Revista de Ciencias Tecnológicas (RECIT). Universidad Autónoma de Baja California ISSN 2594-1925
Volumen 6 (4): e265. Octubre-Diciembre, 2023. https://doi.org/10.37636/recit.v6n4e265

Review

Sustainable practices for the efficient use of green energy in Ciudad Juárez SMEs

Prácticas sostenibles para el uso eficiente de energía verde en PyMEs de Ciudad Juárez

Georgina Elizabeth Riosvelasco-Monroy, Alicia Rojas-Ramírez, Salvador Noriiega-Morales

Universidad Autónoma de Ciudad Juárez, Av. Plutarco Elías Calles #1210 Fovissste Chamizal Ciudad Juárez, Chihuahua, México

Corresponding autor: Georgina Elizabeth Riosvelasco Monroy, Universidad Autónoma de Ciudad Juárez, Av. Plutarco Elías Calles #1210 Fovissste Chamizal Ciudad Juárez, Chihuahua, México. E-mail: georgina.riosvelasco@uacj.mx. ORCID: 0000-0001-9833-7194.

Abstract. - *Carbon emissions have been increasing due to economic growth and development. Fossil-based energy is one of the main factors of environmental pollution. In Mexico, 77.24% of fossil-based energy is from stationary source combustion, 15.7% from industry processes and commercial activities, 6.64% from mobile sources, and 0.05% from agriculture and livestock activities. Specifically, manufacturing operations use 33.4%, of the total consumption of electricity and natural gas. Because the production of green energy is from naturally regenerating sources and does not emit greenhouse gases or compounds, decreases the environmental impact, and because they are able to apply to manufacturing operations, it is pertinent the efforts in this sense. The article presents the PRISMA 2020 as a methodology for searching between distinct databases and current research with the objective of identifying variables and their measurements so micro, small, and mid-size enterprises in Ciudad Juarez, Chihuahua, Mexico can develop collaboration strategies towards a sustainable manufacturing environment. The literature review resulted in the identification of six green energy indicators and their measurements.*

Keywords: SMEs; Sustainable manufacturing; Energy efficiency.

Resumen. - *Las emisiones de carbono han ido en aumento debido al crecimiento y desarrollo económico. La energía de origen fósil es uno de los principales factores de contaminación ambiental. En México 77.24% de la energía de origen fósil proviene de la combustión de fuentes estacionarias, 15.7% de procesos industriales y actividades comerciales, 6.64% por fuentes móviles y 0.05% actividades agropecuarias. En concreto, las operaciones manufactureras utilizan el 33,4%, del consumo total de electricidad y gas natural. Debido a que la producción de energía verde es a partir de fuentes que se regeneran naturalmente y no emiten gases o compuestos de efecto invernadero, disminuye el impacto ambiental, y porque son capaces de aplicarse a las operaciones de fabricación, es pertinente los esfuerzos en este sentido. El artículo presenta el PRISMA 2020 como metodología de búsqueda entre distintas bases de datos e investigaciones actuales con el objetivo de identificar variables y sus mediciones para que las micro, pequeñas y medianas empresas de Ciudad Juárez, Chihuahua, México puedan desarrollar estrategias de colaboración hacia un entorno de manufactura sustentable. La revisión bibliográfica dio como resultado la identificación de seis indicadores de energía verde y sus mediciones.*

Palabras clave: PyMEs; Manufactura sostenible; Eficiencia energética.

ISSN: 2594-1925

1. Introduction

Globally, fossil-fuel usage represents an 80% of the energy, being carbon dioxide (CO_2) responsible for the 60-75% of the total emissions [1, 2].

By 2020, the first five countries with higher energy production are China, United States of America, Russia, Saudi Arabia and India with 19.75%, 15.26%, 10.10%, 4.30% and 4.01%, respectively; while Mexico descended two places setting in seventeenth place with a 1.05% of the energy produced worldwide [3].

This usage is nowadays visible environmentally and economically in climate change. Crude oil, coal, natural gas, green energy and uranium (nuclear energy) represent the primary energy produced globally, with a 29.85%, 26.98%, 23.47%, 14.77% and 4.93%, respectively. From this energy production, comes an energy consumption.

Energy consumption is the amount of energy used to conduct any kind of activity from industrial, commercial or domestic sectors, even though the energy intensity depends on the countries' energy infrastructure [4].

CO_2 emissions have been increasing due to economic growth and development, due to the economy's dependence on fossil fuel leading to an intensified greenhouse effect.

Indistinctively from the kind of usage of fossil-fuel energy, it must be used consciously and efficiently because it is limited on sources [5], for fossil-fuel combustion releases carbon dioxide (CO_2) emissions causing environmental degradation, unsustainable fossil resources use, among other negative consequences for Earth [6].

Energy efficiency and green energy usage are gaining strength globally to promote sustainable development and boost green economic growth. As mentioned by [4], green energy in OECD countries accounted for 10.5% of the total energy, where 15.2% supplied by Europe, a 9.1% from America, 5.5% by Oceania and Asia.

Technologies, practices and assessments in industrial energy consumption have the goal to implement improvements and motivate sustainable development for enterprises to incorporate green energy sources in energy consumption within processes related to production [7, 8].

From the EU strategy to implement energy policy [9], China's attempt to strengthen green energy enterprises with tax incentives [10], countries are adopting different practices focused on environmental responsibility.

Even though, green energy consumption contributes to environmental problems, its adoption requires certain energy strategies and investments depending on the enterprise's needs. Research has increased in regard of green energy quantitative and qualitative perspectives, trying to propose different aspects both negative and positive towards a green energy development [11, 12].

Yet, it lacks a systematic review identifying green energy indicators and their measurements, which guide SMEs towards strategic and collaborative practices within a sustainable manufacturing development.

In Mexico, green energy resources, infrastructure and strategies are still limited in its development and growth within economic sectors, having a gap between Mexico's involvement and other OECD countries [13, 14].

