



**DISCUSSION ON BUSINESS MODEL TOWARD A SUSTAINABLE ENERGY
MANAGEMENT POLICIES OF RENEWABLE ENERGY PRODUCTION**

**DISCUSSÃO SOBRE MODELO DE NEGÓCIO PARA POLÍTICAS SUSTENTÁVEIS DE
GESTÃO ENERGÉTICA NA PRODUÇÃO DE ENERGIA RENOVÁVEL**

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ABSTRACT

Objective: The study aims to propose a business model for converting industrial waste, such as scrap tires, into clean renewable energy through pyrolysis technology, addressing environmental challenges and promoting sustainable energy practices in developing countries.

Methods: The research employs an analytical approach, incorporating experimental data from Vietnam's waste tire pyrolysis industry. It includes case studies, product testing, and real-world business results to evaluate the feasibility of the proposed model.

Results: The study demonstrates the effectiveness of pyrolysis technology in converting waste tires into renewable energy products, such as FO-R oil, carbon black, and steel. The business model offers economic and environmental benefits, such as reducing industrial waste, minimizing greenhouse gas emissions, and creating sustainable business opportunities.

Conclusions: The proposed business model presents a viable solution for recycling industrial waste into renewable energy. Governments and authorities in developing and developed countries are encouraged to implement supportive policies and provide funding channels to promote clean energy production, benefiting society, investors, and the environment.

Keywords: Business model. Clean renewable energy. Developing countries. Pyrolysis technology.





RESUMO

Objetivo: O estudo propõe um modelo de negócio para converter resíduos industriais, como pneus usados, em energia renovável limpa por meio da tecnologia de pirólise, enfrentando desafios ambientais e promovendo práticas energéticas sustentáveis em países em desenvolvimento.

Métodos: A pesquisa utiliza uma abordagem analítica, incorporando dados experimentais da indústria de pirólise de pneus usados no Vietnã. Inclui estudos de caso, testes de produtos e resultados comerciais reais para avaliar a viabilidade do modelo proposto.

Resultados: O estudo demonstra a eficácia da tecnologia de pirólise na conversão de pneus usados em produtos de energia renovável, como óleo FO-R, negro de carbono e aço. O modelo de negócio oferece benefícios econômicos e ambientais, como a redução de resíduos industriais, a minimização de emissões de gases de efeito estufa e a criação de oportunidades de negócios sustentáveis.

Conclusões: O modelo de negócio proposto apresenta uma solução viável para reciclagem de resíduos industriais em energia renovável. Recomenda-se que governos e autoridades em países em desenvolvimento e desenvolvidos implementem políticas de apoio e forneçam canais de financiamento para promover a produção de energia limpa, beneficiando a sociedade, investidores e o meio ambiente.

Palavras-chave: Modelo de negócio. Energia renovável. Tecnologia de pirólise. Gestão de resíduos. Países em desenvolvimento.

1 INTRODUCTION

Renewable energy is a type of energy that is created from sources that form continuously and can be considered infinite. This is a completely clean and clean energy source capable of regeneration. The basic principle of using renewable energy is to extract part of the energy from continuously evolving processes in nature, then incorporate them into technical applications. Although it is a relatively new energy source, renewable energy is widely used. It is used to replace traditional fuel sources in four important areas: motor fuel, power generation, water heating and rural independent power systems.

Advantages and disadvantages of renewable energy:

Advantage:

Clean energy source with little impact on the environment can be regenerated and not worried about exhaustion. Brings many effects, typically saving electricity for factories, enterprises, households, etc (Pratiwi & Juerges, 2020).

Defect:

The initial construction investment cost is quite large due to the need to equip a modern and advanced system. Low stability and easily influenced by natural agents (due to natural origin). This has had a negative impact on the performance of the entire system (Bradu et al., 2023).

