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Perspective

Perspectives on the Promotion of Solid Recovered Fuels in Taiwan

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Abstract: Due to the economic inefficiency of material recycling of general industrial waste and urban waste, the use of solid recovered fuels (SRFs) not only mitigates the environmental loadings from waste incineration plants and sanitary landfills but also creates green electricity and/or heat and thus reduces the use of fossil fuels. In this regard, the Taiwan government formulated the "Solid Recovered Fuel Manufacturing Guidelines and Quality Standards" in 2020 to ensure the manufacturing quality of SRFs. This paper focused on the status of waste management and energy supply, the current regulations for adopting SRFs, and the challenges in the development of SRFs from the viewpoints (or life cycle) of the environmental, economic, and engineering (or technological) characters in Taiwan. Based on the database of the official handbook/yearbook, the energy supply from indigenous biomass and waste was 1678.7 × 10^3 kiloliters of oil equivalent (KLOE) in 2021, which only accounted for about 1.2% of the total energy supply. Obviously, available indigenous biomass and waste for producing SRFs were mostly from waste wood, sugarcane bagasse, and mixtures containing wood/paper. Finally, some suggestions for the increasing use of SRFs in the energy and industrial sectors were addressed to keep in step with the sustainable development goals (SDGs) in 2030, especially in the mitigation of GHG emissions.

Keywords: solid recovered fuel; alternative energy; regulatory promotion; quality standard; Taiwan

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1. Introduction

In Taiwan, the dependence on imported energy ranged from 97.44 to 97.88% during the 2001–2021 [1], showing a significant shortage of self-produced energy (e.g., renewable energy) at this stage. Indigenous energy only supplied 3267.4 × 10^3 kiloliters of oil equivalent (KLOE) in 2021, accounting for 2.27% of the total energy supply. Of the indigenous energy supply in 2021, renewable energy was 3071.5 × 10^3 KLOE which was mostly generated from waste/biomass-to-energy (i.e., 1678.7 × 10^3 KLOE or 54.65% of the total renewable energy supply). In this regard, the combustion of imported fossil energy has resulted in significant emissions of greenhouse gas (GHG) from various sectors, especially in the energy and industrial sectors [2]. On the other hand, increasing amounts of industrial waste were generated from a variety of manufacturing activities, causing a heavy burden on waste treatment facilities in recent years. This situation was attributed to being permitted to co-incinerate non-hazardous industrial waste with municipal solid waste (MSW) since the early 2000s [3]. In order to reduce the dependence on imported energy supply, alleviate the environmental loadings from waste management, and mitigate GHG emissions, the Taiwan government has been actively promoting waste-to-power and waste-to-heat (steam) policies. In fact, most of these alternative fuels are mostly derived from biological waste (e.g., waste wood, sugarcane bagasse) and have been adopted by industrial utilities for heat (or steam) and electricity generation in the combined heat and power system (CHP) [4].

Since the early 2000s, the production of solid recovered fuel (SRF) from non-hazardous waste was a growing industry in the European Union (EU) countries because it was used as an alternative fuel in cement kilns and coal-fired power plants [5]. The production and use of SRFs not only represented a sustainable alternative for waste that cannot be used for material recycling due to economic inefficiency but also decreased the amount of non-hazardous waste in incineration plants and sanitary landfills [6]. However, the co-incineration of alternative fuels in coal-fired power plants, cement making, and other high energy-consuming industries required a substitute for fossil fuels without causing operative and technical constraints. Thus, SRFs must be subject to stringent quality standards regarding the most crucial characteristics [7]. In 2011, the EU announced a new directive (i.e., EN 15349) to define SRFs and their classification codes and standards based on the lower calorific value (net heating value), chlorine, mercury, and other metal contents (or concentrations) [6,8,9]. On the other hand, the sampling and analytical procedures must comply with the standard methods [10].

