

# SOLID WASTES: A POTENTIAL SOURCE FOR ENERGY PRODUCTION IN VIETNAM

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**Abstract:** *This article presents an overview on different types of solid wastes presently available in Vietnam, their current pattern of management as well as potential for energy production.*

## 1. INTRODUCTION

During 2010-2017, total GDP of Vietnam increased around 6.1% per annum with a highest grow rate from the industrial sector (7.4% p.a) followed by the commercial sector (6.8% p.a). It has been seen that development of industry and transport sector, urbanization as well as improved energy access and rising living standards nationwide are major drivers for growing energy consumption. Being a net energy exporter for a long time, Vietnam became a net energy importer in 2015 and this fact continues to grow quickly, primarily driven by increased coal imports.

As of April 2019, with a population of 96.2 million people, about 35,000 tonnes of municipal solid waste (MSW) and 34,000 rural solid waste (RSW) are produced daily in Vietnam. Particularly, in big cities such as Ha Noi and Ho Chi Minh, approx. 7,000-8,000 tonnes of MSW are discharged per day. At present, most of MSW and RSW sources are simply treated by dumping / land fill in big areas, only small amount of them are collected and burned in obsolete boilers characterized by a low energy efficiency and high pollutant emission.

The Government of Vietnam has committed itself to move towards collecting, transporting and treating 100% of non-household waste by 2025 and 85% of waste discharged by households by 2025 in urban areas through its recently approved revised National Strategy on Solid Waste Management. Priority is envisaged to be given to large-scale treatment facilities using modern technologies with a substantial focus on recycling and upgrading landfills to prevent environmental and health impacts.

Currently, about 85% of solid waste is treated by landfills technology which requires a large amount of land in which 80% is unhygienic landfills with the risk of environmental pollution and without utilization of energy generation. Therefore, with a proper municipal solid waste treatment and management, municipal solid waste, which is predicted to increase at the rate of 10% - 16% annually, has a huge opportunity to become a precious resource and fuel for the urban sustainable energy mix of tomorrow

considering environment protection and climate change in urban area.

The Government of Viet Nam (GoV) has set ambitious targets to increase renewable energy production including SW, reduce greenhouse gas (GHG) emissions and fossil fuel consumption within the Renewable Energy Development Strategy (REDS) that was enacted by end of 2015. Accordingly, the government aims at meeting the growing energy demand while ensuring an efficient use of natural resources and reaching energy quality and security. The utilization rate of solid wastes (SW) for energy purpose is expected to increase from a current negligible level to 30% in Foreword of Electricity and Renewable Energy Authority/ Ministry of Industry and Trade 2020, approx. 70% in 2030, and most of SW shall be used for energy purpose in 2050. To encourage efficient SW treatment, the Government of Vietnam has enacted different support mechanisms to promote SW treatment. They encompass: the Decision no. 31/2014/ QĐ-TTg on Feed-in-tariff (FIT) power generation projects using solid waste and the Circular no. 32/2015/TT-BCT on project development and standardized power purchase agreement for SW.

## 2. SOLID WASTES IN VIETNAM

Waste means materials that are discharged from production, business, services, daily life, or other activities. Solid waste is the waste in the solid or muddy form (or sludge) which is discharged from production, business, services, daily life, or other activities as described in Decree 38/2015/ND-CP on waste and scrap management.

Solid waste can be normally divided into four (4) main categories:

- Municipal solid waste (MSW): SW is generated from daily-life activities in urban as well as in rural areas
- Industrial solid waste (ISW): SW is discharged from production, trading and services activities
- Agricultural solid waste (ASW): SW is derived from agriculture related activities
- Hazardous solid waste (HSW): SW contains substances or compounds that exhibit any of the