- Encourage technological progress and innovation

Renewable energy requires innovation and technological development to improve the efficiency





and availability of renewable energy sources. The role of renewable energy

- Ensuring energy security

Renewable energy helps ensure energy security by reducing dependence on fossil energy sources, thereby reducing the risk of energy supply interruptions and energy price fluctuations in the international market. Renewable energy helps reduce dependence on fossil fuels, which are increasingly depleted and can be interrupted by political and economic factors. Developing renewable energy helps diversify energy supplies and ensure national energy security.

Reduce greenhouse gas emissions

Using renewable energy helps reduce greenhouse gas emissions, contributes to the fight against climate change and reduces the negative impact of climate change on the environment and people. Renewable energy is a clean energy source that does not produce greenhouse gas emissions, contributing to environmental protection and combating climate change. Using renewable energy helps minimize negative impacts on the environment and human health.

By using renewable energy, we reduce emissions from burning fossil fuels to produce electricity and heat, reducing the risk of deforestation, land surface subsidence and even sea level rise. . This actively contributes to the fight against climate change and protecting our living environment

Several environmental impacts of used tires are: Huge quantities of scrap tires are the living source of flies, mosquitoes, cockroaches, disease- causing parasites, and fever viruses. Besides, Potential fire hazard from waste tires will cause acid smoke that is harmful to the environment and human health. Scrap tires also take up much landfill space and are dirty while the precious natural resource has been becoming scarce. Disposal of waste tires is one of global serious environmental problems, Therefore, recycling and converting waste tires into clean energy such as fuel oil-renewable (FO-R), by pyrolysis system, is becoming a crucial method to reduce bad effects of global warming and greenhouse gases (Kweku et al., 2018; Letcher, 2022). Continuous waste tyre pyrolysis plant is for processing waste tyres into fuel oil and carbon black for recycle use. Due to continuous feeding and discharge system, the continuous waste tyre pyrolysis plant can keep working without stop, thus to save energy and time.

2 PROBLEM FORMULATION

This paper will find out: Research issue: what is the business model to convert industrial wastes such as waste tires, into clean energy in developing countries? What we can-do for-profit maximization?

2.1 Research Method and Data

In this research, analytical method is used with data from a Vietnam case in waste tire pyrolysis industry. This is an experimental model, and we also test the products by Vietnam clients





in cement industry. All the business results are real examples in Vietnam.

2.2 Conceptual Theories

Pyrolysis reaction will break carbon linkage in the condition without oxygen at high temperature of 300-500°C to produce renewable energy products such as FO-R (oil), carbon black and scrap steel.

2.3 Literature Review

According to research, the number of waste tires in US was 4.2 million tons annually) in Vietnam was 400 thousand tons annually and in Japan was 1 million tons.

Then, Research results also indicated recycling of scrap tyre pyrolysis gives comparable efficiency to diesel oil in medium to high load but it has been questioning on the desulfurization process. More improvement in fuel quality in term of desulfurization, reduction in viscosity is required for tyre oil as an alternate fuel for diesel engine as agent gas, was given batch and continuously during the process. In the study, the calorific values of the liquid and solid pyrolysis products were determined as 9117 kcal m⁻³ and 8710 kcal kg⁻¹ respectively. When the results of the experimental studies were evaluated, synthesis gas rich in CH₄ and H₂ with a high calorific value of 4180 kcal m⁻³ was achieved

Liu et al. (2018) stated that Foreign direct investment (FDI) in advanced renewable energy technology spillover is promising to improve technological capability and promote China's energy industry performance growth. Results demonstrate that FDI renewable energy technology spillover has positive impacts on China's energy industry performance. It can also be found that the technology spillover effects are more obvious in economic and technological developed regions.

ASEAN countries made a lot of essential decisions regarding reinforce the international exchanges like plan of structural adjustment and economic liberalization that has been implemented in 1986, the devotion with the "general agreement on tariffs and trade (GATT)" in 1989, the devotion with the "world trade organization (WTO)" in 1994 and ratification regarding the agreement of free trade with European Union (EU) in 1995 (McKenzie, 2020).

