CHAPTER 3
Research Methodology

This chapter also introduces the methodology to manage incomplete information or unstructured data which may hide in power system industry by used to support the decision-making of energy regulators. Then present the strategic map under Balance Scorecard concept to create the strategic for whole electricity supply industry, and use to identify the task by used task template and communication plan. Finally, task and information used to correct the response person and create Common Information Model creation. After that, it proof of concept by allied with real business case of power system economic.

3.1 Power System Economic attribute

When focusing on the supply side of power system economics, it seems that power producers need to maintain the supply level above the load to avoid a system breakdown. So, this research suggests the indicator that relate with each business side in both supply and demand side of the business. Therefore, indicators can be show are as follow:

Generator

- Law and bill
  - Power development plan
  - Industry certification
  - Generation license
  - Environmental (EVA)

- Engineering
  - expected plant life
  - heat rate and rated output
  - expected fuel cost

- Environmental impact
  - dust, water, air impact level
- Economic
  - internal rate of return
- investment cost
- estimated annual production
- annual production cost
- annual revenue
  - Price of energy resource
  - Power consumption
- Supply elasticity
- Load duration curve
- Load forecasting
- Tariff model
- Reserve margin

Table 3.1 Interest indicator for supply side in power system economics

System	Topic	Indicator
Generation	Power consumption	▪ Supply elasticity ▪ Load duration curve ▪ Load forecasting ▪ Tariff model ▪ Reserve margin
	Cost-benefit	▪ Production cost ▪ Investment cost ▪ Operational and maintenance costs ▪ Production cost separate by type of power plant ▪ Cost to purchase from other country o AP o EP

Table 3.1 Interest indicator for supply side in power system economics (Continued)

System	Topic	Indicator
Transmission and Distribution	Optimal power flow	▪ Overhead lines, cables, transformer, switching devices optimal selection
	Cost-benefit	▪ Cost of transmission and distribution losses ▪ Losses forecasting according to increasing load ▪ Frequency and voltage
	Investment comparison	▪ Time value of investment money in transmission and distribution networks

Table 3.2 Interest indicator for demand side in power system economics

System	Topic	Indicator
End user	Demand forecast	▪ Elastic of demand ▪ Load duration curve ▪ Energy (kWh) ▪ Load profile
	External factor	▪ GDP ▪ Interest rate

3.2 Energy Regulatory Decision Making Framework

The Energy Regulatory Commission (ERC) works under the policy established by the National Policy Council (NEPC), which require the ERC to take responsibility for considering 4 areas, which are

- Regulate, lay down rules for electricity asset management

For asset management, the ERC has the responsibility to assess the asset usage of every investor in the electricity industry because it may lead to changes in the electricity tariff and affect the electricity that the end user needs to pay for. Firstly, the ERC need to give the assets value and monitor the risks involved while using that asset (Graham EARP and A. ELLAM, 2007). Meanwhile, they make cooperate with system operators to monitor and adjust the asset management plan to avoid using the unnecessary assets.

- Licensing

The ERC has the responsibility of issuing the 5 types of electricity and 4 types of natural gas licenses, which are:

Table 3.3 Type of electricity and natural gas licenses

Electricity License	Natural Gas License
1) Power Generation License 2) Transmission System License 3) Distribution System License 4) Retail Supply License 5) System Operation License	1) Natural Gas Pipeline Transportation License 2) Natural Gas Supply and Wholesale License 3) Gas retail and Distribution Licenses 4) LNG Terminal Licenses

When issuing any license, the ERC need to take into account many factors that come from many sources, not only the figure showing the safety and hardware structure of the firms that comes from the department of industrial works but also the stock ratio and technology, which comes from the firm itself.

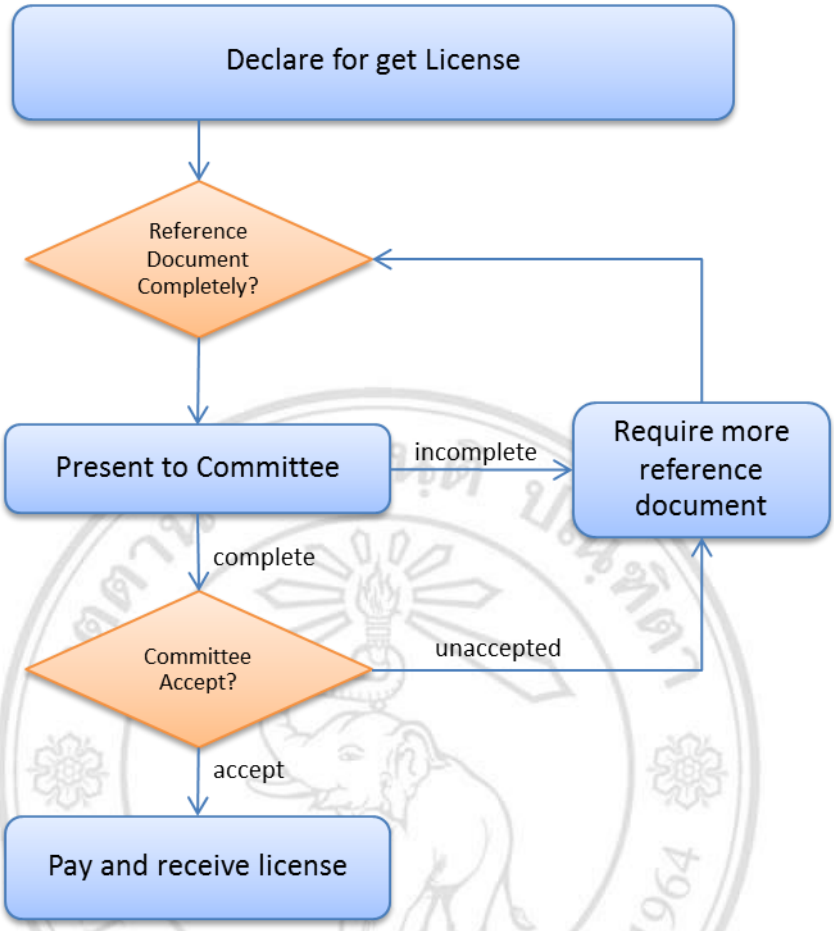

Figure 3.1 License approval workflow process

The figure above shows the decision process for giving licensing to one company. Firstly the information, in any format (paper-based and computer-based), is compiled by the ERC officer, who checks the entirety of the documents. If the documents are not complete, the ERC officer will ask the firm to send those documents directly to the ERC. After the documents are completed, they are taken to the committee meeting to make the judgment regarding giving a license to that firm. It will take approximately forty-five days for officers to compile the documents, and thirty days for the committee to make the decision concerning issuing the license.

- Promote and support a communion by establishing an Energy fund in the "Near the Plant" community

The energy fund is the key instrument used by the ERC as a channel for implementing the subsidy arrangements for underprivileged power consumers, rehabilitating localities, compensating people who have been affected by power plant operations as well as promoting new technology that offer environmentally friendly energy. The revenue of the fund comes from the present ratio (electricity tariff) of the investment cost of power generators.

- Electricity operation (balancing)

In order to regulate the electricity operations, a committee needs to make more complex decisions, not only for the electricity included in a base tariff, fuel adjustment mechanism (Ft) and value added tax, but also to make the decisions to control the power development plan (PDP) for making balance in electricity, affecting the power generation sector, renewable energy promotion and power purchasing. The power development plan (PDP) shows the comparison between electricity usage of end users and the electricity capacity of operators in recent times and also the estimation for the next 15 years. Moreover, the PDP will show the plan of usage fuel ratios and the projects to create, change or maintain electricity generation, which it presents, year-by-year, for the next 15 years (B.L. Song, Member, IAENG, W.K. Wong, J. Fan, and S.F. Chan, 2008). The changing in the long term plan (PDP) for the electricity industry has an effect on the Power Purchase Agreement (PPA) which EGAT makes with an independent electricity operator who produce the electricity between 1-100 MW, and will affect the decisions on Fuel Adjustment Mechanism (Ft) that are adjusted every 4 months. The decision making process for Ft adjustment has concerns with two factors. Firstly, the turnover for the last 4 month, which can have control over the plan, and secondly, the effects of the debts of system operators or debts of the end-users. These two factors will have an effect on the plan for the next 4 months.

Therefore, it means that decisions for auditing the PDP plan have a wide range of effects on the electricity industry and decision makers need to look at many factors, including the factors from the Power Purchase Agreement (PPA), monthly operations, and the factors from the fuel adjustment mechanism.

3.2.1 Analysis of Energy Regulatory decision framework

Based on the ERC's decision framework that was examined for each side above, it is seen that the decision making of regulators needs support information that comes from many sources, sent to regulators at different times, such as yearly, monthly reports, even if the report that the regulator requests from participant is for making decisions in an emergency case. The main sources that provide information to the ERC are:

Table 3.4 The main sources that provide information to the ERC

	Control Power	**Company**
State-own company	Much	EGAT, MEA, PEA, SO
Independent sources	Few	IPPs, SPPs, VSPPs
Outside sources	None (corporation)	State agency

The characteristic of decision making that the ERC exhibits is that the last decision alternative is judged by the group of individuals in a committee, all who have their own expert skills, while their officers compile the information. The structure can be seen in the figure below:

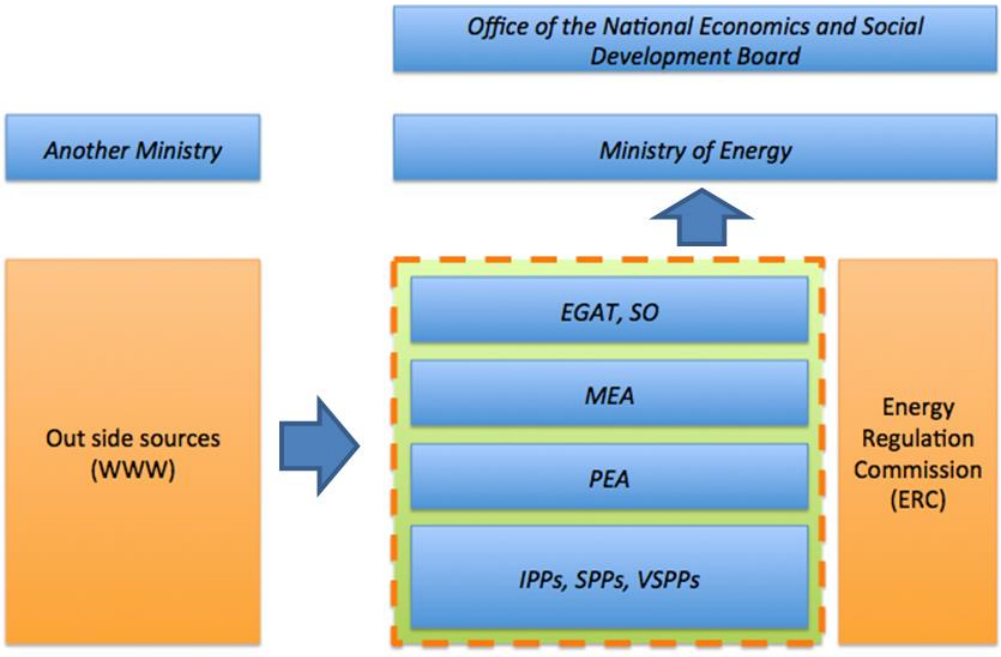

Figure 3.2 Transaction Structure

The figure above shows that the ERC need to make their decisions based on the strategy restricted by the *Office of the National Economics and Social Development Board and ministry of energy*, who have the objective of making a 5 years national development plan that every ministry and government company needs to follow, while the information comes from participants (EGAT, MEA, PEA, etc.) that have their own strategy. Therefore, the decision making of a regulator committee may have a bug and need to make considerations as follows:

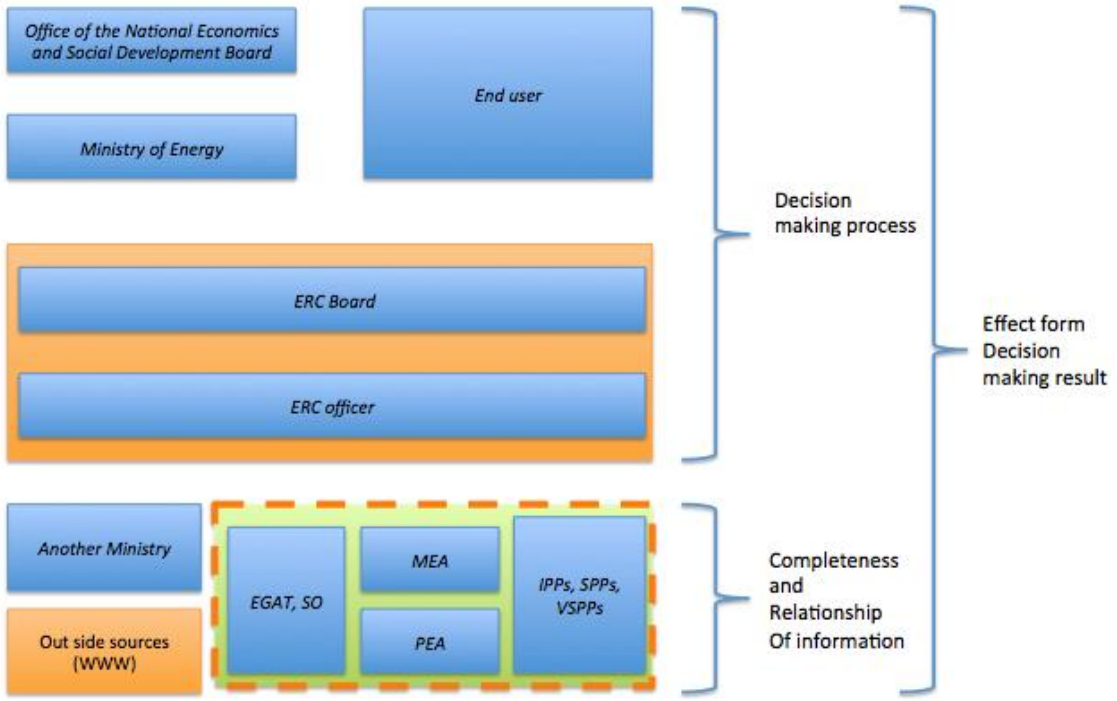

Figure 3.3 The decision making of a regulator committee

- *Completeness and relationship of Information*

For making decisions, information management has an important role to indicate accurately decision results, especially for regulatory work in the Electricity Supply Industry (ESI) because it affects many people's level of satisfaction and affects the buying of power by people in the country.

- *Decision making process*

To achieve the best alternative from the decision-making of the ERC committee, they need to study the relationship between the strategy for the whole country, which is

a 5-years for Thailand, and the strategic plan of the Ministry of Energy. Moreover, the ERC need to study the strategy of their participants who generally send reports to the ERC as information, in order to make the decisions. Therefore, the relationship between the strategies can be analyzed by studying the Balanced Scorecards. For the country's strategic plan, the energy strategy focuses on many sides, which are as follows:

- Stability of energy by obtaining, improving and promoting clean energy, and developing alternative technology used in electricity power plant events if the investment cost for alternative energy will lead to a decrease from the previous plan, the 10th Thai country development plan, from 134,165 million baht to 102,726 million baht. (However, investment in alternative energy from the government has increased considerably from 9,343 million baht to 27,124 million baht).

- Support the study and research of renewable energy such as solar, wind, etc. by giving scholarships to universities and so improve the motivation of people who are interested in studying renewable energy.

- Increase the quality of energy usage at all levels in order to reduce the energy usage of the country.

- Procure new energy to improve and maintain the energy reserve level for the country by focusing on Fuel Diversification.

On the other hand, the balanced scorecards of EGAT, who are the state-own electricity generators, and the balanced scorecard of the PEA who are the state-owned electricity distribution in Thailand are shown in the figure below:

Figure 3.4 Strategic map of Electricity generation authority of Thailand (EGAT)

EGAT's balance scorecard above shows us that EGAT especially focuses on maintaining the company profitability, affecting the price of stock in stock market, by managing efficiency, which in turn relates to the strategy of the government. Moreover, they need to achieve corporate efficiency, which benefits the public because it increases the reserve margin (holding) in the electricity market. For their customers (Public), this balanced scorecard shows that EGAT focus on three participants, which are the relationship of Government, their customers such as MEA, PEA and direct buyers, related to the profit of the company, and the public participants such as the civil population. For the internal processes EGAT separates them into four processes (Adrian Clark, M. Coyne, Steve Hoy, Nis Jespersen, Chris Pavlovski, and Ian Watt, 2011; Giuseppe Nicoletti, Stefano Scarpetta and Olivier Boylaud, 2000). These are, product and technology development, quality of transmission line, quality of electricity generation, and the level of reserves in the electricity market. The last aspect shows the learning and growth of EGAT, reflecting that they are concerned to increase the security level in business operations, and conduct research for finding new generation

technology, to reduce the generation costs and lead to increases in company revenue. Moreover, they also promote human resource management (HRM) to increase the knowledge level of company workers.

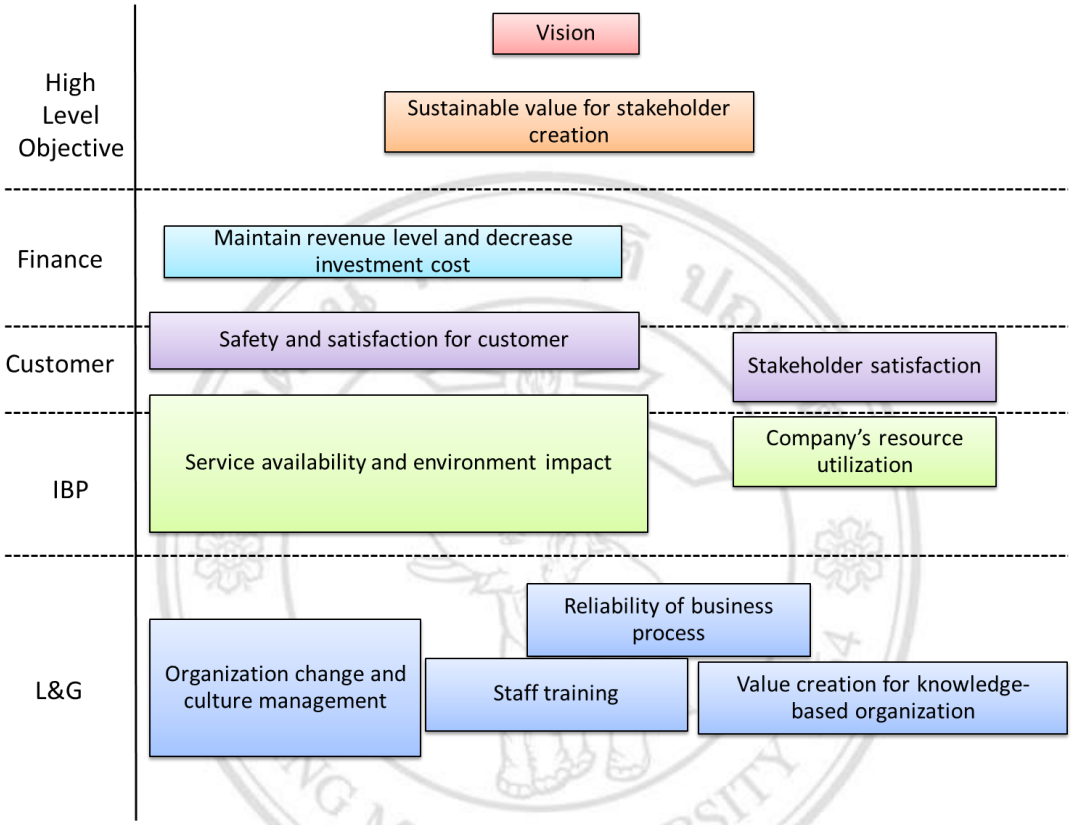

Figure3.5 Strategic map of Provincial Electricity Authority (PEA) years 2008-2011

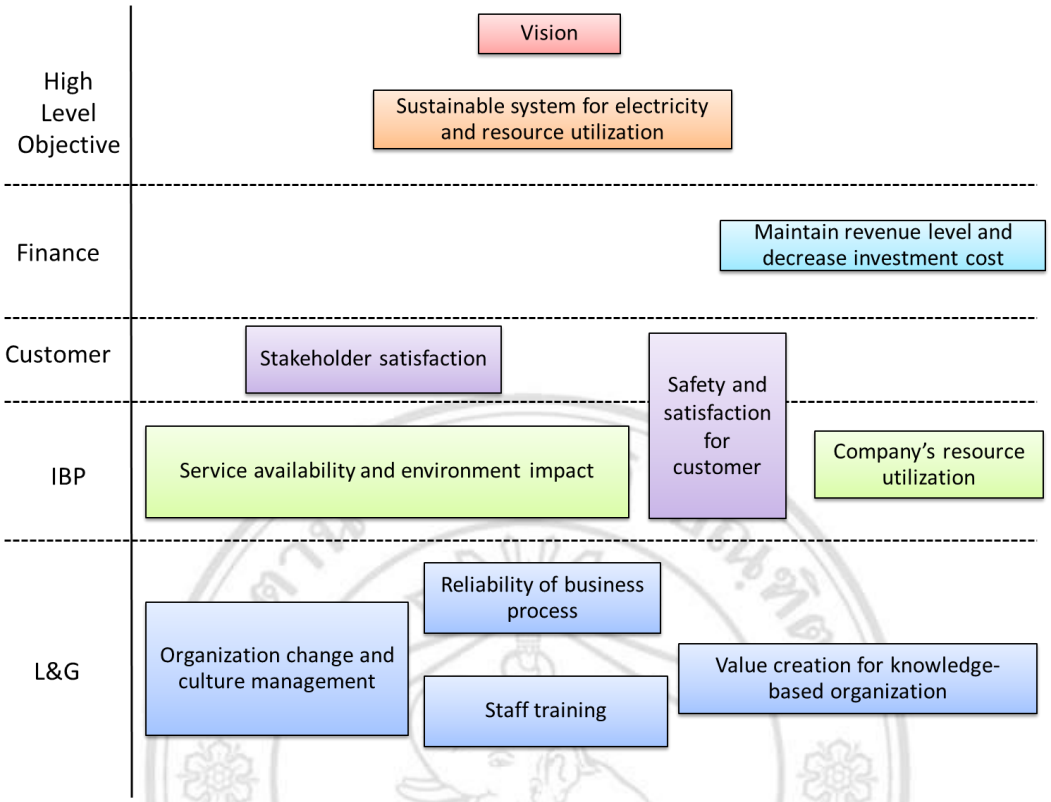

Figure 3.6 Strategic maps of Provincial Electricity Authority (PEA) years 2012-2015

By comparison the PEA's balance scorecard in the last 5 years shows us that the strategy of the PEA is mostly the same as the previous 5 years but that the strategy has changed from three strategies (2007-2011) to four strategies (2012-2016) with the same content. It was necessary for the PEA to change their strategy because they needed to adjust their strategy to follow the changes in the country's plan for Thailand, which became concerned more with people and the environment in Thai society.