**Table1. UMSW through the years in some locations**

No.	Location	Amount of UMSW (tonnes/year)			
		2012	2013	2014	2015
<b>I</b>	<b>Special City</b>				
1	Hanoi	-	-	1,652,720	2,012,975
2	Ho Chi Minh	2,628,000	2,737,500	2,890,800	3,037,800
<b>II</b>	<b>Class I city town and provinces having class I city towns</b>				
1	Thai Nguyen	83,986	84,861	86,140	-
2	Da Nang	277,477	288,112	282,312	-
3	Can Tho	-	-	-	308,790
4	Ba Ria – Vung Tau	-	-	-	255,500
5	Dong Nai	-	219,730	237,615	233,053
6	Hai Phong	-	-	-	365,000
7	Nam Dinh	-	-	-	69,350
<b>III</b>	<b>Provinces having class II city towns</b>				
1	Bac Giang	-	62,780	-	-
2	Thai Binh	-	-	67,160	-
<b>IV</b>	<b>Provinces having class III city towns</b>				
1	Dien Bien	19,929	20,221	25,279	26,284
2	Kon Tum	27,740	28,470	29,565	30,660
3	Lang Son	47,104	47,731	48,330	71,423
4	Ha Tinh	-	-	67,933	72,065
5	Vinh Long	50,299	57,112	57,721	58,035

**Table 2: The RMSW generation in 2016**

No.	Region	Rural population (thousand people)	RMSW load (kg/person/day)	Tonnes/day	Tonnes/year
1	Red River Delta	13,488.50	0.4	5,395	1,969,321
2	Northern mountain	9,789.70	0.2	1,957	714,648
3	Middle region	14,106.70	0.3	4,232	1,544,683
4	Tay Nguyen	4,037.20	0.3	1,211	442,073
5	South-East region	6,077.60	0.4	2,431	887,329
6	Mekong Delta	13,209.90	0.4	5,283	1,928,645
	<b>Total</b>	<b>60,709.70</b>		<b>20,034</b>	<b>7,312,483</b>

characteristics of radioactivity, ignitability, explosiveness, corrosiveness, infectiousness, toxicity or other hazardous characteristics

In this research work, only the first three categories of SW are to be considered.

### 2.1. Municipal solid waste (MSW)

#### *Urban municipal solid waste (UMSW)*

The amount of urban solid waste discharged depends upon the size of the urban population. Estimatedly, the UMSW in cities increases annually by 10-16%. In most cities, the UMSW accounts for 60-70% of total UMSW (in certain cities, the rate comes up to 90%). The UMSW/person rate increases in proportion with the increasing living levels. In the cities classified as the Special Type, Level 1, the UMSW rate is 1.3kg/person/day on average, much higher than 0.5kg/person/day in the cities of Level 4 and 5. The UMSW escalating quickly in big cities, such as Hanoi, Ho Chi Minh City, Da Nang, Hai Phong – where urbanisation and industrialisation soars quickly – accounts for

45.24% of the total UMSW from all remaining cities. In some small cities (from Level II upwards), the UMSW does not increase much due to low living levels and slow urbanisation (see Table 1).

In time to come, the UMSW through out the country continues increasing. In Northern cities alone, the forecast indicates that the UMSW reaches 22,390 tons/day by 2030, an increase of 1.6 times as compared with that in 2020 when the UMSW will be 13,980 tons/day.

Basically, the UMSW depends upon people's income. The waste from the low income urban people contains high rate of organic component, whereas the one from the high income urban people has high rate of inorganic component. The food waste is the main component of the UMSW (83 - 89%) in landfills. The recycled component in the UMSW, for example, plastic, paper, metal decreases substantially thanks to the collection and separation of wastes. The remaining waste is hardly possible for recycling being mainly inorganic (mud, soil). The UMSW has various

characteristics subject to geological regions. In coastal regions, the MSW soars unusually following the tourist seasons. The MSW in coastal areas is typical due to the big use of detergents in catering services, which largely affects water environment. Meanwhile, the MSW is stable and usually normal in mountainous areas. The organic component which can be biologically decomposed is very high. It is common for the waste to be treated on the spot.