In Taiwan, refuse-derived fuel (RDF) from MSW has been used as a substitute fuel in cement making plants in the late 1990s, but it was commonly used for MSW-derived solid fuels without complying with the certified specifications and quality standards. Due to the lack of economic benefits, the production and use of RDF in Taiwan thereafter declined over the past two decades. However, the Taiwan Environmental Protection Administration (EPA) began to promote energy recovery from MSW, non-hazardous industrial waste, and biomass resources (e.g., swine manure, food waste) over the past decade under the promulgation of the Renewable Energy Development Act in 2009 [1]. On the other hand, with the promulgation of the EU regulation governing the classification and standards of SRFs since the early 2010s, the Taiwan EPA thus announced the "Multiple Waste Treatment Plan" in 2017, which focused on the anaerobic digestion of food waste for producing bio-electricity and the use of SRFs in industrial utilities [11]. Thereafter, the EPA further formulated the "Solid Recovered Fuel Manufacturing Guidelines and Quality Standards" on 1 April 2020 to ensure the manufacturing quality of SRFs.

To provide the perspective on the development and promotion of SRFs in Taiwan, the paper was divided into three main parts, including the background of waste management and energy supply, current regulations for adopting SRFs, and the challenges in the development of SRFs from the viewpoints (or life cycle) of the environmental, economic, and engineering (or technological) characters [12]. In addition, some suggestions for increasing the production and use of SRFs in the energy and industrial sectors were addressed to keep in step with the sustainable development goals (SDGs) in 2030, especially in the mitigation of GHG emissions.

2. Data Mining

As mentioned above, this paper covered three main aspects. Therefore, the data mining for analyzing the baseline information and discussing the challenges in the development of SRFs was briefly addressed below.

- Baseline data on waste management and energy supply in Taiwan

The annual statistics of waste management and energy supply in Taiwan were mostly compiled from the official open-access websites [1,13–15], which were established by competent authorities, such as the EPA and the Ministry of Economic Affairs (MOEA).

- Regulations for adopting SRFs in Taiwan

The regulations for the quality standards of SRFs have been established by the EPA. In addition, the relevant regulations governing alternative fuels were obtained from the official website, which was accessed by the Ministry of Justice (MOJ) via the Laws and Regulations Database [16].

- Challenges in the development of SRFs

In order to highlight the challenges in the development of SRFs in Taiwan, the environmental, economic, and engineering aspects were sequentially connected with the quality standards (i.e., heavy metal content, net heating value, and chorine content, respectively), which were extracted from the recently published papers based on the survey of academic research databases, such as Web of Science and Scopus. For example, the chlorine content in the SRF was closely related to process engineering due to the slagging and fouling (or agglomeration and deposition behaviors) [17,18].

3. Status of Waste Management and Energy Supply in Taiwan

3.1. Status of Waste Management

In Taiwan, the fundamental act for waste management (including collection/clearance, storage, treatment, and disposal) was based on the Waste Management Act (WMA). According to the definition of waste by the WMA, it was basically grouped into general waste and industrial waste [3]. The former also includes waste generated by the employees themselves in the industrial sector or industry activities. Furthermore, the waste is mainly categorized into general garbage, recyclable waste, and food (kitchen) waste. General garbage was mostly treated by large-scale MSW incineration plants. Recyclable waste was announced by the EPA as regulated (mandatory) recyclables, such as metal containers, plastic containers, paper, glass, and electronic/electrical appliances or devices [19]. Food waste was mainly reused as pig feed and composting material. In 2021, about 10,049,062 metric tons of general waste, including 3,895,153 metric tons of general garbage, 5,666,869 metric tons of recyclable waste, and 487,041 metric tons of general garbage, were generated [13]. It implied that the resource recovery (including recyclable waste and kitchen waste) rate reached 6.24% in 2021. Concerning general garbage management in 2021, 89.91% was incinerated and 10.09% was treated by other approaches (e.g., sanitary landfill).