Mexico's green energy consumption represents a 9.74% of the total energy consumption versus

ISSN: 2594-1925

European Union that represents 37.40% from their total energy consumption [15, 16].

Research is limited, [17] in 2014 presents how Mexico can generate green energy from natural sources due to geographical position. More specifically, in Juarez City, Chihuahua, Mexico, a known industrial city at the north of the Mexican Republic and border with El Paso, Texas has a bilateral economic movement, that incentivizes SMEs startups, new business models and entrepreneurial environment. However, green energy research applied in Juarez City is scarce and limited.

From seminal research, that presents different initiatives of green energy production projects and their maturity level, by identifying the entities interested in research and development green energy projects [18].

To research where a structural equation model is developed between Green Supply Chain Management and four items within maquiladora industry [13].

Research has yet lack a PRISMA 2020 method within green energy context. Therefore, this paper presents an application of PRISMA 2020 method for a systematic review of the literature to obtain green energy sustainable indicators and measurements [19, 20], where SMEs in Juarez City can collaborate in sustainable manufacturing actions towards a green energy usage, thus, replacing fossil-fuel usage.

The rest of the article is as follows. Section 2 describes a background of Mexico's green energy sources and consumption within the industry sector, and furthermore, Juarez City, Chihuahua position as an industrial city to promote green energy sustainable practices. Section 3 describes a literature review in green energy consumption, barriers and driving factors analysis through the PRISMA methodology.

Section 4 presents the indicators and their measurements, which were identified by the PRISMA 2020 methodology. Section 5 describes the conclusions and recommendations for further research in green energy sources and sustainable practices in the industry sector.

2. Background

2.1 Energy in Mexico

In Mexico, different types of fossil-fuels sources produce energy; the highest of them all is natural gas with a 49.11%, crude oil with a 36.30%, followed by coal and uranium with a 3.06% and a 1.61%, respectively; and green energy sources generate in a 9.74% [3].

In Mexico, from 1990 to 2015, energy consumption increased a 74.1% the origin of which is petroleum and natural gas; by 2021, the transport sector represents a 51.55% of the total energy consumption, followed by the industry sector with a 21.34%, residential and commercial sector with a 17.42% and agribusiness with a 3.31% [3, 21], data presented in Table 1.

ISSN: 2594-1925

Table 1. Sector consumption in Mexico [3].

		Transport	Industry	Residential/Commercial	Agribusiness
Energy		**51.55%**	**21.34%**	**17.42%**	**3.31%**
Gas	Dry Gas	0.06%	32.65%	4.20%	
Liquid	Fuel Oil	0.14%	1.26%		
	Diesel	25.70%			70.36%
	Liquid Gas	2.17%	3.34%	31.91%	2.42%
	Gasoline	66.93%	0.13%		
	Kerosene			0.01%	
Solid	Coal		5.53%		
	Coal Coke		4.20%		
	Petroleum Coke		11.02%		
Biomass	Bagasse		4.09%		
	Firewood			26.10%	
Green	Solar		0.11%		
Electric		0.20%	32.98%		27.21%

As Table 1 shows, fossil-fuel energy is the most used in Mexico by the different sectors, and even though Transport sector has the highest percentage of energy usage, the Industry sector is the one sector that uses a variety of types of fuels for energy, and the only sector that uses green energy as a source. From the production perspective, Mexico has a potential geographical location and climate conditions to produce green energy, such as solar, wind, biomass, hydropower and geothermal [17], sources that can boost green energy consumption in manufacturing processes within the industry sector. Mexico's enterprises can incorporate green energy initiatives engaging in energy efficiency programs and strategies to reach a reduction in greenhouse gas emissions [8, 22, 23]. For enterprises to improve and enable changes in manufacturing processes, a framework of indicators and their measurement should be presented in a way for businesses to adopt sustainable practices.

2.2 Energy in Juarez City, Chihuahua

Juarez city, Chihuahua is located at the north of Mexico in the border with Doña Ana, New Mexico and El Paso, Texas, with a territorial extension of 6,561.14 km2. The town's geographical coordinates are 31°47' latitude north; 31°07' latitude south; 106°11 latitude east; and, 106°57 latitude west [24]. Juarez City geographical position, with an altitude of 1,137 meters above the sea offers a desert weather condition, presenting high temperatures in summer sometimes exceeding the 40 degrees Celsius, and a cold winter reaching sub-zero temperatures. The industry sector, ranking first in energy demand with a 54% of the total energy production, is integrated of 2,589 enterprises,

ISSN: 2594-1925

being a 90% micro, small and mid-size enterprises with 2,337 economic units [18, 25]. Even though Juarez City shows interest in green energy production, it has few projects that have been materialized in green energy, as shown in Table 2 the types of green energy projects and its maturity level.

Table 2. Juarez city green energy projects [18].

Green Energy	Installed Capacity	Technology Level
Biogas (landfill site)	6.4 MW	Maturity
Photovoltaic Solar Energy	221kW	Maturity
Photothermal Solar Energy	--	Maturity
Wind Energy	5kW	Maturity
Biofuel	--	Innovation
Alternative fuels*	--	Innovation
Hydroelectric	--	Maturity
Geothermal Energy	--	Maturity

*Alternative fuels from clothes, tires, organic solid waste, cellulose, cooking oil.

Several private and public organizations and institutions, as well as non-profit organizations and universities are developing the projects mentioned above. This research presents opportunity and strength in Juarez City for green energy adoption within the industry sector, because the initial research and technology development are already in a maturity level [18].

3. Methodology

Because the production of green energy is from naturally regenerating sources and not emit greenhouse gases or compounds, decreases the environmental impact, and because they are able to apply to manufacturing operations [26], it is pertinent the efforts in this sense. For this reason, this article begins with the identification of green energy indicators and their measurements applying the PRISMA statement 2020. The data obtained was screened using the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) methodology as recommended by [19, 20]. In "Figure 1: Literature review following PRISMA 2020 methodology" shows the flow diagram that follows the criteria taken into account for better reporting relevant records associated in the literature review to identify green energy indicators and their measurements.