RESULTS

Finding on a business model in developing countries

(Input) Raw materials: Industrial wastes: plastic or waste tires

According to statistics, Viet Nam discharges about 400,000 tons of waste tires annually and this number in the US is estimated about 4,200,000 tons per year (source: vnu.edu.vn). Global car sales continue to rise in the first half of 2018, data provided by JATO, an auto market research firm, show in 57 countries worldwide, total revenue of car industry in the world in the first half of 2018 reached 44 million cars, increase 3.6% compared to the same period in 2017.

According to statistics, in 2018 global vehicle sales increased 3.6% compared to 2017 (44.03





million units compared to 42.49 million units). This number still very promising, although according to CNN, The global auto industry plunged deeper into recession in 2019, with sales dropping more than 4% in 2019. The number of vehicles sold across major global markets dipped to 90.3 million in last year. Viet Nam's vehicle consumption growth forecasted will reach 22.6% per annum during 2018-2025 and reach 18.5% per annum during the period 2025- 2035. It is forecasted that by 2020, the demand for the domestic automobile market will be about 500,000-600,000 cars and the automobile market will be driven by the GDP per capita surpassing 3,000 USD and the average ownership will be about more than 50 vehicles / 1,000 people. The trend will also take place in Viet Nam during the period 2020- 2030. Thus, the automotive market is expected to reach 750,000-800,000 cars by 2025 and reach 1,7 – 1,85 million cars by 2035. Source:

(<https://bnews.vn/thi-truong-o-to-viet-nam-co-the-dat-800-000-xe-trong-giai-doan-dan-so-vang/86935.html>)

With the number of cars currently in reality and the growth forecasted as above, the number of waste automobile tires are very large, ensuring the input materials for the plant.

Process (pyrolysis) system:



Tires and plastics

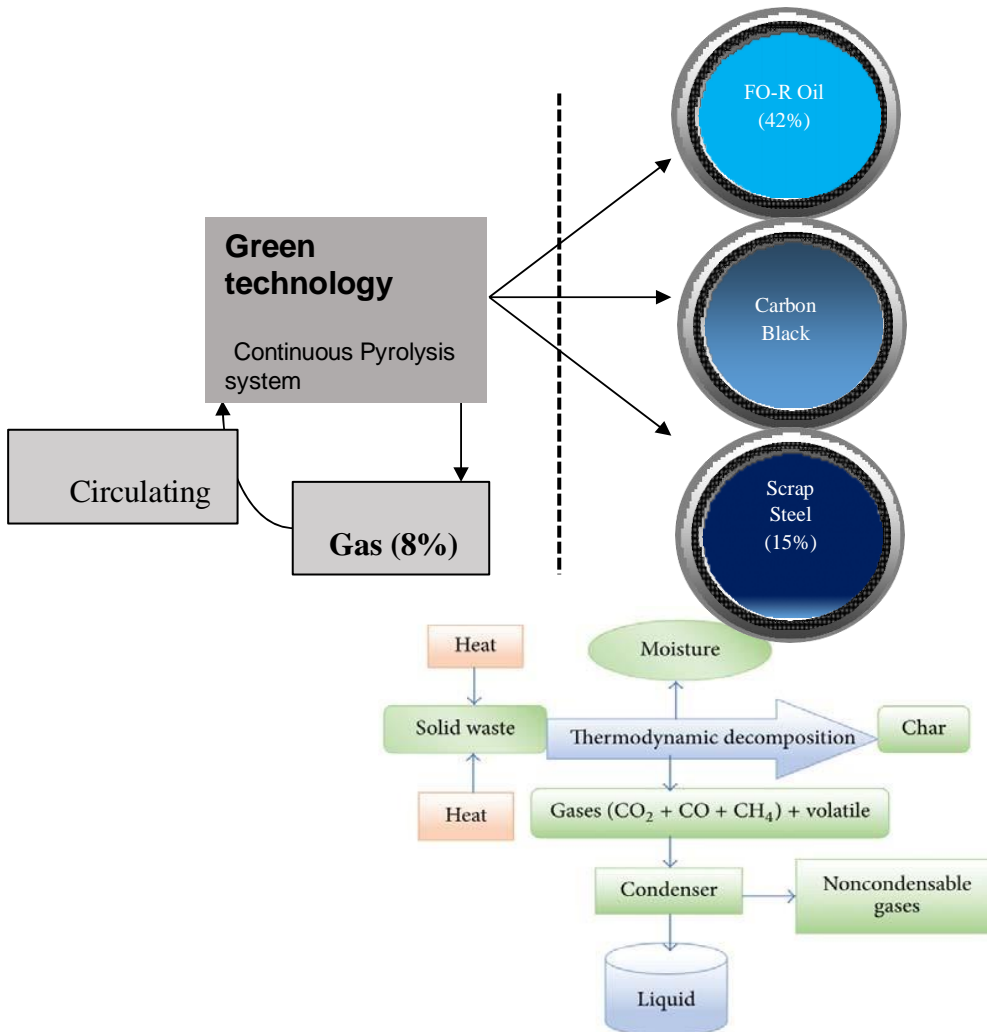


Figure 1 - Main products of pyrolysis process.

Advantages

The advantage of the continuous pyrolysis line is that it separates steel from the beginning by cutting and filtering rubber to increase the quality and price of scrap steel compared to the current line system. The second advantage is that Shredder suppliers in the US such as Ecogreen can provide energy companies with shredding system which help to cut the whole tires into small pieces (with diameters less than 25 mm). Then, they can be put into pyrolysis system and be converted into finished products with proper pyrolysis yield. Steps of pyrolysis are described in the figure 1 (Nahian and Islam, 2016)

(Output) Finished products: FO-R oil, carbon black, scrap steel

The product mix of the project is applied in the following areas (table 2):

Table 2 - Pros and cons of renewable energy

Pros	Cons
<p>Encourage technological progress and innovation</p> <p>Renewable energy requires innovation and technological development to improve the efficiency and availability of renewable energy sources. Investment in research and development in this sector encourages technological advancement and the creation of new solutions to use and make the most of renewable energy sources.</p> <p>Besides the disadvantages of renewable energy, this is a field that plays an important role in promoting sustainable development by reducing consumption of non-renewable resources, reducing emissions and pollution impacts, and creating safety. energy security, job creation and economic development, and encouraging technological advancement and innovation in the energy sector. These benefits demonstrate the role renewable energy plays in building a sustainable future, minimizing negative impacts on the environment and sustaining human development.</p> <p>It is a clean energy source, with little impact on the environment. Can be regenerated and not worried about exhaustion. Brings many effects, typically saving electricity for factories, enterprises, households,...</p>	<p>Defect:</p> <p>The initial construction investment cost is quite large due to the need to equip a modern and advanced system.</p> <p>Low stability and easily influenced by natural agents (due to natural origin). This has had a negative impact on the performance of the entire system.</p> <p>Defect:</p>

As we see from the statistics results. The effect of pressure shows negative figures, for the lower the pressure the higher the oil yield. As for the other variables with positive results, the higher their values the higher the oil yields, such as statistical treatment of oil yield from pyrolysis (Rombaldo et al., 2008; Batista and Gomes, 2021)

3.2. Financial model and analysis

We can propose a financial model for implementing a renewable energy manufacturing factory as follows (table 3):



Table 3: Pyrolysis Efficiency.