In contrast, industrial waste is further divided into general industrial waste and industrial hazardous waste. To track the life cycle of industrial waste effectively (especially in sustainable waste management policy), the EPA established a regulatory framework via the “Industrial Waste Control Center” in 2000. According to the regulation, industrial waste generators must report the generation amount of waste and its management methods using the online system using the codes, where:

- A-type denotes manufactured hazardous industrial waste;
- B-type denotes industrial waste containing toxic chemical substances;
- C-type denotes biomedical/infectious waste and industrial waste identified by the standards;
- D-type denotes general industrial waste without recyclable value;
- E-type denotes scrap mixed metal;
- G-type denotes the renewable resource that has lost its original usefulness and is economically and technologically feasible to be recycled or reused, as announced by the EPA;
- R-type denotes industrial waste with recyclable value, as announced by the EPA.

Based on the official database [15], the reported generation amounts of industrial waste reached 21,950,312 metric tons in 2021, which was more than the previous year (i.e., 20,030,414 metric tons) [20]. They include general industrial waste, 16,590,691 metric tons, hazardous industrial waste, 1,715,315 metric tons, and renewable resources, 3,644,305 metric tons. As compared with the data in 2020 the corresponding amounts (percentages) of industrial waste treatment approaches by recycling (or reuse), self-treatment, commissioned/joint treatment, and exported treatment were 2,323,948 metric tons (10.59%), 822,485 metric tons (3.75%), 18,741,712 metric tons (85.38%), and 32,798 metric tons (0.15%), respectively. Figure 1 further depicted their percentages, which were indicated as follows: A-type (426,285 metric tons), B-type (3000 metric tons), C-type (899,714 metric tons), D-type (4,590,195 metric tons), E-type (60,015 metric tons), G-type (3,612,108 metric tons), and R-type (12,358,994 metric tons). Therefore, about 85.4% of them (i.e., 18,741,712 metric tons) in 2021 were reused and/or recycled because this approach basically referred to as the reuse/recycling of industrial waste as raw material, fuel, or others recognized by the EPA via self-use, sale, or commissioning.

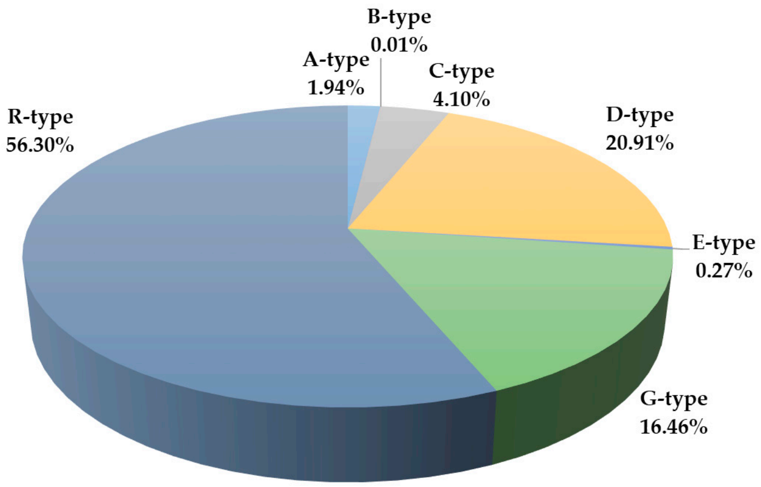

Figure 1. Categories and percentages of industrial waste generation in 2021 [15]. Each category of waste was defined as follows. A-type, manufactured hazardous industrial waste; B-type, industrial waste containing toxic chemical substances; C-type, biomedical/infectious waste; D-type, general industrial waste without recyclable value; E-type, scrap mixed metal; E-type, scrap mixed metal; G-type, renewable resource.