Based on the strategy shown above, in both the country's plan and the strategy of the Energy Regulatory Commission participants, EGAT and the PEA, the balance scorecards should follow the Thai national strategic plan and not resist their participants. Therefore, the recommended balance scorecard of the ERC should be as follows:

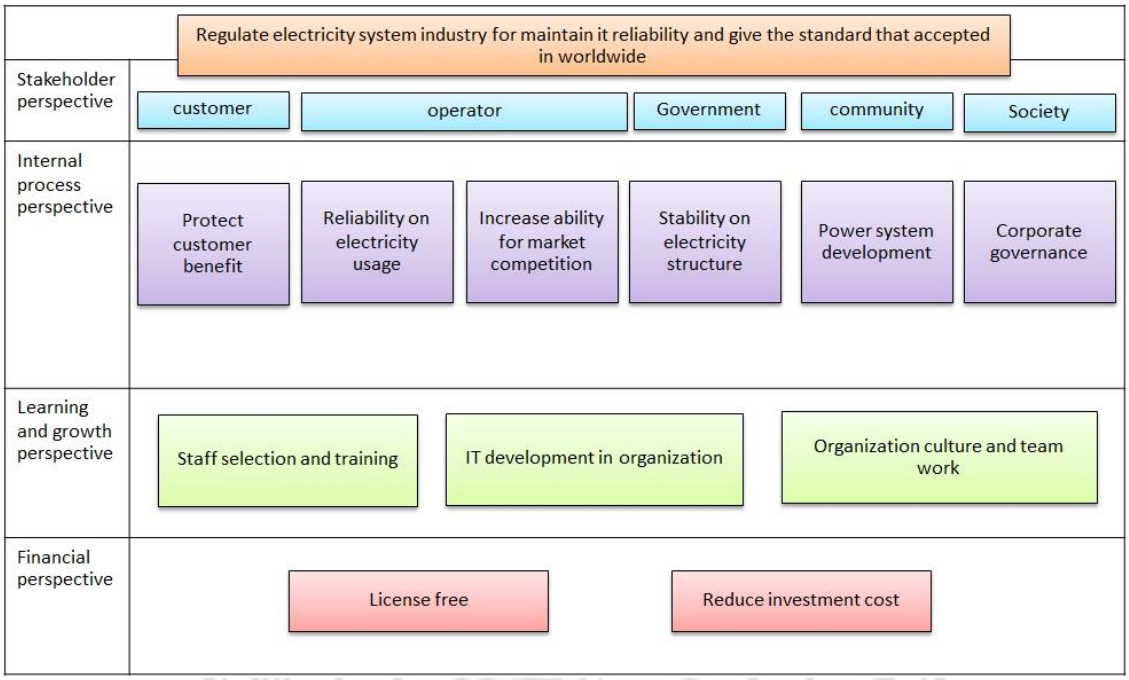

Figure3.7 Strategic map of Energy Regulatory Commission (ERC)

Based on the ERC's balanced scorecard above, we see there are many factors that make the ERC able to serve their vision concerning "regulating an energy operation to make energy reliable and to an accepted standard". To achieve the goal of this vision, the ERC should focus on their stakeholders in the Electricity Supply Industry (ESI), which are end-users, electricity participants (generation, transmission, distribution and dealer), the public (government, society and community).

Regarding the end users, the ERC should focus on protecting the benefits of their end users by increasing the level of service, maintaining the standard of security, and also increasing the electricity network system to transmit electricity to end users across the whole country. With regards to serving the participants, the ERC should focus on improving the quality of electricity operations by improving the operation through electricity bundles to conserve the environment, increase the support levels in electricity market competition by focusing on increasing in the ration of clean energy in electricity generation and give the opportunity for independent dealers to produce and buy electricity in the market. To serve their public participants, the ERC needs to make proper energy reserves and promote renewable energy to make a reliable electricity

structure and cooperate with communities and society to improve and develop the energy fund.

In order to serve their participants, the ERC should also be concerned with improving their internal business processes, not only to seek and develop quality officers in the electricity sector but also develop Information Technology (IT) systems to support the operations of the ERC office. They should also develop the internal behavior of officers in the organization such as organization culture and teamwork. Finally, the ERC should focus on their financial concerns to gather the fees for their business operations and develop the quality of the company finances, asset management and the energy fund.

Based on the theory of the balance scorecard, discussed in chapter 2, the methodology to transfer the strategy from top-level organizations to their partner has revealed that the sub units select some strategy from their headquarters and transform it into their own strategy and indicators, which can be a measurement of the drive to commit their goal.

In creating the balance scorecard for Thailand‘s power system, it starts from analysis of the strategy of organizations, and creates the strategic map that shows the strategic themes, which also shows the relationship, the cause and effect, between the themes. The strategic theme can be presented in four main parts and the cause-effect between those parts. The strategic map can be seen in the figure, as follows:

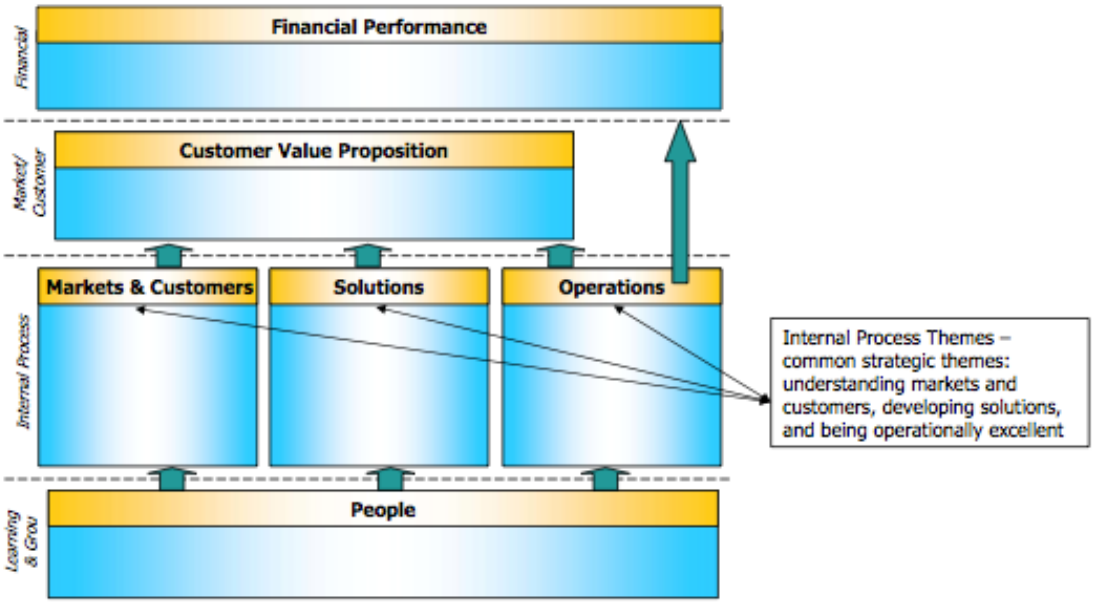

Figure 3.8 The strategic map

First is finance, showing the strategic theme, objective and indicator concerning financial aspects by separating into three main aspects; increase the organization revenue, decrease organization investment costs or increase the quantity of production and organization asset utilization. The second is the theme concerning customers, focusing on the aspects concerning customer satisfaction with the market share, which directly affects the profitability of customers. The third aspect presented concerns internal business processes that analyses the strategic indicator by starting from innovation processes and business operation processes. The last aspect presented concerns the learning and development of people, such as their attitude towards work or training, and business processes of organizations, such as adding ICT or reducing the redundancy of organization business processes (B.L. Song, Member, IAENG, W.K. Wong, J. Fan, and S.F. Chan, 2008; Grégory Wegmann, 2008).

After identify the strategic map, it follows to create the Corporate Balance Scorecard, which is the table to show the description of strategy by presenting the description of strategic objectives, measurements, targets and the initiatives of all strategic themes. These tables are also call “OMTI Models” (Bishop Peter, 1986). Next, the organization uses their OMTI to decentralize their strategic theme to sub-unit organizations, as shown in the figure below:

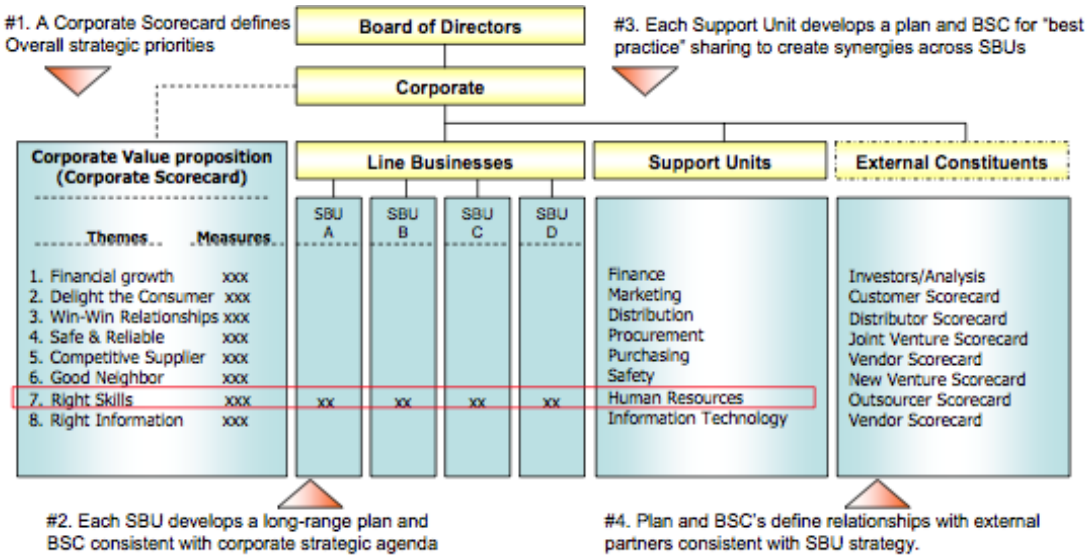

Figure 3.9 OMTI's Structure

The figure above shows the structure to instruct the strategic themes and measurements from the organization's headquarters to their sub business unit (SBU), and the measurement indicator of the strategic theme that is delivered to their sub business unit (SBU), which has changed to support the SBU private goal. Moreover, the success of that measurement of SBU can lead to success for the strategic theme of the organization's headquarters.

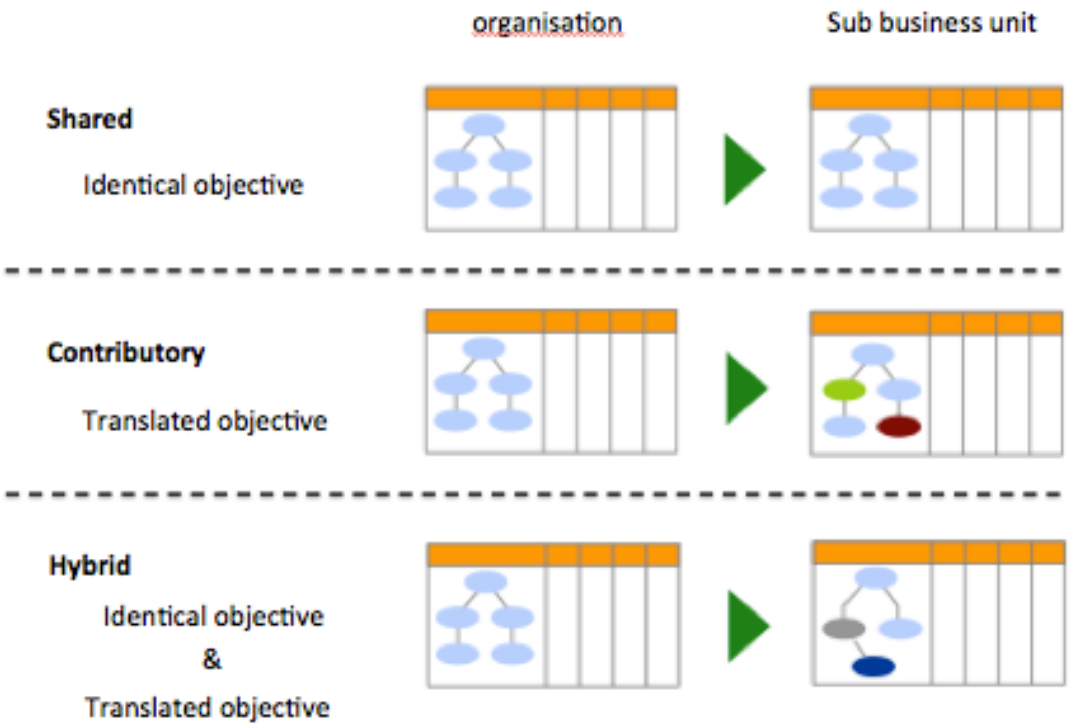

Figure 3.10 Sub Business Unite (SBU) Structure

However, every sub-unit organization also needs to operate their private business to make their own profit, while needing to help achieve the organization's goal for the success of the whole group.

As presented in the balance scorecard in Thailand's power system in detail above, we see that each company receives the national plan and develops their own indicator, and this has a structure known as the Contributory Model.

3.2.2 Why select Balance Scorecard?

The strategic for every organization has important to identify road map of any company in the future, so the selected tools for identify company's strategic should clearly identify the indicator. However, it has many tools in this world and each tool have their unique strength. In Thailand, many companies choose the tools like Total Quality Management (TQM), which used in most of private company and it also call

PMQA for government, as standard for setup their strategy. Though, TQM and PMQA focus on set-up Company strategic in six parts which are leadership skill, information and analysis process, human resource development and management, and management of process quality for measure the organization quality and operation results. Therefore, most of company create their activities for answer the question in six parts then present to TQM committee for get their reward. In this case the quality of company strategic has typically support some business vision but not whole business position. It seems that set strategic based on TQM standard may force the organization set their strategic in the narrow way, and finally cannot answer their business position. Unlike Balance Scorecard (BSC) which focus on four main factors, which are financial, customer, internal business process and learning & growth, in order to show the relationship of each attribute of organization. It seems that all four factors of BSC can applied with many level of organization, and every attribute can change their measurement every time. So, organization can update their measurement and target to set their business position then separate the detail to their clearly strategic plan and project. Consequently, characteristic of BSC compared with another tool can showed in the table below:

Table 3.5 Strategic set up tools comparison

	BSC	**TQM**
Founder	Professor Robert Kaplan and Dr. David Norton	W. Edwards Deming
Idea	Management tool that use to bring strategy to action	Tool which used to improve quality of production
Measurement factor	Present 4 factors are: 1. Financial 2. Customer 3. Internal business process 4. Learning and growth	Present 6 factors are: 1. Leadership 2. Information and analysis 3. Human resource development and management 4. Management of process quality 5. Quality and operation results
outcome	Strategic map, Attribute, OMTI	Strategic map, KPI, project

Table 3.5 Strategic set up tools comparison (Continued)

	BSC	TQM
Benefit	Set up organization vision and mission then set key performance indicator of each activity	Set up clearly plan and activity

3.3 Identify the Balance Scorecard of Power system

Based on the theory of creating Balance Scorecards, discussed above, the strategic plan of the Ministry of Energy was studied and analyzed. The strategic map of the Electricity Supply Industry is shown below:

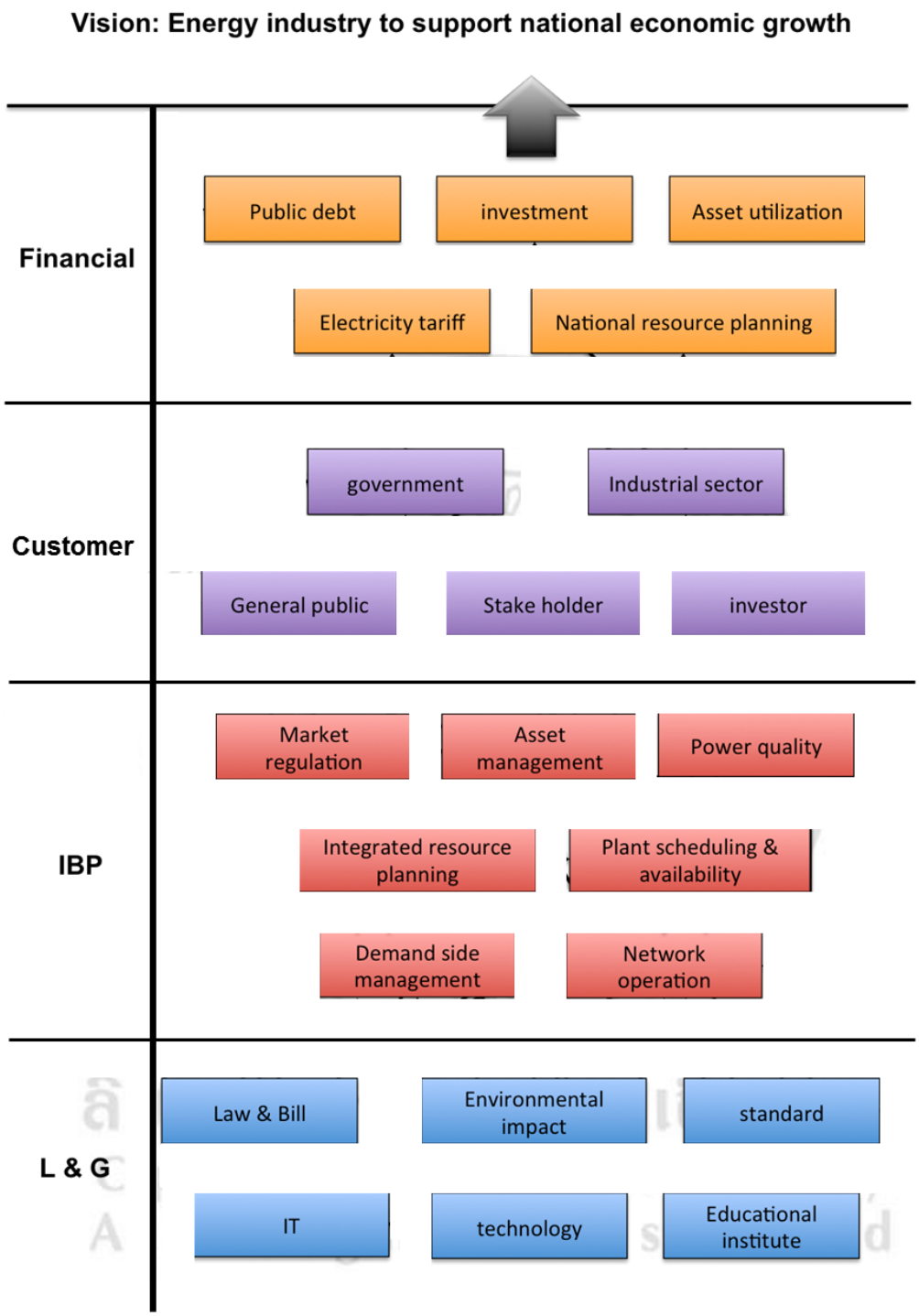

Figure 3.11 The strategic map of the Electricity Supply Industry

By present the Balance Scorecard (BSC) of whole electricity industry. Financial part has focus and present in important position because it has public debt as very important factor. Mover, it also has investment, asset utilities and electricity tariff as important part of this industry. It can argue that every attribute in financial part was very

important and relate not only with whole industrial direction in the future but also affect with the large scale of people who leave in the country. For public debt was very important because the debt which come from this industry has only manage by two solution which are pay by government or pay by people who use the electricity. It expression that both solution was affect with every country resident which come in the form of their obligation as tax ratio from the government and electricity cost that their need to pay. So, public debt can affect with GDP growth rate of the whole country. Another reasons can present for the invest level of electricity sector because it effect with industrial growth for support electricity demand of the country. If electricity industry cannot invest in new technology or new power plant, it will affect with the level of electricity supply which may not support the electricity demand of whole industry that lead to electricity shutdown problem in the country. Finally, the reason for present financial attribute as first part in whole electricity industry BSC because the task and information can identify the player for easily to manage and find the responsive player otherwise the result will affect with every resident in the country and finally effect on growth of GDP of the country that lead to critical damage on country's business.

3.4 Attribute Validation

Based on the strategic map above, the Electricity Supply Industry can separate the attributes into twenty-five attributes that are separated into four main categories based on the balance scorecard. Each attribute can provide details about the attribute theme, objective and measurement, which are provided in the table in appendix A. Moreover, the detail of an objective of each attribute can be discussed separately in the details seen below:

3.4.1 Financial perspective

It present attributes which relate on financial part of industry by finding the relation between attribute and low level data, so it can present the detail below:

3.4.1.1 Public debt

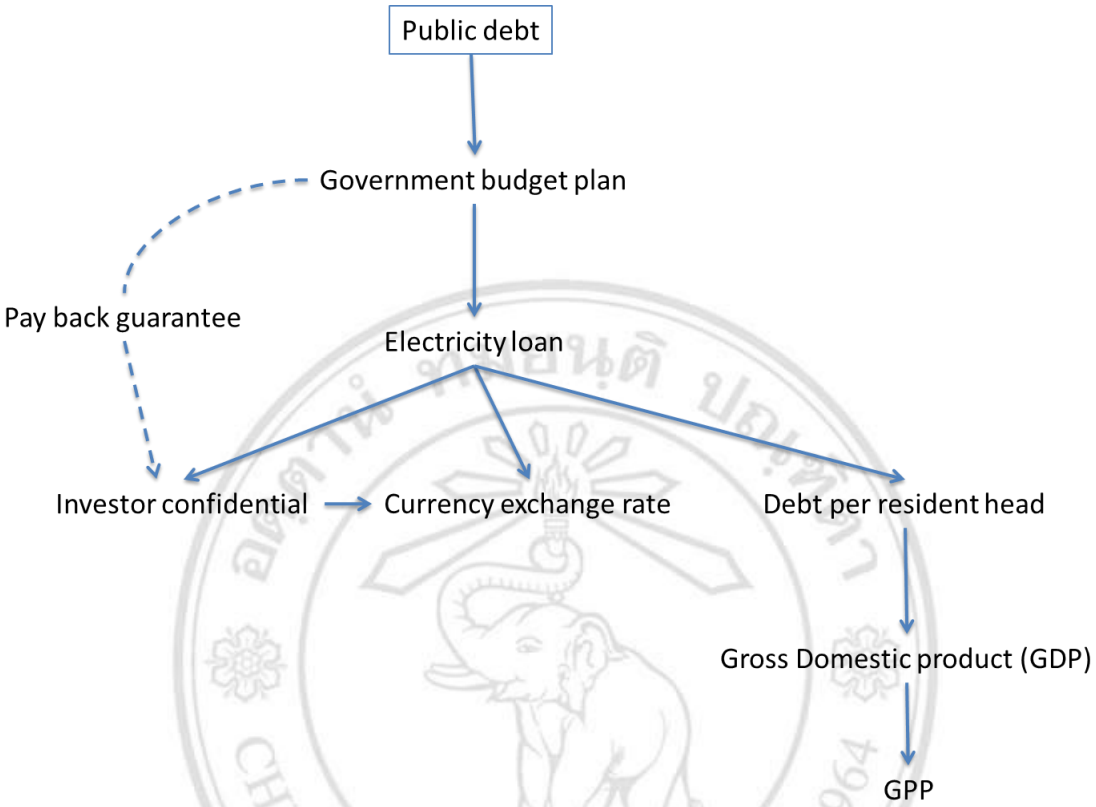

Figure 3.12 Public debt

Figure 3.12 present the process when government spend money for national development, the obligation that impacts upon everyone who lives in country is the public debt, which presents the debt per person that people in that country have a responsibility to pay. Therefore, the government considers the public debt by managing their budget plan, and gaining the confidence of investors in the Electricity Supply Industry by giving electricity loans and pay back guarantees to support operations in industry. Rise in investor confidence can lead to better currency exchange that can also encourage the purchasing power of people in the country and affect the result of Gross Domestic Product (GDP) at the end of the quarter.