	ITEM	Capacity	Wasted tires	Shredded tires
1	Waste tire (tons/line)	17.65	100%	
2	Shreds tires (tons cutting waste tire/line)	15.00	85%	100%
3	FO-R Oil		38.25%	45%
4	Carbon black		34.85%	41%
5	Scrap steel		15%	
6	Gas		11.9%	14%
No	Estimate Change in Net working capital	Day	Unit	
1	Days in Inventory (Oil)	32.9	days	
2	Days in Inventory (Waste tire)		days	
3	Days in A/R	30	days	
4	Inventory turnover (Oil)	11.1	circle/year	
5	Inventory turnover (Waste tire)		circle/year	
6	A/R turnover	12	circle/year	
7	Days of A/P	0	immediate payment	

Table 4: NPV, IRR and FCFE projection

Year	2019	2020	2021	2022	2023
Depreciation		1,374,722	1,883,115	3,190,410	2,337,162
Net profit	(29,700)	2,931,858	14,459,847	18,557,652	20,200,062
(Increase) Decrease in net working capital		(1,162,123)	(2,389,489)	(827,761)	(39,146)
Loan payback	-	(1,142,909)	(2,848,716)	2,848,716)	(2,848,716)
Corporate tax				(1,855,765)	(2,020,006)
Net Cash flow	(29,700)	2,001,548	11,104,756	16,215,820	17,629,356
Capital expenditures	(7,226,402)	(18,951,250)	(7,822,348)		
Free cash flow	(7,256,102)	(16,949,702)	3,282,408	16,215,820	17,629,356

(*source: Thanh et al, 2020)



There are several points we discuss from the above tables:

First, because we are estimating FCFE (for equity), we choose discount rate as return on equity (expected); therefore, it might be 15% to 30% dependent on investors or shareholders. In international formulas, economists can use WACC instead of expected ROE. But WACC is only used for FCFF (free cash flow for firm). Second, this project will bring socio-economic values such as: create more employment for society, solve environmental problems, contribute to national budget through taxes. Furthermore, $NPV > 0$ and IRR 45% is good signals for investors to invest. (see above Table 4). A better control of raw materials and technology might bring good cash flow for firms. As shown in Table 3, the pyrolysis yield is much depending on modern technology.

3 . LIMITATION OF THE MODEL

Firstly, some countries do not widely notice their supporting policies in the field of pyrolysis of industrial wastes into clean energy. Finally, we need to find a proper mechanism for developed countries to transfer their resources to developing countries.

4. DISCUSSION

Minimize consumption of fossil resources

Using renewable energy helps reduce dependence on fossil resources such as oil, coal and natural gas. Reducing the consumption of non-renewable resources contributes to protecting the environment and preserving resources for future generations (Bekhet & Harun, 2016).

Reduce emissions and pollution impacts

Renewable energy, such as solar and wind power, does not produce carbon dioxide (CO₂) emissions and other greenhouse gases. By reducing emissions during energy production and use, renewable energy helps reduce the impact of pollution on the environment and climate (Panwar et al., 2011).

The basic principle of using renewable energy is to extract part of the energy from continuously evolving processes in nature, then incorporate them into technical applications. The increasing demand for energy production and dealing with larger amounts of waste pushes renewable energy companies to solve the produced pollutant waste, emit lesser amounts of CO₂, and generate more energy. Recycling of scrap tires become one of perfect solutions for the recent requirements of the 21st century. In the context of the depletion of natural resources, the quality of the environment seriously affected by the pace of development of industries and urbanization, the reuse and recycling of industrial wastes into production is necessary, because two (2) reasons: in addition to reducing the burden of environmental pollution and protecting the resources of future generations, it also helps businesses





save a large amount of money in production and lower production cost(the cost of buying FO-R oil from used rubber is much lower than that of other natural fuels).

CONCLUSION

This paper recommends a business model to recycle industrial wastes into clean energy for a better environment. This model also opens new research directions for renewable energy industry, new materials research, increases the value for society and developing countries in general, and for the company and investors in particular. The government and authorities in Viet Nam and developing countries as well as developed countries can issue policies which can support renewable energy firms to protect environment. Channels of capital are also needed to encourage these companies to produce clean energy.

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