3.2. Status of Energy Supply

3.2.1. Energy Supply

According to the national energy statistics [1], the energy supply in Taiwan went from 106.49 million kiloliters of oil equivalent (KLOE) in 2001 to 143.97 million KLOE in 2021, indicating an average annual growth of 1.52%. Of this total energy supply in 2021, indigenous energy occupied 2.27% and imported energy thus accounted for 97.73%. In this regard, the dependence on imported energy in 2021 was about 97.44%. It should be noted that the percentage of indigenous energy supply indicated an increasing trend since 2004 because of the promotional development in renewable energy sources, including waste-to-power (or waste-to-energy), solar photovoltaic (PV), hydro power, wind power, and solar thermal energy. For example, the energy supply from solar PV indicated a significant increase from 0.1×10^3 KLOE in 2004 to 761.5×10^3 KLOE in 2021. Based on the classification by energy form, crude oil and petroleum products, coal and coal products, natural gas, nuclear power, biomass and waste, and other forms of renewable energy (including hydropower, geothermal, solar PV, wind power, and solar thermal) contributed 43.39%, 30.78%, 18.11%, 5.59%, 1.17%, and 0.97%, respectively, in 2021. In recent years, the EPA also set policies for promoting waste-to-energy, such as SRFs and biogas-to-power [4].

3.2.2. Waste-to-Energy

According to the official definition in Taiwan [21], biomass energy refers to one of the renewable energy types because it is generated from the direct use or treatment of domestic organic waste. Therefore, lignocellulosic waste or biomass is the largest biomass energy source for producing a variety of energy/fuel forms, including biogas, bioethanol, biodiesel, heat (or stream), and electricity. In 2021, the energy supply from indigenous biomass and waste was 1678.7×10^3 KLOE [1], which was only 0.35% more than the previous year (1672.9×10^3 KLOE in 2020). About 70% of the energy supply from indigenous biomass and waste was used for generating electricity from the MSW incineration plants. Obviously, indigenous biomass and waste was mostly from solid-type resources, including MSW (urban waste), waste wood, sugarcane bagasse, black liquor (a by-product of pulp from the Kraft process), and mixtures containing wood/paper. It should be noted that the woody waste and black liquor are originally from pulpwood, which could be partly imported from other Asian countries (i.e., Malaysia, Indonesia, and Thailand). These solid-type biofuels were generally reused as auxiliary fuels or solid recovered fuels (SRF) in industrial boilers, heaters, or burners.

4. Regulations for Adopting Solid Recovered Fuels in Taiwan

As mentioned above, although the government began to implement industrial waste and MSW minimization (i.e., waste reduction at the source and waste reuse/recycling) over the past two decades, the rapid industrial and economic development in recent years has resulted in higher waste treatment loadings. To promote the use of SRFs in industrial utilities, the EPA announced the "Multiple Waste Treatment Plan" in 2017 [11], which focused on SRFs from industrial waste with high calorific value. This approach not only reduces the environmental loadings from waste treatment facilities (i.e., MSW incineration plants and sanitary landfills) but also creates power generation and/or heat and thus decreases the use of fossil fuels. Currently, the high energy-consuming industries in Taiwan, especially in paper manufacturing, textile, and cement making, have adopted the use of SRFs in their industrial high-efficiency boilers and combustion facilities. To encourage the use of primary solid biomass and other combustible waste for reducing domestic coal consumption, the EPA promulgated the "Co-firing Ratios and Component Standards for Fuel Used in Stationary Pollution Sources" on 23 March 2020 under Article 28 of the Air Pollution Control Act. The EPA further formulated the "Solid Recovered Fuel Manufacturing Guidelines and Quality Standards" to ensure the manufacturing quality of SRFs on 1 April 2020. Table 1 lists the quality standards of solid recovered fuels (SRFs). Based on the quality items in Table 1, the use of SRFs in industrial utilities should prevent the emissions of heavy metals (i.e., Hg, Cd, and Pb), acid pollutants (i.e., sulfur oxides, hydrogen chloride), and dioxins/furans from the stationary sources. Table 2 summarized the waste categories used as feedstocks for producing SRFs, including biomass and fossil-derived waste.

Table 1. Quality standards of solid recovered fuels (SRFs) in Taiwan.

