CHAPTER 1
Introduction

This chapter introduce the foundation of energy since the ancient era which people used energy only for cooking their food, give their light and warm their body, to the current period which energy has necessary in all people life. Moreover, this chapter introduce about the revolution of energy market economies framework and the characteristic of regulatory function that control on Thai energy market, and the problem that they found in this market. After that, it introduces the theme of this research that shows the problem of Thai energy market and the idea to solve it. Then, researcher introduce about the objective and methodology which done with this research, and present the expected outcome that researcher hope to get form this research.

1.1 World Energy History

In the long history of mankind, people know about the power of electricity, which come in the form of lightning from the sky and have power to destroy anything. Most of them believe that is the power of god until ancient people can create lightning rod for protects them. In 2,500 years before B.C., Tuton community who living near Chamberland Sea at the east of Bourtic ocean had discover the yellow stone call “Amber” which have special characteristic as it can absorb the hair shaft with unexplained power. Until the 600 years before B.C., Thales who was the Greece philosopher and scientist claim that when he scrub the Amber with felt can generate some power which can absorb the soft thing such as paper, hair shaft or dust. He gave this unexplained power as “Electron” which came from “Elektra” as the ancient Greece language. In the year 1600, the British scientist name Dr. William Tomas try to proof the solution of Thales by scrub the stone with lather Finally, he found the same result with Thales and call that energy is "Electric" (Daniel Kirschen and Goran Strbac, 2004).

After three hundreds year of founded in Electric, the first power generator was create by American scientist and use for give the light to people who living in the night. Moreover, well-known scientist, Tomas A. Edison, develop the lamp and present to the wildly of people. After that, the electricity becomes one of the main factors of mankind that used in many activities such as transportation, communication, etc. In the first era, most of electricity was generate by the company under governed control, and most of generator was stand near the village. However, the demand to using the energy around the world increase rapidly and governor cannot support all demand, so their make power system become many competitor in the market to support all demand. Moreover, they need to increase side of power generator and find the new energy fuel, which can produce more power while use less sources. By increase the side of power generator, it become in many kind of problem that affect in the wind area such as quality of living of people who live near power generator, affected with air, water environment, and the safety level of village near power generator (Office of the Tasmanian economic regulator, 2011). Although, it become of the theory called "Power System Economics" which can define as electricity's business which focus on balancing between demand and supply of energy market.

On the supply side, energy operator focus on many factors, which affected with electricity generator investment cost? The first factor was the fuel price which concern about the quantity of used fuel to produce one megawatt of electricity power. Technically, the fuels like oil and gas use more units for produce one MW of electricity than nuclear power. The second factor is start time of electricity power generator, which can separate into three levels that are based load generator, reserve plant and peak load plant. The intermediate power generator use fuel like nuclear, oil and gas which use long time to start generator but also can produce much power compare with reserve generator which use short time to run but have many limitation and produce less power generator. The third factor is the technology and quality of power generator, which relate to the level of using fuel to produce electricity. The plant which use newer technology like nuclear can produce more electricity than plant that use older generator like oil and gas (Steven Stoft, 2002).

However, while some new technologies like wind and solar have low electricity cost they also have limitations concerning the investment cost, which is a higher investment than for oil and gas power plants. On the other hand, the factors from the regarding demand are also important and are used by electricity operating planners to estimate the demand level of the user and to improve their short, middle and long term strategic plan to avoid the mistake of producing over the supply demand, leading to high electricity costs. Factors such as Gross Domestic Product (GDP) and Gross Provincial Product (GPP) are also related to the level of electricity usage and show the explanation of the district. The GDP can be defined as the purchasing ability of people in the whole country while the GPP can show the ability to buy products in each province. The other factor that electricity operators need to be concerned with is the exchange rate because it can affect the price of fuel, used to produce the electricity. Based on the effect of the many factors deriving from supply and demand, governments of many countries try to balance multiple supply factors such as investment cost, price, energy (unit) and fuel used with demand factors where energy is needed, gross domestic product (GDP), gross provincial product (GPP), the price of fuel and exchange rates, under the rapid growth of electricity competitors in the market, by setting standards and creating independent organizations to control and adjust the electricity operation plan.