#### *Rural municipal solid waste (RMSW)*

The RMSW stems from households, markets, warehouses, schools, hospitals, administration offices, etc. The RCSW contains fairly big organic component, mainly the food, garden waste which is easily decomposed (65% of the RMSW). Basically, the RMSW generation depends on the population density and consuming demands. However, the RMSW has not yet been sufficiently surveyed due to the limitations of RSW management. The RMSW rate is 0.33kg/person/day on average. The RMSW rate is higher in the Red River and Mekong River deltas as a result of highly developed agricultural production (0.4kg/person/day) while it is lowest in Northern mountainous areas (0.2kg/person/day) as indicated in Table 2.

#### **2.2. Industrial Solid Waste (ISW)**

Developed industry has resulted in very big ISW generation recently, especially in places with developed industrialisation such as Hanoi, Quang Ninh, Hai Duong, Ho Chi Minh City, Binh Duong, Ba Ria - Vung Tau... In Ho Chi Minh City in 2016 alone, the ISW generated was about 1,500 – 2,000 tons/day from over 2,000 big factories and 10,000 production units of small and medium size located inside and outside the industrial processing zones and industrial parks. However, the ISW has not yet been sufficiently surveyed, especially at the small, separated production facilities located amid communities.

The ISW derives from the industries such as paper production, coal thermal energy, chemicals, fertilizers, etc... with typical features of each industrial production and increases quickly recently. Following the data of the General Department of Environment, the SW normally stems from the industrial activities, about 25 million tons/ year.

**Table 3: ISW Forecast generated from paper industry**

No.	Year	Quantity (tonne/year)	Non-hazardous solid waste (tấn/năm)
1	2015	291,552	35,688.9
2	2020	448,590	54,911.9
3	2025	749,453	91,740.5

Note: Average SW load for the paper industry is about 36.36 kg/tonne of paper

The SW comes from the paper and pulp production is sizable, unarmful and possibly flammable. If being co-fired in steam tanks to recover energy, the ISW can meet over 50% demand of fuels for the steam tanks in paper mills (see Table 3).

#### **2.3. Agricultural Solid Waste (ASW)**

Besides the RMSW, a large amount of ASW is also generated annually in the countryside. Approximately, 14,000 tons of plant protection chemical product wrappings, fertilizers of different types, 76 million tons of straw/stalk and 47million tons of husbandry waste is generated every year. With about 7.5 million ha of rice cultivation in our country, the straw/stalk waste reaches 76 million tons annually. However, the quantity of the straw/stalk is not yet included in the amount of local and national SW.

Further, the ASW in the deltas is the abandoned stalks of short-term plants (rice, corn, beans...). In the central plateaux, the agricultural products are mainly the industrial trees with the abandoned plant skins, the post-processing waste (cashew, café...) constituting a large amount of SW after crop harvest.

### **3. SOLID WASTE MANAGEMENT AND ITS POTENTIAL FOR ENERGY PRODUCTION**

According to the General Department of Statistics, the SW collected all over the country was more than 33,167 tons in 2016, in which the normal SW collected and treated with national standards was about 27,067 tons (take 81%). As a result, there remains about 5,100 tons of SW collected but not yet treated following national regulations to say nothing of a large quantity of SW not yet collected having contaminated the earth and water. The highest normal SW amount collected and treated with regulations is in the Eastern South (99.4%) and the Red River delta (88.9%), while the lowest rate of SW treatment is in the Northern high land zone and mountainous areas and the central plateaux (57.5%).