Quality Item	Limit	Testing Method	Sample Basis
Net calorific value [a]	≧10.0 MJ/kg (2392 kcal/kg)	CNS 10835	As received [b]
Chlorine (Cl)	≦3 wt%	EN 15408	db [c]
Mercury (Hg)	≦5 mg/kg	EN 15411	As received [b]
Lead (Pb)	≦150 mg/kg	EN 15411	As received [b]
Cadmium (Cd)	≦5 mg/kg	EN 15411	As received [b]

[a] Lower heating value. [b] Using wind-dried samples or moisture-constant samples. [c] Dry basis.

Table 2. Waste categories used as feedstocks for producing SRFs in Taiwan.

Waste Type	Item Name [a]	Reporting Code
Plastic	Waste resin	D-0202
	Mixture containing waste plastic	D-0202
	Waste plastic	R-0201
	Waste plastic container (PET)	R-0202
	Waste plastic container (PE)	R-0204
	Waste plastic container (PP)	R-0205
	Waste plastic container (PS foamed)	R-0206
	Waste plastic container (PS unfoamed)	R-0207
	Waste plastic container (Others)	R-0208
	Waste bioplastic container (PLA)	R-0211

Table 2. *Cont.*

Waste Type	Item Name [a]	Reporting Code
Rubber	Mixture containing waste rubber	D-0202
	Waste rubber	R-0301
Paper	Mixture containing paper	D-0609
	Waste paper	R-0601
Wood	Waste wooden pallet	D-0701
	Mixture containing wood	D-0799
	Waste wood	R-0701
Fiber	Waste fiber	D-0801
	Waste cotton flock	D-0802
	Waste cloth	D-0803
	Mixture containing fiber, cotton, or cloth	D-0899
	Waste synthetic fiber	R-0801
	Texture leftover	R-0802
Sludge	Pulp sludge	R-0904
	Texture sludge	R-0906
Animal-/plant-derived waste	Sugarcane bagasse	R-0102
Garbage	General waste from industrial activities	D-1801 [b]

[a] Abbreviation of plastic containers: PET—polyethylene terephthalate, PE—polyethylene, PP—polypropylene, PS—polystyrene, PLA—polylactic acid. [b] This sorted waste is combustible waste, which was obtained by mechanical treatment or mechanical biological treatment.

5. Challenges in the Development of Solid Recovered Fuels in Taiwan

Over the past two decades, considerable efforts have been made to produce qualified SRFs for heat and power generation in the industrial and energy sectors around the world, especially in the EU countries and Asian countries [7,22]. In the industrial sector, cement production may be responsible for a significant share of greenhouse gas (GHG) emissions, thus adopting the use of SRFs for reducing the consumption of fossil fuels and also mitigating GHG emissions from the waste management sector [23]. Based on the quality standards in Table 1 and the experiences in the use of SRFs in developed countries, however, the challenges in the development of SRFs in Taiwan must consider three main aspects: emission standards, economic benefits, and engineering modifications.

- Environmental standards
- According to the study on using different proportions of SRFs made by treated palm oil and others (i.e., coal ash, wood dust, and bentonite) [24], the results showed that the emissions of air toxics (e.g., heavy metals, dioxins, polycyclic aromatic hydrocarbons, and acidic gases) from industrial utilities (e.g., cement kiln, combustion chamber) in a CHP plant may be notable. Although the concentrations or levels of the emitted pollutants were lower than those of the discharge standards, it is necessary to adopt multiple air pollution control strategies for stationary sources. In this regard, some feedstocks (e.g., waste wood containing chromated copper arsenate) should be not used as auxiliary fuels the industrial utilities. In addition, the semi-dry (slurry lime) scrubber coupled with high-efficiency particulate control (e.g., bag filter) can be considered to be installed in the vent gas control system.
- Economic benefits
- The production of SRFs from non-hazardous waste (i.e., industrial general waste and MSW) mainly depends on large, reliable, available, homogeneous, and qualified amounts of high calorific fractions as input materials. In addition, these feedstocks for producing SRFs were also suitable for storage and transportation. In this regard, the

input heat, based on the calorific value of SRFs and its fed amount, will be related to the economic efficiency in energy production and/or power generation. Table 3 listed the reported generation amounts of lignocellulosic waste categories used as feedstocks for producing SRFs in Taiwan [15], showing a significant shortage of domestic available materials compared to large amounts of coal consumed annually in the energy and industrial sectors (over 60 million metric tons) [1]. To increase the diversified sources of SRFs and lower the cost in Taiwan, several biomass resources, including crop residues (e.g., corn cob) and waste-activated sludge (e.g., food processing sludge) can be used as feedstocks for producing SRFs.