1.2 Overview of Energy Regulatory Market Framework

In Thailand, before the introduction of electricity, Thai people typically used candles to give them light. In the year 1884, Jamuan Wai Woranart first introduced electricity systems in Thailand (Arepo Consult, 2011). First, he used the electricity in specific areas, in his castle, because he needed to prove to his majesty that electricity was necessary for people and could become an important factor for improving the quality of life of people in the country. After that, his majesty also agreed that major energy such as electricity and natural gas would become one of the main factors affecting a large proportion of people in Thai society. For this reason, he established the office to generate electricity for Thai people, named the Electricity Generation Authority of Thailand or EGAT. After 60 years of operation, EGAT has produced electricity and distributed it to people in the whole country via their partners the

Metropolitan Electricity Authority (MEA) and the Provincial Electricity Authorities (PEA). However, they have found that many people encounter many problems in the energy sector, not only in high investment costs of energy operation, which affects the people, but also in some of the problems of operation itself. A major discussion on this topic was presented by Asst. Prof. Naksitte Coovattanachai, a researcher of the National Research Council of Thailand, revealing that in the year 2004, after 60 years of the energy business operations, there were many problems such as the country's commercial energy need was not significant, there were limited indigenous fossil fuel reserves, it had not been able to increase the contributions of the main indigenous energy resources to the country's energy demand, and rising in oil prices was having an adverse effect on the country's economy (Naksitte Coovattanachai, 2006). These problems could lead to serious problems for the energy business, which has high investment costs, and finally affect the end buyer because people would need to pay more for their electricity (Sombat *Sarntijaree*, 2009).

Moreover, before 2008 the electricity costs were regulated by the electricity operator (EGAT), which ran the business under the Thai government. In order to supply energy power to its buyer with reasonable prices, EGAT established one division called the Electricity Regulator to control energy resources and plan the long term strategy of electricity operations. However, this division was under the control of EGAT, so people questioned the honesty and responsibility of this division. Besides that, the oil and gas crisis in the year 2008 caused the high price of oil and gas from Arab countries and it affected many oil and gas importing countries. These situations had major effects on the investment cost of electricity generation because they needed to use oil and gas as the main factor for producing electricity, and many sectors in Thailand claimed that the electricity price seemed to be unfair in their sector when compared with another sector. To avoid this problem, the Thai government tried to make the image of energy operators clearer by announcing the "Thailand Energy Act 2008".

The important content of this Act was intended to promote the independent organization called the "Energy Regulatory Commission" or "ERC" to regulate and control the problems and make the decisions in order to operate the energy business.

This organization has run their affairs under the objectives of making the energy business run under the same standard, with reliability, availability and clarity in every stage of operation while being fair for every interested party (Naksitte Coovattanachai, 2006). Moreover, the main functions of the ERC are to assess the safety significance, to determine the laws, regulations or criteria to be applied, to collect the relevant information and data, to make a well-informed decision, to write a clear decision on this basis and to publish the decision when needed. The ERC comprises two main groups of people working together. On one side are the ERC officers who have the objective to receive information, give advice and control a short, middle and long term energy strategy plan. They also have an objective to send the report to another group called the Boards of the ERC, a group of 8 specialist people, who have the objectives of making the final decision for giving licensee's permission for electricity generation, manage energy funds and promote the activities of the ERC to the public.

1.3 Regulatory Requirement and Research Specification

For the first year after introduce ERC, they have to make the serious decision result on many complex situation. While looking in the main functions of ERC, the researcher found that committee's decision is the important process especially while their make decision because it will be the complex decision which need to use many specific skill for select the best result in term of making the equivalent for every interested people. Though, they need to make the decision from many sources of data that received from their partners in difference time. Moreover, they need to make the final decision in the limited of time, so they use shot time to study and analyse the relate information. The information that ERC get from their partner come from each indicator based on the partner strategic map. However, data which come from each partner cannot use in committee decision because it come in difference format and measurement. Even if each partner, which are EGAT, MEA, PEA and SO, receive the same strategic from the upper department such as ministry of energy, or country development plan, and use to develop their own strategic map. Therefore, the question for this situation is how regulator committee give the best accurate decision' result from many source of data and the limited of time. As the Information System Consultant of ERC, the main problem of

this organization founded by the researcher while work in the organization can separate into many side are as followed:

- Energy regulatory commission (ERC) establish on the year 2008 after 60 years of their partner (EGAT, MEA, PEA), and have objective to regulate the operation of their partner

- It hard to make the decision for balance supply and demand of energy market because committee need to collect information from many sources

- Even if they receive the strategic from same ministry, but they use that strategy to develop their own strategic map and determine the key indicator and report for company profit.

    - Information that come from their partner have both structure and unstructured data

    - Information that send from their partner may have lack of reliability and easy to modify

    - Information may incomplete because it send by many partner, and does not come in the same time

- Energy regulatory committee use that information (both structure and unstructured data) to make their decision.

