A Survey on Data Model for Obtaining Power by Using Geographic Information System (GIS)

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CAMBODIA

ABSTRACT

With the development of reconstruction of Rural Electrification in Cambodia, Geographic Information System (GIS) has not been applied yet in the field of Power System in Cambodia. Parts of plants in power system are excessive and separate, and their distribution is spatial. Therefore, it is necessary to establish a proper data model to deal with the obtainable power, the power network information, etc. Spatial topography model is adopted to solve the problem with dynamic topography analysis of availabilities power uses related to the locations, the rise in the connected populations, to the financial sustainable, to the maximize development impact and can be linked to the geographical and numerical data, etc.

1. INTRODUCTION

Power Industry is becoming more and more importance as it is the backbone to support economic development. The traditional distribution management mode can not keep up the needs of distribution power network construction and running safety. The new management mode should be adopted to make full use of limited power resources. It is distributed geographically in power system, such as transmission network, distribution network, substation, equipment, user, load, water, coal, etc. Combined with geographic environment, the visualization technology is adopted to manage these data so as to enhance the intuitive comprehension and data management.

This manuscript describes the method to probe the availabilities of power uses in Cambodia by using GIS as a topological data model with several real instances. The instances show that this method is feasible and it will be useful for future Cambodia Rural Electrification (RE) development process.

GIS is the information system which use modern computer tool graphics and database technology to get, to input, to search, to analyses, and to display spatial location data, etc. The geographic special data is dealt with and analyzed by GIS, based on unique spatial analyzed function and visualized expression of GIS. Many kinds of analysis, management and decision making are presented by using GIS.

2. DATA REQUIREMENT

The most requirements in the applied power network as well as the Rural Electrification in Cambodia are data. The dimensional data structure, which include:

- Spatial Location (SL) - is the location determined by a reference coordinate.
- Relatively Location (RL) - is the topology relationship between geographic entities.
- Relatively Attribute (RA) - is independent of geometry location.

Rely on the method of collection, storage, state of explain, object of usage, spatial data is divided into two different data models such as vector model and grid model.

- The vector model was adopted by the borderline or surface to describe the whole physical structure element of spatial object. Using the record of object borderline and identifier to express its attribute, the object entity is described.
- The grid model was adopted by the enumeration of faces fields to describe spatial object directly. It uses digitals matrix to describe grid, and is stored in disk as a simple file structure. File includes the direct address of pixel in sequence. It needs a very large storage space to accurately describe graphic element of point, line, polygon and symbol, for the applying of fine resolution pixel.

The RE information system and the other type of network structure models should integrate all existing system and all need information, such as station and sub-station and automation of station and substation, load management system, remote automation record system, etc. After integrating the RE or the distribution power network equipment data, user data, real-time data, history data, graphic of power network and geographic, then it could manage and analyze distribution power network in detail. It is a system that combines real time and off time management and it has a close relationship with users, because its information can be divided into two types, i.e., distribution power network equipment and another is all kinds' information about the uses.

The grid model could implement overlap operation without complicated geometry calculation to different type of spatial data layer while, vector model is widely used to deal with graphic object on map. Fig.1 Flowchart illustrates distribution power network (DPN) using GIS as a typical structure.

