province’s power sources and electrical network

Presently, Binh Duong province’s exiting electrical network are supplied from power sources such as:

- Thac Mo hydropower plant (2x75MW).
- Can Don hydropower plant (2x38,8)MW.
- Tri An hydropower plant (4x100MW).
- Thu Duc thermal power plant (2x37,5MW).
- VSIP power plant (12MW).

The existing transmission lines at Binh Duong province are as follows:

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of transmission line</th>
<th>Conductor</th>
<th>Length</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>220kV Double circuit Tri An - Binh Hoa T/L</td>
<td>AC-400</td>
<td>37km</td>
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<tr>
<td>2</td>
<td>220kV Long Binh - Thu Duc T/L</td>
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<td>18.3km</td>
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<td>3</td>
<td>220kV double circuit Tan Dinh - Binh Hoa T/L</td>
<td>2xAC-300</td>
<td>10.63km</td>
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<td>220kV double circuit Tan Dinh - My Phuoc T/L</td>
<td>AC-400</td>
<td>15.4km</td>
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<td>220kV-110kV four-circuit Thu Duc - Long Binh upgraded T/L</td>
<td>ACSR</td>
<td>18.3km</td>
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<td>220kV double circuit Tan Dinh - Trang Bang T/L</td>
<td>ACSR</td>
<td>40km</td>
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<td>7</td>
<td>110kV Thu Duc - Song Than T/L</td>
<td>ACSR</td>
<td>10.9km</td>
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<td>8</td>
<td>110kV VSIP - Song Than T/L</td>
<td>AC</td>
<td>7.2km</td>
</tr>
<tr>
<td>9</td>
<td>110kV Binh Hoa - VSIP T/L</td>
<td>ACSR</td>
<td>5.3km</td>
</tr>
<tr>
<td>10</td>
<td>110kV Binh Hoa - Go Dau T/L</td>
<td>ACSR</td>
<td>7.4km</td>
</tr>
<tr>
<td>11</td>
<td>110kV Thac Mo- Ben Cat- Hoc Mon T/L</td>
<td>AC</td>
<td>165km</td>
</tr>
<tr>
<td>12</td>
<td>110kV Thac Mo - Tay Ninh T/L</td>
<td>AC</td>
<td>268km</td>
</tr>
<tr>
<td>13</td>
<td>110kV Tri An - Dong Xoai T/L</td>
<td>AC</td>
<td>129km</td>
</tr>
<tr>
<td>14</td>
<td>110kV Dau Tieng substation and double circuit branch line</td>
<td>AC</td>
<td>2.5km</td>
</tr>
<tr>
<td>15</td>
<td>110kV Phu Giao substation and double circuit branch line</td>
<td>AC</td>
<td>1.3km</td>
</tr>
<tr>
<td>16</td>
<td>110kV double circuit Binh Hoa - Tan Dong Hiep T/L</td>
<td>AC</td>
<td>7.5km</td>
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<tr>
<td>17</td>
<td>110kV Tan Dong Hiep - Sunsteel T/L</td>
<td>AC</td>
<td>2.2km</td>
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<td>110kV Binh Hoa - Tan Uyen T/L</td>
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<td>AC</td>
<td>4.8km</td>
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<td>20</td>
<td>110kV Kumho - Ben Cat 1 T/L</td>
<td>AC</td>
<td>3.9km</td>
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<td></td>
<td></td>
<td>1.5km</td>
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2.2. Power source expansion planning and transmission line expansion planning Dong Nai province’s electrical system

According to Dong Nai’s power network plan in 2005-2010 (up to 2015) approved by Ministry and Industry by letter No. 2984/QĐ-BCN dated on 23/9/2005, power source expansion planning and transmission line expansion planning is as follows:

Stage 2006-2010:

Substations:

- 500kV substations: new construction 500/220kV Song May substation (3x200MVA) (including 220kV substation - 1x125MVA) is supplied by sources of Phu My power plant.

- 220kV Xuan Loc substation: new construction 220kV Xuan Loc substation (1x250MVA) is supplied by sources of 500/220kV Song May substation.

- 220kV Long Thanh substation: upgrade from 1x250MVA to 2x250MVA.

- 110kV substations: new construction of 16 substations with capacity is 671MVA.

Transmission lines:

- New construction of 500kV Phu My - Song May transmission line
- Construction of 220kV transmission line connecting with 220kV Tri An - Long Binh transmission line.

