RDF Waste Power plant in Rayong Province : A Model for Community Sustainable Environmental Friendly RDF Waste Power Plant

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Abstract

The research aimed to study on social and environmental success of RDF waste power plant project in Rayong province and to analyze mechanisms and factors affecting social and environmental success of RDF waste power plant. Qualitative data analysis was conducted by documentary research, relating to the comprehensive solid waste management of the RDF Waste Power Plant in Rayong Province, Code of Practice (CoP), implementation of pre-construction to date in social and environmental aspects and interviews from representatives of RDF waste power plant, The data were analyzed in accordance to the issues of the assessment in Social and Environmental to identify important issues that affected the success of acceptance of people. The lesson learned from the gathered information concerning the waste management leading to the improvement and solution of community waste problems that enabled effectively of the environmentally friendly process.

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The results of the study was found that mechanisms and factors affecting the success of social and environmental operations of RDF waste power plant, 1) Cooperation with the sector in Thailand was possible for the management of specialized knowledge of the private sector; it was feasible to drive the project in efficient manner, as well as verifiable, 2) It was in accordance with the principles of good governance by having a waste learning center based on transparency and public participation, 3) Clear communication and consistency including employing local people would enhance and create opportunities for people in the neighboring area around the RDF waste power plant.,and 4) Consistent environmental impact assessments.

Keywords: RDF waste-to-energy power plant, Environmental Management, Public participation, Rayong Province

โรงไฟฟ้าขยะ RDF จังหวัดระยอง : ต้นแบบของโรงไฟฟ้าพลังงานขยะที่เป็นมิตรต่อสิ่งแวดล้อมที่ยั่งยืนในชุมชน

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บทคัดย่อ

การศึกษามีวัตถุประสงค์เพื่อ ศึกษาความสำเร็จของการดำเนินโครงการโรงไฟฟ้าขยะ RDF จังหวัดระยองและวิเคราะห์กลไกและปัจจัยที่มีผลต่อความสำเร็จของการดำเนินงานด้านสังคมและสิ่งแวดล้อมของโรงไฟฟ้าขยะ RDF จังหวัดระยอง ผ่านการวิเคราะห์ข้อมูลเชิงคุณภาพโดยศึกษาเอกสาร (Documentary Research) ที่เกี่ยวข้องกับการจัดการขยะมูลฝอยครบวงจรของโรงไฟฟ้าขยะ RDF จังหวัดระยอง ประมวลหลักการปฏิบัติ (Code of Practice: CoP) การดำเนินการโครงการก่อนการก่อสร้างจนถึงปัจจุบันในด้านสังคมและสิ่งแวดล้อมผ่านการสัมภาษณ์จากผู้แทนจากโครงการศูนย์กำจัดขยะมูลฝอยรวมแบบครบวงจรจังหวัดระยอง โรงไฟฟ้าขยะ RDF และนำข้อมูลที่รวบรวมได้ถอดบทเรียนในการบริหารจัดการขยะครบวงจรแห่งแรกในระยอง ที่นำมาสู่การต่อยอดและแก้ไขปัญหาขยะของชุมชนได้อย่างมีประสิทธิภาพ และเป็นมิตรกับสิ่งแวดล้อม 1) การร่วมมือกับภาคเอกชนในไทยมีความเป็นไปได้ในการบริหารจัดการองค์ความรู้เฉพาะด้านของภาคเอกชนสามารถขับเคลื่อนโครงการได้อย่างเป็นปกติและมีประสิทธิภาพสามารถตรวจสอบได้ 2) ตามหลักธรรมาภิบาลโดยการมีศูนย์การเรียนรู้สร้างความโปร่งใสและการมีส่วนร่วมของประชาชน 3) การสื่อสารที่ชัดเจนถึงความสม่ำเสมอและเกิดการจ้างงานคนในพื้นที่

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เป็นการเสริมสร้างด้านสร้างโอกาสแก่ประชาชนในพื้นที่รอบโรงไฟฟ้าขยะ RDF 4) การตรวจสอบประเมินผลกระทบด้านสิ่งแวดล้อมที่มีความสม่ำเสมอ