ISSN: 2594-1925

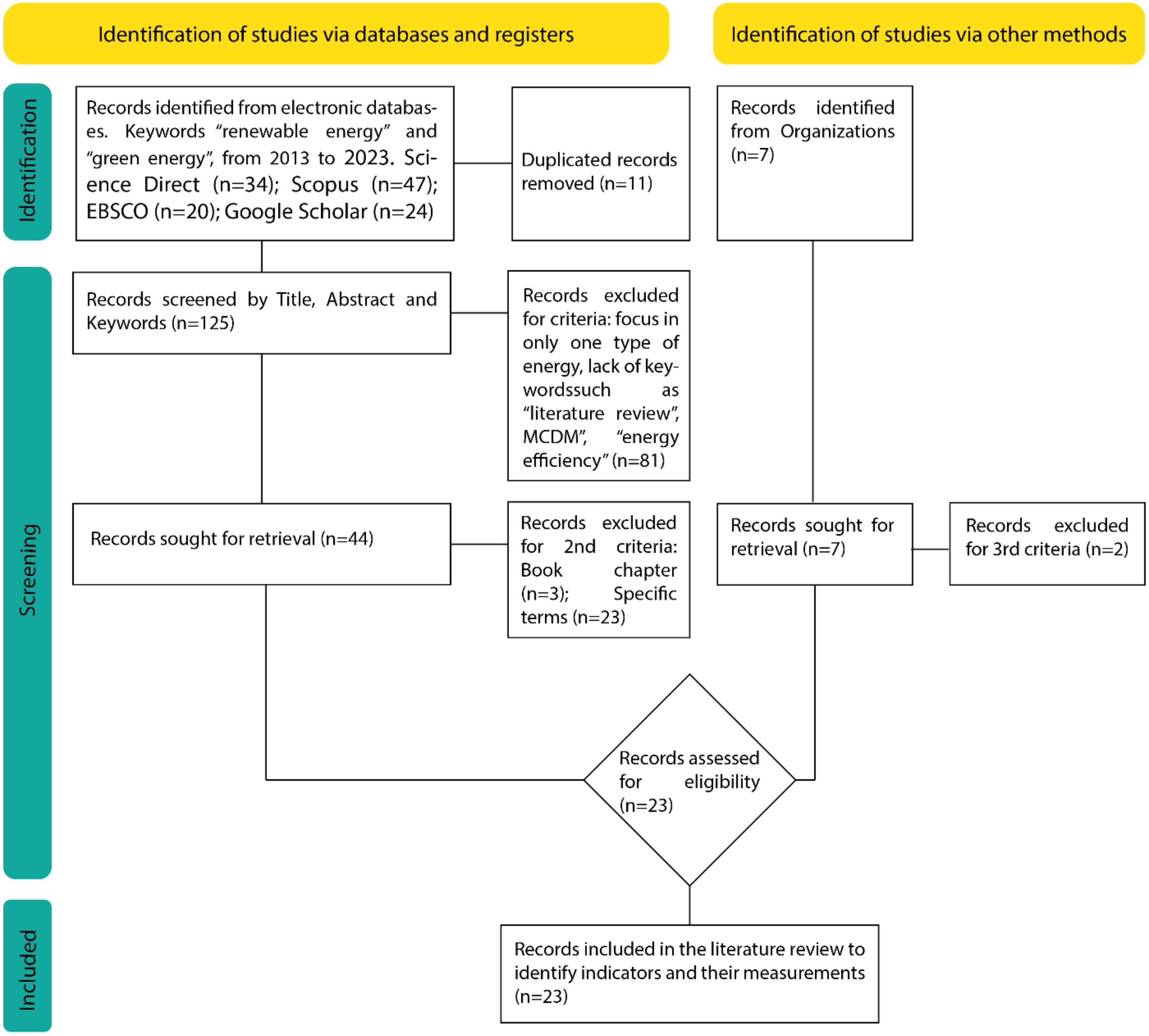

Figure 1. Literature review following PRISMA 2020 methodology.

The authors employed the PRISMA 2020 method to include and exclude records from Science Direct, Scopus, EBSCO and Google Scholar, and other methods through records from organizations. For the literature survey, the search terms "renewable energy factors" AND "green energy" were applied, in a year range from 2013 to 2023, initially obtaining 103 records by eliminating 11 duplicated records. Then, the authors excluded records for not meeting the criteria in the initial screening in Title, Abstract and Keywords. In such a case, the results were reduced to 44 records. Furthermore, only articles, reviews and reports were chosen for the current study, published in English-language and those that had complete access to the entire document, reducing the included records to 23. From this point on, the articles were analyzed by year of publication. In "Figure 2: Year base publications of included records" shows that 2021 is the year where the largest number of articles reviewed are focused on, followed by 2022 with 3 records and 2023 with 2 records. This is an interesting observation taking into account that the United Nations in 2015 adopted the 2023 Agenda and its Sustainable Development Goals. Enterprises are working towards an industrial symbiosis where the

ISSN: 2594-1925

substitution of fossil-fuel can be diminished little by little to open way for green energy production and consumption, where products are being reused or recycle [27].