3.4.1.2 Asset utilization

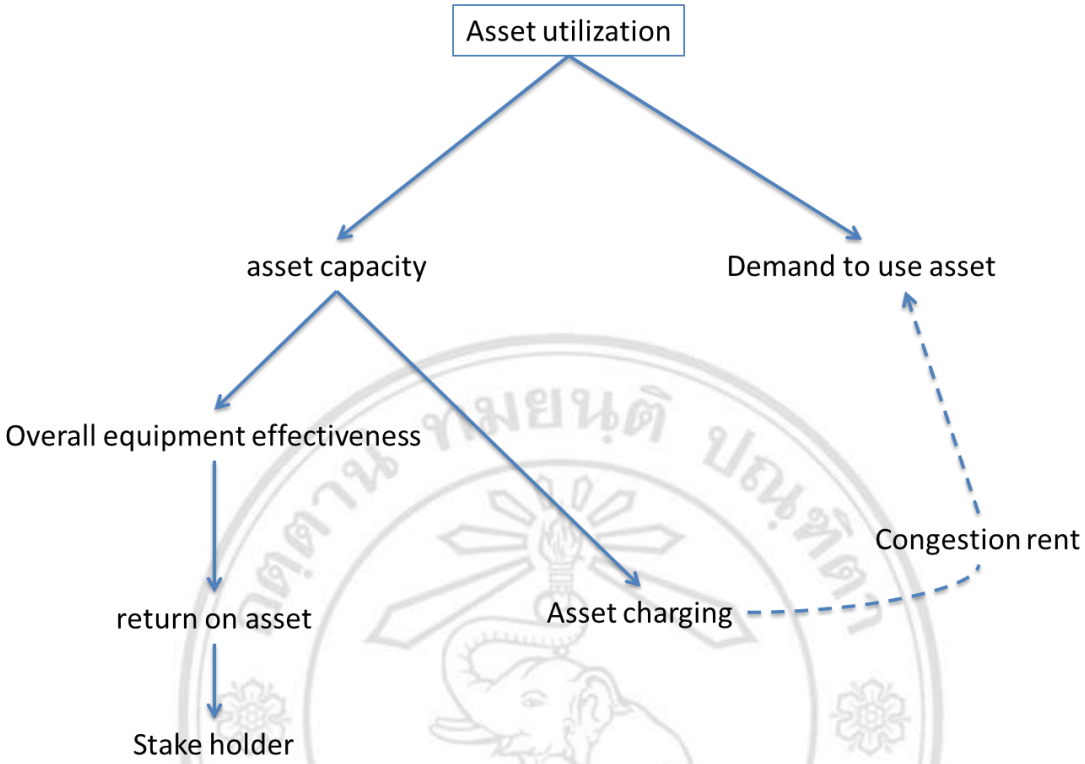

Figure 3.13 Asset utilization

Regarding the asset utilization of the ESI, figure 4.3 show the process that can be considered on two main fronts by making comparison between asset capacity and the demand to use assets. The asset capacity focuses on the overall equipment effectiveness that in turn affects assets to the industrial sector that have the opportunity to gain more company profit so presenting the best result in the annual report that increases the sense of reliance for their stake holders. On the other front, the demand to use assets is utilized by asset charging in the form of "congestion rent" to make money from users.

3.4.1.3 Electricity tariff

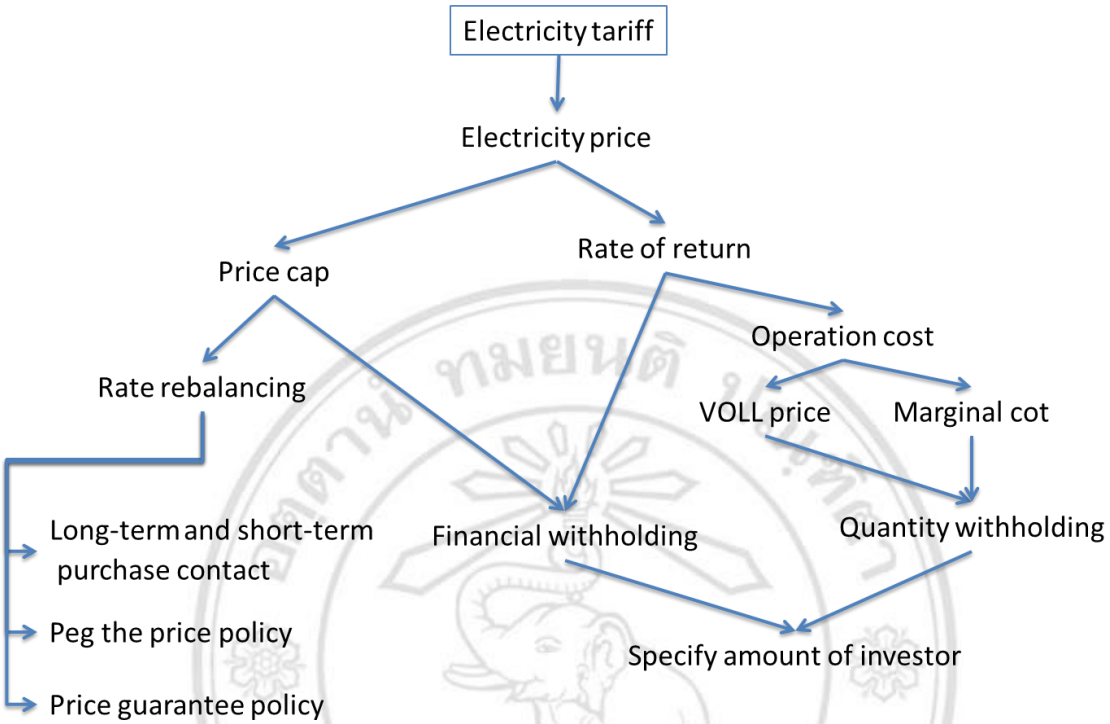

Figure 3.14 Electricity tariff

Figure 3.14 show the process that ESI can maintain the balance of electricity tariffs by considering the evolution of electricity prices. Firstly, it focuses on the price cap, which is the specific price from the generator and customer. The price cap focuses on rate rebalancing that is restricted by the purchase contract and the government policy on electricity pricing, while financial withholding relates to the rate of return (ROR) and operation costs that lead to the lack of quantity withholding. The ESI can control both financial and quantity withholding by limited investment in the electricity market.

3.4.1.4 National Resource Management

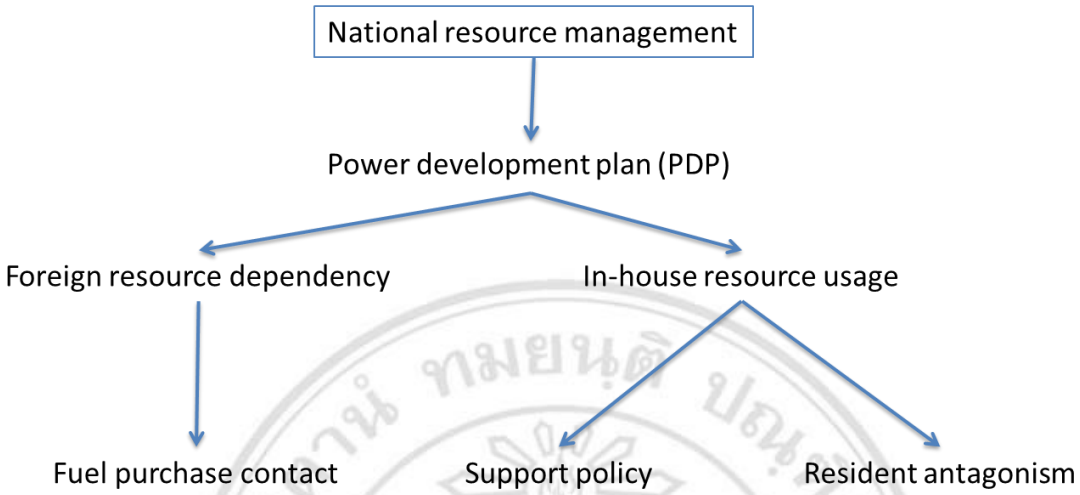

Figure 3.15 National Resource Management

Figure 4.5 present the national resource management which focuses on the reality of resource usage compared against the power development plan (PDP). It compares the ratio of the resources purchased between native sellers and other countries. Regarding the native seller, the government needs to have some policy to support native producers to create a catalyst for investment in new resources and reduce the resources that need to be purchased from other countries. In other words, they control imported resources by signing fuel purchase contracts with sellers to protect the electricity price durability of the country.

3.4.1.5 Investment

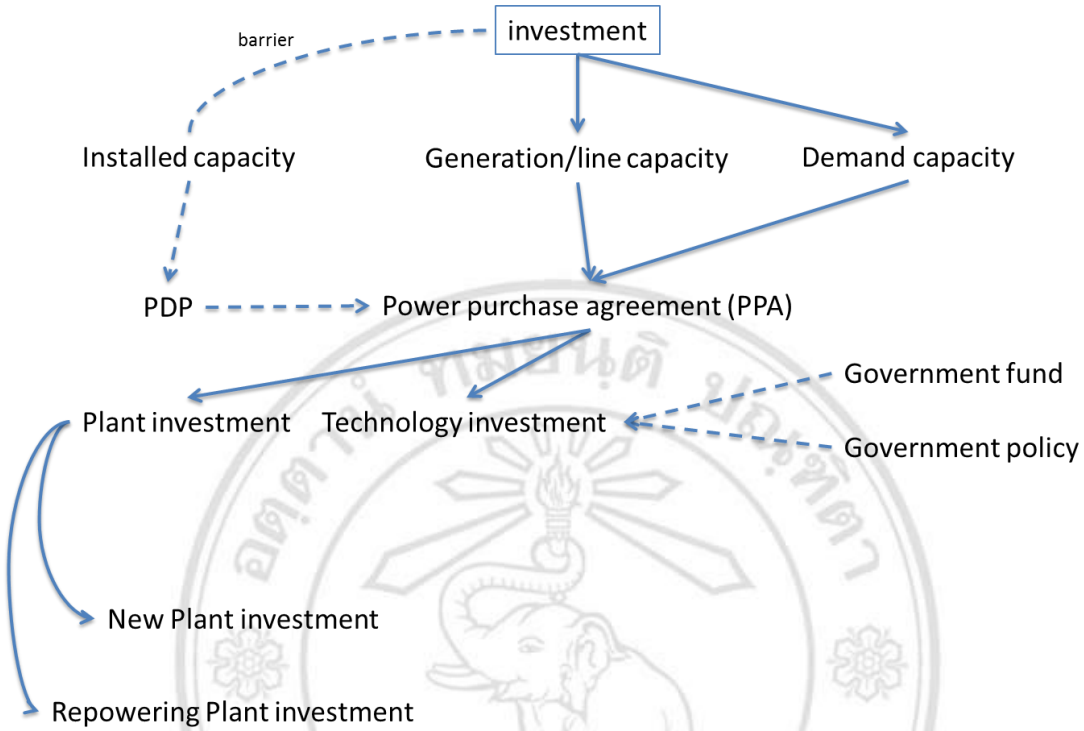

Figure 3.16 Investment

When considering the balance of investment in the electricity market the first consideration is the generation/line capacity and the demand capacity using the electricity of the country. Figure 4.6 shows the processes which use to calculate the electricity capacity; it also focuses on the installed capacity of electricity, and the investment plan in the Power Development Plan (PDP) to calculate the new investment barrier. After specifying the industry capacity and barriers, these are used to determine the Power Purchase Agreement (PPA) that requires bids from investors for plant and technology investment. In order to aid bids on plant and technology investment, there is support from the government fund and policies to increase investor motivation.

3.4.2 Customer Perspective

3.4.2.1 Government

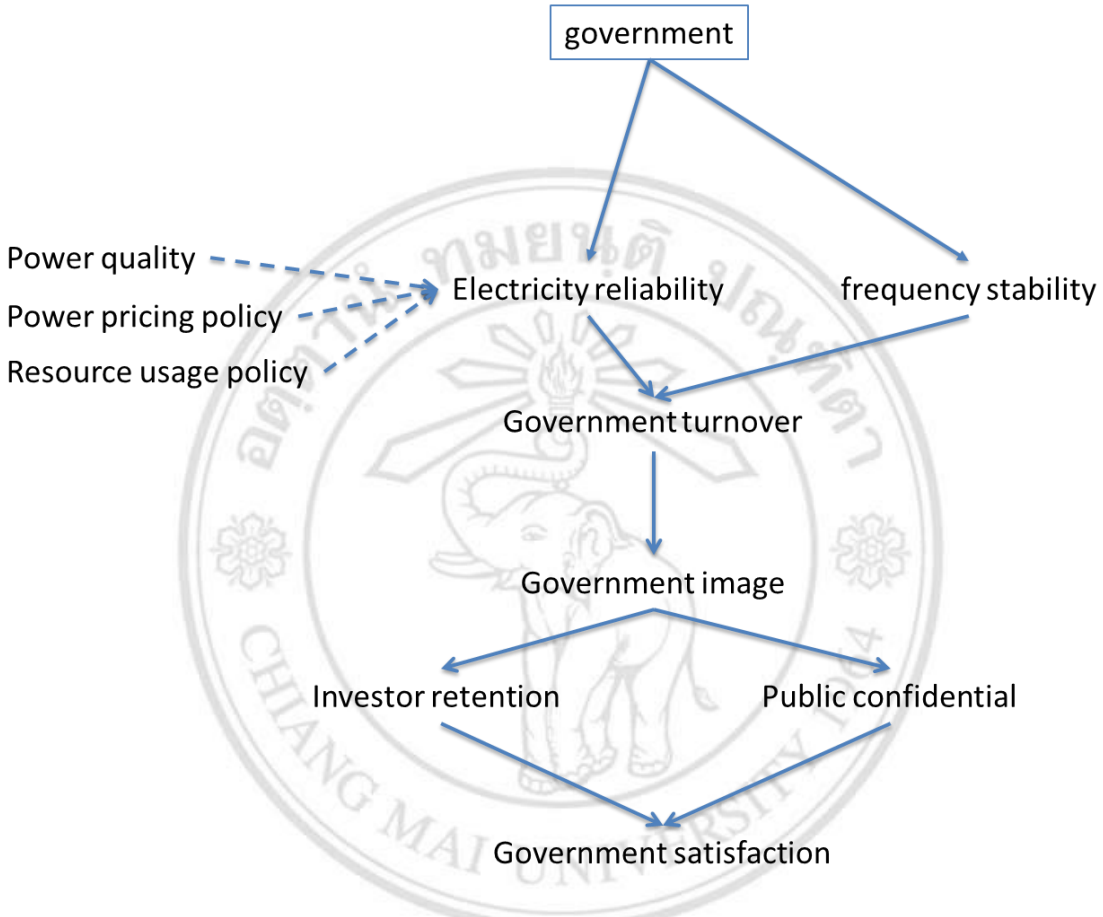

Figure 3.17 Government

In order to keep the government satisfied, it should to follow the process showed in figure 4.7 which the electricity industry needs to maintain electricity reliability and frequency stability to transfer the electricity from the producer, as generator, to the end-user. The reliability and stability of electricity can be managed by controlling the power quality, creating policies such as a power pricing policy and resource usage policy. While the generation and transmitting wires have reliability and stability, the government has the opportunity to get the best turnover, leading to the best results for the nation's economy. Gaining the best result for the country's economy improves the perception of the government's image and has a positive affect regarding investor retention and the confidence of people in society.

3.4.2.2 Investor

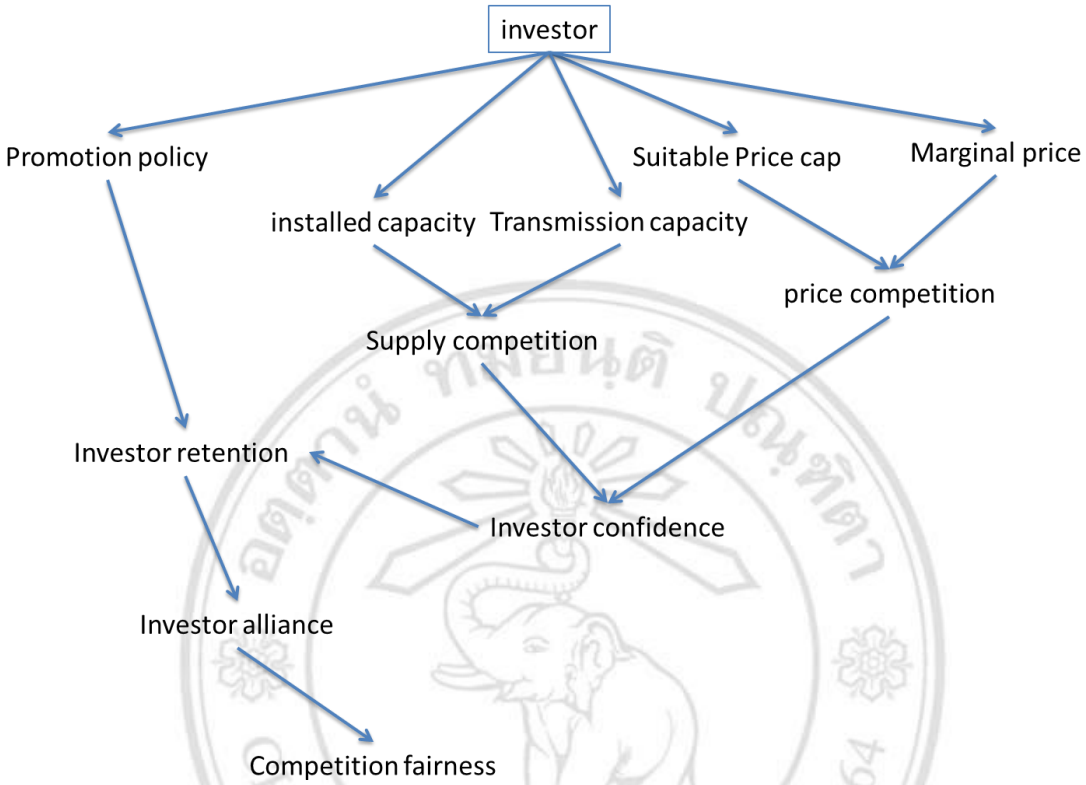

Figure 3.18 Investor

Figure 3.18 show processes to make investors satisfied, the ESI focus on creating investor confidence and making competition fair. To make investors confident, the ESI need to be concerned with not only the capacity of generation and transmission but also focus on the price cap and marginal cost of electricity. The installed capacity and transmission capacity lead to supply competition in the electricity market, while focus on price capping and marginal prices leads to price competition in the market. Moreover, generating laws that support investment can support investor retention, and provide fair competition in the electricity market.

3.4.2.3 General Public

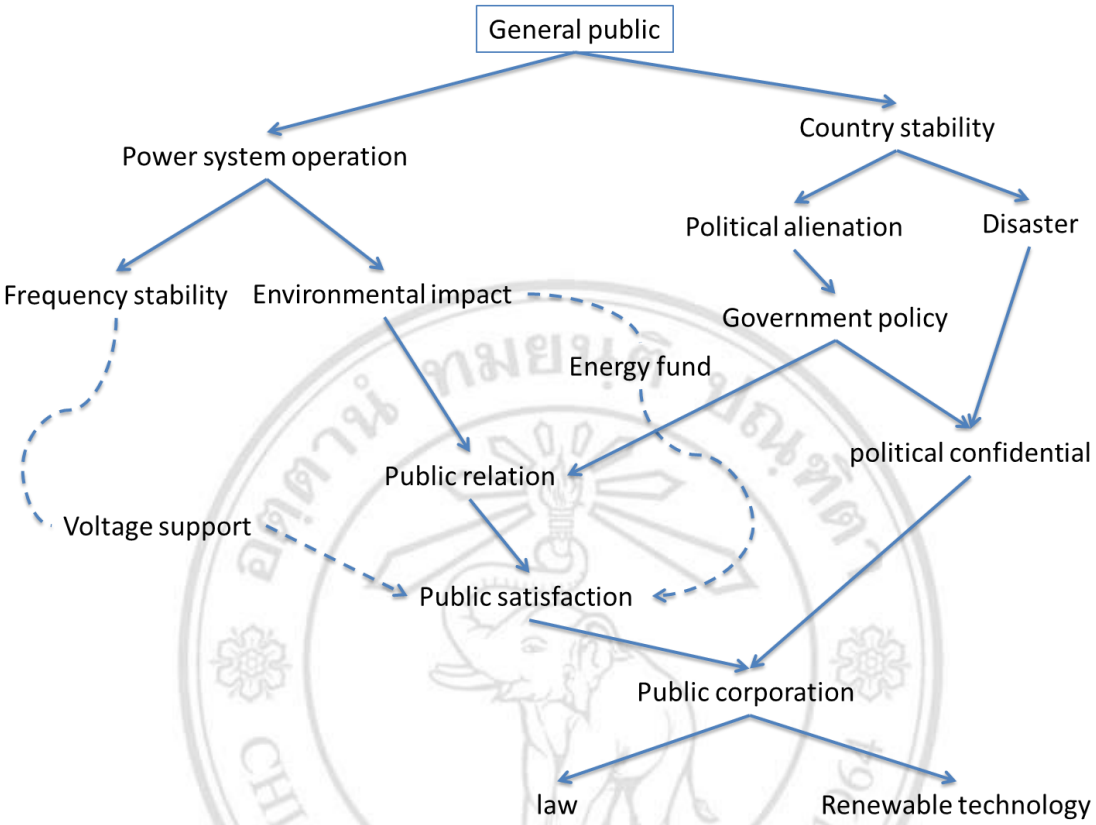

Figure 3.19 General Public

Figure 3.19 present the relationship of each process which relate to satisfaction of the people in the country is very important to the electricity industry and they therefore pay attention to the power system operations and public confidence. Regarding the power system operations, they are concerned with the frequency stability, which provides the voltage support to people, and the environmental impact, which is supported by the energy fund to recompense for the impact from the operations of the electricity industry. If people in society have satisfaction and confidence, they will help the corporate body to improve the operations of the electricity industry by suggesting the suitability of electricity laws and promoting the usage of renewable technologies that improve the electricity industry.