คำสำคัญ: โรงไฟฟ้าพลังงานขยะ RDF การจัดการสิ่งแวดล้อม การมีส่วนร่วมของประชาชน จังหวัดระยอง

Introduction

With the increase of population, production and consumption, the arisen problem is urban garbage overflowing. In addition, dumping or ineffective waste management leads to many environmental problems. Water, soil and air pollution have been caused by non-gathered or non-disposal of waste that were left in the community areas (Pollution Control Department, 2019). The government has been aware of the problem of solid waste management, especially plastic waste management and sea waste issue. There was a campaign for solid waste management policies, such as plastic waste management Road Map. Building of collaborative networks between the public and private sectors, including community solid waste management plans "Clean Province" is an option to focus on solid waste management comprehensively from upper, middle and lower stream. The alternative ways of waste disposal were using fuel waste or Refuse Derived Fuel (RDF). The presentation of idea for effective community waste disposal allowed reduction of environmental problems and pollutions. One option was to convert community waste into fuel through variety of processes under the government policies; Alternative Energy Development Plan 2018-2037 (AEDP 2018) to generate power by community waste for 800 MW in 2037. Operating a waste power plant becomes an interesting choice today by transform waste into energy for power generation, including alternative power as well as solving the issue of urban waste overflowing. However, amid the objection for building waste power plant that caused the concern of people on the production process such as waste odor, waste water that might enter natural water sources, including objection of RDF waste power plant construction in many areas. However, there was no objection to the standards of social and environmental management, due to efficient e Environmental management; before the operation, there was the survey for opinions and evaluation of environmental quality. According to the study on social and environmental aspects of the integrated waste disposal center in Rayong Province under the RDF power plant project, they could accommodate in communities and manage waste effectively by treating 500 tons a day. In the process of energy production, RDF could be converted into waste fuel and sustainable environmentally friendly. Therefore, researchers are interested

in studying and have the lesson learning for operation of RDF waste power plant, in terms of society and environment, that enabled the community acceptability and accommodation with the local community as well as using as the guideline for waste disposal development and production of RDF waste power in other areas.

Purpose of study

1) To study the social and environmental success of the RDF waste power plant project in Rayong province.

2) To analyze the mechanism and factors affecting the social and environmental success of the RDF waste power plant in Rayong province.

Literature Review

Code of Practice (CoP); for the project Waste-to-fire thermal power plants with an installed capacity of less than 10 MW for measures to prevent, rectify and monitor environmental impacts, safety, as well as potential impacts on nearby communities of the power plant, covering from the preparation phase, the construction phase, the operation phase and the demolition process of buildings, machines, or equipment. Participation and opinions expression on the project implementation from the beginning of the project and the CoP report is opened and used as a supporting document for obtaining a license to operate the electricity business. (Energy Regulatory Commission, 2016)

Public Participation; there are a variety of techniques used to create public participation by categorizing the techniques of public participation into 2 types, with details as follows; (Jutarat Chomphan, 2017) 1) Techniques for providing information on good public participation must consist of planning for good information dissemination to the public, in order that people can be fully aware of information and important issues, 2) Participation Techniques when people receive complete and appropriate information, the next step is to set up a platform so people can express their feelings, or opinions to decision-makers appropriately, such as in group discussions, opening a hotline, interviews, hearing meetings.

Good Governance is the main idea base for management and operations to build stability for the organization and treat stakeholders fairly, good management supervision management which can be used for both the public and private sectors. The Good governance, proposed by the Office of the Prime Minister, consists of 6 principles: 1) Principles of Integrity 2) Principles of Rule of Law 3) Principles of Transparency 4) Principles of Participation 5) Principles of Responsibility 6) Principles of Efficiency and Effectiveness. (Office of the Civil Service Commission, 2009)

Social impact assessment (SIA) is the basis for the process of assessing educational social impacts and forecasting the social impact of a project on people, communities and people's way of life through the process of analyzing, forecasting, assessing the impact and management of both direct and indirect impacts on humans and the environment of the planned intervention. All processes of social change that arise from those interventions which leads to sustainability and equality in bio and environment including the culture, traditions and beliefs of the people in the community as well as presenting measures to reduce the impact, prevent and reduce negative impacts on communities and livelihoods. (Dej Wattanachaiyingcharoen, 2010)

Waste fuel or Refuse Derived Fuel, commonly known as RDF, refers to solid waste that has undergone various management processes such as separating combustible materials, tearing or cutting the solid waste into small pieces in order to improve and convert the waste into solid fuel with properties in terms of heating value, humidity, size and density suitable for use as fuel for generating electricity in solid form.