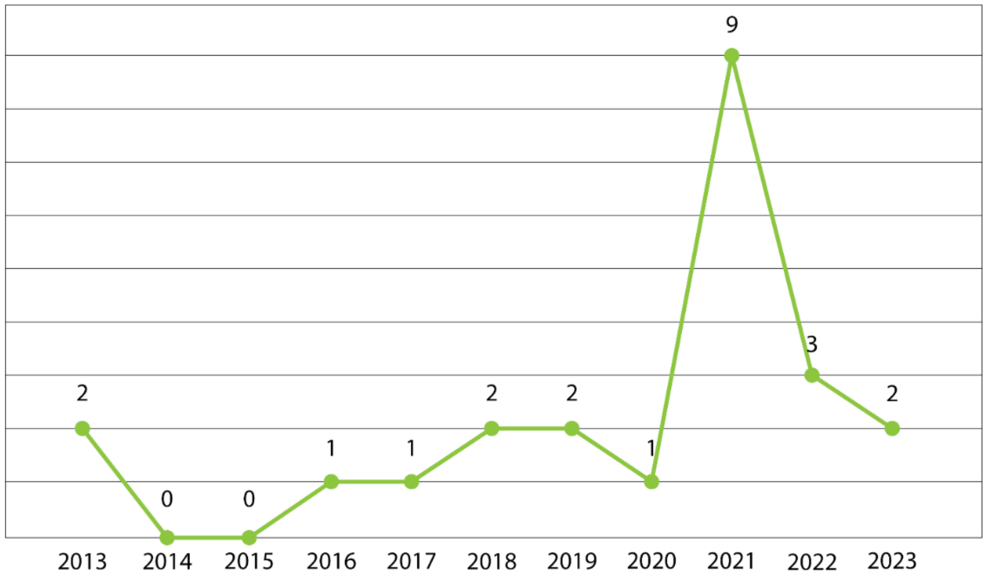

Figure 2. Year base publications of included records.

Additionally, the records screened and reviewed were graphed by Journal publication. In "Figure 3: Journal publication of included records" presents the Journal Sustainability as the journal with more articles published in the renewable energy sector, with five records. Following, the journal Energies with three records and last, Renewable and Sustainable Energy Reviews with two articles.

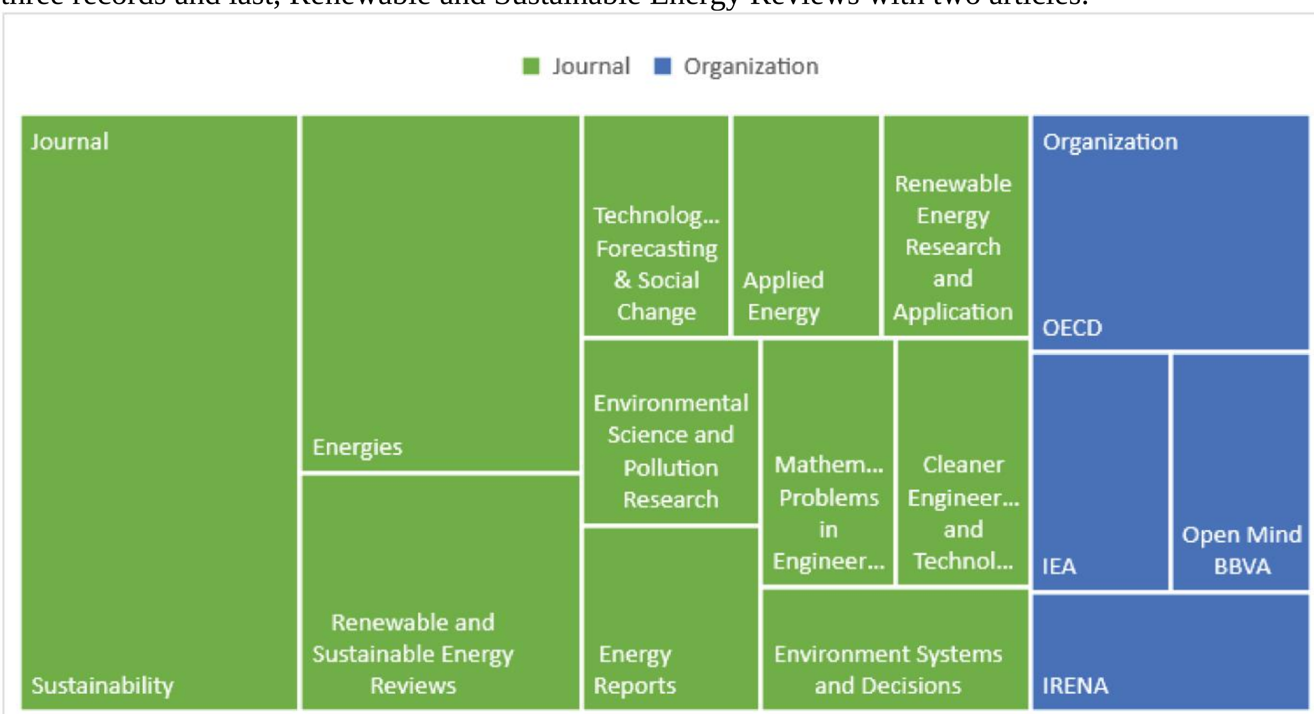

Figure 3. Journal publications of included records.

ISSN: 2594-1925

Mexico is one of the N-11 nations that have not invested in green energy sectors, despite the global efforts to decrease the environmental problems caused by fossil-fuel energy [12]. In the Sustainability journal, research presents different in depths of green energy usage, comprehension, and quantitative analysis, among other. From a description of the importance of R&D in green energy sources to the knowledge and awareness of society in this matter [28, 29], to invest in green energy factors such as democratic ecological footprint, economic growth, and environmental regulations, to have a more efficient energy usage [2].

3.1 Green Energy Indicators and its Measurements

Every transition towards green energy consumption begins with the production of green energy sources, emphasizing in green energy policy, technology-push and market-pull [30]. As described by [27], the industry sector has an important goal to decrease CO_2 emissions and have a positive effect in climate change by practicing measures towards usage efficiency in materials and energy. Nevertheless, this sector depends on a number of variables on the industry sector such as geographical location, government policy, technological and innovation source, adaptation and resilience challenges, among others [31–34]. On the other hand, adapting sustainable practices towards green manufacturing, enterprises seek benefits such as reputation and brand image, consumers' preference on green products and services, and a positive change in economic performance [35, 36]. From the systematic review, six indicators were identified (1) Technology and Innovation, (2) Geographical Aspects, (3) Investment, (4) Government Regulations, (5) Emissions, and (6) Sustainable Practices as shown in Table 2. Each indicator was related to their respective measurements appropriate for creating and adapting green energy in sustainable manufacturing for SMEs.