3.4.2.4 Stakeholder

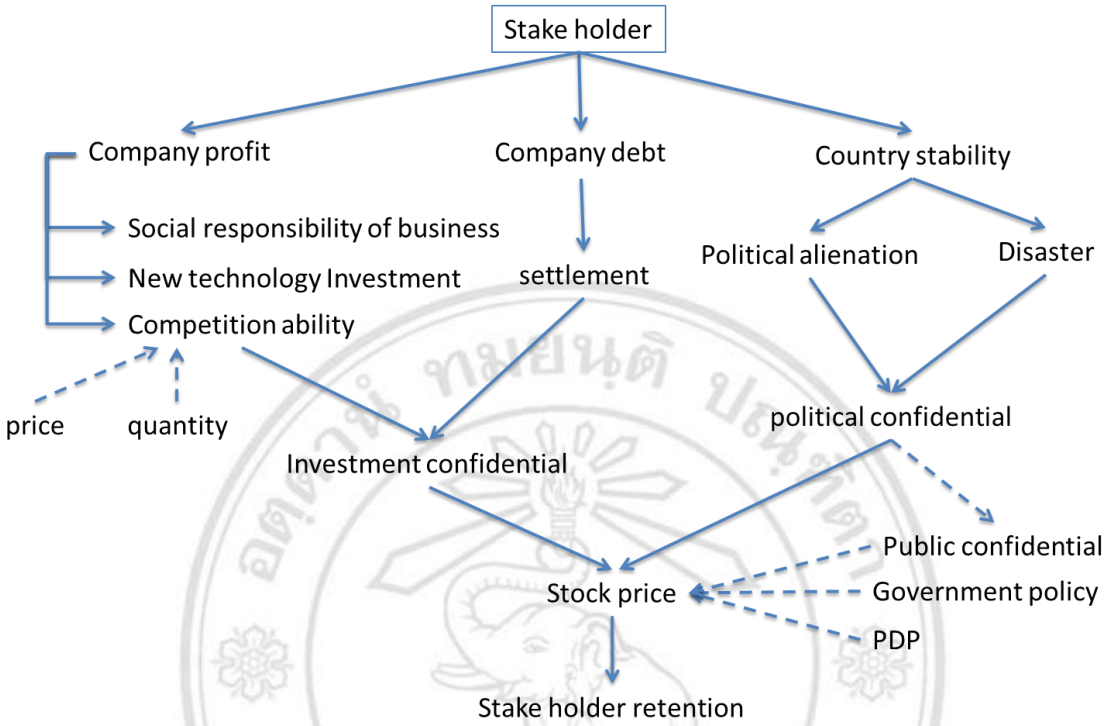

Figure 3.20 Stakeholder

Figure 3.20 show that the stakeholders are an important factor of the business and thus need to be kept satisfied. Their focus is divided between the three main considerations of company profit, company debt and national stability. When stakeholders focus on the company profits, the business needs to take action regarding social responsibility, the level of new investment and the competitive ability of their company. Moreover, stakeholders also have concerns with the level of solvency of the company, which aids stakeholder confidence. On the other hand, stakeholders also focus on the situations or the events that happen in the country, which involve political confidence and its effect on the stock price in the stock market. The political and public confidence of the public can lead a positive effect in the stock price that in turn affects stakeholder retention in the electricity market.

3.4.2.5 Industrial Sector

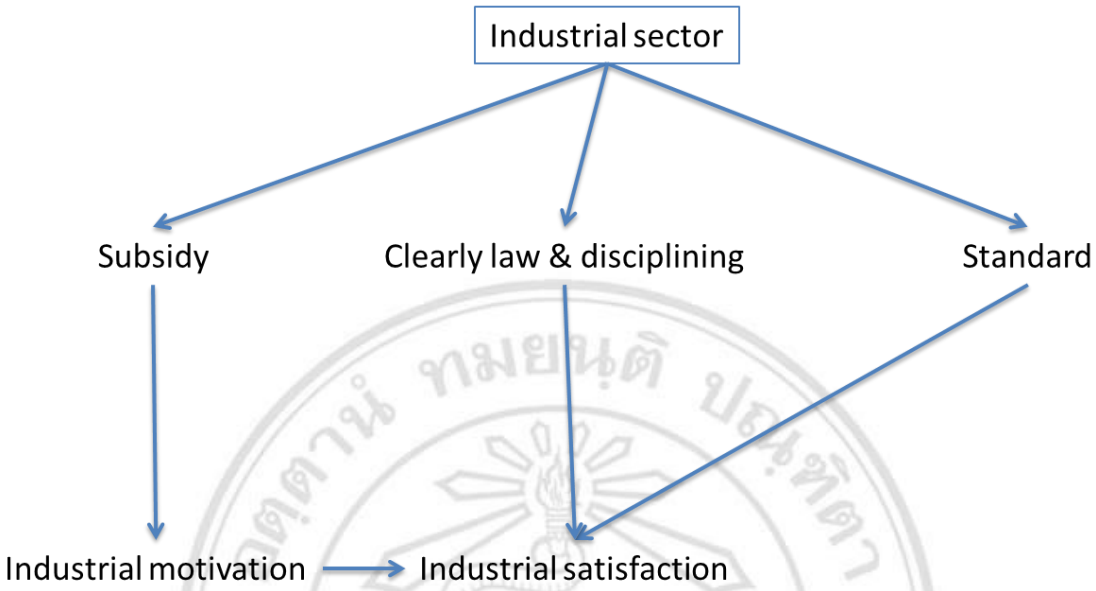

Figure 3.21 Industrial Sector

Regarding the industrial sector, figure 3.21 show the process as the agricultural or transportation industries that relate with electricity industry, the ESI can make them satisfied by presenting the ways that help them to save investment costs. The measure such as spending money to support new technological research to encourage the industrial motivation, or changing the industrial laws that act, or standardize, support for the use of new technology. Moreover, it also reduces the market barriers and so provides an opportunity for new comers to easily be involved in new technology and enter as a power producer in the market.

3.4.3 Internal Business Process

3.4.3.1. Power Quality

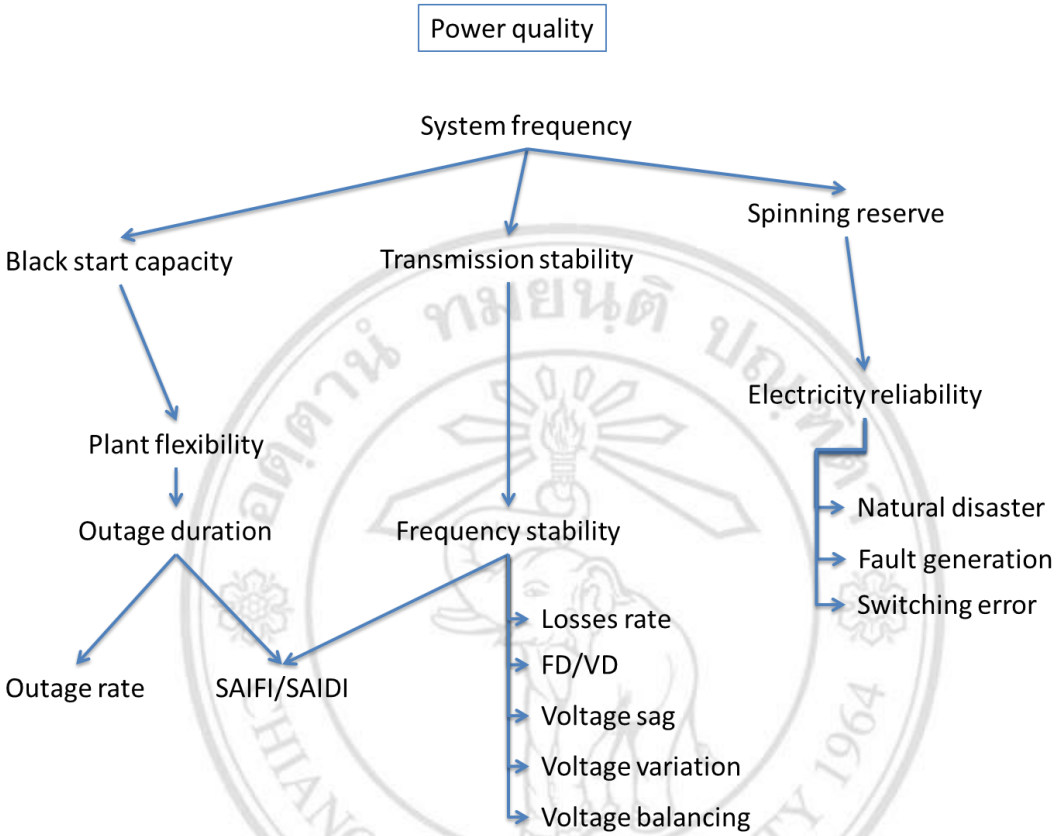

Figure 3.22 Power Quality

In the electricity industry, the power quality seems to be a very important topic, which is show in figure 3.22 that related to people's need to participate in the market. The electricity industry's first concern is with the stability of system frequency, to maintain the level of delivery of electricity to the end-user. In order to maintain system frequency, they focus on back start capacity that affects the plant flexibility and monitors the outage duration of electricity generation. For the transmission stability, the electricity industry is concerned with frequency stability, which is identified by SAIFI/SAIDI, loss rates while delivering electricity from generation to the electricity wire and voltage balance in the electricity industry. Finally, they are also concerned with the system spinning reserve, which affects the electricity's reliability, in that the electricity industry takes account of the violence of natural disasters, the levels of faulty generation and switching errors of the systems of transmission and generation.

3.4.3.2. Network Operation

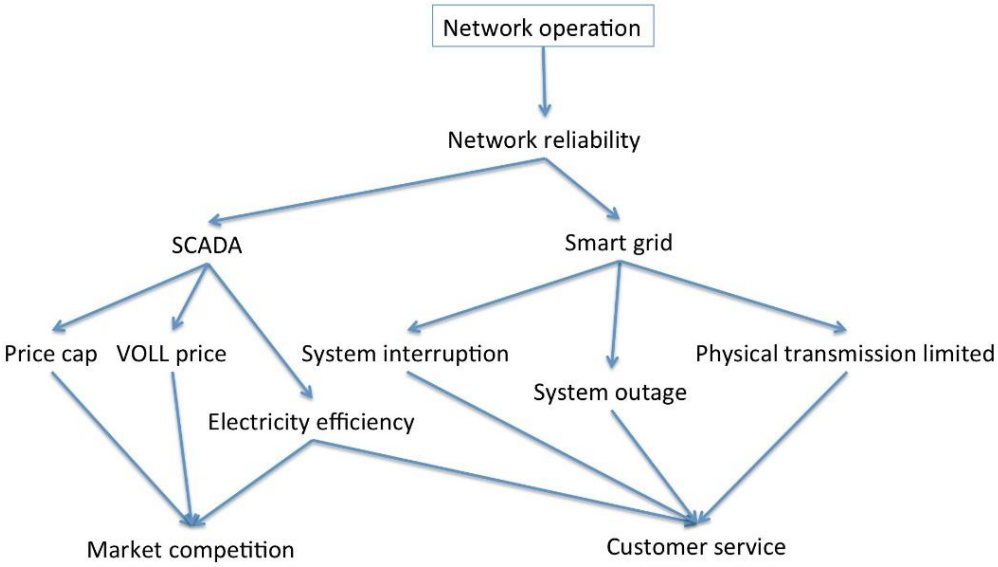

Figure 3.23 Network Operation

Figure 3.23 present the process of network operation in the electricity market relates to the network's reliability to monitor the power flow of electricity and maintain power stability in the electricity industry. The SCADA system is used to monitor the power flow to measure the suitability of price caps, the value-of-lose-load prices and electricity efficiency to identify the competition level in the electricity industry. Meanwhile, the smart grid monitors the power flow in the electricity market by measuring the level of system interruption and the outage and transmission limitations to maintain the level of customer service in the electricity industry.

3.4.3.3 Plant Scheduling and Availability

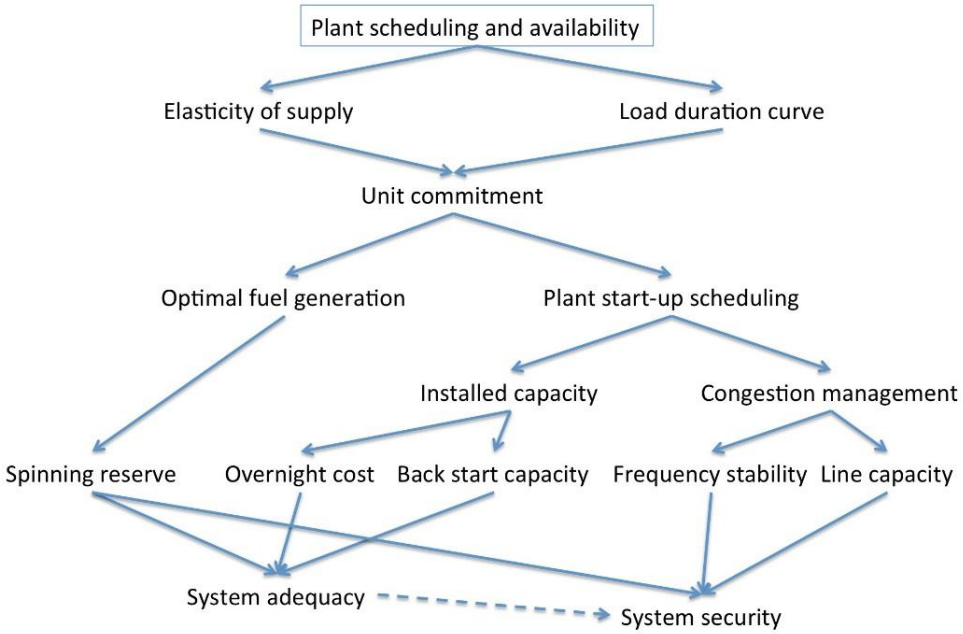

Figure 3.24 Plant Scheduling and Availability

In order to maintain the efficiency of power flow in the electricity industry, it needs to know the time that the generation plant will open and close to maintain the electricity supply and monitor the load duration curve to identify the demand of the country. Figure 3.24 show the process which use to compare the electricity supply and demand, they use unit commitment that the industrial sector use to commit between seller and buyer for make fair competition in the electricity market. They can measure the unit commitment by using optimal fuel generation, by identifying the spinning reserve to monitor the demand and supply of electricity usage, and by identifying the plant start-up schedule that compares installed capacity and congestion management by monitoring the overnight cost, back start capacity, and also the frequency stability and line capacity, to maintain system adequacy and security.

3.4.3.4 Demand Side Management

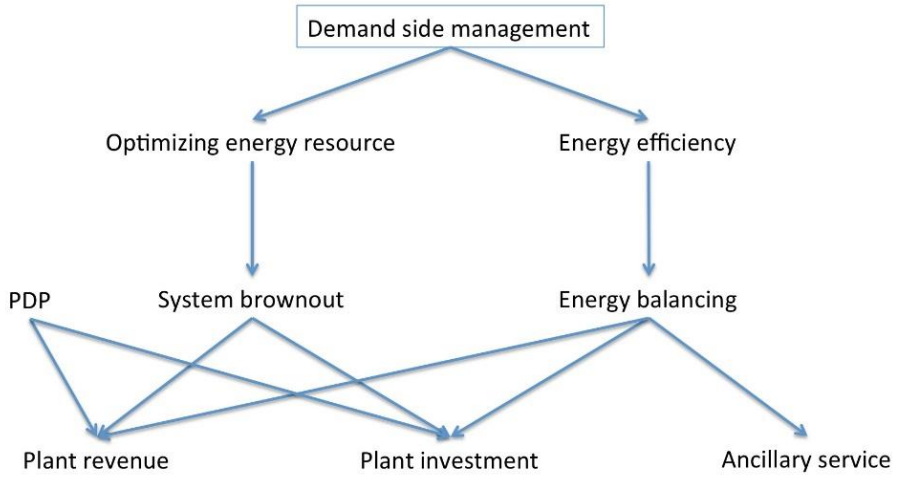

Figure 3.25 Demand Side Management

Figure 3.25 shows the optimizing energy resources and efficiency manages the demand side of management. To optimize energy resources, the electricity industry measures system burnout while analyzing the PDP to maintain the plant revenue and investment. Meanwhile, energy efficiency can be managed by balancing the energy that affects plant investment and increases the ancillary services for the Electricity Supply Industry.

3.4.3.5 Market Regulation

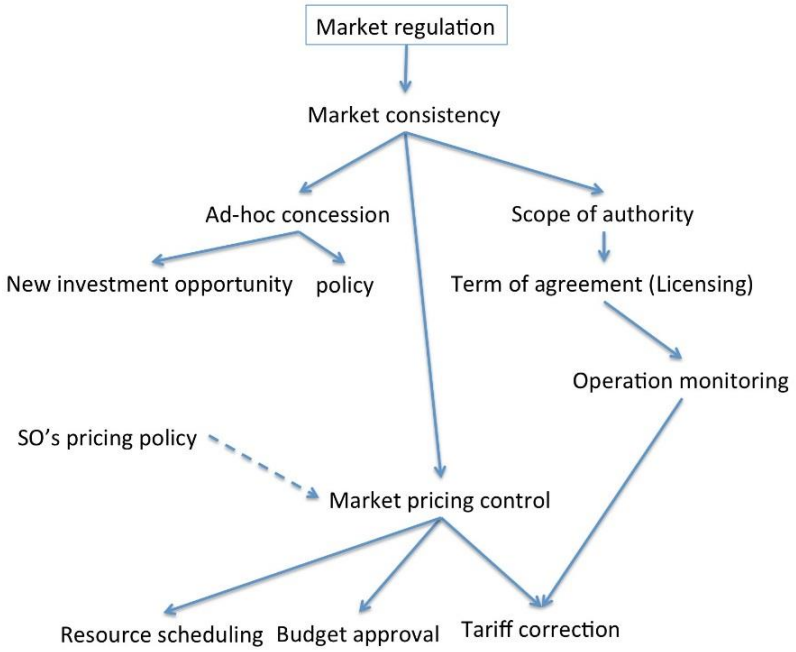

Figure 3.26 Market Regulation

Regulation of the electricity market concerns the market consistency by focusing on ad-hoc concessions, market pricing control, and the scope of authority of the market operation. Figure 3.26 present the process that the ad-hoc concessions are supported by new investment opportunities and suitable policies from the government, while the scope of authority specifies the responsibility of the operator in the electricity market by generating terms of agreement, such as licensing to force the operators to run their businesses according to the rules. Moreover, the market pricing control, supported by the SO's pricing policy, can help operators to regulate the electricity industry by managing the resource scheduling, budget approvals and tariff collection.

3.4.3.6 Asset management

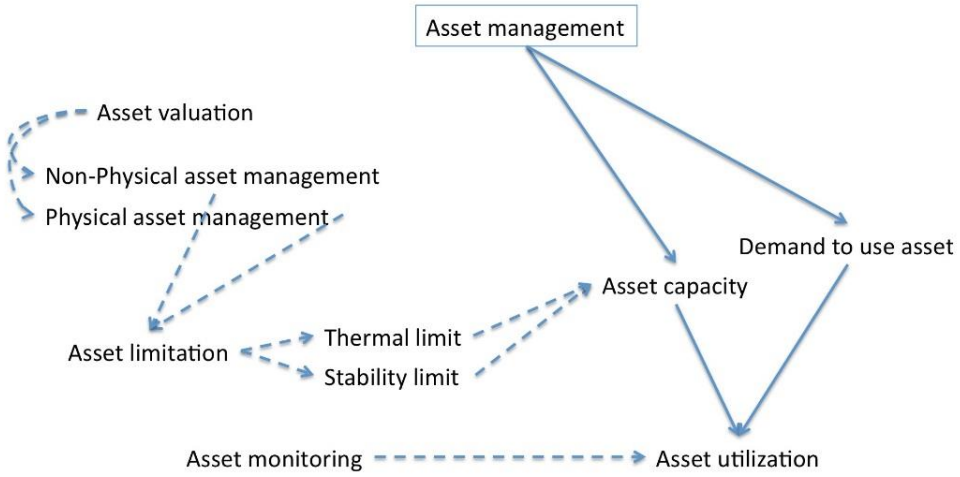

Figure 3.27 Asset management

Figure 3.27 present the process of asset management which show that electricity industry starts with identifying the asset valuation, both physical and non-physical. They also identify the limitation of those assets in order to find the real asset capacity. At the same time, they compare that asset capacity with market demand to identify its utilization in the electricity industry.