Table 1 Showing the type of fuel waste (Refuse Derived Fuel)

Type	Characteristics and production methods of fuel waste	combustion system
RDF-1 MSW	Separating the combustible waste with its original size of the garbage.	Stoker
RDF-2 Coarse RDF	Separating burned waste and crushed or coarsely cut the garbage.	Fluidized Bed Combustor, Multi-Fuel Combustor
RDF-3 Fluff RDF	Separating burned waste and crushed or cut until 95 percent of the waste is smaller than 2 inches.	Stoker
RDF-4 Dust RDF	Segregating the burned waste through the process to be in the form of dust	Fluidized Bed Combustor, Pulverized fuel Combustion
RDF-5 Densified RDF	Separating burned waste through the compaction process, forming into bars, cubes, or, pellets, etc.	Fluidized Bed Combustor, Multi-Fuel Combustor
RDF-6 RDF Slurry	Segregating the combustible waste through the process of being in a slurry form	Swirl Burner
RDF-7 RDF Syngas	Segregating the combustible waste through the Gasification process to produce syngas useable gas fuel	Burner, Integrated Gasification Combined Cycle (IGCC)

Source: Bureau of Waste and Hazardous Substance Management, Department of Pollution Control, 2018

Method

This study was qualitative research by studying related documentary research on the integrated solid waste management of the RDF waste power plant in Rayong Province, the Code of Practice: CoP, the pre-construction project implementation until the present, and the interviews with representatives from the provincial Integrated Solid Waste Disposal Center in Rayong Province and the nearby communities of the Integrated Solid Waste Disposal Center in Rayong Province, community leaders and people in the area of Nam Kok Subdistrict, Thap Ma Subdistrict, Map Kha Subdistrict and Nong Tapan Subdistrict. The collected data was analyzed according to the assessment aspects on Social and Environmental issues in the Integrated Waste Management Project of the RDF Waste Power Plant, Rayong Province, were analyzed through PDCA method in order to identify the important issues affecting the success of building public acceptance.