#### **3.1. Separation, collection and treatment of MSW**

*Separation, collection and treatment of urban municipal solid waste(UMSW)*

Attention has been given recently by the authorities at all levels to the UMSW collection. But it does not meet the demands as UMSW accelerates quickly while the collecting capability remains limited in terms of both human resources and equipment. Concretely, the total UMSW collected and treated in 2016 was about 33,100 tons/day, or 85.5%. However, due to people's low awareness, the amount of waste littered into environment is large and the collection

and separation at sources have not yet been applied widely due to the lack of infrastructure investment, equipment, human resources and community awareness. Following the recent Report of the Department for Technical Infrastructure, Ministry of Construction, there had been about 35 SW Treatment Plants centred in urban areas, invested and put into operation by November 2016. The total design treatment productivity is about 7,500 tons/day (the common average productivity is about 100-200 tons/day). Technological solutions are mainly to produce compost fertilizer (25 facilities), to burn (4 facilities) and to combine. Besides the centred SW Treatment Plants, there had been about 660 landfills of MSW by 2016 (excluding the small landfills scattered in communes) with entire area of about 4,900 ha. Most waste received at the landfills is not separated from sources. More seriously, the unhygienic landfills are open without equipment for collection and wastewater leakage. They are overloaded without being covered and chemically sprayed for deodorant.

*Separation, collection and treatment of rural solid waste (RSW).*

Of the criteria of new rural areas, the criterion on the RSW withdraws much attention. However, due to living habits, most MSW is collected and treated on the spot by local people (discharged to the gardens). Recently, there have been local units specialising on collecting community waste, but still at small dimension. Mostly, cooperatives organise themselves the collection with very simple collecting equipment using the rickshaws. Additionally, the waste collection is not done regularly, but rather be combined with the sledging of canals launched by communal authorities. Following the statistics, about 60% villages and communes conduct regular waste collection; over 40% villages and communes have organised waste collecting teams. The RSW collection rate in rural areas is about 40-45%. The MSW in the country is separated right at households for some wastes: paper, carton, metal (for sale), leftover food, eg, cabbage, kohlrabi leaves... (used for husbandry). Most unused waste is not separated, but mixed including the easily and hardly decomposed wastes: nylon bags, glass, tree trunks, tree leaves, decayed flowers, fruit, animal corpses...

### **3.2. Separation and collection of ISW**

In the country, there is a policy on concentrating the production units in the industrial parks/clusters to facilitate the waste management. Nevertheless, while in some industrial parks/clusters, the regulations on waste management have been well implemented, in some other industrial parks and mostly in industrial

clusters, the centred waste collection and treatment plants have not yet been improved. Having the advantage of centred production activities, the industrial parks have the advantage of managing wastes. Thus, the rate of solid waste collection in the industrial parks is higher than that in the industrial clusters and outside the industrial parks. At present, most industrial clusters are invested and administered by provincial authorities with the ISW management being weak and insufficient. The production facilities located outside the industrial parks/clusters are even in more difficult situations, particularly the investment in infrastructure for pollution control and management. Till October 2017, there had been only 473 enterprises implementing the SW treatment services and 108 enterprises licensed to operate in the area of SW treatment. In reality, the enterprises providing industrial environment services remain at small and medium size with little charter capital and impossibility to invest in large capital demanded sectors.

### **3.3. Solid waste management**

Recently, the SW management has drawn attention. The State has issued many legal papers on managing the SW like the Law on Environmental Protection in 2014; National Strategy of Environmental Protection till 2020, Vision till 2035; National Strategy of Comprehensive Management of SW till 2025 and Vision till 2050 as well as other regulations like the Decree No 38/2015/NĐ-CP of April 24, 2015, issued by the Government on managing the SW plus the Circulars on guidance.

The system of policies and regulations on managing SW has been continuously adjusted to suit to new situations. In 2018, the Prime Minister approved National Strategy of Comprehensive Management of SW as per the Decision No 419/QĐ-TTg. Accordingly, the comprehensive management of the SW is to combine the general accesses with a view to controlling the waste within its life cycle, from the appearance to the last solution, implemented inter-regionally and in multi-sectors to secure the maximum advantages of economy, technology, social and environmental safety.

Additionally, the organizational system of SW management has been regularly practised. Basically, for normal SW management, responsibilities have been clearly divided amid Ministries/Sectors as indicated in Decree No 38/2015/NĐ-CP, Decree No 59/2007/NĐ-CP, and Decree No 80/2014/NĐ-CP. For the decentralisation of local SW management, the Government assigns the provincial People's Committees to empower and decentralise the responsibilities to the professional authorities for

administration (Department of Construction or Department of National Resources and Environment) as per the Decree No 38/2015/ND-CP.