3.4.3.7 Integrated resource planning

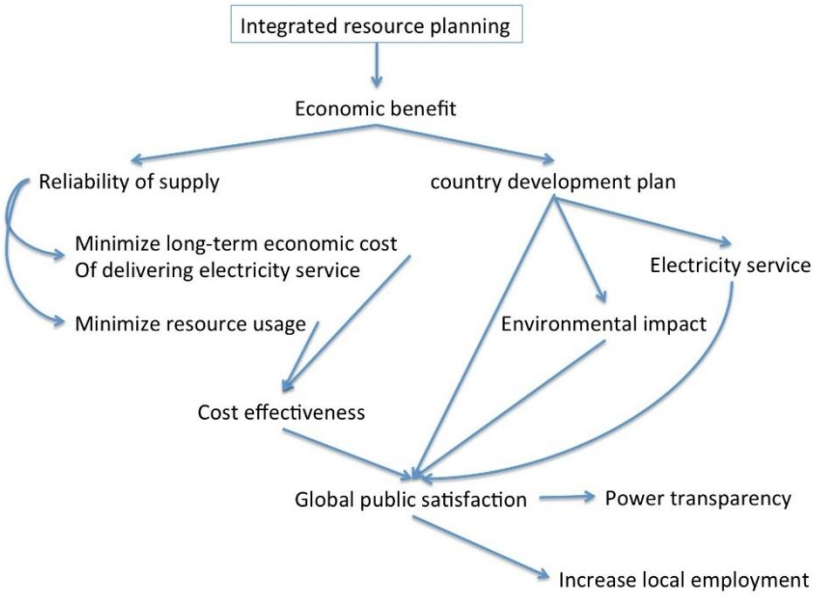

Figure 3.28 Integrated resource planning

In order to create benefits for the electricity industry, figure 3.28 show that the company can improve by integrating resource planning, which analyses the reliability of supply to calculate the minimal long-term electricity delivery cost and resources compared with the level of service and the environmental impact from business operations. By analyzing the reliability of supply and the national development plan, the electricity industry can control cost effectiveness and increase the public satisfaction and so increase the power transparency and local employment in the country.

3.4.4 Learning and Growth

3.4.4.1 Standards

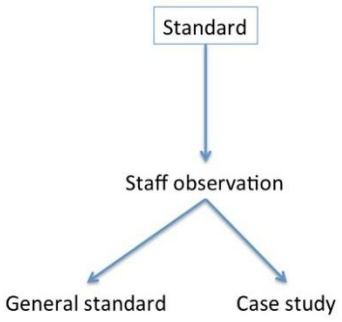

Figure 3.29 Standards

Figure 3.29 present the process to improve the standards of knowledge in the electricity industry; they need to help their staff know the current standards acceptable in the world at large by sending their staff to observe practices in another country. Based on those observations, their staff will have the ability to know new industry standards and also learn from both successful and unsuccessful cases, which will enable them to judge the standard that is suitable for the electricity industry.

3.4.4.2 Information Technology

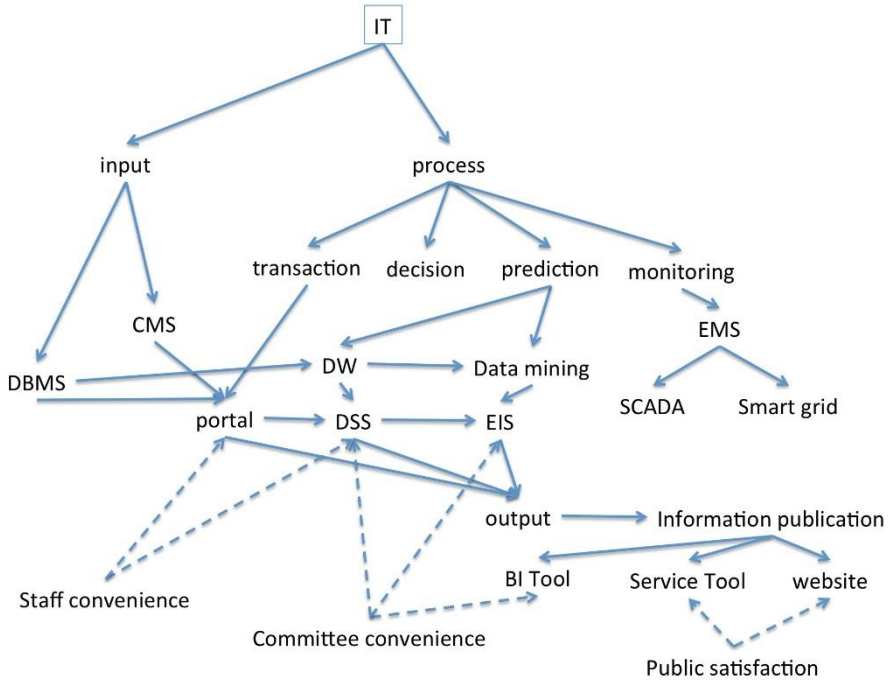

Figure 3.30 Information Technology

In order to provide the ability for any organization to compete in the market, figure 4.20 present the development of information technology plays an important role in every organization. IT development help the staff have the opportunity to run their business faster. For the electricity industry, development of IT can be separated into three main parts. First is the information database development to database management systems (DBMS), which only collect the transaction data for the Content Management System, storing the information and presenting it via a website. Second are the IT tools designed to help staff, committees or any involved parties in doing their job more easily. Some tools like Data

Warehouse (DW) and Data Mining are used to support the committee decision-making and other tools like web portal, SCADA or Smart Grid are used to support and provide the useful information based on the particular job responsibility of the organization's staff.

The last tool that can benefit people who need to participate in the electricity industry is information publication, which acts as the tools to provide the necessary information, which ordinary people should know, concerning the electricity industry and also as the tools that the public use as a way to advice regarding problems or operations of the electricity industry. Using IT to make a connection between the electricity industry and the public can increase public satisfaction and cooperation, which can enhance the image of the industry and its operations.

3.4.4.3 Technology

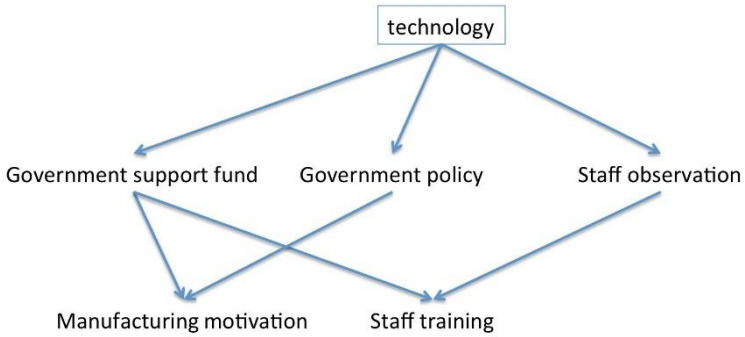

Figure 3.31 Technology

In order to increase manufacturing motivation and staff training, the process in figure 3.31 show improvements in technology are the main factor that the industry needs to focus on. Technology can be improved from many sides, not only from the organization itself but also from the related industries and the government. The organization itself can improve technology by sending their staff to observe modern organizations or another business sector and use the knowledge from those observations as a case for training other staff. Meanwhile, technology can be improved by factors from outside organizations, which are the research funds supported by the government, or the policy that the government signs to support technology development of the organization.

3.4.4.4 Environmental impact

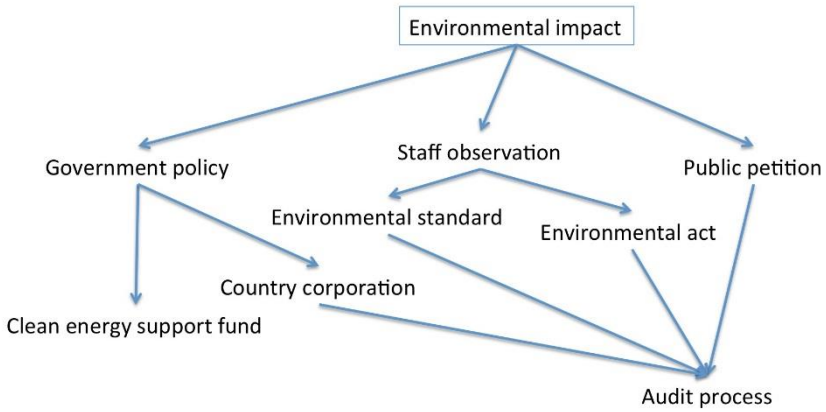

Figure 3.32 Environmental impact

Figure 3.32 show the Environmental impact is a big concern that the electricity industry needs to study because it has many affects for all people. The electricity industry can improve the environmental impact by sending their staff to observe the standards from other countries and use those observations as cases to refer to for the environmental audit process. Meanwhile, the electricity industry needs to study petitions from people in society to find the up-to-dated situation in the country and its effect on public confidence. Moreover, the government can support the electricity industry by offering the suitable policy or by promoting an energy fund to support clean energy in order to improve investor motivation, and lead the industry to improve the impact of environmental standards, in order to gain the cooperation of people in society.

3.4.4.5 Educational Institutes

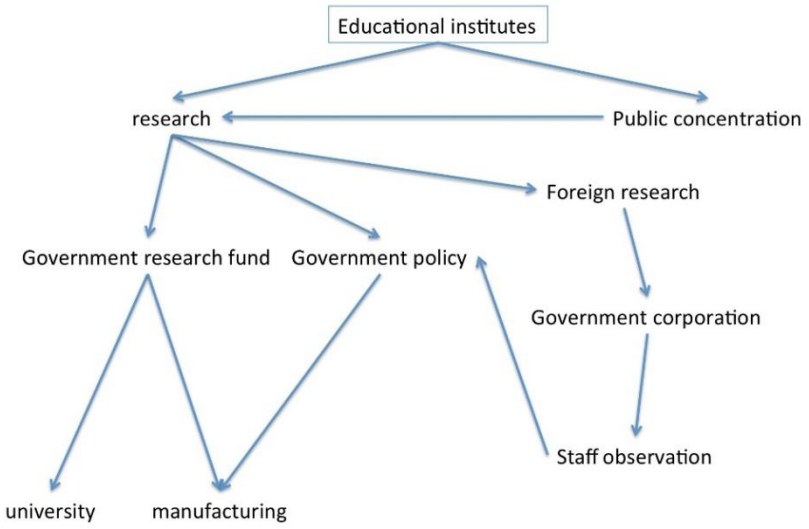

Figure 3.33 Educational Institutes

Regarding educational institutes, processes which show in figure 3.33 show the electricity industry can set the research topics based on the topics that are discussed in the market. After they have set the research topic, they give it to education institutes to solve that topic. Meanwhile, the government can support that research by setting up a support policy or give research funds to any researcher who volunteers to make research in this field.

3.4.4.6. Law and Bill

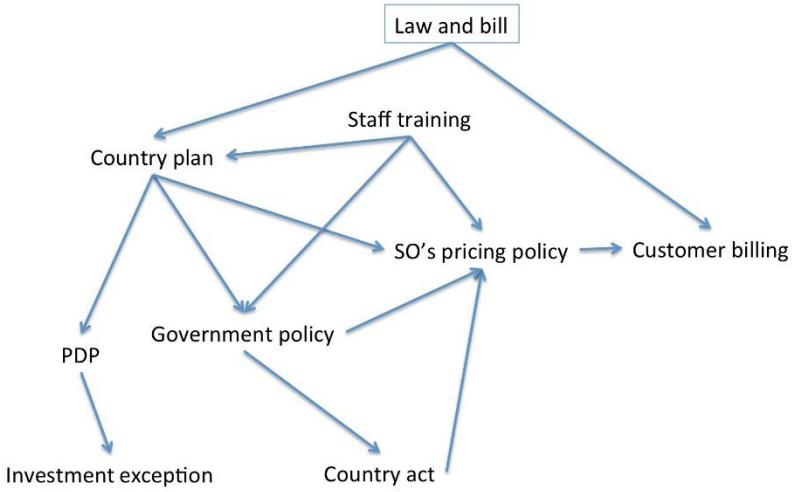

Figure 3.34 Law and Bill

Figure 3.34 show processes with regards to improving the industry laws and bills, they firstly consider the substance of the current national plan, showing the consistency between current law and the plan. Meanwhile, staffs need to improve them in order to study the up-to-dated law used in the world at large and benefit from setting up the right plan and policy. While studying the country's plan, related staff will know about the suitability of the current PDP and can design some laws for making the investment exceptions for the investor. Likewise the government and SO's pricing policy has to be studied by related staff in order to protect the customer billing that leads to increased operation fairness in the electricity industry.

3.5 Apply Task Templates for the Electricity Supply Industry (ESI)

To separate the task of each participant in the Electricity Supply Industry the starting point is with EGAT, which has the responsibility to generate the electricity and sell it to distributors via high voltage transmission lines. Therefore, EGAT has concerns regarding many issues from purchasing fuel, generating electricity and maintaining transmission safety and stability. Meanwhile, the MEA/PEA control the availability and stability of distribution lines such as the distribution capacity and line investment, and also have concerned with the demand side management, including end user billing. EGAT, the MEA and the PEA are controlled by the system operator (SO). The SO controls and maintains the electricity industry by planning the plant operation schedule, integrating resource planning and asset management planning, and also monitors the system operations by assessing the generation efficiency, transmission/distribution stability and safety. Moreover, the SO maintains electricity capacity by bidding with the supplier. While the SO controls the operations of the Electricity Supply Industry, they need to corporate with the Energy Regulatory Commission (ERC) whose responsibility is to be concerned with external factors that affect or has affected the operation of the electricity industry. The ERC also offers advice to the SO in order to make more suitable decisions. The ERC separates into two parts, which are the ERC staff and the ERC committee. The ERC staffs start by compiling information, which they receive from EGAT, the MEA/PEA and the SO. After that ERC staff consider the information and generate the simulation used to present it to committee when they meet. Then the

committee uses that simulation to make the final decision and announce the result in the format of a plan adjustment or support laws and policy.

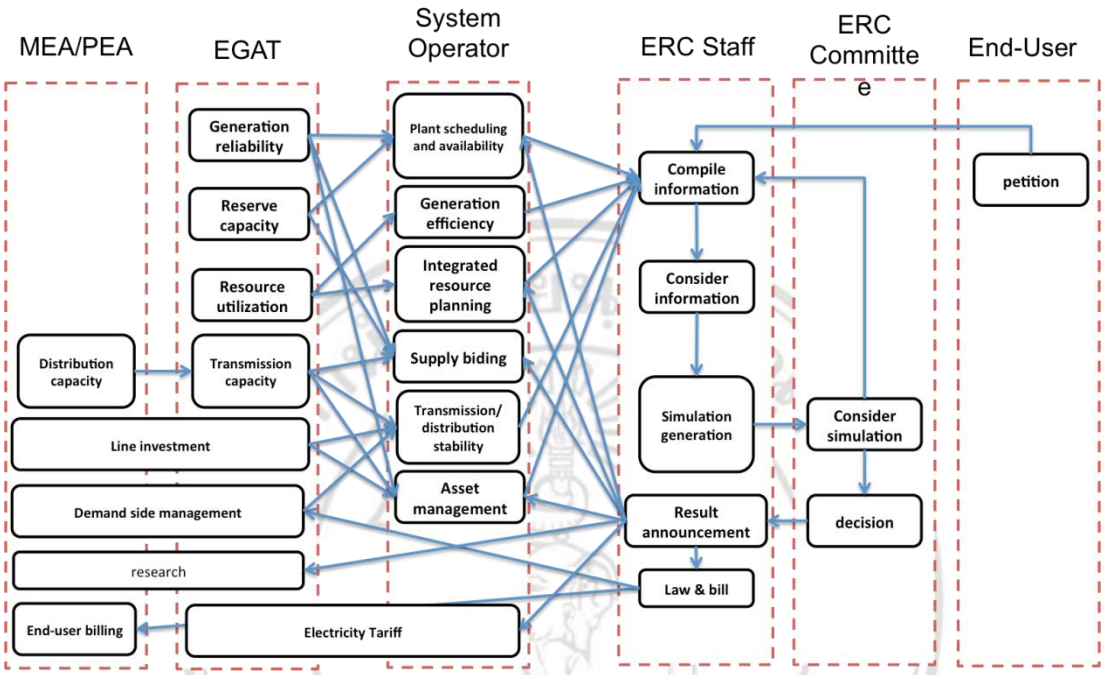

Figure 3.35 information flow on ERC decision process

After that, using a commonKADS task template, as shown below, separates the task of the Electricity Supply Industry:

Table 3.6 Mapping task template with decision type

task	Task template								
	classification	assessment	diagnosis	monitoring	prediction	design	assignment	planning	scheduling
Transmission/ distribution capacity		X		X					
Line investment		X						X	
Transmission/ distribution stability				X					
Demand side management				X					
End-user billing				X					
Research						X			
petition		X							
Generation reliability		X		X					
Reserve capacity		X			X				
Resource utilization		X							
Plant scheduling and availability									X
Generation efficiency				X	X				
Integrated resource planning		X			X			X	
Supply biding		X						X	
Asset management		X		X					
Electricity tariff				X	X				

Transmission and distribution capacity are suitable for assessment and monitoring task templates because they need to monitor the electricity transfer that is sufficient for usage demand. The distribution and transmission line investment uses assessment task templates for assessing the line capacity, and use planning task templates to monitor the bidding process. Moreover, the monitoring task template is

also used for transmission and distribution stability to monitor the faulty operations and switching errors of operators. Demand side management is the task for managing the customer need and a monitoring task template is selected for tracking the customer need and customer satisfaction in accordance with the energy conservation plan. A diagnosis task template is for tracking the faulty operation in end user billing. For the research promotion plan, the planning task template is selected to do the plan for research promotion for any member of the general public or for investors. Moreover, the monitoring task template is also used for tracking the generation reliability, reserve capacity, supply bidding, and customer petitions while also tracking the operation process to avoid the unnecessary errors that are a risk to the operation. Meanwhile, prediction task templates are used in resource utilization, asset management and for electricity tariffs to predict the future value and avoid order errors in plant operation scheduling. The plant scheduling and availability uses a diagnosis task template to monitor the faults in the operation scheduling.

Table 3.7 Identify sender and receiver for each decision type

task	type	Sender	receiver
Transmission/ distribution capacity	monitor	MEA/PEA, EGAT	System Operator
Line investment	planning	MEA/PEA, EGAT	System Operator
Demand side management	monitor	MEA/PEA, EGAT	System Operator
End-user billing	diagnosis	MEA/PEA	Regulator
Research	planning	MEA/PEA, EGAT	System Operator
Generation reliability	monitor	EGAT	System Operator
Reserve capacity	monitor	EGAT	System Operator
Resource utilization	prediction	EGAT	System Operator
Plant scheduling and availability	diagnosis	System Operator	Regulator
Generation efficiency	monitoring	System Operator	Regulator
Integrated resource planning	planning	System Operator	Regulator
Supply biding	monitor	System Operator	Regulator
Transmission/ distribution stability	monitor	System Operator	Regulator
Asset management	prediction	System Operator	Regulator
petition	monitor	Regulator	MEA/PEA, EGAT
Electricity tariff	prediction	Regulator	System Operator

3.6 Task Template Separation for the Electricity Supply Industry

3.6.1 Resource provider

Fuel resources concerns for electricity generation start from increases in the demand for electricity generation, so it firstly is concerned with reserve capacity to specify the resources needed and predict the contract type. In other words it is used to define the resource location to specify the resource usage ratio of the power

development plan and to select the suitable resource needed to be increased for future generations. After the SO finish identifying the resource type, they will use that requirement, both resource type and resource need, to identify how large a contract they need to sign and announce the bidding specification to interested vendors. Then, vendors will send their information to the ERC, which will use it to identify and select the suitable vendor. Regarding vendor selection process, the ERC may compare indicators with previous cases and make the decision based on that case. After the ERC announce their selected bidder, they will generate a license that includes the purchase agreement and report specification that the vendor needs to send to the ERC and the SO according to a committed period. It can be shown in the task template and communication plan below:

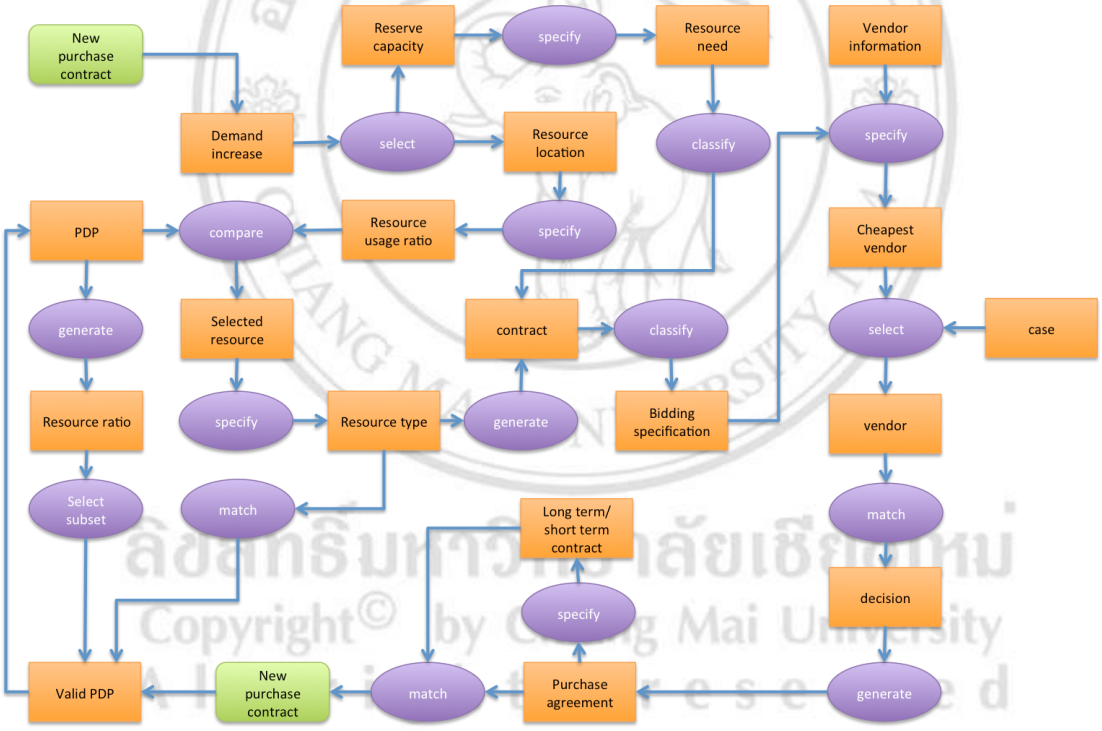

Figure 3.36 Task templates for resource provider

Resource management starts by checking whether current resource capacity is sufficient or not? If it is sufficient, the SO will monitor the contract and request them to send the fuel in line with their contract. On the other hand if the resource capacity is not enough, the SO will request to start bidding with vendors and announce bidding

specifications by firstly checking the PDP for the suitable resource type. Meanwhile, the vendors submit their information to the ERC, who use it to compare with the resource usage plan and select a suitable vendor to generate the license. Finally, the vendor information and resource type is used to make the PDP adjustment and to track the report from the vendor.