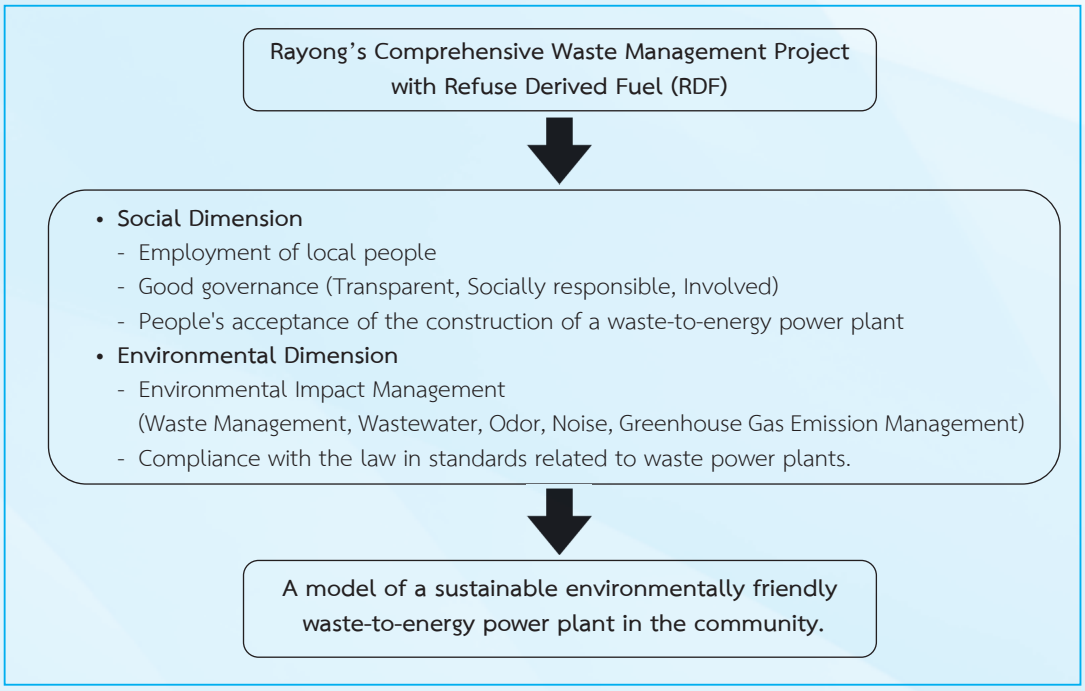


Figure 1 Research concept diagram of the RDF Waste Power Plant Project, the Integrated Solid Waste Disposal Center, Rayong Province Source: author

The research concept of the RDF Waste Power Plant Project of the Integrated Waste Disposal Center in terms of social dimensions was conducted by using the social dimension analysis topic, employment of people in the nearby area of the community waste power plant, Good governance of the project with the communities that builds a reputation for trust, social responsibility and participation through providing opportunities for people in the area. The environmental dimension is an important dimension as it is the one that is in concern of many parties about the impact that may occur in the management of environmental impacts on waste, waste water, odors, noise and greenhouse gas emissions, due to the incineration of waste fuel that occurs in the production process and compliance with the law in measures related to waste-to-energy power plants. In this regard, the Integrated Waste Disposal Center, RDF Waste Power Plant, took the lessons from management in terms of social and environmental dimensions, to create a model of environmentally friendly waste power plants that are sustainable in the community.

Summary of research results

Company information of Refuse Derived Fuel (RDF) Powerplant project

Rayong Provincial Administrative Organization has collaborated with Global Power Synergy Public Company Limited to operate a comprehensive solid waste disposal center project in Rayong, located in the areas overlapping 4 sub-districts, comprising Nam Kok Subdistrict, Thap Ma Subdistrict, Map Kha Subdistrict and Nong Ta phan Subdistrict. For a comprehensive waste disposal center consists of a waste sorting plant and converting into Refuse Derived Fuel (RDF) and a waste incineration plant that generates electricity with a capacity of 9.80 megawatts, with the capability to dispose 500 tons of waste per day, covering an area of approximately 429 rai. The investments for the construction of the incinerator system entirely derived by GPSC investment. This allows Rayong Province to be able to dispose all waste and to support the amount of non-hazardous industrial waste in Rayong that is about 50 tons per day, which will make Rayong Province free from waste problems from both the community and the industrial sector for at least 20 years, promising for safely and sustainably solving the waste problem in Thailand. This project was an investment in the form of public-private partnership (PPP) which helps the government to save budget and speed the project progression, which will lead to capability in completely and sustainably solving the waste problem, and also operation in accordance to international standards, with no more smell, pollution nor environmental impact, resulting in the acceptation from the surrounding community which will be a model for other provinces to be applied across the country. (Rayong Provincial Administrative Organization, 2019)

The area of the Integrated Waste Disposal Center, Rayong, consists of a waste separation project, Waste-to-energy power plant; Rotary Kiln incinerator system that works continuously for 24 hours. Under the environment principles, air pollution is monitored, from the process of collecting to the transmission of infectious waste into the incinerator system. There is a follow-up operation in every step to prevent the spread of germs. For the big problem of organic waste mixed with community waste, since it was wet waste,

weighing more than other elements, which the landfill option would cause odor problems, so it was instead solved by putting sorted organic waste into biogas fermentation system which was a closed system, so there was no disturbing smell and could be used to generate 1 megawatt of electricity as a renewable energy to be used within the integrated solid waste disposal center as well as having a by-product Sludge from fermentation that could be used as a soil improvement material returning to the surrounding communities. Moreover, there is a waste management learning center within the center that is equipped with modern technology in providing knowledge on waste to electricity for those who are interested, including staff from the center from student personnel from the community around Rayong Integrated Waste Disposal Center.