Table 2. Green Indicators and their Measurements.

Indicator	Measurements	Scholars	Description
Technology & Innovation	Technological Development	[31, 32, 37–39]	Technology applied for production processes; technology maturity; efficient use of technology; technology R&D
	Collaboration Capacity	[6, 31, 40]	Intellectual Property on innovations; promote technology transfer and cooperation; address competitiveness issues; accelerate diffusion; coordination among Research Centers, Universities and other enterprises
Geographical Aspects	Soil Water Energy	[17, 27, 34, 38]	Land requirement; environmental impact; resource availability and use efficiency; total energy and source consumption intensity; ground water pollution

ISSN: 2594-1925

Investment	Human Capital	[6, 31, 34, 40, 41]	Efficient use of skills and knowledge of human resources; invest in new human resources; training in green energy usage and resources
	Energy Efficiency	[12, 27, 38, 39, 42, 43]	Energy intensity and final consumption; investments in opportunity areas for renewable energy projects; enhancing renewable energy deployment; share of green energy installed capacity
	Supply Chain Connection	[32, 34, 40, 44]	Establishment on an industry chain; green energy industry manpower; market development plans; accessibility and facility simplicity; flexibility
Government Regulations	Policy	[12, 32, 37, 41, 42, 44, 45]	Environmental regulations and policies; establishment and diffusion in green energy practices; coordination with R&D institutions; green certificates; green power purchase legislations
	Incentive		Incentive measures; preferential purchase prices rates, financial subsidies; Economic returns on green energy projects; Facilitating green energy deployment; Risk investment green energy analysis
Emissions	Indicators	[27, 32, 34, 37, 38, 41, 44–46]	Investment costs; ground, water and air pollution impacts; energy consumption per unit of production; direct energy consumption carbon, heat and electricity footprint; innovation policy
Sustainable Processes	Residual	[7, 12, 27, 33, 34, 37, 38, 40]	No use of hazardous materials or virgin material for products in the production process; Production processes designed to avoid waste
	Reduce		Minor use of material per unit of production; Product design with increased durability
	Reuse		Reuse material in production; Use of waste as input material; Resale of products with minimum defect, Unsold product on inventory; Use discarded components and adapt them for other functions
	Repair		Repair and maintenance of products; Collect defective products in centers (branches or points of sale) through the manufacturer or a third-party company
	Refurbish		Modular product design for ease of disassembly; Disassembly of the overall product structure, checking, cleaning, and potentially repairing components
	Recycle		Recovering the product at the end of its useful life; Ensure the use of recycled raw materials
	Recover		Capture energy from residuals

ISSN: 2594-1925

4. Results and discussions

As mentioned above, CO_2 emissions have increased due to the economic growth and development. From the United Nations to the International Energy Agency, organizations that have developed programs, research and goals such as the Sustainable Development Goals and the Paris Agreement, have triggered awareness and public concern in environmental issues, specifically in SDG 7 for Affordable and Clean Energy, the focus is in green sustainable business practices. As explain by [47], a way to achieve green economy is by changing business practices with regulatory measurements, financial green incentives, sustainable consumption, information sharing, among other activities. SMEs play an important role in each country's economy. In Mexico, they account for 99.7% of private enterprises, and a 35.2% of national total gross production [48]. As it is known, SMEs present certain deficits when new challenges arise. Green energy adoption within manufacturing processes, SMEs have to establish a degree of flexibility and resilience not just in establishing an industry chain, technological indicators, upgrades in machinery; but also, in human capital training or new recruitment [46, 49].

This paper presented a systematic review by applying PRISMA 2020 methodology to the literature review with the objective of identifying green energy indicators and their measurements. This methodology has not been found applied in the field of green energy literature. From an initial screening in several databases, 103 articles were identified and following the PRISMA 2020 diagram flow the resulted records included were 23. From these records, the resulted indicators were six, such as (1) Technology and Innovation; (2) Geographical Aspects; (3) Investment; (4) Government Regulations; (5) Emissions; and, (6) Sustainable Processes, each with their respective measurements variables as shown in Figure 4. The six indicators and their measurements show a path towards SMEs transitioning to sustainable manufacturing, to complement each step of the value chain to reach reduction of waste and water usage, lower heating and energy loads [22], [33], [50]. The latter is to ease enterprises management to develop green energy sustainable practices within their manufacturing processes.

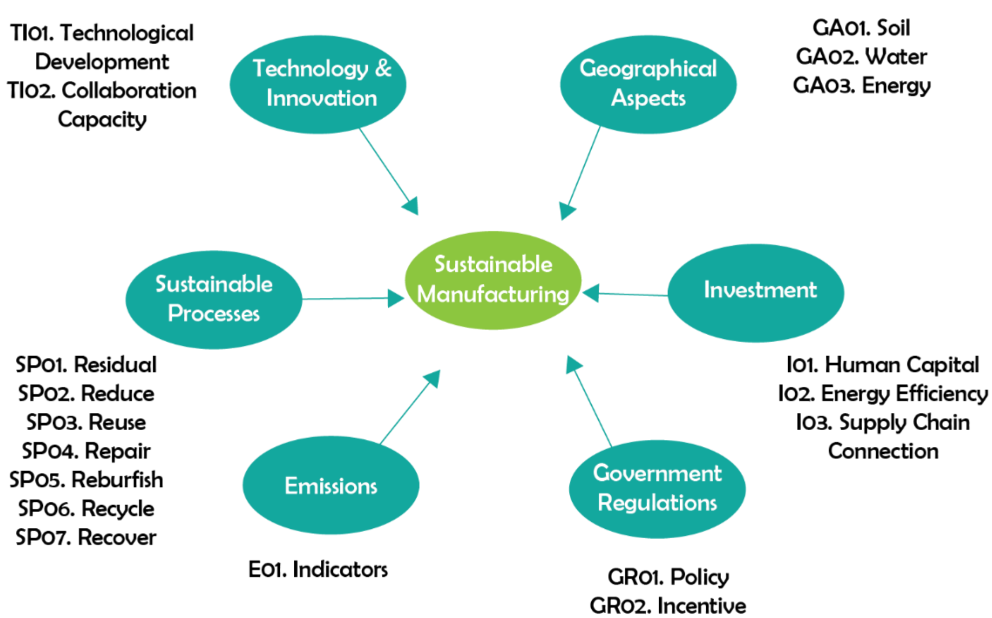

Figure 4. Green energy indicators and their measurements towards a Sustainable Manufacturing.