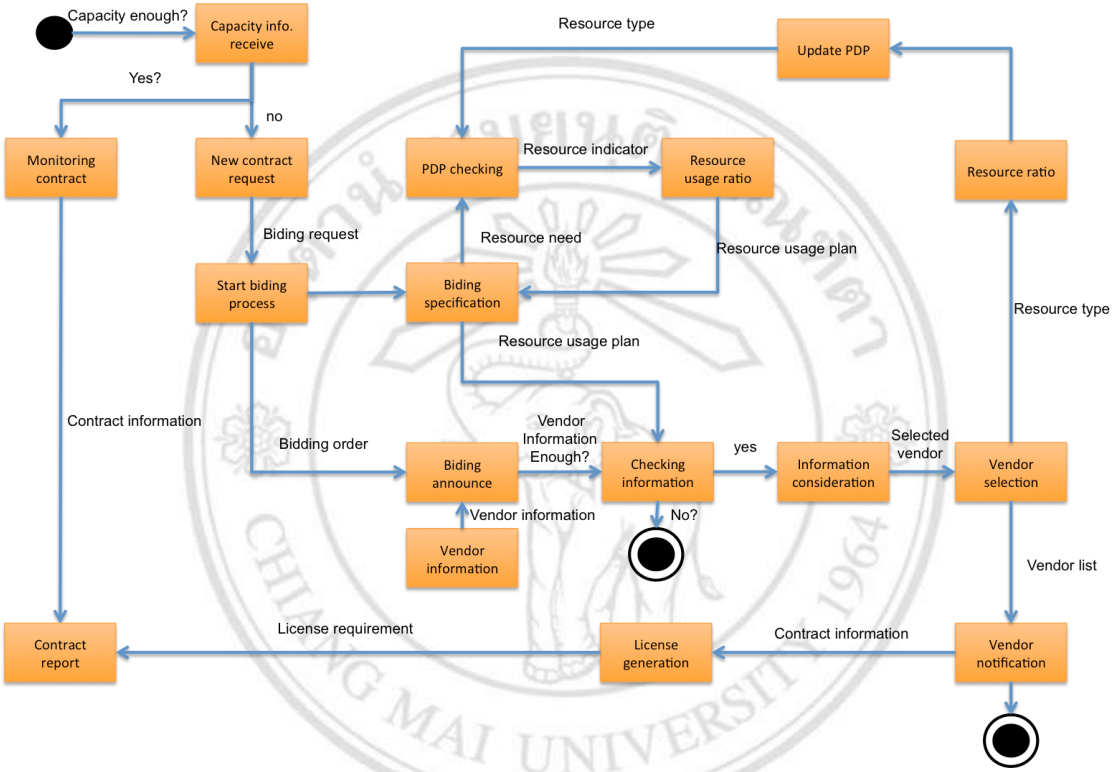

Figure 3.37 Communication plan for resource provider

Table 3.8 CM1 for monitor reserve capacity

communication model	transaction description worksheet CM-1
transaction identifier/name	**Monitor Reserve capacity**: this transaction present the information of generation capacity, which used for monitor the ability in new investment
information object	Information receive task : 1) energy usage ratio in PDP 2) reserve usage ratio 3) contract information 4) lose resource
Agents Involved	**Vendor**: send information to System operator (SO) EGAT: send information to SO **SO**: receive information from Resource vendor and EGAT
Communication Plan	Resource planning and monitoring
Constraints	
Information Exchange Specification	

Table 3.9 CM2 for monitor reserve capacity

communication model	Information Exchange Specification worksheet CM-2
Transaction	**Monitor Reserve capacity**
Agent Involved	1. Sender (Vendor) : vendor information, resource production information 2. Receiver (SO) : vendor information, resource production information 3. Sender (EGAT) : demand level, energy usage report 4. Receiver (SO) : demand level, energy usage report 5. Sender (SO) : more information, bidding specification 6. Receiver (Vendor) : more information, bidding specification 7. Sender (SO) : more information, operation plan adjustment 8. Receiver (EGAT) : more information, operation plan adjustment
Information Items	SO monitor reserve capacity to compare with PDP, and make final decision for announce bidding or adjust operation plan 1. Role: energy usage report, demand level and operation plan use as a core object, while vendor information is the support object 2. Form: - resource production is data string - vendor information present in both data string and text - bidding specification present in both data string and canned text - Demand level present in both data string and chart - operation plan present in the form of data string, canned text and chart 3. Medium : command line interface
Message Specification	
RECEIVE-MESSAGE	Type : ORDER Content : get information Reference : resource usage ratio in PDP From : Vendor, EGAT To : SO
MORE-INFORMATION-MESSAGE	Type : REQUEST Content : request more information Reference : SO request order From : SO To : EGAT, Vendor
FINAL-DECISION-MESSAGE	Type : INFORM Content : final decision announcement Reference : SO announcement From : SO To : EGAT, Vendor
Control over message	

Table 3.10 CM1 for planning resource usage ratio

communication model	transaction description worksheet CM-1
transaction identifier/name	**Planning Resource Usage Ratio**: this transaction present the resource usage information which SO and ERC use to monitor the resource dependency and design the flexible power development plan.
information object	Information receive task : 1) Power Development Plan (PDP) 2) Resource ratio separate by types 3) Contract information 4) Amount resource usage for each generator
Agents Involved	**SO**: send information to Energy Regulatory Commission (ERC) **ERC**: receive information from SO
Communication Plan	Resource planning and monitoring
Constraints	
Information Exchange Specification	

Table 3.11 CM1 for planning resource usage ratio

communication model	Information Exchange Specification worksheet CM-2
Transaction	**Planning Resource Usage Ratio**
Agent Involved	1. Sender (SO) : resource production information, plant operation scheduling 2. Receiver (ERC) : resource production information, plant operation scheduling 3. Sender (ERC) : more information, decision announcement 4. Receiver (SO) : more information, decision announcement
Information Items	ERC compare resource usage ratio with PDP for make decision to generate the new license or adjust the plant operation schedule 1. Role: resource production information use as a core object, while plant operation scheduling is the support object 2. Form: - resource production present in both data string and chart - plant operation scheduling present in both data string and text - Medium :
Message Specification	
RECEIVE-MESSAGE	Type : ORDER Content : get information Reference : resource usage ratio in PDP From : SO To : ERC
MORE-INFORMATION-MESSAGE	Type : REQUEST Content : request more information Reference : Committee order From : ERC To : SO
DECISION-ANNOUNCE-MESSAGE	Type : INFORM Content : final decision announcement Reference : Committee decision From : ERC To : SO
Control over message	

Table 3.12 CM1 for bidding purchase contract

communication model	transaction description worksheet CM-1
transaction identifier/name	**Bidding purchase contract**: this transaction present vendor information that submit to ERC in bidding process, and information require in their contract (Licensing)
information object	Information receive task : 1) Bidding specification 2) Vendor information 3) Decision result 4) License information
Agents Involved	**Vendor:** send information to SO **SO:** receive information from Vendor **SO**: send information to Energy Regulatory Commission (ERC) **ERC**: receive information from SO
Communication Plan	Resource planning and monitoring
Constraints	
Information Exchange Specification	

Table 3.13 CM2 for bidding purchase contract

communication model	Information Exchange Specification worksheet CM-2
Transaction	**Bidding purchase contract**
Agent Involved	1. Sender (Vendor) : vendor information 2. Receiver (SO) : vendor information 3. Sender (SO) : vendor information, bidding specification, PDP 4. Receiver (ERC) : vendor information, bidding specification, PDP 5. Sender (ERC) : more information, new PDP 6. Receiver (SO) : more information, new PDP 7. Sender (ERC) : more information, bidding announcement 8. Receiver (Vendor) : more information, bidding announcement
Information Items	ERC make decision for generate resource purchasing license 1. Role: vendor information use as a core object, while bidding specification and PDP are the support object 2. Form: - vendor information present in both data string and canned text - bidding specification present in both data string and canned text - PDP present in data string, canned text and chart - Medium :
Message Specification	
ANNOUNCE-MESSAGE	Type : PROPOSE Content : get information Reference : From : Vendor To : SO
SUBMIT-INFORMATION-MESSAGE	Type : REQUEST Content : request vendor information Reference : bidding specification From : SO To : ERC
MORE-INFORMATION-MESSAGE	Type : REQUEST Content : request more information Reference : From : ERC To : SO
DECISION-ANNOUNCE-MESSAGE	Type : INFORM Content : final decision announcement Reference : Committee decision From : ERC To : SO
Control over message	

Table 3.14 CM1 for monitoring vendor report

communication model	transaction description worksheet CM-1
transaction identifier/name	**monitoring vendor report**: this transaction present the license information that ERC request from vendor to send in the fix time such as daily, weekly, monthly and yearly
information object	Information receive task : 1) License information 2) Operating information
Agents Involved	**ERC**: send information to Energy Vendor **Vendor**: receive information from ERC
Communication Plan	Resource planning and monitoring
Constraints	
Information Exchange Specification	

Table 3.15 CM2 for monitoring vendor report

communication model	Information Exchange Specification worksheet CM-2
Transaction	**monitoring vendor report**
Agent Involved	1. Sender (ERC) : license information, report request agreement 2. Receiver (Vendor) : license information, report request agreement 3. Sender (Vendor) : report information 4. Receiver (ERC) : report information
Information Items	ERC track the vendor operation based on report that send from vendor 1. Role: report request agreement and report information use as a core object, while license is the support object 2. Form: - report request agreement present in canned text - report information present in both data string and chart - license present in canned text 3. Medium :
Message Specification	
RECEIVE-MESSAGE	Type : REQUIRE Content : vendor report submit Reference : resource purchase contract From : vendor To : ERC
MORE-REPORT-MESSAGE	Type : ORDER Content : notify vendor to submit report Reference : license From : ERC To : vendor
PROBLEM-SOLVER-MESSAGE	Type : ASK Content : ask vendor to solve problem Reference : From : ERC To : vendor
SOLUTION-MESSAGE	Type : OFFER Content : ERC provide solution to solve problem Reference : resource purchase contract From : ERC To : vendor
Control over message	

3.6.2 Electricity Generator: the infrastructure part

To manage generation capability in the Electricity Supply Industry (ESI), a start is made with the monitoring of the levels of generation capacity that can support the demand of electricity usage by monitoring the spinning reserve levels and the current installed generation capacity. If the generation capacity is still sufficient to generate electricity, they will check plant scheduling to monitor start up plant generation and may order the suitable plant to start up in order to make more electricity for the grid system. On the other hand, if the generation capacity is not enough, the SO will request bids for new investment and send bidding specifications, include the generation technology needed, to the ERC. When the ERC receive the bidding specifications and investment information, they will compare the information and select the suitable investor in order to produce the generation license. Regarding the selection process, the ERC also take into account the effect of the electricity tariff, which relates to electricity cost that the end user needs to pay due to the addition of new generation in the market. Moreover, the electricity tariff is controlled by the ERC in order to balance the electricity prices that society need to pay with the debt of electricity operations.

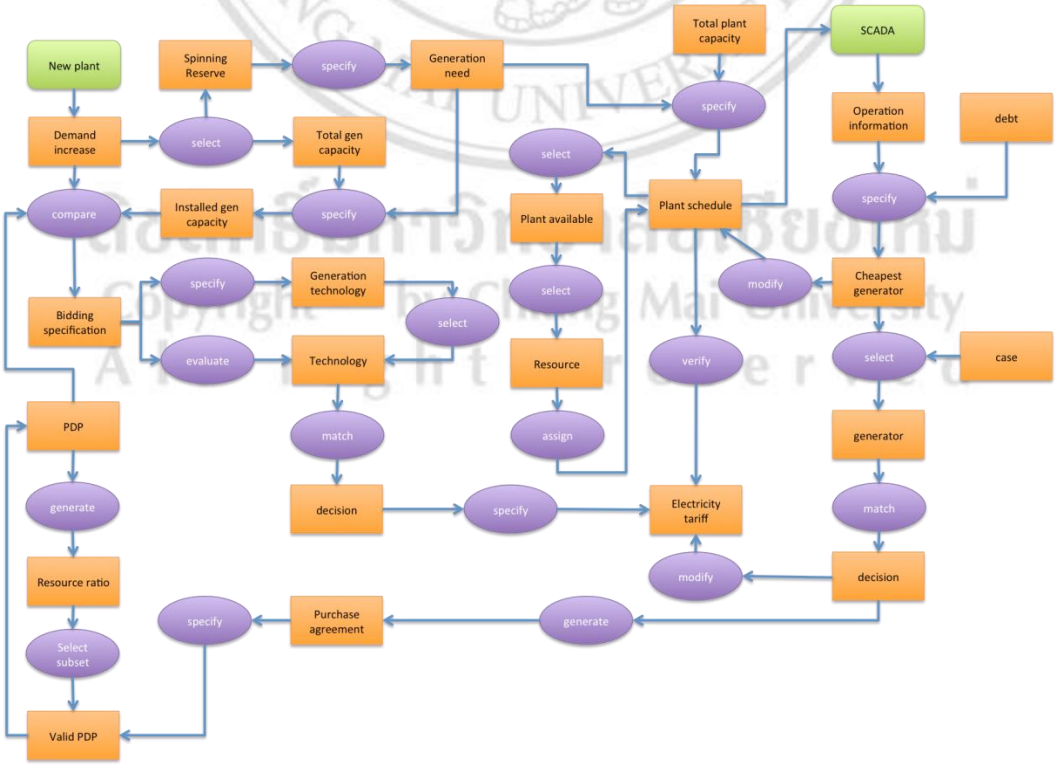

Figure 3.38 Task templates for electricity generator

For control electricity generation, the SO starts by checking the generation capacity, comparing it with demand in order to measure whether there is enough capacity to produce electricity or not. If the capacity is sufficient, they will check the plant operation schedule and make orders to request the available plants to provide electricity for the system grid. On the other hand, if there is not enough electricity capacity to produce electricity the SO will send requests to start a bidding process and generate biding specifications after checking new plant construction plans with the PDP and then send them onto the ERC. Then the ERC get investor information and bidding specifications in order to select the suitable investor in order to issue the license for generation, while also calculating the effect on the electricity tariff. The ERC will also make decisions to adjust the electricity tariff after receiving the operation information and making the decision regarding the fare adjustment (Ft) rate by balancing the operation costs with the costs that people need to pay.

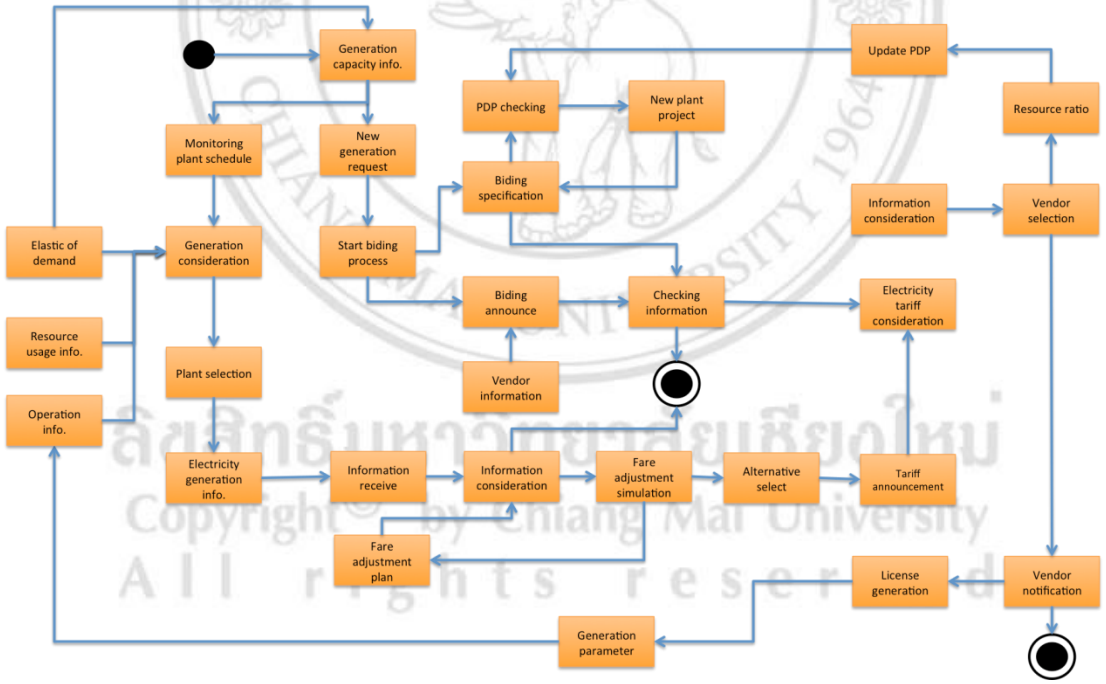

Figure 3.39 Communication plan for electricity generator

3.6.3 Electricity generator: generation efficiency and asset utilization

In order to measure the operation of the ESI, the SO start by tracking the generation efficiency based on monitoring of the plant operation schedule and the spinning reserve levels. Then they use that information to track the power quality and resource usage ratio of the generators. The power quality can be measured by measuring the electricity duration level, system duration rate and loss rate while the generator sends the electricity to high the voltage transmission network. The monitoring of the power quality can help the SO to avoid system burnout, which can cause big problems for the ESI. Meanwhile, they also use the indicators of generation efficiency to assess the asset utilization level of every generator and transmission system and compare this with asset the management plan to avoid unnecessary investment costs.

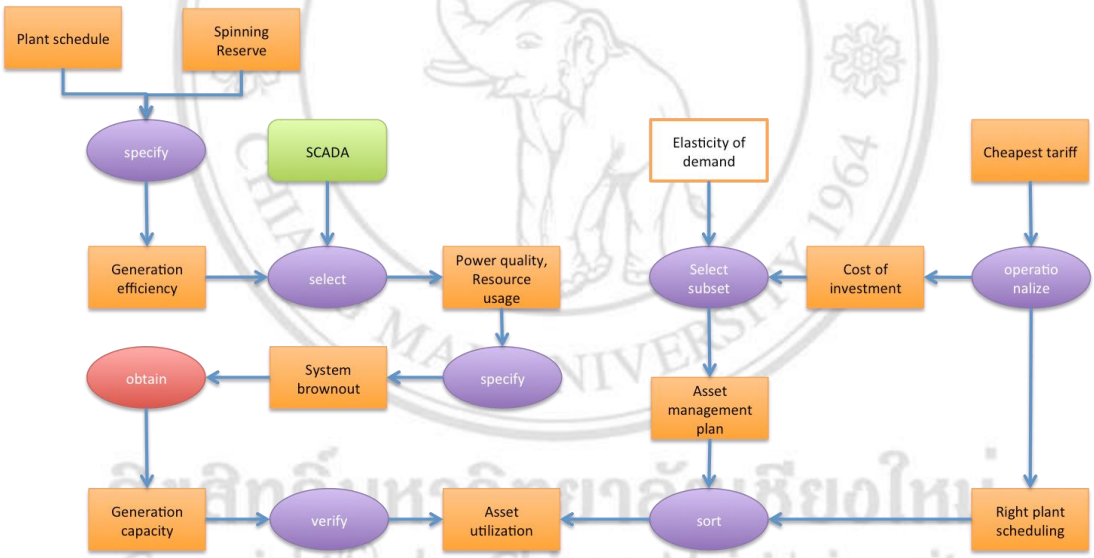

Figure 3.40 Task templates for generation efficiency and asset utilization

In order to monitor the generation efficiency, the SO starts by receiving generation information from EGAT and compares that information with the generation plan. If the operation is missing from the plan the SO will request coordination with the ERC in order to make the final decision. The ERC firstly request the operation information from the SO or the investors and consider the information based on the operation plan or previous cases before making the final decision and giving their advice to the SO in order to offer the best solution to the investors. Meanwhile, the SO

monitors the asset usage and compares this with the asset management plan to calculate the asset utilization in order to use this as an indicator for adjusting the plant operation schedule.