Table 3. Reported generation amounts of lignocellulosic waste categories used as feedstocks for producing SRFs in Taiwan [a].

Lignocellulosic Waste Categories (Waste Code)	2016	2017	2018	2019	2020	2021
Mixture containing paper (D-0699)	214,996	202,614	248,303	209,097	204,647	232,907
Waste paper (R-0601)	2603	4277	3632	4120	3325	3476
Waste wooden pallet (D-0701)	3796	3444	2902	2312	2204	2005
Mixture containing wood (D-0799)	19,471	14,920	15,613	12,872	14,891	23,483
Waste wood (R-0701)	51,705	60,476	65,932	64,329	71,922	96,919
Pulp sludge (R-0904)	377,654	430,424	413,723	398,836	402,126	462,711
Textile sludge (R-0906)	42,509	47,358	45,264	53,837	53,734	61,243
Sugarcane bagasse (R-0102)	13,836	23,183	14,870	15,993	19,718	23,554

[a] Source: Ref. [15].

- Engineering modifications
- In order to evaluate the slagging and fouling tendency of solid fuels (e.g., coal) in industrial utilities, several indices have been developed to modify process engineering in recent years [25,26]. Table 4 summarized the suggested indices for slagging and fouling tendency when using SRFs in industrial boilers, including the alkali/acid ratio, the fouling index, the slagging index, the slag viscosity index, and chlorine content. Usually, these inorganic elements have been identified to cause operational problems during the coal/SRF co-firing in the combustion system [17,18]. To reduce the slagging and fouling tendency, some feedstocks containing high ash and sulfur contents (e.g., rubber, waste tire) for producing SRFs should be not used as auxiliary fuels for industrial utilities.

Table 4. Suggested indices for slagging and fouling tendency when using SRFs in industrial boilers.

Index	Expression by Molecule/Element Symbol [a]	Values	Tendency Degree
Alkali/acid ratio ($R_{B/A}$)	$R_{B/A} = (Fe_2O_3 + CaO + MgO + K_2O + Na_2O)/(SiO_2 + Al_2O_3 + TiO_2)$	<0.206	Low
		0.206–0.400	Medium
		>0.400	High
Slagging index (R_S)	$R_{B/A} \times S$	<0.6	Low
		0.6–2.0	Medium
		2.0–2.6	High
		>2.6	Severe

Table 4. *Cont.*

Index	Expression by Molecule/Element Symbol [a]	Values	Tendency Degree
Fouling index (R_F)	$R_{B/A} \times (K_2O + Na_2O)$	<0.6	Low
		0.6–40	Medium-high
		>0.400	Severe
Chlorine content	Cl	<0.2	Low
		0.2–0.3	Medium
		0.3–0.5	High
		>0.5	Severe
Slag viscosity index (S_r)	$100 \times SiO_2/(SiO_2 + Fe_2O_3 + CaO + MgO)$	>72	Low
		65–72	Medium
		<65	High

[a] Unit: wt% (dry basis).

6. Conclusions and Recommendations

Traditionally, MSW and industrial waste without pretreatment (e.g., sorting) may be often treated in large-scale incineration plants to exploit the energy potential in terms of electricity and/or heat. However, this approach often caused fewer energy efficiencies and serious air pollution due to the economic (e.g., calorific value) and environmental (e.g., chemical properties) characteristics. In this regard, the use of SRFs not only reduces the environmental loadings from waste treatment facilities (i.e., MSW incineration plants and sanitary landfills) but also creates power generation and/or heat and thus decreases the use of fossil fuels. Therefore, the Taiwan EPA announced the regulation (‘Solid Recovered Fuel Manufacturing Guidelines and Quality Standards”) to ensure the manufacturing quality of SRFs on 1 April 2020. The EPA also set Implementation Goals, with the number of SRFs reaching 390,000 metric tons in 2021. This paper summarized the updated data on waste management and energy supply in Taiwan and also highlighted the regulations for adopting SRFs based on the quality standards and available waste codes. In addition, the challenges in the development of SRFs in Taiwan were analyzed from the viewpoints of environmental, economic, and engineering aspects.