- Their decision affect with large group of people and stability of energy business

More detail discussion of ERC decision framework is given in chapter 2

By doing this research, researcher justify that if ERC's committee need to set the standard framework to manage the information that come from many source, and can

support the committee to make their final decision .So, it is believe that if the committee have more clearly information for support their decision. It may make their decision more fast and accurate because they need to make final decision and push that final decision result with reasonable cause to their professional partners. Because ERC is the new private organisation, so they need to create the positive credibility to their partner. It may make more benefit not only with image of ERC committee from interested people but also make benefit with general people who pay the electricity cost.

1.4 Research Theme

1.4.1 Research Methodology and Conceptual Framework

By doing this research, researcher believe that new information which comes from ERC's partner combine with existing knowledge (information from action) that input by energy expertise can generate to new knowledge of ERC. This research focus on use of well-known strategic creation tools for setup any related attributes which can identify the measurement and target of each activity on every strategic title. By identify the activities, a selected tool as Balance Scorecard (BSC) was used for help strategic planner to present their overview picture of organization's component and used to identify task, information and responder of each task. Especially for Energy Management System (EMS) which show as a complex system in every country because it relate with many player and country resident, and have many information related on many task on this business. So created BSC for present the structure of whole business that can support any decision maker to have clear strategic vision, while it also show the conceptual modelling which make player who take responsible in difference area can understand not only their business position but also their related task and information on their hand. While BSC present business activities in big picture, the CommonKADs modelling, which one of knowledge management tool, has used for present the list of player and information flow of each activity by use task template and communication model, when task and information of each activities has identified, a Common Information Modelling (CIM) has created and use to present the overview of EMS, and use to support the decision maker and strategic planner to understand the overall picture

of Electricity Supply Industry. Then the new knowledge has used in order to replace the incomplete information from partner. The research idea can be showed in the figure below:

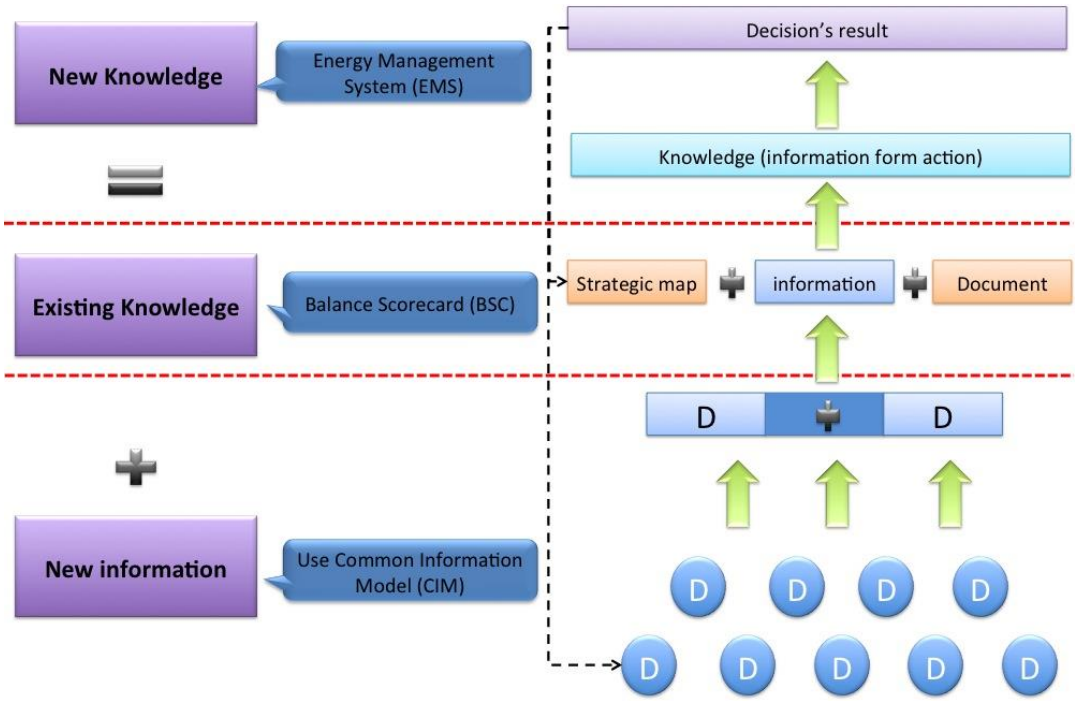

Figure 1.1 Research Idea to Manage Incomplete Information

Normally, the industry economic need to balance their resource on supply side with the resource on demand side even in Electricity Supply Industry that need to produce the electricity and transmit to their customer. Conversely, the side of this industry forces them to separate into many affiliated companies, which are power generator, distributor, transmission line, dealer, system operator and regulator, for hander the difference of business along with electricity's supply chain. Normally, players in this industry can separate in two main type not only licensee but also law enforcement. Firstly is licensee who takes license from government for produce or create electricity to their end user for instance as small power plant (SPPs) and very small power plant (VSPPs) who own generator's license for produce their electricity then sell in their industrial estate area. Another player is law enforcement who takes responsible for manage and control an electricity industry. Most of law enforcement has