- Construction of 220kV double-circuit Nhon Trach - Nha Be transmission line.

- Construction of 220kV double-circuit Nhon Trach - Cat Lai transmission line.

- Construction of 110kV transmission lines such as: connection lines of 500kV Song May, Xuan Loc - Cam My, Xuan Loc - Dinh Quan, Tri An - Vinh An, Long Thanh - Nhon Trach industrial zone, Vinh An - Kiem Tan, Xuan Loc - Song May, Ong Keo - Sun Steel transmission lines.

- 110kV branch lines: 110kV Dau Giay, Bau Xeo, Tam Phuoc, SN. Long Thanh, Sub Steel, Quang Trung, Pou Sung, Dinh Quan 2, AMATA 2 substations.

- Upgrading of 110kV Long Khanh - Xuan Loc transmission line.

Stage 2011-2015:

Substations:

- 500kV substations: Upgrading of 500/220kV Song May substation from 3x200MVA to 2 (3x200) MVA.

- 220kV substations: New construction of 220kV Nhon Trach substation (2x250MVA) and Upgrading of 220kV Xuan Loc substation from 1x250MVA to 2x250MVA and 220kV Song May substation from 1x125MVA to 2x250MVA.

- 110kV substations: New construction of 11 substations with capacity is 440MVA and upgrading of 23 substations with total of capacity is 854MVA.
Transmission lines:
- New construction of 110kV double circuit Cam My - Bau Can - Phuoc Binh - Go Dau transmission lines.
- 110kV branch line into 110kV Xuan Loc 2 substation.
- Upgrading of 110kV double circuit Long Thanh - Long Binh transmission line.

2.3. Power source expansion planning and transmission line expansion planning Binh Duong’s electrical system

According to Binh Duong’s power network plan in 2005-2010 (up to 2015) approved by Ministry and Industry by letter No. 1821/QĐ-NLDK dated on 20/5/2005, power source expansion planning and transmission line expansion planning is as follows:

Substations:

- 220kV substations: new construction 220kV Uyen Hung substation is supplied by sources of 500/220kV Tan Dinh and 500/220kV Song May substations.

- 110kV substations:
  + 110/22kV Tan Uyen substation (upgrade from 1x40MVA and 1x63MVA transformers to 2x63MVA transformers (operation in 2008)
  + 110/22kV Nam Tan Uyen (2x63MVA) substation (operation in 2009) is supplied by sources of 500/220kV Tan Dinh and 220kV Uyen Hung substations.
  + 110/22kV Tan Thanh (1x63MVA) substation is supplied by source of 220/110kV Uyen Hung substation.
  + 110/22kV Hoi Nghia and Phu Giao 2 (2x63MVA) substations operation in 2012-2014 are supplied by source of 220kV Uyen Hung substation.
+ Lien Hop 3 substation (2x63MVA) is supplied by source of 500kV Tan Dinh and 220kV Uyen Hung substations.
220kV and 110kV transmission lines of Tan Uyen district - Binh Duong province up to 2015

- 110kV T/L
- 220kV T/L
- 500kV T/L

- 110kV Tan Uyen
  - 2x63MVA (2008)

- 110kV Bau Beo
  - 1x63MVA (2006)

- 110kV Nam Tan Uyen
  - 1x63MVA (2009)

- 110kV Phu Giao 2
  - 2x63MVA (2001-2015)

- 110kV Hoi Nghia
  - 2x63MVA (2001-2015)

- 110kV Tan Thanh
  - 1x63MVA (2010)

- 110kV Tan Dinh
  - 1x63MVA (2006)

- 110kV T3
  - 2x63MVA (2013-2014)

- 220kV Binh Hoa

- 500kV Song May
CHAPTER 3
LOCATION AND PROJECT SIZE

1.1. Location

The planning lines of 220 kV Song May - Uyen Hung transmission line will be built starting from Trang Bom district, Dong Nai province, ending at Uyen Hung town, Binh Duong province.

1.2. Project size

220 kV Song May - Uyen Hung transmission line is built with following specifications:

- Rated voltage : 220kV
- Number of circuits
  - One-circuit, two-circuit, three-circuit
  - One-circuit (length of 544.4 m)
  - Two-circuit (length of 15,277 m)
  - Three-circuit (length of 6,401 m)
- Start point : 220kV busbar of 500kV Song May substation.
- End point : 220kV busbar of 220kV Uyen Hung substation
- Length of the line : 21,678 m

Conductor:
- 2xACSR 330/43 (for 220kV Song May - Uyen Hung T/L)
- 1xACSR-400/52 (for 220kV connection line)

Overhead ground wire:
- Optical ground wire - OPGW186 (type 24 fibers) and overhead ground wire - PHLOX181.6”.