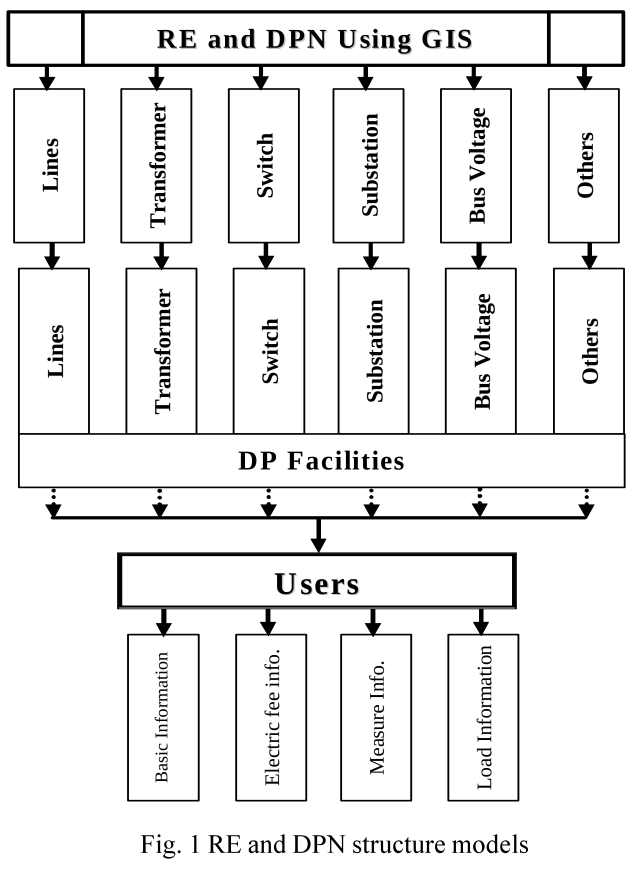

Fig. 1 RE and DPN structure models

3. DATA PATTERN

This manuscript intends to define the data pattern by using spatial whole model, which includes point, line and face. The data pattern contains geographic layer, physical layer and topology layer in GIS system. It includes point, line and faces three basic types. Spatial entity composes one or more part, and part composes of point gathering and this point gathering is a junction of points. Each spatial object interior records its spatial information, and then the whole topology model is established. The creation of GIS power network, the distribution power network diagram and its supply in the area are entry into computer regarding on a respective topology relationship, which use urban street map as a reference acquired by the digital instrument. The map is in form of vector and it can be used as a spatial entity model for describing the whole geographic in the area of power demand and development. Every point symbols is dependent on scale and adopts a pair of abscissa and ordinate (X,Y) which denotes the geographic position of point to point in power forecasting as well as power network distribution, etc., (i.e., populations, locations, pole towers, transformers, and bus voltage levels).

Line contains of a set of sequential points. It begins with at the jumping-off point and ends at terminating point. Point coordinate (X,Y) denote the linear entity, called from the first of (X_1,Y_1) to (X_n, Y_n), such as energy resources, locations, populations, rivers, underground cables, overhead lines, etc. For the direction of line implies in this junction of sequential point can confirm the topology adjacency face. Face composes of a set of sequential lines. It denotes area possessed boundary and location, such as urban, location of power supply, substation.

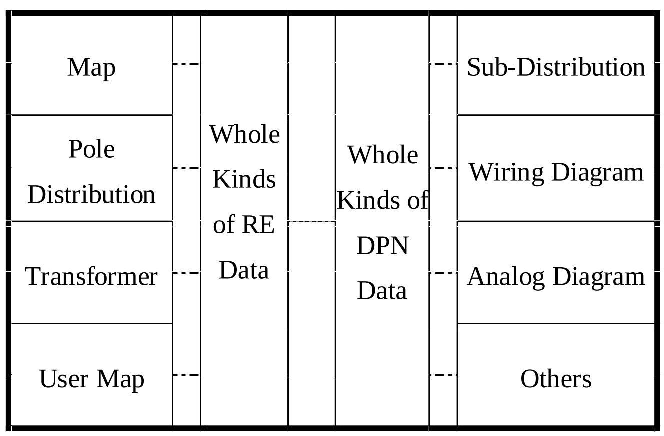

Fig. 2 Rural electrification & power supply data

4. DATA STORAGE SYSTEM

The spatial data denote the geographic position and attribute data that denote non-geographic position of equipment store separately. Spatial data store in the some files. Otherwise, the attribute data store in the property table of relational database. Both type of data linked by spatial index. According to the different subject, the map is decomposed into some layers in order to inquire faster and effectively. In layer stores some files, such as table structure file of attribute data, spatial data file and others. Fig.3 listed the RE and DPN framework model of data storage system.

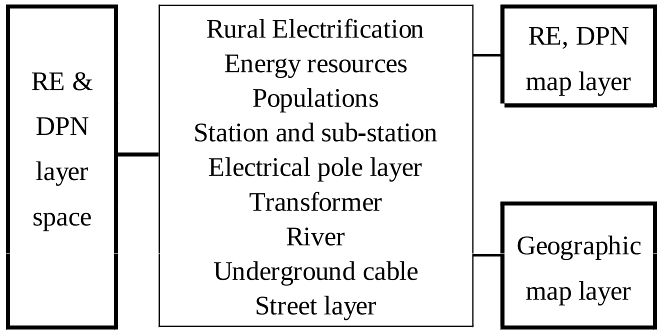

Fig. 3 RE & DPN data storage model

5. POWER SYSTEM OPERATION

5.1 Power Generation

Presently Cambodia has no national grid, and electricity is generated by 22 isolated diesel generating systems. The total installed capacity (Phnom Penh city and other provincials) of 142.45 MW and the maximum output is 117.60 MW or 82.60 percent in year 2001. Phnom Penh accounts for 112 MW of Installed Capacity with the maximum output of 95.1MW. The main consumption is in Phnom Penh's system counted for 82.60% of the maximum output within EDC's coverage area. The increase of total installed capacity and maximum output result from re-operating of 18 MW thermal power plant and the other purchased power from private company.