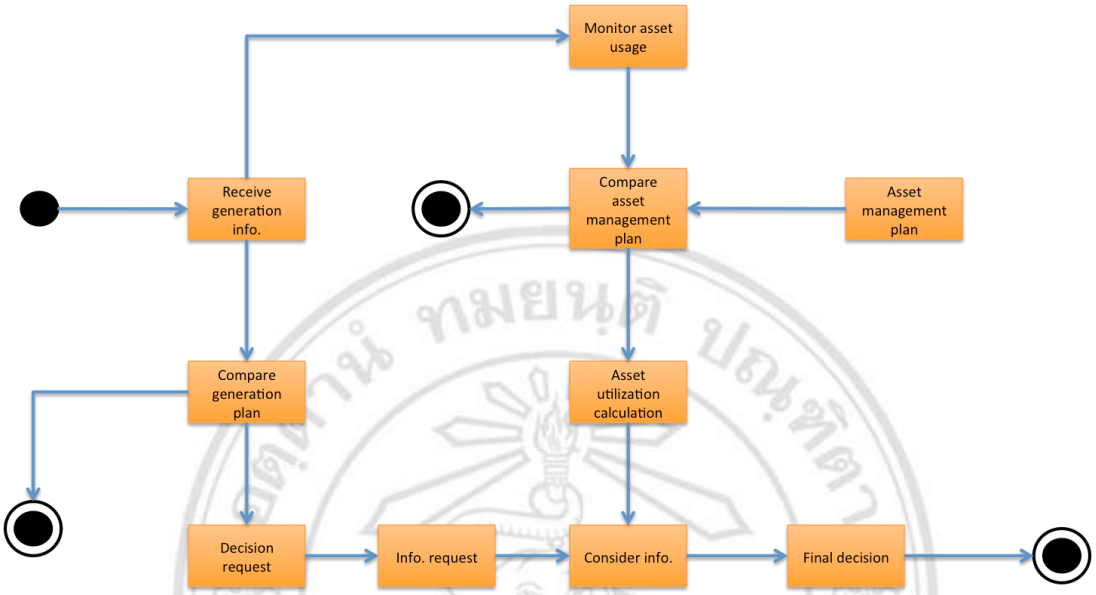

Figure 3.41 Communication plan for generation efficiency and asset utilization

Table 3.16 CM1 for diagnosis generation efficiency

communication model	transaction description worksheet CM-1
transaction identifier/name	**Diagnosis generation efficiency** : this transaction present the information which use to measure the generation operation and tracking the fault operation for generator while compare with plant scheduling
information object	Information receive task : 1) Spinning reserve 2) Plant scheduling 3) Generation information
Agents Involved	**EGAT**: send information to SO **SO**: receive information from EGAT
Communication Plan	Generation efficiency monitoring
Constraints	
Information Exchange Specification	

Table 3.17 CM2 for diagnosis generation efficiency

communication model	Information Exchange Specification worksheet CM-2
Transaction	**Diagnosis generation efficiency**
Agent Involved	1. Sender (EGAT) : energy generation information, fault generation report 2. Receiver (SO) : energy generation information, fault generation report 3. Sender (SO) : more information, plant operation schedule 4. Receiver (EGAT) : plant operation schedule
Information Items	SO get information from each generator to monitor generation efficiency 1. Role: energy generation information and fault generation report use as a core object, and don't have any support object 2. Form: - energy generation information is data string and chart - fault generation report is data string and chart - plant operation schedule plan present in both data string and chart 3. Medium :
Message Specification	
REPORT-MESSAGE	Type : ORDER Content : order EGAT to submit report Reference : From : SO To : EGAT
SUBMIT-MESSAGE	Type : REPORT Content : submit report to SO Reference : SO request report From : EGAT To : SO
SUGGESTION-MESSAGE	Type : INFORM Content : suggest situation Reference : SO announcement From : SO To : EGAT
Control over message	

Table 3.18 CM1 for monitoring asset management and utilization level

communication model	transaction description worksheet CM-1
transaction identifier/name	**monitoring asset management and utilization level**: this transaction present the asset utilization compare with management plan
information object	Information receive task : 1) Asset usage information 2) Plant scheduling 3) Investment cost 4) Asset management plan
Agents Involved	**EGAT**: send information to SO and ERC **SO**: send information to ERC **SO**: receive information from EGAT **ERC**: receive information from EGAT
Communication Plan	Generation efficiency monitoring
Constraints	
Information Exchange Specification	

Table 3.19 CM2 for monitoring asset management and utilization level

communication model	Information Exchange Specification worksheet CM-2
Transaction	**monitoring asset management and utilization level**
Agent Involved	1. Sender (EGAT) : generation report, asset usage report 2. Receiver (SO) : generation report, asset usage report 3. Sender (EGAT) : generation report 4. Receiver (ERC) : generation report 5. Sender (SO) : asset management plan, asset utilization calculation report 6. Receiver (ERC) : asset management plan, asset utilization calculation report 7. Sender (ERC) : more information, plant operation scheduling 8. Receiver (SO) : more information, plant operation scheduling 9. Sender (SO) : plant operation scheduling 10. Receiver (EGAT) : plant operation scheduling 11. Sender (ERC) : more information 12. Receiver (EGAT) : more information
Information Items	ERC make decision on plant operation schedule for manage asset utilization level 1. Role: asset usage report, asset utilization calculation report use as a core object, while generation report and asset management plan are the support object 2. Form: - generation report and asset usage report are data string and chart - asset management plan present in data string - asset utilization calculation report are data string and chart - plant operation schedule present in data string, canned text and chart 3. Medium :
Message Specification	
RECEIVE-MESSAGE	Type : ORDER Content : order EGAT and SO to submit information Reference : From : ERC To : EGAT, SO
MORE-INFORMATION-MESSAGE	Type : REPORT Content : EGAT and SO submit information Reference : ERC order From : EGAT, SO To : ERC
MORE-INFORMATION-MESSAGE	Type : REQUEST Content : request more information Reference : ERC request order From : ERC To : EGAT, SO

Table 3.19 CM1 for monitoring asset management and utilization level (Continued)

communication model	Information Exchange Specification worksheet CM-2
Transaction	**monitoring asset management and utilization level**
FINAL-DECISION-MESSAGE	Type : INFORM Content : final decision announcement Reference : From : ERC To : EGAT, SO
FINAL-DECISION-MESSAGE	Type : OFFER Content : fare adjustment solution Reference : ERC decisions From : ERC To : SO
Control over message	

3.6.4 Electricity transmission and distribution

With regards to the transmission and distribution line, it is primarily concerned with the demand to use the electricity in each location compared with the ability to send electricity to that location. It sees the total line capacity and compares this with the installed capacity to identify the reserve capacity in the system and use that capacity to further make a comparison with the PDP for tracking the construction plan. This is then used to request the start of bidding and the setting of generation bidding specifications. Those specifications are used to select the suitable investor and to generate a license to extend the line capacity. During the consideration process, the ERC also monitor the indicators, which are used to measure the transmission and distribution stability such as FD, VD outage duration rates and loss rates in order to ensure that adding new lines does not interrupt the frequency and voltage and so cause a system interruption.

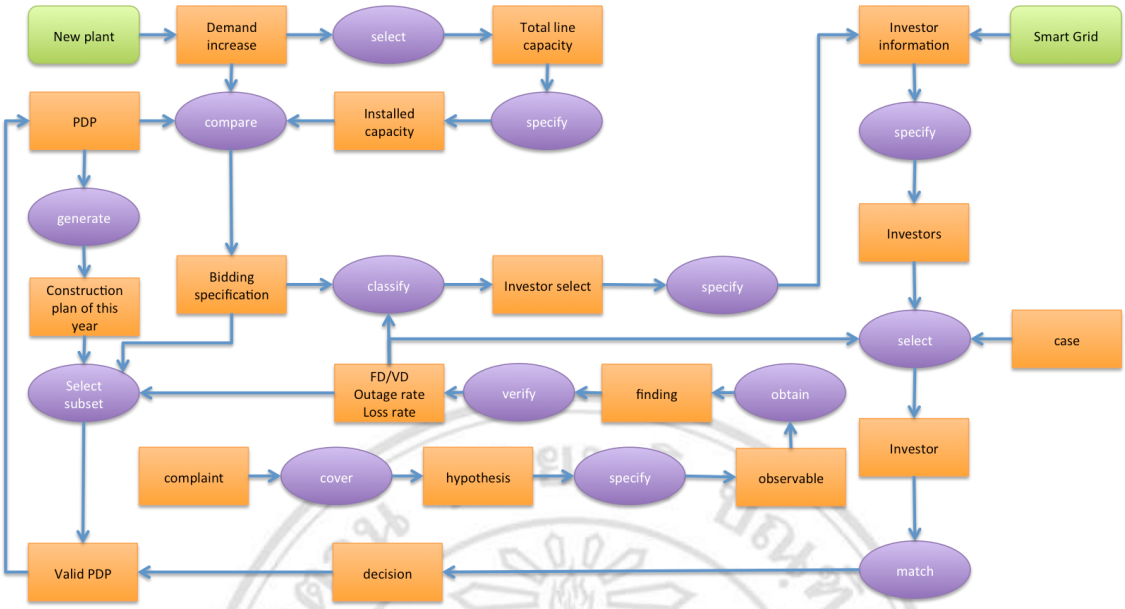

Figure 3.42 Task templates for electricity transmission and distribution

As seen above, the SO firstly starts by checking line capacities and determines whether lines are available to provide the electricity to end-users or not. If there are lines available, they will give the order to use those lines. On the other hand, if there are not any lines available, the SO will request line investment bidding, then check with the PDP to get line construction information and announce the bidding. After that they send information to the ERC who use that information to select the suitable investor to invest in a transmission and distribution line. While selecting the investor, the ERC takes into account the complaints from end users with regards to the system stability and use that information to support their decision. Then they use that investor license to adjust the PDP and the total transmission and distribution capacity.

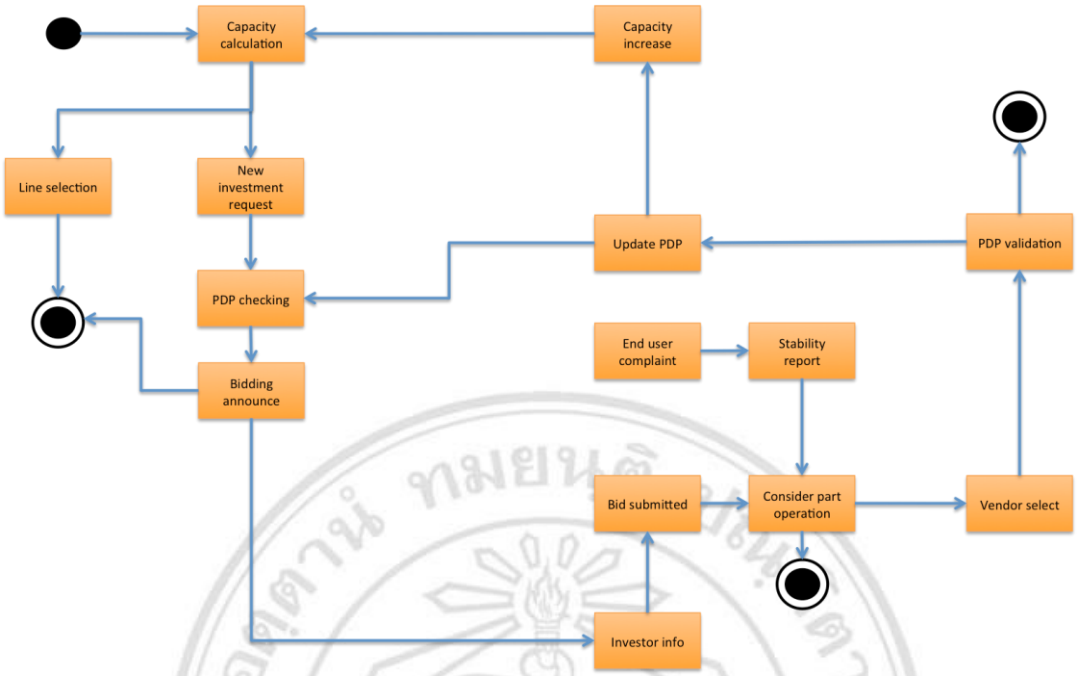

Figure 3.43 Communication plans for electricity transmission and distribution

Table 3.20 CM1 Monitoring line capacity

communication model	transaction description worksheet CM-1
transaction identifier/name	**monitoring line capacity**: this transaction present the amount of line capacity compare with demand to use line
information object	Information receive task : 1) Total line capacity 2) Energy transformation level 3) Location information 4) Line information
Agents Involved	**EGAT, MEA/PEA**: send information to SO **SO**: receive information from EGAT
Communication Plan	Transmission and distribution stability monitoring
Constraints	
Information Exchange Specification	

Table 3.21 CM2 Monitoring line capacity

communication model	Information Exchange Specification worksheet CM-2
Transaction	**monitoring line capacity**
Agent Involved	1. Sender (EGAT, MEA/PEA) : energy transfer information, line interruption report 2. Receiver (SO) : energy transfer information, line interruption report 3. Sender (SO) : more information, switching order 4. Receiver (EGAT, MEA/PEA) : switching order
Information Items	SO get information from transmission and distribution vendor for maintain system stability 1. Role: line interruption report use as a core object, while energy transfer information is support object 2. Form: - energy transfer information is data string and chart - line interruption report is data string and chart - switching order present in data string 3. Medium :
Message Specification	
RECEIVE-MESSAGE	Type : ORDER Content : get information Reference : From : EGAT, MEA/PEA To : SO
MORE-INFORMATION-MESSAGE	Type : REQUEST Content : request more information Reference : SO request order From : SO To : EGAT, MEA/PEA
FINAL-DECISION-MESSAGE	Type : INFORM Content : final decision announcement Reference : SO announcement From : SO To : EGAT, MEA/PEA
Control over message	

Table 3.22 CM1 for bidding line investment

communication model	transaction description worksheet CM-1
transaction identifier/name	**Bidding line investment**: this transaction present information which used in vendor bidding for invest in transmission and distribution development
information object	Information receive task : 1) Bidding specification 2) Investor information 3) Decision result 4) Licensing information
Agents Involved	**EGAT, MEA/PEA**: send information to SO and ERC **SO**: send information to ERC **SO**: receive information from EGAT **ERC**: receive information from EGAT
Communication Plan	Transmission and distribution stability monitoring
Constraints	
Information Exchange Specification	

Table 3.23 CM2 for bidding line investment

communication model	Information Exchange Specification worksheet CM-2
Transaction	**Bidding line investment**
Agent Involved	1. Sender (EGAT, MEA/PEA) : transmission and distribution report, customer demand 2. Receiver (SO) : transmission and distribution report, customer demand 3. Sender (EGAT, MEA/PEA) : bidder information 4. Receiver (ERC) : bidder information 5. Sender (SO) : PDP 6. Receiver (ERC) : PDP 7. Sender (ERC) : more information, bidding specification 8. Receiver (SO) : more information, bidding specification 9. Sender (ERC) : more information 10. Receiver (EGAT, MEA/PEA) : more information
Information Items	ERC get information from EGAT, MEA/PEA and SO to make decision for transmission and distribution bidding investment 1. Role: bidder information and PDP use as a core object, while transmission and distribution report, customer demand are the support object 2. Form: - bidder information is data string and text - PDP present in data string, text and chart - customer demand present in both data string and chart - transmission and distribution report present in data string and chart 3. Medium :
Message Specification	
ANNOUNCE-MESSAGE	Type : PROPOSE Content : get information Reference : From : EGAT, MEA/PEA To : SO
SUBMIT-INFORMATION-MESSAGE	Type : REQUEST Content : request investor information Reference : bidding specification From : SO To : ERC
MORE-INFORMATION-MESSAGE	Type : REQUEST Content : request more information Reference : From : ERC To : SO
DECISION-ANNOUNCE-MESSAGE	Type : INFORM Content : final decision announcement Reference : Committee decision From : ERC To : SO

Table 3.23 CM2 for bidding line investment (Continued)

communication model	Information Exchange Specification worksheet CM-2
Transaction	**Bidding line investment**
FINAL-DECISION-MESSAGE	Type : INFORM Content : final decision announcement Reference : Committee decision From : SO To : EGAT, MEA/PEA
Control over message	

Table 3.24 CM1 for diagnosis line stability

communication model	transaction description worksheet CM-1
transaction identifier/name	**Diagnosis line stability**: this transaction present information which use to monitor the stability of transmission and distribution for avoid system blowout
information object	Information receive task : 1) System duration rate 2) Loss rate 3) Energy transfer rate 4) Location information
Agents Involved	**EGAT, MEA/PEA**: send information to SO and ERC **SO**: receive information from EGAT
Communication Plan	Transmission and distribution stability monitoring
Constraints	
Information Exchange Specification	

Table 3.25 CM2 for diagnosis line stability

communication model	Information Exchange Specification worksheet CM-2
Transaction	**Diagnosis line stability**
Agent Involved	1. Sender (EGAT, MEA/PEA) : transmission and distribution line information, fault transmission and distribution report 2. Receiver (SO) : transmission and distribution line information, fault transmission and distribution report 3. Sender (SO) : more information 4. Receiver (EGAT, MEA/PEA) : more information
Information Items	SO get information from each generator to monitor generation efficiency 1. Role: transmission and distribution line information and fault transmission and distribution report use as a core object, and don't have any support object 2. Form: - transmission and distribution line information is data string and chart - fault transmission and distribution report is data string and chart 3. Medium :
Message Specification	
REPORT-MESSAGE	Type : ORDER Content : order EGAT, MEA/PEA to submit report Reference : From : SO To : EGAT, MEA/PEA
SUBMIT-MESSAGE	Type : REPORT Content : submit report to SO Reference : SO request report From : EGAT, MEA/PEA To : SO
SUGGESTION-MESSAGE	Type : INFORM Content : suggest situation Reference : SO announcement From : SO To : EGAT, MEA/PEA
Control over message	

Table 3.26 CM1 for Monitor investment plan

communication model	transaction description worksheet CM-1
transaction identifier/name	**Monitor investment plan**: this transaction present information which use for investor bidding and monitor line construction plan
information object	Information receive task : 1) Power Development Plan 2) Investor information 3) License information 4) Decision result
Agents Involved	**EGAT, MEA/PEA**: send information to SO and ERC **SO**: send information to ERC **SO**: receive information from EGAT **ERC**: receive information from EGAT
Communication Plan	Transmission and distribution stability monitoring
Constraints	
Information Exchange Specification	

Table 3.27 CM2 for Monitor investment plan

communication model	Information Exchange Specification worksheet CM-2
Transaction	**Monitor investment plan**
Agent Involved	1. Sender (EGAT, MEA/PEA) : construction progress, public obstacle 2. Receiver (SO) : construction progress, public obstacle 3. Sender (EGAT, MEA/PEA) : public obstacle 4. Receiver (ERC) : public obstacle 5. Sender (SO) : construction progress, PDP 6. Receiver (ERC) : construction progress, PDP 7. Sender (ERC) : more information, decision result, PDP adjustment, social compensate policy 8. Receiver (SO) : decision result, PDP adjustment, social compensate policy 9. Sender (SO) : construction plan, social compensate policy 10. Receiver (EGAT, MEA/PEA) : construction plan, social compensate policy 11. Sender (ERC) : more information 12. Receiver (EGAT, MEA/PEA) : more information
Information Items	ERC monitor line construction plan in order to follow the PDP of country 1. Role: construction progress and public obstacle use as a core object, while PDP are the support object 2. Form: - construction progress are data string and chart - public obstacle present in text - PDP present in data string, canned text and chart 3. Medium :
Message Specification	
REPORT-MESSAGE	Type : ORDER Content : order EGAT, MEA/PEA to submit report Reference : From : SO To : EGAT, MEA/PEA
SUBMIT-MESSAGE	Type : REPORT Content : submit report to SO Reference : SO request report From : EGAT, MEA/PEA To : SO
REPORT-MESSAGE	Type : ASK Content : get construction progress and PDP from SO Reference : From : ERC To : SO

Table 3.27 CM1 for Monitor investment plan (Continued)

communication model	Information Exchange Specification worksheet CM-2
Transaction	**Monitor investment plan**
MORE-INFORMATION-MESSAGE	Type : REPLY Content : submit schedule information Reference : ERC order From : SO To : ERC
FINAL-DECISION-MESSAGE	Type : INFORM Content : give suggestion to SO Reference : ERC decision From : ERC To : SO
Control over message	

3.6.5 Demand side management

With demand side management, the SO starts by analyzing the demand of electricity in the country and then compares this with the power generation plan and the PDP to track the operation quality of the ESI. It can propose the demand side by promoting energy conservation to the people, or manage the construction plan in the electricity industry. On the other hand, the ERC can monitor the error of electricity operations by being concerned with end user petitions, which can predict the effect of investment costs on the electricity market and the level of the electricity tariff that affects end user satisfaction and the debt of the system operation. It can then use that information to generate or adjust the support laws and bills in order to increase the efficiency of the electricity operations in the Electricity Supply Industry. Moreover, they use the problems to create research topics and to give their support to laws, policy or research funds in order to motivate people or education institutes to do that research and promote it as knowledge for the electricity market.

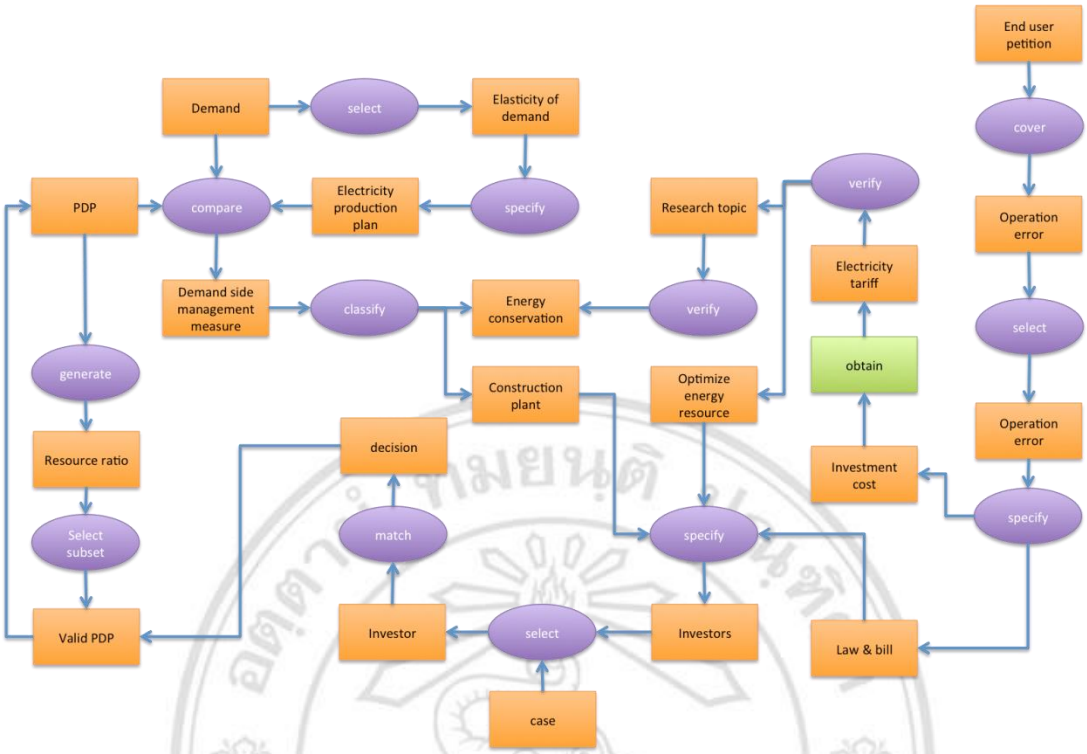

Figure 3.44 Task template for demand side management

The chart demonstrates how the starting point is analysis of the demand level and its comparison with the production plan. If the generation plan is missing, the System Operator needs to corporate with the ERC to adjust the generation plan to avoid an effect on the electricity tariff. Meanwhile, the ERC receives complaint information from end users and makes the decision to solve these problems in order to improve the reliability and safety of the electricity market. Meanwhile, they use the complaints to introduce the energy conservation plan and research topic, which investors can promote to the public to stimulate public coordination and satisfaction.