Insulator:
- 70kN, 100kN insulator disc for conductor suspension string; 160kN, 300kN insulator disc for conductor tension string.

Tower:
- Galvanized Steel towers.

Foundation:
- Steel concrete in situ cast.

Earthing:
- 12 round iron bar combined with pile L63x63x6-2.000 in every tower.

1.3. Scope of project

Scope of project is all of Song May - Uyen Hung transmission line from 220kV busbar of 500kV Song May substation at Bac Son commune, Trang Bom
district, Dong Nai province to end in 220kV busbar of 220kV Uyen Hung substation at Uyen Hung town, Binh Duong province.

1.4. The project area

A map of project area is presented below. The project covers an area from Trang Bom district, Dong Nai province to Uyen Hung town, Tan Uyen district, Binh Duong province.
Figure 3.2 Map of project area in Dong Nai

Tan Uyen district

500kV Song May S/S
CHAPTER 4
LOAD FORECASTING

The forecast of load demands of Dong Nai province is showed in table 4.1

<table>
<thead>
<tr>
<th>Load Type</th>
<th>2010</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture - Silviculture - Aquiculture</td>
<td>24.6</td>
<td>32.9</td>
</tr>
<tr>
<td>Industry - Construction</td>
<td>4,776.6</td>
<td>9,485.7</td>
</tr>
<tr>
<td>Commerce - Hotel - Restaurant</td>
<td>288.3</td>
<td>669.1</td>
</tr>
<tr>
<td>Resident - Public Administration Offices</td>
<td>955.5</td>
<td>1,397.7</td>
</tr>
<tr>
<td>Other consumer</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>6,045.1</td>
<td>11,582.4</td>
</tr>
</tbody>
</table>

The forecast of load demands of Binh Duong province is showed in table 4.2

<table>
<thead>
<tr>
<th>Load Type</th>
<th>2010</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture - Silviculture - Aquiculture</td>
<td>15.8</td>
<td>31.9</td>
</tr>
<tr>
<td>Industry - Construction</td>
<td>1,261.7</td>
<td>2,030.7</td>
</tr>
<tr>
<td>Commerce - Hotel - Restaurant</td>
<td>219.9</td>
<td>899.4</td>
</tr>
<tr>
<td>Resident - Public Administration Offices</td>
<td>1,034.7</td>
<td>1,935.8</td>
</tr>
<tr>
<td>Other consumer</td>
<td>188.8</td>
<td>536.3</td>
</tr>
<tr>
<td>Industrial zones</td>
<td>3,952.1</td>
<td>6,867.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>6,672.9</td>
<td>12,301.3</td>
</tr>
</tbody>
</table>
5.1. Transmission line

5.1.1. Line route alternatives

The alternatives of lines have basic characteristics as follows:
- Start point: 220kV busbar of 500kV Song May substation.
- End point: 220kV busbar of 220kV Uyen Hung substation

220kV Song May - Uyen Hung transmission line from 220kV busbar of 500kV Song May substation at Bac Son commune, Trang bom district Dong Nai province to end in 220kV busbar of 220kV Uyen Hung substation at Uyen Hung town, Binh Duong province.

Alternative 1: The length of line route is 21.4km.

Alternative 2: The length of line route is 23.5km.

Alternative 3: The length of line route is 21.67km.

5.1.2. Comparison of line route alternatives

Based on the meeting with People’s Committee of Dong Nai and Binh Duong, line route is approved to run parallel with 500kV Song May - Tan Dinh transmission line in order to decrease land area affected and affected houses within right of way (ROW). Therefore, the alternative 3 is chosen.