5.2 Peak Power Demand

The amount of power demand in the year 2001, 2000, 1999 and 1998 is shown in the Table 1. Through this information we can say that the demand of power in year 2001 is rapidly increasing from 70.30 MW to 77.60 MW in Phnom Penh city. Also, the amounts of power demand in some provincials are also increasing from 7.45 MW to 11.08 MW of respectively year. Table 2 listed the detailed information relating to the recent power installations in Cambodia and the possibility output from each generator.

Table 1 Breakdown of Yearly Peak Power Demand, MW

EDC	2001	2000	1999	1998
PHN's	77.60	70.30	64.00	61.00
Provincials'	11.08	7.45	6.1	5.89

6. POWER SECTOR STRATEGY

Cambodia faces a major challenge to develop an adequate and reliable source of electric power in the years ahead. Based on intensive studies of the best means of providing a national electricity supply network, the Royal Government has developed a long-term power sector strategy for electric power over the next 20 years. The strategy establishes the sector's policy and action plans for: Investment in the power sector; Priorities for generation and transmission; Establishment of the power sector's Regulatory Framework; Commercialization of EDC; Private sector participation; Provincial and Rural Electrification (See Table 2 below).

Table 2 Power plant installations in some areas to meet the growing demand

Location	Capacity, [MW]	2001	2000	1999	1998	1997
PHN's	• Total Installed Capacity	112.00	112.00	98.20	77.80	116.12
	• Max O/P	95.10	100.50	85.00	66.60	81.00
	• EDC's installed capacity	62.00	62.00	63.20	42.80	85.62
	• Max O/P	52.10	55.50	59.00	41.60	60.00
	• IPP's-I Installed capacity	35.00	35.00	35.00	35.00	35.00
	• Max O/P	28.00	30.00	26.00	25.00	21.00
	• Jupiter Installed capacity	15.00	15.00	-	-	-
	• Max O/P	15.00	15.00	-	-	-
SHV's	• Installed capacity	10.39	10.00	10.00	10.56	5.56
	• Max O/P	8.28	7.80	7.80	8.94	3.94
SRP's	• Installed capacity	8.62	4.04	4.04	2.96	2.96
	• Max O/P	4.42	2.80	2.80	2.40	2.40
	• EDC's Installed capacity	8.70	2.50	2.50	2.96	2.96
	• Max O/P	1.49	1.35	1.35	2.40	2.40
	• Priv. Gen. Installed capacity	5.92	1.54	1.54	-	-
	• Max O/P	4.42	1.45	1.45	-	-
KGC's (Priv. Gen)	• Installed capacity	3.59	2.03	2.03	3.30	3.30
	• Max O/P	2.90	1.66	1.66	1.44	1.44
Takeo (Priv. Gen)	• Installed capacity	0.90	1.12	-	-	-
	• Max O/P	0.90	0.90	-	-	-
BTTBG's	• Installed capacity	6.85	1.12	-	-	-
	• Max O/P	6.00	0.90	-	-	-
TOTAL	• *Installed Capacity*	*142.35*	*129.20*	*114.63*	*94.62*	*127.94*
	• *Max O/P*	*117.60*	*113.66*	*97.26*	*79.38*	*88.78*
	• *Percentage*	*82.60%*	*87.98%*	*84.85%*	*83.89%*	*69.39%*

7. PRIORITIES FOR GENERATION AND TRANSMISSION

Load forecast of electricity generation in Cambodia is expected to face a significant increase in demand over the next 20 years. Electricity demand in Cambodia is forecast to grow from 97 MW and 522 GWh in 1998 to 746 MW and 2634 GWh in 2016. While the majority of this growth will occur in Phnom Penh, there will be significant growth in provincial towns. The Transmission System of Cambodia consists of (1) a generation master plan and; (2) a transmission master plan.

Further details of the estimated generation output required to meet electricity demand growth a schematic diagram of the generation and transmission plan together with the dates for commissioning of generation units is given in Fig. 4. In relation to the transmission system and location of hydro plants, a Cambodia development map of Cambodia is given in Map of Fig. 5.