ISSN: 2594-1925

4. Conclusions

SMEs are accounted for as pollution-intensive because they account for an approximately 90% of economic units, a 60% of employment and a 60% of value added [33]. Enterprises in the industry sector are making efforts to achieve sustainable manufacturing and mitigate environmental pollution. However, these efforts cannot provide effective results unless certain metrics and sustainable practices are implemented properly; this information is still under development and is not available to manufacturing plants. As [40] mentions, SMEs can contribute successfully to the environmental problems by replacing fossil-fuel consumption with green energy consumption. By developing a PRIMSA 2020 method, the authors identified 6 green energy indicators and 18 measurements to mitigate SMEs' challenges and barriers to implement green energy within manufacturing processes. From a process efficiency to waste disposal and disruptive product design with reuse of raw material and infrastructure efficiency, SMEs can demonstrate that changes can be made to reduce emissions. In this context, this research probes the impacts and importance of indicators on energy usage and emissions, and sustainable practices through R's techniques and by a systematic literature review with the PRISMA 2020 from 2013 to 2023. The main contribution in green energy adoption is towards SMEs businesses; by delimiting entrepreneurs, six indicators that can aid develop sustainable practices within manufacturing processes. SMEs can work in a sustainable manufacturing process by taking into account strategic actions within the six green energy indicators (1) Technology and Innovation, (2) Geographical Aspects, (3) Investments, (4) Government Regulations, (5) Metric and Emissions, and (6) Sustainable Processes. A collaboration between SMEs that have a similar geographical position can create opportunities in implementing sustainable actions for a green energy transition to mitigate CO_2 emissions. For future research, an in-depth analysis of structural equation model of the indicators and their measurements should be performed with a bigger sample in the Industry and Commercial sector, taking into account micro, small, mid-size and big enterprises.

5. Acknowledgement

This research received funding as part of the main author's scholarship given by the National Council for Science and Technology.

6. Authorship acknowledgement

Georgina Elizabeth Riosvelasco-Monroy: Conceptualization; Methodology; Validation; formal analysis; Investigation; Resources; data curation; Writing - review and editing; Display; Supervision; Project administration; Fund acquisition. *Alicia Rojas-Ramírez*: Conceptualization, Writing - Original draft; Methodology; Investigation. *Salvador Noriega-Morales*: Conceptualization; Methodology; Validation; Investigation; Supervision; Project administration.

References

[1] Secretaría de Medio Ambiente y Recursos Naturales, "Informe de Resultados del Registro Nacional de Emisiones 2015-2018," 2020. [Online]. Available: https://www.gob.mx/cms/uploads/attachment/file/776803/informe_rene_emisiones_2015-2018.pdf

[2] CONACYT, "Energía verde y eficiencia para el sector industrial, comercial y residencial," 2022. [Online]. Available: https://conahcyt.mx/wp-content/uploads/pronaces/micrositios/energia_y_cambio_climatico/energia/policy_briefs/Policy_Brief_III_Pronaces_ECC.pdf

[3] M. J. Pereira Blanco, "Las energías renovables: ¿Es posible hablar de un derecho energético ambiental? elementos para una discusión," Jurídicas

ISSN: 2594-1925

CUC, vol. 11, no. 1, pp. 233-254, Sep. 2015, https://doi.org/10.17981/juridcuc.11.1.2015.10

[4] OpenMind BBVA, "La búsqueda de alternativas a los combustibles fósiles," 2023. Accessed: Jul. 08, 2023. [Online]. Available: https://www.bbvaopenmind.com/ciencia/medioambiente/alternativas-combustibles-fosiles/

[5] J. F. Dong, Q. Wang, C. Deng, X. M. Wang, and X. L. Zhang, "How to move china toward a green-energy economy: From a sector perspective," Sustainability (Switzerland), vol. 8, no. 4, 2016. https://doi.org/10.3390/su8040337

[6] Secretaría de Energía, "BALANCE NACIONAL DE ENERGÍA," 2021. [Online]. Available: https://www.gob.mx/cms/uploads/attachment/file/805509/BNE-2021.pdf

[7] S. Yu, J. Liu, X. Hu, and P. Tian, "Does development of renewable energy reduce energy intensity? Evidence from 82 countries," Technol Forecast Soc Change, vol. 174, Jan. 2022, https://doi.org/10.1016/j.techfore.2021.121254

[8] M. R. A. Bhuiyan, H. Mamur, and J. Begum, "A brief review on renewable and sustainable energy resources in Bangladesh," Cleaner Engineering and Technology, vol. 4. Elsevier Ltd, Oct. 01, 2021. https://doi.org/10.1016/j.clet.2021.100208

[9] OECD, "SMEs and Green Growth: Promoting sustainable manufacturing and eco-innovation in small firms," 2010. [Online]. Available: https://www.oecd.org/cfe/smes/46404383.pdf

[10] M. Patterson, P. Singh, and H. Cho, "The current state of the industrial energy assessment and its impacts on the manufacturing industry," Energy Reports, vol. 8. Elsevier Ltd, pp. 7297-7311, Nov. 01, 2022. https://doi.org/10.1016/j.egyr.2022.05.242

[11] J. Giera and E. Kulińska, "Risk factors in a logistics company using renewable energy sources," Energies (Basel), vol. 14, no. 23, Dec. 2021, https://doi.org/10.3390/en14238152