5.1.3. Comment

Based on the above comparison of alternatives, alternative 3 is the most optimal. The line route of alternative 3 is chosen. The line route of alternative 3 goes through areas with features as follows:
a) **Trang Bom district’s area:** From start point ĐĐ1 to G0 section.
   - The line route from the start point near 500kV Song May substation to G0 is about 173.3m. The line goes on land to belong to Bac Son commune, Trang Bom district - Dong Nai province. There are not any affected houses within ROW in the route section.

b) **Vinh Cuu district’s area:**
   - The route of line from G0 to G1 is about 1,723.7m, the route runs parallel with connection line of 220kV Tri An - Long Binh transmission line. The route goes through Tan An commune, Vinh Cuu district - Dong Nai province. The line route goes across indigo, rubber trees. There are 6 houses in ROW.
   - The route of line from G1 to G2 is about 1,422.4m, the route goes through Tan An commune, Vinh Cuu district - Dong Nai province. The line route goes across cajuput, cashew tree, rice field. There is not affected house in ROW.
   - The route of line from G2 to G3 is about 2,054.3m, the route goes also through Tan An commune, Vinh Cuu district - Dong Nai province. The line route goes across cajuput, rice field. There are not affected houses in ROW.
   - The route of line from G3 to G4A is about 1,200.1m, the route goes also through Tan An commune, Vinh Cuu district - Dong Nai province. The line route goes across cajuput, rice field. There is one affected house in ROW.
   - The route of line from G4A to G5B is about 190m, the route goes also through Tan An commune, Vinh Cuu district - Dong Nai province. The line route goes across rice field. There is not affected house in ROW.
   - The route of line from G5B to G6 is about 2,307.1m, the route runs parallel with 500kV Phu My - Song May transmission line. The line route goes across cajuput, rice field, some agricultural produce, 220kV Tri An - Hoc Mon T/L, 110kV Tri An - Tan Hoa T/L and Dong Nai province. The line section goes Tan An commune, Vinh Cuu district, Dong Nai province. It also goes through Thuong Tan commune, Tan
Uyen district, Binh Duong province with length of 380m. There are 12 affected houses in ROW.

c) Tan Uyen district's area:
- The route of line from G6 to G7 is about 5,041.9m, the route runs parallel with new 500kV Song May - Tan Dinh transmission line. The route goes through Thuong Tan, Tan My communes, Tan Uyen district, Binh Duong province. The route goes across some cajuput, rice-field and rubber trees. There are 2 affected houses in ROW.
- The route of line from G7 to G8B is about 654.9m. The route goes across rubber trees, some indigo trees. It goes Tan My commune, Tan Uyen district, Binh Duong province. There are no affected houses in ROW.
- The route of line from G8B to G9 is about 875.1m. The route goes across some rubber trees. It also goes Tan My commune, Tan Uyen district, Binh Duong province. There are only one affected houses in ROW.
- The route of line from G9 to G11 is about 3483.1m. From G9 to G10, the route runs parallel with existing 500kV Pleiku-Tan Dinh transmission line. The route goes across most rubber trees and some cajuput trees. It also goes Tan My commune, Tan Uyen district, Binh Duong province. There are no affected house in ROW.
- The route of line from G11 to G12 is about 1912.9m. The route goes across most rubber trees. It also goes Tan My commune, Tan Uyen district, Binh Duong province. There are two affected houses in ROW.
- The route of line from G12 to ĐC is about 577.3m. The line goes along with DH411 street and across most cajuput trees and then connect into 220kV Uyen Hung substation. The route goes through Uyen Hung town, Binh Duong province.

Table 5.1: Summary of the 220kV Song May - Uyen Hung transmission line's length and deviation angle.

<table>
<thead>
<tr>
<th>No.</th>
<th>From point to point</th>
<th>Length (m)</th>
<th>Deviation angle</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>220kV Busbar of 500kV Song May substation - DD1</td>
<td>31.5</td>
<td></td>
<td>500kV Song May substation</td>
</tr>
</tbody>
</table>

PECC3
Table 5.2: Summary of the 220kV connection line’s length with 220kV existing Tri An - Long Binh transmission line and deviation angle.

<table>
<thead>
<tr>
<th>No.</th>
<th>From point to point</th>
<th>Length (m)</th>
<th>Deviation angle</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>220kV Busbar of 500kV Song May substation - DD2</td>
<td>50</td>
<td></td>
<td>500kV Song May substation</td>
</tr>
<tr>
<td>2</td>
<td>DD2 - G0</td>
<td>119.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>G0 - G1</td>
<td>1723.7</td>
<td>L 7°31'44&quot;,</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>G0 - G4A</td>
<td>6400.5</td>
<td>R10°55'57&quot;</td>
<td>The same route as 220kV Song May - Uyen Hung line section</td>
</tr>
<tr>
<td>5</td>
<td>G4A - G4A1</td>
<td>76.6</td>
<td>R98°33'03&quot;</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>G4A1 - G4A2</td>
<td>48</td>
<td>L5°50'57&quot;</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>G4A2 - G4A3</td>
<td>250</td>
<td>R9°51'00&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total (m)</strong></td>
<td><strong>6,945</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total (m) 21,678
Figure 5.1: 220kV Song May - Uyen Hung transmission line route (Alternative 3)
5.1.4. Transmission line layout