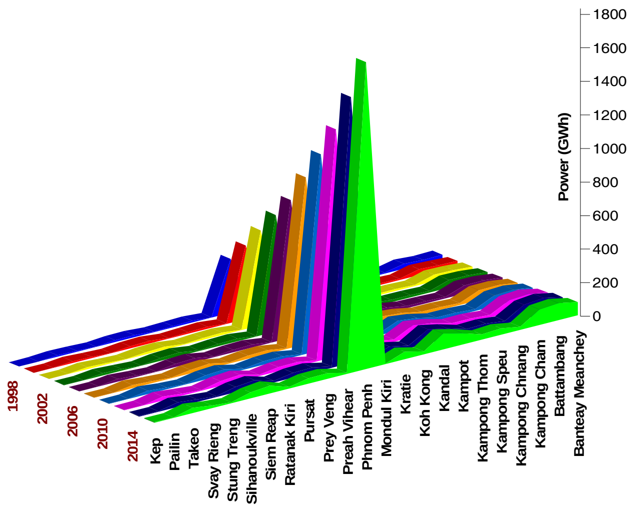

Fig. 4 Expected Generation Output in GWh according to the following years

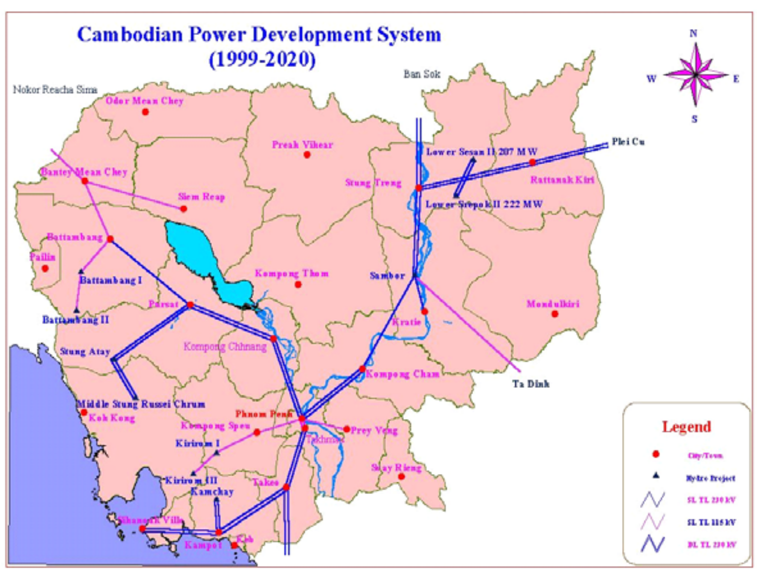

Fig. 5 The transmission system and location of hydro power plants project in Cambodia

7.1 Generation Master Plan

The Generation Master Plan has been developed on the following criteria:

- Base load thermal generation will be located in Sihanouk Ville to give independent access to imported oil and thereby reducing the amount of oil transported on the Mekong,
- Peak load thermal generation in Phnom Penh,
- Small and medium size diesel units for base and peak load generation in the provincial towns and cities,
- Hydro development based initially on the smaller easily accessible sites such as Kirirom, and Kamchay and subsequently mid size hydro projects.

7.2 Transmission Master Plan

The transmission master plan has been developed taking into account the following strategies to achieve Cambodia's electricity sector objectives:

- Reduce reliance on imported oil for energy generation (diversification of energy sources),
- Increase operational efficiency of the system (minimize losses),
- Encourage least cost development of provincial load centers by a cost effective mix of grid expansion and local private generation,
- Increase competition in power generation by providing access to competitive sources of imported electricity from Vietnam, Thailand or Laos,
- Maintain the reliability of power supply at the level required and financially supported by customers,
- Facilitate export of electricity.

The scope of work includes implementation of the following projects:

- Year 2011: 20 km single circuit 230kV transmission from WS to South Phnom Penh (SPP) and a terminal substation in SPP.
- Year 2011: single circuit 115kV transmission line between Battambang 2, hydro station and Battambang substation.
- Year 2012: 260km double circuit 230 kV transmission line between North Phnom Penh and Kompong Chhnang including switchyard at North Phnom Penh and intermediate 230kV switching station at Pursat.
- Year 2012: 50km single circuit 115kV transmission line from East Phnom Penh to Prey Veng and 115/22kV terminal substation at Prey Veng.
- Year 2013: 20km 230kV transmission from North Phnom Penh to West Phnom Penh including a single circuit between West Phnom Penh and South Phnom Penh and a 115kV transmission between West Phnom Penh and GS3.
- Year 2014: connection of IPP5, 90MW gas turbines to Sihanouk Ville switchyard.
- Year 2015: 115kV u/g cable connection single circuit from IPP2 to Central Phnom Penh including a terminal substation at Central Phnom Penh.
- Year 2016: double circuit 230kV transmission line from Stung Atay to Middle Stung Russei Chrum (125MW).
- Year 2016: 230kV switching station at Kompong Chhnang and a terminal substation.
- Year 2016: 110km double circuit 230kV transmission line from Pursat to Battambang including switchyard at Battambang.

8. CONCLUSIONS

With the development of reconstruction of urban power system in Cambodia, Geographic Information System is meanwhile widely applied in power distribution system. Nodes in power system are excessive and separate, and their distribution is spatial. Therefore, it is necessary to establish a proper data model to deal with the power network information. This manuscript describes the method to construct the power network GIS by using spatial topology data model with several real instances and referring to this method we can draw the nodes of power system as well as to establish the topology data model to deal with the power network and rural electrification information, etc.

9. REFERENCES

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