[12] B. Asadov and E. Asadov, "New environmental policy of the European Union: Some aspects of transition to green energy," in IOP Conference Series: Earth and Environmental Science, Institute of Physics, 2022. https://doi.org/10.1088/1755-1315/1096/1/012034

[13] X. Fu and S. Tang, "The Impact of Tax Policy on Performance of Green Energy in Power Industry," Energy Reports, vol. 8, pp. 862-867, Dec. 2022, https://doi.org/10.1016/j.egyr.2022.12.087

[14] Z. Fatima, V. Oksman, and R. Lahdelma, "Enabling small medium enterprises (Smes) to become leaders in energy efficiency using a continuous maturity matrix," Sustainability (Switzerland), vol. 13, no. 18, Sep. 2021, https://doi.org/10.3390/su131810108

[15] J. Wang, S. You, E. B. Agyekum, C. Matasane, and S. E. Uhunamure, "Exploring the Impacts of Renewable Energy, Environmental Regulations, and Democracy on Ecological Footprints in the Next Eleven Nations," Sustainability (Switzerland), vol. 14, no. 19, Oct. 2022, https://doi.org/10.3390/su141911909

[16] J. L. García Alcaraz et al., "Effect of Green Supply Chain Management Practices on Environmental Performance: Case of Mexican Manufacturing Companies," Mathematics, vol. 10, no. 11, Jun. 2022, https://doi.org/10.3390/math10111877

[17] M. Chen, W. Jiandong, and H. Saleem, "The role of environmental taxes and stringent environmental policies in attaining the environmental quality: Evidence from OECD and non-OECD countries," Front Environ Sci, vol. 10, Nov. 2022, https://doi.org/10.3389/fenvs.2022.972354

[18] P. F. Borowski, "Mitigating Climate Change and the Development of Green Energy versus a Return to Fossil Fuels Due to the Energy Crisis in 2022," Energies (Basel), vol. 15, no. 24, Dec. 2022, https://doi.org/10.3390/en15249289

ISSN: 2594-1925

[19] SEMARNAT, "Informe de Resultados del RENE 2015-2018," 2020. [Online] Available: https://www.gob.mx/cms/uploads/attachment/file/776803/informe_rene_emisiones_2015-2018.pdf

[20] G. S. Alemán-Nava et al., "Renewable energy research progress in Mexico: A review," Renewable and Sustainable Energy Reviews, vol. 32. pp. 140-153, Apr. 2014. https://doi.org/10.1016/j.rser.2014.01.004

[21] A. Córdova, K. Navarro, M. Paniagua, and G. Reveles, "Evaluación de Capacidades de Generación de Energía Renovable en Ciudad Juárez, Chihuahua," Ciudad Juárez, 2010.

[22] M. J. Page et al., "The PRISMA 2020 statement: An updated guideline for reporting systematic reviews," International Journal of Surgery, vol. 88, Apr. 2021, https://doi.org/10.1016/j.ijsu.2021.105906

[23] N. R. Haddaway, M. J. Page, C. C. Pritchard, and L. A. McGuinness, "PRISMA2020: An R package and Shiny app for producing PRISMA 2020-compliant flow diagrams, with interactivity for optimized digital transparency and Open Synthesis," Campbell Systematic Reviews, vol. 18, no. 2, Jun. 2022. https://doi.org/10.1002/cl2.1230

[24] S. Akçaba and F. Eminer, "Sustainable energy planning for the aspiration to transition from fossil energy to renewable energy in Northern Cyprus," Heliyon, vol. 8, no. 6, Jun. 2022, https://doi.org/10.1016/j.heliyon.2022.e09813

[25] S. I. Salah, M. Eltaweel, and C. Abeykoon, "Towards a sustainable energy future for Egypt: A systematic review of renewable energy sources, technologies, challenges, and recommendations," Cleaner Engineering and Technology, vol. 8. Elsevier Ltd, Jun. 01, 2022. https://doi.org/10.1016/j.clet.2022.100497

[26] Ayuntamiento de Juárez, "Plan Municipal de Desarrollo 2021-2024," 2021. Accessed: Jul. 09, 2023. [Online]. Available: www.juarez.gob.mx/plan-municipal-de-desarrollo-2021-2024.pdf

[27] INEGI, "Directorio Estadístico Nacional de Unidades Económicas," Accessed: Aug. 23, 2023. [Online]. Available: https://www.inegi.org.mx/app/mapa/denue/default.aspx

[28] M. A. Butturi, F. Lolli, M. A. Sellitto, E. Balugani, R. Gamberini, and B. Rimini, "Renewable energy in eco-industrial parks and urban-industrial symbiosis: A literature review and a conceptual synthesis," Applied Energy, vol. 255. Elsevier Ltd, Dec. 01, 2019. https://doi.org/10.1016/j.apenergy.2019.113825

[29] A. Karaeva, E. Magaril, V. Torretta, P. Viotti, and E. C. Rada, "Public Attitude towards Nuclear and Renewable Energy as a Factor of Their Development in a Circular Economy Frame: Two Case Studies," Sustainability (Switzerland), vol. 14, no. 3, Feb. 2022, https://doi.org/10.3390/su14031283

[30] S. Ntanos, G. Kyriakopoulos, M. Chalikias, G. Arabatzis, and M. Skordoulis, "Public perceptions and willingness to pay for renewable energy: A case study from Greece," Sustainability (Switzerland), vol. 10, no. 3, Mar. 2018, https://doi.org/10.3390/su10030687

[31] Z. X. He, S. C. Xu, Q. Bin Li, and B. Zhao, "Factors that influence renewable energy technological innovation in China: A dynamic panel approach," Sustainability (Switzerland), vol. 10, no. 1, Jan. 2018, https://doi.org/10.3390/su10010124

[32] C. Xu, H. Zhou, and Y. Sun, "Research on the Development Characteristics of Green Energy Industry in Main Developed Countries," in E3S Web of Conferences, EDP Sciences, Oct. 2020. https://doi.org/10.1051/e3sconf/202019402020