With regards to responsibilities and authorities for SW management in Viet Nam, Ministry of Natural Resources & Environment (MoNRE) is responsible for industrial and hazardous SW management while Ministry of Construction (MoC) and MoNRE are in charge of MSW management based on Decree no 38/2015/ND-CP.

MoNRE is in charge of:

Providing guidance on procedures, proposed confirmation, adjustment of certification to meet environmental protection requirements for MSW;

Providing guidance on techniques, management process in the classification, storage, gathering, transit, transportation, pre-processing, reusing, recycling, co-treatment, treatment, the formulation and implementation of environmental protection plan as per Article 98, Law on Environmental Protection;

Managing and inspecting environmental protection activities of SW management on daily life basis.

Besides, MoNRE is also responsible for formulating policy framework for waste management, appraising and approving reports on environmental impact assessment of new SW treatment projects.

MoC is responsible for:

- Providing guidance on the management of construction investment in SW treatment facilities under the approved plan;

- Providing guidance on the methods of preparation, cost management and service evaluation of SW treatment;

- Notifying technical and economic norms on collection, transportation and treatment of SW;

- Construction investment capital rate of SW treatment facilities;

With regards to waste management mechanism, the MoC has issued Decision No. 322/QĐ-BXD of April 6<sup>th</sup>, 2012, on the rates of construction investment capital and level of expenses for treatment of life-circle-based SW (around VND 400,000/tons for domestic waste combustion technology). Other technologies will enjoy lower tariff (fertilizer, fuel pellet production).

### 3.4. Solid waste treatment technology

On planning SW treatment, the Prime Minister has approved to date the Planning for building the SW treatment in 4 priority economic zones in the North, the Middle Zone, the South and the Mekong delta with 8 inter-regional and inter-provincial SW Treatment sections. However, the inter-regional and inter-provincial SW Treatment Model does not suit

urban SW treatment, but the management of hazard waste. In October 2016, the Prime Minister approved the adjusted Planning of SW management for Northern priority economic region till 2030. Accordingly, for the Northern priority economic region, there has been adjusted planning based upon reality. Accordingly, the inter-regional and inter-provincial planning is only done for hazard wastes. To date, most provinces and cities have set up and approved local SW management. This is a big leap forwards as compared with the previous period. Financial investment has been promoted. Large projects funded with the capital from the ODA, FDI or State have been implemented to separate source wastes, collect and treat the SW using modern technology in some provinces. The State encourages all domestic and foreign organisations, individuals to participate in investment and construction of waste treatment plants and the supported projects through various favourable policies and investment facilitation. Additionally, the capital raised by the Environmental Protection Fund of Vietnam is also regarded as an important financial source to support the waste treatment projects.

Though the financial investment is diversified, it is not yet balanced amid different sectors. Most fund is being structured to be allocated to waste collection and transportation. Fund for waste treatment and disposal remains very little. The financial mobilisation on the principle “the polluters have to pay” is not yet effective, particularly for the MSW or the SW released from the agricultural sector and trade villages.

Next to promoting the system, policies, technology and finance, some measures have been also set out to manage effectively the SW as follows:

- *For the municipal solid waste (MSW):* Work out plan and conduct gradually the classification of MSW at sources; Continue studying proper technologies to deal with the SW in Vietnamese realities in order to reuse, recycle, recover energy, and minimize the SW to be dumped; Multiply the SW treatment centres with the participation of enterprises which are mobilised and licensed to provide the SW treatment services to nearby localities with a view to raising the SW treatment effectiveness and securing stable operations; Complete treating and closing the landfills of SW causing environmental pollution; Mobilise all investment sources and boost up the socialisation of waste collection, transportation and treatment of SW, reducing the financial support from State budget; Move to the situation whereby the production facilities, businesses, services causing the MSW must pay for all costs of MSW collection, transportation, and partially for the cost of waste treatment.