In order to promote the production and use of SRFs in Taiwan, some recommendations or solutions were addressed below:

- Expanding the available waste sources, including bamboo residues, spent mushroom compost, and biological sludge, which are in compliance with quality standards.
- Revising the quality standards of SRFs by adding the elements relevant to air toxins and slagging and fouling tendency.
- Increasing the production of SRFs from combustible MSW, which was used in high energy-consuming industries, such as steel manufacturing and cement making.
- Co-firing SRFs in coal-fired power plants for reducing the use of fossil fuels and GHG emissions.
- Surveying the concentrations (or levels) of the air pollutants emitted from the vent stack in the coal/SRF combustion systems.
- Increasing the feed-in-tariff (FIT) rates of SRF-to-power systems due to the capital and operating costs increased.
- Increasing the diversified sources of SRFs including crop residues (e.g., corn cob) and waste-activated sludge (e.g., food processing sludge).

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References

1. Ministry of Economic Affairs (MOEA, Taiwan). *Energy Statistics Handbook-2021*; MOEA: Taipei, Taiwan, 2022.
2. Environmental Protection Administration (EPA, Taiwan). *Taiwan Greenhouse Gases Inventory*; EPA: Taipei, Taiwan, 2021.
3. Tsai, W.T. Promoting the Circular Economy via Waste-to-Power (WTP) in Taiwan. *Resources* **2019**, *8*, 95. [CrossRef]
4. Lee, Y.R.; Tsai, W.T. Overview of biomass-to-energy supply and promotion policy in Taiwan. *Energies* **2022**, *15*, 6576. [CrossRef]
5. Sarc, R.; Seidler, I.M.; Kandlbauer, L.; Lorber, K.E.; Pomberger, R. Design, quality and quality assurance of solid recovered fuels for the substitution of fossil feedstock in the cement industry—Update 2019. *Waste Manag. Res.* **2019**, *37*, 885–897. [CrossRef] [PubMed]
6. Ferronato, N.; Mendoza, I.J.C.; Siñani, N.G.M.; Portillo, M.A.G.; Torretta, V. Perspectives in solid recovered fuel production in Bolivia: Analysis of characteristics and potential benefits. *Waste Manag.* **2022**, *144*, 324–335. [CrossRef] [PubMed]
7. Yang, W.S.; Lee, Y.J.; Kang, J.G.; Shin, S.K.; Jeon, T.W. Assessment of quality test methods for solid recovered fuel in South Korea. *Waste Manag.* **2020**, *103*, 240–250. [CrossRef] [PubMed]
8. Viczek, S.A.; Aldrian, A.; Pomberger, R.; Sarc, R. Origins of major and minor ash constituents of solid recovered fuel for co-processing in the cement industry. *Waste Manag.* **2021**, *126*, 423–432. [CrossRef] [PubMed]
9. Szydełko, A.; Ferens, W.; Rybak, W. Effects of calcium, sodium and potassium on ash fusion temperatures of solid recovered fuels (SRF). *Waste Manag.* **2022**, *150*, 161–173. [CrossRef] [PubMed]
10. Gerassimidou, S.; Velis, C.A.; Komilis, D. Establishing a sub-sampling plan for waste-derived solid recovered fuels (SRF): Effects of shredding on representative sample preparation based on theory of sampling (ToS). *Waste Manag.* **2020**, *113*, 430–438. [CrossRef] [PubMed]
11. Multiple Waste Treatment Plan (Environmental Protection Administration, Taiwan). Available online: https://www.ey.gov.tw/Page/448DE008087A1971/8f06d8fb-0864-41b3-911e-a8e31ed16b60 (accessed on 31 January 2023). (In Chinese)