[33] W. C. Huang, C. H. Jhong, and J. F. Ding, "Key factors influencing sustainable development of a green energy industry in Taiwan," Math Probl Eng,

ISSN: 2594-1925

vol. 2013, 2013, https://doi.org/10.1155/2013/791896

[34] OECD, "No net zero without SMEs: Exploring the key issues for greening SMEs and green entrepreneurship," OECD Library, 2021, https://doi.org/10.1787/bab63915-en

[35] M. L. Tseng, V. Ardaniah, R. Y. Sujanto, M. Fujii, and M. K. Lim, "Multicriteria assessment of renewable energy sources under uncertainty: Barriers to adoption," Technol Forecast Soc Change, vol. 171, Oct. 2021, https://doi.org/10.1016/j.techfore.2021.120937

[36] K. K. Shisara, N. Wijewardana, M. A. K. K. Shisara, and Y. N. S. Wijewardana, "Expertise Green Manufacturing Practices towards Sustainability Design and development of a pick and place mechanism for placing stickers on t-shirts View project Expertise Green Manufacturing Practices towards Sustainability," Journal of Technology and Value Addition, vol. 3, no. 1, pp. 31-44, 2021, [Online]. Available: https://www.researchgate.net/publication/355033478

[37] V. D'Angelo, F. Cappa, and E. Peuffo, "Green manufacturing for sustainable development: The positive effects of green activities, green investments, and non-green products on economic performance," Bus Strategy Environ, May 2022, https://doi.org/10.1002/bse.3226

[38] A. Kuś and D. Grego-Planer, "A model of innovation activity in small enterprises in the context of selected financial factors: The example of the renewable energy sector," Energies (Basel), vol. 14, no. 10, May 2021, https://doi.org/10.3390/en14102926

[39] S. Li and Y. Hu, "A Multi-Criteria Framework to Evaluate the Sustainability of Renewable Energy: A 2-Tuple Linguistic Grey Relation Model from the Perspective of the Prospect Theory," Sustainability (Switzerland), vol. 14, no. 8, Apr. 2022, https://doi.org/10.3390/su14084419

[40] M. L. Kamari, H. Isvand, and M. A. Nazari, "Applications of Multi-Criteria Decision-Making (MCDM) Methods in Renewable Energy Development: A Review," vol. 1, no. 1, pp. 47-54, 2020, https://doi.org/10.22044/RERA.2020.8541.1006.

[41] V. Dimić, M. Milošević, D. Milošević, and D. Stević, "Adjustable model of renewable energy projects for sustainable development: A case study of the Nišava District in Serbia," Sustainability (Switzerland), vol. 10, no. 3, Mar. 2018, https://doi.org/10.3390/su10030775

[42] Ş. E. Can Şener, J. L. Sharp, and A. Anctil, "Factors impacting diverging paths of renewable energy: A review," Renewable and Sustainable Energy Reviews, vol. 81. Elsevier Ltd, pp. 2335-2342, Jan. 01, 2018. https://doi.org/10.1016/j.rser.2017.06.042

[43] N. Fatima, Y. Li, M. Ahmad, G. Jabeen, and X. Li, "Factors influencing renewable energy generation development: a way to environmental sustainability", https://doi.org/10.1007/s11356-021-14256-z/

[44] H. Dzwigol, A. Kwilinski, O. Lyulyov, and T. Pimonenko, "The Role of Environmental Regulations, Renewable Energy, and Energy Efficiency in Finding the Path to Green Economic Growth," Energies (Basel), vol. 16, no. 7, Apr. 2023, https://doi.org/10.3390/en16073090

[45] S. A. Qadir, H. Al-Motairi, F. Tahir, and L. Al-Fagih, "Incentives and strategies for financing the renewable energy transition: A review," Energy Reports, vol. 7. Elsevier Ltd, pp. 3590-3606, Nov. 01, 2021. https://doi.org/10.1016/j.egyr.2021.06.041

[46] Z. A. Elum and A. S. Momodu, "Climate change mitigation and renewable energy for sustainable development in Nigeria: A discourse approach," Renewable and Sustainable Energy Reviews, vol. 76. Elsevier Ltd, pp. 72-80, 2017. https://doi.org/10.1016/j.rser.2017.03.040

[47] J. Polcyn, Y. Us, O. Lyulyov, T. Pimonenko, and A. Kwilinski, "Factors influencing the renewable

ISSN: 2594-1925

energy consumption in selected european countries," Energies (Basel), vol. 15, no. 1, Jan. 2022, https://doi.org/10.3390/en15010108

[48] J. A. Purwandani and G. Michaud, "What are the drivers and barriers for green business practice adoption for SMEs?," Environ Syst Decis, vol. 41, no. 4, pp. 577-593, Dec. 2021, https://doi.org/10.1007/s10669-021-09821-3

[49] OECD, "Financing SMEs and Entrepreneurs 2020: An OECD Scoreboard," 2020. [Online]. Available: https://www.oecd-ilibrary.org/sites/e9073a0f-en/index.html?itemId=/content/publication/e9073a0f-en

[50] C. G. Machado, M. P. Winroth, and E. H. D. Ribeiro da Silva, "Sustainable manufacturing in Industry 4.0: an emerging research agenda," Int J Prod Res, vol. 58, no. 5, pp. 1462-1484, Mar. 2020, https://doi.org/10.1080/00207543.2019.1652777

[51] Deloitte, "Sustainable manufacturing: From vision to action Contents." [Online]. Available: https://www.deloitte.com/content/dam/assets-shared/legacy/docs/industry/energy-resources-industrials/2022/gx-eri-sustainable-manufacturing-2021.pdf

[52] M. Matus Ruiz and J. Carrillo, "Las pymes intensivas en conocimiento de Ciudad Juárez: Diversidad de trayectorias, prácticas y entendimientos sobre la I4.0," Frontera norte, vol. 33, pp. 1-25, Sep. 2021, https://doi.org/10.33679/rfn.v1i1.2093

ISSN: 2594-1925