operated or take stock over fifty percent of whole stakeholder by the government. The law enforcement in Thailand can identify as Electricity Generation Authority of Thailand (EGAT), Metropolitan Electricity Authority (MEA) and Provincial Electricity Authority (PEA) who take the main part such as main power plant, distribution and transmission line for send the electricity to whole country. Eventually, government achieves them by give the country vision and context policy for set player into same direction, while government also sent an audit committee to check their business operation. Therefore, every player set their own strategic theme to support the country vision, but the content deep into their strategic title has their individual activities in order to make their maximum profit and can answer only the requirement of audit committee. It seem that strategic map which set to support only the answer of audit committee has not enough efficiency because every player set their activity to make their maximum profit, so it cannot find the way to manage the profit of whole industry which limit the industry profit at one point two percent plush three percent of interest. If this industry cannot limit their profit they usually push their obligation to their customer who need to pay for their lost, and it will reduce the government image. Moreover, it cannot support the Gross Domestic Product (GDP) which is the important vision of the whole country because people need to pay their unnecessary expense to support the inefficient management of any industrial player. Consequently, this thesis has theme to design Energy Management System by use common tool as Balance Scorecard (BSC) with the purpose of identify any related attribute, formerly also can identify the target and measurement of each attribute which can specify the player and information of every task that related in this industry. Afterward, the Common Information Model (CIM) has used to design Energy Management System for support the same direction to every player by reduce an unnecessary expense for their customer, and also can support the upsurge of country GDP though limitation of industry profit ratio.

Therefore, researcher claims the hypothesis of this research that incomplete information can acquire from expertise's experience and some documents. The second is to managed incomplete information can help committee to make no unreasonable risk, and can make risk as low as reasonably, and by Managing incomplete information,

it can improve the decision's result, make decision more fairness, and save time of decision making. Therefore, the research methodology has designed in the figure below:

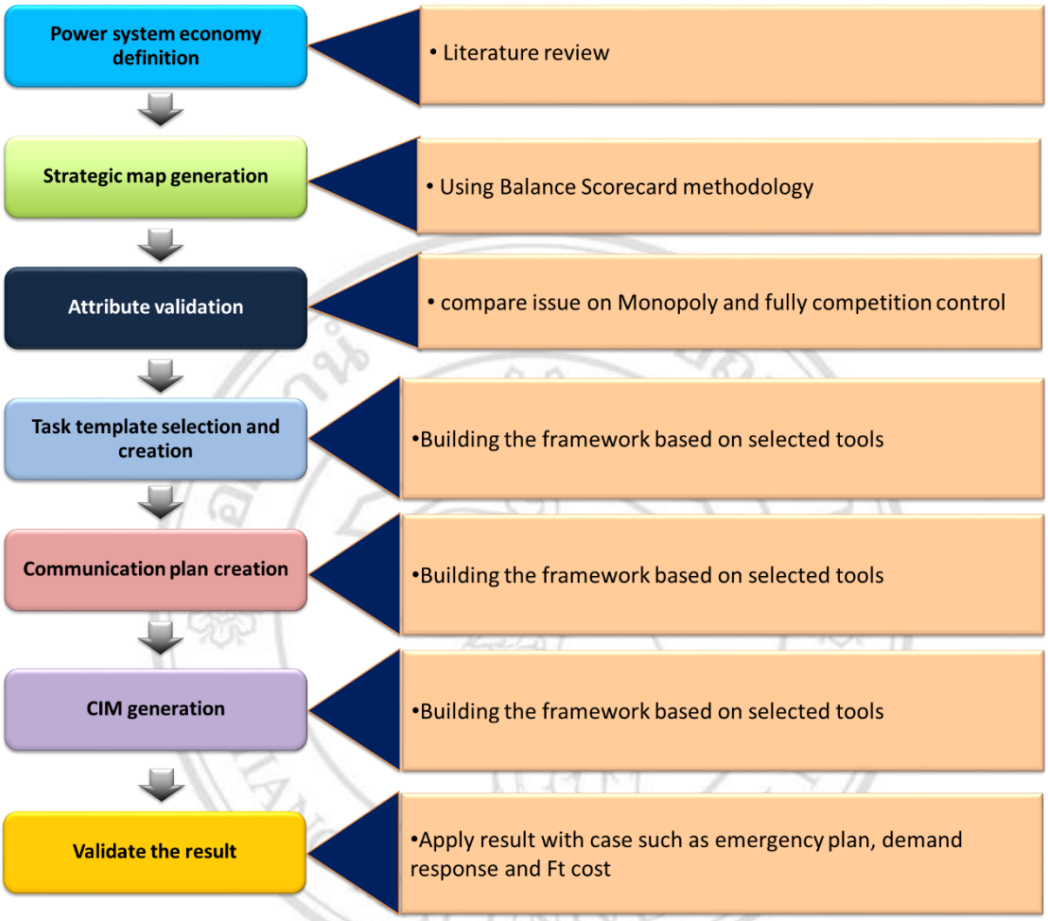

Figure 1.2 Research Methodology

Based on the figure above, researcher firstly start from analysis the energy market by study in the balance score card (BSC) of each partner from governance such as ministry of energy to independence organization such as EGAT, MEA or PEA for analysis and compare amount the important factor which organization has concern, and generate the balance score card which match with Energy Regulatory Commission (ERC). After get the important factors in every side of ERC's BSC, each attribute has validated by the researcher, and bring those factors to match with information that send from ERC's partner in order to see the redundancy and sending period from their partner. Meanwhile, researcher analyst the relationship of task and information flow

between each partner. By analyst the task and information work flow, researcher use information and knowledge management tools such as CommonKADS to design the task template and information plan, and use this template to identify the factor for find the accuracy of each factors based on shot, middle and long term of strategy plans.

1.4.2 Research Objective

In order to complete this research, the researcher set the objective are as follows:

- To develop online economic modeling framework for ERC to use in its decision making activities.
    - To discover the method for manage incomplete information.
    - To prove that information which provide by knowledge database can replace in blank information from report.
- To suggest that the risk in decision-making can reduce by manage incomplete information, and prove that managing incomplete information can improve the ability of committee to make better decision.
- After that, the researcher set down the scope of this research to cover the effect of the decision on groups of people and the research will be limited only to the method to manage both structured and unstructured information, and will not go into the process of using that information to help the committee in making decisions.

1.4.3 Research Outcome

The outcomes of this research can defined are as follows:

- Clear information flow can improve the committee's decision accurately.
- Accurately decision can improve the balancing between supply and demand of electricity business.

- Decision result under improving information flow can generate new knowledge
- New knowledge can support the risk for incomplete information and make more accurately in short, middle and long term energy strategic plan.

1.4.4 Research Novelty

The novelty of this research is as follow:

- Create ESI Balance Score Card (framework)
- Generate information exchange framework for major parties in ESI using communication model especially for electricity industry.
- While expression in organization structure, it seem that data come into organization process form many type, and user who use that information can separate them into two main type not only the structure data which can identify as data on formal format such as cash flow, inventory tangible asset, databases but also can separate to unstructured data which can count as eighty-five percent of all data in organization and it come from intangible format such as document, email, task schedule, meeting minute or video & audio conference record. Therefore, it can contend that unstructured data which are largest part of data in organization need to managed and transfer its format to structure data for easily to present to any stakeholder in business. By focus on the structure data side, it present the data which come into tangible format and can present in the graphical picture that everyone can easily to understand. However, Energy Management System (EMS) which use by Electricity Supply Industry was work on only structure data which can count as fifteen percent of all data in organization. So this thesis present an idea to manage incomplete information by use CommonKADS methodology which provide task template and communication plan creation process to design EMS for receive unstructured data and present it with structure data by use IEEE standard for power system economic call Common

Information Model (CIM), and present it as Unified Modeling Language (UML) of EMS. Finally, it can make benefit to every stakeholder in organization to easily understand their business in order to make the right decision in the right time.