Power production and operation, environmental management measures and living together with the community.

social

In terms of society, the analysis of RDF waste power plant project and the comprehensive waste treatment center was conducted before construction. It was required to make good understanding in the four zones through communication for the purpose of construction, analysis and evaluation of the impact of housing and community life to open for community participation in accordance to the theory of community participation. Employment of people to work in the power plant waste sorting plant, and coffee shops. It is considered as a kind of social dimension that can build the trust of the community and society around the RDF power plant. This leads to social transparency and responsible social activities through continuous social campaigns, exchanging views and support as well as needs of people and the creation of new career through projects operation. For the people acceptation and participation on RDF power plant construction, the process of understanding and communication was conducted in 4 Sub Districts in 5 forums in the understanding stage of RDF power plant project through explanation of the village head, then there was the stage of opening for public opinions and informing the Cop guidelines for biomass, and solids, not exceeding 10 MW., as well

as continuously identifying solutions to social problems through online 24 hours. In addition, the solution to the theoretical problem was conducted through the PDCA method. As the power plant is not a short-term project, it is need for the vision for communities to sustainably go along with the power plant. Planning to provide good information to the community so that the community can fully understand the information and problems on health and safety around the plant and the use of hazardous chemicals, as well as to ensure the work efficiency of plant by focusing on communication with people in the areas.



Figure 2 Zero Waste Village , Rayong Province Source: Rayong Provincial Administrative Organization,2021

Environment

On the course of environmental impact management, in the construction process, environmental impact assessment was done by inspecting the quality index before construction at the nearby communities in the aspects of garbage, waste water, smell, noise and greenhouse prose which probably caused by RDF power plant construction. The possible management and solving guideline are as follows;

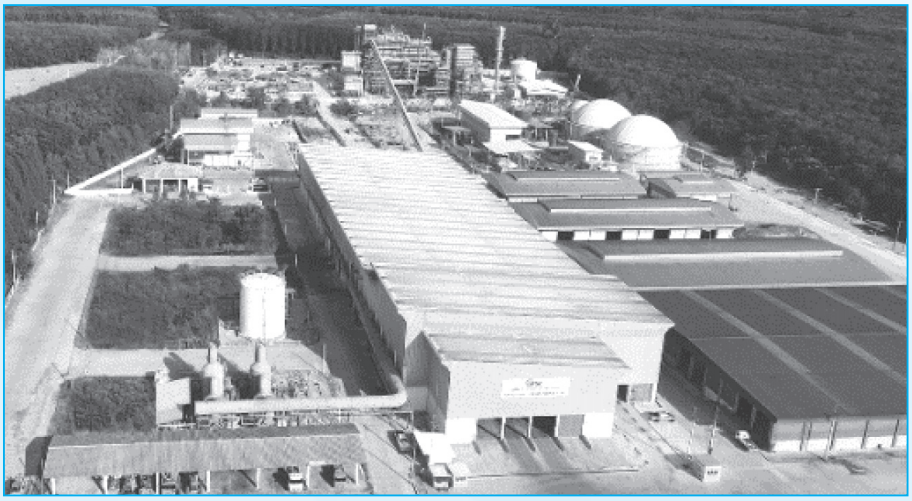


Figure 3 Overview RDF Waste Power Plant Project, the Integrated Solid Waste Disposal Center, Rayong Province Source: Rayong Provincial Administrative Organization,2021

1) Waste Management: under the clear management practice or guidelines, if we can manage waste to create value by transforming it into energy; with our long-term vision of how to manage waste that is increasing every day, how to accommodate the power plants and environment to go along with the communities. One solution is to have an efficient waste management center for waste management and care, from the source to the destination. The by-products obtained through waste sorting is that each type of waste derived by municipal waste can be converted into RDF solid fuel, while organic municipal waste or waste that can be recycled and sold. This will increase efficiency. However, there may still have environmental impact. The possible solution is to design a closed room for garbage disposal with a door blocking between the waste pick-up pits garbage and the yard that the car runs into to dump the garbage into the pond. The areas must open only for the garbage trucks Garbage to run back and forth to pour the garbage into the garbage pit inside the room. There should also be the fan installation to ventilate the air inside the garbage room, the area above the waste pit and above the garbage feeding funnel into the oven in order to have some air for combustion in incinerators.