5.1.4.1 General

5.1.4.1.1 Climatic conditions

Climatic conditions are as follows:

Air temperature:
- Minimum air temperature: 15°C
- Yearly average air temperature: 30°C
- Maximum air temperature: 40°C
- Air temperature at maximum wind velocity: 25°C
- Air temperature in thunder: 20°C

Wind pressure:

The design maximum wind pressure at 10 m elevation is 60 daN/m²

Atmospheric conditions:
- Average humidity: 80%
- Pollution level:

The pollution levels in accordance with IEC is: 2.0cm/kV

5.1.4.2. Conductors

Conductors for 220kV Song May - Uyen Hung transmission line are used ACSR 330/43.

Cross-section:
- Aluminum: 332m²
- Steel: 43.1mm²
- Total: 375.1mm²

Calculated diameter: 25.2mm

Weight (total): 1.255 kg/m

Rated tensile strength (RTS): 103,784N

Elastic module: 7,034daN/mm²
Heat elasticity coefficient: \(19.3 \times 10^{-6} \text{J}^2/\text{C}^2\)

Conductor for 220kV connection line to 220kV Tri An - Long Binh Line are used ACSR 400/52.

Cross-section:
- Aluminum: 400m²
- Steel: 51.9mm²
- Total: 452m²

Calculated diameter: 27.6mm
Weight (total): 1.510 kg/m
Rated tensile strength (RTS): 12300daN
Elastic module: 7,034daN/mm²
Heat elasticity coefficient: \(19.3 \times 10^{-6} \text{J}^2/\text{C}^2\)

**5.1.4.3. Earthwires**

Earthwire for 220kV Song May - Uyen Hung transmission line is used PHLOX 181.6:

Cross-section: 181.63mm²
Calculated diameter: 17.5mm
Weight (total): 975 kg/km
Rated tensile strength (RTS): 16024daN
Elastic module: 12,400daN/mm²
Heat elasticity coefficient: \(14.2 \times 10^{-6} \text{J}^2/\text{C}^2\)

**5.1.2.4. Overhead Ground Wire Fiber (OPGW)**

OPGW for 220kV Song May - Uyen Hung transmission line is OPGW186 with fibre in accordance with ITU-T G.652 (24 fibers).

**5.1.2.5. Insulators**

The suspension and tension insulator string units shall be of the cap and pin type and shall comply in all respects with IEC 60305, IEC 60383 and IEC 60120. Insulator units shall be of glazed porcelain or tempered glass type.
5.1.4.6. Tower
Towers are used steel lattice tower type for 1 circuit, 2 circuits and 3 circuits.

5.1.4.7. Foundation
Foundations are designed to be suitable for the ground conditions. Foundation type which is recommended for 220kV Song May - Uyen Hung transmission line is individual footing foundation.
CHAPTER 6
PROJECT EXECUTION

10.1. Project management

d) Investor: National Power Transmission Corporation (NPT)

e) Project management: Southern Viet Nam Power Project Management Board on behalf of EVN manages to carry out the project.

f) F/S carried out by Power Engineering & Consulting J.S Company No. 1 (PECC1).

g) Technical design carried out by Power Engineering & Consulting J.S Company No.3 (PECC3).

10.2. Working progress

Working progress of the project is planned as follows.

- FS report and approval: 04/2009

- Technical design and approval: 08/2010

- Bidding documents for procurement of goods 02/2011

- Putting in operation: 12/2012
CHAPTER 7
PROCUREMENT OF GOODS
AND REFUNDING THE BUDGET

11.1. Package of bidding documents

h) Package No.1: Supply of steel tower
i) Package No.2: Supply of conductors and overhead ground wires
j) Package No.3: Supply of insulators and Accessories
k) Package No.4: Supply of optical ground wire (OPGW) and fittings
l) Package No.5: Construction of 220kV Song May - Uyen Hung T/L.
m) Package No.6: Transport equipment and materials.

11.2. Planning progress of refunding the budget

220kV Song May - Uyen Hung transmission line is planned refunding the budget in two years after the beginning of project.