**Table 4 Overview of waste treatment measures implemented in Ho Chi Minh City**

Year	Waste load (ton/day)	Implementing company/organization	Capacity (ton/day)	Technology used	Treatment fee
2017	~8,700	Vietnam waste treatment Company Ltd	5,500	Landfill (US techn.)	20.9 USD/ton (~480.000 VND/ton)
			100	Composting (US techn.)	
		Vietstar - Lemma	1,800	Composting (US techn.)	19 USD/ton (~440.000 VND/ton)
		Tam Sinh Nghia	1,300	Composting (domestic techn.) + Burning (domestic techn.)	20.38 USD/ton (~460.000 VND/ton)
		CITENCO	500	Landfill (domestic techn.)	360.000 VND/ton
2020	~10,081	All the above-mentioned companies/organizations are capable to handle waste			
2025	~12,864	Need more investors /treatment companies	1,000 ton/day @ 2 plants	Modern WTE technology	Reasonable

**Table 5 Master plan for waste treatment in Hanoi till 2030 with a vision to 2050**

Zone	Location	Treatment technology			
		Recycle	Sanitary burial with LFG recovery	Composting	Modern WTE
I	Nam Sơn (Sóc Sơn)	○	○	○	○
I	Việt Hùng (Đông Anh)	○		○	○
	Kiều Kỵ (Gia Lâm)	○	○	○	
	Phù Đổng (Gia Lâm)	○	○	○	○
	Cầu Diễn (Từ Liêm)			○	○
II	Châu Can (Phú Xuyên)	○	○	○	○
	Cao Dương (Thanh Oai)	○	○	○	○
	Hợp Thanh (Mỹ Đức)	○		○	○
	Mỹ Thành (Mỹ Đức)		○		
	Vân Đình (Ứng Hòa)	○	○		○
	Đông Lỗ (Ứng Hòa)	○	○	○	○
III	Xuân Sơn (Sơn Tây)	○	○	○	○
	Đan Phượng	○			○
	Núi Thong	○	○	○	○
	Lai Thụ (Thạch Thất)	○		○	○
	Đồng Ké	○	○	○	○
	Tây Đằng		○		

- For industrial solid waste (ISW): Deploy the classification of the ISW into 3 groups at all enterprises: Reusing and recycling group for production materials, Reusing group for production of construction materials and site leveling, and the group of waste to be treated; Ensure reusing and recycling to the maximum the ISW; Recover fully energy in the process of waste treatment and minimize landfills; Accelerate green production at production facilities; Limit spread of waste; Draw up regulations, technical guidance and roadmap for waste audit.

SW treating and recycling technology is decided based upon the components, characteristics and quantity of the SW discharged, local concrete conditions following the principle 3RVE: Reduce, Reuse, Recycle, and Validate

(increase the value of the waste by applying the “profit generating” treatment technology in order to recover materials and energy; The impossibly used waste must be eliminated.

Presently, 4 types of technologies are used to treat and recycle the SW:

- *Biological incubation to make organic fertilizer*: is the process of decomposing biologically the organic waste which is easily biologically decomposed, under the human influence and control, into the stable products like humus, called compost.

- *Combusting technology (with or without heat recovery)*: is the process of treating waste whereby the burnable materials in the waste is burnt. Burning to recover energy is to turn technologically the waste into energy (WTE), such as gasification, pyrolysis and anaerobic digestion.

- *Sanitary burial*: is the suitable method in the developing countries, especially in the South East Asia, thanks to the cheap cost. The SW of different types is dumped in a place and covered with soil. The SW in the landfills is biologically decomposed to produce the products: organic acid, nitrogen substances and some gas like CO<sub>2</sub>, CH<sub>4</sub>... The SW buried must be unharmed.

- *Other technologies*: classification, pelletizing, briquetting, hydromex, petrochemical.