Such measures cause the air pressure in and above the area to be less than atmospheric pressure and as a result, odors and dust will not spread to outside, this thus reduces foul odor problems in the solid waste receiving room and that otherwise will diffuse from the solid waste receiving room to outside. Another solution is to use only the community solid waste as fuel, not to accept hazardous waste, infectious waste, radioactive substances or other objects (eg. construction waste, demolition, bricks, stone, concrete and those are oversized the waste inlet to be fed into the furnace) for the use of the project's fuel. The solid waste fuel characteristics should be prepared to be suitable to the selected combustion technology such as size and humidity, etc., in order to control combustion conditions to achieve complete combustion and reduce emissions of pollutants, arising from the project.



Figure 4 Sign of the RDF Waste Power Plant Project, the Integrated Solid Waste Disposal Center, Rayong Province Source: Rayong Provincial Administrative Organization,2021

2) Wastewater Management: the integrated waste disposal center of the RDF Power Plant has the efficient waste and water management through the water management method used in the industry by adding new water to the process without discharging around the power plant. It is considered as a good circulation system with efficiency considering the reuse of water from the sewerage ponds, such as watering plants and green areas within the project area, which is the internal use of the projects or Zero Discharge Water Balance.

3) Odor management: the problem of odor is managed a sorting plant that is a closed plant inside. At the negative pressure, there is no ventilation of odors from outside and inside. Furthermore, 500 tons of waste are sorted per day through hot air blowing to get 200 tons of RDF waste per day for fuel. Other garbage will be sold while organic waste such as durian scraps, fruit scraps will be fermented in biogas . Solving the problem of odor of RDF waste power plants is mainly about the sorting process. After the sorting is done, the segregated waste will be converted into RDF fuel through conveyor belts and conveyed to the incinerator to reduce air pollution from the RDF. The incineration is controlled to a temperature of 8 5 0-1 ,1 00 degrees Celsius for 2-3 seconds to achieve complete combustion. Pulse Jet Bag Filter in the air pollution Bag filter treatment system, is designed to be placed behind the air pollution treatment system to trap light ash dust derived by combustion and activated carbon is used to remove dioxin compounds and heavy metals and reduce the potential for cancer-causing dioxin compounds. As Thailand does not yet have a law on the protection of dioxin compounds, environmental concerns arise.

4) Noise Management: before construction, there was the prevention of noise during the construction from the use of various machinery , drilling and temporary fencing around the construction area to reduce the noise level from construction bothering neighboring communities. Moreover, personal protective equipment were provided for working workers who exposed to loud noise as well as inspected maintenance of machinery and equipment for various installations to be ready for use at all times. The building's area was planned to be in the middle zone of the project area in order to have the most distance from the community and to have perennial planting around the boundary of the project area, enabling to noise control and reduction to prevent impact against nearby communities.

5) Greenhouse and Air pollution conditions: the measure concerning greenhouse conditions to prevent global warming are planned using the method of T-VER-METH-WM-04 Version 03 CoP legal standards, namely the standard values displayed through the

display screen in front of the RDF waste power plant. The CO and NOx emissions of RDF combustion show ; however RDF combustion can significantly decrease the CO emission due to its distinct pellet structure and burning pattern. The major of acidifying air pollutants are SO2, NOx CFs that RDF samples due to emissions released during the incineration of Municipal Solid Waste (MSW). Incineration had a greater impact on the environment due to air emissions, such as carbon dioxide, sulfur dioxide and nitrogen dioxides. a pilot scale vertexing fluidized bed to help If it exceeds the standard, it will be notified to the plant for inspection and can be promptly prevented in the affected condition areas.

There are also measures to monitor environmental impacts, statistical record of complaints in various problems against the communities including methods and timeframes for corrective action with a summary and result report every 6 months pursuant to the legal Code of Practice (CoP) conducted for the project of waste-to-fire thermal power plants with an installed capacity of less than 10 megawatts to prevent repeat complaints concerning the environment.