12. Rigamonti, L.; Borghi, G.; Martignon, G.; Grosso, M. Life cycle costing of energy recovery from solid recovered fuel produced in MBT plants in Italy. *Waste Manag.* **2019**, *99*, 154–162. [CrossRef] [PubMed]
13. Environmental Protection Administration (EPA, Taiwan). *Yearbook of Environmental Protection Statistics 2021*; EPA: Taipei, Taiwan, 2022.
14. Energy Statistics (Bureau of Energy, Ministry of Economic Affairs, Taiwan). Available online: https://www.moeaboe.gov.tw/ECW/english/content/SubMenu.aspx?menu_id=8706 (accessed on 22 January 2023).
15. Industrial Waste Reporting and Management Information System (Environmental Protection Administration, Taiwan) (In Chinese). Available online: https://waste.epa.gov.tw/RWD/Statistics/?page=Month1 (accessed on 22 January 2023).
16. Laws and Regulation Retrieving System (Ministry of Justice, Taiwan). Available online: https://law.moj.gov.tw/Eng/index.aspx (accessed on 13 January 2023).
17. Szydełko, A.; Ferens, W.; Rybak, W. The effect of mineral additives on the process of chlorine bonding during combustion and co-combustion of Solid Recovered Fuels. *Waste Manag.* **2020**, *102*, 624–634. [CrossRef] [PubMed]
18. Gerassimidou, S.; Velis, C.A.; Williams, P.T.; Castaldi, M.J.; Black, L.; Komilis, D. Chlorine in waste-derived solid recovered fuel (SRF), co-combusted in cement kilns: A systematic review of sources, reactions, fate and implications. *Crit. Rev. Environ. Sci. Technol.* **2021**, *51*, 140–186. [CrossRef]
19. Tsai, W.T. Recycling waste electrical and electronic equipment (WEEE) and the management of its toxic substances in Taiwan—A case study. *Toxics* **2020**, *8*, 48. [CrossRef] [PubMed]
20. Tsai, C.H.; Shen, Y.H.; Tsai, W.T. Sustainable material management of industrial hazardous waste in Taiwan: Case studies in circular economy. *Sustainability* **2021**, *13*, 9410. [CrossRef]
21. Renewable Energy Development Act (Ministry of Economic Affairs, Taiwan). Available online: https://law.moj.gov.tw/ENG/LawClass/LawAll.aspx?pcode=J0130032 (accessed on 25 December 2022).
22. Štofová, L.; Szaryszová, P.; Mihalčová, B. Testing the bioeconomic options of transitioning to solid recovered fuel: A Case Study of a thermal power plant in Slovakia. *Energies* **2021**, *14*, 1720. [CrossRef]
23. Khan, M.M.H.; Havukainen, J.; Horttanainen, M. Impact of utilizing solid recovered fuel on the global warming potential of cement production and waste management system: A life cycle assessment approach. *Waste Manag. Res.* **2021**, *39*, 561–572. [CrossRef] [PubMed]
24. Kuo, Y.M.; Huang, S.W.; Kuan, W.Y. Characteristics of emissions from reclamation of solid-recovered fuel (SRF) in a cogeneration plant. *Aerosol. Air Qual. Res.* **2021**, *21*, 210112. [CrossRef]
25. Chen, C.; Bi, Y.; Huang, Y.; Huang, H. Review on slagging evaluation methods of biomass fuel combustion. *J. Anal. Appl. Pyrolysis* **2021**, *135*, 105082. [CrossRef]
26. Lachman, J.; Balas, M.; Lisy, M.; Lisa, H.; Milcak, P.; Elbl, P. An overview of slagging and fouling indicators and their applicability to biomass fuels. *Fuel. Process. Technol.* **2021**, *217*, 106804. [CrossRef]