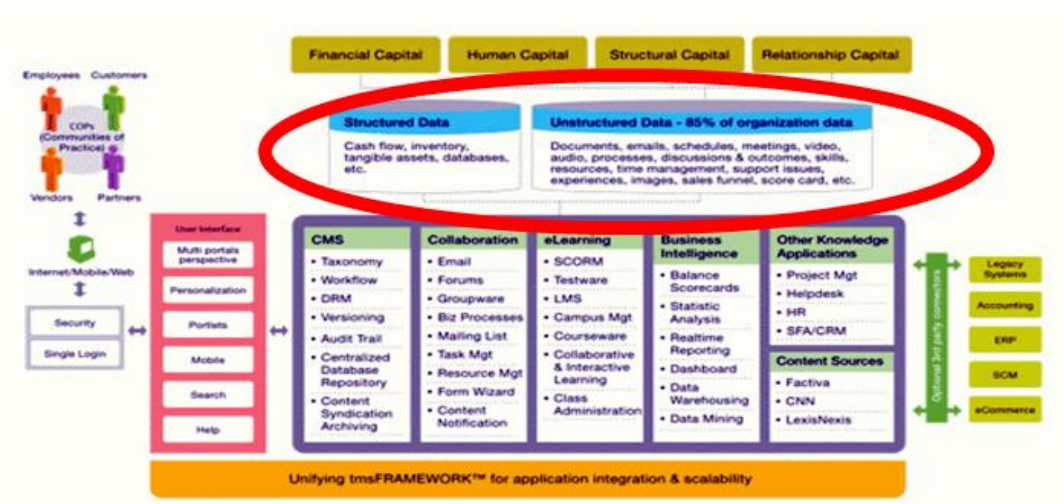

Figure 1.3 Manage Both Structure and Unstructured Information

1.5 Defining Electricity

In general term, the electricity industry can separate in many functions that make up electricity delivered to their customer. It start from the made up of electricity then transport to distributer via transmission line. After that the distributer serve the electricity to their end-user by use their distribution line in each area. Moreover, the electricity system industry (ESI) needed to control by system operator (SO) to secure the short-term balance, security and reliability of the system, and other associated service such as construction or maintenance. The main functions can define are as follows:

- Generation

  To generate the electricity, generator needs to concern many things. Firstly, they need to concern in demand of their end-user, which change in the various time horizons that change in a day, a year, or in the business cycle.

The other special feature that they need to concern is electricity cannot be economically stored which means the generation capacity needed to equal with peak demand and partly unused in periods of lower demand, and the reserve capacity has been required to cope with random demand fluctuations or generation shortfalls. The other point is a diversified portfolio of electricity generating technologies is needed to provide the different loads of electricity with lest cost based on the vary of the cost of electricity production that characterize by a merit order of generating plant with high capital intensity, technical and economic longevity included with long lean and construction time.

- Transportation: Transmission and Distribution

  After generator produce electricity, their send the electricity to their buyer by used electricity transmission that is the very high voltage line. It refers to transportation over an interconnected network, which shared by all end users. The transmission line also call network externalities that benefit to all interconnected partied by increasing reliability and security to reducing the cost of generation which may result in the additional value of investment in grid augmentation being reduce by successive investment, and there are system-wide economies of scale as in the case of distribution. However, transmission line is own by monopoly because it may run two transmission line in parallel for connect through the several paths for increased reliability, so it means that transmission service can be provided by different owner within a single interconnected network in general. On the other hand, distribution refer to the transportation from the interconnected network to a specific group of end users which often considered a natural monopoly since duplication of distribution line would be inefficient due to the large fixed cost of the investment.

- End user supply

  End-user supply refers to the delivery of electricity to end-users. It includes the procurement of energy and transportation services, and the metering and

billing consumption. They perform with two functions, which are act as the broker who buy and sell energy which try to make a profit from assuming the risk of price volatility and from adjusting price to consumption patterns. End user supply can also made the competitive by using the "value-added services" like supplying differentiated electricity such as green energy, or packing electricity such as serve electricity with another utility service such as gas.

- System operator

  System operator can be define as the operation controller who maintain the level of transportation service to ensure that the system operate constantly and maintain the electrical equilibrium which means power supply should equal to the power demand at each node of the network by controlling inflows and outflows of energy over the network. The scope of system operator can be changed from the regulatory framework which regulate the decision that made at the time of delivery always control by the system operator, while the decisions made in the emergency time can be made either by the system operator or market participants. Moreover, the information technology is the important part to help system operator to make decision faster and accurately. In generally, system operator should give monopoly control over the system because the benefit of increased reliability and lower costs are only possible under a centralized system operation.

- Related service

  For the general feature of electricity system industry, the generation, transmission, distribution, end user supply and system operator are the important feature. However, ESI was expand wildly and have more complex structure functions which can reduce the cost of investment that can gives way to a number of different and more specialized of market player. In order to have many players in the market, ESI need to find some more function to reduce their risk. The function such as financial service can make up their

benefit that offers by a growing number of power exchanges between countries.