Success and Factors Affecting Success

According to the interview about the power plant from RDF fuel, it was the first integrated waste management model in Rayong, leading to further improvements and solutions to community waste problems. It could effectively reduce the landfill area and was environmentally friendly, reflecting the comprehensive waste management within the communities as well as upgrading community products to generate income for the community, increase employment of local people. In this regard, the clear communication, good governance, social accountability, and participation were mechanisms that enable communities and power plants to go along. “Investment in the RDF Waste Power Plant Project, the Integrated Waste Disposal Center Rayong Province has a low return in comparison to other energy investments. However, the important thing is the company's mission to support the management of the government through cooperation with local agencies in order to be the model of truly integrating cooperation between government,

private and public sectors." said the RDF waste power plant representative. Success in the acceptation dimension from people maybe because; 1) Cooperation with the private sector in Thailand has the possibility to manage the private sector's body of knowledge, enabling the project to be driven in a normal and effective manner that can be traced; and 2) According to the principles of good governance , having a learning center within the plant is considered transparent and with public participation in order that everyone will be able to learn and understand waste management through the form of recycling waste into electric fuel 3) The clear and continuous communication and employment of local people are the effective ways of enhancing opportunities for people in the nearby areas of the RDF waste power plant 4) Consistent environmental impact assessment. As a result, the Project will be recognized as the prototype of waste management and create value-added to the MSW at the same time. Thus, the collaboration between Rayong Provincial Organization and GPSC shall provide benefit of waste management to Rayong Province and their people as well as be the learning center for other local administrative organizations in the future.

Research Discussion

Today's waste management has a greater impact on the environment than normal disposal. As waste collection in other areas have been conducted through unsanitary dumping and incineration, with no technology, causing many pollution problems, and without generating any benefit Management of waste is a main concern and one of the most crucial issues in modern society. Effective waste management considers prevention, recycling, and handling of waste in such a way that most effectively protects human health and the environment and Environmental Effects focused on Municipal Solid Waste (MSW) to energy technologies and monitor other issues. Although odor issue, Factors affecting MSW composition include season of the year, geographic location, population characteristics, and degree of urbanization (Zabaniotou, A., Giannoulidis, N., (2002), Rayong Province is a fruit farmer. Sometimes organic waste such as fruit rinds, durians, mangosteens are present in large numbers during fruit festivals. There may be

a problem of smelling garbage during the fruit season. which is still a problem sometimes solved. is to enhance understanding consistent with the research of residents' perceptions, concerns and attitudes towards waste management facilities. According to the characteristics and environmental impact of RDF management and the good practice of Policy analysis for sustainable refuse-derived fuel production in Espírito Santo, Brazil to sustainable RDF project, (Giselede Lorena Diniz Chaves., (2021), the proposed solid waste management policy, it is envisioned that there will be sufficient waste streams for RDF production under dynamic uncertainties, given the limited cost-benefit-risk trade-off assessment. In addition to the direct benefits of sustainable RDF production as a substitute for fossil fuels, the indirect environmental benefits are salient as the regulations for circular economy can be functional in the future.

Good governance of the project with the communities that builds a reputation for trust, social responsibility and participation through providing opportunities for people in the area. The environmental dimension is an important dimension as it is the one that is in concern of many parties. As the future requirement is to wisely promote environmental sustainability management of other problem not only waste management, but also planning to manage future waste, as well as the issue of public health and the environment in the long run, which required for long-term following up. The performed to select the most viable waste management alternative based on technical, economic, environmental, and stakeholder preferences (Lionel P.Joseph Ramendra Prasad,2020). The law relating to waste power plants affecting public health should be undertaken in the form of an additional social impact assessment (SIA) project to forecast the social impact of the project against people, communities and the way of life of people in the communities (Det Wattanachaiyingcharoen, 2010) and other impacts like Local community organization process to inform development guidelines, to acknowledge the problems and needs of local people older residents reported most concern about the potentially adverse health impacts of long-term exposure to odours from MSW facilities. However, although awareness of MSW facilities and concern about potentially

adverse health impacts varied according to the characteristics of residents., the necessity for a waste power plant to transport waste through trucks roaming across the community road, the affect to land prices and village construction, businesses, shops of villagers, Medium-term and long-term agricultural areas of power plants with 20-year power supply contracts, including the proposed mitigation measures, prevention and reduction of negative impacts against communities and sustainable livelihood.

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