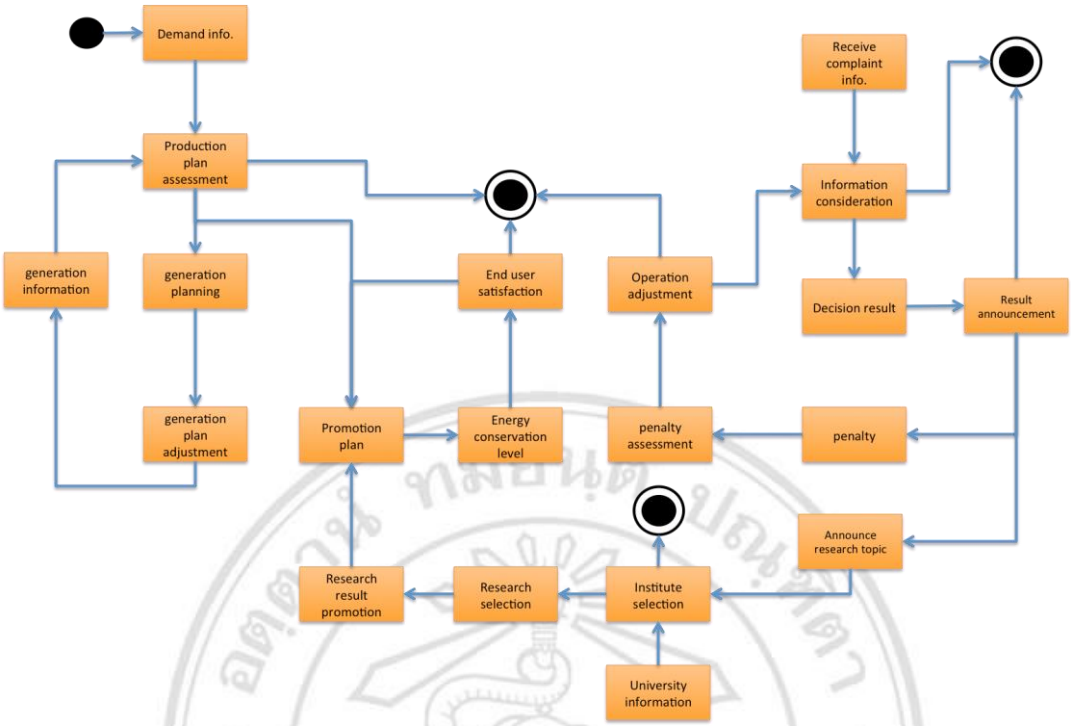

Figure 3.45 Communication plans for demand side management

Table 3.28 CM1 for Demand assessment

communication model	transaction description worksheet CM-1
transaction identifier/name	**Demand assessment**: this transaction present information to measure the level on demand of using energy, and consider the factors that relate with demand assessment
information object	Information receive task : 1) Elasticity of demand 2) GDP 3) Exchange rate 4) Energy production plan
Agents Involved	**MEA/PEA**: send information to SO and ERC **SO**: send information to ERC **SO**: receive information from EGAT **ERC**: receive information from EGAT
Communication Plan	Demand side management
Constraints	
Information Exchange Specification	

Table 3.29 CM2 for Demand assessment

communication model	Information Exchange Specification worksheet CM-2
Transaction	**Demand assessment**
Agent Involved	1. Sender (EGAT, MEA/PEA) : customer information, energy usage information 2. Receiver (SO) : customer information, energy usage information 3. Sender (EGAT, MEA/PEA) : customer information, energy usage information 4. Receiver (ERC) : customer information, energy usage information 5. Sender (SO) : PDP, plant operation schedule 6. Receiver (ERC) : PDP, plant operation schedule 7. Sender (ERC) : more information, PDP adjustment, energy conservation policy 8. Receiver (SO) : PDP adjustment, energy conservation policy 9. Sender (SO) : energy conservation plan, construction plan 10. Receiver (EGAT, MEA/PEA) : energy conservation plan, construction plan 11. Sender (ERC) : more information 12. Receiver (EGAT, MEA/PEA) : more information
Information Items	ERC monitor electricity construction plan and PDP in order to control over energy usage demand 1. Role: PDP and energy usage information use as a core object, while customer information and plant operation schedule are the support object 2. Form: - energy usage information are data string and chart - customer information present in text - PDP present in data string, canned text and chart - plant operation schedule present in text and data string 3. Medium :
Message Specification	
REPORT-MESSAGE	Type : ORDER Content : order EGAT, MEA/PEA to submit report Reference : From : SO To : EGAT, MEA/PEA
SUBMIT-MESSAGE	Type : REPORT Content : submit report to SO Reference : SO request report From : EGAT, MEA/PEA To : SO

Table 3.29 CM2 for Demand assessment (Continued)

communication model	Information Exchange Specification worksheet CM-2
Transaction	**Demand assessment**
REPORT-MESSAGE	Type : ASK Content : get demand information from EGAT, and plant operation schedule from SO Reference : From : ERC To : EGAT, MEA/PEA, SO
MORE-INFORMATION-MESSAGE	Type : REPLY Content : submit information to ERC Reference : ERC order From : EGAT, MEA/PEA, SO To : ERC
MORE-INFORMATION-MESSAGE	Type : REQUEST Content : request more information Reference : ERC request order From : ERC To : EGAT, MEA/PEA, SO
FINAL-DECISION-MESSAGE	Type : INFORM Content : final decision announcement Reference : PDP, license agreement, law and bill From : SO To : EGAT, MEA/PEA, SO
Control over message	

Table 3.30 CM1 for End user petition monitoring

communication model	transaction description worksheet CM-1
transaction identifier/name	**End user petition monitoring**: this transaction present
information object	Information receive task : 1) Complaint information 2) Energy operation report 3) Decision result 4) Penalty traction
Agents Involved	**End user**: send information to ERC **ERC**: send information to SO **SO**: send information to EGAT, MEA/ PEA **ERC**: receive information from end user **SO**: receive information from ERC **EGAT, MEA/PEA**: receive information from SO
Communication Plan	Demand side management
Constraints	
Information Exchange Specification	

Table 3.31 CM2 for End user petition monitoring

communication model	Information Exchange Specification worksheet CM-2
Transaction	**End user petition monitoring**
Agent Involved	1. Sender (end user) : complaint 2. Receiver (ERC) : complaint 3. Sender (EGAT, MEA/PEA) : operation information 4. Receiver (ERC) : operation information 5. Sender (SO) : fault generation report, line interruption report, PDP 6. Receiver (ERC) : fault generation report, line interruption report, PDP 7. Sender (ERC) : social compensate policy 8. Receiver (SO) : social compensate policy 9. Sender (SO) : construction plan, energy conservation plan 10. Receiver (EGAT, MEA/PEA) : construction plan, energy conservation plan 11. Sender (ERC) : more information 12. Receiver (EGAT, MEA/PEA) : more information
Information Items	ERC monitor electricity operation and manage end user complaint 1. Role: complaint, operation information, fault generation report and line interruption report use as a core object, while PDP are the support object 2. Form: - operation information, fault generation report and line interruption report are data string and chart - complaint present in text - PDP present in data string, canned text and chart 3. Medium :
Message Specification	
RECEIVE-MESSAGE	Type : ORDER Content : get information Reference : From : end user To : ERC
REPORT-MESSAGE	Type : ASK Content : ask operator to submit their information Reference : From : ERC To : EGAT, MEA/PEA, SO
MORE-INFORMATION-MESSAGE	Type : REPLY Content : submit information to ERC Reference : ERC order From : EGAT, MEA/PEA, SO To : ERC

Table 3.31 CM2 for End user petition monitoring (Continued)

communication model	Information Exchange Specification worksheet CM-2
Transaction	**End user petition monitoring**
MORE-INFORMATION-MESSAGE	Type : REQUEST Content : request more information Reference : SO request order From : SO To : EGAT, Vendor
FINAL-DECISION-MESSAGE	Type : INFORM Content : result suggestion Reference : From : ERC To : SO, vendor
Control over message	

Table 3.32 CM1 for Classify research and energy conservation

communication model	transaction description worksheet CM-1
transaction identifier/name	**Classify research and energy conservation**: this transaction present the information that use to specific the research plan and energy conservation plan and end user satisfaction
information object	Information receive task : 1) Energy production plan 2) PDP 3) Location information 4) Research information 5) Fund and policy information
Agents Involved	**MEA/PEA**: send information to SO and ERC **SO**: send information to ERC **SO**: receive information from EGAT **ERC**: receive information from EGAT
Communication Plan	Demand side management
Constraints	
Information Exchange Specification	

Table 3.33 CM2 for Classify research and energy conservation

communication model	Information Exchange Specification worksheet CM-2
Transaction	**Classify research and energy conservation**
Agent Involved	1. Sender (ERC) : energy conservation plan, construction plan, research information 2. Receiver (SO) : energy conservation plan, construction plan, research information 3. Sender (SO) : energy conservation information, PDP, research information 4. Receiver (EGAT, MEA/PEA) : energy conservation information, PDP, research information 5. Sender (EGAT, MEA/PEA) : construction progress, customer satisfaction 6. Receiver (SO) : construction progress, customer satisfaction 7. Sender (SO) : customer satisfaction level 8. Receiver (ERC) : customer satisfaction level 9. Sender (ERC) : more information 10. Receiver (EGAT, MEA/PEA) : more information
Information Items	ERC assess the result of energy conservation plan and research topic from the satisfy of end user 1. Role: energy conservation plan, construction plan, research information and customer satisfaction use as a core object, while PDP are the support object 2. Form: - energy conservation are data string and text - construction plan present in data string and text - Research information present in data string, text and chart - Customer satisfaction present in data string and chart - PDP present in data string, canned text and chart 3. Medium :
Message Specification	
RECEIVE-MESSAGE	Type : OFFER Content : give energy conservation plan and research information to operator Reference : From : ERC To : EGAT, MEA/PEA, SO
RECEIVE-MESSAGE	Type : REQUEST Content : track progress from EGAT, MEA/PEA and SO Reference : energy conservation plan, research information From : ERC To : EGAT, MEA/PEA, SO
SUBMIT-MESSAGE	Type : REPORT Content : submit report to ERC Reference : SO request report From : EGAT, MEA/PEA, SO To : ERC

Table 3.33 CM2 for Classify research and energy conservation (Continued)

communication model	Information Exchange Specification worksheet CM-2
Transaction	**Classify research and energy conservation**
FINAL-DECISION-MESSAGE	Type : INFORM Content : final decision suggestion Reference : From : ERC To : EGAT, MEA/PEA, SO
Control over message	

3.7 Case study: Electricity Generator in the Infrastructure Part

In order to offer greater understanding, this thesis provides a case study, selecting the part of electricity generators in the section of infrastructure monitoring and planning. This is so that tasks were analyzed by using the commonKADS model to design the task template and communication plan that are already shown in figure 3.40 and 3.41 above. Therefore, it is used to design the communication definition, which describes the transaction name, object, agent involve in that transaction, information item and message. It is presented in the form of CM 1 and CM 2 worksheet, which are shown below:

Table 3.34 CM1 for Monitoring spinning reserve

communication model	transaction description worksheet CM-1
transaction identifier/name	**monitoring spinning reserve**: this transaction present spinning reserve information that use to monitor the generation capacity for avoid system interruption.
information object	Information receive task : 1) Total reserve capacity 2) Elasticity of demand 3) Spinning reserve information
Agents Involved	**EGAT**: send information to SO **SO**: receive information from EGAT
Communication Plan	Generation monitoring and scheduling
Constraints	
Information Exchange Specification	

Table 3.35 CM2 for Monitoring spinning reserve

communication model	Information Exchange Specification worksheet CM-2
Transaction	**monitoring spinning reserve**
Agent Involved	1. Sender (EGAT) : energy generation information, customer demand 2. Receiver (SO) : energy generation information, customer demand 3. Sender (SO) : more information, plant operation schedule, generation production plan 4. Receiver (EGAT) : plant operation schedule, generation production plan
Information Items	SO monitor spinning reserve level for avoid system blowout 1. Role: energy generation information, customer demand and generation production plan use as a core object, while plant operation schedule is the support object 2. Form: - energy information is data string and chart - customer demand present in both data string and chart - generation production plan present in data string - operation schedule present in both data string and chart 3. Medium :
Message Specification	
RECEIVE-MESSAGE	Type : ORDER Content : check EGAT report Reference : Power purchase plan (PPA) From : EGAT To : SO
MORE-INFORMATION-MESSAGE	Type : REQUEST Content : request more information Reference : SO request order From : SO To : EGAT
FINAL-DECISION-MESSAGE	Type : OFFER Content : operation schedule suggestion Reference : SO announcement From : SO To : EGAT, Vendor
Control over message	

Table 3.36 CM1 for Monitoring generation capacity

communication model	transaction description worksheet CM-1
transaction identifier/name	**monitoring generation capacity**: this transaction use to monitor the generation capacity and compare with the demand of electricity using
information object	Information receive task : 1) Total capacity 2) Generation capacity 3) Reserve capacity ratio 4) Energy demand
Agents Involved	**EGAT**: send information to SO **SO**: receive information from EGAT
Communication Plan	Generation monitoring and scheduling
Constraints	
Information Exchange Specification	

Table 3.37 CM2 for Monitoring generation capacity

communication model	Information Exchange Specification worksheet CM-2
Transaction	**monitoring generation capacity**
Agent Involved	1. Sender (EGAT) : energy generation information, customer demand 2. Receiver (SO) : energy generation information, customer demand 3. Sender (SO) : more information, plant operation schedule, bidding announcement 4. Receiver (EGAT) : plant operation schedule, bidding announcement
Information Items	SO monitor and track generation capacity to make electricity business run smoother 1. Role: energy generation information, customer demand and bidding announcement use as a core object, while plant operation schedule is the support object 2. Form: - energy information is data string and chart - customer demand present in both data string and chart - bidding announcement present in canned text - operation schedule present in both data string and chart 3. Medium :
Message Specification	
RECEIVE-MESSAGE	Type : ORDER Content : get information Reference : PPA From : EGAT To : SO
MORE-INFORMATION-MESSAGE	Type : REQUEST Content : request more information Reference : SO request order From : SO To : EGAT
FINAL-DECISION-MESSAGE	Type : INFORM Content : final decision announcement Reference : SO announcement From : SO To : EGAT
Control over message	

Table 3.38 CM1 for Generation investment bidding

communication model	transaction description worksheet CM-1
transaction identifier/name	**Generator investment bidding**: this transaction present the bidding process and decision result.
information object	Information receive task : 1) Bidding specification 2) Vendor information 3) Decision result 4) License information
Agents Involved	**EGAT**: send information to SO and ERC **SO**: send information to ERC **SO**: receive information from EGAT **ERC**: receive information from EGAT
Communication Plan	Generation monitoring and scheduling
Constraints	
Information Exchange Specification	

Table 3.39 CM2 for Generation investment bidding

communication model	Information Exchange Specification worksheet CM-2
Transaction	**Generator investment bidding**
Agent Involved	1. Sender (EGAT) : generation report, customer demand 2. Receiver (SO) : generation report, customer demand 3. Sender (EGAT) : bidder information 4. Receiver (ERC) : bidder information 5. Sender (SO) : PDP, plant operation schedule 6. Receiver (ERC) : PDP, plant operation schedule 7. Sender (ERC) : more information, bidding specification 8. Receiver (SO) : more information, bidding specification 9. Sender (ERC) : more information 10. Receiver (EGAT) : more information
Information Items	ERC get information from EGAT and SO to make decision for generation bidding investment 1. Role: bidder information and PDP use as a core object, while generation report, customer demand and plant operation schedule are the support object 1. Form: - bidder information is data string and text - PDP present in data string, text and chart - customer demand present in both data string and chart - generation report present in data string and chart - plant operation schedule present in both data string and chart 3. Medium :
Message Specification	
ANNOUNCE-MESSAGE	Type : PROPOSE Content : get information Reference : From : EGAT To : SO
SUBMIT-INFORMATION-MESSAGE	Type : REQUEST Content : request investor information Reference : bidding specification From : SO To : ERC
MORE-INFORMATION-MESSAGE	Type : REQUEST Content : request more information Reference : From : ERC To : SO
DECISION-ANNOUNCE-MESSAGE	Type : INFORM Content : final decision announcement Reference : Committee decision From : ERC To : SO

Table 3.39 CM2 for Generation investment bidding (Continued)

communication model	Information Exchange Specification worksheet CM-2
Transaction	**Generator investment bidding**
FINAL-DECISION-MESSAGE	Type : INFORM Content : final decision announcement Reference : Committee decision From : SO To : EGAT
Control over message	

Table 3.40 CM1 for Scheduling plant operation

communication model	transaction description worksheet CM-1
transaction identifier/name	**Scheduling plant operation**: this transaction present the information of plant availability which use to schedule the generation plan
information object	Information receive task : 1) Energy generation 2) Reserve capacity 3) Resource usage ratio 4) Technology information 5) Plant scheduling
Agents Involved	**SO**: send information to ERC **ERC**: receive information from EGAT
Communication Plan	Generation monitoring and scheduling
Constraints	
Information Exchange Specification	

Table 3.41 CM2 for Scheduling plant operation

communication model	Information Exchange Specification worksheet CM-2
Transaction	**Scheduling plant operation**
Agent Involved	1. Sender (SO) : energy generation information, plant operation schedule, generation production plan, plant information 2. Receiver (ERC) : energy generation information, plant operation schedule, generation production plan, plant information 3. Sender (ERC) : more information, plant operation schedule 4. Receiver (SO) : plant operation schedule
Information Items	ERC make decision on plant operation schedule for control resource usage in plant operation 1. Role: energy generation information, plant operation schedule and generation production plan use as a core object, while plant information is the support object 2. Form: - energy generation information is data string and chart - generation production plan present in both data string and chart - plant operation schedule plan present in both data string and chart - plant information present in both data string and text 3. Medium :
Message Specification	
REPORT-MESSAGE	Type : ASK Content : get plant schedule from SO Reference : From : ERC To : SO
MORE-INFORMATION-MESSAGE	Type : REPLY Content : submit schedule information Reference : ERC order From : SO To : ERC
FINAL-DECISION-MESSAGE	Type : INFORM Content : final decision announcement Reference : ERC decision From : ERC To : SO
Control over message	

Table 3.42 CM1 for Monitoring electricity tariff

communication model	transaction description worksheet CM-1
transaction identifier/name	**Monitoring electricity tariff**: this transaction present plant operation that affect with investment cost, and lead to change in electricity tariff
information object	Information receive task : 1) Generation investment cost 2) Energy generation 3) Plant scheduling plan
Agents Involved	**EGAT**: send information to SO and ERC **SO**: send information to ERC **SO**: receive information from EGAT **ERC**: receive information from EGAT
Communication Plan	Generation monitoring and scheduling
Constraints	
Information Exchange Specification	

Table 3.43 CM2 for Monitoring electricity tariff

communication model	Information Exchange Specification worksheet CM-2
Transaction	**Monitoring electricity tariff**
Agent Involved	1. Sender (EGAT) : generation report, investment cost 2. Receiver (SO) : generation report, investment cost 3. Sender (EGAT) : fare adjustment simulation 4. Receiver (ERC) : fare adjustment simulation 5. Sender (SO) : PDP, plant operation schedule 6. Receiver (ERC) : PDP, plant operation schedule 7. Sender (ERC) : more information, fare adjustment selection 8. Receiver (SO) : more information, fare adjustment selection 9. Sender (ERC) : more information 10. Receiver (EGAT) : more information
Information Items	ERC make decision on plant operation to monitor and assess the electricity tariff 1. Role: investment cost and fare adjustment simulation use as a core object, while generation report, PDP and plant operation schedule are the support object 2. Form: - generation report and investment cost are data string and chart - fare adjustment simulation present in both data string and chart - PDP and plant operation schedule present in data string, canned text and chart 3. Medium :
Message Specification	
REPORT-MESSAGE	Type : ORDER Content : order EGAT and SO to send report Reference : PDP From : EGAT, SO To : ERC
MORE-INFORMATION-MESSAGE	Type : REQUEST Content : request more information Reference : ERC request From : ERC To : SO, EGAT
PLAN-ADJUSTMENT-MESSAGE	Type : INFORM Content : adjust PDP and plant operation schedule Reference : ERC decisions From : ERC To : SO
FINAL-DECISION-MESSAGE	Type : OFFER Content : fare adjustment solution Reference : ERC decisions From : ERC To : SO
Control over message	

After designing worksheets CM1 and CM2, they were used to make the common information model for future steps. The CIM for generators can be shown as follows:

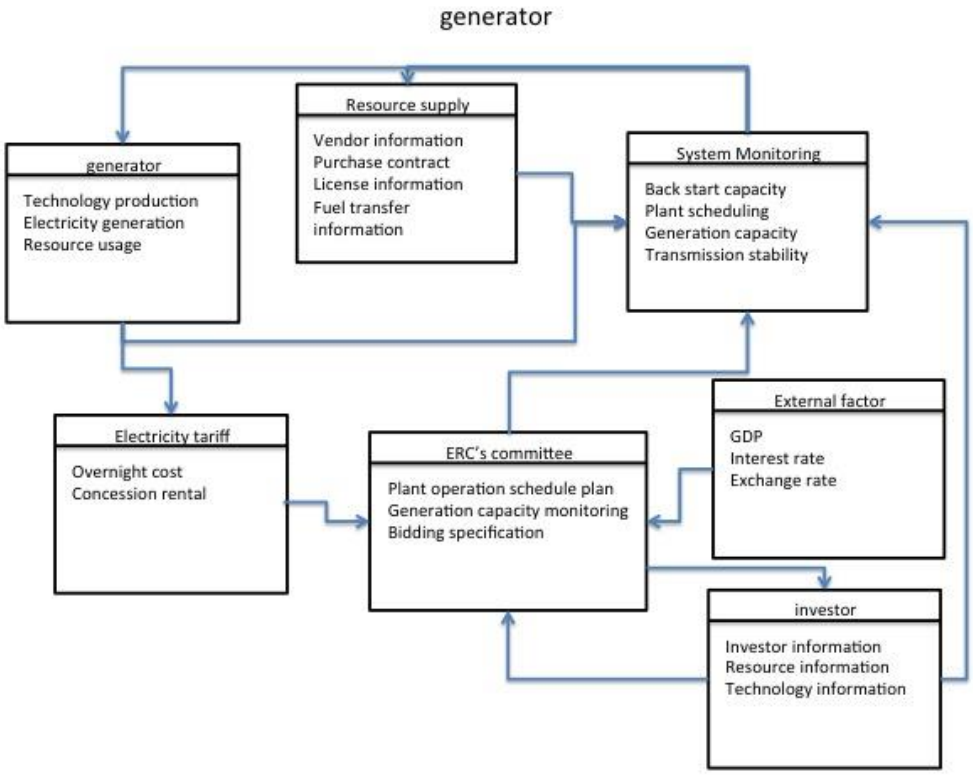

Figure 3.46 CIM for Electricity Regulatory Commission

Based on the CIM above, we see that the information from resource suppliers and generators was sent to the system monitoring and that the results from generation have an effect on the electricity tariff and need to be monitored by the ERC committee. That committee makes decision by using the information from electricity tariffs and external factors and then sends their decision results to the system operator and investors in order to have their work assessed.

Chapter Review

In this chapter, the methodology was applied to create balance scorecard for electricity industry, and use CM1 and CM2 form commonKADs model to identify task and communication between stakeholders. As a result it show that industry task and communication can identify by create balance scorecard for electricity industry.