Table 1.1 Function Structure of The ESI

Function	Key Economic Characteristic	Implications
Generation	• Limited scale economies at plant level • Co-ordination economies at system level • Complementarity with transmission	Potentially competitive
Transmission	• Network extremities • In general not a nature monopoly • Large sunk cost	Investment incentive need special attention One grid but possibly several owner
Distribution	• Often a nature monopoly • Large sunk cost	No competition
System Operation	• Monopoly (due to technical constraints)	No competition
End user Supply	• Limited scale economies • No special features	Potential competitive
Related Services: • Power Exchanges • Financial construct • Construction and maintenance of assets	• No special features	Potential competitive

Table 1.1 shows the economic characteristic separate by each electricity industry function for present the correct type of each function. For example, the generation should have its characteristic for indicate the operation at plant level and focus to measure of connection between it generator and the transmission system, while the transmission and

distribution need to focus on the risk on cost of its future investment. Meanwhile, the end user supply and other relate services need to concern on the level of competitive that may affect with the system stability and interruption of electricity industry.

In order to make ordinary people to understand every arguments in this thesis because electricity industry has complexity industry and uniqueness which only technical player can understand the word description. Moreover, it has many players in this industry that may not stretch the description of one technical term in the same way. Hence, the technical term for the whole electricity industry has described in the following table.

Table 1.2 Description for Energy Management System

vocabulary	description
Based load	The minimum generating capacity that ESI can supply their electricity to support their customer.
Black-start capacity	The ability of electricity generation from available generator which can produce the electricity to support electricity grid in case of peak load.
Capacity factor	The ratio that generator can produce electricity in the period of time
Competition	The process that happen when two or more player try to reduce price of their production and present to buyer to sold their produce.
Competitive equilibrium	The point that generator can supply electricity to their customer while production in minimum.
Competitive market	The status on perfect competitive is happened.
Contingency	An unexpected situation which come from failure case of system.
Cost of production	The cost of produce one watt electricity which can calculate from fixed cost, variable cost, average cost, marginal cost, startup cost and no-load cost.

Table 1.2 Description for Energy Management System (Continued)

vocabulary	description
Demand	The amount of electricity that customer used in one period of time. The demand normally tracks by system operator in second-by-second to avoid system failure.
Demand elasticity	The balance of electricity demand and its sell price.
Efficiency	The moment that production cost of electricity has minimize.
EGAT	Electricity generator which own by Thai government. They take responsible to generate electricity to support whole country business.
Energy	The electricity that flow form generator to customer passing distribution and transmission line in a period of time.
Energy Management System (EMS)	System that identify task and information in electricity industry which used for identify player in each task.
Energy regulatory commission (ERC)	Electricity regulator in Thailand.
Electricity Supply Industry (ESI)	Group of player that responsible to generate the electricity and transmit to their customer.
Electricity tariff	The way which uses to calculate electricity cost that setup by government and regulator.
Forward contact	The agreement between generator and resource supplier in order to commit the future resource delivery to generator.
Financial withholding	The moment that production price come above market marginal cost.

Table 1.2 Description for Energy Management System (Continued)

vocabulary	description
Force outage	The order to shout down generator production or stop transmits electricity at one period of time.
Grid	The structure of transmission network in one area.
Incremental cost	The unnecessary cost that producer need to avoid from produce the electricity.
Installed generating capacity	The maximum level of electricity (MW) generation which come from all plant in country.
Interchange	Electricity that flow from one grid to another grid.
Kilo	The meter which use to measure the 1000 k of electricity.
Load	The quantity that customer use electricity form electric system.
Load factor	The gap between average load and peak load in a period of time.
Load shedding	The process to reduce electricity load from some area of customer to avoid system outage.
Marginal cost (MC)	The cost that come after variable cost and gives the variable cost curve is not smooth.
Market price	The price for electricity that government allow dealer to sale to their customer.
Market architecture	The map to show every player who responsible in every part of industry.
MEA	Player who take responsible for transmits electricity to their customer in Bangkok area
Monopoly	The situation that have only one player to control the market, so they can control the production price
Operating reserve	The plant that shout down while demand is low and can start up itself in shot time by order from system operator.

Table 1.2 Description for Energy Management System (Continued)

vocabulary	description
Optimal power flow	The cost of electricity dispatch which come from power transmission constraints.
Outage	The situation which happen and cause power system to shutdown at one period of time.
Peak load	The highest level of electricity use at one time a day.
Peak load plant	The plant that use high level of resource cost such as clued oil, which may affect with electricity cost when start-up.
Plant scheduling	The process of system operator to open or shutdown the power plant for balance electricity demand and supply.
Power	The electricity that flow from one area to another area.
Power system	Electricity system that include all player in supply chain such as electricity generator, distributor, transmission and dealer.
Price spike	The moment that electricity price increase from order of system operator who order to start-up expensive power plant.
Profit	The cost that come from transfer electricity to customer as smooth as possible.
PEA	Player who takes responsible for transmits electricity to their customer in every province except Bangkok.
Perfect competition	The situation that has many players in the market, so they try to reduce product cost to persuade their customer to buy product with them.
Regulator	Independence corporation who take responsible to regulate electricity market.