- Depending upon the source of the SW, proper technologies will be applied. For example, for the normal MSW and ISW, the biological incubation is used to produce compost and recover gas. So is the traditional method of burial for the same purposes. Burning is also used (with or without recovering energy), as seen in Tables 4 and 5.

### 3.5. Potentials to use the SW for producing power in Vietnam

Of the foreign imported treatment technologies being used in our country, 2 are used effectively: i) Recycle the SW into clean coal; ii) Burn the waste to recover energy (WTE).

Recycling the SW into clean coal has the advantage of making lower investment than that of burning method. It is safe for failing to produce dioxin gas because it does not need to use high heat. Sulfur gas given off in the combustion process is just little, about 0.2%. In using the clean coal to make power, the leftover coal can be stored or used as the fuels in other sectors. Burning technology to recover energy is the most common method for SW

treatment and power generation. The potential to recover energy from the SW is very great in our country. In only 7 waste treatment compounds (Decision No 1440/2008/QĐ-TTg), about 1.400 million kWh/year can be generated to bring about US\$ 140 million (USCent 10.05/kWh as per Decision No 31/2014/QĐ-TTg for the WTE projects). During 2015 – 2020 period, average quantity of waste in the cities like Hanoi, Hồ Chí Minh City, Hải Phòng..., is the stable provision of materials for the Waste-Power Plants with capacity of 500 tons/day (approx. 8MW<sub>e</sub> capacity) comparable to about 350MW power produced from waste.

### 4. CONCLUSIONS

Solid waste generation has close relationships with population, urbanization and affluence. Waste generation rate of a country or region can be linked to gross domestic product (GDP) per capita, energy consumption per capita, as well as private final consumption per capita.

It has been observed in Vietnam that MSW was disposed in open dumps located in the outskirts of the cities and provincial towns without any concern for environmental degradation or impact on human health. Current pattern of solid waste management is still a major issue in many places that needs to be improved in order to make use of such resource for energy production in the country.

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### REFERENCES

1. Ministry of Industry and Trade (MOIT). Vietnam Energy Outlook Report 2019: Overview of the Vietnamese energy sector, November 2019.
2. [https://en.wikipedia.org/wiki/Demographics\\_of\\_Vietnam](https://en.wikipedia.org/wiki/Demographics_of_Vietnam)
3. The World Bank. Solid and industrial hazardous waste management assessment options and action area to implement the National strategy, 2018
4. Biomass energy in Vietnam <https://www.bioenergyconsult.com/biomass-energy-vietnam/>
5. MOIT/GIZ. Business directory in sugar industry in Vietnam, 2017.
6. [https://databank.worldbank.org/data/views/reports/reportwidget.aspx?Report\\_Name=CountryProfile&Id=b450fd57&tab=y&dd=y&inf=n&zm=n&country=VNM](https://databank.worldbank.org/data/views/reports/reportwidget.aspx?Report_Name=CountryProfile&Id=b450fd57&tab=y&dd=y&inf=n&zm=n&country=VNM).
7. MOIT/GIZ (2017). Development Guidelines for Grid-connected Power Generation Project using Solid Waste in Viet Nam.
8. MONRE (2017). Current national environment situation in Vietnam. Chapter 2: Solid Wastes.
9. Decision no. 31/2014/QĐ-TTg on Feed-in-tariff (FIT) power generation projects using solid waste
10. Circular no. 32/2015/TT-BCT on project development and standardized power purchase agreement for SW
11. Decree 38/2015/ND-CP on waste and scrap management.
12. Hoang-Luong PHAM, Dowon SHUN and Le-Hoa TRAN. Chapter 1 - Assessment of solid waste and biomass potential for energy production in Vietnam, KIER 2019-0019 Project Final Project, submitted to Korea Institute of Energy Research, December 2019.

## TIỀM NĂNG SỬ DỤNG CHẤT THẢI RẮN ĐỂ SẢN XUẤT NĂNG LƯỢNG Ở VIỆT NAM

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