Table 1.2 Description for Energy Management System (Continued)

vocabulary	description
Reliability	The situation that player can produce and transmit electricity to their customer within suitable cost.
Risk	The situation that can happen on the future and player need to identify some plan to solve that problem.
Spinning reserves	The amount of electricity generation that can produce to serve surplus demand.
SPPs	Small power plant who own small side of power plant, which can produce electricity around 50 – 10 MW and normally use renewable resource for produce the electricity, that produce the electricity and sold to electricity grid.
Surplus	The gap between value of electricity production and its quantity to transfer to their customer.
System Operator	Player who take responsible to control electricity generation level, and manage plant scheduling.
Unit commitment	Quantity of electricity that one power plant commits with system operator when they start to produce the electricity.
Unit commitment	The amount of electric power that generator commit with dealer
Value of lost load (VOLL)	The cost of electricity that cannot transfer to their customer.
VSPPs	Player who own very small power plant like household solar system which can produce electricity to use by themselves and sold to electricity grid if available.

1.6 Glossary

1. Energy Regulatory Commission (ERC) is the group of selected people who have objective to control overall operation in electricity system on Generation, transmission, Distribution and retail.

2. Decision Support System (DSS) is the computer system which use to support the decision making of any individual or group of people

3. Knowledge Management (KM) is the comprises a range of strategies and practices used in an organization to identify, create, represent, distribute, and enable adoption of insights and experiences for professional worker give to next generation of the worker

4. Knowledge Engineering (KE) is the techniques, which use to capture knowledge from professional worker and present in touchable structure.

5. Ontology is one of Knowledge Engineering technique, which uses to design and present the data flow of organization into layer structure.

6. Common Information Modeling (CIM) is another one of Knowledge Engineering technique, which uses to present the difference information structure in organization in same and easy to understand format.

1.7 List of Publication

1. Energy Management System by using Balance Scorecard present SKIMA 2012 conference at Chengdu university, Chengdu, China

2. 3D Energy Framework Strategy by Balance Scorecard published in Life Science Journal 2014; 11(2) page. 209-220

3. Alternative Design Approach for Energy Management System published in Life Science Journal 2014; 11(2) page. 221-234

1.8 Thesis Overview

Chapter 2

This chapter shows the revolution of energy regulation from its foundation in the world and its coming to Thailand. First, it shows the development of energy regulators in many countries like the United Kingdom, the United States, etc. where it changed from deregulation to regulation, then the researcher compares and analyses the problems that occurred within those countries. Moreover, this chapter also explains the type of competitive markets not only for normal business but also for the energy regulatory business. After that, the researcher presents the revolution of the Thai energy market and the problems that occurred before and after introducing the energy regulation commission The researcher then shows the literature review of the tools that the researcher selects in order to analyze and control the Thai energy regulatory market framework in this research. The final content of this chapter presents the best framework that the researcher can recommend to the Thai energy regulatory framework.

Chapter 3

Because the decision making procedure is an important process of every organization, so this chapter presents the structure of the standard of organization and the relationship of decision levels, which relate to many levels of the organization's workers. Then, it explains the type of decision-making and the tools, which relate to decision-making, called the decision support system (DSS). After that, it presents the analysis of important factors that relate to decision-making for energy regulation and affect the strategy, development and planning of the Thai energy market. The end of this chapter presents the predictive model of Thai energy regulatory markets based on the expectation of decision factors, process workflows and market frameworks.

Chapter 4

This chapter presents the demonstration process to find the accuracy of the recommended framework, which is designed in chapter 3, and applied in two important cases, Ft costs and electricity license agreements, on which the energy regulator committee make decisions regularly and the result of those decisions regarding their

effect on many people. The researcher starts by defining and specifying the important decisions' factors, relating to each case, and apply them to the workflow simulation. This action is used to test that the framework recommended by the researcher can help the regulatory committee make decisions more accurately and limit the risks and mistakes, which happen as a result of the decisions.

Chapter 5

This chapter presents the demonstration results from the simulation in chapter 4, showing the accuracy level of the results. Moreover, it show the comparison of decision results from the regulatory committee both before and after the changed framework, and recommends the benefits of the framework, which affects the decision levels in long, middle and shot term electricity operation plans.

Chapter 6

In the last chapter, the researcher presents the conclusion of this thesis, which shows the way to apply the new model to optimize the Thai energy regulatory framework. This chapter also presents the pros and cons of the results and proposes future action; as the researcher offers the thesis to discussion regarding the future develop of this topic.